

RESEARCH REPORT

1. Name: Arthur Alaniz	(ID No.: SP09001)												
2. Current affiliation: Stanford University													
3. Research fields and specialties: <table style="width: 100%; border: none;"><tr><td style="width: 33%;">Humanities</td><td style="width: 33%;">Social Sciences</td><td style="width: 33%;">Mathematical and Physical Sciences</td></tr><tr><td>Chemistry</td><td style="border: 1px solid black;">Engineering Sciences</td><td>Biological Sciences</td></tr><tr><td>Agricultural Sciences</td><td colspan="2">Medical, Dental and Pharmaceutical Sciences</td></tr><tr><td colspan="3">Interdisciplinary and Frontier Sciences</td></tr></table>		Humanities	Social Sciences	Mathematical and Physical Sciences	Chemistry	Engineering Sciences	Biological Sciences	Agricultural Sciences	Medical, Dental and Pharmaceutical Sciences		Interdisciplinary and Frontier Sciences		
Humanities	Social Sciences	Mathematical and Physical Sciences											
Chemistry	Engineering Sciences	Biological Sciences											
Agricultural Sciences	Medical, Dental and Pharmaceutical Sciences												
Interdisciplinary and Frontier Sciences													
4. Host institution: University of the Ryukyus													
5. Host researcher: Professor Mohammad Reza Asharif													
6. Description of your current research <p>Because I am starting graduate studies at Stanford University this coming Fall, I haven't decided on a specific topic of research. But during my undergraduate studies at University of Southern California, I concentrated on digital signal processing. And, I will choose a topic of research closely related to digital signal processing.</p> <p>My senior project at University of Southern California was on blind source separation of audio sources. Using a digital signal processing board, our group was able to separate multiple sources in real-time / real-world.</p> <p>Last summer I attended a similar program to the JSPS summer program in Beijing, China. I was with a lab at Tsinghua University working on TDS-OFDM, a packet sending technique for digital television. I focused on writing / testing MATLAB scripts simulating packet identification, channel estimation, frequency offset estimation and signal timing error correction.</p> <p>At Stanford I would like to continue with digital signal processing. I will choose a research topic either in artificial intelligence or neural prosthetics.</p>													

7. Research implementation and results under the program

Title of your research plan:

EAPSI:Echo Cancellation in a Double-Talk Environment

Description of the research activities:

Learned various echo-cancellation techniques from Professor Asharif and his lab. Wrote MATLAB scripts simulating double-talk, echo-cancellation systems using various algorithms (LMS, NLMS, CLMS, FECLMS and FDCLMS). Programmed a digital signal processing board (Texas Instruments DSK 6713) to run LMS (Least Mean Squares) and NLMS (Normalized Least Mean Squares) algorithms in real-time. Developed a new algorithm, FDCLMS (Frequency Domain CLMS), based on the CLMS (Correlation Least Mean Squares) algorithm of Professor Asharif. Ran real-world, real-time tests using the DSK 6713 and FDCLMS algorithm. Held presentations on how to use the DSK 6713 in order to teach PhD students of Professor Asharif's lab about digital signal processing boards.

8. Please add your comments (if any):

Originally my intention was to implement earlier algorithms in the real world, but due to calculation speed limitations it proved to be too difficult. With all other algorithms but FDCLMS, I used simulated echoes. Only the FDCLMS algorithm, with its greatly improved speed, was able to run successfully in the real-world.

9. Advisor's remarks (if any):

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1. Name: Daniel J. Arenas	(ID No.: SP09002)
2. Current affiliation: University of Florida	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Osaka University	
5. Host researcher: Professor Seiji Takeda	
6. Description of your current research <p>Before joining this program, my work focused on the optical studies of nanostructures, such as periodic hole-arrays. These arrays exhibit enhanced transmission (ET) at resonant wavelengths. In this effect, the energy transmitted through the array at resonant wavelengths surpasses the open area fraction, f, of the arrays (a value much higher than the value predicted by diffraction optics). These nanostructures have suggested many exciting applications due to the theoretical prediction that light gets trapped in these structures for characteristic lifetimes. This prediction has suggested application in the temporal manipulation of light, all-optical switching and nonlinear optics. In our work, we presented reflectance and transmittance measurements for various periodic hole arrays with resonant wavelengths across the NIR and MIR region. The newly available reflectance measurements allowed the calculation of absorption and the ohmic losses of the incident electromagnetic field. The results were compared to available computational results relevant to the temporal trapping of the fields and the data showed agreements. The second part of the project focused on femtosecond measurements of periodic hole arrays. These studies are aimed to test theoretical predictions of light getting temporarily trapped inside these 2D structures.</p>	

7. Research implementation and results under the program

Title of your research plan:

Fabrication and Optical Studies of Nanostructures

Description of the research activities:

The first purpose of this research was to learn more about the fabrication and characterization of nanostructures. Several nanostructures were grown via vapor deposition methods. SiC nanowires were grown from a Si substrate with a thin layer of a metal catalyst, and the sample was heated up to various temperatures and exposed to a gas containing carbon. The nanowires grow from the well known vapor-liquid-solid process (VLS) where supersaturation allows for the growth of the nanowires after cooldown. The growth of nanowires was very sensitive to the growth conditions (i.e. gas pressure, gas exposure time, and temperature), and a great part of the research was spent optimizing these conditions by growing multiple films. The remaining part of the research involved the characterization of these nanostructures by using a Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM).

The results yielded very interesting nanowires. The TEM images and elemental analysis by x-ray suggested that the bulk of the nanowires is composed of Silicon Carbide but that the surface of the nanowires are mostly thin layers of carbon. The results suggest that these SiC nanowires are wrapped by carbon fibers, or possibly a multi-walled carbon nanotube.

The second purpose of this research was to construct nanostructures that I could later take to my optics lab and perform optical studies on. We now have many different samples for various growth conditions and characterized by SEM. The SiC nanowires with the carbon surface were also characterized by TEM, electron diffraction and energy-dispersive x-ray (EDX) analysis. We expect that optical studies by infrared spectroscopy and Raman spectroscopy may provide additional information about these structures. More specifically, Raman spectroscopy may provide information about the vibrational modes of the carbon layers surrounding the SiC nanowires.

The third purpose of this project was to setup a long lasting collaboration. We have discussed future projects where researchers at Takeda Lab will grow new samples, characterize them by SEM and TEM, and send them to my lab in America for optical

studies.

8. Please add your comments (if any):

I am very happy with the outcome of this program. Although the nanostructures we studied were different from the ones originally suggested, this project yielded results in a very short period of time. I was able to learn a great deal in the fabrication and characterization of nanostructures. I was able to fabricate them and characterize them myself and now I can take these samples to America and continue the project by performing optical studies.

At last, but not least, I feel I have made some wonderful friends from the students in Takeda Lab and gained some amazing mentors in Professor Takeda and Associate Professor Hideo Kohno. We are planning to continue a long lasting collaboration.

Thank you, JSPS, for this amazing opportunity.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Annemarie Baltay	(ID No.: SP09003)
2. Current affiliation:	PhD Candidate Department of Geophysics Stanford University, Stanford, CA 93305
3. Research fields and specialties:	Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution:	University of Tokyo, Hongo Campus
5. Host researcher:	Dr. Satoshi Ide
6. Description of your current research	<p>My current PhD research addresses the controversy surrounding energy scaling of earthquakes. The question of whether or not earthquakes, as they increase in size, radiate seismic waves more efficiently is at the core of our understanding the physics of faulting as well as our ability to anticipate and mitigate the effects of strong shaking.</p> <p>Currently, we cannot predict when or where the next large, destructive earthquake will occur, but we can make statistical estimates of what the ground shaking will be across an area, due to the potential earthquakes. This hypothetical ground motion is estimated by scaling up existing measurements from ubiquitous smaller and moderate sized earthquakes. However, we must understand if this linear relationship between smaller and large earthquakes holds.</p> <p>One way to understand this scaling relationship is through radiated seismic energy, the energy that leaves an earthquake, radiates through the earth, and arrives at a station. Scaled energy is the ratio of the radiated energy to the moment, also known as apparent stress. If larger earthquakes are indeed more efficiently radiating energy, then they will exhibit a higher apparent stress.</p> <p>Many studies indicate that apparent stress increases with seismic moment, while others imply it does not, which would indicate self-similarity of earthquakes across many orders of magnitude. The on-going controversy in the sub-field on energy scaling may possibly be due to the difficulty in estimating scaled energy. While moment, from which the magnitude is derived, is easy to measure, radiated energy is difficult to accurately estimate because the waves are strongly affected—attenuated, scattered and amplified—by the complex geology of the Earth, before arriving at the station. These effects must be corrected for, so that measurements truly reflect the source.</p> <p>My method corrects for path and site effects by using an empirical Green's function (eGf) correction technique to estimate radiated energy from the coda. The seismic coda refers to the scattered waves that continue to arrive long after waves taking the fastest path</p>

from an earthquake have arrived. I take advantage of the time averaging properties of the coda by creating spectra from the coda decay level over a time interval following the S-wave arrival. Co-located events recorded at a single station are compared, assuming that they all have the same path and receiver term and thus only the source term remains. The smallest event is used as the eGf, and its signal is deconvolved from the larger events in the spectral domain, creating source spectra. Radiated energy is defined as the integral of the source velocity spectra over all frequencies, so the measured spectra must be extrapolated to high and low frequencies, then integrated.

I have used this methodology for four data sets in the western United States. Energy estimates from these three data sets indicate stress drops around 1 MPa, consistent with many other studies. The average scaled energy for most of the events falls between 10^{-5} and 10^{-4} , very similar to other studies, which find a representative value of 3×10^{-5} . I find no conclusive evidence for variations in scaled energy, but the number and size of earthquakes is limited. California simply does not have enough recordings of large earthquakes, and the quality of the recordings we do have does not allow analysis of events smaller than magnitude 3.

7. Research implementation and results under the program

Title of your research plan:

Scaled radiated energy in Japan earthquakes estimated from the seismic coda

Description of the research activities:

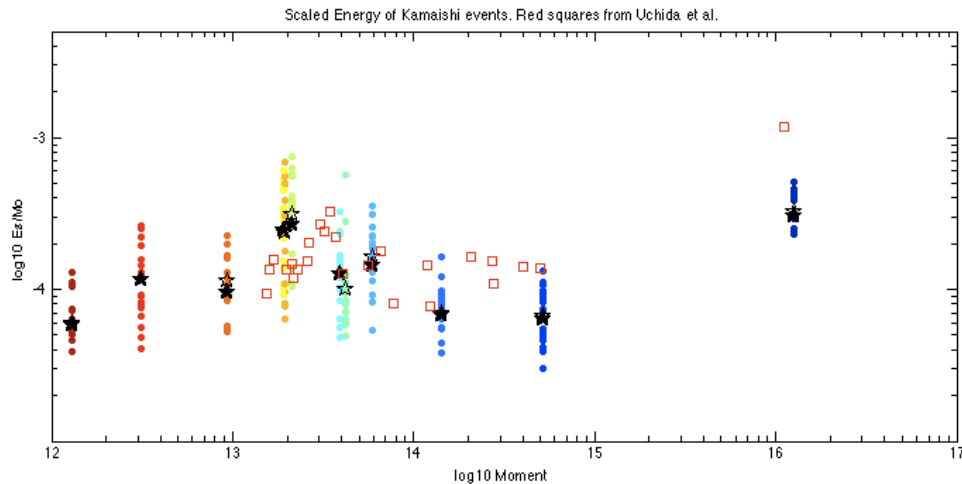
The goal of my research for the summer was to extend the measurements of scaled seismic energy made in the US to sites in Japan. Due to the extensive seismic network in Japan and the plethora of earthquake activity, it is the perfect natural laboratory for earthquake studies. The instrumentation in Japan allows measurements over a much larger magnitude range than possible in California, aiding in the resolution of the energy scaling controversy.

This summer, I acquired seismic data from the NIED (National Research Institute for Earth Science and Disaster Prevention) networks, including Hi-Net, a hi-sensitivity broadband network, and K-Net, a network of accelerometers. I chose three areas in the Tohoku region of Honshu to analyze: Kamaishi, Iwate-Miyage, and Mid-Niigata.

The Kamaishi events are off-shore earthquakes that repeat about every 8 years, with many smaller events in the meantime. The largest event is magnitude 4.7, and the last one occurred in 2008. My analysis of these events shows the apparent stress to be higher than the average global values. As well, the largest event has an apparent stress higher than the intermediate events, but there does not seem to be an obvious trend. Another study, by *Uchida et al.* [2005], looked at many of the same events, and our results are similar. This comparison validates my method further. For this data set, I was able to use Hi-Net data exclusively, and the lab in which I was working has a direct setup to access and preprocess this data. In the figure below, the average scaled energy for each event is shown by a black star, while individual measurements from each station are shown in colored dots. The estimates made by *Uchida et al.* [2005] are shown with red squares.

As the summer is always shorter than anticipated, I am still in the midst of apparent stress calculations for the Iwate-Miyage events and Mid-Niigata events. The 2008

magnitude 7.2 Iwate-Miyage mainshock occurred in the middle of the Tohoku region, on the Iwate-Miyage border. The 2004 Mid-Niigata maishock had a magnitude of 6.8 and occurred on the west side of Tohoku. Because these events are larger than the aforementioned Kamaishi earthquakes, use of the Kik-Net accelerometer network was necessary. This added some data-acquisition challenges, as the format is different than for the Hi-Net data. I acquired a data set for both of these areas, however, and the analysis will be finished in the fall when I return to my home institution.



As well as analysis of new data, I spent time this summer refining the method and making some steps more robust and removing any human interaction. Due to the regularity of the Japanese data and networks, it may be possible to automate my entire method to run on any events in Japan. This scale of analysis would greatly aid in the determination of global apparent stress. Throughout the summer, through discussion with my hose adviser, we developed a more rigorous mathematical and theoretical backbone to the methodology. This may aid in the understanding of some side results. More work will be done here, but it is possible that we can determine magnitude of small earthquakes independently through this method. As well, we can measure a site effect that varies from station to station, and expansion of the analysis to all of Japan would create a potentially useful site map, to further understand the interaction of seismic waves through the crust.

8. Please add your comments (if any):

The Japan Society for the Promotion of Science Summer Program is great. All summer I felt that I had support of a family, JSPS, behind me, should anything go wrong. Researchers with whom I visited were always impressed that I was with JSPS, and it seemed to be an asset for networking. As well, the initial orientation was really great to get me accustomed to Japanese language and culture, and I felt right at home when I arrived in Tokyo. My host researcher here was also very aware of the program, which made it easy when arranging logistics and financial aspects.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Tracy Becker (ID No.: SP09004)
2. Current affiliation: University of California at Berkeley
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Disaster Prevention Research Institute, Kyoto University
5. Host researcher: Professor Masayoshi Nakashima
6. Description of your current research <p>Structural isolation, a method of “decoupling” ground and structural movement in earthquakes, consists of putting a flexible layer typically between the building and its foundation. Isolation works in two ways; it increases the period of the building, decreasing the energy input from the earthquake and concentrates the displacement in the isolation layer, limiting the damage due to Interstory drifts. Isolated buildings in Japan number in the thousands while the number in the U.S. remains around one hundred. Unlike its use in Japan, isolation technology in the U.S. has remained within mainly essential, public buildings such as hospitals, city halls or 911 centers. The technology has not spread to use in typical office or residential buildings, which may also see increased safety and performance benefits.</p> <p>My research at UC Berkeley is focused on increasing the use of structural isolation in the U.S. To help know what topics to focus on, it is beneficial to evaluate the differences in Japanese and US research and design processes for structural isolation as well as overall opinions and concerns about structural isolation. This may offer insight into the disparity of isolation use in the two countries and aid in promoting isolation in the US. I will try to distinguish reservations or difficulties in the U.S. design process and utilize the Japanese practice to explore solutions.</p> <p>At UC Berkeley I am focused on applying performance based design to structural isolation. Performance based design is seen as the major selling point of structural isolation in the U.S. Specifically I am researching triple friction pendulum (TFP) bearing behavior and the effects of super-structure yielding on isolated building performance during rare earthquakes. TFP bearings are not yet used in Japan while super-structure yielding is not allowed in either country. I have been able to discuss my home research at length with my host advisor as well as Japanese professional engineers and receive feedback for practical implementation.</p>
7. Research implementation and results under the program

Title of your research plan:

Comparison of US and Japanese Isolation Design Practices

Description of the research activities:

Site, Office and Research Complex Visits

During my stay in Japan I had the opportunity to visit with professional engineers with structural isolation experience from three major Japanese firms and one global firm with a Japan office. I also meet with the head of the Japanese Society of Seismic Isolation. I went on three site visits to isolated buildings, one of which was still under construction, and visited 2 research complexes.

I learned a significant amount from these visits, not only about the Japanese isolation practices but also about the attitude of Japanese designers towards isolation. A limited summary of observations is provided below.

Peer Review Process

One of the main reasons structural isolation has flourished in Japan is that there was already a streamlined peer review process for isolated buildings before the Kobe earthquake catalyst occurred. In Japan the majority of isolated buildings are peer reviewed with the same review guidelines that have existed since the 1970's for tall buildings. Recently Japan has introduced linear design methods for a very limited number of isolation applications. In the U.S. all isolated building must be peer reviewed.

Unlike in the U.S. where the peer review process vary project by project and can take 3 months to more than a year, the Japan process is standardized and typically take on the order of a month to a month and a half. In Japan the designers initially give a presentation to a review board and do questions and answers. Afterwards two members of the review board are assigned to thoroughly review the project. Once satisfied with the design they report back to the board, which approves the design.

In the U.S. there are disagreements about the scope of the peer review and what authority the reviewers have. Adopting a process similar the Japanese peer review would greatly cut down on time and money in the design and review process.

Design Ground Motions

In both Japan and the U.S. nonlinear analysis is required for isolated building design. In the U.S. a geotechnical engineer must be hired to come up of a list of site-specific ground motions for use in the analysis. The geotechnical peer review must then review these motions. The U.S. uses the average response from seven ground motions or the maximum response from three ground motions for design values. The majority of designers go with the average form seven.

In contrast, tall or isolated buildings in Japan are always subjected to the same three earthquakes or the "golden set." In addition, one or two site-specific ground motions are used. These site-specific motions can be reused for different projects in the same area.

Granted, Japan is a much smaller country than the U.S., but if each major area (i.e. San Francisco Bay Area, Los Angeles Metropolitan Area, Washington State) had its own

set of ground motions to be used for each building there would be significant decrease in design cost from geotechnical fees.

Isolation Device Approval

In the U.S. isolation devices are approved for use on a case-by-case basis. The designer comes up with testing procedures for the isolation bearings used in the building and the owner pays for these tests. However, in Japan each bearing manufacturing company has a catalogue of pre-approved devices. This cuts down on testing costs as well as design costs.

Isolation and Damping Devices

One difference between Japanese and America isolation design is in the technology used. Japan relies, almost entirely, on rubber bearings, sometimes with the additional use of flat sliders. Rubber bearings include both natural rubber bearings and high damping rubber bearings; lead core rubber bearings are rarely used in current design. Natural rubber bearings are most often used because the isolation period and damping ratio can then be selected independently.

In the U.S. both rubber and friction pendulum bearings are used, and both systems competitively bid on projects. Japanese designers appear to be interested in the use of triple pendulum bearings; however, this technology has not been used in any peer-reviewed building. One reason that friction pendulum bearings are not in use in Japan may be that there is no approved catalogue for this technology.

Damping devices used in American isolated buildings are predominantly viscous dampers. However, Japan commonly uses hysteretic dampers. Extruded lead dampers are no longer used; however, helical or U-shaped steel dampers are very common. The reasoning behind the use of hysteretic dampers is that viscous dampers are not activated at small velocities, such as in windstorms. If damping is required at these low force levels then hysteretic dampers are employed.

Conclusion

There are many topics on which U.S. and Japan design differ. Furthermore, culture has a large affect on the design philosophies. However, by understanding how design practices vary and the pro's and con's of each side, we can improve our overall practice and increase the use of isolation as a protective system in our buildings.

8. Advisor's remarks (if any):

I am truly impressed with Tracy Becker for her enthusiasm about research, in particular her continuing quest to satisfy her curiosities. I wish that the pieces of information she has collected in Japan would be of help in the accomplishment of her graduate study. During her stay in Kyoto University, she has integrated herself so elegantly into our group and created many new friendships with other students. Such friendships shall be a source to enrich both the professional and private life of her for many years to come. I wish to congratulate Tracy on her great achievement for the past two months.

Masayoshi Nakashima, Professor of Kyoto University

RESEARCH REPORT

1. Name: Zachary Beckstead	(ID No.: SP09005)
2. Current affiliation: Clark University, Worcester, MA USA	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Ritsumeikan University, Kyoto	
5. Host researcher: Professor Tatsuya Sato	
6. Description of your current research <p>The main question that I have been exploring is the relationship between people and culture. More particularly, I am concerned with the impact of places or our surroundings on psychological functions and the meaning making processes. How do people both shape and come to be shaped by their environments? How can we conceive of this relationship and which methods are most appropriate for investigating the interaction between people and their worlds? The discussion of the relationship and co-construction of person and culture is not new, but had generally been neglected in psychology. Within the last few decades, the field of cultural psychology has developed offering rich conceptual frameworks that link people and higher levels of organization (e.g., groups, society, etc) and interplay between both. The most promising theoretical outlooks posit people and society as inclusively separated. This allows for us to study ‘culture’ at the level of social organizations and ‘culture’ in the minds of people. The issue of how people draw on meanings from their socio-cultural environment and how the socio-cultural environment provides guidance is of central relevance. What has received less attention is how material objects that human beings construct and utilize become imbued with both social and <i>personal</i> significance and how this factors into the processes of the internalization of values and beliefs.</p> <p>My research seeks to address the mutual construction of people and their worlds through focus of pilgrimages and visits to temples and shrines. Through the material organization of pilgrimage centers and other symbolic sites, social institutions and collective meaning systems can encode systems of thought or ideas. These may be ignored and blocked, transformed and modified by the active meaning-seeking individual. However, the material does more than simply represent abstract concepts. Thus the material and sensual surroundings are settings for people to relate to the holistic structure through multi-sensorial engagement and derive generalized meanings from. How a place is organized and how visitors are guided through the immediate environment, I suggest, not simply designed for the transmission of knowledge of cultural values and ideas, but rather intended to heighten emotional resonance the escalation of feeling. It is through the approach and ritual actions that feeling is generated and meanings elaborated. Temples and shrines are not rigidly structured, however, and attention should be paid to the experience of people visiting ‘sacred sites’ in order to understand the mutual construction of people and their worlds.</p>	

7. Research implementation and results under the program

Title of your research plan: Cultural Maps: Charting the Relationship between Materiality and Psychological Functioning

Description of the research activities:

The first phase of my research in Kyoto included rigorous field observations of the organization and layout (e.g., paths, organization of buildings, signs etc.), the activities of the visitors to these sites, and included formal and informal interviews with mainly local Kyoto residents. Due to the abundance of temples and shrines in Kyoto (and Japan in general), it was impossible to make detailed observations at numerous locations. I took notes of the similarities and differences of temples and shrines of many shrines at first, but quickly focused on Ninnaji and Kenkun Jinja due to their central location to my host university and their particular qualities (i.e., Ninnaji had many neighborhood visitors as well as sightseers). The thesis of my current research has been the organization of the place affords heightened emotions and feelings for visitors. How visitors approached—by foot, car, train and bus—various signs and structures, and the paths were each organized. Next, I focused on the material construction of the buildings and focused on what the structures *do* to people--instead representing abstract social values—through constraining and affording movements. This approach considered the cultural semiotic devices that were encoded into the environment in order to facilitate the escalation of feeling and transformation of a visit or into a moving experience.

Additionally, I collaborated with the research lab at Ristumeikan University to assess the internalized feeling and elaboration of meaning concerning visits to temples and shrines. This research study was comprised of three separate but interrelated parts that roughly correspond to pre-test, central test, and post-test. This study did not follow the logic of traditional experimental science, i.e., prediction and control, independent and dependent variables. Instead, it was what we might label phenomenological experimentation. The focus of the experiment was not on meaning as an outcome, but rather the process and elaboration of meaning in real time. The participants in this study consisted of members in a naturally occurring groups of friends at Ritsumeikan University. Since we were concerned with both the collective or joint experience and meaning-making and the trajectories of individual meaning making, we decided to use a group of friends with separate and interweaving histories and relationships to add a more natural dimension to the study (i.e., friends often visit shrines and temples together). Participants for this study and were female between 19 and 22.

The first or pre-test consisted of an open-ended interview and three tasks to gain insight into the life history of the participants, particularly in regards to temple/shrine visits. Participants were asked to bring in photos of important objects/locations that were personally important or significant to their self. We were interested in investigating whether participants brought shrine-like objects into their home. Second, we asked the participants to recall the last time they visited a temple or shrine. They were asked to draw a map of the temple or shrine to help their memory and additionally questions such as “*when did this visit occur? Who did you go with? Please describe in as much detail as possible what you remember feeling and thinking*” were included. Additional and unique questions emerged from this task that allowed us to get a better sense of the role temples/shrines and visits to these played in their life. We also asked participants to reflect on a visit that stood out as specifically important or significant. The same instructions as with the last visit to a temple/shrine were given. Finally, a sequence of photos taken from the approach/entrance to a temple were presented on a computer screen one after another. These photos included four photos of inappropriate actions of individuals at the temple. Participants were asked to describe their feelings by typing it into another computer. This was undertaken to see if the participants reacted affectively to the inappropriate photos. Again, these tasks and questions were intended to a) gain personal context into the history of the participants’ visits to shrines and b) test internalized feelings about

shrines/temples at boundary conditions.

The second part of this research included taking the group to visit Kenkun Jinja shrine in Kyoto. This part of the project was an extension of one of the author's previous research in the United States at the Massachusetts War Memorial. The participants were asked to enter and move around together—exploring, taking photos, or whatever they normally would do at a shrine or temple—and to then return to the entrance when finished. One researcher followed the group with a video camera to record their movement and actions. A member of the group was also given a digital recorder to capture any dialogue between the group members that the video missed. The group had visited temples and shrines before—along and as members of groups—and so little instruction was needed of 'how to' proceed. The emphasis was on visiting the shrine as naturally as possible and we emphasized that the participants could take photos, wander around, and do anything they would do at a typical visit. Of course the purpose for this visit differed from more spontaneous or group-planned visits and must be taken into account of in the analysis. However, going as a group of friends and doing typical activities brings the visit closer to normal experience for the participants.

Finally, we were interested in the exploring personal sense making processes and individual trajectories in coordination with the collective or group. We expected the group have similar experiences but to also break into individual experiencing. Video of the groups' visit was presented to each participant individually shortly after their visit. The visit lasted nearly forty minutes; however, participants were only shown the first twenty-three minutes due to time constraints. This portion of their short trip included their arrival to the main hall of the shrine at the top of the hill and offered us a sufficient time-span in which to investigate the personal relating of the participants to the material, symbolic, and social structures of the shrine and each other and personal meaning construction. Participants were asked to say "stop" or begin typing when they saw or recalled something that left an impression of feeling] and thought and immediately write this down. We kept track of the correspondence between place of shrine and utterance. Participants were also asked a few follow-up questions regarding their overall-experience and future plans for visiting a temple. Taken together, the group visit and individual post-interviews allowed us to examine both convergences and divergences of experiences between friends and intra-psychologically as well. Also, we were able to observe the development in-real-time of feeling and meaning that reached the level we might label sacred or spiritual. All data will be transcribed and translated into English and then analyzed in the fall.

RESEARCH REPORT

1. Name: Sean Bird	(ID No.: SP09006)
2. Current affiliation: Indiana University	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences <u>Chemistry</u> Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: National Institute Advanced Industrial Science and Technology	
5. Host researcher: Dr. Hideo Tokuhsa	
6. Description of your current research <p>We are interested in the selective properties of natural pores found in eukaryotic cells. We are also interested in mimicking this selectivity <i>in vitro</i>. Specifically, we are investigating how genetic material and certain proteins are able to travel in and out of the cell nucleus. Moreover, we are interested in how the conduit responsible for this transport, the nuclear pore complex (NPC) governs this highly specific transport. Thus, we are currently developing a means for measuring the physical properties of specific protein-protein interactions involved in nucleocytoplasmic transport. Nsp1, a protein extending from the inner walls of the NPC, and Impβ, a chaperone protein responsible for shuttling proteins through the NPC and into the nucleus, are the two proteins we are currently focused on. Specifically, we are interested in determining the strength of the interaction between these two proteins by calculating the equilibrium coefficient. This is determined by measuring the ratio of the concentration of the bound complex in solution versus the product of concentrations of the free proteins in solution. Or, the rate of the association versus the rate of disassociation.</p> <p>The reason we are interested in this physical property is because we feel that it may be a possible indicator of how mutations Nsp1 will interact with Impβ. Currently, we are able to form a hydrogel made entirely of Nsp1 and a buffered solution. This hydrogel is interesting to us in the fact that, when put into a solution containing Impβ, in addition to many other proteins, only Impβ will diffuse into the Nsp1 hydrogel. Thus, the Nsp1 hydrogel acts as a sort of <i>in vitro</i> NPC. Although, we wonder, by changing the composition of the protein, can we change the degree of the specificity?</p> <p>In order to test the specificity of the hydrogel, a large amount of material is needed. Therefore, the ability to predict the specificity would be a great advantage. One way of</p>	

doing may be measuring the binding strength between the Nsp1, or a mutant of Nsp1, and Imp β . One way of making this measurement while keeping the material used is by surface plasmon resonance (SPR). In SPR, a protein is immobilized onto a gold surface and a laser is shined on the back of the surface at an angle that causes the laser light to resonate with the electrons on the gold, thus creating a plasmon. Any changes on the other side of the gold will change the angle of resonance. This change in the resonance angle, and in our case, the rate of change in this angle is what is measured. The change in the resonance angle is a result of flowing another protein - Imp β in our case – over the immobilized Nsp1. Therefore, the rate of association is measured. Then, a buffered solution is flowed over the complex and the rate of dissociation is measured. Therefore, we can measure the equilibrium constant by means mentioned earlier.

7. Research implementation and results under the program

In order to perform the proposed experiment, it was first necessary to be able to prove that Nsp1 was indeed immobilized on the gold surface. To do this, the necessary chemical reactions were performed and the substrate was analyzed by Fourier transform infrared reflection-absorption (FTIR-RAS) spectroscopy. Evidence of protein binding, rather than physical adsorption, was observed during this project.

Next, gold substrates suitable for SPR analysis were prepared using an established method. The substrates were then modified with Nsp1 using the SPR instrument. This step provided further evidence that the gold had been successfully modified with Nsp1. Various concentrations of Imp β were then flowed over the Nsp1-modified gold in order to obtain the rate of association between the two proteins. The rate of dissociation was then determined, which allowed us to calculate the equilibrium constant.

Title of your research plan:

Utilization of Surface Plasmon Resonance to Investigate Binding Between Nucleoporins and Nuclear Transport Receptors

Description of the research activities:

Research activities consisted of developing a method for Nsp1 immobilization on a gold surface, obtaining experimental evidence to show that Nsp1 had been immobilized, and determining the equilibrium constant for Imp β -Nsp1.

8. Please add your comments (if any): This was a great experience all around.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Hayden T. Black	(ID No.: SP09007)
2. Current affiliation: University of North Carolina at Chapel Hill	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences <input checked="" type="checkbox"/> Chemistry <input checked="" type="checkbox"/> Engineering Sciences <input checked="" type="checkbox"/> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: University of Tokyo	
5. Host researcher: Dr. Kazunori Kataoka	
6. Description of your current research <p>My research focuses on the synthesis of functional polymers for gene delivery applications. The study of gene delivery is concerned with the development of methods for delivering DNA to cells, a process that could ultimately provide a new therapy for treating disease. The complexity of the human body requires a “delivery vector” which can serve to protect and deliver DNA to a desired cell line. Polymeric materials have emerged as an important class of gene delivery vectors due to their wide range of chemical and biophysical characteristics. Gene delivery can often be enhanced by conjugating biochemical moieties to the delivery vector, for example compounds which can promote cellular uptake and or trafficking of the DNA to the nucleus. In this regard it is necessary to develop polymers that are capable of straight forward functionalization. Much of my previous research at UNC was directed towards the synthesis of functional polyethers, a class of polymers which often exhibit very low toxicity. In particular polyethylene glycol (PEG) is a polyether that has become widespread in the field of biomaterials due to its good solubility in water as well as its low toxicity. My research at UNC was focused primarily on the synthesis of PEG derivatives that contain side chain functionality as a platform for functional, non-toxic biomaterials.</p>	

7. Research implementation and results under the program

Title of your research plan:

Surface Functionalized Micelles for Efficient Gene Delivery

Description of the research activities:

Work in the Kataoka lab at The University of Tokyo has focused on the use of block copolymer micelles as gene delivery vectors. These materials are comprised of a cationic polymer block, capable of binding DNA, and a water soluble PEG block which helps to reduce the toxicity and increase the solubility of the complex. My research for the summer focused on the synthesis of a diblock copolymer, functionalized on the PEG terminus with an alkyne (triple bond). The alkyne functionalized polymer is capable of reacting with azides in a commonly utilized reaction termed “click chemistry”.

Therefore, the goal of my research was to prepare a block copolymer with alkyne functionality for the straightforward functionalization of the micelles. In addition, using click chemistry I set out to conjugate dexamethasone to the polymer, a steroid which has been shown to dilate the nuclear pores and aid in the nuclear import of DNA. The steroid functionalized polymers could then be studied as functional materials for gene delivery.

The work entailed in my research involved both the synthesis of an azido analog of dexamethasone along with an alkyne functionalized diblock copolymer. In addition, an azido analog of cholesterol was also desired. Cholesterol functionalized micelles provide an appropriate control for the study of dexamethasone functionalized micelles, as the two are structurally related and may exhibit similar modes of cellular uptake.

The dexamethasone-azide compound was first synthesized by reaction of dexamethasone-mesylate with sodium azide. After purification by column chromatography the pure azide compound was obtained. Next the cholesterol-azide was synthesized by reaction of cholesteryl chloroformate with an azido amine (11-Azido-3,6,9-trioxaundecan-1-amine). Purification using column chromatography afforded the pure cholesteryl-azide compound.

The synthesis of the alkyne functionalized copolymer was achieved by first synthesizing an alkyne-PEG-NH₂ macroinitiator, used for the ring opening polymerization of the second block. The macroinitiator was synthesized by reaction of PEG diamine with 4-pentynoic acid using typical coupling reagents. The mixture of polymer products was then purified using preparatory ion-exchange chromatography. Once purified the macroinitiator was used for ring opening polymerization to afford the alkyne functionalized diblock copolymer.

8. Please add your comments (if any):

While in Japan I have also gained insights into new ways of organizing a group who share common research goals. The group that I worked with in Japan was much larger (≈ 60 members) than the group I work with at home in the U.S., and had a defined structure which maximized their output. It was very interesting to see such large groups of people working closely and effectively together to achieve important research results.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Ryan Blair	(ID No.: SP09008)	
2. Current affiliation: University of California, Santa Barbara		
3. Research fields and specialties:		
Humanities	Social Sciences	Mathematical and Physical Sciences
Chemistry	Engineering Sciences	Biological Sciences
Agricultural Sciences	Medical, Dental and Pharmaceutical Sciences	
Interdisciplinary and Frontier Sciences		
4. Host institution: Nara Women's University		
5. Host researcher: Tsuyoshi Kobayashi		
6. Description of your current research: Take a piece of string, tie a knot in it, and glue the ends together. The result is a knotted circle living in 3-space. This is what mathematicians call a knot. Two knots are equivalent if one can be stretched, tangled and untangled to coincide exactly with the other. However, cutting and gluing are not allowed. Knot theory is the mathematical study of knots and is contained in the broader mathematical field of Topology. Topology is the study of the global properties of spaces. The study of knots is of fundamental importance in Topology since it can be shown that every nicely behaved 3-dimensional space can be obtained by "filling" a knot. Hence, studying 3-dimensional spaces can be reduced to studying knots and their fillings. One historically very successful way of studying knots is to break them up into simpler pieces and relate the properties of the pieces to the properties of the whole knot. A connected sum is a type of knot that can be decomposed into two simpler knots, known as summands. A tangle product is a type of knot that can be decomposed into simpler pieces, known as essential tangles. Tangle product is a natural generalization of connected sum. A maximum of a knot is a point on the knot that is higher than all other near-by points. After stretching and untangling, what is the fewest number of maxima necessary to make a specific knot? The answer is an integer known as the bridge number of the knot. Width is a related integer that is inspired by the bridge number and has played an important role in the field of Topology. Width takes into account not only how many maxima, but also their relative positions. The behavior of bridge number under connect sum is well known, however, the behavior of width under tangle product is still a mystery. My research investigates the interconnections between the four concepts of connect sum, tangle product, bridge number and width.		

7. Research implementation and results under the program

Title of your research plan: Bridge Position for Links and Essential Surfaces

Description of the research activities: Progress was made on several projects including the primary project outlined in my research proposal.

The primary project was to extend known results relating bridge number and Conway products to the more general setting of tangle products. I began the program with a conjecture relating bridge number of a tangle product to the bridge number of its essential tangle pieces. A modified version of the conjecture was proven true during my stay in Nara. A proof of this conjecture is now being written down to be submitted to an academic journal.

Significant progress was also made in understanding how width of a connected sum relates to width of the summands by using results of Heath and Kobayashi. We hope to give a large class of examples for which width is not additive. This is an exciting and ambitious project that will continue to be investigated past the end date of the program.

8. Please add your comments (if any): I would like to thank all of the mathematicians I met at Nara Women's University for their many helpful insights and warm hospitality. I would like to especially thank Kobayashi-sensei for his patience and great insights, without which the above progress would not have been possible.

9. Advisor's remarks (if any): Mr. Blair's contribution to our math department was enormous in many senses. In the mathematical research aspect, I could have very fruitful times with him. The research is still in progress and will last after his return to the U.S. Another aspect that I would like to emphasize is his contributions to the international understanding, particularly to my students. He gave many talks on knot theory for my students and he tried to have good communication with them. This had to be a very good experience for them. I am very glad to have been able to have him as our guest.

RESEARCH REPORT

1. Name: Layla Goli Booshehri (ID No.: SP09009)
2. Current affiliation: Rice University
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Tohoku University
5. Host researcher: Dr. Go Yusa
6. Description of your current research <p>Single-walled carbon nanotubes (SWNTs) possess highly unusual electronic and optical properties, making them objects of great interest for basic scientific studies as well as potential applications. However, one unresolved issue with SWNTs is their puzzlingly low photoluminescence quantum yield (or quantum efficiency), where a large majority of photo-created electron-hole pairs decay non-radiatively without emitting photons. This is a critical issue that has to be resolved before SWNTs can be used for optoelectronic devices, and many possibilities have been suggested as the origin of the low quantum yield. In particular, optically inactive (“dark”) excitonic states are predicted to exist below the first bright exciton state and can trap the majority of the exciton population at low temperature. To investigate such a possibility, temperature and magnetic field dependent photoluminescence measurements of SWNT thin films at mK temperatures were performed at Tohoku University.</p>

7. Research implementation and results under the program

Title of your research plan:

Magneto-Photoluminescence of Carbon Nanotubes at Ultralow Temperatures.

Description of the research activities:

In photoluminescence spectroscopy, the SWNT sample is mounted and illuminated with a bright lamp or laser tuned to be resonant with an interband transition of the specific-chirality nanotubes of interest. The photoluminescence is emitted in all directions, and a portion is collected with a set of lenses and focused onto the entrance slit of a spectrometer, where the spectrum is recorded by scanning the grating. The photoluminescence is then detected with sensitive detectors. For this study, a 670nm laser is used to be resonant with (8,3) chirality nanotube and a Si CCD 2D array detector is used for detection. For low temperature, magneto photoluminescence, Dr. Yusa's dilution refrigerator is continuous cycle and can approach below 20 mK, while the superconducting magnet can reach 8 Tesla. It is equipped with a unique optic fiber system, which allows one to perform optical experiments at mK temperatures. Thus, this unique system provides a 20 mK, 8 Tesla environment for magneto-optical studies. The SWNT sample is cooled to 20 mK inside the bore of the 8 Tesla superconducting magnet. Using fiber optics, the 670nm laser is then incident on the sample, where is it collected optically and detected. Temperature dependent measurements are performed from 20mK to 5K, while investigating the magnetic field dependent photoluminescence intensity.

8. Please add your comments (if any):

My EAPSI/JSPS experience this summer was like none other, as not only did I work and collaborate in a research lab at the forefront of science, I gained the invaluable experience of working in an international environment. I learned to successfully adapt, communicate, and coexist with my Japanese collaborators, while learning new physics and experimental techniques. I will take back with me enjoyable memories, alongside a new understanding of research and collaborative efforts. I learned new experimental techniques that will be extremely beneficial both to my graduate research and my future career as a researcher. I am truly grateful for the opportunity to participate this summer.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Mollie Brooks	(ID No.: SP09011)
2. Current affiliation: University of Florida, Biology Dept.	
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical</u> and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Kyushu University	
5. Host researcher: Yoh Iwasa	
6. Description of your current research <p>Changing from one sex to another depending on size is observed in certain species of plants, coral, fish, shrimp and other organisms. Up to now, most theory on sex change evolution has assumed that larger individuals have greater reproductive success in at least one sex; in plants it is assumed that female reproductive success is size dependent because it is limited by size dependent resources. However, seed number is often observed to be uncorrelated with female plant size in pollen limited plant populations. In these populations, female fecundity is limited by pollen more than resources. I wanted to see if sex changing was an evolutionarily stable strategy (ESS) when reproductive success does not increase with size. I also wanted to test how sex changing would be affected by changes in various life history traits under these new assumptions.</p> <p>Previously, Dr. Iwasa showed that sex change is the ESS when one sex has a faster growth rate and reproductive success increases with size. This ESS is examined using a growth-rate advantage model. I wanted to create a new growth-rate advantage model in which one sex has a faster growth rate and mortality risk decreases with size, but reproductive success does not increase with size. It is common for mortality to decrease with size because smaller individuals are more vulnerable to weather and predation or herbivory. Size dependent mortality is an important aspect of my theory because it gives a benefit to being larger.</p> <p>When I originally wrote my research proposal, I thought that creating this new model would be trivial and we would accomplish much more. However, incorporating size dependent mortality made the mathematics more complicated than in the original growth-rate advantage model. We did not exactly accomplish everything in my research proposal, but I learned a great deal from the collaboration. We found some constraints of sex change in this</p>	

situation and tested how the ESS changes with respect to different traits. In some ways, we accomplished more than I expected because we wrote most of a manuscript on this new model and its implications for sex change evolution.

7. Research implementation and results under the program

Title of your research plan:

New approaches to predicting sex change evolution in a changing environment

Description of the research activities:

First I gave a presentation of my idea and what my goals were. Then we decided what our assumptions for the model would be. We wrote equations to describe reproductive success under our assumptions. We used calculus to find conditions of the ESS. I wrote computer code in R to numerically find a solution to the conditions. We realized that female lifetime fecundity was too high because mortality was unrealistically low. We went back and changed our assumptions and solved for a new set of conditions. The new conditions were difficult to solve. We did some more calculus to find other conditions for optimality. These were easier to solve and the solution held for the other conditions. Once I figured out how to solve our system of equations numerically, I tested the solution's behavior by making small changes to our parameter values. From the very beginning, we typed up our equations and added text. We passed versions of the document back and forth, each adding pieces. This document quickly became a working manuscript that we will complete in the coming months and submit to Theoretical Population Biology.

RESEARCH REPORT

1. Name: Mark Calnon	(ID No. SP09012)
2. Current affiliation: University of Kansas	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: National Institute of Advanced Industrial Science and Technology	
5. Host researcher: Dr. Haruhisa Kurokawa	
6. Description of your current research <p>Modular robots have become a significant research topic due to their ability to perform self-reconfiguration and self-assembly. These abilities enable modular robots to remain robust in environments where they are expected to perform diverse, possibly dangerous actions for an extended period of time without human intervention. For this reason, modular robots are promising candidates for space applications in construction and maintenance. While self-reconfiguration has been frequently studied for the M-TRAN III, progress in self-assembly has remained limited. This is due to the inherent difficulties of inter-robot docking, including the M-TRAN's limited sensing and processing and its low tolerance for alignment errors. At the University of Kansas, my research focused on lowcost, autonomous mobile robots, and I will apply this research at the Field Robotics Research Group to provide a foundation for self-assembly in the M-TRAN. This research will demonstrate modular robots that are capable of searching for, identifying, and docking with external modules. This will include the ability to detect and discriminate between external modules and other obstacles within the environment, as well as to identify relative pose misalignments and to collaborate with external modules to perform inter-robot docking.</p>	

7. Research implementation and results under the program

Title of your research plan:

Autonomous Self-Assembly in the M-TRAN III Modular Robotic System

Description of the research activities:

During the first phase of research, I investigated the M-TRAN's capability of collaborating with external modules using Bluetooth communication. While the MTRAN modules had already included the capability of communicating using Bluetooth, this functionality had not previously been demonstrated. My initial experiments included constructing a new method of inter-module communication and a demonstrating simple collaboration experiment in which two modules worked together to acquire sensor readings from the environment. This experiment successfully demonstrated M-TRAN collaboration between separate modules using Bluetooth communication.

During the second phase of research, the IR-based sensing capabilities of the MTRAN were investigated. Using both the M-TRAN's active and passive IR sensors, a method was developed for identifying both obstacles and external modules within the environment. Active and passive IR data was collected from many relative orientations between separate modules, and a Gaussian Mixture Model that represented these IR readings was constructed using an Expectation-Maximization algorithm. This model was then used to predict the relative orientation of separate M-TRAN modules during docking.

This method of detecting and discriminating between external modules and other obstacles within the environment was then demonstrated through an IR-based search experiment. During this experiment, the M-TRAN successfully demonstrated the ability to the navigate through its environment, while avoiding obstacles and identifying and heading towards external M-TRAN modules.

During the third phase of research, new locomotion methods were evaluated for the M-TRAN. Previous methods of locomotion, including snake-based methods and walker-based methods, did not provide the necessary accuracy for environmental sensing and maneuverability that is required for inter-robot docking. A new method of locomotion was developed that allowed for improved IR-based environmental sensing. Through additional experimentation, this method of locomotion was

expanded to include the necessary maneuverability for inter-robot docking. During the fourth phase of research, additional data was collected to model the speed and distance traveled of the M-TRAN during locomotion. Both the IR model and the locomotion model were then included in a probabilistic tracking algorithm, implemented as a Particle Filter, that was used to maintain the most likely relative orientation between separate modules during docking.

8. Please add your comments (if any):

While this research demonstrated the viability of inter-robot collaboration and docking with the M-TRAN, additional work is needed to complete this goal. First, additional locomotion methods should be evaluated for the final stages of inter-robot docking. Current locomotion methods do not allow for the small scale misalignment corrections that are necessary during the final millimeters of robot docking. Second, additional testing is necessary for the probabilistic tracking algorithm that is used to maintain the relative orientation of separate modules during docking. Additional IR models may be required for the tracking algorithm to remain robust when encountering the significant noise that exists in the M-TRAN's IR-based sensing.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Erik M. Casbeer	(ID No.: SP09013)
2. Current affiliation: Florida Institute of Technology	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences <u>Chemistry</u> Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Konan University, FIRST	
5. Host researcher: Dr. Satoshi Fujii	
6. Description of your current research <p>The oxidation of peptides by reactive oxygen species such as the hydroxyl radical (OH·) and superoxide (O₂⁻) has been well characterized, however, oxidation of amino acid residues by iron-based oxidants has not been studied to any extent. These oxidants have a greater potential to modify proteins than reactive oxygen species because of their selectivity. For example, ferryl species can oxidize proteins by conversion of the side chains of amino acid residues to carbonyl derivatives, therefore the oxidation of peptides by Fe(VI) is relevant to biological processes. However, the potential of aqueous Fe(VI) to cleave amino acid backbone structures and modify side-chains is not known. The mechanistic pathways, in terms of either electron transfer or hydrogen abstraction, have also not been explored. Electron paramagnetic resonance (EPR) will be used to elucidate whether or not radical species are formed in reactions of Fe(VI) with amino acids and peptides. EPR is a technique that is used for studying chemical species that have one or more unpaired electrons, such as free radicals.</p> <p>The EPR study will provide a better understanding of the fundamental chemistry of aqueous Fe(VI) with particular emphasis on the Fe(VI) oxidation of aromatic amino acids and their dipeptides which have been suitably chosen as models for proteins. This study will provide information on whether the reaction of Fe(VI) with aromatic amino acids and dipeptides proceeds via an electron transfer, and if so, it will be established whether the oxidation takes place in one-electron steps to form free radical intermediates, or two-electron steps. EPR experiments will allow for the identification of the possible formation of radicals in the reactions of Fe(VI) with amino acids and dipeptides. For example, EPR experiments have identified new amino acid derived radicals in small peptides containing glycine and thus determine if attack occurs primarily at side-chains or backbone sites of the peptides to form a radical. EPR studies performed on the oxidation of the aromatic species aniline and phenol by Fe(VI) have also shown to proceed by a one-electron step to form Fe(V) and a radical species. It is possible that a similar attack may be true in peptides containing aromatics due to the large side-chain groups.</p> <p>Selection of substrates is based on their relevance in biological and environmental reactions. The Amino acids used were Tryptophan (Trp), Tyrosine (Tyr), Phenylalanine (Phe), Histidine (His), Proline (Pro) and Glycine (Gly). The dipeptides used were Trp-Gly, Tyr-Gly, Phe-Gly, His-Gly and Pro-Gly.</p>	

7. Research implementation and results under the program

Title of your research plan:

Reactivity of Aqueous Iron(VI) with Aromatic Amino Acids and Their Peptides: An EPR Study.

Description of the research activities:

EPR measurements were performed on aqueous solutions of the amino acids reacted with Fe(VI) at varying concentrations and pH values. The concentrations and pH were varied in order to determine if the formation of a radical species is dependant on the these variables. Kinetic studies previously performed show that the reaction of amino acids with Fe(VI) is much slower in basic media than in acidic, because of this initial experiments were done at pH 12 at high concentration of amino acid (50mM – 100mM) and a Fe(VI) concentration of 1mM. Since the reaction still proceeds very quickly and any radical species that are produced are short lived, a spin-trap needs to be used. The use of a spin-trap allows the free radical produced to be identified indirectly by allowing it to add to the spin-trap to produce a more stable radical species that can be identified by EPR. The spin-trap itself is a diamagnetic species, therefore it will show no EPR signal. The spin-traps that were used were POBN (α -(4-Pyridyl-1-oxide)-*N*-*tert*-butylnitron) and MNP (2-methyl-2-nitrosopropane). POBN was useful and showed a radical species was present in reactions with Gly, Trp, His, Phe and Pro. MNP however did not show a radical species with any of the amino acids, this could be due to a reaction between the spin-trap and Fe(VI).

EPR measurements with the amino acids showed that there is a dependence for both pH and concentration. If radical species were seen it was at high concentration (50mM – 100mM) and high pH (9-12). At low concentration and pH the reaction proceeds too rapidly and the short-lived radical species cannot be seen using this method.

Tyrosine showed no radical species when reacted using a spin-trap, these reactions were carried out only at pH 12 and at very high concentration (50mM – 200mM) because tyrosine was insoluble at low pH values which could be due to the polarity of the amino acid.

Dipeptides were synthesized in the lab using the Fmoc solid-phase peptide synthesis method. Reactions carried out with the spin-traps and Fe(VI) with these peptides did not show a radical species, however only very low concentrations (2mM – 15mM) of the peptides were able to be synthesized, which means that the reaction again proceeded very quickly and was most likely unable to be seen with this EPR method.

Some initial experiments were performed at Kyoto Institute of Technology using a continuous flow EPR. The use of continuous flow EPR can detect very short-lived radical species without the use of a spin-trap down to times as fast as 50 milliseconds. By adjusting the concentrations of both the amino acids and Fe(VI) as well as the flow rate of each will be able to show the radical species, if any, that is present in the reaction. In the experiments that were done a radical for the reaction of 100mM Phe with 5mM

Fe(VI) at pH 9 was very clearly seen. Radicals could not be seen under similar conditions with other amino acids.

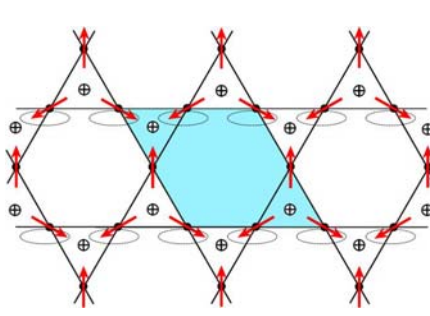
8. Please add your comments (if any):

The results obtained in my research have given good initial insight into what is happening in the reactions between amino acids and Fe(VI), it appears that the reactions will produce a short-lived radical species. However more experiments need to be done with the continuous flow EPR in order to determine the types of radicals that are present at various concentrations and pH values. Also further work must be done with peptides, unfortunately I was unable to see a radical species with any of the peptides used, however, further studies will also give more insight into what is happening in these reactions as well.

9. Advisor's remarks (if any):

The reaction studied by Mr. Casbeer is very important to understand how Fe(VI) oxidizes the biological substrates such as proteins. In general, radical reactions are very complicated and the detection of short-lived radicals by EPR is hard to optimize the experimental condition, especially when the life-time of radicals is very short. During his two months' stay in Japan, however, Mr. Casbeer found several amino acid radicals with spin-trapping technique. These observations will provide insights into the reaction mechanisms. In addition, it is particularly worth noting that he detected Phe radical directly with continuous flow EPR. To my knowledge, this is the first example of Phe radical without any spin traps. Unfortunately, he will go back to U.S. soon, further studies should be carried out to understand fully the Fe(VI) reaction with amino acids, peptides and proteins, if possible.

RESEARCH REPORT

1. Name: Aaron Chen	(ID No.: SP09014)
2. Current affiliation: Ohio State University	
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Tokyo Institute of Technology	
5. Host researcher: Dr. Hidekazu Tanaka	
6. Description of your current research <p>Most systems will reach an ordered ground state as the temperature approaches absolute zero. We study an exotic class of magnetic material – the Kagomé antiferromagnet, whose arrangement of spins still appears to be disordered albeit at low temperature. The disordered ground state emerges both from the quantum nature of spin with small values and the frustration of spin due to the geometry of a Kagomé lattice.</p>  <p><i>Figure 1: “$q=0$ structure”, a possible ground state for classical spins with antiferromagnetic interactions (favoring anti-parallel alignment) on a Kagomé lattice. The spins still have the freedom to rotate (denoted by the dotted circles) even at absolute zero temperature. The lack of a unique ground state causes the frustration of spins.</i></p> <p>Recently, Professor Tanaka’s group has successfully grown crystals which exhibit Kagomé lattice structures*, e.g. $A_2Cu_3SnF_{12}$ (A = Rb or Cs). However, there are still problems to be solved for these systems, such as structural phase transitions at low temperature, magnetic interaction between different layers of Kagomé lattice planes, and the insufficient size of the crystal for neutron scattering experiment to determine the spin structure and its excitations etc. As the experimental goal for this summer program, we search for new crystals of similar form to $A_2Cu_3SnF_{12}$ to produce better Kagomé spin systems, and test for their magnetic properties and crystal structures.</p> <p>*T. Ono et al., Phys. Rev. B 79, 174407 (2009)</p>	

7. Research implementation and results under the program

Title of your research plan:

Study of the ground states of Kagomé antiferromagnets

Description of the research activities:

- Crystal growing process (7 to 10 days for each crystal)
 - 1) Mix proper amount of chemicals and grind into powder.
 - 2) Dehydrate the powder by heating and pumping for three days.
 - 3) The powder was sealed into a platinum tube and put into a furnace, following several heating and cooling steps programmed into the temperature controller.
- Measurement

When a crystal of grain size up to a few millimeters could be obtained, we would measure its magnetic susceptibility by SQUID (Superconducting QUantum Interference Device) or specific heat by Quantum Design's PPMS. X-ray diffraction (XRD) would also be performed on crystals successfully synthesized the first time in order to determine its structure.

Table 1: Summary of compounds made during the summer program

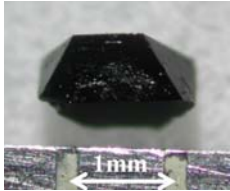
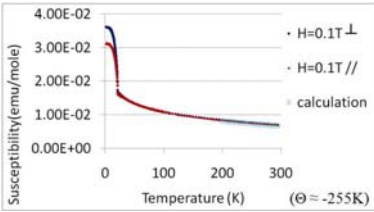
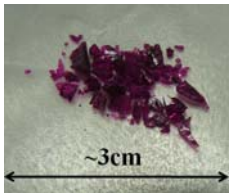
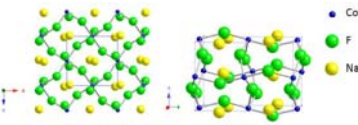
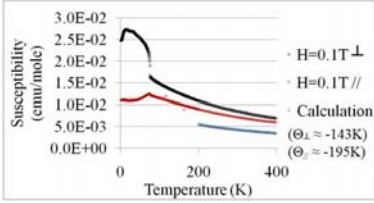
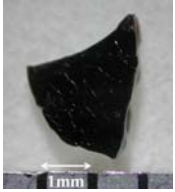
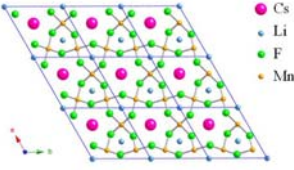
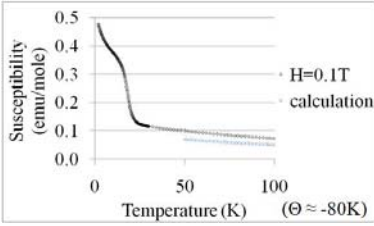

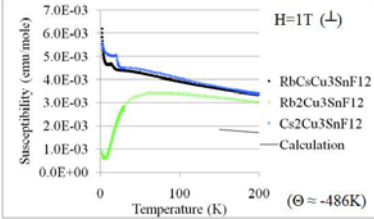
Compound: objective / actual	Crystal shape	XRD	SQUID	PPMS
$\text{Cs}_2\text{Fe}_3\text{SnF}_{12}$ / $\text{Cs}_{0.5}\text{FeF}_3$	bulk ~ 1mm	v	v	
$\text{Cs}_2\text{Co}_3\text{SnF}_{12}$ / --	none			
$\text{Rb}_2\text{Cu}_3\text{SnF}_{12}$ / $\text{Rb}_2\text{Cu}_3\text{SnF}_{12}$	sheet ~ 5mm			v
$\text{Cs}_2\text{Co}_3\text{NaF}_{12}$ / NaCoF_3	bulk ~ 5mm	v	v	
$\text{Cs}_2\text{Cr}_3\text{NaF}_{12}$ / --	none			
$\text{Cs}_2\text{Mn}_3\text{LiF}_{12}$ / $\text{Cs}_2\text{Mn}_3\text{LiF}_{12}$	poly-crystal	v	v	
$\text{RbCsCu}_3\text{SnF}_{12}$ / --	sheet ~ 3mm			
$\text{RbCsCu}_3\text{SnF}_{12}$ / --	sheet ~ 5mm		v	

• Results

Table 1 lists all the compounds synthesized during the summer program. $\text{Rb}_2\text{Cu}_3\text{SnF}_{12}$ and $\text{Cs}_2\text{Mn}_3\text{LiF}_{12}$ (and possibly $\text{RbCsCu}_3\text{SnF}_{12}$) have Kagomé structures. From SQUID measurement, the overall interactions for crystals listed in Table 2 turned out to be antiferromagnetic with strengths estimated by the Curie-Weiss temperatures (Θ) shown in the graphs. Spin response in NaCoF_3 appears to be sensitive to the direction of applied field (“ \perp ” denotes field perpendicular to the crystal cleavage plane

and // parallel). Susceptibility of $\text{RbCsCu}_3\text{SnF}_{12}$ is compared with $\text{A}_2\text{Cu}_3\text{SnF}_{12}$ ($\text{A}=\text{Rb}, \text{Cs}$) as in T. Ono et al. (2009). Calculation of susceptibility at high temperature is based on Curie-Weiss law assuming that magnetic moment is due to spin only.

Table 2: Results of four selected crystals

Crystal	Structure, space group	SQUID
 <p>$\text{Cs}_{0.5}\text{FeF}_3$</p>	<p>(Ion positions to be determined) $\text{Ima}2(46)$, orthorhombic</p>	
 <p>NaCoF_3</p>	 <p>$\text{Pnma}(62)$, orthorhombic</p>	
 <p>$\text{Cs}_2\text{Mn}_3\text{LiF}_{12}$</p>	 <p>$R\text{-}3(148)$, hexagonal</p>	
 <p>$\text{RbCsCu}_3\text{SnF}_{12}$</p>	<p>(To be determined)</p>	

8. Please add your comments (if any):

9. Advisor's remarks (if any):

During his stay in our laboratory, Mr. Chen worked hard. He tried to prepare many crystals, which is reported above. At first stage, I suggested to prepare new kagome antiferromagnets such as $\text{Cs}_2\text{Fe}_3\text{SnF}_{12}$ and $\text{Cs}_2\text{Co}_3\text{SnF}_{12}$, which have not been reported. Unfortunately, the crystals that we aimed to prepare were not obtained. However, he continued to prepare crystals and succeeded in preparing kagome antiferromagnet $\text{Cs}_2\text{Mn}_3\text{LiF}_{12}$, whose magnetic properties has not been reported. Because model substance of kagome antiferromagnet is limited, $\text{Cs}_2\text{Mn}_3\text{LiF}_{12}$ will certainly attract considerable attention. He also succeeded in preparing $\text{CsRbCu}_3\text{SnF}_{12}$, which is a mixture of $S=1/2$ kagome antiferromagnets $\text{Cs}_2\text{Cu}_3\text{SnF}_{12}$ and $\text{Rb}_2\text{Cu}_3\text{SnF}_{12}$. The latter has a nonmagnetic ground state owing to the strong quantum fluctuation. The development of the research on these substances is of great interest.

RESEARCH REPORT

1. Name: Kevin Thomas Connolly	(ID No.: SP09016)
2. Current affiliation: University of Washington, Seattle	
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: KEK·HIGH ENERGY ACCELERATOR RESEARCH ORGANIZATION	
5. Host researcher: Dr. Takeshi Kobayashi (senior host), Dr. Ken Sakashita (working host)	
6. Description of your current research <p>I am currently working on the Tokai-to-Kamioka (T2K) experiment, a next-generation long-baseline neutrino particle physics experiment. As a general description, the interest of elementary particle physicists is to understand the fundamental constituents of matter in our universe, and the forces which govern their interactions. A natural consequence of such a pursuit is the reduction of matter to what we call elementary particles, that is, “things” which are the indivisible building blocks (as far as our current knowledge permits us to understand) of observable matter. Elementary particles fall into two very broad categories, quarks and leptons. Within each of these families of parties are further specifications, and, in particular, within the lepton family is a group of particles referred to as neutrinos, known for their incredibly small mass (they were believed to be massless, like the photon, until 1998 – 42 years after the first detection of neutrinos!).</p> <p>Within in the field of neutrino physics a phenomenon referred to as neutrino oscillations was recently confirmed (1998). The oscillation concept, generically speaking, says that neutrinos (there are a variety of types of neutrinos) can mix with each other, and that creation of one specific type of neutrino does not necessarily mean you will detect that <i>type</i> at a later point in space-time. Rather, you have a likelihood of the original neutrino <i>oscillating</i> to a different type. The strong interest in this occurrence is that neutrino oscillation implies the existence of neutrino <i>mass</i> – remember, the neutrino has long-since been considered massless. Thus, this hypothesized phenomenon, only recently confirmed</p>	

has generated much interest over the past few years. The T2K experiment aims to address some of the remaining questions within the realm of neutrino oscillations which may lead to further significant understanding in our standard model of particle physics.

There are two main sites involved in this experiment: the proton synchrotron at J-PARC (Japan Proton Accelerator Research Complex) and the associated detectors located in Tokai Village, and the Super-Kamiokande detector, located 295km away in Kamioka. The “near site” is responsible for operating the accelerator which is used in generating the neutrino beam. Continuous monitoring and operating of the accelerator is of crucial necessity. The beamline itself has various monitors to assure all beam parameters are within sufficient operating conditions. In addition to the beamline monitoring there is a “near detector” hall which houses multiple detectors to sample the neutrino beam near the production point. The near detectors measure such properties as neutrino direction, flux, and energy spectrum, all of which are essential in calculations of the expected results at the far detector, Super-Kamiokande.

The T2K experiment is underway with its final detector tests and construction, and is scheduled to commence with data taking at the end of this year.

7. Research implementation and results under the program

Title of your research plan:

Implementation of a NTP server for a local network, and a brief introduction to neutrino beam monte carlo simulation.

Description of the research activities:

With the near detector site consisting of both a beamline group and a near detector group at physically distant locations, it was advised that all computers associated with the physics tasks at the J-PARC site have their timing synchronized. The standard way for achieving such a setup is via a Network Time Protocol (NTP) server. Using a local GPS source, you can connect a one pulse-per-second signal (PPS) directly to a computer and maintain micro-second precision locally, without dependence on external network computers.

The implementation of the NTP server with the local GPS clock involved familiarization with linux kernel modifications, PPS signal manipulation and hardware setup, and in-depth NTP source patching and configuration.

In addition to my tasks involved with setting up the local NTP server, which was of primary importance, I had a chance to go through the process of setting up and briefly exploring the standard monte carlo (MC) software package, jnubeam. Though my usage of the jnubeam software was limited, the introduction to its setup and configuration will be useful for future work.

8. Please add your comments (if any):

It is somewhat hard to write about the details of my summer work here, as a lot of it involved thoroughly digging through program source code and working out bugs and testing various setups – all of which are time consuming and revealing, but nevertheless lend themselves in very few ways to writing lengthy descriptions without getting into technical details.

Furthermore, I had a lot of fun working in a Japanese group and practicing Japanese. Everyone was very friendly and helpful and it was an enjoyable experience overall!

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Michael David Conover	(ID No.: SP09017)
2. Current affiliation:	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences <u>Interdisciplinary and Frontier Sciences</u>	
4. Host institution: IBM Japan, Tokyo Research Laboratory	
5. Host researcher: Dr. Mei Kobayashi	
6. Description of your current research <p>This summer I accomplished four primary goals; I developed a nuanced understanding of the singular value decomposition technique for latent semantic analysis of text corpora, I implemented a number of new software development techniques that resulted in the efficient production of scientific information products (analyses, charts, etc) and demographic analyses, I developed a streamlined text mining / matrix manipulation workflow that allows a generic collections of documents to be represented and manipulated in a highly efficient and useful way, and I created and prototyped a novel information retrieval algorithm.</p> <p>The latent semantic analysis is sophisticated way to detect the semantic structures underlying a text corpora. It intelligently disambiguates words with multiple meanings, and produces, effectively, a sophisticated semantic representation of a document collection that relies on relationships between words rather than lexical tokens individually. In reading extensively about and implementing this technique I significantly improved my understanding of the topology of the vector space, and the ways in which documents cluster together and how the relationships between them are structured.</p> <p>Additionally by developing a new software framework from scratch I was able to put into practice many of the scientific software development techniques and insights I've developed over the past several years in a combined, elegant manner. This led to the development of a Python-based text mining and matrix manipulation framework that integrates with plotting and analytical tools for scientific experimentation. The information products produced by this software framework became features of my final internal report which included an extended discussion of various aspects of the system's structure and vector space topology,</p>	

and provided the catalyst for many insights into the strengths and weaknesses of the Innovation Jam system.

Finally, I developed a novel information retrieval algorithm that, due to IBM's intellectual property constraints, I cannot discuss at length. The basic intuition is that in many systems there is information content that is captured in unexpected ways, and by tapping into this information content, we were able to prototype an algorithm that is not constrained by the traditional lexical limits of vector-space information retrieval.

7. Research implementation and results under the program

Title of your research plan:

Innovation Mining – Knowledge Extraction in the IBM Innovation Jam

Description of the research activities:

Development of software infrastructure, development of two novel algorithms, one of which is a strong candidate for publication.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Marshall Cox	(ID No.: SP09018)
2. Current affiliation: Columbia University	
3. Research fields and specialties: Engineering Sciences Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: University of Tokyo	
5. Host researcher: Professor Takao Someya	
6. Description of your current research My current research involves the integration of organic and inorganic materials to build novel systems and devices. My main project is the fabrication of a chronically implanted perfusion measuring device for neo-cortical observation in epileptic patients. This project, a partnership with the Cornell University Neuroscience department, uses both commercially available surface-mount optoelectronic devices as well as organic materials fabricated in-house in an effort to determine the surface tissue oxygen usage in the neo-cortex. Such data is useful to evaluate epilepsy, as well as a potential step towards more effective treatment. Other research concentrations include materials and architectural development for organic photovoltaics, including n-type and p-type materials (electron-transporting and hole-transporting). This work is done in partnership with a chemistry laboratory at Columbia University.	

7. Research implementation and results under the program

Title of your research plan:

Large Area Electronics Development

Description of the research activities:

Research activities under the program involved the development of dielectric materials layers for large area field effect transistors. Specifically, this work dealt with surface energies of self-assembled monolayers and deposition condition analysis, and manifested itself as an experimental design in process parameters and materials.

A second project in the program involved modifying substrate surface energies to enhance adhesion to a conductive polymer material, also via self-assembled monolayer modification.

8. Please add your comments (if any):

This program was fantastic. In addition to the large amount of information that I learned at this laboratory, and I believe they learned as well, I was also able to connect with another lab on the campus to begin an international collaboration for device prototyping. And, of course, Japan is amazing in a myriad of ways. A fantastic job by both the NSF and JSPS, and an amazing opportunity that I would gladly take part in again.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Andrew Davidson	(ID No.: SP09019)
2. Current affiliation: University of California @ Davis	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Tokyo Institute of Technology	
5. Host researcher: Professor Takayuki Aoki	
6. Description of your current research Currently my research focuses on the development and use of data parallel primitives for GPU Computing. More specifically I have been interested in auto-tuning these parallel primitives. When an auto-tuned method is run, it will automatically select algorithm parameters for optimum (or near-optimum) performance. During the Spring Quarter at the University of California at Davis I began working on auto-tuning the common 'reduction' data-parallel primitive. A reduction is the result of a binary operation on all elements within a set (array). In layman's terms, this is the accumulation of many elements to one final result (e.g. the sum of n elements). There are a variety of ways to do this on a parallel architecture such as the GPU. However the optimum way requires various algorithmic optimizations, as well as tuning on a number of machine specific parameters.	

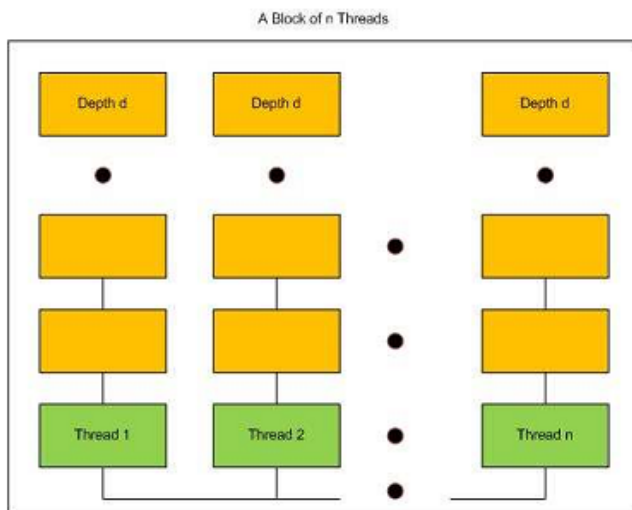


Figure: A group of n threads in one block. In this example, this block (with $n \cdot d$ elements) is reduced to one value.

7. Research implementation and results under the program

Title of your research plan:

Auto-Tuning Parallel Primitives for GPU Computing

Description of the research activities:

I completed my reduction auto-tuned algorithm and ran tests on three different GPUs: an NVIDIA GTX 280 (eight active memory controllers), a Tesla C1060 (eight active memory controllers, with a slower memory clock), and an NVIDIA 8600GT M (two active memory controllers). The vast performance differences between each of my test cards ensure that my method is not biased towards a certain performance tendencies. The results from these tests show that the auto-tuned method's performance follows very closely to the "Algorithm Lower Bound" which checked every possible thread combination, and reported the minimum time. The theoretical lower bound is the minimum time it would take to read x elements given a machines memory bandwidth. It does not take into account launch overhead, block reductions, and GPU to CPU copy (for the final reduction step among blocks). Therefore I believe achieving 85% to 93% of that theoretical performance demonstrates the effectiveness of this tuning algorithm. Another data-parallel primitive I have begun tuning is the scan primitive, commonly used for a variety of parallel algorithms. However, development of this tuned procedure is still in progress.

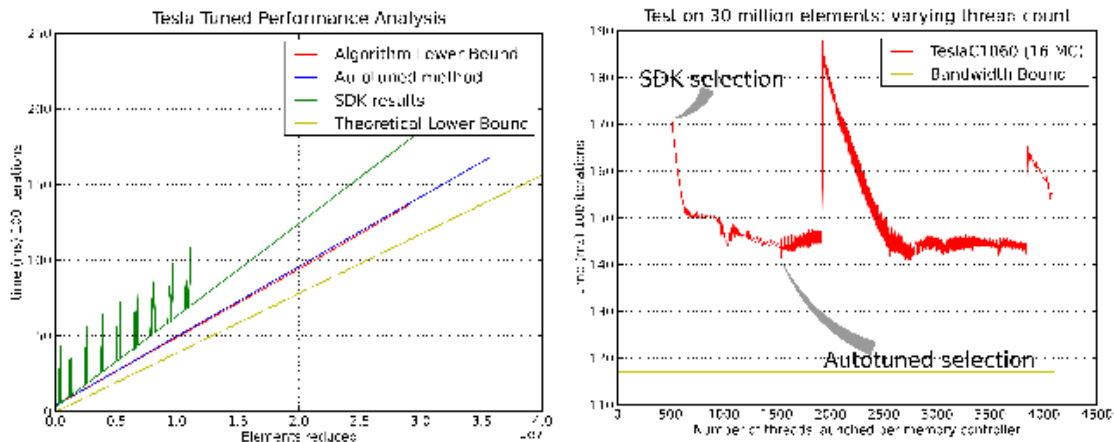


Figure: Results of my auto-tuned method in comparison with the NVIDIA SDK and a brute force combination of every possible configuration.

8. Please add your comments (if any):

I thoroughly enjoyed this summer program. I felt the chance to see a foreign lab at work, network with foreign researchers in similar fields, and experience Japanese culture were great opportunities and I'm glad I took advantage of them.

9. Advisor's remarks (if any):

I am very happy to host an excellent student from the US active laboratory. He always studies his research topics with high motivation and the students of my laboratory are stimulated very much. Although his stay is only two months, I hope it will be a good starting point for the collaboration on GPU Computing.

RESEARCH REPORT

1. Name: Steve R. Davis	(ID No.: SP09020)	
2. Current affiliation: University of Kansas (USA)		
3. Research fields and specialties: Systematic Entomology		
Humanities	Social Sciences	Mathematical and Physical Sciences
Chemistry	Engineering Sciences	Biological Sciences
Agricultural Sciences	Medical, Dental and Pharmaceutical Sciences	
Interdisciplinary and Frontier Sciences		
4. Host institution: National Institute for Agro-Environmental Sciences, Tsukuba		
5. Host researcher: Dr. Hiraku Yoshitake		
6. Description of your current research		
<p>Weevils are one of the most diverse groups of extant organisms, with approximately 60,000 described species. They are extremely important economically, being of great agricultural significance because they are associated with all major groups of plants and plant parts. My Ph.D. dissertation focuses on the morphological phylogeny of the weevil family Curculionidae, which will utilize ca. 600 extant taxa, constituting the largest taxon sampling by far to date for phylogeny of the group. Until now there have been five phylogenetic hypotheses (Oberprieler <i>et al.</i> 2007) proposed of weevils and their relatives (Curculionoidea), all mostly focusing on the relationships of the families within the Curculionoidea and all utilizing very few taxa (at most 150 taxa in McKenna <i>et al.</i> 2009, with fewer than 50 taxa in the remaining studies). The knowledge of higher-level weevil relationships, however, still remains poor at best, particularly within the largest family Curculionidae. Similar to my Master's thesis (which utilized 301 taxa to infer the phylogeny of one subfamily within Curculionidae- Baridinae), this phylogeny of the family will attempt to examine all tribes of every subfamily. Fossil taxa will also be integrated into the analysis, thereby making it feasible to infer approximate ages for the evolution of particular clades.</p>		

7. Research implementation and results under the program

Title of your research plan:

Phylogenetic study of the weevil subfamily Ceutorhynchinae (Coleoptera: Curculionidae) based on morphology

Description of the research activities:

As a result of my Master's thesis research, the beginning stages of my Ph.D. study is focusing on phylogeny reconstruction of the weevil subfamily Ceutorhynchinae, which appears to be a closely related group to Baridinae. Due to its cosmopolitan distribution, varying levels of habitat range and diet breadth, Ceutorhynchinae, in particular, is a prime target for investigating the evolution of host use in phytophagous insects. However, no phylogenetic hypothesis has been proposed for the evolution of Ceutorhynchinae to date. Currently, largely due to the lack of comprehensive morphological examinations within the subfamily, there has been great confusion in the higher classification of Ceutorhynchinae which hinders contemporary systematic and ecological studies. Thus, this first phylogenetic treatment will assess the relevance of the current classification scheme at the generic and tribal levels, test the subfamily for monophyly, and delimit the major taxonomic ranks, thereby providing a framework for the subfamily which may assist future research on this group, such as the investigation of host use evolution, character system evolution, and biogeography.

For this study, Dr. Yoshitake and I are sampling taxa from each of the 11 current tribes in the subfamily, which will result in the first phylogenetic hypothesis for this fairly large group of weevils, with a current total of 1,316 described species (Colonnelli 2004). As a result of our collaborative efforts during the JSPS summer program, we have dissected 190 exemplar species and have compiled a list of 130 morphological characters for inclusion in the data matrix and subsequent analyses. Of the total number of taxa in our matrix, we have thus far coded the characters for approximately $\frac{1}{4}$, the remainder of which will be examined upon my return to the University of Kansas and at which time I will run the analyses. In addition to our joint phylogenetic study, Dr. Yoshitake and I are collaborating on a few smaller systematic studies within Ceutorhynchinae, encompassing taxonomic revisions and examining evolutionary relationships within certain tribes and genera.

8. Please add your comments (if any):

As a result of my summer collaboration under the JSPS program, I have obtained valuable insight into my morphological phylogenetic research that I would not have received had I not been able to visit Japan and work closely with Dr. Yoshitake.

9. Advisor's remarks (if any):

Mr. Steve Davis is a so diligent and excellent student that he could finish almost all works he attended to during his stay in Japan. Although some data analyses remain, I think we can complete those within this year. The result of our study will be presented at the annual meeting of the Entomological Society of America held in Indianapolis from 13 to 16th December 2009. I really enjoyed the two months with Mr. Davis, a student of great promise, and appreciate the JSPS Summer Program 2009 very much.

RESEARCH REPORT

1. Name: Matthew T. Dickerson	(ID No.: SP09021)
2. Current affiliation: University of Kentucky, Lexington, KY 40506	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Tokyo University	
5. Host researcher: Kazuhiko Ishihara	
6. Description of your current research <p>My research focuses on the application of molecular imprinting in the development of a protein detection system. Presently, most protein detection is done through expensive antibody-based tests like enzyme-linked immunosorbent assay (ELISA). An alternate system employing molecularly imprinted polymers could potentially reduce the cost of such tests. Molecular imprinting is a process in which a pattern is pressed into a polymer layer using target molecules. This impression retains an affinity for the protein used to make the initial imprint. By constructing this imprinted surface using a hydrophilic polymer, in this case a 2-methacryloyloxyethyl phosphorylcholine (MPC) based polymer, it is possible to make a surface that selectively binds only the desired protein. This is due to one of the characteristics of the MPC polymer, which is the ability of the phosphorylcholine group to prevent protein adsorption. However, the inclusion of molecular imprinting the repulsion between the protein and the surface can be overcome. My research this summer combines this selective surface with a quartz crystal microbalance (QCM). A QCM is able to measure small changes in the mass adsorbed on the surface of a quartz crystal. The crystal is vibrated at a certain frequency and as mass is added the frequency drops accordingly. The top of the quartz crystal is typically coated with a layer of gold that allows for further modification. To this gold layer the imprinted MPC polymer was added. For the present experiments bovine serum albumin (BSA) was used as a model protein.</p> <p>The BSA imprinted surface (molecularly imprinted polymer (MIP)) was compared with a surface that had been imprinted with a stamp with no protein (Non-imprinted polymer (NIP)), a surface with only MPC, and a hydrophobic surface coated with poly(butyl methacrylate (PBMA)). BSA should bind well to the hydrophobic PBMA, very little to the hydrophilic MPC and NIP, and to some extent on the patterned MIP surface. Once QCM testing was complete the results were verified through ELISA. Small plastic disks were sputter coated with gold to simulate the gold-coated QCM substrates and then these were coated with MIP, NIP, MPC, or PBMA. These surfaces were incubated with BSA for a set period of time and the binding quantified using a microplate reader. In addition, both the silica microspheres used as the protein stamp and the polymer substrates were analyzed by</p>	

X-ray photoelectron spectroscopy (XPS) to verify their surface composition.

7. Research implementation and results under the program

Title of your research plan:

Construction of a QCM based Protein Detection System using Molecularly Imprinted Polymer Substrates

Description of the research activities:

A copolymer of MPC, 3-methacryloxypropyltrimethoxysilane (MPTS), and *p*-nitrophenyloxycarbonyl poly(ethylene glycol) methacrylate (MEONP) (PMSiN) was synthesized and purified using solvent precipitation. Successful synthesis of PMSiN was verified using nuclear magnetic resonance imaging (NMR). The MEONP units can react with proteins under mild conditions and PMSiN can bind chemically to the silica surface.

Silica microspheres were cleaned 20 minutes using a plasma treatment and incubated in 0.5 wt% PMSiN for one hour. The microspheres were then dried thoroughly, PMSiN was cross-linked at 70 C, and stored at RT. Unmodified and functionalized microspheres were analyzed using XPS to demonstrate that the microspheres had been successfully coated with PMSiN.

Modified microspheres were incubated overnight at 4°C with either phosphate buffered saline (PBS) (pH 7.8) or 1mg/ml BSA. The adsorbed BSA concentration was measured using a photospectrometer and the microspheres were mixed with a 1:1 molar ratio of sodium docecylsulfonate (SDS) and 2.5mg/ml 2-methacryloyloxyethyl phosphorylcholine-co-2-methacryloyloxyethyl oxycarbonyl 4-phenylazido (PMPaz) (photoreactive MPC). Gold QCM surfaces were first coated in PBMA then MIP, NIP, or PMPaz alone was spread on the top of the PMBA layer. The surfaces were then dried for 1 hour at 37°C and the PMPaz was cross-linked using UV radiation for 1 minute. The surfaces were finally sonicated in distilled water to remove the protein-coated microspheres and unreacted polymer. The modified surfaces were then examined using QCM.

Glass slides were sputter coated with gold and cut into squares. The gold surfaces were then coated with PBMA, MIP, NIP, or left unmodified. Each surface was examined using XPS to verify the presence of polymer.

Finally, a number of plastic disks were coated with gold as mentioned above. An equal number were left unmodified, coated with PBMA, MIP, or NIP. These were placed in well plates and incubated with BSA. After 24 hours the plates were washed thoroughly and analyzed using ELISA.

PMSiN was successfully synthesized; however, QCM results were ambiguous. BSA bound very little to PMPaz and to a slightly greater extent NIP. At this time I

attribute NIP binding mostly to surface roughness and possibly to the presence of SDS on the surface. Moreover, BSA bound much more to PBMA as expected. In contrast to the previous results, which were expected, BSA was found to bind to MIP surfaces at a level nearly identical to NIP. I believe this is due to BSA molecules that were left behind from the imprinting process. Essentially, the surface was already covered with BSA so additional protein molecules could not bind.

XPS results for the modified silica microspheres indicated the presence of PMSiN through the measurement of phosphate groups while results for MIP and NIP surfaces were a bit more questionable. SDS was not observed but this may be due to its low concentration.

I was not able to confirm the selectivity of the MIP substrate using ELISA. PBMA bound BSA well and PMPaz was resistant to binding; however, NIP surfaces actually bound more BSA than MIP. At this time I believe this is the result of a combination of factors including the surface morphology and SDS of NIP leading to nonspecific BSA binding and the presence of leftover BSA from the imprinting step left on the MIP surfaces, which limited BSA binding for the ELISA.

8. Please add your comments (if any):

Several unforeseen issues were encountered that slowed down progress. SDS in NIP leading to nonspecific binding forced me to repeat QCM tests several times to find the right concentration. Also, in retrospect BSA might have been a bad choice for this study. A protein with a higher isoelectric point, such as lysozyme, pH 11 may be a better choice because SDS does not interact strongly with BSA. In the future a solution containing SDS should be applied before the addition of PMPaz to ensure that SDS molecules not bound to the BSA on the microspheres are not present. This free SDS likely contributes to nonspecific protein binding. Also, microspheres should be washed more thoroughly to limit the amount of unbound BSA that remains in the polymer matrix of the MIP samples.

9. Advisor's remarks (if any):

In the present study, new polymer system for making molecular imprinting surface was developed. The molecular design of the polymer system may be well done. It did not have significant difference based on the molecular imprinting under the experimental conditions. However, optimization of the molecular imprinting process using this polymer system will provide success results.

RESEARCH REPORT

1. Name: Addie Dickson	(ID No.: SP09022)
2. Current affiliation: University of Texas Southwestern Medical Center at Dallas	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: University of Tokushima	
5. Host researcher: Ken-ichi Miyamoto	
6. Description of your current research <p>In the lab of Makoto Kuro-o at UT Southwestern Medical Center at Dallas, I currently study the extra-renal function of FGF23/Klotho signaling. Klotho is a single-pass transmembrane receptor known to be involved in suppression of multiple aging-like phenotypes. In complex with FGF receptor, Klotho functions as a co-receptor for FGF23, a member of the endocrine FGF family. FGF23 is a phosphaturic hormone that signals through Klotho in the kidney to decrease levels of active vitamin D and to decrease phosphate resorption. In addition to the kidney, Klotho is also expressed in the pituitary gland and several areas of the brain including the hypothalamus; however, its roles in these tissues remain largely unexplored. Several lines of evidence have led us to believe that FGF23/Klotho may function in the hypothalamus to promote fertility. Klotho-deficient mice are infertile due to low circulating levels of GnRH; however, GnRH neurons are intact in these animals. In the hypothalamus, Klotho is expressed in the AVPV, a nucleus where kiss-peptin cell bodies reside. Kiss-peptin is a hormone that signals through its receptor, GPR54, to stimulate GnRH release. Indeed, Kiss1 mRNA is absent in brains of Klotho-deficient mice indicating that FGF23/Klotho in the AVPV may be important for kiss-peptin production. In the pituitary gland, Klotho appears to be co-expressed with TSH- and common glycoprotein alpha (Cga)-producing cells; therefore, FGF23/Klotho activity in the pituitary may modulate production of TSH, LH, and FSH. Since phosphate is an essential nutrient for general growth and bone strength, it is also necessary for proper energy metabolism and fertility. Therefore, we believe that FGF23 may function as a “phosphate sensor”, integrating information about phosphate availability to the pituitary and hypothalamus, organs that control energy metabolism and fertility.</p>	

7. Research implementation and results under the program

Title of your research plan:

Effects of systemic FGF23-overexpression in hypothalamus

Description of the research activities:

Miyamoto and colleagues have previously observed that chronic FGF23 overexpression in mice results in decreased food intake and body weight loss in these animals (unpublished data). The known sites of FGF23 action are kidney and parathyroid; however, these organs are not typically thought to be involved in feeding behavior. Thus we hypothesize a novel site of FGF23 action in brain, particularly in the hypothalamus, which is the body's main appetite control center.

Following protocols previously described, we implemented a naked-DNA injection system to chronically overexpress human FGF23 (hFGF23) in mice. For this study, we utilized a non-degradable mutant form of hFGF23 (R179Q) in order to allow hFGF23 accumulation in serum. Ten C57BL6 male mice at 8 weeks of age were intravenously injected with either mock vector (n=5) or hFGF23 (n=5). After a 24-hour recovery period, mice were transferred to metabolic cages where their food and water intake, body weight, and urine output were monitored for the next 4-5 days. hFGF23-expressing mice were sacrificed on day 4, while mock vector-injected mice were sacrificed on day 5, and tissues, blood, and urine were harvested. At the time of sacrifice, hFGF23-injected mice expressed 62-fold more hFGF23 in serum than mock-injected controls. Since FGF23 is a phosphaturic hormone, these mice exhibited increased phosphate wasting (105% versus 24%, $p < 0.005$) as compared to controls. Consistent with previous results, 4 days after naked DNA injections, hFGF23-overexpressing mice consumed 80% less food ($p < 0.005$) than their mock-injected counterparts. Additionally, water consumption was decreased by 40% ($p < 0.005$) and urinary output was decreased by 55% ($p < 0.05$) in these animals as compared to controls, indicating another novel site of FGF23 action in the hypothalamus to control electrolyte balance. We are currently working to identify the molecular targets of FGF23 in hypothalamus using quantitative real-time PCR and cDNA microarray analysis.

Endogenous FGF23 expression is limited to bone; therefore, FGF23 must cross the blood-brain barrier (BBB) in order to act in the hypothalamus (unless there is an additional source within the brain). However, FGF23's ability to penetrate the BBB has not thus far been demonstrated. Real-time PCR analysis confirmed that the naked-DNA injection system employed in these experiments did not produce non-physiological overexpression of hFGF23 directly in brain, but only in liver. Therefore, we are currently using immunohistochemical techniques to show that hFGF23 produced in liver did indeed cross the BBB and to exert its actions in the hypothalamus.

This work is being continued as an ongoing collaboration between the Kuro-o and Miyamoto laboratories.

8. Please add your comments (if any):

This study has allowed me to gain a new experimental skill (naked-DNA injection) that is of tremendous use to my colleagues and me at UT Southwestern. This system allows us to chronically and systemically overexpress FGF23 (or any other gene of interest), whereas we were technically limited before to only acute overexpression systems.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Kristy Lynne Forsgren (ID No.: SP09024)
2. Current affiliation: University of Washington
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Ehime University
5. Host researcher: Dr. Takeshi Miura
6. Description of your current research <p>Several studies have been aimed at understanding oogenesis (the development of an egg capable of fertilization) in teleosts. However, have primarily focused on the later stages of oocyte development, maturation, and ovulation. Early oogenesis is of interest because aspects of fecundity and egg quality are thought to be determined during this time and have not been investigated in detail. Much of the literature aimed at determining fecundity has been focused on egg production at the time of spawning. Similarly, high quality eggs have been defined as those eggs producing the healthiest, fastest growing fish and post-hatch survival. The majority of maternal RNAs and genes and nutritive elements are most likely incorporated during the early stages of oogenesis. Therefore, research focusing on early oogenesis may provide insight into the factors that determine fecundity and egg quality. My research is aimed at understanding two critical stages that occur during early ovarian development in teleost fish: the perinucleolar stage (last stage of primary growth) and the early cortical alveoli stage (first stage of secondary growth). Specifically, I am interested in the physiological role of sex steroids during these two stages. My research on coho salmon (<i>Oncorhynchus kisutch</i>) indicates that steroids have specific roles during various stages of early ovarian development.</p>

7. Research implementation and results under the program

Title of your research plan:

The Physiological Role of Sex Steroids During Early Ovarian Development in Amago Salmon (*Oncorhynchus rhodurus*)

Description of the research activities:

During the JSPS Summer Program in Miura-sensei's laboratory, I learned several new techniques including: resin embedding of ovarian tissues for light microscopy, RNA extraction from cultured tissues, differential display for the identification of novel gene expression, transformation and cloning of gene sequences using *E. coli*, and bioinformatics techniques to identify genes of interest.

Amago salmon (*O. rhodurus*) ovarian fragments were incubated in 11-ketotestosterone (11KT), testosterone (T), and estradiol-17 β (E2) for 3 and 6 days using an established protocol (Miura et al. 2007). Histological analysis revealed that late perinucleolar oocytes incubated with 11KT and T resulted in an increase in oocyte volume. However, E2 had only minor effects on growth of late perinucleolar oocytes. These results are similar to the coho salmon. Thus, it appears that steroids may have a physiological role in the regulation of early oocyte growth.

Differential display was used to identify differentially expressed genes in oocytes cultured in steroids for 3 days. RNA was extracted from cultured oocytes, cDNA was synthesized and amplified then separated on an agarose gel. Fragments of interest were extracted from the gel, cloned, and sequenced at Ehime University. Gene sequences were analyzed and compared using DNASIS software. A similarity search of the predicted amino acid sequences was performed using FASTA and NCBI. As a result, eight steroid-responsive genes were identified: four genes were down-regulated by all steroids, two genes were up-regulated by androgens, and two genes were down-regulated by E2. These results provide evidence for the direct involvement of steroids in early ovarian development.

Overall, my main goal of identifying genes whose expression is regulated by steroids during the late perinucleolar oocyte stage was accomplished. Determining the expression levels of these novel genes would further enhance our knowledge of early development of the teleost oocyte. Therefore, I will continue this research by developing quantitative rt-PCR primers to measure the expression levels of the genes that have been identified upon my return to the University of Washington (UW). I did not have time to analyze late perinucleolar oocytes cultured for 6 days or cortical

alveoli oocytes cultured for 3 and 6 days. Histological analysis and differential display on these tissues will also be completed at UW. The information obtained from this research will contribute to our overall understanding of the factors that control ovarian development and that are central to the ability to enhance teleost reproduction in captivity (e.g. aquaculture) including species of conservation and commercial importance.

8. Please add your comments (if any): Participation in the EAPSI program was an invaluable scientific and cultural exchange. My ambitious research plan would not have been possible without the tools, and the intellectual and practical expertise of Miura-sensei and Dr. Chiemi Miura. I would like to extend my thanks to Masato Higuschi and Sonoko Yamaguchi for also dedicating their time and experience to the success of this project. I anticipate that this experience will firmly establish future collaborations with the Miura laboratory, which I hope will be far reaching and extend not only to my current research, but my future career path as well. I sincerely thank Drs. Takeshi and Chiemi Miura for a memorable once-in-a-lifetime experience.

9. Advisor's remarks (if any): Ms. Kristy Forsgren stayed for 2 months in our laboratory and she mainly tried to identify the genes whose expression is regulated by steroids during the perinucleolar oocyte stage in Amago salmon (*Oncorhynchus rhodurus*) using differential display method. She was well done experiment and succeeded to identify 8 unique cDNA clones for this period. Furthermore, her preliminary results were much greater than estimated. I consider that she will get more excellent results by her future research collaboration us. She could also communicated well with the members of our lab and local community, and she contributed to a local social contribution of University.

RESEARCH REPORT

1. Name: Erin Grey	(ID No.: SP09025)
2. Current affiliation: The University of Chicago	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: The University of Tsukuba's Shimoda Marine Research Center	
5. Host researcher: Dr. Yasunori Saito	
6. Description of your current research: For my PhD research, I studied the ecology of marine organisms from Japan, the colonial ascidian <i>Botrylloides violaceus</i> , that had recently been introduced to Washington state, USA. Through observations and experiments, I was able to show that neither competition nor predation from other species limited <i>B. violaceus</i> ' success in Washington. This finding supports the popular "enemy-release" hypothesis, which posits that species are limited by competitors or predators in their native range, and absence of competitors or predators is a major reason these species can succeed in new areas. Through the NSF-JSPS Summer Research Program, I further tested this hypothesis by surveying the competitors and predators of <i>B. violaceus</i> in its native habitat in Japan. I also collected and prepared samples for a genetic study which will help identify the sources of introduction of this now globally common exotic species.	
7. Research implementation and results under the program Title of your research plan: The Population Structure and Native Ecology of Botryllid Ascidians in Japan	

Description of the research activities:

With the help of Dr. Yasunori Saito, I collected and identified 5 different botryllid ascidians species, including *Botrylloides violaceus*, and cultured them at the University of Tsukuba's Marine Research Center in Shimoda, Shizuoka Prefecture, Japan. I also collected potential predators of botryllid ascidians, including two flatworm species, a sea slug and a sea snail. Planned feeding experiments with these predators were cancelled when the animals either died or disappeared in early August. However, specimens of each potential predator species were identified and fixed in ethanol for permanent records.

To survey other areas for *B. violaceus*, its competitors and its predators, I traveled around Japan visiting marine stations with Lauren Stefaniak, another NSF/JSPS Summer Fellow. In total, I visited 8 sites (Shimoda, Sugashima, Shizugawa, Misaki, Asamushi, Usujiri, Otaru and Akkeshi), and I was able to collect *B. violaceus* at every site, along with any other botryllid species that was present. I now have an extensive dataset to analyze the genetic variation of *B. violaceus* its native range of Japan, as well as that of at least 3 other botryllid species. I have also gained excellent background knowledge on the distribution and ecology of *B. violaceus* and other botryllids in Japan, which will help my futures studies of these species in both the US and Japan.

8. Please add your comments (if any):

This program was wonderful in many ways. First, the orientation experience in Tokyo the first week really helped me adapt to living in Japan. Second, my host researcher, Dr. Yasunori Saito, went out of his way to help me with my research and to show me around the country.

9. Advisor's remarks (if any):

I think this program is good for the young scientists of foreign countries to know Japanese culture and tradition, as well as Japanese scientists and laboratories. I hope that many of the participants of this program will do collaborate with Japanese scientists in future.

RESEARCH REPORT

1. Name: Tom Hartl	(ID No.: SP09026)
2. Current affiliation: Departments of Developmental Biology, Genetics, and Bioengineering Howard Hughes Medical Institute Clark Center West Wing W252 318 Campus Drive Stanford University School of Medicine Stanford, California 94305-5439	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: RIKEN Advances Sciences Institute 2-1 Hirosawa, Wako, Saitama 351-0198	
5. Host researcher: Tatsuya Hirano	
6. Description of your current research Maintenance of an intact genome and proper regulation of the genes within are crucial aspects for life. Our work has implicated the <i>Drosophila</i> condensin II complex in both processes. Condensin II's ability to reconfigure chromosomes into spatially separated and discrete units is necessary to ensure proper meiotic segregation. When this "individualization" activity fails in a condensin II mutant background, chromosomes remain entangled, and either cosegregate or become lost during cell division. This leads to the creation of aneuploid sperm. We have also implicated condensin II as a factor necessary to individualize interphase somatic chromosomes from one another. This is relevant in <i>Drosophila</i> because the association of homologous chromosomes is thought to facilitate gene regulation activity in <i>trans</i> . We speculate that condensin II individualization spatially distances aligned chromosomes from one another and prevents this <i>trans</i> -communication between allelic loci. This is supported first by an increase of homologous chromosome pairing in a condensin II mutant background. Secondly, loss of condensin II leads to elevated production from alleles that are known to	

depend on pairing for transcriptional activation. These meiotic and interphase condensin II roles support its necessity to *Drosophila* genome integrity and transcriptional regulation. Given the conservation of condensin from bacteria to humans, it is likely that equivalent or related roles exist in a variety of species.

7. Research implementation and results under the program

Title of your research plan: **An investigation into whether human condensin complexes regulate interphase chromosome dynamics: testing possible roles in territory formation and antagonizing homolog pairing**

Description of the research activities:

Background: In eukaryotes, individual interphase chromosomes generally do not physically overlap and appear to be sequestered away from one another. These “chromosome territories” also do not occur at random nuclear positions, but rather, each can be found within specified nuclear domains. There are currently no known components that contribute to territory formation. Thus, it remains untested whether chromosome territories serve a functional purpose to interphase activities such as gene expression or DNA replication. We have data suggesting a direct role of the condensin II complex in territory formation in *Drosophila*. During the normal spermatocyte growth period leading up to meiotic divisions, each of the three major bivalents is spatially distanced from one another into chromosome territories. In a condensin II mutant background, territory formation fails and chromatin appears diffuse throughout the nucleus.

Eukaryotic interphase nuclear architecture also includes physical associations between different chromosomes. In many cases, these have been correlated with altered transcriptional production from the implicated loci. This was first evident in *Drosophila*, where in adult somatic tissues, homologous chromosomes pair along their entire lengths at frequencies ranging between 95 and 100%. With certain allelic pairs, somatic homolog pairing enables enhancer elements from one allele to act upon the promoter of the allelic locus. This process was discovered and named “transvection” in 1954 by Ed Lewis. Aside from *Drosophila*, somatic pairing of entire chromosomes is rarely observed in eukaryotes. This makes two predictions – perhaps *Drosophila* acquired an ability to pair homologs, or alternatively, homolog pairing may be considered the constitutive state of the cell and non-*Drosophila* acquired mechanisms to actively prevent it. We have demonstrated that the *Drosophila* condensin II complex acts as an interphase homolog-pairing antagonist.

Hypothesis: Like *Drosophila*, we predict that the human condensin complex is necessary to establish interphase chromosome territories and prevents inter-chromosomal associations.

Methods: We first set out to reduce the function of two condensin subunits (SMC2 and Cap-H2) in IMR-90 cells. This was achieved successfully in the first month of my stay in the Hirano Lab by the transfection of SMC2 or Cap-H2 dsRNAs. Then, chromosomes 18 and 19 were detected by FISH with whole chromosome paints acquired from Cambio. After several conditions, we identified a suitable methodology utilizing 1% formaldehyde fixation and Cot1 DNA as a blocking agent. Cells were visualized with confocal microscopy to generate three-dimensional images and are in the process of being analyzed by me with Image J “Object Counter.” Key points of analysis are:

1. Chromosome 18 and 19 volumes – one simple prediction is that loss of condensin function will lead to a “swelling” of the interphase chromosome territories and an increased volume.
2. The distance between homologous chromosome territories. We predict homolog-pairing levels to increase when condensin levels are reduced.
3. Estimate the nuclear positioning of the chromosome territories. This is being performed at first by measuring the distance between the “geometrical center” of each chromosome territory and the nuclear periphery. Later, we have discussed furthering this analysis through a collaboration with another Japanese researcher who currently conducts such studies.

The preliminary results from these studies are very promising. *After SMC2 reduction, it appears that chromosome 19 territories are expanded.* All parties are very enthusiastic by this result as SMC2 would be the first factor implicated in the establishment/maintenance of human chromosome territories. This not only highlights a new function of the condensin complex in interphase chromosome biology, but may allow an elucidation into the role of chromosome territories in cell biology. Although my time at RIKEN has ended, we have discussed possible short and long-term plans for this project. In the short-term, validation of this result through quantitation of the phenotype are necessary. One possible long-term study involves the observation that early replicating regions lie in the nuclear interior and those replicating later are at the periphery. Perhaps altered territory formation through condensin loss would disrupt this temporal pattern.

8. Please add your comments (if any): My stay at the RIKEN has been a wonderful experience. First, we have promising results suggesting that SMC2 is necessary for chromosome territory formation. This could lead to substantial discoveries in cell biology. Second, on a practical level, I learned human cell-culture techniques, expanded my knowledge of confocal microscopy, and gained a better understanding of image analysis software. Finally, the program gave me a once in a lifetime opportunity to work and live in Japan for 2 months. My colleagues have been patient, intellectually stimulating, friendly, and fun. I will never forget it!

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Amanda Herberger	(ID No.: SP09027)
2. Current affiliation: University at Buffalo	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Ocean Research Institute, University of Tokyo	
5. Host researcher: Professor Yoshio Takei	
6. Description of your current research: <p>Ionic Ca^{2+} is an important messenger in physiological systems (for example, excitation-contraction coupling in muscle), and is maintained within narrow bounds in the body fluids of animals. The extracellular calcium-sensing receptor (CaSR), a member of the family C G protein-coupled receptor (GPCR) superfamily, is a sensor for Ca^{2+} homeostatic systems in vertebrates. Protein sequence alignment and phylogenetic analysis of CaSRs and related vertebrate GPCRs exposes similarities among these receptors and estimates the evolutionary history of CaSRs. In CaSRs, two conserved regions were noted that set them apart from other, related GPCRs: the ligand-binding sites of the Venus flytrap domain, and the external face of the receptor that is engaged in dimerization of the functional receptor. We infer that these conserved structural features emerged during the evolution of CaSRs from an ancestral GPCR. Current research is aimed at the addition of the elephant shark, <i>Callorhincus milii</i>, CaSR sequence to the existing phylogeny by data mining of genome databases and by direct cDNA sequencing, and to use phylogenetic analysis of synonymous and non-synonymous codon changes to seek evidence for evolutionary selection of CaSRs.</p>	

7. Research implementation and results under the program

Title of your research plan: Sequencing the Extracellular Calcium-sensing Receptor of a Primitive Chondrichthyan Fish and Reevaluation of Receptor Protein Phylogeny

Description of the research activities:

During my two month JSPS program experience at the Ocean Research Institute in Professor Yoshio Takei's Laboratory of Physiology, I learned several new techniques including: reverse transcription of mRNA tissues, cDNA synthesis, transformation and cloning the CaSR sequence in competent cells for full length sequencing, and quantitative RT-PCR. With the use of bioinformatics, I was able to confirm the CaSR for the elephant shark with my PCR products.

Elephant shark mRNA tissue samples were used to create a cDNA library. This library was then used for gel electrophoresis, where expected band sizes were extracted, transformed, and cloned using competent *E. coli* cells, and then sequenced. This sequence information was used to design primers for quantitative real time PCR analysis. RT-PCR was used to identify CaSR expression levels in various elephant shark tissues, such as brain, heart, gill, liver, rectal gland, gonads.

My objectives of cloning and sequencing the elephant shark CaSR was accomplished. In addition, I was able to perform an RT-PCR to quantify the tissue expression of the CaSR in multiple tissues. However, this is the first time that the elephant shark CaSR has been sequenced and analyzed; therefore, when I return to the University at Buffalo, I would like to continue this research and further develop additional primer sets to continue my analysis of the CaSR expression levels. This novel information obtained from my research will contribute further support for the evolutionary selection of the CaSR.

8. Please add your comments (if any):

My research and cultural experiences in Japan have been an excellent opportunity for me to learn laboratory techniques and cultural differences. This research experience would not have been possible without the help of Takei-sensei, Hyodo-sensei, post-doctoral fellows, graduate students, and staff at the Ocean Research Institute. This summer's collaboration with my lab has allowed me to develop my knowledge and ability in laboratory techniques. I have fully enjoyed my overall experiences this summer, and anticipate my return to Japan in the future.

9. Advisor's remarks (if any):

Because of her friendly personality, she adapted to the lab very quickly and built up good friendship with the staff and graduate students of this lab. She also performed quite excellent works on the Calcium-sensing receptor in such a short time. The cloning of the receptor in the cartilaginous elephant fish is new and I am convinced that she will continue the work after her return to Buffalo and publish the work as an original paper.

RESEARCH REPORT

1. Name: Ervin LeRoy Johnson III	(ID No.: SP09029)
2. Current affiliation: University of California, San Francisco (UCSF)	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Doshisha University	
5. Host researcher: Professor Tomoyuki Takahashi, MD/PhD	
6. Description of your current research <p>The capacity to preserve consistent function in the face of environmental and developmental challenges is a general theme in biological systems. Indeed the homeostatic regulation of some cellular processes is necessary for life. This is particularly evident in the developing nervous system. During childhood, neuronal and glial cell numbers increase considerably; and as ion gradients and the composition and properties of ion channels change, the electrical properties of neurons are dramatically altered. Interestingly, risk for seizure is significantly higher in children than in adults, which might reflect the strain that neurodevelopment puts on neural network function.</p> <p>Still, for most children pathologic neural network behavior is avoided and brain function remains normal. In fact, in certain domains such as new-language acquisition, the childhood brain outperforms that of the adult. This indicates that neurons and/or neural networks compensate for developmental changes in cell numbers and electrical properties. This process has been termed ‘neural homeostasis’.</p> <p>Current models of neural homeostasis propose that individual cells detect deviations from baseline neural activity cell-autonomously. Additionally, cell-autonomous and non-cell-autonomous means of returning activity back to baseline have been described. The non-cell-autonomous, or synaptic, forms of homeostasis are characterized by postsynaptic cells influencing the neurotransmitter release properties of their presynaptic partners to regulate their own activity.</p>	

A particularly interesting example of ‘synaptic homeostasis’ was recently described at the glutamatergic *Drosophila* neuromuscular junction (NMJ). In this study, the authors demonstrate that in the short term application of an ionotropic glutamate receptor antagonist decreases the muscle response to the fusion of individual synaptic vesicles (quantal response) and leads to a proportional decrease in the muscle response to a presynaptic action potential, which elicits the simultaneous fusion of many synaptic vesicles. Over the course of approximately ten minutes however, the average number of synaptic vesicles that fuse in response to a presynaptic action potential (quantal content) gradually increases. Ultimately, the increase in quantal content precisely compensates for the decrease in quantal response thereby returning the muscle response to a presynaptic action potential back to baseline.

While the *Drosophila* NMJ preparation is an excellent system for the genetic and molecular characterization of this synaptic homeostat, the presynaptic compartment is technically difficult to access in this preparation. Thus, a detailed mechanistic understanding of presynaptic homeostatic mechanisms may be difficult to achieve. Furthermore, an analogous experimental preparation in the mammalian central nervous system could prove invaluable to the development of treatments for diseases of improper network activity such as epilepsy.

An especially interesting candidate mammalian synapse that might be expected exhibit a comparable synaptic behavior is the well-studied calyx of Held-Principal cell synapse (calyx) in the mammalian auditory brainstem. Ultrastructural, molecular, and functional similarities between the *Drosophila* NMJ and the calyx suggest that the calyx may also exhibit synaptic homeostasis. Furthermore, the calyx preparation offers unparalleled access to the presynaptic terminal. Indeed, this presynaptic compartment is accessible to various forms of manipulation including direct patch-clamping. Thus, It was my goal this summer to elicit synaptic homeostasis at the calyx.

7. Research implementation and results under the program

Title of your research plan:

Establishing the calyx of Held as a System for the Study of Synaptic Homeostasis

Description of the research activities:

Before attempting to elicit synaptic homeostasis at the calyx two technical challenges had to be overcome. Thus, my research plan this summer was necessarily divided into three sequential steps. First, I had to learn to prepare rodent brainstem slices and conduct whole-cell excitatory post-synaptic current recordings under field stimulation. Next I had to determine the proper concentration of glutamate receptor antagonist to achieve partial synaptic blockade. Finally, with these two technical challenges solved, I was able to attempt to elicit a homeostatic response to receptor blockade.

As I spent the past 4 years working with *Drosophila*, I found moving to a mammalian system to be an especially daunting aspect of my summer research plan. While I have experience working with rodents in the past, the scale of the dissection and tissue preparation protocol were significantly more involved than I had remembered. Fortunately for me however, I had two excellent mentors and in approximately two weeks I became comfortable with the procedures and was able to prepare my own brainstem slices.

Next I moved on to identifying the proper concentration of glutamate receptor antagonist. In an ideal setting I would have been much more methodical in my approach, ultimately resulting in a dose response curve plotting quantal response amplitudes as a function of glutamate receptor antagonist concentration. In the interest of time however, I took a much less systematic approach and repeated experiments much fewer times than I would have preferred. Ultimately however, I was able to settle on a concentration that I believe was appropriate.

Finally, I moved on to attempting to elicit synaptic homeostasis. With the limited time I had remaining I was able to collect some preliminary data. Unfortunately however, my ability to collect data was diminished by relatively short time period over which brainstem slices are healthy enough for whole-cell recordings. Thus, my data is thus far inconclusive.

Ultimately, although I would have preferred to have more time to complete my research goals, I am pleased with the work I was able to complete this summer. I am also fortunate enough to have been given the opportunity to return to Professor Takahashi's laboratory in the near future to continue my research.

8. Please add your comments (if any):

I am grateful to have received the opportunity to come to Japan and carry out a research project while learning about Japanese research culture and Japanese culture in general. However, I do not feel that 10 weeks is sufficient time to achieve all three of these goals. I understand that there are considerable funding constraints that may make it impossible to extend the program significantly. Still, in my view even one more week would have been very valuable. I would be remiss however if I did not repeat my gratitude for having been chosen to participate in the excellent program.

RESEARCH REPORT

1. Name: Christopher A. Kieslich	(ID No.: SP09030)
2. Current affiliation: Department of Bioengineering, University of California, Riverside	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Cybermedia Center, Osaka University, Suita Campus	
5. Host researcher: Susumu Date	
6. Description of your current research <p>The complement system, a component of innate immunity, is a cascade of protein interactions whose proper function is vital to the body's ability to fight infection. When proper regulation fails, the complement system is unable to recognize "self" from "non-self" and therefore attacks own tissues leading to an autoimmune disease. Despite intense research efforts, there are no anti-complement drugs in use in the clinic today. Two important targets for complement regulation are the G-protein coupled receptors for the complement anaphylatoxins, C3a and C5a (C3aR and C5aR), which when activated lead to the chemotaxis and activation of leukocytes. My current research focuses on the application of computational methods to gain a better understanding of the C3a:C3aR and C5a:C5aR interactions. In its current state, my research primarily involves the construction and analysis of computational models of C3a/C5a bound to their receptors C3aR/C5aR. Based on these models, computer simulations are used to investigate the dynamic and physicochemical characteristics of the anaphylatoxin-receptor complexes. From this knowledge, peptides are designed using <i>in silico</i> methods, and experimental assays are performed to determine the activities of the best-predicted analogs. The analogs with the most activity, as well as already published potent peptides, will be optimized through the development of pharmacophore models. Since small organic molecules are preferred as drug candidates, a grid service-based virtual screening platform will be used to search an online database of drug-like molecules. Experimental assays will be used through out for validation of the calculations and predictions.</p>	

7. Research implementation and results under the program

Title of your research plan: *Docking studies for the complement system receptor C5aR using a grid computing platform*

Description of the research activities:

The project that I originally had proposed for the JSPS Summer Program, involved the implementation of a grid-computing platform for virtual drug screening. This platform has been developed by my host researcher, Professor Susumu Date of Osaka University, and Dr. Jason Haga, a collaborator at University of California, San Diego. However, after arriving in Osaka and discussing further with Professor Date what I hoped to gain from the project, it was decided that the scope of the project should be changed. The new project was to focus more on the grid-computing aspect of the virtual screening studies and was to be structured as a series of training exercises, since grid-computing is Professor Date's primary field of research. Also, grid-computing technology can be utilized to perform many other types of simulations, so this experience will be very beneficial for other portions of my thesis research. Grid-computing utilizes software, known as middleware, to gain access to available shared computing resources across institutions and nations. The communication and security of the grid is organized into two levels, the first level representing communication and security within a computer cluster, which typically has a single owner, and a second level for communicating with the computer clusters that belong to the grid. Therefore my new project was two-fold, and the first aim of my project was to setup a Beowulf-style computer cluster from the bottom up. The constructed cluster was to be capable of performing docking simulations using the software DOCK (UCSF), which were to be utilized in my originally proposed virtual drug screening studies. My constructed computer cluster was setup with both a job scheduling system and a message passing interface (MPI) which provide two separate methods of job distribution. A series of docking simulations were performed to test the two job distribution methods, SGE and MPICH2, as well as to compare the efficiencies of these two systems. Based on a comparison of the total simulation time for a set of docked molecules and the average docking time per molecule, it was observed that SGE job distribution was noticeably more efficient. Following the testing of my Beowulf computing cluster, the next step was to now focus on the second level of communication needed for the distribution of jobs in a grid environment. Communications on a grid are all based on a middleware package

known as the Globus Tool Kit, which provides methods for job submission, data transfer, and most importantly security. A second scheduling system, Condor G, which is built on the Globus platform, was also setup and tested. This summer project has provided me with an introduction into power high-throughput and grid computing technologies and resources that will continue to enhance my ability as a researcher in computer aided drug design.

8. Please add your comments (if any):

Through the JSPS/NSF Summer Research Program I have gained valuable research experience, met some great new friends, and had exposure to the wonderful culture of Japan, all of which I hope to keep with me for a lifetime. So, I would like to thank Professor Date and the members of his lab, for their amazing hospitality, as well as the organizers from JSPS and NSF for giving me this life changing opportunity. All of these people have made this summer unforgettable.

9. Advisor's remarks (if any):

Chris has learnt the basics of cluster computing and Grid computing from both aspects of theory and practice. Now he can build his own computing cluster system composed of multiple computational resources, set up DOCK simulation software and perform his biological analysis by taking advantage of distributed computing. Also, he has already mastered how to use multiple computational resources such as cluster systems on the Internet using Grid technologies. I as a supervisor hope what he has learnt through his stay in our labo help and contribute to his future research. Also, I hope he enjoyed the stay in Osaka and he thinks his stay valuable and fruitful to his life from now. Honestly, I was surprised by his active attitude to learning. He always seemed to try to absorb everything possibly useful for his research from us. Furthermore, his progress to learn was more than I expected. Moreover, his learning attitude and achievement was enough to stimulate Japanese students in the laboratory. Therefore, I am thinking that this kind of opportunity is also helpful to us as the host institution. Again, I hope he actively works on his research field by leveraging what he has learnt in Japan and we can meet again.

RESEARCH REPORT

1. Name: Gabriele Koch	(ID No.: SP09031)
2. Current affiliation: Osaka University	
3. Research fields and specialties: Humanities <u>Social Sciences</u> Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Department of Human Sciences (Graduate School of Human Sciences)	
5. Host researcher: Professor Muta Kazue	
6. Description of your current research: <p>My research focuses on Japanese discourses surrounding the trafficking of women into the Japanese sex industry. Japan has had a well-developed commercial sex industry since the creation of a system of licensed prostitution in the late sixteenth century. Although the 1956 Prostitution Prevention Law criminalized prostitution, the law's narrow definition allowed for the legal proliferation of a multi-billion dollar sex industry offering every service short of penile-vaginal intercourse. Transnational criminal networks have facilitated the entry of Southeast Asian and Latin American migrant women into this industry since the 1980s, as well as of Eastern European women since the breakup of the Soviet Union. In the 1990s, migrant support networks and international organizations alike began referring to foreign sex workers as victims of human trafficking, invoking a human rights paradigm to construct migrant women as particular subjects vulnerable to abuse. Over the past decade, the Japanese government has increasingly generated policy action on sex trafficking, such that trafficking debates now connect three overlapping areas of concern: migrant labor, sex work, and human rights.</p> <p>Against the backdrop of a pervasive rhetoric on human rights and gender equality in the public sphere, what do trafficking discourses – entailing government policies and legal deliberations, mass media and academic debates, and advocacy by nongovernmental organizations (NGOs) – reveal about notions of the rights of foreigners, women, and sex workers? My research uses ethnographic field methods in order to explore trafficking and sex work as frames through which to examine the understanding and deployment of human rights in Japan today.</p>	

7. Research implementation and results under the program:

Title of your research plan: Trafficking and Human Rights Discourses in Japan

Description of the research activities:

My research activities can be broadly divided into archival research, interviews and participant-observation, as well as a more general scouting out and cultivating of research networks for my future dissertation fieldwork. I spent a significant amount of time in the archives of the Tokyo Women's Plaza, where I accessed primary sources such as shelter newsletters and advocacy materials, as well as government documents, academic commentary, and conference proceedings. I conducted interviews, both formal and informal, with numerous activists, researchers, scholars, and feminists, as well as with journalists, lawyers, police officers, and sex workers. I also participated in NGO events, attended academic conferences, such as the Japan Women's Studies annual meeting, and observed a Cabinet Office opinion exchange meeting.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Nadia Kulshina	(ID No.: SP09032)
2. Current affiliation: Fred Hutchinson Cancer Research Center/ University of Washington	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: University of Tokyo RCAST	
5. Host researcher: Prof. Hiroaki Suga	
6. Description of your current research <p>Cyclic dimeric guanosine monophosphate (c-diGMP) has been shown to function as a second messenger in bacteria, controlling production of adhesive matrix components and multicellular behavior, including biofilm formation. However, very few c-diGMP targets are known, and how this small molecule controls complex bacterial behavior remains unknown.</p> <p>Last year a breakthrough was made showing that c-diGMP achieves coordinated regulation of multiple pathways by binding to a riboswitch. Riboswitches are mRNA domains that consist of an aptamer and an expression platform, and regulate gene expression <i>via</i> direct binding of a ligand. At the molecular level the two crucial biological properties of a riboswitch are its exquisite specificity for its cognate ligand, and the ligand-binding induced conformational changes that lead to modulation of gene expression.</p> <p>The overall goal of my thesis project is to understand how the c-diGMP riboswitch recognizes its cognate ligand, and to determine how this event is transduced into RNA conformational changes. To accomplish my goal I will employ a variety of approaches and methods, ranging from isothermal titration calorimetry to small-angle X-ray scattering and X-ray crystallography.</p> <p>As part of the EAPSI program at the RCAST, University of Tokyo my goal was to analyze the mechanism of recognition by the c-diGMP riboswitch using the SELEX technology (see below). I performed <i>in vitro</i> selection for variant c-diGMP riboswitch RNAs that will recognize the cognate ligand, c-diGMP, and for RNAs with altered specificity that will recognize and bind c-diAMP instead. Comparison of the selected sequences from the two pools will provide insight into the role of specific riboswitch</p>	

moieties and bases in ligand recognition. This SELEX analysis will allow me efficiently to explore the sequence space of the c-diGMP riboswitch, and it will provide a rich complement to my structural studies.

7. Research implementation and results under the program

Title of your research plan: **How a bacterial second messenger functions: ligand recognition by the c-diGMP riboswitch**

Description of the research activities:

Systematic evolution of ligand by exponential enrichment (SELEX) is a method that is used for the development of aptamers, which are oligonucleotides (RNA or ssDNA) that bind to their target with high selectivity and sensitivity. This method was described primarily in 1989-1990, and is now widely used for basic research, drug development, diagnosis and therapy. The starting point for a SELEX procedure is a chemically synthesized DNA oligonucleotide library consisting of about 10^{13} - 10^{15} different sequences. For an RNA aptamer selection this library first has to be transcribed into RNA. This randomized RNA is then incubated with the target molecule. The bound RNAs are partitioned from the unbound, and bound RNAs are then reverse-transcribed. The resulting dsDNA is then converted to a new pool of RNA by *in vitro* transcription and subsequent purification. Now the next SELEX round is started. Iterative cycles of the selection and amplification of the initial random oligonucleotide pool allow for the reduction to relatively few sequences with the highest affinity and specificity for the target. The last SELEX round is stopped after the amplification step and the PCR products are cloned to get individual aptamer clones from the selected pool. These individual aptamers are sequenced and sequence analyzed.

The initial DNA libraries were created *de novo* from chemically synthesized DNA. I created two libraries: one with complete randomization of selected regions, and another with limited mutagenesis of the same regions. The randomized pool allows for sampling of a very large sequence space (with complexity on the order of 10^{13}). However, such wide variety of initial sequences might lead to a solution with a mode of binding that is unrelated to the wild-type (wt) sequence and consequently not informative as to the structural basis of selectivity of the wild-type RNA.

Additionally, because initial sequences are present in very few copies, limitations of PCR, transcription and other molecular biology manipulations might lead to losses of sequences. The second pool of moderately mutagenized sequences will contain sequences in higher copies and that are more similar to the wt sequence. Residues that were randomized/mutated are located in the single stranded regions of the c-diGMP riboswitch. These regions were chosen because they were shown to have increased protection upon binding of the ligand, and therefore are likely to be

important in ligand recognition.

Step 1: Selection

The selection process consisted of two steps: selection of the species of the correct length on a denaturing PAGE, and the selection of active species. The first step ensures that the faster migrating species in the subsequent step are not just deletion mutants. To separate the bound and unbound forms I used the electrophoretic mobility shift assay (EMSA): RNA was incubated with c-diAMP or c-diGMP, as appropriate, and then run on a native PAGE. Preliminary data showed that the bound c-diGMP riboswitch migrates faster than the unbound. Moreover, in this assay the wt riboswitch is highly specific for its cognate ligand and doesn't undergo a change in mobility when incubated with other nucleotides (GTP, 5'GMP, 5'AMP) or c-diAMP. The RNA is then eluted from the gel and prepared for the next step.

Step 2: Amplification

The selected RNAs were reverse transcribed. The corresponding cDNA was amplified in a subsequent PCR. The T7 promoter was incorporated at this step with the 5'-end primer.

Step 3: Conditioning

The previous step yielded double stranded DNA, which was transcribed by T7 polymerase into RNA. This RNA was the input for step 1.

During the summer in Dr. Suga's laboratory I optimized the EMSA conditions for partitioning the bound and unbound RNA for the full-length construct with the added primer regions. I then performed 4 rounds of selection; after the 4th round the DNA template became significantly shorter, indicating that the pool is contaminated with deletion mutants. I will continue working on the selection once I return to my laboratory in the US, and in order to avoid such pool contamination I will use appropriate markers at the denaturing gel purification step.

RESEARCH REPORT

1. Name: Antony Lam	(ID No.: SP09033)
2. Current affiliation: University of California, Riverside	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Institute of Industrial Science, the University of Tokyo	
5. Host researcher: Dr. Yoichi Sato and Dr. Kris M. Kitani	
6. Description of your current research <p>With the wealth of images and videos on the Internet, there is a need for automated means of searching such files. Many current search engines today rely exclusively on user annotated text tags to find desired content. My current research is in the area of computer vision based information retrieval. Specifically, my aim is to analyze the content of image and video files to determine their relevance to user search queries.</p> <p>In particular, I have been focusing on the area of Content-Based Image Retrieval in the work at my home institution. This work involves the retrieval of still images based on queries for objects and the faces of specific people. In addition to analyzing the content of still images, I have also been investigating the use of relevance feedback in my retrieval system.</p> <p>Relevance feedback is an iterative method of mining information from users that has existed since the 1970s. The basic idea is that a search engine returns a ranked list of items to a user based on his or her query. The user then indicates to the search engine, which of the top items in the list were relevant. The search engine would then improve its search rankings with respect to the new information. The feedback process could then be repeated by the user until satisfaction.</p> <p>The next phase of my work is to investigate how well similar ideas could be applied to the searching of videos for particular activities such as cooking and game playing. This phase of work was started at my host institution and will be continued at my home institution with continued collaboration between both sides.</p>	

7. Research implementation and results under the program

Title of your research plan: Video Retrieval of Activities with Relevance Feedback

Description of the research activities:

The research conducted at my host lab involved different phases. The first phase was to create a small dataset of sample videos to use as test data for the proposed video ranking system. (Larger sets of videos will be used in future work.) The videos made consisted of footage of card game variants being played and the goal was to be able to identify the difference between the variants by having the computer automatically learn the rules of a given variant through observation.

After recording all the videos, the recognition of playing cards present in the videos needed to be done before trying to have the computer learn the pattern of moves made to infer the rules of the game. This task proved more daunting than expected as the cards would not always be in perfect alignment and some of the videos had noise. (See Fig. 1.)



Figure 1. A sample frame from one of the videos.

These issues were eventually resolved with the use of heuristics that allowed for robust automated alignment of card images into some canonical form for easy processing.

The next phase of the project involved building a Stochastic Context Free Grammar (SCFG) system for automatically building grammars to describe observed patterns of play. (SCFGs are able to capture structure in a hierarchical manner and can be used to interpret things probabilistically.) The idea is to have the computer look at say ten sample videos (called the training data) of a particular variant of the game and then for the computer to be able to tell how similar a new video is to the variant that it learned.

The SCFG phase of the work involved implementing a grammar learning algorithm called Frequent, the inside algorithm for computing the probability of an observed sequence of actions in the videos, devising a heuristic for augmenting a grammar to accept patterns not observed in the computer's training data while still being able to tell if the novel pattern is similar to known patterns from the training data, and ultimately testing the system.

In the testing of the system, each of the variants of the games would be searched for with two iterations of user feedback. At each iteration of feedback, the user would indicate to the computer which of the top 10 ranked videos were relevant and the computer would include those videos as additional training data to improve its notions of the rules of the game. The videos would then all be re-ranked and the process repeated (videos where feedback was already given would not be shown again to the user). The results of searching for one variant of the game have been included in Fig. 2.

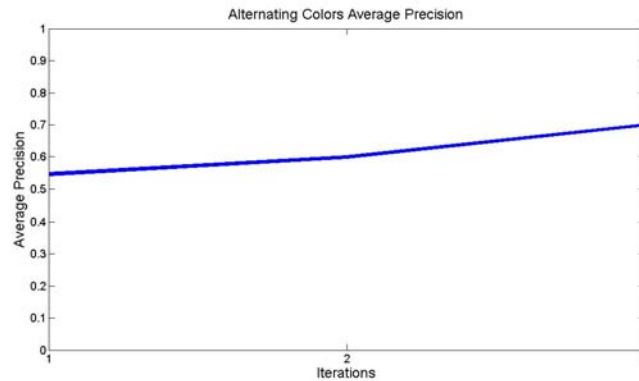


Figure 2. Average precision (1 is an ideal ranking) of one game.

8. Please add your comments (if any):

I would like to thank NSF and JSPS for the excellent opportunity to work in Japan over the summer as well as thank my host researchers for volunteering their time. While the time was short, I was able to have many good interactions with people both inside and outside the lab and was able to achieve reasonably good results in the experiments. My host researchers will continue to collaborate with me when I return to the US and we plan to submit the work to an international conference in the next few months. I certainly hope to be able to continue my collaborations with them in the years to come.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Chang Won Lee	(ID No.: SP09034)
2. Current affiliation: University of California, Irvine	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: The University of Tokyo	
5. Host researcher: Dr. Yuji Ikegaya	
6. Description of your current research <p>Neurons communicate through transient electrical pulses called action potential (AP). The APs can be measured by intracellular or extracellular recordings, which constitute major techniques in neuroscience research. Multi-sensor recording technology, which uses several closely placed sensors (at intervals of < 50 microns), is a promising technique to measure APs extracellularly. This technique yields a better quality of recorded APs which facilitates subsequent processing and analysis of APs. Motivated by recent advances in multi-sensor recording technology, we developed a method to estimate the number and positions of neurons, based on their AP waveforms collected through multi-sensor microelectrodes.</p> <p>Based on the volume conductor theory and biophysics of neuronal membrane, the generation of APs can be simplistically described by low-dimensional generative models (e.g. dipoles or monopoles). Applying these models to analyze the measured APs makes it possible to infer the actual position and signal magnitude of neurons. The knowledge of these parameters will provide useful information for the process of electrode positioning and guidance. In addition, this information may have significant scientific implications, as cells can be differentiated based on their dendritic morphology and size, which are often in correlation with their functional role.</p>	

7. Research implementation and results under the program

Title of your research plan:

Localization of neurons activity in cultured hippocampus of rat via multi-sensor recording technology and functional multineuron calcium imaging (fMCI)

Description of the research activities:

During the East Asia and Pacific Summer Institutes, I have acquired data of electrical activity from cultured slice of Wistar/ST rats (SLC, Shizuoka, Japan) via the four-sensor electrode, tetrode (Thomas Recording GmbH, Germany). Functional multineuron calcium imaging (fMCI) has also been performed in order to obtain the spatiotemporal pattern of action potentials from neuronal population during extracellular recording. fMCI provides single-cell-resolution and identifiable location of neuron images. Moreover, the electrical activities of neurons in rat brain slices have been collected with multi glass micropipettes, which is a typical technique to acquire neuronal electrical activity. Data of simultaneous electrical neuronal activity has been collected from about one-week-in-vitro slices in most experiments. No physical or chemical stimulation has been introduced to the slices. For fMCI, the slices were incubated for 1 hr with 5 μ l of Oregon green 488 BAPTA-1AM, 2 μ l of Cremophor EL, and 2 μ l of Pluronic F-127 to 2 ml of Artificial cerebrospinal fluid. Images were collected with up-right microscope (Nikon, Japan) and captured with cooled CCD cameras [iXon DV885 (Andor, Belfast, UK)].

An electrical stimulator has been applied in order to validate the method in simplified circumstance where only one electrical source exists. Because the current method has been developed for monopole model, this experiment has been operated to validate the method. The data collected during EAPSI program will be analyzed in my institute.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Ichi Lin	(ID No.: SP09035)
2. Current affiliation: The University of Arizona	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences <u>Interdisciplinary and Frontier Sciences</u>	
4. Host institution: RCAST, University of Tokyo	
5. Host researcher: Dr. Ryohei Kanzaki	
6. Description of your current research <p>Dragonflies possess an amazing ability to track small targets as can be observed in their preying activities. Such high-speed pursuit of prey is possible due to the ability of the dragonfly to rapidly process its visual information and relay the processed information from its brain through the Ventral Nerve Cord (VNC) to the thoracic motor centers, which in turn initiate appropriate motor responses. Eight Target-Selective Descending Neurons (TSDNs) in each of the two parallel connectives of the VNC have previously been identified. They have been found to be purely visual and responsive only to movements of small targets. In addition, among them at least one was selective for target movement in the leftward, rightward, upward, or downward direction.</p> <p>Although much is known about these neurons in open-loop conditions, scientists have not yet been able to study their responses in a closed-loop target pursuit situation. My research involves the characterization of the neural mechanisms involved during target pursuit through the use of a mobile robotic platform driven by TSDN signals recorded and processed from a live dragonfly aboard the platform in real-time. By allowing the dragonfly to “drive” the platform in a real-world environment, more meaningful and accurate neural responses can be recorded.</p> <p>Prior to construction of the robotic system, a virtual reality system will first be used to investigate the capability of a dragonfly to pursue a moving target in a simulated environment. The live dragonfly will fly in a virtual world and pursue a virtual small target seen on a computer display.</p>	

7. Research implementation and results under the program

Title of your research plan:

A Visual Small Target Tracking System Using Live Dragonflies

Description of the research activities:

The summer project served as a preliminary investigation to my PhD dissertation project. Open-loop data was collected from the ventral nerve cord of dragonflies while small moving targets of various parameters (i.e. direction of travel, target size, and speed of travel) were presented. Small-target visual stimuli were provided using VisionEgg software and experiments were designed and coded in Python language. Matlab scripts were constructed for analysis of the open-loop data, and the correlation between obtained spike shape/pattern and each small moving target parameter was investigated. Using this information, spike decoding algorithm was then initially constructed to be used in the closed-loop virtual system experiments. During my stay I have gained a great deal of knowledge from the Kanzaki lab. This includes the construction of a low-latency (using Ubuntu Linux OS) and high frame rate (using a DMD chipset) visual display system, which I shall attempt to build upon my return to the United States. In addition, I also learned many different techniques on neural recording, such as the use of suction electrodes, the use of differential electrodes, and electrophysiology on silkworm neck motor neurons. Among many activities conducted during the summer, we also constructed a mini dragonfly insectarium in which dragonflies were brought up to adult forms from the larval stage.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Derek J. Lura	(ID No.: SP09036)
2. Current affiliation: University of South Florida	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Saga University	
5. Host researcher: Dr. Kazuo Kiguchi	
6. Description of your current research: <p>Current research focuses on the use of robotic methods in the simulation of serial manipulators; robots, prostheses, exoskeleton devices, and the human upper body. The benefit of simulation in robotics has been well established; the use of simulations can greatly reduce the cost and time involved in the development, and testing of robots, and their control devices. Simulations can be quickly created to test a hypothesis concerning the behavior of a control mechanism or design. Previous work has primarily focused on the simulation of the human upper body when performing tasks with different prostheses of varying complexities. Within the simulation the performance of each prostheses can be quantitatively analyzed, because the simulation can be setup and run with little expense and time it is possible to test a large number of configurations. As a greater number of configurations are tested it becomes the more likely the idea solution will be found. The results of the simulation can also be used to improve each change in the models configuration, thus increasing the speed at which the idea solution is approached. The expansion of simulation methods developed for use at Saga University will continued and applied to simulations for other robotic systems and the human upper body at the University of South Florida. Future collaboration will hopefully lead to the development of simulation tools applicable in a wide range of fields.</p>	

7. Research implementation and results under the program

Title of your research plan:

Simulation of 7 Degree of Freedom Upper-Limb Assistive Exoskeleton

Description of the research activities:

Creation of simulation software using the Python programming language. Software includes functions for kinematic and kinetic simulation of a 7 degree of freedom upper-limb assistive exoskeleton currently being developed at Saga University. The Software is comprised of three separate programs. The first program, the "Parameter Editor," allows for the parameter file to be opened, edited, and saved, from a GUI interface, so that even a person with no programming experience will be able to make effective and accurate changes to the model. The second program, the "Controls Program" contains a series of control methods and a visualization window that shows a primitive model of the upper-limb assistive exoskeleton. While the PyODE simulation runs on the variables from the parameter file, the visualization does not update with changes to the parameter file due to the complexity of the visual model. The third program, the "Server Program," runs the simulation, the visualization window, and an XML-RPC server, using a module included in the Python (versions 2.2 and up) distribution. The XML-RPC server allows the simulation to communicate with any XML client, which can be implemented into the control code for the exoskeleton in almost any programming language, and can even allow the simulation to run on a remote location.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Miyeko Mana	(ID No.: SP09037)
2. Current affiliation: New York University	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Riken Center for Developmental Biology	
5. Host researcher: Asako Sugimoto	
6. Description of your current research. <p>Embryogenesis requires the coordination of multiple complex cellular processes, such as DNA replication, nuclear positioning, setting up asymmetries and proper execution of cytokinesis, to name a few. Each one of these processes involves numerous molecular components. In order to understand the organization and coordination of these components, a critical parameter is their subcellular localization during each cell division. Unbiased approaches that systematically address the dynamics of protein localization, combined with other aspects of protein function, provide the materials by which we can begin to construct a molecular blueprint of cellular organization. Network models for protein and genetic interactions occurring within <i>Caenorhabditis elegans</i> early embryo have led to an increased understanding of such a molecular organization, yet they remain a static representation of molecular events. Localization data contributes spatial and temporal dimensions to the network models further resolving molecular relationships during different embryonic states. Comprehensive knowledge of the subcellular location of proteins provides a dynamic view that begins to explain the coordination and interplay between these components during embryogenesis.</p> <p>In an effort to generate a localization network, I have initiated a study to localize ~150 proteins selected by their connection to a core set of seven proteins required for the establishment of anterior-posterior polarity of the early <i>C.elegans</i> one-cell embryo. For my PhD thesis project, I am generating GFP fusion strains representing all the proteins of this “polarity module” in order to analyze their localization patterns with live-imaging during the first two rounds of mitotic cell division. Analyzing the localization pattern of these gene products, of both known and unknown proteins, will generate many hypotheses about molecular relationships that may contribute greatly to our understanding of the dynamic</p>	

cellular processes that participate in establishing the anterior-posterior axis in early embryogenesis.

7. Research implementation and results under the program

Title of your research plan:

Protein interactions and functional dependencies in the subcellular localization network for *Caenorhabditis elegans* early embryo.

Description of the research activities:

The projects I pursued address molecular relationships of 1) dynamic proteins, proteins that localize to multiple distinct compartments in the cell at different times in the zygote, and, 2) co-localized proteins and their functional dependencies. The experiments represent a proof-of-concept to the idea of a localization network by connecting groups of proteins together in a coordinated way. In my 9 weeks working in Japan I conducted the following parallel projects:

- I. Immunoprecipitation of W10G11.20 and KIN-19.
- II. Molecular characterization of gene *kin-19*.

Immunoprecipitation (IP) of W10G11.20 proceeded by identification of protein interactors using Mass spectrometry (MS) was training ground for learning a new protocol and procedure. W10G11.20 is part of a multisubunit protein complex. The IP/MS results identified all 11 components of the complex along with many other candidates that W10G11.20 potentially binds with *in vivo*. KIN-19, however, is not part of a complex so the immunoprecipitation required modifications to the protocol in order to obtain better results. Observing differences from the control are few so additional modifications are needed before continuing with the mass spectrometry to identify protein partners.

KIN-19::GFP fusion protein is seen on the centrosomes and cytoplasmic puncta. These puncta resemble p-granules, the protein and RNA assemblies that segregate to the posterior of the first cell and remain in the posterior cell before giving rise to the germline. It is therefore possible that KIN-19 has functional roles in both subcellular compartments and loss of kin-19 would disrupt the normal function or formation. Removal of kin-19 via RNAi results in reduced number of p-granules

as seen by a p-granule specific marker, PGL-1::mCherry (PGL-1 protein fused to mCherry fluorescent protein). PGL-1::mCherry aggregates are less in number and PGL-1::mCherry appears to be more dispersed in the cytoplasm. It is possibly that KIN-19 is required in part for proper p-granule assembly or aggregation. Furthermore, the centrosomal organization during mitosis is less organized; the centrosomal mass as seen in a TBG-1::mCherry embryo (gamma tubulin protein fused to mCherry fluorescent protein) is larger in diameter and tends to disassemble after anaphase more quickly than the control. This phenotype indicates that the microtubules may not be tightly anchored to the centrosome. The next experiment would be to remove *pgl-1* or *tbg-1* to see if KIN-19::GFP localization is disrupted.

kin-19 is essential for survival yet whether or not these observed defects are responsible is unclear. Interestingly, *kin-19* (RNAi) embryos often have a polar body on each pole whereas typically both polar bodies are located on the anterior pole. In wildtype, the embryo extrudes a polar body at the anterior pole during meiosis I and again during meiosis II. Observing polar bodies on each pole indicates that after meiosis I, the nucleus migrates to the opposite pole to complete meiosis II. This nuclear migration can be observed with DIC live-imaging and raises questions about polarity establishment at an early time point than I have considered thus far.

RESEARCH REPORT

1. Name: Matthew Nichols Martin (ID No.: SP09038)
2. Current affiliation: Rensselaer Polytechnic Institute, Troy, NY, USA
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> <u>Chemistry</u> Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: University of Tsukuba
5. Host researcher: Professor Toshiharu Teranishi, Chemistry Department
6. Description of your current research <p>Since entering graduate school three years ago, I have been working with Professor Sang-Kee Eah of the physics department at Rensselaer Polytechnic Institute in Troy, NY. Our research focuses on the synthesis, self-assembly, and characterization of nanomaterials. Specifically, I focus on spherical gold nanoparticles between one and ten nanometers in diameter. Below ten nanometers, gold nanoparticles exhibit extremely strong optical and electronic properties that bulk gold (>100nm) does not possess, making them extremely useful for future sensing, optical, and catalytic devices.</p> <p>We have discovered a synthesis method for gold nanoparticles yielding stable gold nanoparticles which can be tuned in size from ~3-7nm. However, the major benefits of our procedure are its speed and application opportunities; our synthesis takes less than 10 minutes without requiring a cleaning or purification process, and our nanoparticles are charged in nonpolar solvents, allowing us to fabricate close packed thin-film monolayers of gold nanoparticles. Thin films of nanoparticles have countless applications in basic science research, engineering, and device fabrication.</p> <p>Although we can synthesize larger nanoparticles (up to ~10nm), the procedure is not highly reproducible yet. We have also synthesized gold nanoparticles less than 2nm in diameter, entering the field of nanoclusters. Nanoclusters are heavily researched because they are extremely useful as catalysts, and they also could be used as building blocks for small scale devices. Currently we have extended our nanoparticle synthesis method to nanoclusters, however, we cannot produce distinctly sized nanoclusters yet.</p>

7. Research implementation and results under the program

Title of your research plan:

Synthesis and Self-Assembly of Charged Gold Nanoparticles in Nonpolar Solvents

Description of the research activities:

I had several goals for the summer that I discussed with Professor Teranishi, and we agreed on the following goals.

1) Understand the nature of charge and its origins on our nanoparticles:

This was a difficult goal, and we were not able to determine where the negative charge on our nanoparticles was coming from. In order to study charge, we used nuclear magnetic resonance spectroscopy (NMR) to determine the amounts of excess trace chemicals on our nanoparticles. However, our nanoparticles were very clean, and chloride, hydroxide, sodium, and borohydride ions were not present in our samples. Thus NMR did not point to the culprit behind nanoparticle charge.

Similarly, X-ray fluorescence spectroscopy (XRF) was performed to detect chemicals attached to the surface of our gold nanoparticle cores. However, just like NMR, our samples were clean, and we did not detect significant amounts of any trace chemicals. XRF however was useful in determining the molecular weight ratios of compounds used in our synthesis procedure.

I also performed IR spectroscopy, but that was inconclusive for the same reasons.

2) Learn nanoparticle shape control:

I had no experience in nanoparticle shape control before coming to Teranishi lab; I could only make spheres. A post-doc, Cuncheng Li, taught me how to make gold octahedral, gold rods, cubes, urchins, and plates. This might be interesting for future research because I would like to see how different shape nanoparticles self-assemble into larger two-dimensional structures.

3) Teach my method to Teranishi Lab:

- a. I taught my method to many students and both post-docs in Teranishi's laboratory, and I believe they will implement it for their own research!

4) Learn anything else I have time for:

- a. I had no extra time in the lab, since I was not able to finish the first goal.

8. Please add your comments (if any):

I really enjoyed the JSPS program and it was quite exciting to be a visiting fellow with a world-class researcher and laboratory like Professor Teranishi and his students. I am a physicist by training, and in an ever-increasing cross-disciplined research world, I can not think of a better place to broaden my chemistry horizons than his lab at the University of Tsukuba. Also I am extremely grateful that I was at a university, as many students in the lab were close to my age and we became friends that will surely collaborate in the future, or even just keep in contact.

The program seemed extremely well-run and efficient at every step. Allowing us to live throughout Japan also was great since it provided us with many opportunities to travel and explore the country. I see myself coming back to Japan, whether research related or recreation motivated! Thank you for all the hard work JSPS!

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Alfredo Adolfo Martinez-Morales (ID No.: SP09039)
2. Current affiliation: Department of Electrical Engineering University of California, Riverside, California 92521, USA
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Tohoku University
5. Host researcher: Professor Tadahiro Ohmi
6. Description of your current research In this research project the main objective involved the development of a science-based approach for the realization of a cost effective, high performance and high throughput solar cell technology. Using a low temperature (200°C) deposition technique, high quality photosensitive amorphous silicon (α -Si) thin films were deposited. The deposition process was assisted by a newly-developed and novel microwave excited high density plasma process, based on a metal surfacewave excitation plasma (MSEP) technology. An extensive experimental process was designed and executed to carefully investigate the correlation between plasma and deposition parameters with the resulting opto-electrical properties of as-deposited α -Si thin films. Furthermore, this investigation also studied the deposition of three different types of amorphous silicon layers; n+ type, p+ type and intrinsic layers as the three different types of thin films are required for the implementation of the solar cell device structure proposed in this work. The experimental results obtained in this work further support and are consistent with the potential application of the newly-developed microwave excited plasma technology for the realization of a new generation of solar cell devices. Precise control by design and during deposition by the investigated process will allow the deposition of thin films with the opto-electrical properties needed for the high conversion efficiency and low energy-cost solar cells of tomorrow.

7. Research implementation and results under the program

Title of your research plan:

High-yield manufacturing of new thin film amorphous silicon solar cells exhibiting very high conversion efficiency and low energy-cost production.

Description of the research activities:

This research project involved two main areas of focus; 1) establishing a very high quality plasma process and 2) developing a high productivity plasma processing technology.

In order to satisfy both objectives, a scientific-based approach was implemented in this study. The research activities involved the careful design of experiments in order to optimize the plasma and process conditions required to obtain high quality and high photosensitive α -Si thin films.

The processing parameters investigated in this research project were: pressure of processing chamber, microwave power used to excite the plasma, temperature and gap distance of the processing stage, partial/total gas flow rate of processing gases, dilution ratio of processing gases and gas ratio of doping gases. Additionally, optimization of the normalized ion flux and ion bombardment energy was also investigated.

Relating to the research targets mentioned above, this work involved the operation and optimization of the newly developed MSEP-based process equipment, as well as investigating the structural quality and composition of as-deposited α -Si thin films, analyzing the opto-electrical properties of the α -Si thin films deposited by MSEP, manufacturing of α -Si thin film solar cells and evaluating the conversion efficiency of the fabricated devices using a solar simulator.

Among the specific material properties investigated on the as-deposited α -Si thin films were the following: structural quality and thickness, chemical composition, contamination content, transmittance and reflectance properties, absorption coefficient, band gap, conductivity under dark and illuminated conditions and photosensitivity.

8. Please add your comments (if any):

I truly feel that my research experience was extremely enriching both academically and culturally here in Japan. This has been an amazing opportunity of a lifetime that surpassed all my expectations. I feel that one of the most beneficial components of the EAPSI program (beyond conducting research at top notch centers and universities) was the unique opportunity to expand our network with other students, researchers and professionals in and outside our own area of research. In the short time period that I was in Japan, I have been able to start developing new friendships at a personal as well as professional level. Now, more than ever I can appreciate the importance of developing a worldwide network and the interdisciplinary nature of research.

I truly believe the main reason as to why, my experience was so enriching and positive in Sendai has a lot do with the kindness and helpfulness of the members of my research lab. From the moment I arrived to my lab, they were extremely friendly and willing to assist me in any possible manner. I will always remember this summer as one of the most rewarding experiences of my life.

9. Advisor's remarks (if any):

Mr. Alfredo Adolfo Martinez-Molales, who is Ph.D candidate student of University of California, Riverside (UCR), has stayed in my laboratory for 2 months and carried out enthusiastically experiments to create new silicon thin film solar cells having very high conversion efficiency by using newly developed plasma process equipment : 915 MHz Metal Surfacewave Excitation Plasma (MSEP) completely free from contaminations and damages. Joint research project between my laboratory and UCR on the silicon thin film solar cells having very high conversion efficiency is going to be accelerated by the very excellent efforts of Alfredo in these 2 months, where this joint research project has started last year in order to overcome the global warming issues by developing new thin film silicon solar cells having very high conversion efficiency, i.e., the total generation energy of these new solar cells completely larger than the entire energy used for the solar cell productions under the strong collaborations between Japan and United States Universities.

RESEARCH REPORT

1. Name: Morgan Therese McCarthy (ID No.: SP09040)
2. Current affiliation: San Francisco State University
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: University of the Ryukyus
5. Host researcher: Dr. Akihiro Takemura
6. Description of your current research <p>My current research focuses on the molecular evolution of genes that relate to novel morphological characteristics in the family Syngnathidae. The family Syngnathidae, which includes seahorses, seadragons, and pipefishes, is a charismatic group that contains some of the most striking examples of diversity and novel morphology among teleosts. They exhibit unique morphological and physiological traits including sex role reversal, fused jaws, elongated snouts, dermal plates in the form of bony rings, lack of or transient pelvic and caudal fins, and highly developed camouflage characteristics.</p> <p>In particular, I am investigating the molecular evolution of HoxA13 within the family Syngnathidae. HoxA13 is associated with the development of elongating fields in a variety of structures that occur in a phylogenetically diverse set of taxa. Due to the highly conserved yet dynamic nature of Hox genes, my hypothesis is that HoxA13 is implicated in the evolution of elongating fields snout length and dermal appendages within the family Syngnathidae. These characters are derived features associated with specialized feeding modes and camouflage. I am sequencing HoxA13 in species that represent 33 genera within the family Syngnathidae. I will compare the rates of molecular evolution between taxa and contrast the evolution of HoxA13 with the evolution of species within the family. If HoxA13 has been under high selective pressure for feeding efficiency or camouflage, I would expect to see increased sequence diversity in species with the most elongated snouts and elaborate dermal appendages. In addition to deriving gene sequences, I will also be measuring the expression levels of HoxA13 in embryos during key developmental stages in which the snout and dermal appendages begin to form. This part of my research will allow me to definitively link HoxA13 to the development and evolution of these unique traits within the family Syngnathidae.</p> <p>One final, crucial aspect to my molecular evolution research is the phylogeny of Syngnathidae. In order to compare sequence divergence of HoxA13 between taxa, I</p>

must know how the taxa are related evolutionarily. In other words, I need to be able to compare the gene tree to the species tree within Syngnathidae. To date, there has been no reliable phylogeny published for the family Syngnathidae. Phylogenetic analysis of morphological characters results in conflicting hypotheses, while the few molecular studies to date generally suffer from issues of taxon undersampling and have failed to produce a robust overall phylogeny. I am collaborating with Dr. Healy Hamilton and Mr. Graham Short at the California Academy of Sciences to create a robust and comprehensive molecular phylogeny of the family Syngnathidae. A comprehensive molecular phylogeny for this important and diverse group of fishes will help resolve issues of species and genus boundaries, directly support the documentation and wise management of marine biodiversity, and open up doors to further molecular studies of this family and its relatives.

7. Research implementation and results under the program

Title of your research plan:

Sampling Syngnathids in Okinawa

Description of the research activities:

I came to Japan this summer to collect seahorses and pipefish, members of the family Syngnathidae. Japan, and Okinawa in particular, is a hotspot of syngnathid diversity. Tens of species can be found in habitats ranging from coral reefs, to seagrass beds, to mangroves, and even freshwater streams and rivers. In addition, there are several species of both pipefish and seahorses that are endemic to southern Japan including *Doryrhamphus japonicus*, *Halicampus punctatus*, and a white color variant of the pygmy seahorse, *Hippocampus bargibanti*, found nowhere else in the world.

My sampling effort in Okinawa was necessary for further resolution of the phylogenetic tree for the family Syngnathidae. Although humans have a long history of fascination with some species such as seahorses and sea dragons, we know surprisingly little regarding their taxonomy, systematics, and evolution, the most basic building blocks of biological knowledge. Species and genus boundaries are uncertain, evolutionary relationships at the species, genus and subfamily level are largely unresolved, and many new species remain to be described.

My collaborators, Dr. Healy Hamilton and Mr. Graham Short, at the California Academy of Sciences are creating a comprehensive molecular phylogeny for the family Syngnathidae. Before I came to Japan, a total of 59 species in 33 genera within Syngnathidae and one species from the sister clade, Solenostomidae had been sampled. During my stay in Okinawa, I collected 18 species of pipefish and one species of seahorse, representing at least 10 different genera within Syngnathidae. I sampled in over 30 locations around Okinawa, Miyako, Iriomote, Ishigaki, Hatoma, and the Kerama Islands. One major accomplishment was my collection of the endemic pipefish, *Doryrhamphus japonicus*. In addition, I have collected at least 5 species of pipefish that I have been unable to identify, which may lead to new species identification or first records of collection in Okinawa. The

specimens that I have collected will be instrumental in the resolution of the phylogeny for Syngnathidae.

During my stay, I was also able to rear two species of pipefish in captivity – *Corythoichthys haematopterus* and *Syngnathoides biaculeatus*. I learned not only how to care for and maintain pipefish in an aquarium, but I also was successful in raising a gravid male pipefish and watch his brood hatch over one hundred juvenile pipefish. This was extremely exciting for a couple reasons – (1) pipefish are very difficult to maintain and even more difficult to have successfully reproduce in captivity and (2) I was able to collect dead embryos and juveniles to create a developmental series. I preserved the embryos in a solution called RNAlater, and I will use these specimens to measure expression levels of HoxA13 for my molecular evolution research.

Not only did I accomplish all of my goals this summer in Okinawa, but I also learned a great deal about Okinawan culture, made connections with foreign researchers, and increased my confidence as a researcher in both the lab and the field. I feel very fortunate to have had this opportunity. I know that the research I have done and the connections I have made will only help as I continue my career as a biologist. Thank you.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Nicholas William Miles (ID No.: SP09041)
2. Current affiliation: University of Florida
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Univeristy of Tokyo and National Institute for Basic Biology
5. Host researcher: Hirokazu Tsukaya
6. Description of your current research <p>The evolution of carnivorous plants represents one of the most interesting changes ever in evolution. Carnivorous plants evolved from photosynthetic ancestors that were primary producers that provided for the rest of the food chain to become, at least partially, secondary consumers. To understand the great changes in the function of the plant we must understand the basic changes in morphology and the genetics that control the morphology. The morphology of the leaves of carnivorous plants is what I am investigating. The plant leaf, which is usually flat and parallel to the ground, takes on the most aberrant forms when carnivorous. In pitcher plants, the leaf is tubular and stands vertically to hold liquid prey. Amazingly, pitchers evolved multiple times during the history of plants. What genetic changes were involved in those great changes in morphology? Did the three different independent evolutions of pitcher plants come about through similar or different genetic changes? Using what is already known about the key genes involved in leaf development in model plants, I hope to look at the behavior of those same genes in pitcher plants to answer these questions about the evolution of development (Evo-Devo).</p>

7. Research implementation and results under the program

Title of your research plan:

EVO-DEVO OF CARNIVOROUS PITCHER PLANTS

Description of the research activities:

During my time in Japan I was able to make a lot of progress on my research involving the developmental genetics of the carnivorous pitcher plant, *Cephalotus follicularis*. Under the tutelage of the Assistant Professor, Dr. Yamaguchi, and with the advise of Professor Tsukaya, I was able to isolate a dozen genes from three plant species and complete seven rounds of In-situ Hybridization. The genes that were isolated were of interest because they have been shown to be important in the development of leaves in non-carnivorous plants. The isolation of these genes from carnivorous plants represents the only known instance of the sequence of these genes being known for a carnivorous plant. With those genes isolated the next goal was to know where in the carnivorous pitcher leaf those genes were being expressed using In-situ Hybridization. This can be a difficult goal because expressed genes are in the form of RNA and RNA can be very unstable and easily degraded by contaminants in the laboratory environment. So, extra care must be taken to have a very sterile laboratory. The first step in the In-situ Hybridization was to cut off from the plant the material that I wanted to visualize the gene expression in. This was done in a way so that all the biological processes would stop in the tissue as well as all the cellular components would be preserved, especially the RNA. This part of the procedure needed to be optimized and the best chemicals to use varied with the species of plants. So, I had to do this many times to find the optimal chemicals. Once the tissue had been preserved or "fixed" and imbedded in a wax like chemical called "paraffin", I then had to cut the material into small sections that were placed on special microscope slides. The next day was then completely dedicated to hybridizing the RNA in the tissue to a special complimentary sequence that I had synthesized. The day after that is used to bind a dye to the complimentary synthesized sequence. After that the area of the tissue that is expressing my gene of interest is visualized by the presence of the dye. I was able to do this procedure seven times. The genes that I was able visualize will help to understand which parts of the complex leaves of carnivorous pitcher plants correspond to the simple leaves of other non-carnivorous plants. The evolution of the developmental genetics for leaves will also be better understood.

RESEARCH REPORT

1. Name: Timothy I. Miller (ID No.: SP09042)
2. Current affiliation: University of Illinois at Urbana-Champaign
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: University of Tokyo
5. Host researcher: Dr. Yozo Fujino
6. Description of your current research <p>Catastrophic bridge failures in the United States (Minneapolis, 2007) and the rest of the world have increased the public's awareness of and desire for effective monitoring of civil infrastructure. For effective monitoring, it is required to use smart, wireless, multi-scale sensors. One of the issues faced with wireless sensing networks is that of providing perpetual power. Currently, the wireless sensors commonly employed in structural health monitoring applications utilize single-use batteries. Using these batteries will provide power to the smart sensors for only a limited amount of time before needing to be replaced. Routine replacement of batteries can result in exorbitant fees, not to mention the danger that may be associated with handling sensors in precarious locations. To remedy this problem, I am conducting research to pragmatically utilize an alternative energy source for the smart sensors. My efforts are focused on utilizing a solar cell to recharge the batteries that power the sensor, thus allowing near-perpetual operation of the sensors with minimal maintenance. In addition to using energy-harvesting devices for the wireless sensors, I am also conducting research to increase their energy efficiency. By increasing the efficiency of the sensors, or at least limiting the power consumption at critical times, they can remain in use for longer periods of time.</p>

7. Research implementation and results under the program

Title of your research plan:

Energy Harvesting and an Energy Efficient Program for Wireless Sensors

Description of the research activities:

As a researcher at the University of Tokyo, I was concerned with creating a data acquisition program for the Imote2 wireless sensor platform. The Imote2 runs an operating system called TinyOS, and so development of the program involved first learning the computer language pertinent to TinyOS. After becoming sufficiently familiar with programming on the Imote2, I was tasked with modifying a data acquisition program to behave in a more energy efficient manner: to store acquired data on flash memory indefinitely until the user requests them rather than sending the data to a distant sensor after each acquisition. Storing data on flash memory in this manner keeps it safe in the event of a power failure (since it is non-volatile memory), and also affords the user the flexibility to request that data be sent (a power-hungry operation) only when the energy in the system is high. I have created the desired program, and tests in the laboratory show that it works with limited success. While I was unable to perform a full-scale test of the program on a bridge in Japan, the knowledge I gained and the progress I made are critical to my success with this project in the future. Other laboratory members at the University of Tokyo will conduct a full-scale test on a Shinkansen bridge in the near future to determine the program's efficacy.

Additionally, while at the University of Illinois, I developed a method to power the Imote2 wireless sensor with a photovoltaic solar cell and a lithium-ion (Li-ion) rechargeable battery. At the University of Tokyo, I was interested in comparing the performance of that system with the performance of a system utilizing rechargeable Nickel metal hydride (NiMh) batteries and a photovoltaic cell to determine which would be more pragmatic. Charging NiMh batteries can be done without the use of a complicated charging circuit, and thus may be a desirable alternative to Li-ion batteries, which require a rather complex charging circuit. To prepare for this comparison, I assisted in the selection of weatherproof enclosures for the wireless sensors. The enclosures possess a transparent lid to allow direct light exposure on the solar panels. They also allow the release of gases built up from the NiMh batteries. I have selected the components for the NiMh setup, but have yet to complete laboratory testing.

8. Please add your comments (if any):

I am greatly obliged to thank everyone at JSPS and the NSF for giving me the opportunity to come and perform research in Japan. Not only was it a great academic experience, it was also a fantastic cultural experience. It is my belief that this program is helping to break down the cultural barriers between nations, and contributing to a greater international collaboration in science and engineering. I whole-heartedly recommend this program to anyone interested.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Garret Miyake	(ID No.: SP09043)
2. Current affiliation: Colorado State University	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences <u>Chemistry</u> Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Nagoya University	
5. Host researcher: Professor Eiji Yashima	
6. Description of your current research <p>Optically active, one-handed helical synthetic polymers are fundamentally intriguing due to their ability to mimic naturally occurring biological helices as well as their technologically important and commercially implemented applications. Thus it is of great importance to not only develop strategies to synthesize optically active, one-handed helical polymers, but also understand the formation and stability of the helical structure. To this end, we have synthesized two enantiomeric zirconocenium catalysts and have employed them to develop the asymmetric coordination polymerization of functionalized vinyl monomers towards optically active polymers.</p>	

7. Research implementation and results under the program

Title of your research plan: Stereomutation of Stereoregular Vinyl Polymers

Description of the research activities:

We have synthesized novel polyacetylene polymers that have excess one-handed helicity. Furthermore, we have established the ability to cause an inversion in the helix-sense of these polymers. These polyacetylenes possess chiral side-groups that are well-established organocatalysts, thus the ability of these polymers to act as asymmetric organocatalysts has been examined. Lastly, enabled by the ability to control the helix-sense of these polymers, we have investigated the influence of the helicity of the polymer on the enantioselectivity of the catalyzed reactions.

RESEARCH REPORT

1. Name: Stacy M. Morris	(ID No.: SP09044)
2. Current affiliation: Department of Chemistry, Kent State University, Kent, OH 44242 U.S.A.	
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> <u>Chemistry</u> Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: National Institute for Material Science (NIMS), Namiki Site, Tsukuba, Japan	
5. Host researcher: Dr. Ajayan Vinu	
6. Description of your current research <p>My dissertation topic is the ‘Synthesis, Adsorption and Structural Properties of Polymer-Templated Mesoporous Aluminum and Aluminum-Metal Oxides.’ The purpose of this dissertation research project, being performed at Kent State University, is the systematic synthesis and characterization of a broad and interesting catalog of tailorable mesoporous alumina materials. There is great interest in ordered mesoporous alumina (OMA) materials. Not only in the number of materials which can be synthesized and characterized but in the number of industrial applications well suited for them. They are useful as gas sensors, chemiresistors, adsorbents, catalysts for the catalytic degradation of pollutants and chemical warfare agents as well as for fuel cells. As more research is performed and the properties are better understood, the number of suitable applications will rise. There has been and will continue to be great interest in obtaining well-defined mixed metal oxides with high surface area and pore volumes which is described in the research proposal.</p> <p>Thus far, several aluminum-metal oxides have been studied as part of this dissertation, including chromium, titanium, nickel, cobalt, calcium and magnesium aluminum oxides (Morris et al. 2008). Synthesis of titanium aluminum oxides from organic precursors of Al and Ti was studied in detail with molar fractions of Ti from 5 to 75%; mesoporous structure and uniformity of these oxides was maintained up to 50% (Morris et al. 2009). Studies such as the one described herein add to the already growing catalog of mesoporous aluminum oxides tailorable for use in numerous applications.</p>	

7. Research implementation and results under the program

Title of your research plan:

Soft Templated Synthesis, Adsorption Properties and Structural Characteristics of Titanium Aluminum Oxides Using Mixed Precursors

Description of the research activities:

Using a recent paper on soft-templated mesoporous aluminum titanium oxides as a point of reference (Morris et. al 2009), the purpose of this project was to synthesize and characterize a series of titanium aluminum oxides using a mixture of metal chloride (inorganic precursor) and metal alkoxide; our aim was to replace organic precursors with less expensive inorganic ones. Also, this study was focused on the role of the precursor on the final structure. Mixtures to be explored included aluminum chloride/ titanium isopropoxide and aluminum isopropoxide/ titanium chloride at various molar fractions of aluminum to titanium (10%, 20%, etc.). The procedure (previously reported in Morris et. al 2008) includes the use of block copolymers as structure directing agents in ethanolic solution, addition of the precursors and nitric acid as a hydrolysis agent and solvent evaporation at 60°C. This process uses self-assembly to form mesostructures such as channel-like or cage-like which is highly dependent upon the block copolymer used.

A series of samples was prepared using the above mentioned procedure. The resulting materials were calcined at 400°C and their nitrogen adsorption properties measured. The results thus far are mixed. Several samples resulted in poorly porous materials and some promising samples with acceptable porosity. It is unclear the exact reason for these results. Further studies will be continued at home institution by optimizing recipes, which afforded good samples. Hydrolysis rates for the precursors, the effect of nitric acid vs. hydrochloric acid and citric acid as a hydrolysis agent and perhaps the exploration of metal nitrates as precursors will be explored. The PI will continue the synthesis and characterization of the samples by using nitrogen adsorption, thermal analysis, and X-ray diffraction with Dr. Vinu's laboratory assisting in TEM, SEM and EDX analysis.

In addition to the above collaborative project that has been focused on the synthesis of Al-Ti oxides from metal chlorides precursors, two additional joint projects between Kent State University and NIMS are in progress. One of the involves the synthesis of OMA with cage-like pores, and the other one refers to the synthesis of mixed alumina-titania samples prepared by varying acid concentration; in the latter

case Al and Ti isopropoxides are used instead of chlorides. It was shown that the acid concentration has a pronounced effect on the adsorption and structural properties of mixed oxides as reflected in changing the shape of adsorption hysteresis loop from type I to type II; the first one is characteristic for channel-like structures, while the second one for cage-like structures. In these projects, numerous good quality samples have been synthesized and their adsorption properties have been studied at Kent State University. Adsorption analysis of these samples revealed their high surface area; large pore volume and well-developed mesoporosity. Further characterization of the aforementioned samples will be continued at NIMS by Dr. Vinu's lab in order to characterize their structural and morphological properties by TEM, SEM and EDX as well as perform some catalytic testing.

8. Please add your comments (if any):

The research proposed under a broad title "Tailored Porosity in Soft Templated Alumina and Alumina-Supported Metal Oxides" was focused on mesoporous alumina-titania, which seems to be a most interesting material for adsorption and catalysis-related applications. While synthesis of alumina-titania from organic precursors was successful, the replacement of organic precursors with inorganic ones is still a challenging task. Therefore, more experimental work on the synthesis of alumina-titania from inorganic precursors will be carried out at Kent State University. Collaboration with Dr. Vinu's group is expected for characterization of these materials by TEM, SEM and elemental mapping

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Paul D Nation	(ID No.: SP09045)
2. Current affiliation: Dartmouth College	
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: NTT Basic Research Laboratories	
5. Host researcher: Dr. Hiroshi Yamaguchi	
6. Description of your current research <p>In the first of two projects, we address how black holes lose energy at the end of their evolution. As Stephen Hawking famously showed, black holes will radiate energy like that of a blackbody with temperature fixed by the mass of the black hole. The assumption underlying this result is that the mass of the black hole remains approximately fixed during the emission process. This approximation breaks down in the final moments of a black hole where the radiation begins to take a substantial portion of the remaining energy from the black hole. We investigate modeling this final evaporation phase using a quantum mechanical model consisting of three harmonic oscillators, two of which are coupled via a nonlinear parametric interaction. Starting the third mode in an excited state models the energy, or equivalently mass, of the black hole. Additionally we can account for unavoidable energy loss to the rest of the universe by assuming an environment at zero temperature. We are able to show using numerical simulations that our model reproduces the expected thermal behavior on short time scales. However at longer times the spectrum of the outgoing radiation deviates markedly from the thermal spectrum predicted in the semiclassical analysis. This deviation from the semiclassical result depends on what quantum state the initial black hole energy is in, and thus it may be possible to distinguish between initial states from the outgoing photons. This result may help to shed light on the so called information loss paradox of black holes. Stated simply, if the radiation is always thermal than it can contain no information, and thus information inside a black hole is trapped forever. This loss of information breaks many of the fundamental laws in physics and thus hints at some new physics needed to remove this contradiction. We hope that our model may yield some answers as to the transfer of information from black holes.</p>	

Next, we investigate the possibility of creating a laser using only micromechanical elements. In a conventional laser, atoms are excited into releasing photons inside a cavity that is used to amplify the effect. Here we suggest using a pair of coupled resonators as our “effective atom”. The resonator dynamics behave like that of a system comprised of only two states, symmetric and anti-symmetric with differing energies. Unlike a normal laser where many atoms are needed, we can use a single pair of oscillators as our system uses phonons, which unlike electrons can have many particles occupying the same state. The cavity is generated by a third, larger, mechanical oscillator into which our two-state system is embedded. Assuming the frequencies of both the cavity and coupled oscillators is the same, and rate of energy loss of the two-level system is greater than that of the cavity, then the system will exhibit laser-like behavior. Readout of this effect can be performed by measuring the amplitude of the excited cavity mode.

7. Research implementation and results under the program

Title of your research plan:

Modeling Black Hole Evaporation with a Trilinear Hamiltonian and Lasing with Mechanical Resonators

Description of the research activities:

Research on the evaporation of black holes consisted of both analytic and numerical work. The trilinear Hamiltonian model can be analytically evaluated in the short time limit allowing for comparison with the semiclassical black hole derivations. Including dissipation was modeled with a zero temperature Lindblad master equation, the evolution of which was calculated using a quantum Monte-Carlo method.

The concept of an all mechanical laser was bore out of an investigation into novel uses of perfectly coupled mechanical oscillators. The basic design and operating parameters were constructed using previous experimental setups fabricated by the NTT Physical Sciences group.

8. Please add your comments (if any):

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Daniel M Nover (ID No.: SP09046)
2. Current affiliation: University of California - Davis
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Lake Biwa Environmental Research Center
5. Host researcher: Dr. Michio Kumagai
6. Description of your current research <p>My current research focuses on the dynamics of ultra-fine particles in lakes and reservoirs. At Lake Tahoe (California/Nevada, USA), management goals focus the research on the impact of particles on water clarity, algal productivity, and oxygen demand. At Lake Biwa (Shiga, Japan), management goals focus the research on the impact of particles on oxygen demand, particularly in the benthic nepheloid layer of the lake. This layer at the lake bottom experiences low dissolved oxygen concentrations during periods of intense thermal stratification, occasionally achieving anoxia in the summer months. While particles in this layer clearly control oxygen concentration due to oxygen demand and microbial activity, the dynamics of these particles remain poorly understood. Because Lake Biwa is an ancient lake with a high degree of species endemism, the deterioration of the lake water quality under increased warming (and therefore increased stability) is of significant concern for conservation and management efforts. Additionally, the waters of Lake Biwa are the drinking water source for the nearby large cities Kyoto, Osaka and Kobe. Management of fine particles in-situ remains an essential component in controlling drinking water treatment costs.</p>
7. Research implementation and results under the program <p>Title of your research plan: In situ particle concentration and size analysis in the benthic boundary layer of Lake Biwa, Japan</p>

Description of the research activities:

During the summer program, we conducted 5 separate sampling cruises in which we measured physical and chemical water quality profiles along the sampling transect routinely used by the Lake Biwa Environmental Research Institute. This data includes measurements of dissolved oxygen, temperature, turbidity, chlorophyll α , conductivity, as well as distributions of fine particles broken down into 32 separate size classes from 1.25 μm - 250 μm in diameter. This data is currently being analyzed to determine the relationship between particles and oxygen concentration. Such a profile was also used to identify the location of the benthic nepheloid layer for our 2 week mooring experiment.

The 2 week mooring experiment involved the paired deployment of both the LISST 100X and an acoustic Doppler current profiler (ADCP). The LISST was placed about 1 m above the bottom of the lake, squarely in both the benthic boundary layer and the smaller nepheloid layer in order to measure changes in particle size distribution over a 2 week period. The ADCP was deployed 17 m above the LISST looking down at the lake bottom. The ADCP data can be used to identify the periods of internal waves, seiches, current velocity, as well as turbulent kinetic energy and Reynold's stress. All of these measurements and calculations will be compared to results from the LISST instrument to identify the particle dynamics in the bottom water layer and how these relate to physical forcing and the energy of internal waves.

8. Please add your comments (if any):

This research was carried out with the enormous resources and assistance of the Lake Biwa Environmental Research Institute (LBERI) under the vision and leadership of Dr. Michio Kumagai. Without the enormous support from Dr. Kumagai and everyone else at LBERI, this research would have been impossible.

9. Advisor's remarks (if any):

I enjoyed working with Mr. Nover during his stay at our institute. His research interest is very close to my field and we could obtain very good field data in Lake Biwa. He also actively joined several meeting with other researchers and students and I hope that he learned many things about Japanese culture and history in addition to the sciences.

RESEARCH REPORT

1. Name: Erin Asayo Osborne (ID No.: SP09047)
2. Current affiliation: University of California, Berkeley
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Osaka University Graduate School of Frontier Biosciences and Kobe Advanced ICT Research Center
5. Host researcher: Dr. Yasushi Hiraoka
6. Description of your current research <p>Is a gene like a light switch? It may seem like a fitting metaphor. Genes are typically in an on or off state. However, the transition between the on and off states of gene expression is rarely as simple as a flick of the switch. In order to better understand complex transcriptional dynamics, I study a type of gene repression that is capable of inhibiting whole regions of genes based on their position within the genome. Termed silencing in the budding yeast <i>Sacchomyces cerevisiae</i>, this type of inhibition involves the combined effort of DNA, nucleosomes, and Silent Information Regulator (Sir) proteins to produce a “silent chromatin landscape” that is not permissive to transcriptional machinery.</p> <p>Previously, our lab and others have determined that the establishment of silencing involves cooperative Sir protein assembly, the removal of nucleosome methyl and acetyl modifications, and the twisting of DNA into an ordered structure. Recently, we determined that the process of silencing establishment takes one to two cell divisions to affect the cellular phenotypes of individual cells and that this timeline can be hastened by the pre-emptive removal of nucleosome methyl marks. Still, many mysteries remain. Most pressingly, we are interested in how silent chromatin is replicated, how cell-cycle phases contribute to silencing establishment, and the actual mechanism of silencing. During my time in the JSPS program, I implemented a microscopy-based technique for monitoring transcriptional dynamics in individual yeast cells in order to better explore transcriptional silencing at finer resolution. As higher eukaryotes utilize analogous heterochromatin structures for controlling cell identity and fate, further insight on yeast silencing informs research in the fields of regenerative medicine and cancer therapy.</p>

7. Research implementation and results under the program

Title of your research plan:

Visualizing transcriptional silencing dynamics in yeast.

Description of the research activities:

Developing a microscopic assay for monitoring silencing. By placing a green fluorescent protein (GFP) gene within the silenced *HML* region, the transcriptional state of the locus could be monitored visually. Cells compromised in silencing fluoresced due to the uncontrolled expression of the *GFP* reporter at the *HML* locus. Cells competent to silence the *HML* locus, in contrast, did not glow. In order to improve the fidelity of the system, a fast-folding, high turn-over GFP variant was selected. Initial experiments confirmed that the fluorescence was robust, reproducible, with low background, and highly dependent on the transcriptional state of the cell.

Monitoring silencing establishment. I measured the establishment of silencing in single cells using the GFP-reporter system. To induce the un-silenced state, I grew cells in 5 mM nicotinamide, a potent Sir2 inhibitor. Cells fluoresced to a high degree in this un-silenced state. By flushing nicotinamide from the media, I could observe the establishment of silencing over time as a gradual loss of fluorescence intensity. Typical time courses involved 10 z-stacked images captured every 10 minutes for 6 hours. Though silencing establishment caused fluorescence intensity to decline over the course of roughly 5 hours, bursts of activity could still be observed within individual cells.

Monitoring silencing establishment in the absence of Dot1. Previously, I determined that cells lacking the protein Dot1-- and consequently the core nucleosome methyl marks (H3 K79 me¹, me², me³) that Dot1 catalyzes-- expeditiously establish silencing in a cell morphology assay. I was able to recapitulate this phenotype using the GFP-fluorescent system described above. This result is consistent with a model that the removal of H3 K79 methylation, a mark of euchromatin, is rate limiting for silencing establishment.

Controlling for degradation rate over time. In addition, I characterized the degradation rates of fluorescent signal upon inhibition of transcription and translation in order to establish a baseline for maximal signal loss. To do so, a time course measuring fluorescence intensity was measured upon application of a transcriptional inhibitor (20 µg/ml thiolutin) or a translational inhibitor (2.5 µg/ml

cycloheximide) to cells constitutive for GFP expression (*sir3*Δ cells). Most noticeably, highly synchronous nature of the decline in fluorescence intensity due to inhibition contrasted greatly with the aberrant, jumpy decreases observed in silencing establishment. Indeed, the loss of fluorescence was synchronous and quite rapid when translation was inhibited but more gradual when transcription was inhibited. Still, the rates approximate those observed in the silencing establishment time course assays. This is further evidence that silencing does not require a long timeline of excessive cell divisions to silence genes. Further analysis of the data collected will be instrumental in determining whether specific phases of the cell cycle are favored in this process.

8. Please add your comments (if any):

I will always cherish my time in the Hiraoka lab. What a stimulating environment! It was an exceptional experience to work with so many intelligent senior scientists, expert technicians, and wonderful staff. They also happen to have the best microscopes on earth. Hiraoka sensei and Haraguchi sensei have built not only a wonderful research institution but have also facilitated an ambiance of support and friendly camaraderie. Everyone was so nice and went out of their way to make me feel welcome. Thanks!

9. Advisor's remarks (if any):

It was a great opportunity to work with a visiting student. Erin Osborne introduced a new experimental system and a new idea into my laboratory. The experience working on a new experimental system brought about problems we have never thought of, and it was quite stimulating to resolve such problems. She worked efficiently, quickly setting up experimental conditions to obtain reliable results in this short period. As you can see in her report, she made successful accomplishments. Overall, it was a great opportunity to work with Erin.

RESEARCH REPORT

1. Name: Mr. RAVISHANKAR PALANIAPPAN	(ID No.: SP09048)
2. Current affiliation: University of Central Florida	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Fukuoka Institute of Technology, Fukuoka.	
5. Host researcher: Dr. Leonard Barolli	
6. Description of your current research Current sensor network technology for detection and tracking are focused solely in terms of static networks and suffers from device specific inadequacies such as lack of coverage, power and fault tolerance. Failing nodes result in coverage loss or breakage in connectivity and hence there is a pressing need for a robust system. In this work a unique sensor network is fielded that uses multiple frequencies and transmit powers to improve coverage. A novel approach to track a sensor node is also presented. Simulation data is compared to experimental results for validation.	

7. Research implementation and results under the program

Title of your research plan:

A Novel Sensor Web System for Tracking and Surveillance

Description of the research activities:

Recent advances in MEMS devices have fueled the growth of Wireless Sensor Networks (WSN) for use in various fields such as location tracking systems. A wireless sensor network is a network of distributed sensor nodes each equipped with its own sensors, computational resources and transceivers. These sensors are designed to be able to sense specific phenomenon over a large geographic area and communicate this information to the user. Most sensor networks are designed to be stand-alone systems that can operate without user intervention for long periods of time. The sensor nodes have limited on-board processing capability to reduce battery consumption, weight and cost. The problem of localization and tracking of sensor nodes has been widely researched. The proposed work involves research in two distinct areas of wireless sensor network, a) sensor node localization and b) sensor node tracking in real-time

In general sensor nodes are deployed in areas to locate and monitor different physical phenomenon such as humidity, soil and water levels. They can also be used to track entities such as fire-fighters in a building when they are carrying a mobile sensor in their gear. Our research addresses the requirements of the latter case. Our proposed system will eliminate the need for setting up a infrastructure of sensors as the nodes will be able to localize automatically and track a mobile sensor in near real-time. The issues addressed in this paper deal with the following design goals

- Small wireless sensor devices lack GPS capability and therefore need a localization scheme
- The small nodes have short range RF transceivers which can be used for localization
- The nodes have to be deployed Ad-hoc and cannot have any pre-planning or infrastructure setup.
- The localization and tracking should be adaptive to the number of nodes available at any given time

This work makes use of the inherent capabilities of wireless sensors for localization and tracking. The nodes use a simple measure of connectivity to gather reference data points and localize themselves. They then serve as reference nodes to

track a mobile node in the sensor web.

The main contributions of this work are

- It presents a unique method of localization that builds on a few initial anchor nodes at known locations to locate all the sensor nodes in the grid.
- It demonstrates a method to track a target sensor node in real-time by using static reference nodes that continuously re-localize their position information to track the target.
- It demonstrates the capability to use multiple transmit powers and frequencies to improve the tracking efficiency.

The experimental and simulation studies conducted are preliminary results from an on-going work for developing a robust tracking system using sensor networks. The next stage of the research will involve mobile reference nodes that will continuously localize their positions in real-time to expand the size of the sensor field.

We would like to acknowledge Fukuoka Institute of Technology and the graduate students for their support and encouragement for this work. We also thank National Science Foundation of United States and Japan Society for Promotion of Sciences for their summer program funding in Japan to support this research.

8. Please add your comments (if any):

The work has been submitted for publication at the International Conference on Complex, Intelligent and Software Intensive Systems (CISIS), 2010, Krakow, Poland

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Molly Sabrina Pankey (ID No.: SP09049)
2. Current affiliation: Department of Ecology Evolution & Marine Biology University of California, Santa Barbara
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Tokai University School of High Technology for Human Welfare
5. Host researcher: Dr. Manabu Sakakibara
6. Description of your current research <p>My research concerns how animals have evolved light perception. Interestingly, the majority of animal phyla sensitive to light lack eyes altogether, relying on a diffuse system of photoreceptive neurons to receive light information. Such nonvisual photoreception may represent an ancient mechanism predating the evolution of eyes. Indeed, nonvisual photoreceptors have been implicated in several biological roles ranging from predator avoidance to circadian rhythmicity and migration to bioluminescence regulation. Despite such tremendous biological and evolutionary significance, many aspects of nonvisual photoreception are poorly characterized. I am interested in understanding the relationship between photoreceptors in the nonvisual system and those in the eye. One approach is to compare the molecular machinery employed in each photoreceptor type. Photoreceptors can traditionally be classified as ciliary or rhabdomeric, each with a unique biochemical pathway called the phototransduction cascade. Other approaches include morphological and electrophysiological comparisons. With Dr. Sakakibara, I am studying nonvisual photoreception in the pond snail, <i>Lymnaea</i>. This animal has been a model for understanding neurological processes in behavior, including light response. Although <i>Lymnaea</i> possesses eyes, it is the dermal photoreceptors that are responsible for sensing shadows and initiate predator-avoidance behavior. In order to understand which phototransduction pathway operates in dermal photoreceptors, we undertook behavioral and electrophysiological tests using pharmacological agents known to target the ciliary and rhabdomeric pathways, respectively.</p>

7. Research implementation and results under the program

Title of your research plan:

Behavioral and electrophysiological evidence for cyclic nucleotide mediated phototransduction in *Lymnaea stagnalis* extraocular photoreceptors

Description of the research activities:

Methods summary. Both blind and sighted animals were tested for shadow responses in the presence of each drug (2APB and L-cis-diltiazem). Replicating the drug conditions, we then took intracellular recordings from the ganglion cell receiving input from the photoreceptors. This was to verify the drug's effect on the photoreceptors specifically. Results. We found no significant difference in the shadow response rate OR the drugs' effect between sighted and blind snails. We found that 2APB (rhabdomeric target) has a weak effect, causing snails to respond to 7.5% fewer shadow stimuli than normal. However, cis-diltiazem (ciliary target) has a pronounced effect, causing snails to respond to 50% fewer shadows. This result was confirmed with intracellular recordings of ganglion cell RPeD11, which receives input from multiple extraocular photoreceptors. In the presence of 2APB, the photo response remained intact. With cis-diltiazem, the photoresponse was abolished and this effect was reversible when the drug solution was replaced with saline.

8. Please add your comments (if any):

Hiroshi Sunada (Sakakibara lab) also collaborated on this project. We intend to present our results at upcoming conferences in Japan and in the U.S.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Adrienne B. Perkins	(ID No.: SP09050)
2. Current affiliation: Georgia State University - Atlanta, GA USA	
3. Research fields and specialties: Humanities <u>Social Sciences</u> Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: National Mental Support Center for School Crisis, Osaka Kyoiku University – Osaka, Japan	
5. Host researcher: Professor Yozo Takino	
6. Description of your current research: <i>Specific Aim</i> The specific aim of this research study is to increase understanding of cultural variations in risk and protective processes that may contribute to aggression, school violence, and victimization in American and Japanese students. The study offers to elucidate the risk and protective processes by gathering data from a sample of American and Japanese secondary students in grades 7-12. In this study, school violence, aggressive behavior, school victimization, and behavioral and health risks that affect a substantial number of middle and high school students are assessed using a version of Georgia State University's Prevention and Intervention Group Survey (PIGS). Collected data will be analyzed statistically in order to determine which risk and protective processes are shared across cultural groups or are unique to specific cultural groups. The study will provide reliable and valid data on aggression and victimization, as well as assess the role of family, school, and peer variables in the development of aggressive behavior and victimization. Ultimately, the study results will add to the research literature on designing culturally informed school violence and aggression prevention and intervention strategies. <i>Research Questions and Hypotheses</i> This research study addresses two broad sets of questions. The first set refers to rates of school violence and victimization: What are the rates of aggressive and violent behavior and victimization across middle and high school in American and Japanese schools? How do these rates and patterns of change vary by culture and gender? 1. Consistent with past research, higher rates of both aggressive behavior and victimization are expected in middle/junior high school students as compared to high school students in both the American and Japanese samples. 2. Higher rates among boys than girls of committing and being victimized by violence in both the American and Japanese samples are also expected. The second set of questions relates to the identification of risk and protective processes involved in school violence and victimization and to cultural variations in those processes: What are the factors that increase or decreased likelihood of committing acts of aggression and being victimized? Do these factors vary as a function of age, ethnicity, and gender? In examining these	

questions with regard to culture, cultural group comparative and within-group analyses will be conducted to identify shared risk factors across groups.

3. With respect to risk and protective factors, exposure to poverty, community violence, and substance use are expected to similar positive associations with violent behavior and victimization for American and Japanese students. Students' engagement in school (reflected in perceived competence, achievement, high aspirations) and perceptions of a positive school climate will protect both American and Japanese students from aggressive behavior and victimization.

7. Research implementation and results under the program

Title of your research plan: Aggression, School Violence, and Victimization: A Cross-Cultural Comparison of Risk and Resilience among American and Japanese Students

Description of the research activities:

Methods and Measures

The Japanese version of Georgia State University's Prevention and Intervention Group Survey (PIGS) was created through an iterative process of initial translation, back-translation, and de-centering to produce a modified instrument that was culturally appropriate in both languages. Throughout the translation process, feedback was continuously sought and received from both Japanese secondary teachers and university students.

The PIGS was administered in two junior high schools and one high school in the Osaka City Schools district during the month of July. Next, the JSPS research fellow entered each student's response into the PIGS secure internet-based platform. Finally, preliminary statistical analyses were conducted on the Japanese sample.

Data/Results

The following are selected results for the sample of 1,034 (n=1,034) Japanese junior high and high school students in grades 7 through 12:

Demographics

- Boys = (n=516, 49.9%) and Girls = (n=518, 50.1%)
- Grades 7 through 12:
 - Junior High School (n=712, 68.9%) and High School (n=322, 31.1%)

Aggression and Violence

Students were asked if in the past week they had committed at least one act of aggression (teasing to make people angry, calling others bad names, fighting, threatening to hurt others, etc.). Response options ranged from: *none*, *1 time*, *2-3 times*, *4- 5*, to *6 or more times*.

- 82% of students reported that in the past week they had committed at least one act of aggression.
- 19.4% of students had gotten into a physical fight in the past week.

- In the past week, 12.2% of girls and 26.9% of boys had gotten into a physical fight. Therefore, boys were found to be significantly more likely to be involved in physical fights.
- In the past week, 21.9% of junior high school students and 14.3% of high school students had gotten into a physical fight. Therefore, junior high school students were found to be significantly more likely to be involved in physical fights.

School Victimization

Students were asked if in the past year they were a victim of an act of bullying while at school in the past year. Examples of bullying include being chased, attacked, or beaten. Response options ranged from: *none, 1 time, 2-3 times, 4- 5, to 6 or more times.*

- 29.8% of students reported that in the past year they were a victim of at least one act of bullying while at school.
- 29.5% of girls and 42.5% of boys reported some form of victimization within the past year while at school; it was significantly more likely for boys to report victimization as compared to girls.
- 35.1% of junior high school students and 18.6% of high school students reported some form of victimization within the past year while at school; it was significantly more likely for junior high school students to report victimization as compared to high school students.

Conclusion

As hypothesized, higher rates of both aggressive behavior and victimization were found in middle/junior high school students as compared to high school students in the Japanese sample. Also, as hypothesized, higher rates among boys than girls of both bullying and victimization were found in the Japanese sample.

8. Please add your comments (if any):

A comparison sample of secondary American students in the Atlanta Metropolitan area will be recruited upon the JSPS fellow's return to Georgia State University. Therefore, this study will be ongoing at Georgia State University during the 2008-2009 academic year. The second set of research questions and hypotheses will be addressed upon completion of data collection and analysis of the American sample.

The JSPS fellow would like to sincerely thank the JSPS for providing this excellent learning opportunity and research experience. She plans to use the data collected during this summer's program as the basis for her pre-dissertation project at Georgia State University.

9. Advisor's remarks (if any):

Ms. Perkins spent most of time at the NMSCSC revising and editing the Japanese version of the PIGS with me and inputting a lot of data obtained from the Japanese sample. She also visited Japanese secondary schools to meet with teachers and principals at which time she discussed school safety and school climate.

I hope this stay will be a useful experience for her pre-dissertation project when she returns to Georgia State University.

RESEARCH REPORT

1. Name: Emily A. RAY (ID No.: SP09051)
2. Current affiliation: University of North Carolina at Chapel Hill
3. Research fields and specialties: Mathematical and Physical Sciences Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Yokohama National University
5. Host researcher: Dr. Toshohiko BABA
6. Description of your current research <p>Resolution of images formed by light is limited by the loss of evanescent waves in the near field. These waves carry the high spatial resolution information but decay after scattering. To image nanoscale objects below the diffraction limit with visible light, the evanescent waves must be retained. Materials with a negative refractive index amplify evanescent waves and a diffraction grating can convert them to propagating waves that do not decay in the near field. While negative refractive index materials are not naturally occurring, materials that exhibit the same effect for wither TM or TE waves can be fabricated. One such material is the metamaterial comprised of alternating slabs of metal and dielectric with subwavelength thickness. Evanescent waves couple to surface plasmons that are supported by the negative refractive index and amplified. The ratio of thickness of the dielectric to metal can be varied to adjust the coupling wavelength and all the metamaterial to amplify a large band of evanescent waves from an object. With a diffraction grating, the light is collected in the far-field and a subwavelength image is formed.</p> <p>Other periodic structures such as photonic crystals demonstrate a negative refractive index based on the folding of higher order bands in the photonic band structure. To adjust the coupling wavelength, periodicity and diameter of the holes is modified. To scale from parts in the infrared to visible wavelengths with less power consumption, the hole size in decreased to allow transmission of scattered evanescent waves.</p>

7. Research implementation and results under the program

Title of your research plan:

Negative Refractive Index of Photonic Crystals

Description of the research activities:

I learned to fabricate silicon photonic crystals that exhibit a negative refractive index and characterize their interaction with light in the infrared range. We used electron beam photolithography, reactive ion etching, oxygen ashing, polishing, and wet etching to fabricate a Si hole array on an airbridge structure with hole diameter near 200 nm. We demonstrated a negative refractive index with the focusing through the photonic crystal of a small spot size light beam incident from an integrated silicon waveguide at 1315 nm. Greater clarity in the negative refractive index effects were explored by increasing the distance of the photonic crystal from the source and its width by factors of 5, 6, 8, and 10. The most efficient transmission and focusing of the photonic crystal was at a factor of 5 increase at 1287 nm incident light.

8. Please add your comments (if any):

Baba Sensei and his students were incredibly helpful, knowledgeable, and patient in teaching me their fabrication techniques. I was able to attend conferences with them and work alongside a truly skilled group. I feel incredibly lucky to have had the opportunity to work with this group and attend conferences with them. They have given me great insight into academic life in Japan and an invaluable new set of skills.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Hannah T. Reynolds	(ID No.: SP09052)
2. Current affiliation: Duke University	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: National Museum of Science and Nature	
5. Host researcher: Dr Kentaro Hosaka	
6. Description of your current research <p>Most molecular fungal phylogeography studies have concerned fungi with air-dispersed spores, especially human or plant pathogens and wood-rotting fungi, and have indicated that long-distance dispersal has frequently occurred in the evolution of these fungi. Subterranean fungi, such as <i>Elaphomyces</i>, are dispersed by mammals that unearth and eat them. I am interested in whether this difference in ecology may cause a decrease in the frequency of long-distance dispersal compared to the air-dispersed fungi.</p> <p>My dissertation research is on the phylogeography and phylogenetics of the fungal family Elaphomycetaceae. This family consists of two genera, the subterranean <i>Elaphomyces</i>, and <i>Pseudotulostoma</i>, which grows above-ground. Both genera are ectomycorrhizal, forming mutualist associations with tree roots. The genus <i>Elaphomyces</i> has been found in Europe, North America, South America, Australia, Asia, and in Oceania, while <i>Pseudotulostoma</i> has been found only in Guyana and Japan. I am investigating the historical biogeography of the Elaphomycetaceae, and want particularly to understand where these genera originated, how they have spread, and the role of long-distance dispersal in their evolution.</p>	
7. Research implementation and results under the program Title of your research plan: Diversity of East Asian Elaphomycetaceae: Japanese species and phylogeography	

Description of the research activities:

There have been 14 species of *Elaphomyces* found in Japan, 9 of which are endemic. My goal this summer was to collect *Elaphomyces* species and *Pseudotulostoma japonica* from multiple locations and to access herbarium material in order to a) better understand the morphology of Japanese species and b) obtain tissue samples for molecular work. The Japanese specimens will be crucial additions to the global study of the phylogeography of the Elaphomycetaceae.

Herbarium Research:

At the National Museum of Science and Nature, I worked in the National Fungal Collection to describe, photograph, and when necessary, identify specimens of *Elaphomyces* and *Pseudotulostoma*. A small amount of material from each specimen was taken for DNA extraction and sequencing, to be done on my return to Duke University. Additionally, I visited the SAPA herbarium at the Hokkaido University Museum and the Tottori Mycological Institute Herbarium in order to examine specimens of endemic Japanese species. In Tottori, I was fortunate to find original specimens, including type specimens, from Dr. Imai's personal collection, who described many of the Japanese species in the 1920's.

Field Collections:

Several locations in Japan were targeted for collection: Chichi-jima (Ogasawara Islands), Hachijo-jima, Ibaraki, Saitama, Fukushima, Tochigi, Tottori, and Hokkaido. *Elaphomyces* species were found in the latter five prefectures, and *Pseudotulostoma japonica* was found in Tochigi and Saitama. All collections were from predominately *Quercus*-dominated forests. The species *Elaphomyces granulatus* and *E. variegatus*, widespread through the Northern Hemisphere, were found in Honshu (in Saitama and Fukushima, respectively). Two endemic species were found: *E. nopporensis* in Hokkaido, and *E. neosperulus* in Tochigi. A species found in Tottori closely resembles the widespread Northern Hemisphere species *E. mutabilis*, which has not yet been reported from Japan. More specimens of European and American *E. mutabilis* will be examined for comparison with the three Tottori specimens, to determine their identity. In addition to the target fungi for this project, several other subterranean fungi (truffles) and mushrooms were collected. All specimens will be stored at the Japan National Museum of Science.

Collecting was greatly aided by the expertise of local professional and amateur mycologists. In Hachijo-jima, I participated in a field course led by my host, Dr Hosaka, and Drs. Hosoya and Ebihara, also from the National Museum of Science. The course was made of a few college students and the rest were non-scientists interested in natural history. In Fukushima, Dr. Hosaka and I participated in a foray for *Cordyceps*, a fungus that parasitizes numerous insects and its one fungal host,

Elaphomyces. This foray was run by the Japanese Society for Cordyceps Research, an amateur society. I was able to meet with several other professors and amateur collectors throughout Japan, and greatly appreciate their help in collecting and donating specimens. I am looking forward to continuing these valuable collaborations.

8. Please add your comments (if any): I am looking

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Lauren Marie Stefaniak	(ID No.: SP09053)
2. Current affiliation: University of Connecticut, Department of Marine Sciences	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Nagoya University, Graduate School of Science, Sugashima Marine Biological Laboratory	
5. Host researcher: Dr. Hitoshi Sawada	
6. Description of your current research: <p>Over the past thirty years, an increasing number of previously unrecorded populations of a colonial ascidian of the genus <i>Didemnum</i> have been documented in temperate coastal regions of the world (i.e., both coasts of North America, northern Europe, the UK, Ireland, New Zealand, and Japan (Lambert 2009)). Identification of this invader, or even determination of how many species are involved, has been problematic. Various populations have been identified under as many as five different, previously described <i>Didemnum</i> species names (<i>D. lahillei</i> Hartmeyer, 1909 – France; <i>D. helgolandicum</i> Michaelsen, 1921 – France and northern Europe; <i>D. lutarium</i> Van Name, 1910 – New England; <i>D. carnulentum</i> Ritter and Forsyth, 1917 – California and Washington; and <i>D. pardum</i> Tokioka, 1962 – Japan) as well as two new species described from New Zealand and New Hampshire (<i>Didemnum vexillum</i> Kott, 2002 and <i>Didemnum vestum</i> Kott, 2004, respectively) (Lambert 2009). However, recent morphological (Lambert 2009) and molecular (Stefaniak et al. 2009) studies of worldwide populations, have shown that there is only one species involved in all of these non-native populations and the most appropriate name for the species is <i>Didemnum vexillum</i>, Kott 2002.</p> <p>While the native range of <i>D. vexillum</i> is not conclusively known, preliminary evidence suggests that Japan is the likeliest portion of the known range to be the origin (Lambert 2009, Stefaniak et al. 2009). The earliest known sample believed to be <i>Didemnum</i> was collected from Mutsu Bay in Japan in 1926, 67 years before the next confirmed sample collected from the Damariscotta River Estuary, ME, USA (Lambert 2009). Unfortunately, the 1926 sample has degraded, precluding definitive identification. However, in preliminary sampling, Stefaniak et al. (2009) measured the greatest genetic</p>	

diversity in samples from Japan compared to samples collected from other parts of the world. Molecular markers used were mitochondrial DNA. As a portion of my Ph.D. dissertation research, I propose to use population genetic techniques to determine the native range of *D. vexillum*.

Determining that the relatively recently discovered worldwide populations of *D. vexillum* belong to a single species opened opportunities for comparisons among populations and coordination of projects among ascidian researchers. Similarly, determining the native range of *D. vexillum* will pave the way for studies on population and community-level interactions and reproductive biology with comparisons between populations of *D. vexillum* living in native areas with co-evolved interactions and populations in exotic environments exposed to a suite of novel interactions. Additionally, creation of a vouchered DNA bank containing samples from many native populations will provide a baseline of native genetic diversity for use in population genetic studies investigating the spread of *D. vexillum* within invaded regions.

Lambert G (2009) Adventures of a sea squirt sleuth: the remarkable story of *Didemnum* sp., a global ascidian invader. *Aquatic Invasions* 4(1): 5-28

Stefaniak L, Lambert G, Gittenberger A, Zhang H, Lin S and Whitlatch RB (2009) Genetic conspecificity of worldwide populations of *Didemnum vexillum* Kott, 2002. *Aquatic Invasions* 4(1): 29-45

7. Research implementation and results under the program

Title of your research plan: Determining the native range of the putatively invasive ascidian *Didemnum vexillum*: collection of Japanese samples of *D. vexillum* for population genetics.

Description of the research activities:

Research visits were arranged at seven marine laboratories around Japan: Sugashima Marine Biological Laboratory (Nagoya University), Shimoda Marine Research Center (University of Tsukuba), Misaki Marine Biological Station (University of Tokyo), Shizugawa Nature Center, Asamushi Marine Biological Station (Tohoku University), Usujiri Fisheries Station (Hokkaido University), and Akkeshi Marine Station (Hokkaido University). At each of the university-affiliated stations, snorkel surveys were made along available rocks and dock structures, while at the Shizugawa Nature Center, a survey was made along the shore line at low tide. Additionally, at Misaki MBS and Shizugawa Nature Center, aquaculture facilities were examined via boat. Multiple colonies of *D. vexillum* were collected at Sugashima MBL, Misaki MBS, Shizugawa Nature Center, Asamushi MBS, and Usujiri Fisheries Station. No *D. vexillum* was found at Shimoda MRC or Akkeshi Marine Station, however, this does not preclude the possibility that *D. vexillum* is present, but simply was not found. At all sites, except Akkeshi, other species of *Didemnum* were also found. Samples of those colonies were also taken. In total, 82 samples of *D. vexillum* and 17 samples of other *Didemnum* species were collected. All samples were preserved in 95% ethanol.

Samples were shipped back to the United States for further processing. DNA will be extracted from each sample and a fragment of the mitochondrial gene *col* will be isolated and sequenced. The sequence will then be used in a population genetics study along with sequences from other parts of the world including North America, Europe and New Zealand.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: James David Stone	(ID No.: SP09054)
2. Current affiliation: Institute of Arctic Biology and Department of Biology and Wildlife University of Alaska Fairbanks, USA	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Mathematical Biology Laboratory, Kyushu University	
5. Host researcher: Professor Yoh Iwasa	
6. Description of your current research My dissertation research examines pollinators' role in maintaining cosexual plant populations and the effects pollinators' behavior can have on plant sex ratios. I use complimentary theoretical models and field experiments to study the relationship between pollination ecology and sex ratios in gynodioecious populations. A gynodioecious population is one in which females and hermaphrodites coexist. Gynodioecy is the second most common breeding system among flowering plants and is found in diverse plant taxa. Gynodioecious populations' sex ratios vary widely among different species and even among populations of the same species. Despite decades of research on the ecology and genetics of gynodioecious species, the large amount of variation in gynodioecious sex ratios cannot be adequately explained. Variation in pollinator behavior and its effect on sex ratios is understudied but may help explain why there is so much variation in gynodioecious sex ratios. My research seeks to improve our understanding of the relationship between pollinator behavior and sex ratios and demonstrate its contribution to sex ratio variation in gynodioecious populations. This summer I have focused on developing improved theoretical side of my dissertation work: modeling the relationship between pollinator behavior and gynodioecious sex ratios. My efforts in Japan have been devoted to developing models that explicitly define plant fitness in terms of a pollinator's visitation behavior and its preference for a particular sex of plant. Capitalizing on my host's expertise in developing analytical models, we have developed equations that formalize the relationship between several aspects of pollinator	

behavior and predicted equilibrium sex ratio. The models we have developed provide insight into the maintenance of gynodioecy and how, mechanistically, gynodioecious sex ratios evolve in response to changes in pollination ecology.

7. Research implementation and results under the program

Title of your research plan:

Modelling variation in pollinator behavior and its influence on gynodioecious sex ratios.

Description of the research activities:

Upon arriving at Kyushu University, Professor Yoh Iwasa arranged for me to give a seminar on my project to other members of his Mathematical Biology Laboratory to introduce the group to my work and so that I could benefit from their feedback.

While in Japan, I have worked with Professor Iwasa to develop analytical models building off of my previous work using simulation-based approaches to model the relationship between pollinator behavior and sex ratios in gynodioecious populations. We met frequently to discuss the most appropriate ways to use mathematical expressions to describe the underlying biology. I have limited experience modeling and benefitted from Professor Iwasa's wealth of experience in applying mathematical techniques to biological questions. His guidance has made my efforts more efficient by directing me towards models that are analytically tractable and away from the overly complicated scenarios I was initially trying to model. Furthermore, he has helped me simplify complicated biological relationships into more succinct and elegant expressions.

The equations we developed were implemented into multiple models that describe equilibrium sex ratios in gynodioecious populations, each with slightly different assumptions. I am still in the process of analyzing the full models but am pleased with the expressions we have developed describing pollinators' influence on siring success, pollen limitation, and the self-pollination rate of hermaphrodites. These are the essential components of our new models and each provides insight into pollinator-mediated processes that affect plant fitness.

In my original proposal I sought to include more aspects of pollination ecology in our models. It quickly became apparent through discussions with Professor Iwasa

that such complexity must be added incrementally, if at all, for the model to remain interpretable. So we opted for a simplified and arguably more useful model. My next task is to mature the developing manuscript of this summer's work and submit it for publication. I now have the mathematical framework necessary to incorporate additional biology into our models in the future, building off of the foundation we developed this summer.

Professor Iwasa has also enriched my research by introducing me to theoreticians and ecologists at Kyushu University, especially renowned ecologist, Professor Yahara. Yahara is an expert on plant reproductive ecology and I benefitted from meeting with him and his graduate students. Some members of his laboratory are studying aspects of pollination biology related to my project and I have found their research exciting and hope to remain in contact with them. All of the seminars, meetings, and informal interactions I have had with Japanese researchers have been enjoyable and promoted networking and information exchange regarding our research.

8. Please add your comments (if any):

I am grateful for the exposure this summer program has provided me to Japanese scientists in my field. Kyushu University is a special place for studying ecology and mathematical biology thanks to its faculty and students. I look forward to the opportunity to work with Professor Iwasa in the future and to collaborate with any of the Japanese researchers I met this summer at Kyushu University.

RESEARCH REPORT

1. Name: Stefanie Taushanoff (ID No.: SP09055)
2. Current affiliation: Liquid Crystal Institute, Kent State University
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Tokyo Institute of Technology
5. Host researcher: Dr. Hideo Takezoe
6. Description of your current research <p>The blue phases of liquid crystals occur in highly chiral systems when molecules pack in a double-twist cylinder form interspersed with line defects. Broad-temperature-range, room temperature blue phase materials were fairly recently reported [1], followed a few years later by Samsung's unveiling of a blue phase LCD television [2], two events that stimulated new interest in blue phase materials. We are working towards a broad range, room temperature blue phase liquid crystal mixture made using bent-core liquid crystals as a primary component.</p> <p>It is already known that achiral bent-core liquid crystals can enhance the chirality of chiral mixtures, causing blue phases to appear in mixtures that previously showed no mesophases between the cholesteric and isotropic [3]. It is also known that adding chiral sections to bent-core liquid crystals can create blue phases [4]. Both cases result in blue phases showing a broad temperature range, but because bent-core materials also tend towards high transition temperatures none of these efforts resulted in room or near-room temperature materials. Our research focuses on bent-core liquid crystals with isotropic transition temperatures under 100°C, with broad nematic ranges.</p> <p>[1] <i>Nature Letters</i>, Vol 436 No 18, 2005 [2] Samsung Press Release (May13,2008) http://www.samsung.com/us/aboutsamsung/news/newsIrRead.do?news_ctgry=irnewsrelease&ws_seq=8351 Accessed August 13, 2009. [3] M. Nakata, et al. <i>Phys Rev E</i>, 2003, 68 [4] Y. Chennabasaveshwar, et al. <i>Chem. Mater.</i>, 2006, 18, 6100-610</p>
7. Research implementation and results under the program <p>Title of your research plan: Towards Room Temperature Blue Phase Materials Using Bent-core Liquid Crystals</p>

Description of the research activities:

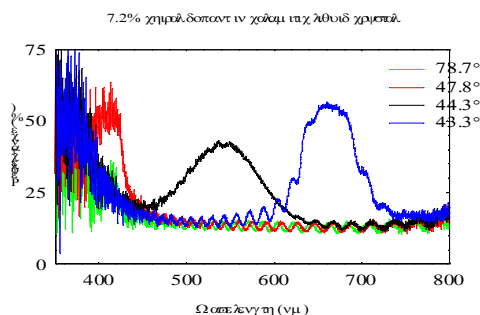
Mixtures of bent-core liquid crystal and high HTP chiral dopants were characterized and compared to mixtures of calamitic liquid crystal with the same concentrations of chiral dopant. Characterization methods included polarizing optical microscopy, differential scanning calorimetry, optical activity measurements, and spectrophotometry.

Mixtures of rod-shaped liquid crystal with chiral dopant showed typical cholesteric phases (Fig. 1) and (in concentrations $>5\%$) evidence of blue phases. These mixtures displayed behavior typical of highly chiral materials.

Mixtures of bent-core liquid crystals with chiral dopant were not so easily characterized. Starting at low concentrations (1.4% chiral dopant), the mixtures transition from isotropic to an optically isotropic, blue-to-bright-blue uniform texture that defied any attempt to characterize it via spectrophotometry (Fig. 2). There is a clear absence of platelet textures at any temperature, eliminating BPI and BPII as possible phases, making BPIII (blue fog) the most likely phase.

The mixtures show relatively large temperature ranges (up to 18°C) that extend to within 30° of room temperature (crystallization typically around 50°C) and were stable for 24 hours or more. A preliminary phase diagram (Fig. 3) indicates that the 'sweet spot' for these particular components resides in concentrations greater than 1.4% but less than 4.9% chiral dopant; lower concentrations have larger temperature ranges but display problems with image sticking when switched with electric fields.

Broad-temperature range, stable blue phase materials are of interest in the display industry because of their fast switching speeds and the fact that they do not require alignment layers. Our successes in finding mixtures with broad temperature ranges and improved stability could make them attractive for display purposes, although our materials still suffer from high switching voltages (5 - 6 V/ μm or more to achieve suitable brightness (Fig. 4)). Initial switching speed measurements (3.2 wt% chiral dopant) show τ_{90} on the order of 10ms (9.2 ms at 68°C , 20 V/ μm pulse (Fig. 5)) and τ_{10} between 5 – 10 ms, depending on the temperature. This is comparable to the original broad temperature range blue phase materials of Coles and Pivnenko [1] and blue phases formed by T-shaped molecules [2].



Figures

Fig 1. Reflection changes with temperature in a mixture of calamitic liquid crystals and chiral dopant (left). All the colors are visible at once when the cooling cell experiences a temperature gradient (right).

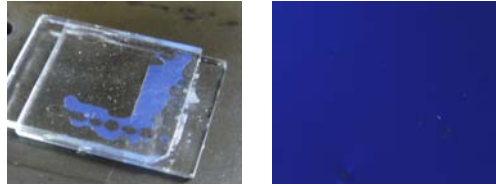


Fig 2. A cell containing bent-core liquid crystal and chiral dopant shows a pale blue color (left). A uniform blue texture in a 3.2% chiral dopant in bent-core mixture under the microscope (right).

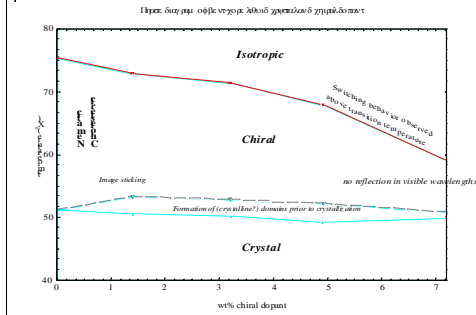


Fig.3: Preliminary phase diagram

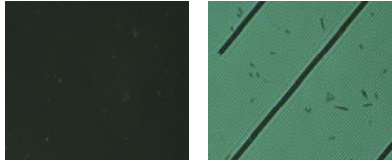


Fig 4: 4.9% chiral dopant in bent-core liquid crystal at 57°C and 0.36V (left) and 57.1V (right). The small rods in the image are spacers.

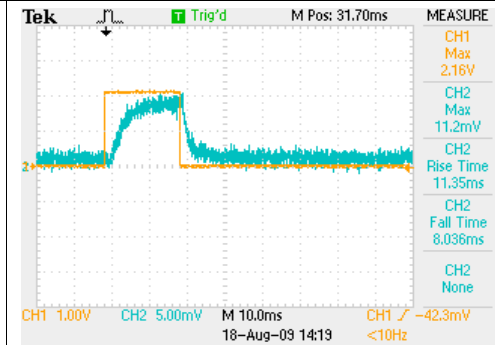


Fig 5: Measuring the switching speed of an in-plane cell at 68°C

[1] *Nature Letters*, **2005** Vol 436 No 18

[2] *Advanced Materials*, **2007** 19, 4145-4148

8. Advisor's remarks (I) (if any):

I want to know the phase boundary between the N* and Blue phases in Fig. 3. I also want to know helical pitches as functions of both temperature and chiral content. It is interesting to know how the response time depends on the helical pitch. The response time measurements at a fixed temperature using mixtures with different chiral contents would give this answer.

If you use bent-core nematogens with negative dielectric anisotropy in rubbed cells, which specify the tilt direction, with ITO at both surfaces and apply an electric field between both surfaces, you can make devices operatable under more realistic applied voltages.

9. Advisor's remarks (II) (if any):

Ms. Stefanie Taushanoff worked hard here with my student, Mr. Van Khoa Le, and obtained interesting results more than what I can expect in such a short period. Further studies such as switching speed and the extension of temperature range covering room temperature are still necessary.

RESEARCH REPORT

1. Name: Natalie A. Wali (ID No.: SP09056)
2. Current affiliation: University of California, Los Angeles
3. Research fields and specialties: Materials Science – Structure Materials Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: University of Tokyo
5. Host researcher: Dr. Yutaka Kagawa
6. Description of your current research <p>Ceramic matrix composites combine the physical and chemical stability of a monolithic ceramic phase with the toughness of a reinforcement to create a material that can be applied to extreme environments, such as hypersonics (Mach 5 to 10, or between ~1,700 and 3,400 m/s). In these applications, the hot parts of re-usable aero-vehicles will experience severe thermal shock and thermo-mechanical cycling in a highly oxidizing environment at temperatures above 1800 °C.</p> <p>Fundamental studies on a refractory-based composite for aerospace structures are performed. The material is carbon fiber-reinforced zirconium carbide (Cf/ZrC) manufactured by reactive melt infiltration (RMI) by Ultramet (Pacoima, CA). To make the composite, a high strength carbon fiber is selected as the reinforcement. The fibers are coated with a multilayer interface (coating), of which several types were used in different processing batches. The coated fibers are then woven into a two-dimensional fabric preform. Next, a controlled level of amorphous carbon is rapidly deposited onto the preform using chemical vapor deposition to form a porous C/C skeleton. Molten zirconium metal infiltrates the porous preform in an evacuated environment assisted only by gravity and capillary forces. The zirconium melt reacts with the previously deposited carbon to form zirconium carbide : $Zr+C \rightarrow ZrC$. This processing method is comparatively cheaper and faster than other common ceramic processing techniques.</p> <p>Extensive microstructural characterization has already been performed and a microstructure formation mechanism was proposed to explain the presence of several interesting microstructural features. An ongoing evaluation of the processing method is performed with the computational fluid dynamics software FLUENT (ANSYS, Inc.). A critical assessment of the high temperature performance and environmental stability of this material is planned.</p>

7. Research implementation and results under the program

Title of your research plan:

In-situ Compression Test of a Carbon Fiber-Reinforced Zircon Carbide Composite Produced by Reactive Melt Infiltration for Ultra-high Temperature Applications

Description of the research activities:

Two types of Cf/ZrC were chosen for the major experiment of this program: one with uncoated fibers, and one where the fibers had been coated with two protective layers, ZrO₂ over HfN. Transmission electron microscopy revealed that the layers reacted during processing to form nonstoichiometric oxycarbides. This reaction in turn bound the carbon fibers to the matrix, a consequence which is known to have a detrimental effect on the strength. Direct determination of the shear strength of the interface is very difficult as the small fiber diameter (~ 7 μm) precludes it from many conventional tests, such as the fiber push-out test. An experiment was devised to determine the strain distribution in the area of the fiber-matrix interface with an *in situ* compression test. Before loading, the initial strain distribution in the sample must be determined. There is residual strain after processing from the thermal expansion mismatch between carbon and ZrC and volume change that accompanies reaction. It is expected that the samples with the oxycarbide layer around the fibers will demonstrate more extensive strain during compression due to the chemical bond between the fiber and matrix.

2mm x 5mm x 10mm bars were machined, two for each Cf/ZrC type. The surfaces of interest were polished to 1 or 0.1 μm roughness. Instead of affixing a conventional strain gage to the surface, a 500 μm x 500 μm gold grid with 5 μm spacing was deposited on the regions of interest by an electron beam lithography technique developed by the host research group. The deformation in the grid spacing is used as a measure of strain change. Compression is performed at room temperature in a modified scanning electron microscope so that micrographs of the surface could be taken as the load was applied. The grid deformation and corresponding strain distribution on the surfaces are obtained by digital image correlation with an image processor. The results for the composite with uncoated fibers and the one with coated fibers will be compared and correlated to the interfacial properties.

Several small experiments were also conducted. The porosity and density of the different types of Cf/ZrC were obtained by the Archimedes method using an electronic balance. Four monolithic ZrC stubs were made by spark plasma sintering (SPS) at the host institute, each one with a different holding time and temperature. The densities and porosities of these samples were also determined by the Archimedes method. The hardness values of the SPS and RMI samples were determined with a dynamic sub-micron indenter.

8. Please add your comments (if any):

The title of the research plan performed in this program is different from the one in the program proposal. This is due to a drastic change in the experimental plans after arrival at the host institute and due to a limited supply of material for testing. In addition, there was no time left to perform the compression tests.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Russeen Paul Wali (ID No.: SP09057)
2. Current affiliation: UCLA Department of Chemistry and Biochemistry
3. Research fields and specialties: Mathematical and Physical Sciences Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: World Premiere Institute (WPI) for Materials Nano-Architectonics (MANA) at the National Institute of Materials Science (NIMS)
5. Host researcher: Prof. Masakazu Aono, Prof. Tomonobu Nakayama, Prof. Genki Yoshikawa
6. Description of your current research <p>Molecular or particulate sensors have many applications including industrial process monitoring, medical diagnostics, and agricultural quality control. There are a variety of extant sensor schemes each competing in niche markets with limited success. Electrical sensors can distinguish surroundings based on a change in resistance, capacitance, or inductance caused by adsorption of analytes onto the substrate. Common sensors focus on one of these properties and apply within a limited application range where other parameters are constant or where variation is controlled. Mechanical sensors can distinguish surroundings based on a change in stiffness or mass induced by analyte adsorption. There are two common types of mechanical sensors, static bending sensors and dynamic sensors in which the mechanical resonance is altered. Dynamic sensors are used widely in process control for integrated circuit manufacturing (e.g. quartz crystal microbalances). Static bending sensors have been used in the most sensitive electronic noses built to date. If these various sensing modalities could be combined in a single unit, it would be hugely more selective and much more widely applicable.</p> <p>My research interests are information-rich electromechanical sensors. These electromechanical sensors measure resistance, capacitance, inductance, and mechanical resonance properties of micromechanical oscillators. All properties are measured using a single electrical impulse which hits a piezoelectric material and is transduced into mechanical motion of the resonator. This mechanical motion produces an electrical response signal which is read and immediately analyzed using a pre-programmed personal computer. Measurements, including pre-programmed data analysis, occur in < 1s.</p>

7. Research implementation and results under the program

Title of your research plan:

A Micromechanical Chemical Vapor Sensor

Description of the research activities:

A type of electronic nose based on coated cantilevers was constructed and tested. The cantilevers had integrated piezoresistive motion sensors, which change resistance in response to applied stress. Motion of a cantilever even as low as a few nanometers produced an easily measurable resistance change. The cantilever chip was mounted onto a piezoelectric element so that it could be vibrated in a precisely controlled manner using electrical signals. A piezoresistive response signal was separated into responses at various frequencies using Fourier Transform. A polymer-based coating on the cantilevers enhanced sensitivity and specificity by providing more adsorption sites for gas molecules with chemical properties similar to the coating. Separately, an information-rich electromechanical resonance sensing method was demonstrated. This method uses coated piezoelectric elements as sensors which yield electrical and mechanical information. Finally, modeling of cantilever dynamics was explored using COMSOL simulation software.

8. Please add your comments (if any):

I would like to thank the NSF and JSPS for funding this great opportunity to conduct research in Japan. I would also like to thank my host researchers at MANA/NIMS for allowing me to work with them and for helping me adjust to life here. Although what we did is different from what was planned I feel I have learned much from the experience.

9. Advisor's remarks (if any):

Thank you to JSPS and NSF.

RESEARCH REPORT

1. Name: Michelle L. Walsh (ID No.: SP09058)
2. Current affiliation: University of New Hampshire
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Maizuru Fisheries Research Station, Kyoto University
5. Host researcher: Yoh Yamashita
6. Description of your current research <p>Flatfishes (flounders, halibuts, soles) are among the most desirable and highly priced fishes consumed by humans. Although flatfishes have supported valuable fisheries throughout the world, over the past few decades, catches of many species have steadily declined. Individual marine fish are capable of releasing 100,000+ eggs annually but because of the vulnerability of the small, early life stages, few survive to maturity. Spawning and rearing flatfish in captivity, and releasing the young at a size or age beyond this period of high mortality may enhance natural populations. This practice (called stock enhancement) is one of the few tools available to fisheries scientists for conserving, managing, and restoring natural fish populations. The popularity and value of flatfishes for human consumption make them an attractive candidate for stock enhancement.</p> <p>Japan has the highest per capita consumption of fish in the world, so it is not surprising that Japanese scientists lead research in marine fish stock enhancement. Japan is the most active country with respect to flatfish stocking, both in the number of fish released and the range of species reared. Japanese scientists, particularly those associated with Kyoto University, have pioneered flatfish enhancement methodologies including the development of strategies that ease the transition of cultured flatfishes from the captive environment to the natural one. Japan is the only country that has been successful in providing high recapture rates of stocked flatfish (up to 30%), economic profitability of stocking effort, and evidence of biological contribution to wild spawning stocks. Indeed, the governing structure of Japan (localized prefectures) has contributed to such successes.</p> <p>Conditioning is the process of providing organisms reared for stock enhancement with some degree of "natural" experience prior to release. Conditioning fish before stocking</p>

may offset hatchery deficiencies and increase the survival of released individuals. One method of conditioning involves first releasing fish in acclimation cages for a short period in the wild so they can experience natural life without predation risk. This summer, I examined the differences in feeding success between conditioned and unconditioned Japanese flounder *Paralichthys olivaceus* released for stock enhancement in Takahama Bay, Japan.

7. Research implementation and results under the program

Title of your research plan:

Assessing the feeding success of cage-conditioned Japanese flounder *Paralichthys olivaceus* released for stock enhancement

Description of the research activities:

Japanese flounder were spawned and reared to the juvenile stage (ca. 100mm TL) at the Obama Station, Japan Sea-Farming Association, Tomari 26, Obama 917-01, Japan, according to the general protocol described by Sekai (2000). Fish were immersed in an alizarin complexone [ALC; red fluorescent dye; as per Yamashita et al. (1994)] bath to distinguish two groups of flounder (40,000 per group): (1) conditioned before release in the shallow, wild coast, and (2) a control group reared in the hatchery until release. We conducted cage-release conditioning for 1 week from 22-29 June 2009 in a total of 8 cages (5000 fish per cage) at Takahama Beach in Takahama Bay (LAT 35°N 29'38", LON 135°E 32'43"), which is within Wakasa Bay, Fukui Prefecture, along the midcoastal area of the Japan Sea. Conditioned fish were released on 29 June (Day 0) and unconditioned fish were released the following day (Day 1) at the conditioning location in depths of 1-2m. We subsequently recollected released fish via 2-m beam trawl (20 cm height x 8 mm² mesh) during the morning on 9 sampling occasions (Days 2, 4, 7, 14, 22, 28, 35, 49, and 63). In addition, fish were collected via 12 fyke nets set along the rim of the bay in cooperation with local fishermen.

To quantify feeding success, 113 collected fish samples (28 conditioned, 41 unconditioned, 44 wild) were processed to assess onset of feeding, stomach fullness and diet composition. Onset of feeding was determined by examining the percentage of empty digestive tracts over time. Stomach fullness was expressed via the Stomach Contents Index (SCI), which equals the total weight of the stomach contents/total weight of the fish sample minus stomach contents multiplied by 100. Diet composition was portrayed by the Index of Relative Importance (IRI), which

combines frequency of occurrence, percent numerical composition, and percent dry weight into one convenient number for comparison.

Most released fish (both conditioned and unconditioned) were feeding by 2-3 weeks post release. There were no patterns of stomach fullness for any fish as time progressed in the wild. No unconditioned fish were collected after week 3 in the bay, but conditioned fish continued to be collected over a month after release. Like wild fish, both conditioned and unconditioned fish ate mostly mysids and small fishes, including the goby *Istigobius hoshinonis* and the juvenile mackerel *Trachurus japonicus*. There appeared to be no strong differences in feeding onset or diet composition between conditioned and unconditioned fish; however conditioning may have other benefits which were not assessed in this study, such as increasing burying ability, predator avoidance, survival or stocking efficiency.

8. Please add your comments (if any):

This was a remarkable experience that will lead to both presentation at international conferences (including next year's International Stock Enhancement Symposium in Shanghai, China) and publication. My collaboration with these Japanese scientists will continue in the future. In fact, I have already arranged to come back and work with the Maizuru Fisheries Research Station in 2010.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: David A. Weese (ID No.: SP09059)
2. Current affiliation: Auburn University
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: University of the Ryukyus, Nishihara-cho, Okinawa Japan
5. Host researcher: Yoshihisa Fujita and Michio Hidaka
6. Description of your current research <p>The geologic history of a region can have a significant impact on the development of its flora and fauna, with past events and potential alterations in climate consequently shaping the community patterns and evolutionary trajectory of species. In this context, the Ryukyu Islands have a complex history of repetitive periods of land connections and oceanic isolation that have likely influenced its native species. Understanding the evolutionary relationships of taxa restricted to these islands could help in elucidating the geologic history of the Ryukyus. To address this, genetic studies of shrimp species from anchialine habitats (coastal land-locked bodies of brackish water with subterranean connection to the sea) are needed since their evolution has been shown to be strongly correlated with the age and history of island systems. Along with offering an excellent opportunity to test geologic hypotheses of the Ryukyus, comparing different shrimp species provides an opportunity to understand how variation in traits such as egg size and larval development affect patterns of aquatic biodiversity. While this study will provide additional insight into the evolution and ecology of anchialine organisms in general, it also has applied utility in developing management strategies for these organisms and their environments around the world.</p>

7. Research implementation and results under the program

Title of your research plan: Population Structure and Evolutionary History of Anchialine Shrimp Across the Southern Ryukyu Islands

Description of the research activities:

The objective of my summer research was to collect individuals of anchialine shrimp belonging to three genera from sites on at least seven islands from the Miyako (3 islands) and Yaeyama (4 islands) groups in the southern Ryukyus. To date my host and I have traveled to over fourteen islands in the southern Ryukyus with two more collection trips planned in the coming days. We have collected 556 anchialine shrimp belonging to four genera from 20 anchialine habitats across eight islands (Okinawa, Ishigaki, Irabu, Miyako, Taketomi, Tarama, Kuroshima, and Minami Diato). I hope to sample at least two more islands before the end of the summer program. In our collections, we report the first record of three anchialine shrimp species from the island of Ishigaki as well as the first occurrence of anchialine shrimp from one cave on Minami Diato. Additionally, we have collected a new species of anchialine shrimp and a new species of anchialine fish from habitats on Miyako Island. Genetic analyses of the population structure and evolutionary histories of collected shrimp will be conducted at Auburn University in the following months.

8. Please add your comments (if any):

The EAPSI fellowship has offered me an exciting and unique opportunity to further develop my thesis research as I experienced Japanese culture and society on a firsthand basis. This program has allowed me to develop relationships with many Japanese scientists and graduate students. By interacting with these researchers, I have gained valuable insight into the international scientific community, which will prove useful for future research endeavors while furthering my professional experience.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Nicholas E. Wierschem (ID No.: SP09060)
2. Current affiliation: University of Illinois at Urban - Champaign
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: University of Tokyo
5. Host researcher: Dr. Hitoshi Shiohara
6. Description of your current research <p>The deterioration of reinforced concrete structures due to the corrosion of steel reinforcement has generated a lot of interest in concrete structures reinforced with highly corrosion resist fiber reinforced polymer (FRP) bars. However, due to the linear elastic behavior of FRPs, FRP reinforced concrete structures lack ductility and energy dissipation; these weaknesses make FRP reinforced concrete structures unsuitable in many situations in seismic regions. Currently, my research at the University of Illinois seeks to help solve these problems by exploring the reinforcement of concrete structures with Shape Memory Alloy – FRP (SMA-FRP) composite bars. This new type of composite reinforcement material consists of a polymer matrix reinforced with superelastic shape memory alloy (SMA) wires both with and without additional conventional fiber reinforcement. The benefits of this material come from the unique properties of SMAs. These properties include a stress-strain relationship with significant hysteretic area with out residual strain, large strain capacity, and high corrosion resistance. Because of the high cost of SMAs, this reinforcement is only proposed to be used in high ductility demand regions of concrete structures which are otherwise reinforced with FRP bars. In my research, the properties of these composites have been explored experimentally with cyclic tension tests of SMA-FRP composite coupons. From this experimental testing, an analytical material model of the behavior of SMA-FRP composite reinforcement was created and explored. Longitudinal reinforcement of concrete structures using SMA-FRP was analytically explored using finite element models of reinforced concrete sections, substructures, and frames. The performance of SMA-FRP reinforcement was evaluated in comparison to structures reinforced solely with FRP. The results of this ongoing research project have shown that SMA-FPR composite reinforcement shows tremendous promise in adding ductility and energy dissipation to concrete structures primarily reinforced with FRP bars.</p>

7. Research implementation and results under the program

Title of your research plan:

Reinforced Concrete Beam-Column Joint Correlation Study

Description of the research activities:

In the analysis of concrete frame structures it is common to assume that there is no damage to the beam-column joints. Regrettably, this assumption may not always be correct and the resulting damage reduces the performance of the structure. In order to prevent damage to the joint one must understand the behavior of the joint and use that knowledge to design adequate joint reinforcement. However, current beam-column joint models have thus far proved insufficient. To develop a better understanding the behavior of concrete beam-column joints, a new model has been developed which assumes a different failure mechanism. This model, developed by Dr. Hitoshi Shiohara, is based on experimentally observed damage pattern from tests of concrete beam column joints. From the observed damage pattern, a model was created that simulates the behavior of the beam-column joint through the interaction of 4 rigid plates. Each of these plates has 3 degrees of freedom (DOF) (2 translation and 1 rotation) and one set of DOFs is needed to form a basis of comparison; therefore, the total number of independent DOF in the joint model is 9, hence the name, Nine Parameter Model (NPM). Finite element modeling based on the NPM has been successfully compared to experimental results. Unfortunately, the complexities of this model make it impractical for the typical design environment; as a result, steps were taken to simplify the model by condensing the number of DOF. This research project set out to verify the simplified NPM through comparison with experimental data. The data set used for this comparison came from beam-column joint tests performed at the University of Tokyo. As a part of this research project, the researcher assisted in the preparation and testing of the last six beam-column joint included in this data set. From this comparison, it was found that the NPM performed well in predicting the capacity of the beam-column joint, and in most situations, the predicted capacity of the beam-column joint was within a few percentage points of the experimentally determined capacity.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Brooke Wilken	(ID No.: SP09061)
2. Current affiliation: University of Wisconsin, Madison	
3. Research fields and specialties: Humanities <u>Social Sciences</u> Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Kokoro Research Center (Kyoto University)	
5. Host researcher: Dr. Sakiko Yoshikawa / Dr. Yukiko Uchida	
6. Description of your current research <p>Currently, I am doing research on cultural differences in cognition. Within psychology, there are many recent findings showing how individuals from Western cultures typically differ from individuals from Eastern cultures in attention or perception. In particular, Westerners tend to have more analytic cognitive styles, in which they attend to or perceive focal objects more than background objects. On the other hand, Easterners tend to have more holistic cognitive styles, in which they attend to or perceive more background objects. Although most research up to this point has examined how and why these cultural differences originated, my current work is building on these findings to investigate the <i>consequences</i> of cultural differences in analytic and holistic cognition. Presently, I am interested in what consequences these perceptual differences are having on how we influence each other within our interpersonal interactions.</p> <p>Recent findings on influence have shown that individuals in America (a Western culture) tend to have motivations to influence others and the situation around them more than do individuals in Japan (an Eastern culture). Additionally, leadership literature has found that effective leaders are those with an ability to attend to or focus on the group's central goals. However, these studies have only been conducted with Western cultural samples and therefore their results may not be entirely generalizable. In Eastern cultures, where research has shown that individuals prefer people who take a more holistic perspective, effective leaders may be those individuals with an ability to attend to or focus on not only the group's main goal, but also others and the whole situation or environment as well. If this is the case, then inducing Americans to perceive more holistically may lead them to become less influential than would inducing them to perceive more analytically. On the</p>	

other hand, inducing Japanese to perceive more holistically may actually lead them to become slightly more influential than would inducing them to perceive more analytically. However, these results may depend on the type of person with whom they are interacting. Since some research shows that there are stronger distinctions between ingroups and outgroups in Japan than in America, these differences may only appear when interacting with close others and not with strangers. If inducing analytic or holistic perception in American and Japanese friends and strangers leads to such results, then this would indicate that cultural differences in perception can have consequences for the ways in which individuals influence each other when interacting. Therefore, more broadly, other cognitive differences across cultures may also have consequences for our interpersonal behavior, which I plan to examine as well in my current line of research.

7. Research implementation and results under the program

Title of your research plan:

Culture and the Interpersonal Consequences of Differences in Perception

Description of the research activities:

To induce 11 American stranger dyads, 11 Japanese stranger dyads, and 11 Japanese friend dyads to perceive either analytically or holistically, they were given a change-blindness computer task. In this task, they received 15 image pairs, with each image presented on-screen for 560ms. In between each image and its pair, there was an 80ms blank screen. Within each image pair, there was one change in either a focal or background object (the analytic and holistic conditions, respectively). Individuals were instructed to press a key and enter the answer as soon as they noticed what changed within each image pair.

After being induced to perceive either analytically or holistically, then interpersonal influence was measured in two tasks. The first was a tangrams task, in which participants were put into pairs to match tangrams cards with each other. They did this task without looking at the other person's cards, but merely by describing the cards verbally and nonverbally. These interactions were videotaped to code for influence behaviors. The second task was a questionnaire, in which they were asked to rate how influential both they and their partners were on 6 different measures (e.g., "In your interactions with your partner, who had more influence?" 1=You, 7=Your Partner).

At the end of the experiment, all participants were told what the study was about and

then thanked for their participation.

Since data must still be obtained from American friend dyads, the videotaped interactions have not yet been coded for interpersonal influence behavior. However, ignoring the distinction between friends and strangers until data collection is complete, the influence ratings from the questionnaire have been preliminarily examined using a 2 (culture) x 2 (condition) ANOVA.

As expected, the influence ratings showed that Americans felt they were significantly more influential than did Japanese. Further, it was found that Americans felt that they became less influential when they were induced to perceive holistically, whereas Japanese actually felt that they became more influential when they were induced to perceive holistically. This indicates that while being more holistic in America means feeling less influential, being more holistic in Japan means actually feeling slightly more influential. Therefore, being an effective leader in America may involve being more analytic in one's perceptions and focusing on a focal goal, whereas being an effective leader in Japan may involve being more holistic in one's perceptions and focusing on others and the surrounding situation as a whole.

In sum, the results so far provide evidence that cultural differences in perception have consequences for our influence behavior during interactions. More broadly, these preliminary findings suggest that other cognitive differences across cultures may also have consequences for our interpersonal behavior.

8. Please add your comments (if any):

The title and the project reported here are not the same title and project originally proposed in the application.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: June Elmer Wolfe III (ID No.: SP09062)
2. Current affiliation: Baylor University and Texas AgriLife Research
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Shimane University, Matsue Department of Ecology and Environmental Science
5. Host researcher(s): Dr. Tsuguhiro Nonaka – Host Researcher Dr. Tomoyuki Kuwabara – Host Research Advisor Dr. Hiroaki Somura – Host Counterpart
6. Description of your current research Phosphorus plays a unique role in surface water eutrophication (excessive nutrient enrichment) which negatively affects aquatic ecosystems worldwide. Lakes Shinji is a shallow, brackish lake located in Shimane Prefecture, Japan which produces about 40 percent of Japan's supply of Shijimi clams (<i>Corbicula japonica</i>) as well as a number of other delicacies. It suffers from phosphorus-driven eutrophication. Although many earlier policies which led to this condition have been abandoned, the lakes still display problems such as phytoplankton blooms, anoxia, and reduced biodiversity. The Environmental and Eco-Engineering team lead by Dr. Tsuguhiro Nonaka at Shimane University has developed recycled concrete materials (RCM) with large nutrient sorption capacities and bio-adhesion properties. RCM are being used to re-establish wetlands around the lakes and to cap nutrient-laden bottom sediments. During the 2009 JSPS Summer Program I worked with Dr. Tomoyuki Kuwabara and was helped by Dr. Hiroaki Somura to measure the phosphorus sorption capacity of three RCMs and examined their surface colonization by native periphyton. We also conducted several experiments involving the phosphorus sorption properties of RCM alone and in conjunction with Lake Shinji periphyton. The research aimed to answer four basic questions. 1) What is the phosphorus affinity of the RCM? 2) What is the effect of RCM type upon periphyton growth? 3) What is the effect of periphyton upon phosphorus sorption by RCM? 4) Is phosphorus sorbed to RCM biologically available to periphyton?

7. Research implementation and results under the program

Title of your research plan:

Optimizing bio-mediated processes to improve the functionality of recycled concrete materials used to remediate phosphorus in aquatic ecosystems

Description of the research activities:

This research examined the effect of different recycled concrete materials (RCM) upon periphyton colonization and phosphorus uptake. Host scientists in the Department of Ecology and Environmental Science prepared RCM based on descriptions the submitted EAPSI proposal. Aggregate materials including a local “Kimachi” rock, a recycled concrete, and a foamed glass were mixed with Portland cement and formed under pressure into 50mm dia. x 50 mm tall cylinders. The department conducted standard concrete testing on each of the materials.

RCM Phosphorus Sorption: Each material’s phosphorus sorption capacity was measured using laboratory batch experiments. A known RCM mass was equilibrated in a solution containing a known amount of dissolved phosphorus (P) for 48 hours. The concentration at equilibration was plotted against the amount of P sorbed (mg/g) and fitted with a Langmuir model to determine the maximum potential P sorption. Measurements indicated that RCM formed of foamed glass sorbs ~2.9 mg/g or 14 to 24% more than RCM made of Kimachi rock or recycled concrete, ~2.5 and 2.2 mg/g, respectively. Dissolved P sorption rates were also determined for each RCM material. The foamed glass RCM exhibited faster PO₄ sorption than Kimachi rock or recycled concrete based materials.

Periphyton growth on RCM: RCM materials were placed in Lake Shinji to evaluate their colonization by native periphyton. RCM were glued to concrete paving squares and deployed in a protected area in approximately 0.5 m of depth. Replicated samples were harvested at 2, 3, 4, and 5 weeks following deployment. Biomass accumulation as ash free dry mass (AFDM) and chlorophyll a (C_a) and taxonomic analysis were conducted on each RCM sample. AFDM increased over time for all three materials. C_a biomass increased during the first three sample dates but decreased slightly at the final harvest date. As a result, the autotrophic index (AI, ratio of AFDM to C_a) increased over time. Ending AI values were high (i.e > 700) indicating water quality impairment, however this may have been due to the large number of diatoms dominating the RCM surfaces. Taxonomic evaluation showed typical periphyton species found in Lake Shinji including several green filamentous algae and numerous diatoms. Quantitative cell counts were used to determine relative species abundance. Species were sorted into four functional groups representing the major periphyton growth forms observed. Diatoms were dominant during the first two and last sampling date. Functional groups were equally represented during the third sampling date.

Phosphorus Uptake by Periphyton-covered RCM: Replicated RCM were deployed into Lake Shinji for three weeks to allow periphyton colonization. Samples were removed to the laboratory where half of the samples were treated with a formalin solution to kill the periphyton. Live and dead periphyton covered RCM were placed in separate 1 ppm P solutions. Water samples were collected at 0, 30, 60, 120, 240, and 480 minutes after initiation and analyzed for remaining P content. RCM with live periphyton removed more than 50% of the dissolved P load within the 8 hour experiment. RCM covered with dead periphyton removed less than 5% of the load and Kimachi rock exhibited a slight release of P. These results indicate that the periphyton biofilm inhibits phosphorus uptake by the RCM. A second experiment was conducted to compare RCM covered with live periphyton to RCM without periphyton. Replicated samples were placed in separate 1 ppm P solutions. Water samples were analyzed for P at 0, 24, 48, 96, and 168 hours following initiation. In this case, RCM with and without periphyton both removed between 90 to 100% of the P load again showing the effect of the biofilm on RCM P sorption.

Availability of RCM bound phosphorus: Replicated RCM were equilibrated in solutions containing 1, 5, 10, 50, 100 ppm dissolved P for 48 hours and deployed into Lake Shinji for three weeks to allow periphyton colonization. Samples were harvested and analyzed for C_a biomass to determine availability of sorbed P. Recycled concrete and Kimachi rock RCM exhibited similar biomass responses over all 5 sorbed P concentrations. Foamed glass however showed a general increase in biomass with increasing sorbed P concentration indicating that P may be less tightly bound to this material and therefore more biologically available.

Conclusions:

- RCM exhibited different P sorption capacities based on composition
- Lake Shinji periphyton rapidly colonized all three RCM, showing no preference
- Periphyton biofilms appeared to negatively affect dissolved P sorption by RCM
- Increasing amounts of P sorbed to RCM exhibited both null (rock, concrete) and positive (foamed glass) effects upon periphyton biomass accumulation

8. Please add your comments (if any):

The experience of living and working in Japan has been personally rewarding. I have learned a tremendous amount about my science, my friends, and myself. The students and faculty at Shimane University have been most helpful in this endeavor. The opportunity to work with and meet Japanese researchers through the JSPS Summer Program has helped me continue to develop a network of collaborative scientists. I look forward to much future cooperative work that will result from this program.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Eric Yee (ID No.: SP09063)
2. Current affiliation: University of California, Los Angeles
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Kyoto University
5. Host researcher: Dr. Masayoshi Nakashima
6. Description of your current research <p>My research under Professor Nakashima was to conduct a “blind analysis” of a tall building. This blind analysis was the prediction of a structure’s response subjected to earthquake loading given a limited amount of information. Since limited information is provided, the predicted outcome is expected to have minimum influence from external sources and data bias. These predictions are compared to structural response data of a full-scale structure subjected to ground motions at E-Defense.</p> <p>E-Defense is the world’s largest shake table facility located in Miki City, Japan, where numerous structures have been shaken to evaluate their engineering performance. The structure to be evaluated through blind analysis was a 21-story building. Since testing a full-scale 21-story building is unfeasible, an equivalent test structure was engineered. The test structure consisted of a four-story, two-span by one-bay steel frame with an equivalent system mounted on top. This equivalent system consisted of concrete slabs, dampers, and rubber isolators, which were designed to mimic the structural response of the upper 17 stories. This structure was subjected to several different ground motions until some of its members finally fractured.</p> <p>Typically, the results of a blind analysis are the final response values. The techniques and approaches used to compute such values are generally unavailable but are just as important as the final results. My blind analysis allows the evaluation of the modeling approaches used and to see how such approaches affect the final results.</p>

7. Research implementation and results under the program

Title of your research plan:

“Blind Analysis” of Equivalent Tall Building Subjected to Long Period Ground Motions at E-Defense

Description of the research activities:

To compute the necessary structural response values, a model was created using the SAP2000 program. In order to make as few modeling assumptions as possible, I decided to model the major structural elements as close as possible to the actual test specimen. Model geometry, material properties, and certain element behavior were provided and input accordingly into the structural analysis program. A rendering of this model is presented in Figure 1.



Figure 1. SAP2000 rendering of structural model.

This model was analyzed using two out of four ground motions the actual test specimen was subjected to. Once my model was set, I was given some actual test data in order to evaluate the accuracy of my model. Initial results showed that my response in one direction was not as accurate as in the other direction and that my lower stories performed more accurately than the upper equivalent portions. For my second round of the blind analysis, I would have to address these two issues.

To complement my modeling, I was given the opportunity to visit E-Defense and inspect the construction of an identical structure for future testing. Construction procedures as well as detailed inspections allowed me to better understand structural components such as the beam-column connection detail shown in Figure 2.

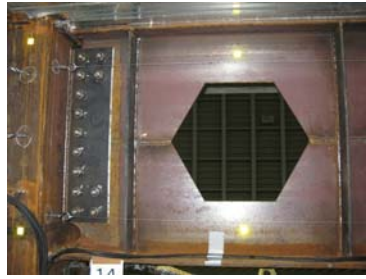


Figure 2. Beam-column connection.

Since I was provided with slightly more information, round 2 of the blind analysis consisted of addressing the inaccuracies from round 1 of the blind analysis. After days of debugging, it was found that my structural response was dependent on the sequence in which I created certain elements. This new fact was taken into account and the new model was again subjected to two sets of ground motions. The results were generally more accurate than before.

One of the major conclusions of this study was the observation that the computer model was able to more accurately predict results under complex conditions than under relatively simpler conditions. This was attributed to the simple fact that actual test data were more affected by external influences under simple conditions than under complex conditions.

8. Please add your comments (if any):

This experience was one of the most wonderful times of my life. I had the opportunity to conduct research in an area I would not have the opportunity in my home university and was relatively well prepared for such an endeavor. Most importantly, I met wonderful people and was able to develop many close relationships with my fellow JSPS and Kyoto University colleagues. These relationships developed from mutual respect and time well spent in and out of the office. Hopefully, we will have many opportunities to collaborate on future projects between countries.

9. Advisor's remarks (if any):

Eric Yee is a very modest and capable gentleman. He is very natural in style, and his manner to deal with office mates is elegant. Although his stay is short, he has given my students great influence about research and life. The subject he has challenged with us is also of a great benefit for the progress of one of my research projects, and I am very positive that he and my students will write an interesting paper based on his research in Kyoto. I learned that he wants to pursue an academic career. I trust that he will grow up to a decent academician, wishing the best of a good luck on his career.

RESEARCH REPORT

1. Name: Shong Yin	(ID No.: SP09064)
2. Current affiliation: Department of Electrical Engineering, UC Berkeley	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: National Institute of Materials Science-Namiki Site	
5. Host researcher: Dr. Kazuya Terabe, Atomic Electronics Group	
6. Description of your current research <p>Ionic memories are a potential candidate for replacing flash memory beyond the 32nm node. Fast switching speed, low switching power, and scalability all make this an attractive technology. The ionic memory is fundamentally an electrochemical device, different from the flash memory which is an electrostatic charge storage device. The metrics used to evaluate non-volatile memories include read speed, program/erase speed, operating power consumption, endurance cycle-ability, and data retention time. Although both solid electrolyte and flash memories share system-level attributes of non-volatile memories, the physical mechanisms that affect those attributes are different.</p> <p>At UC Berkeley I have been developing solution processing methods for depositing silver sulfide. I am currently investigating the use of sintered nanoparticles films to control microstructure. The impact of grain size on electronic and ionic conducting properties and effect on memory device characteristics are being explored. In-situ heating x-ray experiments show that sintering of nanoparticles begin as low as 130C, and thermogravimetric analysis shows that the nanoparticle encapsulant does not evolve from the film until 250C. The effect of grain size on ionic and electronic conducting properties will be explored.</p>	

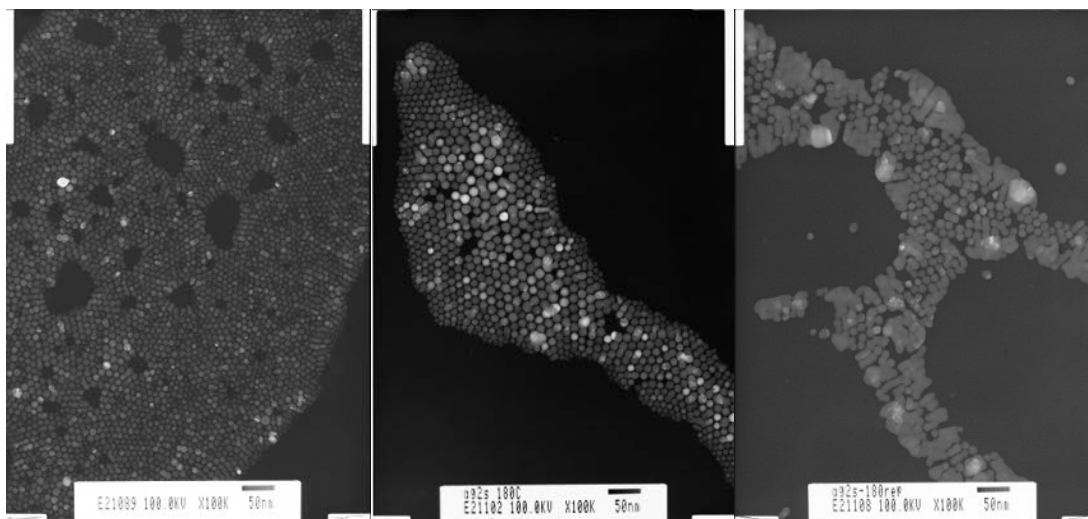
7. Research implementation and results under the program

Title of your research plan:

Electrochemical Characterization of Sintered Nanoparticle Thin Films

Description of the research activities:

The research conducted this summer consisted of several components: nanoparticle synthesis and characterization, thin film deposition and electrochemical characterization. Octadecylamine encapsulated silver sulfide nanoparticles were synthesized based on a published method [1]. Size distributions were characterized by TEM. Higher monodispersity was observed at a lower reaction temperature (130C) and more aggressive washing.



130C (2 wash cycles)

~10nm size, monodisperse

180C (2 wash cycles)

~7-14nm size, polydisperse

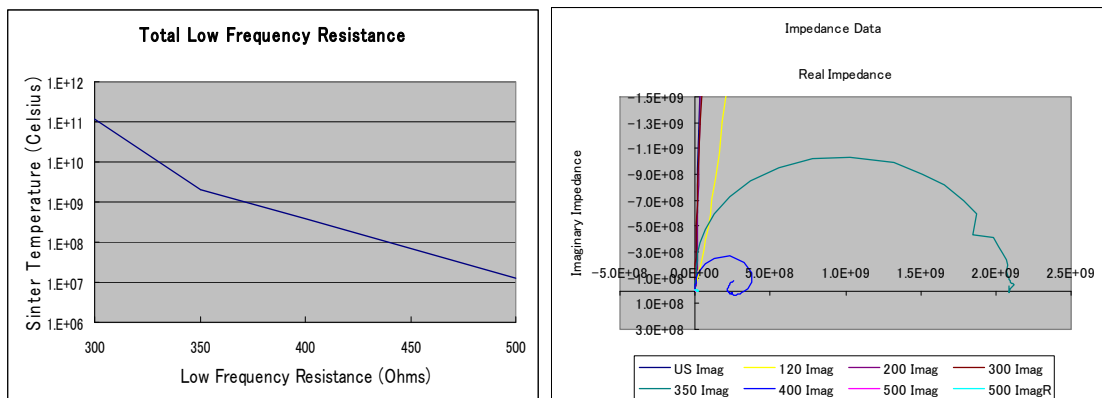
180C (4 wash cycles)

~14nm, agglomeration

Nanoparticle films were spun onto oxidized silicon substrates and sintered at various temperatures for an hour under Argon atmosphere. Severe cracking was observed at temperatures above 200C in films prepared from a 40mg/mL concentrated solution. Spinning thinner films from a 20mg/mL solution resolved this issue.

Electrical impedance spectroscopy and polarization tests were conducted on the sintered films. Significant reduction in total electrical film resistance, and presence of polarization and ionic conductivity did not occur until temperatures greater than 355C, the boiling point of octadecylamine. This suggests that the presence of octadecylamine in the film inhibits electronic and ionic transport, despite grain growth

within the film. To facilitate onset of conduction at a lower temperature, silver sulfide nanoparticles encapsulated by a lower boiling point ligand will be prepared for future studies.



[1] *Chem. Commun.*, 2007, 4474 - 4476

8. Please add your comments (if any):

Dr. Terabe has been an excellent host advisor during my brief tenure at NIMS. He was very helpful in providing access to equipment, ordering reagents, and facilitating experiments. During my second day, he drove me to the local store to purchase supplies. I thank my host secretary Hashimoto-san for setting up lodging and accommodations. My stay here in Japan has helped progress my research, and learn about Japanese culture.

9. Advisor's remarks (if any):

Mr. Shong Yin has studied and worked from his own motive in NIMS during JSPS summer program. He was planning and executing the excellent experiments himself in collaboration with us. He also has learned a Japanese language and the culture, and visited Japanese historic spots. I believe these experiments are very useful in his future.

RESEARCH REPORT

1. Name: Markita P. Landry (ID No.: SP09065)
2. Current affiliation: University of Illinois at Urbana Champaign
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> <u>Chemistry</u> Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences <u>Interdisciplinary and Frontier Sciences</u>
4. Host institution: Osaka University
5. Host researcher: Toshio Yanagida
6. Description of your current research <p>Protein-DNA interactions lie at the heart of many essential cellular processes such as replication, recombination, and repair. Recent advances in optical “tweezers” have made it possible to resolve motions on the scale of a single base pair of DNA, 3.4Å. These high-resolution optical traps have the potential to reveal protein-DNA interactions at their fundamental length scales and should reveal how certain proteins bind to DNA or recognize target sequences.</p> <p>Telomerases are enzymes that have been actively studied in various organisms because of their fundamental involvement with both cancer and aging (1). There are a variety of different telomerase enzymes whose broad function is to protect the integrity of chromosomal ends by various different means. As with most sequence-specific DNA binding proteins (SSDBP), the mechanism by which TelK recognizes its target sequence and both quickly and accurately catalyzes DNA hairpin formation in linear prokaryotic chromosomes is poorly understood. Moreover, the study of TelK- DNA complexes provide unique views into the importance of electrostatic interactions as gateways to overcoming high energy barriers of substrate formation. TelK is not an ATP dependant enzyme, which is surprising given the degree of DNA distortion accomplished by the enzyme, and the large energy barrier intrinsic in DNA hairpin formation.</p> <p>Preliminary studies with high resolution optical tweezers have shown that TelK function is highly regulated by tension. TelK is unable to form DNA hairpins under any tension, which raises questions about its fundamental recognition sequence finding mechanism. Surprisingly, TelK has shown to condense nonspecific DNA (DNA lacking the TelK recognition sequence) at a very fast rate. Control studies using EcoRV, a restriction endonuclease, show no DNA condensation with nonspecific DNA. This is the first known observation of DNA condensation occurring by an ATP independent SSDBP. This unexpected behavior of TelK has prompted the need for single molecule imaging of</p>

TelK- DNA interactions in order to visualize the unique sequence of events undertaken by TelK to catalyze the formation of hairpin structures in linear chromosomes.

7. Research implementation and results under the program

Title of your research plan: International Collaboration in Single Molecule Biophysics: Single Molecule TIRFM Imaging of Protelomerase TelK Mechanism for Recognition Sequence Identification

Description of the research activities:

TIRFM (Total Internal Reflection Fluorescence Microscopy) is a powerful tool for imaging single molecules with nanometer resolution. In order to better understand the mechanistic properties of TelK- DNA interactions, TIRFM was used to visualize individual quantum dot labeled TelK proteins and their interactions with lambda DNA strands suspended between two glass micropedestals. At first, only nonspecific DNA was used, to study the manner in which TelK finds its recognition sequence by interacting with DNA segments not comprised of the target sequence. The current widely accepted mechanisms by which SSBPs search for their recognition sequences include 1D DNA scanning, 3D DNA hopping, and intersegmental transfer (2). To date, all proteins imaged with TIRFM have been shown to undergo 1D DNA scanning as their primary method for finding their recognition sequence (2). However, the results of our TRIFM study indicates that TelK does not move laterally on the DNA within the resolution of our instrument (1-5 nm), and therefore does not undergo 1D DNA scanning.

To further investigate the nature of this phenomena, a TelK mutant, TelK 538, was imaged as well. TelK 538 is a c-terminally truncated mutant of the 640 amino acid full length TelK. It has been previously shown that TelK 538 is still active in forming DNA hairpins. However, it forms hairpins at a 50-fold slower rate than the full length wild type (3). We found that TelK 538, as with its full length counterpart, also does not undergo 1D diffusion along DNA. However, the dissociation rate of the 538 mutant from nonspecific DNA is 25-fold slower than the dissociation of the full length protein from nonspecific DNA. These results suggest that the c-terminal domain of TelK is primarily responsible for allowing TelK to dissociate from nonspecific DNA, and by doing so it allows TelK to find its recognition sequence more quickly in the absence of 1D scanning. Therefore, the overall DNA search mechanism for TelK is one of 3D motion in lieu of 1D scanning.

In addition to the lack of 1D scanning, TelK also does not form DNA hairpins at its target sequence if the DNA substrate is in a linear form. For both optical trapping and TIRFM assays, in which the DNA is held fully extended, hairpin formation is not observed within a 20 minute timeframe. In order to determine if DNA conformation (linear vs. globular) affects hairpin formation, an assay was designed in which a strand of DNA containing the TelK recognition sequence is attached to a glass surface at one end, and attached to a free floating fluorescent antidigoxigenin polystyrene microsphere at the other end, thereby allowing the DNA to take on a more natural globular conformation. Indeed, with this assay, TelK has been shown

to form DNA hairpins in under a minute, whereas Telk 538 forms hairpins at a much slower rate and with reduced efficiency in comparison to the full length protein. This assay confirms that TelK proteins will cut DNA in its globular form, but not in an extended conformation.

These results are justified if one considers that the frequency at which TelK is able to sample multiple sites on a DNA substrate in the absence of 1D diffusion is directly proportional to its dissociation rate from nonspecific DNA. It follows that TelK is able to sample a greater number of sites by randomly hopping from site to site on a DNA molecule in a globular conformation, versus a linear conformation. Moreover, in bulk biochemical hairpin forming assays, hairpin formation occurs even faster, possibly due to the emergence of 3D intersegmental transfer when DNA strands are in closer proximity than they are in a single molecule assay.

The functional reasons behind TelK's recognition sequence finding mechanism remain poorly understood, since it would seem that 1D diffusion would be the most energetically efficient search mechanism for any SSDBP. One possible explanation is that TelK stores energy for its energetically expensive hairpin forming reaction in the strong initial binding to nonspecific DNA, and uses this potential energy of DNA distortion to drive the reaction towards the formation of DNA hairpins. If this is correct, it is possible that the complexity of an ATP independent protein's function could be directly correlated to its binding strength to nonspecific DNA, which in turn could influence the degree of 1D scanning undertaken by that SSDBP. In spite of this ambiguity, the discovery of a protein that uses 3D hopping as its primary recognition sequence finding mechanism is exciting. We plan to study different proteins both within and outside of the recombinase protein family in search for other proteins who use mechanisms other than 1D diffusion to find their recognition sequences, in order to better understand the methods by which SSDBPs find their recognition sequences.

1. Aihara, H. *et al. JMB* **337**, 77 (2004)
2. Halford, S. *et al. Nucl. Ac. Res.* 32 (2004)

Personal communication with Huang, W. M. June 2009.

8. Please add your comments (if any): This experience has been phenomenal, both from a cultural aspect and a research aspect. From a cultural perspective, I learned much about Japanese culture, and the different methods used by scientists in this part of the world, to tackle scientific questions of a biophysical nature. These different approaches helped me look at my project from an entirely different perspective, and allowed me to expand my toolbox for better understanding protein- DNA interactions on a single molecule level. I have gained much in terms of scientific perspective, raw data, and an international collaboration I hope will continue to produce exciting results in the field of single molecule protein- DNA interactions.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: La Kenya Evans	(ID No.: SP09066)
2. Current affiliation: San Diego State University	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Hokkaido University	
5. Host researcher: Dr. Jun Nishioka	
6. Description of your current research My current research involves the observation of bioaccumulation, removal of metals from the environment by metabolic processes of a living organism (Davis et al. 2003), of copper (Cu), zinc (Zn), lead (Pb) and iron (Fe) by the brown algae <i>Laminaria Japonica</i> . Subsequent observations of biomagnification, the uptake of metals through and animal's body surface or intestine (Ratte 1998), into green urchins (<i>Strongylocentrotus droebachiensis</i>) allows me to observe the trophic transfer of these metals into higher trophic levels.	

7. Research implementation and results under the program

Title of your research plan:

Bioaccumulation of copper, iron, lead and zinc by kelp and their transfer to higher trophic levels.

Description of the research activities:

In order to do heavy metal contamination experiments all of the equipment used must be cleaned to avoid contamination. First the equipment must be soaked in soap water for 24hrs and then acid washed for another 24hrs. Any equipment that has easily dissolvable parts should not be put in acid. Soaking these parts in soap water should be sufficient enough for heavy metal work. After each wash, all equipment must be rinsed with double distilled water and stored in a lint free environment before use.

For my experiment, metal concentrations of zinc (Zn), copper (Cu), lead (Pb) and iron (Fe) were prepared using 1000ppm standard solutions of $Zn(NO_3)_2$, $Cu(NO_3)_2$, $Pb(NO_3)_2$, and $Fe(NO_3)_2$ in 0.1mol/l·HNO₃. The following concentrations were targeted and then added to seawater tanks: 250ppm, 177ppm, 6ppm, and 1μM for zinc (Zn), copper (Cu), lead (Pb) and iron (Fe) respectively.

My experiment consisted of two parts: algae in contaminated seawater and urchins in contaminated seawater. The brown algae, *Laminaria Japonica*, were allowed to bioaccumulate for 3 days in both metal contaminated and non-metal contaminated seawater. After the bioaccumulation period, the algae were fed to the green sea urchin, *Strongylocentrotus droebachiensis*, in metal and non-metal contaminated seawater for 3 days. This allowed for both bioaccumulation and biomagnification to be observed in controlled clean and metal contaminated environments.

Upon completion of each testing period, soft tissue samples from the algae and urchins (both gonad and vascular system tissues) were collected. The samples were dried at 150°C for 2 hours, weighed, and microwave digested in 1000 ul of HNO₃. The resulting solutions were then corrected to 10ml with milli-Q H₂O. Standard solutions of Zn (0,3,5, and 10ppb), Cu (0, 25, 50, and 100ppb), Fe (0,10,30,and 50ppb), and Pb (0, 25, 50, and 100ppb) were made from 1000ppm standard solutions of $Zn(NO_3)_2$, $Cu(NO_3)_2$, $Pb(NO_3)_2$, and $Fe(NO_3)_2$ in

0.1mol/l·HNO₃ to create a standard curve. All samples were analyzed for their heavy metal concentration on a Graphite Furnace Atomic Adsorption Spectrometer (GFAAS).

8. Please add your comments (if any):

This was a very valuable experience for me to further my knowledge of heavy metal work. I am very grateful to Jun Nishioka, my advisor, and my fellow lab mates for all of their help during my stay in their lab. Not only was I able to develop my scientific skills, my Japanese and cultural awareness greatly improved as I spent time with my lab mates. I was invited and included in many of their everyday activities and really felt as if I was part of the lab. Creating good relations with my advisor and lab mates, I feel, was the most important part of my stay in Japan.

9. Advisor's remarks (if any):

La Kenya Evans has been in our laboratory for about two months. She learned trace metal work for investigating seaweed and sea urchin culture experiments and how to conduct several experiment on her own. She has made good relationships with the students in our laboratory, and has kept active communication with them. Her visit has made a good influence on the students in our laboratory. I believe we have made a good relationship and will keep it in future.

Jun Nishioka

RESEARCH REPORT

1. Name: Kate M. Pickett (ID No.: SP09067)
2. Current affiliation: University of Kansas
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Hokkaido University
5. Host researcher: Dr. Masaki Yuki
6. Description of your current research <i>Overview:</i> In the present research we consider the impact of mobility on friendship experience and place connection. <i>Background and present research</i> <i>Relationship models.</i> Research in social and cultural psychology explores the implications of various models of self and relationship that are afforded by particular social contexts. The work highlights two models of relationship: A voluntaristic-independent model of relationship characteristic of <i>high relational mobility</i> involves experience of relationship as a relatively frictionless “free-market” of choice. People feel at liberty, but also compelled to choose their relationship partners. Socio-ecological affordances provide many opportunities to make, but also break, relationship ties (Anderson, Adams & Plaut, 2008; Schug et al., 2009; Yuki et al., 2007). An embedded-interdependent model of relationship characteristic of <i>low relational mobility</i> involves experience of relationship as inherent connection. People feel a fundamental rootedness in the social context of relationships. Socio-ecological affordances provide few opportunities (or necessity) to make new relationship ties (Anderson, Adams & Plaut, 2008; Schug et al., 2009; Yuki et al., 2007). <i>Mobility.</i> Recently researchers in psychology have renewed interest in socio-ecological factors that impact psychological experience. One example is research that links residential stability and mobility to psychological outcomes such as self-concept (e.g. one’s understanding of their self as traits, group memberships), pro-community behaviors, and well-being (Oishi, Lun & Sherman, 2007; Oishi et al., 2007). Another example is research that links relational mobility (the amount of opportunities to form new relationships in a given social context) to various psychological outcomes. For example higher relational mobility predicts the relationship between self-esteem and subjective well-being (Yuki et al., 2009) and it predicts the perceived trait similarity

between friends (Schug et al., 2009).

The present study provides the opportunity to explore residential and relational mobility simultaneously and examine whether relational mobility will moderate the relationship between residential mobility and voluntaristic forms of relationship experience (e.g. high number of friends, shorter friendships, relationship maintenance strategies).

Friendship. As stated, we examine of the relationship between level of relational mobility and friendship outcomes. To the extent that relational mobility is high, people are likely to have a greater number of friends, but also have shorter friendships. People can easily make new friends but also easily “fall out of touch” from friends due to the relative ease of moving in and out of relationships. Furthermore, higher levels of relational mobility are likely to be associated with relationship maintenance (e.g. phoning and emailing, sending cards) and relationship expansion (e.g. seeking new friends) when one moves to a new environment. Although these strategies are also necessary when relational mobility is low, they may be less possible or necessary for friendship maintenance.

Place. In addition to friendship connections, the present study also explores connection to place. While previous research (discussed above) focuses on models of human social-relational context the present research extends the experience of relational mobility and relationship connection to the experience of residential mobility and place connection. Just as variation in *relational* mobility promotes particular models of people-relationship connection (voluntaristic-independence and embedded-interdependence)– *residential* mobility is likely to afford particular kinds of connection to places (voluntaristic and embedded).

Main Hypotheses

(1) Higher relational mobility will predict voluntaristic kinds of friendship outcomes (e.g. greater number of friends, shorter friendships, more relationship maintenance strategies) and lower relational mobility will predict more embedded kinds of friendship outcomes (e.g. fewer friends, longer friendships, less relationship maintenance strategies).

(2) Greater residential mobility will predict more voluntaristic kinds of place connection outcomes (e.g. less connection to hometown, greater willingness to move) and greater residential stability will predict more embedded kinds of place connection (e.g. more connection to hometown, less willingness to move).

Method

Students at Hokkaido University complete questionnaires about friendship, connection to place and home town, relational mobility, and residential mobility.

7. Research implementation and results under the program

Title of your research plan:

Mobility, friendship and place connection: A socio-ecological approach

Description of the research activities:

We finalized questionnaire measures (including English-Japanese translation) and recruited participants. Data collection is now finished. A total of 134 participants completed the study. We are currently compiling participant responses into electronic format in order to prepare for statistical tests of hypotheses.

8. Please add your comments (if any):

Of course it would be optimal to have data analyzed in time for this report. We moved data collection to a later date than we had originally intended in order provide better quality, more complete responses (otherwise we would have asked students to complete the measures during the exam period). However, I will be able to complete data analyses from the US.

Dr. Yuki and the lab were a very great help and I enjoyed my experience tremendously.

9. Advisor's remarks (if any):

I really enjoyed working with Kate. She brought us her fresh ideas, and very interesting collaborative research. I am looking forward to the results from analyses of data which we have collected. I thank NSF and JSSP for this invaluable opportunity. If I were to give one suggestion, it would be good if there are other kinds of grants of this sort, which have different time length, such as for three to six months.

RESEARCH REPORT

1. Name: A. Anthony Bloom	(ID No.: SP09101)
2. Current affiliation: University of Edinburgh, Scotland, UK	
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences <u>Interdisciplinary and Frontier Sciences</u>	
4. Host institution: National Institute for Environmental Research	
5. Host researcher: Dr Shamil Maksyutov	
6. Description of your current research Spaceborne Observations of Methane: improving our current understanding of CH ₄ sources and sinks.	
7. Research implementation and results under the program Title of your research plan: Improving Our Current Understanding of Atmospheric Methane Sources and Sinks using the new Greenhouse gases Observation SATellite (GOSAT). Description of the research activities: Methane (CH ₄) is the third most abundant greenhouse gas in the atmosphere after water vapor and CO ₂ . Concentrations have more than doubled since pre-industrial levels, mostly due to the rapid increase of anthropogenic CH ₄ sources. Although we have identified the prominent CH ₄ sources and sinks, their magnitudes and distributions remain poorly understood. Spaceborne observations of CH ₄ provide an unprecedented coverage of global CH ₄ distributions, which contribute to the substantial improvements in CH ₄ source and sink estimates. The Japanese Space Agency (JAXA) Greenhouse gases Observation SATellite (GOSAT) was successfully launched on January 23 rd 2009. The aim of the GOSAT mission is to accurately measure the atmospheric levels of CO ₂ , CH ₄ , aerosol levels and cloud-cover. During the JSPS Summer Program I have been working at the National Institute for Environmental Studies (NIES) in Tsukuba, Japan, where I have had the opportunity to work on some of the first CH ₄ and CO ₂ measurements from GOSAT. A first inspection of the preliminary data has been very encouraging: we find that the magnitude and distribution of GOSAT CH ₄ concentrations is in agreement with previous space-borne measurements of CH ₄ , notably from the SCIAMACHY instrument onboard ENVISAT.	

In parallel with the GOSAT data analysis, I have been developing a novel approach to determine the magnitude and distribution of methane emissions from wetlands, the single largest source of methane. Methanogenesis is the production of methane as a result of anaerobic decomposition of organic matter, and the primary seasonal controls of wetland methanogenesis are temperature and water volume. We use global water volume, temperature and CH₄ concentration measurements to determine the magnitude of wetland CH₄ emissions in eight key global wetland regions. We determine the sensitivity of wetland emissions due to monthly changes in water volume and temperature. We then enter the emission sensitivities into the NIES Chemistry Transport Model (NIES CTM). Finally we compare the distribution of the sensitivities with CH₄ ground station measurements to determine the magnitude of each wetland source. The integration of satellite measurements of CH₄, namely from GOSAT and SCIAMACHY, will substantially improve the accuracy of the derived wetland emissions.

During my stay I have developed strong partnerships with several researchers at NIES. We are currently preparing our results for publication, and I am hoping we will be able to further continue our current collaborative efforts upon my return to the University of Edinburgh.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

<p>1. Name: Antonio Caraballo Ortiz (ID No.: SP09102)</p>												
<p>2. Current affiliation:</p> <p>Cranfield University</p>												
<p>3. Research fields and specialties:</p> <table style="width: 100%; border: none;"><tr><td style="width: 33%;">Humanities</td><td style="width: 33%;">Social Sciences</td><td style="width: 33%;">Mathematical and Physical Sciences</td></tr><tr><td>Chemistry</td><td style="border: 1px solid black;">Engineering Sciences</td><td>Biological Sciences</td></tr><tr><td>Agricultural Sciences</td><td colspan="2">Medical, Dental and Pharmaceutical Sciences</td></tr><tr><td colspan="3">Interdisciplinary and Frontier Sciences</td></tr></table>	Humanities	Social Sciences	Mathematical and Physical Sciences	Chemistry	Engineering Sciences	Biological Sciences	Agricultural Sciences	Medical, Dental and Pharmaceutical Sciences		Interdisciplinary and Frontier Sciences		
Humanities	Social Sciences	Mathematical and Physical Sciences										
Chemistry	Engineering Sciences	Biological Sciences										
Agricultural Sciences	Medical, Dental and Pharmaceutical Sciences											
Interdisciplinary and Frontier Sciences												
<p>4. Host institution: Fracture Mechanics and Safety Assessment Laboratory, The University of Tokyo</p> <p>5. Host researcher: Professor Shuji Aihara</p>												
<p>6. Description of your current research</p> <p style="text-align: center;">Viable Alternatives to Subsea Intelligent Pigging</p> <p>My research in the UK focuses on providing reliable alternatives to subsea intelligent pigging for pipelines areas where in line inspection tools cannot be used or have limited performance. The study is based on the conjecture that it is possible to characterize the internal and external condition of the pipeline system by using a combination of other technologies and by a following an integrity and condition monitoring plan. The project investigates viable integrity and condition monitoring techniques for risers, in particular those that cannot be inspected with regular intelligent pigs.</p> <p>As the aging population of the worldwide infrastructure related to pipelines and risers is growing, an increasing number of pipelines in the North Sea are approaching or exceeding the limit of their original design life. However, there is no reason why these pipeline systems cannot continue in service provided their integrity can be properly and regularly monitored to confirm accurately the pipeline remains fit for its intended purpose.</p>												
<p>7. Research implementation and results under the program</p> <p style="padding-left: 20px;">Title of your research plan:</p> <p style="padding-left: 20px;">J R-curve Estimation by Drop Weight Tear Test</p>												

Description of the research activities:

Drop Weight Tear Tests, DWTT, were carried out at room temperature on line pipe steel materials complying with API-5L X65-modified and with ultimate tensile strengths of 661 and 656MPa. The thickness of the specimens was 13mm and 6mm and crack length was modified in 5mm increments from 10 to 20mm.

As a result of the research at the university of Tokyo a paper was submitted for presentation to the European Conference on Fracture Mechanics ECF18. This paper discusses the application of the new procedure for evaluating the J-integral resistance curve from the load displacement results of a single edge-notched specimen subjected to a drop-weight-tear test, DWTT. Crack growth was monitored using video recording by means of a high-speed camera (20000 frames per second). The J-value for the specimens was also calculated using a simplified estimation method that relates the total energy absorbed during crack growth and the difference between the ligament areas for two specimens; each of them having a different initial crack length value.

I also had the opportunity to witness a series of pipeline burst tests carried out in Kushiro, North Japan, with involvement of Nippon Steel Corporation, Sumitomo Steels and experts from the University of Tokyo. This experience gave me the opportunity to work with Japanese engineers in the field and to get a taste for the efficiency at the work place of my Japanese colleagues.

8. Please add your comments (if any):

Great experience! I have learnt a lot and made valuable contacts. It has been a very positive experience and I would like to thank the JSPS and all the staff involved in the programme for giving me this opportunity and providing the support and guidance along the way. Aihara-sensei and I are planning to continue our collaborative efforts in the future and I plan to return to Japan in 2011 under one of the JSPS follow-up fellowships.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Matthew C. Clarke	(ID No.: SP09103)
2. Current affiliation: University of Cambridge	
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Nagoya University	
5. Host researcher: Professor Toshiaki Shoji	
6. Description of your current research <p>My research focuses on the representation theory of finite groups of Lie type. These groups, among the most important finite groups in mathematics have been studied, in various guises, since the mid 19th century. Of the finite simple groups, the classification of which was arguably the greatest achievement of 20th century pure mathematics, almost all are finite simple groups of Lie type. Classifying them is one thing, but understanding them on a deeper level is another, and this task is of central importance in modern mathematics.</p> <p>Groups are, essentially, abstract symmetry systems. For example, the set of all symmetries of a geometrical object is an example of a group if we consider the ways in which one may combine these symmetry operations. One of the most useful ways of studying groups is go in the reverse direction, i.e. start with an abstract group and study the geometric structures which it can operate on by symmetry transformations. This is formulated precisely and studied in the area of mathematics known as representation theory.</p> <p>In the latter part of the 20th century and since there have been major advances in the representation theory of finite groups of Lie type, but this is still not fully understood and many interesting questions and problems abound. In fact the study of these groups now lies at the confluence of many exciting and sophisticated areas of modern mathematics such as algebraic geometry and perverse sheaves. My main interest is currently in classifications of representations of finite groups of Lie type and determination of character values.</p>	

7. Research implementation and results under the program

Title of your research plan: Modified generalized Gelfand-Graev representations of finite groups of Lie type

Description of the research activities:

One of the problems I am very interested in, and which my supervisor on the JSPS Summer Program 2009, Professor Toshiaki Shoji, is a world expert in, is the determination of the character tables of finite groups of Lie type.

Although various classification theorems of characters of finite groups of Lie type exist, some are better than others. For the purpose of determining character values, one must obtain a classification which includes as much information about the individual characters as possible. One such classification was obtained for the finite groups of Lie type known as the special linear groups. This used a special class of representations invented by Professor Shoji called modified generalized Gelfand-Graev representations, and the corresponding characters of these representations. (Characters are essentially a succinct way to encode a representation.) Using this classification, he was able to prove the famous Lusztig's conjecture and give a method for computing the full character tables for these groups, one of the central goals of representation theory.

During my stay in Nagoya University I have been studying how to generalize these modified generalized Gelfand-Graev representations to a different class of finite groups of Lie type, the special unitary groups. Many complications have arisen due to the fact that the latter are defined in a more complicated way than the special linear groups, but a good understanding of the problem of how to construct these objects has been obtained. Using the training and expertise I have acquired on modified generalized Gelfand-Graev representations from Professor Shoji, I will continue with my investigations in Cambridge, which should be completed within a few months. If the construction has no analogue for the special unitary groups I will write a report explaining this to other researchers in the field. If the construction is successful, Professor Shoji and I will write a joint paper for publication describing it.

RESEARCH REPORT

1. Name: James Gaffney	(ID No.: SP09104)
2. Current affiliation: Imperial College London	
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Graduate School of Engineering, Osaka University	
5. Host researcher: Prof. Ryosuke Kodama	
6. Description of your current research <p>We are currently interested in the description of atomic physics and quantum mechanics in simulations of the behavior of extremely hot, highly ionized gases. In particular we investigate the effect of light on plasma systems which are of interest in fusion power, astrophysics and laser experiments. This is a complex problem and so including such effects in (already very difficult) plasma dynamics simulations is a significant challenge. In general the effect of light is reduced to a description in terms of the plasma opacity; We aim to accurately calculate this quantity.</p> <p>Our calculations need to include all of the subtle effects that are important to the behavior of the plasma. Theorists have been attempting to do this for many years and as a result many very useful models have been developed to make such difficult (and therefore time consuming) calculations tractable. Experimental tests have shown, however, that these methods are not accurate enough. We are developing new, improved methods that will solve this problem; in order to do this, we will motivate our research by experimental findings which were not available to previous researchers.</p> <p>The advent of high power lasers now means that high quality data which are relevant to our studies are being produced. We aim to use this data to address the particular problem of angular momentum coupling between plasma electrons, and the splitting of absorption lines that occurs as a result. Previous work has shown that Monte Carlo methods may provide an accurate and efficient way of treating this problem. Such a new model will be of interest to plasma physicists with diverse research interests due to the improved description of plasma behavior, and significantly reduced calculation times.</p> <p>In most cases calculated values of the opacity are used as an input for further plasma simulations. This means that it is important to test not just the accuracy of the calculated opacity, but also of this second stage of simulation. By testing the accuracy of our results at all stages we can ensure that the correct physics has been included. This is an important process and so collaboration with laboratories with experimental capability is essential.</p>	

7. Research implementation and results under the program

Title of your research plan:

Describing Atomic Physics in Fast Opacity Codes

Description of the research activities:

My aim during this trip was to form a working relationship with researchers in Japan, and to try to develop our models to meet their requirements. The development and testing of a new opacity model is a long process, during which the researching relationships made in Japan will provide extremely useful 'end user' input.

After meetings with several of the academics at my host institution (Osaka University) and other institutions (Kyoto University) my time in Japan has been spent in developing our opacity code to describe new data taken at both institutions. This data is of interest to our work as it demonstrates complex spectral structure in a (relatively) easily accessible regime, making it perfect for the assessment of both our new complete model, and of future fast models. The data also represents an excellent test of other theories that are being investigated by my colleagues at Imperial College. This modeling is also of interest to my host researchers as the nature of our full calculations allow detailed analysis of the origin of spectral components. Accurate modeling of atomic spectra is also of great importance for the diagnosis of plasma conditions in experiments. Preliminary results are showing good agreement with the experiment data and have already motivated a change in our approach to the problem.

I have also spent some time in Japan modeling the behavior of some laser-produced plasmas used by researchers at Osaka university to study material properties at high density. These simulations represent the 'end result' of my PhD research, as they use values of the opacity to model the dynamics of real experiments. The accuracy of such calculations is also of great importance in almost all branches of plasma physics. As such this modeling provides an extremely useful test of our results, and is interesting from an experimental point of view as radiation is frequently used as a plasma diagnostic.

The working relationships that have been started during my time in Japan have already proven to be very useful for Imperial College's Plasma Physics research, and will continue to be useful after I return to the UK.

8. Please add your comments (if any):

This has been a very useful experience, and I'm sure that the relationships that have been made will prove very fruitful. I would like to thank all the members of the High Energy Density Science Laboratory at Osaka Univ. (Kodama-Lab.) for making me very welcome during my stay, and for their willingness to share knowledge and interest. Thanks also go to the JSPS and British council for their hard work and support prior to and during my stay in Japan.

I hope that the relationships formed over the past 10 weeks will continue after I return to the UK

9. Advisor's remarks (if any):

His activity in Japan was remarkable, especially on research. He has contacted different groups for his research theme and future collaborations. I believe that his action must be quite useful and important for UK-Japan collaboration on high energy density science as well as his doctor theses.

RESEARCH REPORT

1. Name: Helen Jennifer Gallon	(ID No.: SP09105)
2. Current affiliation: University of Manchester, U.K.	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences <u>Chemistry</u> Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: National Institute for Advanced industrial Science and Technology (AIST), Tsukuba, Japan.	
5. Host researcher: Dr. Hyun-Ha Kim	
6. Description of your current research <p>The use of non-thermal, atmospheric pressure plasma for conversion of methane into clean fuels such as hydrogen and methanol is a growing area with potential for establishing new environmental and sustainable technologies.</p> <p>The consumption of fossil fuels to give carbon dioxide and fugitive releases of methane leads to a harmful build-up of greenhouse gases in the atmosphere. It is a priority goal to reduce these greenhouse gas emissions and increase the contribution of renewable energy sources such as hydrogen and methanol which can power fuel cells and internal combustion engines. It is anticipated that fuel cell technology will not be sufficiently well developed before 2050 and fossil fuels will continue to form part of the energy strategy well into the 21st century. Therefore, it is important to develop viable technologies that can release the hydrogen contained in methane whilst sequestering the carbon as an interim “bridging” measure. In addition to methane found extensively as natural gas, it is also produced as landfill site emissions and sustainably-produced biogas. In the case of landfill gas and biogas, methane is produced in conjunction with a considerable amount of carbon dioxide. Subsequently, there is great interest in the conversion of methane with carbon dioxide (known as dry reforming).</p> <p>Current industrial methods for production of hydrogen and methanol from methane require multi-stage processes using extreme temperatures, pressures and expensive catalysts, and consequently are not energy efficient for delivery of clean fuels to power fuel cells. The use of non-thermal plasma offers a potential technology for production of clean fuels at low temperature and atmospheric pressure in a one-stage and portable system. Plasma discharges are created when an electric field is applied to a gas mixture. This induces a breakdown of gas to give electrons, ions and free radical species. These highly active species react with gas molecules resulting in chemical reactions that would normally require highly elevated temperatures and pressures. The use of plasma in conjunction with catalysis has been shown to increase selectivity towards desired products.</p> <p>During my PhD research I have investigated the use of different reactor systems for conversion of methane with CO₂ and with O₂, namely corona, packed-bed dielectric barrier discharge (DBD) and coaxial DBD reactors. Within these investigations I have determined the effects of variable gas flow rates and compositions. Analysis of product gases by micro-gas chromatography and mass spectrometry has been used to confirm the production of hydrogen, methanol, liquid aldehydes and higher hydrocarbons. In order to explain differences between the reaction with CO₂ and with O₂, I have analysed reaction rate data allowing me to develop a model for the reaction mechanism; this is an important</p>	

development in this field as reaction mechanisms within plasma systems are poorly understood. I have presented the results of my research at both national and international conferences.

Current and future research will be focused on combining non-thermal plasma with catalysts in a one-stage process (plasma-catalysis); this technique has been shown to enhance conversions of methane synergistically and improve product selectivities. More specifically, the choice of appropriate catalysts will be critical in order to guide the conversion of methane towards specific product channels. Therefore, it is crucial to gain a better understanding of the reaction mechanisms both within the plasma volume and on the catalyst surface. In addition, I will be investigating the optimisation of electrical parameters in the plasma system for maximum hydrogen production, a task which requires an extremely specialised design of power supply. This type of system together with the use of optical emission spectroscopy can be used to identify and optimise the concentration of active radical species in the plasma. This technique could be used to compare the effect of different catalysts on radical formation. This is an exciting area for research which has received little attention in plasma methane reforming.

7. Research implementation and results under the program

Title of your research plan:

Methane Reforming Using Non-Thermal Plasma-Catalysis

- 1) Identification of C₂ hydrocarbons in the product gas.
- 2) Investigation into the use of a NiO/Al₂O₃ catalyst for dry reforming.
- 3) Investigation into the temperature dependence of dry reforming reactions.
- 4) Monitor the plasma generation on the surface of catalysts and reactor packing materials.

Description of the research activities:

- 1) The C₂ hydrocarbons in the product gas mixture have been successfully identified under a range of different conditions. The dependence of power input, feed gas mixing ratio, a NiO/Al₂O₃ catalyst and temperature on the production of C₂ species has been established. In all cases, C₂H₂ was the major C₂ product and lower selectivities were observed for C₂H₄ and C₂H₆.
- 2) The use of a NiO/Al₂O₃ catalyst was found to inhibit the dry reforming reaction under plasma conditions. In the presence of the catalyst conversions of both CH₄ and CO₂ decreased.
- 3) An investigation into the temperature-dependence of plasma-assisted dry reforming in the presence and absence of a catalyst was carried out. At 300 °C the formation of carbon black inhibited the generation of a stable plasma discharge and an arc-like plasma discharge was observed. This was the case in both the presence and absence of a NiO/Al₂O₃ catalyst.
- 4) Microscope-ICCD (intensified charge-coupled camera) images have been taken for plasma generation on the surface of quartz wool, a NiO/Al₂O₃ catalyst, γ -Al₂O₃, BaTiO₃ both in mixtures of CH₄/CO₂ and in air. The results show a high intensity, uniform plasma discharge generation over the quartz wool surface; this result is in good agreement with experimental results carried out at Manchester, in which quartz wool packing gave the highest conversions of CH₄ and CO₂. The low intensity plasma generated on the surface of the Ni catalyst suggests that the lower conversions of CH₄ are likely to be due to physical effects.

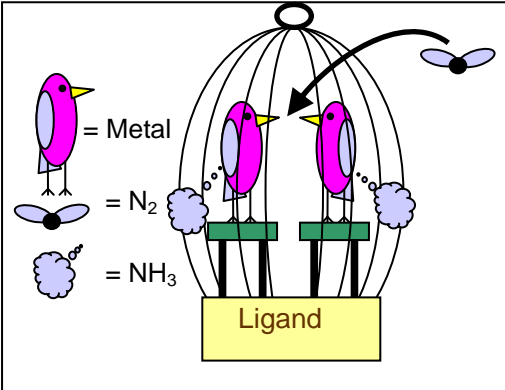
8. Please add your comments (if any):

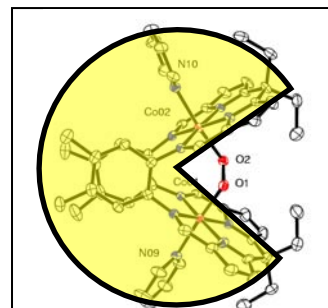
During my summer placement at AIST, Tsukuba under the JSPS Summer Program I have acquired a wide range of meaningful scientific results. The use of highly specialised equipment and facilities at AIST has complemented my previous research and will form an invaluable part of my PhD thesis.

I am the third PhD student to visit the Excited State Chemistry Research Group at AIST as part of an ongoing collaboration with the Plasma Chemistry Group at the University of Manchester. Both institutes have found this collaboration to be highly successful with several joint scientific papers published between the two institutes.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: James W. Leeland	(ID No.: SP09106)
2. Current affiliation: University of Edinburgh	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences <u>Chemistry</u> Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Tokyo Institute of Technology	
5. Host researcher: Prof. Hiroyuki Kawaguchi	
6. Description of your current research	
I work in the field of inorganic chemistry, using “ligands” and metals;	
	<p>A ligand is a molecule that can hold a/some metal atom(s) in a certain place.</p> <p>Imagine a bird cage, and inside the birdcage are some birds. Now, depending on the size of the cage and the size of the birds, you can fit a different number of birds in your cage. Also, you can fit various types of birds in the cage.</p> <p>In this case, the cage is the ligand and the birds are the metal atoms. Now let's say a fly flies into the cage, it gets eaten by a bird and then it gets</p>
changed into something else. That is what I am trying to do on a molecular level. I am trying to use my ligand and metal “complex” to change a small molecule, such as dinitrogen (N ₂) into something else, like ammonia (NH ₃)	
The ligand I use can fit two metal in it, it is also called a Pacman ligand. This is because when it holds two metal atoms, it folds into a shape like the 80's computer game character Pacman. This system can then actually “bite” down on small molecules and change them into something else. The cobalt Pacman [Co ₂ L(py)(O ₂)] (See right) can catalytically change oxygen into water.	
The transformation of the small molecule dinitrogen (N ₂) has been a challenge for chemists for hundreds of years. Dinitrogen is very very stable and so it is very very difficult to change it into anything else. Though nature can change dinitrogen into ammonia at room temperature and pressure, the only industrial process that does it is the Haber-Bosch	



Cobalt Pacman “eating”
O₂. [Co₂L(py)(O₂)]

process. This uses very high temperatures and pressures and also uses 3-5% of the world's natural gas supply and 1-2% of the world's energy. Thus is it desirable to do the same transformation at lower temperatures and pressures.

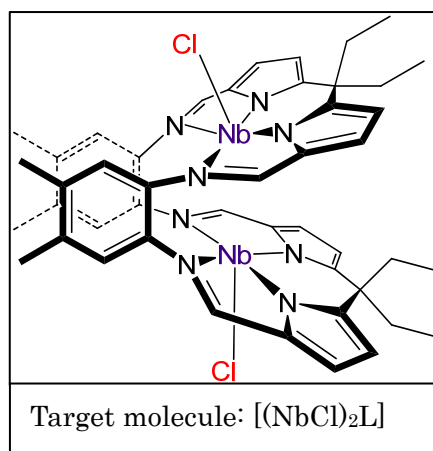
However, much like how different birds eat different food, different metals can possibly transform different small molecules. So to do this transformation, you have to pick the "correct" metals to put in the ligand.

7. Research implementation and results under the program

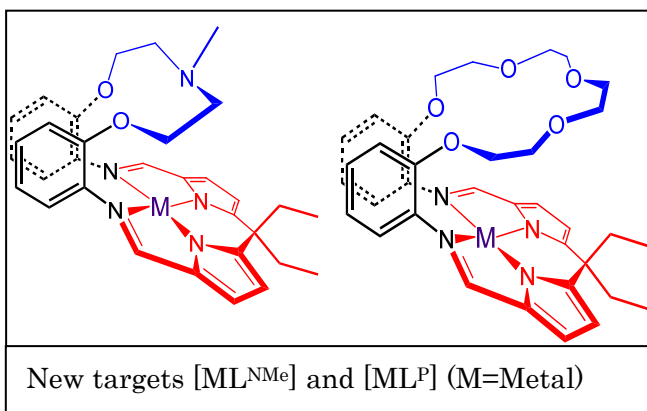
Title of your research plan: Pacman to Chew up Dinitrogen?

Description of the research activities:

After studying the literature, possible candidates to do the job are the metals niobium and tantalum. The Kawaguchi group I have been working with in Tokyo have expertise in these metals. My aim in Japan was to make new Pacman systems with these metals (see right) and then test to see if it can transform dinitrogen.



Unfortunately, it is inherently difficult to use standard analytical techniques with niobium and tantalum. As well as this, they are incredibly air-sensitive (they decompose if any air gets in) making them difficult to handle. Thus, though I have some evidence that I have made the desired complex, my results were inconclusive.

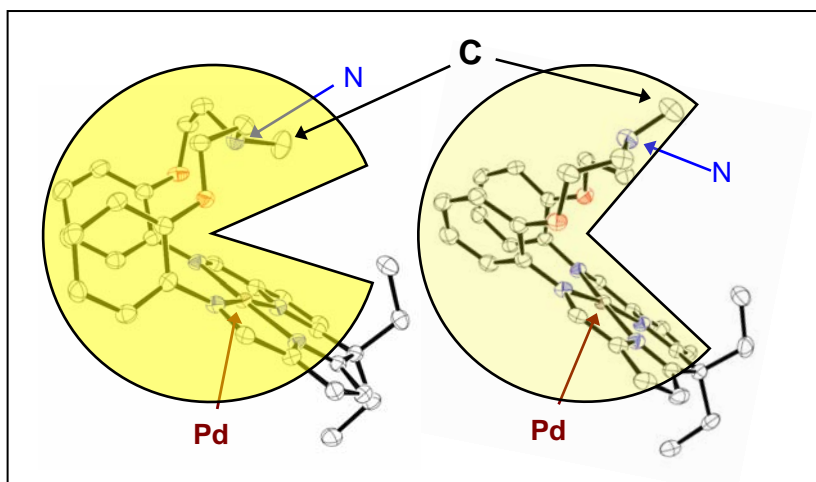


The ligand used above is a symmetrical ligand, the top is the same as the bottom. Making an asymmetrical Pacman ligand is desirable as then it could be easier to synthesise either a complex with two different metals in one Pacman, or a complex with only one metal ion complexed. This could make it easier to fine-tune the reactivity a Pacman system, leading to

greater reactivity. Just before coming to Japan I made two new ligands $\text{H}_2\text{L}^{\text{P}}$ and $\text{H}_2\text{L}^{\text{NMe}}$. No complexes had been made using these ligands so far and so my secondary aim was for a proof of principal. I was aiming to show that these newly designed ligands could also have a Pacman shape once complexed to a metal.

Initially, attempts were made to synthesise palladium complexes of the new ligands. This is because palladium is a simple metal to use with which you can do many forms of analysis on easily. Furthermore, it is not air sensitive so it is easier to handle. Two new compounds $[\text{PdL}^{\text{NMe}}]$ and $[\text{PdL}^{\text{P}}]$ have been successfully

synthesised. Both the solid state and solution state structure of $[\text{PdL}^{\text{NMe}}]$ show the distinctive Pacman shape. The solid state structure also shows the flexibility of the non-complexed (upper) half (see below). This flexibility could be used to aid the “biting” down onto small molecules. This bodes well for future work in trying to get some more catalytically active metals in the future.



Crystal structure of PdL^{NMe} showing both “closed mouth” (left) and “open mouth” (right) conformation

Furthermore, I have some encouraging evidence towards the synthesis of an iron complex $[\text{FeL}^{\text{P}}]$. Though more work is needed this is a very encouraging result as iron is extensively used in small molecule activation in both nature and in the laboratory.

8. Please add your comments (if any):

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Kylie Tamsin Maxwell (ID No.: SP09107)
2. Current affiliation: University of Edinburgh
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences <u>Interdisciplinary and Frontier Sciences</u>
4. Host institution: Nara Institute of Science and Technology
5. Host researcher: Dr Kentaro Inui
6. Description of your current research <p>Many artificial intelligence researchers have investigated ways to generate or acquire the common-sense knowledge necessary for reasoning, including automated analysis of written information. Initially, this research project aimed to study better methods of extracting such knowledge from text in the form of ‘events’, including actions, like “Bill hit the ball” and states, such as “the ball is white”. The study of event relations was made more tractable by narrowing research to a single domain, and law was selected because documents explicitly set out reasoning with regard to specific circumstances (i.e. events).</p> <p>Initially research focused on improving the accuracy of events extracted. In particular, it is difficult to penetrate sentence meaning when support or equi / raising verbs are employed, and therefore overall accuracy may be improved by focusing on these categories of verbs. However, feasibility studies on the corpus under consideration (NTCIR data in Japanese and English, acquired for this project), revealed fewer examples of ambiguous event predicate behaviour than expected. Consequently, it was determined that construction of a test set for direct evaluation of accurate event extraction would be difficult, especially given the time available. Research focus thus shifted to a project with broader scope. This requires collaboration beyond the JSPS summer program, but ultimately will enable indirect evaluation of accurate event extraction. The evaluation has not been completed in the past two months, but will involve a real-world application in information retrieval (IR).</p> <p>Completed work this summer focused on laying the groundwork for this larger project, and realizing an algorithm for extracting appropriate information from text so that this information can be used to construct feature vector representations of events. In future work, a machine learning classifier will be constructed to predict the degree of ordered relation between events (such as entailment). It is intended that the classifier will be used for query expansion, to improve performance in IR. In this way the accuracy of event extraction is evaluated indirectly via the performance of an application in which</p>

improvements in event extraction are expected to make a difference.

7. Research implementation and results under the program

Title of your research plan:

Semantic Event Representation in Automatic Text Processing

Description of the research activities:

Research activities included feasibility assessments for the task under consideration, discussion with departmental colleagues regarding state-of-the-art techniques for boosting precision of an automatically generated test corpus, and coding the algorithm for event extraction.

The coded algorithm was an adaptation of a basic event extraction algorithm that aimed to represent events in a way that could be applied in future work in computational linguistics, information retrieval, and automated reasoning. Processing in the legal domain posed an extra challenge since the average length of a legal sentence is four to twelve times what it is in standard English (newswire text). The algorithm extracts *dimension=word* features for event vectors where dimensions are: *predicate modifier*, *arg0*, *arg1*, ..., *arg_n* and *modifiers of arguments*. Taking a simple example, two subevents would be extracted from, "John made an attack" (thus temporarily avoiding issues with support and equi/raising verbs):

- (a) Predicate=made Argument1=John Argument2=attack
- (b) Predicate= attack Argument1=John

By breaking down text in this manner, events are comprised of multiple subevents denoted by the support verbs / nominalised actions, and their corresponding event arguments. As sentences become longer and more complicated, sentence meaning is interpreted via the rule-based algorithm that considers how other words, such as adverbs or prepositional phrases, can attach to, or scope over, these subevents. The algorithm appears to have advantages over prior attempts to include dependency tracing in query expansion since it incorporates heuristics to accommodate negation and idiosyncracies when tracing dependency trees.

Crucially, the algorithm is intended to provide sufficient context for each subevent to reduce its ambiguity and enable the classifier to make accurate predications about event relatedness.

Discussion with colleagues was fruitful since working with the Japanese language is different from working with English. For example, since Japanese frequently omits obligatory event arguments, such as pronouns, from a sentence, much information about events may be gained through sophisticated coreference resolution i.e. identifying when arguments are omitted and who or what they would

be if they were present. By reasoning about coreference information, it is possible to expand the set of arguments discovered for each predicate. This insight is valuable in constructing better training data for the classifier.

In addition, insights were gained regarding the use of predicate anchors for obtaining high precision event relations, based on recent work at NAIST. This information will be applied to automatically construct a high-quality corpus for training and testing the classifier as an extension of the current work. Collaboration on this is planned to continue after the end of the JSPS programme.

8. Please add your comments (if any):

It was very beneficial being able to discuss the work of early-career Japanese researchers with them at some length in person. For those who find it difficult to communicate the detail of their work in English, it can be difficult to understand exactly what is being said in a conference paper. This makes it difficult to draw upon very interesting work. Only with a significant period of time, and a whiteboard for drawing, were ideas transferred clearly. This was wholly worthwhile for both parties – for their practice communicating in English and my understanding of what is clearly excellent work.

In addition, since there were many conference deadlines coming up in my field, I found myself correcting the English on a few conference papers. This brought me closer to the work going on in the lab, and I believe the feedback on written English was very helpful to the authors.

The fact that the research institute was not based in a city or near social amenities made it somewhat difficult to adjust to life in Japan, but I would not want this to deter others from having the flexibility to choose their research destination. Overall the lab was a welcoming environment and my supervisor and department head were wonderful hosts.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Adam David Naylor	(ID No.: SP09108)
2. Current affiliation: Condensed Matter Physics Group, University of Leeds, UK	
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Institute for Solid State Physics (ISSP), University of Tokyo	
5. Host researcher: Professor YoshiChika Otani	
6. Description of your current research <p>Spintronics is an emergent technology that aims to exploit the spin of the electron. Despite being a relatively young discipline, the rapid commercialization of early spintronics devices has already had a significant effect on the data storage industry. In 2007 the Nobel Prize for physics was awarded to Albert Fert and Peter Grunberg for their contribution to spintronics.</p> <p>Successful implementation of a spintronics device requires the ability to generate, manipulate and detect an imbalance of electron spins. My research has been primarily focused on detecting an imbalance of electron spins by measuring spin polarised currents – a flow of electron charge where more electrons have spin up than spin down, or vice-versa.</p> <p>A spin-polarised current can be measured by forming a point contact between a superconductor and a ferromagnetic metal. The rate at which electrons can cross the interface is limited by the spin polarization of the incident current – which can then be determined by measuring the resistance of the interface with changing bias voltage. The value for the spin polarization of the current is determined by the ferromagnet used to form the contact, and the cleanliness of the interface.</p> <p>While a spin-polarised current is a flow of charge with an imbalance of spin, a pure spin current is a flow of spin with no net charge transfer. Spin currents are highly desirable for spintronics devices as they have the potential to allow the storage and communication of information without the heat dissipation associated with a flow of charges. One method of generating a pure spin current is the direct Spin Hall effect (SHE). In a material where the spin Hall effect is present an unpolarised charge current generates a transverse spin current. My research in Japan focused on the search for the spin Hall effect in a superconductor.</p>	

7. Research implementation and results under the program

Title of your research plan:

Quasiparticle diffusion in superconducting aluminium

Description of the research activities:

A series of nanoscale devices based on the lateral spin valve structure were fabricated. The devices were created using electron beam lithography and shadow evaporation, and then measured in a helium-3 cryostat at 350mK.

A lateral spin valve consists of a single wire, known as the spacer, which is contacted by two perpendicular wires, called electrodes. For the direct spin Hall effect measurement the device consists of a superconducting aluminium (Al) spacer with one copper (Cu) and one permalloy (Py) electrode. Before the spin Hall effect measurement could be completed it was necessary to determine the quasiparticle diffusion length in Al, and the size of the diffusive quasiparticle current that results from a nonlocal current injection. This was completed using a device consisting of two copper electrodes and the Al spacer. The quasiparticle diffusion length was measured as 311 ± 5 nm, and the quasiparticle current found to be of the order μ A.

Unfortunately the deposition of a Py electrode was found to damage the superconductivity in the Al wire. To overcome this barrier in the future it may be necessary to form a tunnel barrier contacts between the Al and the Py electrode.

8. Please add your comments (if any):

Firstly I would like to thank JSPS for the opportunity they have given me. My time in Japan was much more than simply the chance to work in a fantastic research environment; it was a wonderful way to experience the Japanese way of life, spend time with Japanese people, visit some incredible places and enjoy the superb food!

Secondly I wish to thank Professor Otani and everyone in the Otani group at the ISSP. They could not have been more welcoming and accommodating and made the visit very special, particularly my office colleagues who made sure that time spent in the ISSP was never dull! Arigato gozaimasu!

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: William Rubens	(ID No.: SP09109)
2. Current affiliation: Imperial College London	
3. Research fields and specialties:	
Humanities	Social Sciences
Chemistry	Engineering Sciences
Agricultural Sciences	Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences	Mathematical and Physical Sciences
4. Host institution: Tokyo University	
5. Host researcher: Professor Mio Murao	
6. Description of your current research	
<p>Currently I work with Professor Duff on the subject of black holes and quantum information. This work began when Prof. Duff noticed that the formula that governs the entropy of a certain class of black holes is identical to the formula that quantifies entanglement in three qubit systems.</p> <p>Black holes are the endpoint of evolution for massive stars. After a star has used up all its hydrogen, it will start burning its heavier elements and grow into a red giant. After it has converted all its fuel to iron, it can no longer use thermonuclear explosions to prevent gravitational collapse. If there is enough matter in the star, it will collapse down to what is known as a black hole.</p> <p>Black holes are called black as they are of such a large mass, concentrated in such a small volume, that the gravitational attraction is so large you would need to travel faster than the speed of light to escape. Hence, nothing, including light may escape a black hole if it gets close enough. This is the reason they are black. The distance from the center from which there is no return is called the event horizon, and will have important implications in the sequel.</p> <p>During the second half of the 20th century a number of calculations began to show that black holes exhibited a set of laws that was similar to the laws of thermodynamics. The first law of thermodynamics relates the change in internal energy of a system to a concomitant change in temperature, entropy, pressure and volume. On the black hole side,</p>	

a change in mass is related to a concomitant change in surface gravity, event horizon area, angular velocity and angular momentum. The second law of thermodynamics states that in any equilibrating process, the overall amount of entropy may only increase. On the black hole side, we say the size of the event horizon may only increase (if you drop something into a black hole, its overall mass will increase, and hence so will its event horizon)

These developments were of fundamental importance in the study of black holes (and in the study of quantum gravity) because we were suddenly able to ascribe to black holes an entropy that is proportional to the area of the event horizon.

In the totally different field of quantum information theory, we study qubits. Qubits (short for QUantum BITS) are the quantum generalization of the classical bit. A bit is the smallest unit of information, and can be 1 or 0. Your computer is made of billions of them. A qubit is the same as a bit except that it obeys the more murky laws of quantum mechanics, the end result is that qubits may be 0 or 1 or some combination of both at the same time. This little bit of extra freedom granted to qubits by the quantum mechanics gods allows them to be used in considerable more interesting ways. For example, you can actually do real teleporting with qubits. However, their most important application is in the construction of a quantum computer.

In any case, this extra freedom granted to a qubit (the fact that they can be some combination of two different realities at the same), if it is to be usefully used in an environment with multiple qubits, it needs to be 'entangled' with some of the extra freedom of another qubit. This is a bit like when your shoe laces get entangled and can no longer be separated into their individual laces. Entanglement itself is not a super well understood quantity. However, for basic systems consisting of two or three qubits, it is more-or-less understood.

The current research that I perform began when professor Duff noticed that the formula for the entanglement of three qubits is the same as the formula for the entropy of a very special kind of black hole. From there we have gone on to show that their classifications match and we have repeated the exercise for different dimensional black holes and more complicated quantum information systems. At the very least we may learn new information about the different fields by using mathematical tools from one side on the other, but the hope is that we may be able to find some physics behind this growing correspondence.

7. Research implementation and results under the program

Title of your research plan: Hopf Fibrations of Two and Three Qubits and the geometric measure of entanglement.

Description of the research activities:

We used the 2nd and 3rd Hopf fibrations to provide an alternative description of the entanglement of two and three qubit systems. This allowed us to calculate values of the geometric measure of entanglement for two and three qubits.

Hopf fibrations are mathematical structures that provide different ways of viewing certain multidimensional spheres. These multidimensional spheres also happen to describe qubits, hence using these Hopf fibrations we were able to look for new ways of measuring the entanglement of qubits.

8. Please add your comments (if any):

I am incredibly grateful to both JSPS and Professor Murao for giving me the opportunity to come to Tokyo for the summer to work. I have had a wonderful time and hope to come back again soon.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Daniel Kenneth Wilton	(ID No.: SP09110)
2. Current affiliation: PhD Student in the laboratory of Kristjan Jessen and Rhona Mirsky at University College London	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Iwate Medical University	
5. Host researcher: Professor Koujiro Tohyama	
6. Description of your current research <p>I am currently investigating the role of the cell fate determinant Numb in Schwann cell development. Schwann cells are the major glial cell in the peripheral nervous system and are required for the correct functioning and survival of the nerves. They wrap around axons and form the myelin sheaths important for saltatory conduction. Schwann cells develop from the neural crest through three transitions (Fig.1). These are the formation of Schwann cell precursors (SCP) from neural crest cells, the formation of immature Schwann cells from precursors and, lastly, the postnatal generation of non-myelin- and myelin-forming cells. A wide range of signaling molecules from the axon and the surrounding environment influence these developmental transitions and determine whether the Schwann cell adopts the myelinating or non-myelinating phenotype. In this research project I will seek to determine the role of the signalling protein Numb in the transition of SCPs to immature Schwann cells and in axonal sorting at the onset of myelination.</p> <p>A number of prior studies in our laboratory indicate that Numb plays a role at multiple stages during Schwann cell development. Firstly, Numb expression is strongly and selectively elevated in early myelinating cells(Fig.2). In addition, we have found that Numb is localized to points of contact between SCPs(Fig.3) in a similar manner to that observed in radial glial cells (Rasin et al 2007). As Precursor-Precursor contact is lost upon transition to the immature Schwann cell phenotype, Numb may play an important role in this transition.</p> <p>Finally, we have shown that altering Numb protein levels in immature Schwann cells has a dramatic effect on cell shape: the length of the radial lamellipodia are reduced when Numb expression is suppressed but increased when Numb is over-expressed. At the onset of myelination a process known as radial sorting occurs where Schwann cell radial lamellipodia project into bundles of axons and segregate them to generate a 1:1 relationship between axons and Schwann cells. Therefore by regulating lamellipodia length Numb may play an important role in myelination.</p>	

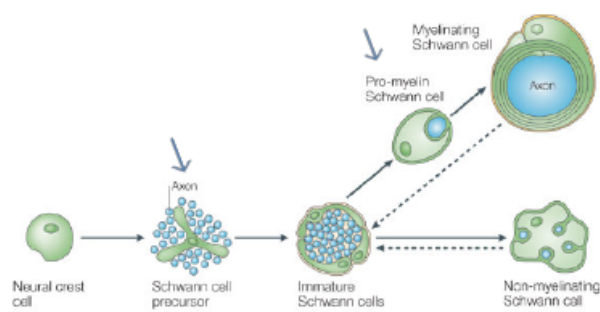


Fig. 1. Schwann cell lineage. Arrows indicate the stages I will investigate in this study

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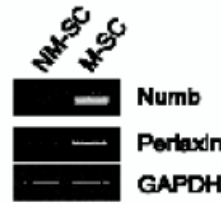


Fig. 2. Numb mRNA levels are higher in myelinating Schwann cells

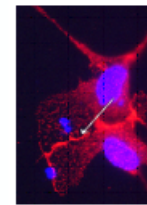


Fig. 3. Numb stains points of contact between Schwann cell precursors

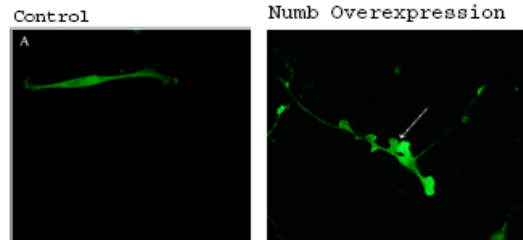


Fig. 4. Transfection of immature Schwann cells with a Numb overexpression construct increases the number of radial lamellipodia (white arrow).

7. Research implementation and results under the program

Title of your research plan:

Understanding the role of the protein Numb in Schwann cell development and myelination by identifying its location in Schwann cells at different developmental ages.

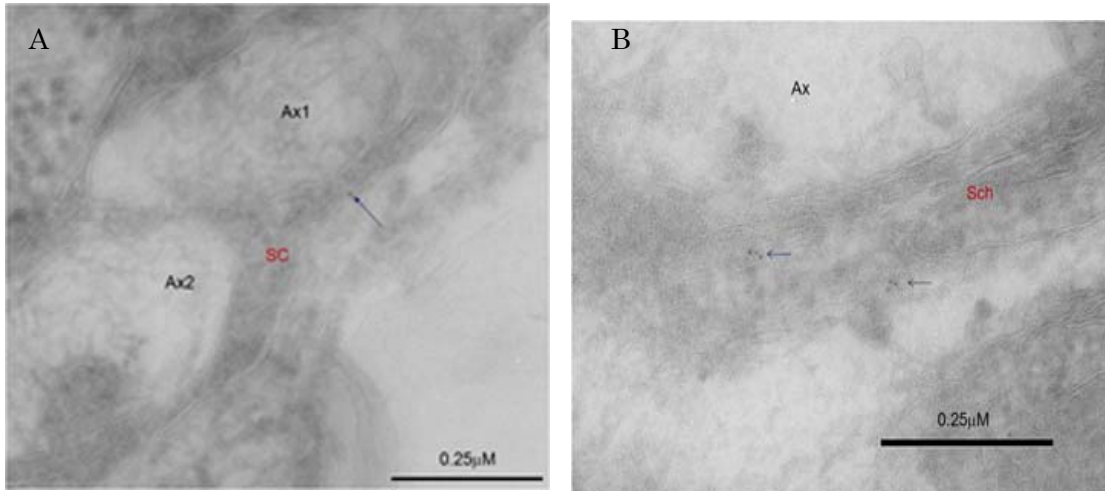
Description of the research activities:

Sciatic nerves (which consist predominantly of axons and Schwann cells) were obtained from rats at different stages of development. The ages chosen were embryonic day 14, embryonic day 18, postnatal day 0 and postnatal day 5 as these reflect different points in the Schwann cell lineage.

These nerves were subsequently rapidly frozen and cut using a technique called ultra cryosectioning. The thin sections generated were transferred to metal grids and subsequently stained with markers for numb and its known binding partners. Sections were then viewed under a transmission electron microscope to enable cells in the nerve to be observed at very high magnification. Intracellular components such as the nucleus, ribosomes and plasma membranes can be easily identified using this technique.

As shown in Figures 1 and 2 in postnatal day 0 nerves Numb was found to be polarized to the outer membrane of the Schwann cell which contacts the basal lamina and was absent from other structures in the nerve such as the axons and connective tissue. Signaling between integrin in the membrane of the Schwann cell and components of the basal lamina is important for radial sorting of axons prior to myelination. The presence of Numb in the outer membrane is further evidence that it may, as has been reported in other cell types, interact with integrin at this site and play a role in sorting. Unfortunately due to time constraints and the technical difficulty associated with the ultra cryosectioning process I have not yet been able to obtain data from nerves at the other developmental ages. However several samples have been

prepared and this project will be continued both here in Japan and in my laboratory in the United Kingdom as part of an ongoing collaboration with Professor Tohyama's group.



Figures A and B: Ultra cryosections of postnatal day 0 rat sciatic nerve stained with an antibody to numb. Arrows indicate numb location in the nerve. Ax = axon, SC = Schwann cell

Alongside this research I also carried out an investigation to determine if Numb plays a role in the Schwann cell response to peripheral nerve injury. Previous studies in my laboratory have shown that while Numb is expressed at high levels during development it is absent from the adult nerve. However using a model of nerve injury and the technique of immunohistochemistry I was able to demonstrate with Confocal microscopy that Numb expression is increased after nerve cut at sites distal to the nerve injury and that it can be localized to Schwann cells (Fig. C)

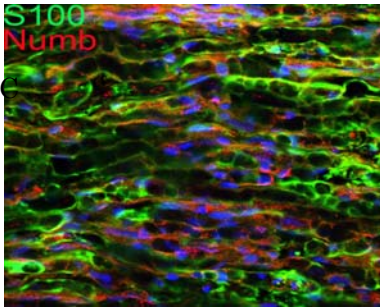


Figure C: Cryosection of the distal stump adult rat sciatic nerve 1 week post nerve cut stained with antibodies to Numb and S100. S100 is a marker for Schwann cells, please note the overlap between the two stains.

8. Please add your comments (if any):

I would like to take this opportunity to thank Professor Tohyama and all of the members of his laboratory for aiding me in carrying out this research. Without their tireless effort and advice I would not have been able to obtain these results. Also without their good humor and friendship my stay here would have been considerably less enjoyable.

RESEARCH REPORT

1. Name: Arnaud Boullanger (ID No.: SP09201)
2. Current affiliation: Institut Charles Gerhardt, Université Montpellier 2 (France)
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences <u>Chemistry</u> Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Waseda University
5. Host researcher: Pr. Kazuyuki Kuroda
6. Description of your current research <p>Metal particles at the nanoscale represent a transition between the atomic and solid states and offer great interests due to their unique properties attributed to quantum confinement and surface effects. Many potential applications can be found with this new generation of objects such as catalysis, non-linear optics, magnetic storage, biosensors... Nevertheless, even if it seems obvious that getting such properties require a well-defined shape, size and distribution, the parameters of their synthesis remain yet difficult to control and their determination constitutes thus a significant challenge for scientists.</p> <p>One of the most promising approaches to achieve this objective could be the use of hybrid mesoporous silicas as a host matrix for nanoparticles. Indeed, these materials contain an inorganic silicon oxide skeleton with also organic functions such as thiols, amines, phosphonates... covalently linked to silicon atoms within a porous structure. This strategy combines many advantages such as the formation of resistive materials (mechanical and thermal stabilities) but also the possibility to use the organic terminations as local "anchors" from which the nanoparticles could then grow up.</p> <p>My current research deals with the synthesis of such materials within a cubic phase and their use as a host for nanoparticles. In these materials, the porosity comes from the removal of a template, surfactant molecules self-organized in micelles (sphere-shaped structure), around which silicon oxide can polymerize. The resulting spherical pores, arranged along a body-centered cubic structure, constitute "cages" which can be then applied for the control of the particles' growth (size, location and distribution) <i>via</i> the pendant organic groups attached inside the pores. Different techniques are employed to fully characterize materials and nano-objects such as nuclear magnetic resonance (^{13}C, ^1H, ^{29}Si nuclei), X-Ray diffraction, elementary and thermogravimetric analyses, nitrogen-sorption experiments and electronic microscopies. These particles will then find applications in catalysis, important for industrial processes and environment protection.</p>

7. Research implementation and results under the program

Title of your research plan:

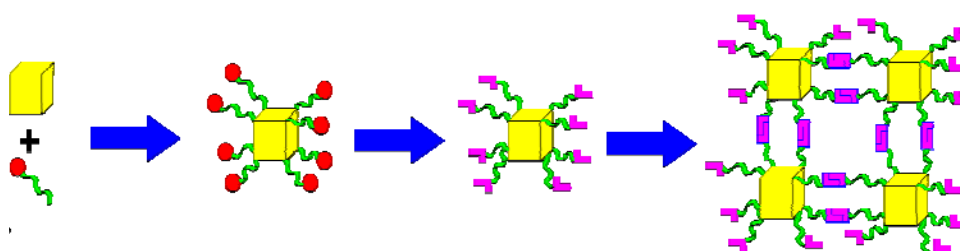
From new functionalized cubic-cage molecules to 3-D nanostructured hybrid materials

Description of the research activities:

Over the course of the twentieth century, technological progress led to the industrialization and consequently to the mass consumption. Without neglecting the positive impacts of such a revolution on our comfort in the daily life, we should not forget that this phenomenon also contributed to the global warming because of greenhouse gases' release such as carbon dioxide or methane (from vehicles, factories...). The resolution of this major problem has now become the concern of every nation and the ratification of the Kyoto protocol by 183 countries (entered into force in 2005) tends to prove it. Nevertheless, even if this text plans to reduce massively the release of such gases into the atmosphere, it becomes urgent to find complementary solutions with our scientific skills in order to achieve this ambitious objective: the rescue of our beautiful planet.

One solution consists in the trapping of greenhouse gas molecules. Porous materials at the molecular range could be good candidates to realize it: carbon dioxide could be capped inside the structure of the material and then chemically converted into a harmless molecule for environment. Previous works have already been carried out by different groups to prepare nanostructured materials. Thus, Professor Kuroda *et al.* (Tokyo, Japan) synthesized new amphiphilic cage-like molecules able to self-assemble into cylindrical channels, leading to 2-D nanostructured silicas with honeycomb structure. In parallel, Professor Corriu's team (Montpellier, France) prepared 1-D lamellar materials using specific molecular precursors that can easily self-recognize *via* physical interactions and then auto-assemble to generate the expected material.

The objectives of my research can be summarized in the scheme presented just below and will combine the skills of both groups cited previously. The aim is to prepare a 3-D porous network based on the self-assembly process of functionalized cubic-cage molecules. This synthesis requires three different stages. First of all, the preparation of the "naked" cubic-cage silica molecules (yellow cubes) through catalytic hydrolysis of



trichlorosilane (HSiCl_3), then the functionalization of the cage (on silicon atoms) *via* hydrosilylation reaction in order to confer it eight mobile “arms” terminated by an ester group (red balls, $-\text{COOR}$). Different esters are employed to study the influence of the chain’s length (green linker) on the final material. The last step is the conversion of the ester into an acid function (purple L-shaped bricks, $-\text{COOH}$). This stage should be followed by the auto-combination of the bricks into dimers by physical interactions (hydrogen bonds) to lead the target material. Another approach consists in the direct synthesis of tolyl-functionalized ($\text{CH}_3\text{-C}_6\text{H}_4\text{-}$) cage molecules *via* hydrolysis of 4-tolyltrichlorosilane ($\text{CH}_3\text{-C}_6\text{H}_4\text{-SiCl}_3$) followed by the conversion of the methyl group ($-\text{CH}_3$) into acid function ($-\text{COOH}$). This precursor contains a rigid carbonated cycle ($-\text{C}_6\text{H}_4\text{-}$) that should avoid any motion of the lateral chains and thus modify the self-assembly process of cages.

Some interesting features were obtained. First of all, it was impossible to realize the complete functionalization of the cage molecules. The number of “arms” that could be attached depended on the size of the ester: the more hindered it was, the more difficult it was to graft it (six maximum with the smallest ester). However, this fact should not disturb the formation of the 3-D material, but this step was not completely achieved. Secondly, a major part of the time was dedicated to the synthesis of 4-tolyltrichlorosilane precursor. The conditions were very strict because reagents were sensitive to air and moisture, and many attempts were tried to get it. Finally, only a mixture of two different molecular precursors could be obtained, leading however to a material after hydrolysis. The solid has not been yet characterized. Another attempt using phenyl group ($-\text{C}_6\text{H}_5$) instead of tolyl ($\text{CH}_3\text{-C}_6\text{H}_4\text{-}$) led to a material composed of fully functionalized silicon atoms. It is important to notice that the material was composed of both opened and closed cages.

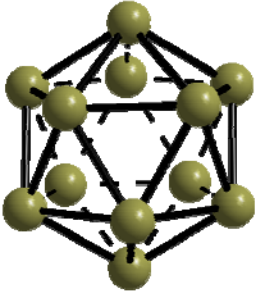
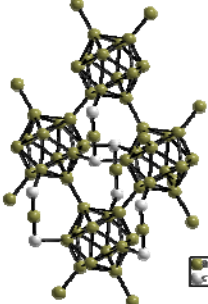
As a conclusion, this project was very interesting but also very ambitious, which implies much more time than two months of work to continue and improve the results. This project should logically start a future collaboration between Japan and France. All this work could be followed by the insertion of metallic centers into the 3-D network to confer it a crystalline structure that would make characterizations and applications much easier. The resulting material would belong to the class of MOF materials (Metal Organic Framework), currently “hot” topic in research.

8. Please add your comments (if any):

- Excellent and unforgettable experience: research project led inside an famous and Japanese team, fruitful scientific discussions with Japanese researchers and students, improve of my English, initiation to the Japanese language and culture, new knowledge about the silicon chemistry... I would strongly recommend this program to all Ph-D students and doctors allowed to apply. It is a chance that everyone should take!

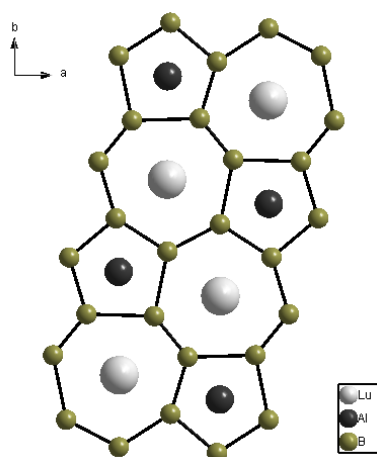
9. Advisor’s remarks (if any): Mr. Arnaud Boullanger has shown an excellent ability to perform experiments in very efficient and remarkable ways, which has stimulated my students. He has got new results which should be survey further. He has enjoyed the Japanese way of life and associated very friendly with students. His stay in my lab is very fruitful for both the Japanese and French sides.

RESEARCH REPORT

1. Name: Romain Gautier	(ID No.: SP09202)
2. Current affiliation: Ecole Nationale Supérieure de Chimie de Rennes	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences <u>Chemistry</u> Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: National Institute for Materials Science	
5. Host researcher: Dr. Takao Mori	
6. Description of your current research <p>Borides are important materials for structural applications because of their low density and thermal conductivities, very high melting temperatures and electronic transport properties. Despite their extensive use, the structure of these materials has not been well determined.</p> <p>The Boron Carbide structures are known to be composed of boron-rich icosahedra and linear three atoms chains but the distribution of boron and carbon atoms onto the different sites has been an active subject of debate. Since electronic densities of both atoms are similar, X-Ray diffraction techniques have failed to locate the C and B atoms. Spectroscopic methods, more powerful in determining the local atomic environment, have also been used during the past few years.</p> <div style="display: flex; justify-content: space-around; align-items: center;"><div style="text-align: center;"><p>Structure of an icosahedron</p></div><div style="text-align: center;"><p>Structure of B₁₀C₂ composed of icosahedra and linear CBC chains</p></div></div> <p>Coupled with NMR measurements, calculations within density functional theory allow identifying three atoms chains as CBC chains.</p> <p>The complexity of the atomic structure still does not allow a complete structural</p>	

description and more powerful spectroscopic NMR need to be used.

The REAlB₄-type compounds are also of great interest. They have a similarity to the AlB₂-type compounds in their crystal structure, and some compounds of this structural family present interesting magnetic transitions that are supposed to be due to intrinsic building defects. These compounds are composed of a network of planar five- and seven-boron rings that accommodate differently sized rare-earth and aluminum atoms.



Structure of LuAlB₄

In order to investigate the intrinsic building defects and to have a better understanding of these magnetic transitions and, spectroscopy experiments need to be monitored.

7. Research implementation and results under the program

Title of your research plan: Synthesis of Boride compounds

Description of the research activities:

Boron Carbide compounds enriched with ^{13}C atoms were synthesized in order to realize NMR spectroscopy and localise the C atoms in the structure.

Firstly, Boron Carbide compounds with ^{13}C natural abundance were synthesized in order to optimize the experimental conditions.

Compounds obtained only by induction heating were shown to present poor crystallinity and impurities. Using a melting arc furnace as a final synthesis step, allowed us to obtain good crystallinity Boron Carbide compounds. The B/C stoichiometry was checked using X-Ray diffraction and the impurities were removed by chemical treatments.

NMR experiments and calculations within density functional theory will be monitored at the University of Rennes.

LuAlB_4 compound was prepared by induction heating a mixture of LuB_4 and Al. Impurities remain after synthesis and experiments are monitored to optimize the preparation.

The LuAlB_4 structure will be investigated using NMR spectroscopic methods at the University of Rennes.

8. Please add your comments (if any)

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Frédéric Labat	(ID No.: SP09203)
2. Current affiliation: Ecole Nationale Supérieure de Chimie de Paris	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences <u>Chemistry</u> Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Environmental and Renewable Energy Systems Division, Graduate School of Engineering, Gifu University	
5. Host researcher: Prof. Tsukasa Yoshida	
6. Description of your current research <p>Our research mainly focus on the ab-initio modeling (essentially based on Density Functional Theory, DFT) of dye-sensitized solar cells (DSSC), which perform with some remarkable analogies to the natural process of photosynthesis, shifting the optical response of a large band gap semiconductor (typically TiO_2) from the UV to the visible by dye sensitization. Besides operation without noise, toxic and greenhouse gas emissions, these cells also provide a higher tolerance for impurities compared to traditional inorganic photovoltaic modules, since absorption and electron transport processes are separated, and respectively carried out by the dye and the semiconductor, thus emerging as a possible photovoltaic technology at low cost. Operating principles rely on electronic processes localized at the dye/semiconductor interface, where an ultrafast electron injection takes place between the dye excited state and the semiconductor conduction band.</p> <p>An efficient computational protocol has been developed to quantitatively describe both isolated and adsorbed systems. To this end, UV-Visible spectra of dyes are simulated using time-dependent DFT and a polarizable continuum solvation model, while both the isolated semiconductor and combined dye/semiconductor systems are investigated using large supercells under periodic boundary conditions. Electron injection times are computed using a simple orbital-based model. Large clusters are also extracted from obtained periodic structures in order to study the semiconductor influence on the dyes' UV-Visible spectra.</p> <p>Our main aims are:</p> <ol style="list-style-type: none">(i) to <i>in silico</i> characterize and design either organometallic or purely organic dyes, in order to improve both the dye light response and the semiconductor surface coverage;(ii) to characterize the dye/semiconductor interface, and in particular to take into account the electron injection process, in order to optimize the energy levels matching between dye and	

semiconductor, and thus to improve the ultrafast electron transfer.

7. Research implementation and results under the program

Title of your research plan:

Bridging the gap between experimentalists and theoreticians: the case of hybrid photovoltaic systems

Description of the research activities:

To date, dye-sensitized solar cells with the best performances are made of a titania mesoporous thin film sensitized by a ruthenium complex dye (N3 and other derivatives have shown 12% of overall light-to-electricity conversion efficiency) [1]. These conventional dyes are expensive however due to the scarcity of the metal. On the other hand, metal-free sensitizers such as organic dyes have recently appeared as an interesting alternative. Indoline dyes in particular have demonstrated overall conversion efficiencies higher than 9% [2], good long term stability, much higher molecular extinction coefficient and lower cost than the Ru-complex dyes, and have been shown efficient with both TiO₂ and ZnO matrices.

During the last decade, the hosting institution in Japan – Prof. Tsukasa Yoshida's group; Environmental and Renewable Energy Systems Division, Graduate School of Engineering, Gifu University – has been strongly engaged in the research and development of low-temperature (<100°C) electrodeposited ZnO-based DSSC systems [3], an alternative to the most commonly found high-temperature synthesized TiO₂-based cells.

In particular, design of new dyes for solar cells applications, which requires a fine tuning to the supporting semiconductor, with both absorption in the Near IR/Visible range (the solar spectrum) and a low lying excited state able to inject in the conduction band of the semiconductor, has been one of their major goal. Among the most efficient indoline dyes obtained, D149 (see Fig. 1) has shown a very promising overall light-to-electricity conversion efficiency of 5.6% when applied to ZnO-based DSSC [4].

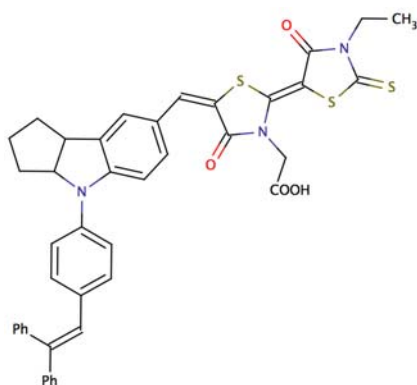
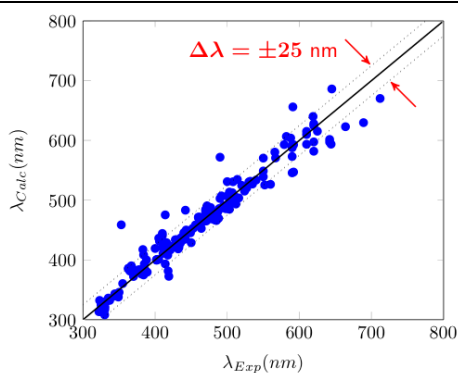


Fig. 1: Schematic structure of D149.

The first step of our computational protocol (i.e. structural and photophysical characterization of isolated organic dyes used in the cells) has been applied to a series of meaningful D149 derivatives with significantly different performances for DSSC application. Since calculations will last longer than the period of the fellowship, no



results can be discussed so far. However, this step has already been successfully tested on a set of about 200 organic dyes (see Fig. 2), with a mean error of 25 nm on the band maxima positions.

Fig. 2: Computed band maxima positions with respect to the experimental data for a set of about 200 organic dye molecules obtained with our computational protocol.

Adsorption of selected dyes on ZnO surfaces, followed by structural and electronic characterization as well as investigation of the semiconductor influence on the dyes' UV-Visible spectra is expected in the forthcoming months. This protocol would enable efficient computational prescreening to significantly reduce the huge array of candidate materials and guide the experimental investigation for DSSC application.

References:

- [1] M. Grätzel, Inorg. Chem, 2005, **44**, 6841; S. Ito, T. N. Murakami, P. Comte, P. Liska, C. Grätzel, M. K. Nazeeruddin, M. Grätzel, Thin solid films, 2008, **516**, 4613.
- [2] X. D. Li, D. Zhang, Z. Z. Sun, T. Chen, S. Huang, Microelect. J., 2009, **40**, 108.
- [3] T. Yoshida and H. Minoura, Adv. Mater., 2000, **12**, 1219; T. Yoshida, T. Pauporté, D. Lincot, T. Oekermann and H. Minoura, J. Electrochem. Soc., 2003, **150**, C608.
- [4] H. Minoura, T. Yoshida, Electrochemistry, 2008, **76**, 109.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Grégory LALET	(ID No.: SP09204)
2. Current affiliation: CNRS	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences <u>Chemistry</u> Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Kawasaki Laboratory	
5. Host researcher: Pr. Akira Kawasaki	
6. Description of your current research The aim of that research is to create a composite material with a better thermal conductivity and a lower coefficient of thermal expansion than aluminum. The composite is based on an aluminum matrix reinforced by carbon fibers. That kind of material is need in the power electronic industry in order to improve the lifetime and reliability of power electronic chips. 2 or 3 steps are needed to obtain the material by a powder process: 1) Mixing the aluminum powder with the carbon fibers 2) Sintering the mix under an uniaxial pressure 3) Extruding the sintered material If the process is stopped at step 2) then the fibers will be dispersed under a plane. If the process is continued to step 3) then the fibers will be aligned along the extrusion axis leading to different properties. Depending of the application the step 3) will be needed or not. The work in Japan has been focused on step 2).	

7. Research implementation and results under the program

Title of your research plan:

Synthesis of Aluminum/carbon fibers composite by Spark Plasma Sintering

Description of the research activities:

The target of the research activities conducted in Japan is to compare two sintering methods: the induction sintering (used in France) and the spark plasma sintering (SPS) (used in Japan).

2 mixes (aluminum reinforced by 20%^{vol} of carbon fiber and aluminum reinforced by 20%^{vol} of carbon fiber) and 2 parameters (time and temperature of sintering) have been investigated.

The efficiency of the process will be discussed based on the thermal properties that will be measured in France.

For the meantime, only the relative density (directly linked to thermal properties) of the composites has been measured and the results for both sintering methods are similar. But even if the relative densities are the same, the microstructures are different; this is suggesting that the properties will probably be different depending of the sintering method. In order to quantify the differences, the samples obtained by SPS will be deeply characterized in France leading to know what method is the best suited to get composites materials with optimized properties.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Guillaume Lefebvre	(ID No.: SP09205)
2. Current affiliation: RAPSODEE Center – Ecole des Mines d’Albi-Carmaux	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences <u>Interdisciplinary and Frontier Sciences (Physicochemistry and Process Engineering)</u>	
4. Host institution: <i>IMRAM</i> , Tohoku University 2-1-1, Katahira, Aoba-ku, Sendai, 980-8577 Japan	
5. Host researcher: Fumio Saito Prof. Tohoku University Director of <i>IMRAM</i>	
6. Description of your current research <p>Surface energy of powders is a growing number of studies, in particular, the work of adhesion that can be characteristic of the interface between powder and liquid. In the same way, the steps of stirring, mixture and dispersion of powders in liquid are processes that are rather well understood. However, the studies showing the influence of the work of adhesion between powder and liquid on the powders are rarer.</p> <p>My thesis project is to control the surface energy of talc in order to observe the influence of its wettability, characterized by its work of adhesion with water, on its setting in dispersion. I have investigated talc powder because it is widely used in many industrial areas such as paper, paints, ceramics, cosmetics and pharmaceuticals, while it is hydrophobic material.</p> <p>For the modification of the surface energy of talc particles, dry particle coating has ever been used in Albi and appears as an interesting innovating process: materials with relatively large particle size (host particles; 1-500 \cdot m) are mechanically coated with fine particles (guest particles; 0.01-50 \cdot m) in order to create new functionalities or to improve their initial characteristics and it doesn’t require the use of solvents and subsequent drying. Since the size of the guest particles is sufficiently small, Van der Waals interactions are strong enough to obtain a stable ordered mixture and the mechanical forces applied by the coating device keeps them firmly attached onto the host particles. In Albi, for the dry coating, I used a Cyclomix device, initially used as a high shear mixer and the guest particles are fumed nano-silica (Aerosil R972) particles.</p> <p>The work of adhesion of talc particles with water, modified either by coating with different concentrations of silica or by different times of coating, is estimated by contact angles measurements of the different samples with water.</p> <p>Finally, the aim of the study is to put this work of adhesion in relation with the dispersion velocity of talc powder in water.</p>	

7. Research implementation and results under the program

Title of your research plan: “Surface modification of powders: in search of new dry coating devices”

Description of the research activities:

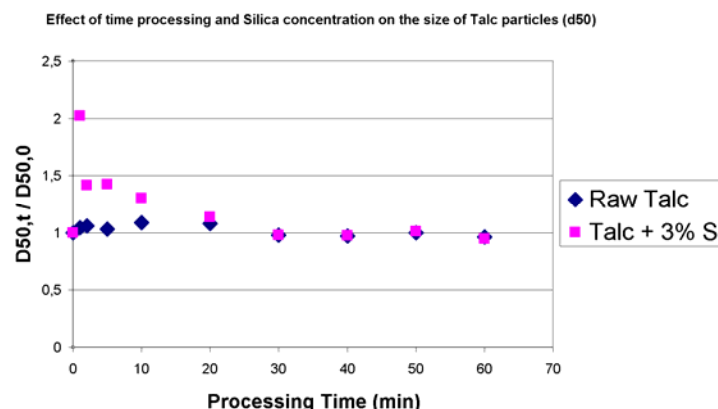
In France, the device used for the dry coating of talc particles by nano-silica is called as “Cyclomix”, which is initially used as a high shear mixer. In Japan, the goal of my project is to obtain dry coating with another device: a planetary bead mill, initially used as a milling device.

In my case, I have just wanted to change the surface characteristic of talc (host) particles by coating with fine silica (guest) particles, while the size of host particles is remained so as to be the same as that in the initial stage even in milling. Thus, the first objective was to study the effect of the velocity of the planetary mill on the size of the talc particles. For that, I observed the effect of the different velocities of the planetary mill (between 100 and 800 rpm) on the size of talc particles. It allowed me to keep the size by maintaining the rotational speed at low speed of rotation (100 or 200 rpm). When the speed is fixed at 250 rpm, one hour milling makes the size of particles possible to be 0.7 times larger than the initial size. Therefore, I chose the speed at 200 rpm, which keeps the size and its distribution of powder.

Then I have prepared the same samples those I have studied in France with different silica concentrations and different periods of time of coating. Thus, by using the planetary mill, I could carry out dry coating of talc particles with:

- different silica concentrations (1, 3, 5, 7 and 10 %) for 30 min,
- different periods of time in operation (1, 2, 5, 10, 20, 30, 40, 50 and 60 min) without and with silica (3%) because the high energy induced by a planetary mill alone can modify the surface of the talc particles controlling its wettability,
- two different mono-size diameters of media (beads size: 10 and 15 mm).

The size distribution of each sample has been checked by size distribution analyser operated under wet condition. For instance, I could observe a size modification for short time operation with silica and not without silica (graph below) and these results could help me to solve a similar problem that I obtained in France.



I also took pictures with Scanning Electron Microscope to insure me that I obtained the same kind of dry coating in France.

All the samples have been sent in France where I will be able to characterize their

wettability and their dispersion property to put them in relation and compare the results obtained with “Cyclomix”.

8. Please add your comments (if any):

I am extremely grateful for the privilege to participate in the JSPS Summer Program 2009. This experience of working in a foreign laboratory and the unique opportunity to collaborate with some of the leading scientists in the field of Materials has been a real honor for me.

I hope that the relationships established through this experience will have a fruitful future and that these results will play a significant role in my doctoral dissertation

Finally, I also want to thank all the members of the IMRAM laboratory for having helped me to discover the Japan way of life. Arigato gozaimashita (Merci in French).

9. Advisor's remarks (if any):

The research student (Guillaume Lefebvre (G.L.)) is open-minded, excellent and friendly French PhD student, who always wishes to collaborate with our staffs and students. In addition to that, this internship program seems to be effective for both sides to strengthen more and more. In this sense, through the research done by the student (G.L.), the friendship would be like a rainbow over the nations, and this would be accompanied with good collaboration work in the future.

The host professor (F.Saito) would like to thank to all related members in JSPS as well as the teaching staffs at the Ecole des Mines d'Albi, France for offering the student (G.L.) to come over to Sendai, Japan.

I hope that it would be better to have mutual exchange for both sides as follows:

The two Institutes will encourage the following activities.

- (1) Exchange of faculty members and researchers
- (2) Exchange of graduate students (M.Sc., Ph.D.)
- (3) Conducting joint research and academic meetings
- (4) Exchange of information, publications and materials for academic purposes
- (5) Other activities as may be mutually agreed by the two Institutes

RESEARCH REPORT

1. Name: LEPAGE	(ID No.: SP09206)
2. Current affiliation: Ecole Normale Supérieure, Paris	
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Kyoto University	
5. Host researcher: Dr. Fumiharu Kato	
6. Description of your current research <p>I am working in algebraic geometry. It consists of studying geometrical objects (called varieties) locally defined by polynomial equations. However the objects I am studying are defined by equations whose coefficients are not “usual” numbers (e.g. real or complex numbers). My coefficients are so called p-adic numbers. There is, as in the case of real and complex numbers, a distance between the p-adic numbers. Thanks to this distance one can endow a variety with a topology.</p> <p>I am studying an algebraic invariant of the variety, which is defined in terms of the algebraic structure and of the topology, called the tempered fundamental group of the variety. More precisely I try to know what can be recovered of a curve in terms of its tempered fundamental group.</p>	
7. Research implementation and results under the program	

Title of your research plan: Tempered anabelian geometry

Description of the research activities:

I tried to characterize subgroups of the tempered fundamental group of a curve defined from the points of my curve. I could characterize some of these subgroups but I was not able to prove that one could distinguish the points from them.

I also studied, on the advice of Pr. Shinichi Mochizuki, the symmetries of the tempered fundamental group of higher dimensional spaces associated to a curve (the configuration spaces of the curve) in terms of the symmetries of the tempered fundamental group of the curve and the symmetries of a purely algebraic fundamental group of the configuration space.

We came to an idea about this, but there still are some details to check up.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Anna Loussouarn (ID No.: SP09207)												
2. Current affiliation: Institut Jean Nicod (CNRS, EHESS, ENS), Ecole Doctorale 3C (Paris VI), EHESS												
3. Research fields and specialties: <table><tr><td>Humanities</td><td>Social Sciences</td><td>Mathematical and Physical Sciences</td></tr><tr><td>Chemistry</td><td>Engineering Sciences</td><td>Biological Sciences</td></tr><tr><td>Agricultural Sciences</td><td colspan="2">Medical, Dental and Pharmaceutical Sciences</td></tr><tr><td colspan="3">Interdisciplinary and Frontier Sciences</td></tr></table>	Humanities	Social Sciences	Mathematical and Physical Sciences	Chemistry	Engineering Sciences	Biological Sciences	Agricultural Sciences	Medical, Dental and Pharmaceutical Sciences		Interdisciplinary and Frontier Sciences		
Humanities	Social Sciences	Mathematical and Physical Sciences										
Chemistry	Engineering Sciences	Biological Sciences										
Agricultural Sciences	Medical, Dental and Pharmaceutical Sciences											
Interdisciplinary and Frontier Sciences												
4. Host institution: Kyoto University, Graduate school of education, Division of cognitive psychology in education, Kusumi's lab, 5. Host researcher: Professor Takashi Kusumi												
6. Description of your current research My present researches are pursued both at the conceptual level of analytic philosophy of mind and epistemology, and at the experimental level of cognitive psychology, (part of the European Science Foundation program on metacognition, IP6 project). Indeed, my philosophical researches are pursued within the tradition of naturalist philosophy, according to which there is continuity between conceptual and empirical researches. On the level of philosophy of mind, I am working on the twofold hypotheses of i) the existence of a non-conceptual form of metacognition (or procedural self-monitoring), and ii) its being a precursor of theory of mind. More specifically, I am interested in the differences between the properties of metamemory, ie. the set of dispositions allowing the monitoring and control of one's knowledge and memory abilities and metaperception, ie. the set of dispositions allowing one to monitor and control one's perceptual abilities and one's perceptual contents. On the experimental level, I am running experiments on the (metaperceptual) evaluation of one's performance in a detection task.												
7. Research implementation and results under the program Title of your research plan: Exploring metaperception in Japanese students.												

Description of the research activities:

Inter-individual differences in metacognitive strategies are quasi-systematically mentioned in the literature on metacognition, both in humans and in non-humans animals (Smith et al, 2003, Proust, 2008). However, few if any cultural studies on metacognition have been pursued. One study has been pursued at the University of Kyoto, by Dr. Carvalho (Carvalho & Kusumi, submitted).

Therefore, my visiting in Kusumi's lab represented the opportunity to investigate cultural differences (between French students versus Japanese students) i) in metaperceptual performances, and more specifically ii) in the taking into account of feedback about one's metaperceptual evaluations. Some cross-cultural studies have shown cultural differences in problem-solving (Brenner, et al, 1999), as well as in inductive reasoning (Kubota, 1997, Hazen, 1984, Norenzayan, 2000), suggesting (with Hookway, 2003) a difference in reliance on metacognitive feelings.

Metacognitive evaluations have often been shown to be overestimating in American and European populations (Son et al, date, Beck et al, 2007). There might be also inter-cultural differences in self-esteem and overestimations. In fact, it has been reported differences in tolerance and coping with feedbacks of failures or errors in a study comparing Asian and American populations (Son and colleagues, talk at IJN, Metcalfe, 2008). De facto, theories of learning diverge across cultures, as well as methods of education: some cultures plausibly do give more importance to metacognitive evaluations of learning than others, and frequency and nature of the feedback given to learners do vary. Consequently, one might predict different effects of feedbacks in Japan and French populations.

My expected outcomes were the following: i) I wanted to observe whether there were inter-cultural differences in metacognitive patterns and in the taking into account of feedback in a metaperceptual task. ii) very generally, I wanted to interact with researchers at the theoretical level on metacognition.

This experimental part of my work has been not only facilitated, but also, made possible, thanks to the collaboration of a Japanese undergraduate student, Mr. Matsuo. As soon as I have met my host researcher, Professor Kusumi, he suggested to use the functional part of my JSPS fellowship to pay an undergraduate student in order to assist me in several aspects of my experimental work. Indeed, Mr. Matsuo did help me in i) translating from English to Japanese the instructions of my experiments (which otherwise, was non-verbal), ii) finding 40 participants, and in iii) organizing the planning of the passations. The functional part of my fellowship also allowed me to pay participants: each subject received 500 yen for his collaboration. Thanks of Professor Kusumi and thanks to the assistance of Mr. Matsuo, I was able to find the forty participants I needed for my experiments before the end of July.

In fact, the lab was moving in a new building at the end of July and I wanted all participants to run the experiment in the same conditions. I had then a severe time constraint, since I had to finish to run the experiments before the moving. Consequently, I have worked very hard during the first month of my stay at Kusumi's lab. I was arriving at the laboratory at 8am and left it at 8pm.

Until the moving at the end of July, I have shared a room with five others Japanese PhD or post-doctoral students. My colleagues have expressed very kind hospitality. The proximity with Japanese PhD students was an occasion to share not only a room, but also ideas on the psychological researches.

During July, I have also kindly been invited by Professor Kusumi to give two oral presentations, one 30 minutes presentation at the Brown bag seminar of Kusumi's

lab, which was taking place every Wednesday at lunch time, and one in the Colloquium, to which not only the members of Kusumi's lab but also other members of the department attended. In the first presentation, I have introduced my methodology, the general topic of my researches, and I have presented my research plan in Japan. In the second presentation, I have presented two different approaches of metacognition. I also attended to these seminars every week.

8. Please add your comments (if any):

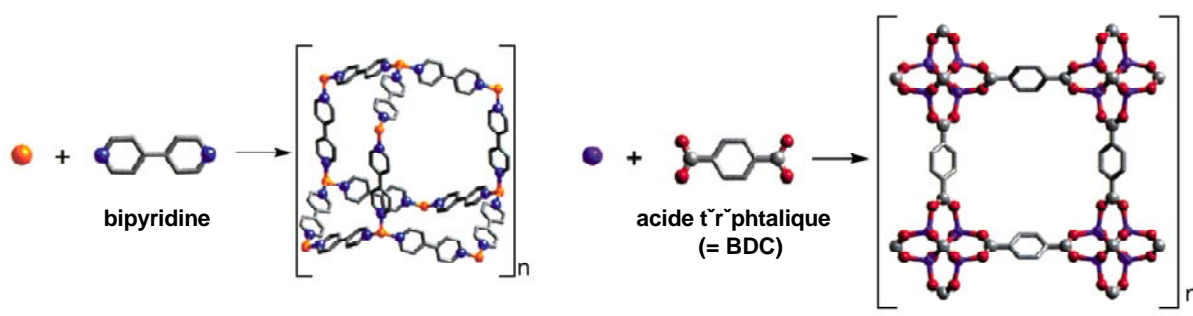
To have the opportunity to present my researches have also allowed me to apprehend the different approaches on the concept of metacognition. Whereas the view on metacognition in my lab is a non-conceptualist one, the researchers in Kusumi's lab were mostly accepting a conceptualist view on metacognition. Furthermore, these presentations, but also the possibility to attend to the seminars allowed me to observe that compared to French research, the domain of analytic philosophy and more specifically, of cognitive analytic philosophy is not very much developed in Japan. In my host lab, there are no connections between philosophy and psychology. Nevertheless, the members of Kusumi's lab seemed to be stimulated by the idea that there is a continuity between conceptual researches and empirical investigations. They appeared to be interested in the discipline of cognitive philosophy, and I have had many interesting discussions on this issue with my colleagues.

I have also been attending to the Brown Bag seminar every Wednesday and to the Colloquium on Fridays, until the end of the seminars in the end of July. This allowed me to have an idea of the diversity of researches in experimental psychology, which were pursued at Kyoto University. Even though my understanding was limited by the fact that the presentations were often given in Japanese. The assistant professor, Professor Kirk, kindly regularly summarized for me in English the purpose of the presentations, in order for me to be able to understand the main lines of the presentations. I must say nevertheless that I was surprised about the fact that English is not a more common practice in the seminars and also about how low the level of the students was in English.

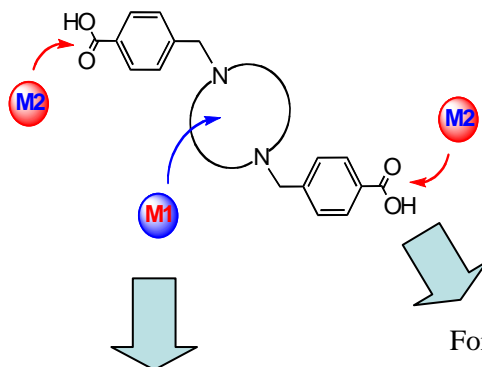
After the moving, I also shared a working-room with three other students. My main aims during the second part of my stay at Kyoto University were i) to analyze the data that I had collected in July, and ii) to make progress in two theoretical papers that I had in preparation. I must say that the new room was very small and not very comfortable, as did also regret my host researcher and the other colleagues. Consequently, I judged that it would more comfortable for me to work at the library. I have been able to get a pass to access the library of the university thanks to my host researcher and the secretary of the lab. I was able to work in very good conditions there. During August, I analysed the results of my experiments and made progress in my papers. Concerning the results of the experiment, I was not able to make the comparison between Japanese and French metaperceptual behaviours yet since the experiment needs still to be run in France. But I observed that Japanese students did take feedback into account in order to monitor and control their performance in a change detection task.

Even though I elected the library as my working-room, I had many interactions with the Japanese researchers I have met. Thanks to their kind hospitality, I have been introduced to their ways of life. I went several times to the Japanese festivals with my colleagues and we had a lot of fun together there. I was also very lucky and very happy to enjoy Kyoto during summer, period at which there are plenty of nice 'matsouri'. I had the feeling to be not only a tourist here in the beautiful city of Kyoto, but also a guest in the Japanese culture.

RESEARCH REPORT

1. Name: ORTIZ Guillaume	(ID No.: SP09208)
2. Current affiliation: Institut de Chimie de Moléculaire de Bourgogne Burgundy University (France)	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Kyoto University Katsura Campus	
5. Host researcher: Professor Susumu Kitagawa and Dr Satoshi Horike	
6. Description of your current research <p>Improvement of gas separation by adsorption processes lies on the ability to rationally design and fine-tune adsorptive properties of adsorbents for specific gas feed mixtures and more specifically for the post-combustion CO₂ capture. Government's objectives are to reduce up to 2050 of 60% CO₂'s emissions of steel industry and emergence of news technologies is necessary for CO₂ capture. My present work will focus to the use of new porous Metal-Organic Frameworks (MOFs) for this purpose.</p>  <p style="text-align: center;"><i>Schema: Principle of Metal Organic Frameworks</i></p> <p>Metal Organic Frameworks (MOFs) are the result of the organization between a metal of transition and one organic linker (ligand) for obtain by solvothermal synthesis a three dimensions material porous and stable.</p> <p>Owing to the reactivity of CO₂ with primary and secondary amines, it is a challenge to develop new porous MOFs whose framework contains polyamine linkers. The choice of the nitrogen functionalised organic linkers is of critical importance for the required application and our contribution is to use <i>N</i>-functionalised diaza- and tetraaza-macrocycles as spacer ligands integrated into the framework of the adsorbent.</p>	

Herein we prepare of various MOFs including cyclic polyaminocarboxylates in order to combine at the same time CO₂ adsorption by the porous framework and if it's possible CO₂ chemisorption on the amine.



Metal complex capable of interacting with CO₂
by amines or metal

Formation of a bi- or three-dimensional rigid
frameworks : *stability of the building*
(*permanent porosity*)

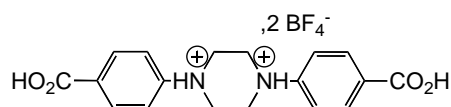
Scheme 1: principle of the new MOFs. 2D or 3D rigid frameworks and metal complex for interaction with CO₂.

7. Research implementation and results under the program

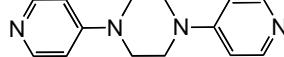
Title of your research plan: Synthesis of new MOFs for the CO₂ capture with specific amino-ligands.

Description of the research activities:

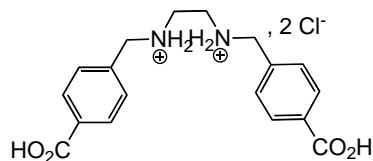
Durant the summer I try with 4 ligands was synthesis before the summer to obtain new and interesting MOFs for industrial applications with 4 ligands were synthesis before the summer.



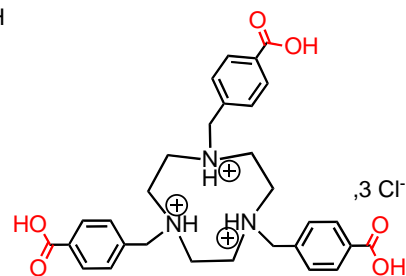
1,4- dibenzocarboxylique-pyperazine



1,4- bypiridine-pyperazine



1,4- (di-4-carboxybenzyl)-ethylenediamine

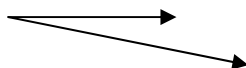


1,4,7-tris(4-carboxybenzyl)-Triazacyclononane

I obtain with the 1,4,7-tris(4-carboxybenzyl)-Triazacyclononane two new materials. This ligand is very interesting because it has 3 nitrogens free for the adsorption of CO₂ directly

by the amine for form a carbamic acid or if 3 nitrogens can coordinate a metal for obtain the coordination by using basic lewis properties of the CO₂.

Channel and
porosity of the
structure



QuickTime™ et un
décompresseur
sont requis pour visionner cette image.

Figure: View of the 3D porous materials along the C axis.

This shape is interesting because it was porous and so very interesting for the adsorption of the CO₂.

Now the future of this work is to calculate the capacity of adsorption for the CO₂ at room temperature and 1 atmosphere (industrial application).

Conclusion:

During this summer I try to synthesis new Metal Organic Frameworks with new ligands with amine groups for specific adsorption of CO₂. I synthesis 2 new interesting MOFs with the 1,4,7-triazacyclononane and Cobalt in the first time, and in a second time with the Nickel, 1,4-piperazine-bipyridine, terephthalic acid.

Now, for continue the future collaboration between our lab (ICMUB) and Kitagawa lab's in Kyoto, we will do the adsorption of CO₂ and write a paper for confirm the collaboration.

8. Please add your comments (if any):

I want to thanks in the first time, Professor Kitagawa. In the second time I want to thanks Doctor Satoshi Horike for worked with him all this summer, i very enjoy the work with him.

And sure I want to thanks Professor Takashi Uemura, the secretary Mieko , Doctor Julien Reboul, Nobuhiro Yanai, Yu Hijikata, Satoru Shimomura, Kohei Nakamura, Yu Kadowaki, Kazuya Asano, Koji Kitayama, Tomohiro Fukushima and all others people for this special summer.

And for finish I want to thanks JSPS for this fantastic summer program.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Emilie Roulleau (ID No.: SP09211)
2. Current affiliation: Université du Québec à Montreal- GEOTOP
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: University of Tokyo, Ocean Research Institute
5. Host researcher: Dr. Yuji Sano
6. Description of your current research <p>My PhD at the Université du Québec à Montréal is focused on the mantle sources that produced alkaline magmatism in eastern North America, and particularly the Cretaceous Montereian Hills in Québec. The mantle sources of the nine, NW-SE oriented, Montereian igneous intrusions are a long-standing problem. There are two hypotheses for explaining their origin: the passage of a hot spot (which implies lower mantle) or magmatism related to continental break-up and rifting (upper mantle). Deciphering between the hotspot and intrusions through reactivated rift faults has strong implications for the tectonic history of the region. We performed Sr, Nd and Pb analyses at GEOTOP that showed Ocean Island Basalt (OIB; lower mantle) signature. But the isotopic data correlate also with Common Mantle Reservoir (CMR; Lustrino and Wilson, 2007) and Low Velocity Component (LVC; Hoernle et al., 1995), both sources interpreted as Sub-Continental Lithospheric Mantle (SCLM, upper mantle). The trace elements can be explained by melting of fertile spinel-garnet lherzolite. So, Montereian magmas are generated near the boundary of garnet and spinel mantle stability domains (60-80 km depth : upper mantle). The low K/Th, Rb/Sr and K_2O/Na_2O, and high Ba/Rb are compatible with the hypothesis of amphibole-bearing in mantle source. So, the presence of residual amphibole in the mantle source of the Montereian hills and the location of melt zone near spinel-garnet boundary domain place important constraints on the location of the magma source between 60 to 80 km (Furman and Graham, 1999; Weinsten et al., 2006, and references therein) at the base of the lithospheric mantle (Hofstetter, A. and Bock, G., 2004) strongly supporting the hypothesis of a continental rifting (Faure et al., 1996).</p> <p><u>References:</u></p>

Faure, S., Tremblay, A. and Angelier, J., 1996. *Tectonophysics*, 255: 111-134.
Furman, T. and Graham, D., 1999. *Lithos*, 48(1-4): 237-262.
Hoernle, K., Zhang, Y.-C. and Graham, D., 1995. *Nature*, vol.374: p. 34-39.
Hofstetter, A. and Bock, G., 2004. *Geophysical Journal International*, 158(1): 67-84.
Lustrino, M. and Wilson, M., 2007. *Earth-Science Reviews*, 81(1-2): 1-65.
Weinstein, Y., Navon, O., Altherr, R. and Stein, M., 2006. *Journal of Petrology*, 47(5): 1017–1050.

7. Research implementation and results under the program

Title of your research plan:

Nitrogen and argon isotopes to trace the mantle source of the Montereian Hills, Québec, eastern Canada.

Description of the research activities:

To confirm the results obtained with radiogenic isotopes, we decide to use isotopic compositions of volatiles trapped in igneous rocks from the Montereian hills, particularly nitrogen and the noble gases, which are inert and rare. Indeed, if the hypothesis of the metasomatism of SCLM by a rising plume is true, percolating volatiles through the SCLM and the crust could have conserved the pristine mantle signature. I separated mineral phases (clinopyroxene and amphibole) at the GEOTOP-UQAM, before the early of JSPS program. The Center for Advanced Marine Research (Director Prof. Yuji Sano) of the Ocean Research Institute (ORI) of the University of Tokyo is one of the best equipped in Japan and given me the opportunity to analyze Ar, N₂ and CO₂ isotopes in Montereian separate minerals. After 2 months, I achieved my objective and I analyzed 8 samples of separate clinopyroxene and amphibole for nitrogen and argon isotopes. The CO₂ gas has been captured during the extraction of Ar and N₂ gas. The $\delta^{13}\text{C}_{\text{CO}_2}$ will be analyzed by ORI laboratory after my departure from Japan.

Preliminary results give a very interesting information on the origin of Montereian magmas. The $\delta^{15}\text{N}$ measured in my samples range from -7 to +4.6 ‰ and it is well correlated with Sr, Nd and Pb isotopes indicating two sources. The first ($\delta^{15}\text{N} = -7\text{‰}$) seems to indicate an upper mantle source as sampled by MORB or the subcontinental mantle diamonds (Fischer et al., 2005). The heavier $\delta^{15}\text{N}$ values show also more radiogenic Sr and Nd indicating a contamination by the crust. This contamination follows a precise regional trend from West to East, possibly related to the increasing thickness of the crust beneath the Montereian Hills. The N₂/ Ar show

two groups: 4 samples with $N_2/Ar = 114$ to 310 and 4 samples have 892 to 2613. The first group has N_2/Ar values comparable to MORB and subcontinental mantle which are respectively 124 and 234 (Marty et al., 1997; Marty and Dauphas, 2003). Our preliminary results are consistent with a previous study on Ne, Kr, He and Ar isotopes from carbonatite of Oka Mount that is one of Monteregian hills (Sasada et al., 1997). The upper mantle signature obtain with noble gas argue in favor of a shallow mantle as origin of Monteregian hills. This first result is consistent with the hypothesis of continental rift model.

References:

Fischer et al., 2005. GRL, 32: L11305.

Marty et al., 1997. EPSL, 152: 101-112.

Marty and Dauphas, 2003. EPSL, 206: 397-410.

Sasada et al., 1997. GCA, 61(19): 4219-4228.

8. Please add your comments (if any):

I enjoyed working in ORI laboratory. The researchers in the laboratory were of great help and support at any time. My Japanese supervisor gives me a nice overview of the Japanese culture.

9. Advisor's remarks (if any):

She is very good at laboratory and has worked hard. I think that the data obtained here is important in geochemistry and she may write a good paper in future.

RESEARCH REPORT

1. Name: Olivier Sanfilippo	(ID No.: SP09212)												
2. Current affiliation: University of Nice Sophia-Antipolis, Center of Modern and Contemporary Mediterranean													
3. Research fields and specialties: <table><tr><td>Humanities</td><td>Social Sciences</td><td>Mathematical and Physical Sciences</td></tr><tr><td>Chemistry</td><td>Engineering Sciences</td><td>Biological Sciences</td></tr><tr><td>Agricultural Sciences</td><td colspan="2">Medical, Dental and Pharmaceutical Sciences</td></tr><tr><td colspan="3">Interdisciplinary and Frontier Sciences</td></tr></table>		Humanities	Social Sciences	Mathematical and Physical Sciences	Chemistry	Engineering Sciences	Biological Sciences	Agricultural Sciences	Medical, Dental and Pharmaceutical Sciences		Interdisciplinary and Frontier Sciences		
Humanities	Social Sciences	Mathematical and Physical Sciences											
Chemistry	Engineering Sciences	Biological Sciences											
Agricultural Sciences	Medical, Dental and Pharmaceutical Sciences												
Interdisciplinary and Frontier Sciences													
4. Host institution: University of Tokyo, department of Occidental History													
5. Host researcher: Professor Katsumi Fukasawa													
6. Description of your current research <p>François Caron ; Biography of an intermediary between Europe and Asia This research is about the character François Caron who was born to Brussels-Huguenots parents. Later they went to Amsterdam. It is here that as a young person, François, makes a commitment to help cook on a ship for the Dutch East India Company (VOC) due to leave for Japan. In 1619 he arrives at Hirado where the Dutch factory is established. He spends 22 years in Japan and during the course, succeeds in climbing the diplomatic levels of the VOC. He becomes united to a catholic during his first marriage in Japan, during which he has 6 children.</p> <p>During the permanent closure of Japan to foreign powers in 1641, he joins Batavia (headquarters of the VOC in Asia, built on Java Island), and then Holland. He later becomes Councilor "Du Raad Van Indie" (Council of India, executive organ of VOC, chaired by the Governor general) and returns to Asia. He then becomes governor of Taiwan, leads fights against the Portuguese and the Spaniards and will eventually reach the post of Chief executive officer of the VOC, that is, the number two representative of Holland in India.</p> <p>On return to Holland for reasons of "discord", he "is retired". He is however recruited by Colbert who is setting up the French East Indies Company and cannot appoint someone of such invaluable skill and knowledge of the ground (as shown in the report which Caron drafts for Colbert). From its creation, Caron is named Director of the company, asked to establish the bases of the future French establishments in Asia and will join the first French Squadron en route to Japan. The adventure stops however on the coast of Coromandel (India). The war in Europe having spread to the Asian seas, the French Squadron is isolated and finally harassed everywhere, in spite of diverse takings (the Bay of Trincomale in the North of the current Sri Lanka, or the taking of Sao Tome on the India coast). With the hostility of the forced French officers only growing, François Caron leaves India to join France. It is on his return, while his ship is diverted towards Portugal where François Caron dies. His ship runs aground then breaks on a low bottom in the canal of Lisbon, on April 5th, 1673.</p>													

François Caron was an inescapable character of the diplomatic and European landscape in Asia. In particular, his knowledge of the Japanese Asian habits and customs, make him the central person in the bosom of international relations. His unique experience of Japan at the beginning of the Edo-Bakufu era, opens new perspectives for approaching in a quite particular way, the study of the European vision of the Japan of Tokugawa.

My general research axes are : Field of study regarding biography, study of the Dutch and French society and more widely the European elites of the Ancient Regime. Connections between the European nations in Asia, in particular the alliance game, the conflicts that crystallized around the notions of religious war. The European vision of Asia and the study of mentalities and culture, in particular those of Japan. The Indian Companies, their strategies, operations and the men which compose them. The social networks which get organized around the character of François Caron, the Japanese network, quite important to understanding the success of this character in Japan. The scientific network, the lounges and the academies, etc.

7. Research implementation and results under the program

Title of your research plan: François Caron ; His life in Japan in the Edo era.

Description of the research activities:

My research took place according to various axes. A first part aimed to deepen my scientific knowledge of the strictly Japanese context of the first half of the XVIIth century, that is, on the first 50 years of the Edo era. In this frame I was able to develop a rich bibliography on the subject of Japan, its institutions, its relations with foreign countries, in particular the West, its culture, etc. This first stage was particularly successful. I was able to get access to the works and the sources which interested me, they were numerous and they allowed me to make one really big jump forward on my research.

The areas of bibliographical and archival research were the following:

- General Library of the University of Tokyo
- Library of the Philological faculty
- Library of the department of Japanese History
- Library of the department of Western History
- Collection of the Historiographical Institute
- Collection of the Institute of the Oriental Civilization

The second part, directly linked to the first, consisted in searching through the heart of the archive material for traces of the character that interested me. Even then, I was able to enrich my sources and find a number of indispensable pieces of information.

In the same vein, I was given the opportunity to meet specialists of domains close to my research, and so I was able to open discussions around areas of mutual research:

The Professor FUKASAWA Katsumi. Department of Occidental History of the University of Tokyo. Professor Fukasawa made this whole project possible. During my stay under his supervision, we were able to exchange a number of ideas on my research, and so opening new perspectives of work and exchange. He himself brought me the necessary means to meet the following specialists.

The Associate Professor of the Historiographical Institute of the University of Tokyo, MATSUKATA Fuyuko, specialist in the foreign relations of Japan during the Edo era. Our exchanges allowed the acquisition of new data, the release of my points of view concerning my research subject. I was also able to get access to certain

documents at the bottom of the Historiographical Institute and especially to share his knowledge of the subject.

The Director of the Institute of Oriental Culture, the Professor HANEDA Masashi. We were able to speak once again on the cultural exchanges during the period of the 17th century. It was also an opportunity to approach the project which is coordinated by the Director (and co-coordinated in particular by Professor FUKASAWA): "Eurasia in the Modern Period: Toward a New World History".

This important research avenue, also supported by the JSPS, reviews a number of my research problems, in particular the Asian ports, the maritime history but mainly as regards the cultural interactions. I hope this interview will create an opportunity for me to follow the works of this project and more widely those of the Institute of the Oriental Culture.

During my stay I also had the great pleasure of working within the Department of Western History and to familiarize myself with the work of its Japanese researchers. This experience was most enriching. Tying up links with the various present members, sharing our resources and ideas. I also had the honor to present a seminar about my research and to take advantage of this experience to push my ideas to a new and informed public.

Following this, my research began a more cultural aspect with a visit to the cities of Nagasaki and Hirado, and diverse cultural sites important to me: in particular the faithful reconstruction of the Dutch counter of Deshima and the diverse pieces exposed in diverse museums. Furthermore, it was possible for me to walk in the tracks of this François Caron character. For me, it was also an opportunity of appropriating, even fleetingly, some additional fragments of Japanese culture, and to try, by the same measure, even for just one moment, to put myself in the skin of Caron by placing myself in the geographical frame in which he evolved.

In parallel to these set works, I finished the first version of an article bringing to light a part of my research made within the framework of this program. This article will treat the Japanese social and institutional networks of the character of François Caron. It should normally be the object of a publication in the review of the Department of Western History of the University of Tokyo. This article has also allowed me to bring in new elements particularly important for my thesis.

To conclude, this program was for my part a unique and crucial experience in the continuity of my research career. I received all the help which I needed and more still. The contacts created here, have opened new enriching and rewarding perspectives for the future. I hope in my turn to have contributed a little more to this magnificent exchange and still thank The Professor Katsumi FUKASAWA and all the members of the JSPS for all of this.

9. Advisor's remarks (if any):

During his stay in Japan, Mr. Olivier Sanfilippo proved to be a very industrious researcher and implemented his research program with much skill and dynamism. He explored a lot of books and documents which will be useful for the preparation of his thesis. He proved also a very agreeable person capable of making a friendly relationship with every Japanese researcher whom he got acquainted with, so that the academic and cultural exchange between him and my students at the University of Tokyo has been extremely fruitful for both sides. In all respects I am satisfied to have received this young and promising researcher, so I am grateful to the JSPS for having awarded him a fellowship for the Summer Program 2009.

RESEARCH REPORT

1. Name: SABRE	(ID No.: SP09213)
2. Current affiliation: CNRS	
3. Research fields and specialties: Humanities <u>Social Sciences</u> Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Seika Daigaku- Kyoto	
5. Host researcher: Pr Yoshimura Kazuma	
6. Description of your current research This project of research is included in a PhD work. This PhD, conducted from an anthropological point of view, focuses on two points. First, I have shown that some fans of manga (in France) are building and sharing their own fantasy about Japan. Hence, the following questions: what is the nature of this “fantasy of japaneeseness” for the fans and how are they using it, especially to build their own identity. The image of Japan in France is renewed, as it is not only “classical” or “traditional” elements which are praised and put forward (for example temples, martial arts, tea ceremony, etc.), but also media and entertainment (manga, animation, video game, etc.) Consequently, and as a second point, I have noticed that French fans strongly desire to go to Japan, to visit the country and to experience Japanese way of life. So, what happens when they discover the concrete reality of Japan? Are they engaged in intercultural process? And when the western fans are travelling, is manga staying there main point of interest? This research was directly linked to that second point. I have visited the Manga Museum during my fieldwork last year and I was really interested by taking it as a case study, to understand with that precise example how foreign tourists, from the West (with a specific focus on French people) perceive manga. In other words, this research was a way to precisely study the impact of manga as a touristic object. To question the significance and the interest of the Manga Museum for foreign tourists is a way to understand how manga (and then Japanese pop culture) becomes a sightseeing object and how it is engaged in a making of heritage process. Indeed, the use of the notion of “Heritage” to qualify what’s happening with manga and Japanese pop culture now is also a part of the research, as it needs to be detailed and	

discussed. The fact that the Japanese government and the tourism industry now include the “Cool Japan” theme into their promotional campaign is also a part of that praise of manga, as an object which deserves consideration.

7. Research implementation and results under the program

Title of your research plan:

Pop Culture tourism in Japan: Questioning manga as Heritage.

Description of the research activities:

The research was then established as a case study, a focus on a specific site dedicated to manga, which can be a place to visit for tourists. The purpose was to understand how foreign visitors perceived the Museum once they have visited it, and also to know their reasons to choose to come to that place: are they manga lovers or just curious to learn more? In other words, are people coming to the Museum because they already know and enjoy manga or because they consider it as a cultural element which deserves to be known as part as Japanese culture?

More broadly, this research was also a means to go further with the parallel between manga as a touristic object and the notion of Heritage. Looking at how foreign visitors perceive both manga and the Museum could be a way to understand more precisely the process running now.

In order to reach that goal, I used the ethnographical method, adapting it to fit that specific fieldwork: I create a survey, both in English and French (as my work is more focused on the French case) which was available for people at the entrance of the Museum. Questions were both closed and opened: it is important for analysis to grasp as much as possible “discourse”, that is to say texts written by people to give their opinion, comments and critics.

To complete, I made participant observation into the galleries, to see how people behave during their visit, and also to speak with some visitors, to go further in trying to catch their thoughts and feelings.

At that day, I have more than 400 surveys filled, and I spoke with around 30 people at the end of their visit. It can seem a short number of interviews but it was more long discussion, sometimes with different visitors in the same time, and what people told to me really tallied to what I found in the surveys.

I also conducted interviews with the researchers working at the Museum and with the main administrator.

Now, surveys and other data need to be analyzed but I can give a broad idea of what people said: the Museum seems for them to be more a library, as it displays a lot of manga. (In fact, the Museum has 3 functions: exhibitions, library and research center.) To me, it means that there is a gap between what manga is for them (a

cultural element about which they want to learn more) and for Japanese people (an entertainment among others.) It also showed a difference between the western conception of what is a museum and the conception at work in the Manga Museum.

Finally, it seems that manga is interesting for both lovers and curious visitors: firsts want to see what they love into its original context, and the seconds want to discover one element of Japanese culture, among others but not less important.

To conclude, the question of a parallel between manga and the notion of Heritage is perceived differently by Japanese readers, researchers and by foreign tourists: as in Japan manga is considered as an everyday life element, there is nothing to do with Heritage but, on the opposite, foreign people mainly think that manga is Heritage because it is anchored into Japanese culture and everyday life.

Eventually, the research is not finished yet now the analysis of data will begin and allow to answer more precisely and to detail that first and temporary conclusion.

8. Please add your comments (if any):

This research was a really good opportunity for me to exchange with manga researchers, as these works are not always available in Europe. I hope to continue that research, as tourism and image of Japan are field constantly moving now. I would like to use that research as a basis for future work because it was so interesting for me to look at manga from the Japanese perspective, as I am use to look at it from France.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Dupont Delphine (ID No.: SP09214)
2. Current affiliation: University Pierre et Marie Curie
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Kyoto University
5. Host researcher: Professor Miwa
6. Description of your current research <p>During my Ph.D I focus on the category $\text{Perv}(X)$ of perverse sheaves on X, when X is C^2 stratified by a generic arrangement of lines or a smooth toric variety stratified by the torus action. Let's remark that these spaces are locally isomorphic (by stratified isomorphisms) to C^n or product of C^n and C^* stratified by the normal crossing. I use stack theory to glue the description of Galligo, Granger and Maisonobe (GGM) and I obtain an equivalence between $\text{Perv}(X)$ and an explicit subcategory of the category of representations of the quiver associated to the stratification. The strategy goes as follow : thanks to a description of the 2-category of stacks on a stratified space, I give an elementary way to define a strictly constructible stack (stack whose restrictions to each stratum are constant) on C^n stratified by the normal crossing. As the stack of perverse sheaves $\text{PPP}(C^n)$ is strictly constructible, this allows me to define a stack on C^n, $\text{CCC}(C^n)$, of categories of representations of quivers, equivalent to the stack $\text{PPP}(C^n)$. As a stack can be defined by stacks on open covering with descent conditions, I can define a stack $\text{CCC}(X)$ on X equivalent to the stack $\text{PPP}(X)$. Hence the category of global sections of $\text{CCC}(X)$ is equivalent to the category $\text{Pcerv}(X)$. The last step is to give an explicit description of the global sections.</p> <p>The aim of my stay in Kyoto can be developed in two points :</p> <ul style="list-style-type: none">- First I wanted to understand the stack of perverse sheaves on less specific stratified spaces : topological spaces with Thom-Mather stratification. On this type of spaces the stack of perverse sheaves is constructible (the restriction to each stratum is locally constant and not constant) and not strictly constructible. Hence I needed to give a way to define constructible stacks with the data of categories, functors and isomorphisms of functors.- Secondly I wanted to find applications to my work and in particular in the theory

of D-modules.

7. Research implementation and results under the program

Title of your research plan: Stacks of perverse sheaves and applications

Description of the research activities:

During my stay in Kyoto I was in an office with several international researchers. Hence I could exchange with them and have interesting discussions. I also met professor Miwa and professor Kashiwara. And thanks to the JSPS fellow I could assist to some international conferences “Workshop on Non-abelian Hodge theory and Geometry of Twistor structures” in Kyoto, “Workshop on Equivariant Gromov-Witten theory and symplectic vortices” in Kobe.

All the discussions with the researcher that I met during my stay allow me to understand how to describe the stack of perverse sheaves on a space stratified by a Thom-Mather stratification. I describe the 2-category of constructible stacks on constructible spaces. The description of the 2-category of strictly constructible stacks was simple because the data of a constant stack is equivalent to the data of a category. This is of course not true for a locally constant stack. But Polesello and Washkies have shown that the 2-category of locally constant stack is 2-equivalent to the 2-category of 2-groupoid representations. Hence I obtain a combinatoric way to define a constructible stack. Once done, we have to define an object in this new 2-category equivalent to the image, by the 2-equivalence, of the stack of perverse sheaves. And this object will define a stack equivalent to the stack of perverse sheaves. The most difficult part is to compute the image of $\text{PPP}(X)$ in the new 2-category. At the end we will study the global sections of this stack to exhibit explicit category equivalent to the category $\text{Perv}(X)$.

During the conferences I met lot of international researchers, in particular Masa-Hiko Saito, Takuro Mochizuki, Claude Sabbah and Carlos Simpson. The exchange that we had was very instructive and thank's to that I start two collaborations.

- The first one is with professor C. Simpson. Recently the theories of n -categories and n -stacks have developed rapidly and offer a very useful language in lot of domains of mathematics. Notice that the stalk of a n -stack is a filtered n -colimit. Hence result on n -limits and n -colimits should have lot of applications. In my PhD I had to show the commutation of a filtered 2-colimits and a finite 2-limit. In a joint project with C. Simpson we plan to generalize this result to the n -limits and n -colimits. In a first time we

consider the n -limits indexed by a category. In the case of close model category we can characterize when the homotopic limits and colimits commute. The n -categories define a close model category, but C. Simpson does not define the $n+1$ -limits (resp. $n+1$ -colimits) as the homotopic limit (resp. colimit) in these close category. Hence we need to prove that the notion of $n+1$ -limit and $n+1$ -colimit coincide with the notion of limit and colimit homotopic in the close category associated to the n -category. In a second time we want to generalize the notion of filtered n -colimit when the n -colimit is indexed by an n -category. E. Dubuc and R. Street have already generalize this notion in the case of 2-limits.

- The second one is with Professor C. Sabbah. We want to define the stack of perverse sheaves with Stokes structures. The case of dimension one is straight-forward because of the stratification. The first interesting case is to consider product $C \times S$ where S is a topological space stratified by the product stratification. The most difficult part of it will be to restrict this stack in order to have a constructible stack.

Hence the two points of my project has been realize.

8. Please add your comments (if any): The experience was very interesting not only in mathematic and also in a personal point of view.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Damien VOIRY	(ID No.: SP09215)
2. Current affiliation: Centre de Recherche Paul Pascal (CRPP)	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences <u>Chemistry</u> Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Nanotube Research Center, AIST, Tsukuba	
5. Host researcher: Dr. Said Kazaoui	
6. Description of your current research <p>Covalent functionalization of carbon nanotubes (CNTs), either single or multi-walled, is extensively used to solubilize and to process these exceptional materials. Moreover, the functionalization may be used to give nanotubes additional mechanical, electrical and/or optical properties. Both type of functionalization are of interest for the development of CNTs fibers in our laboratory.</p> <p>Although many functionalization routes are known, most of them damage the structure of CNT because the chemical reactions are performed with highly reactive intermediates and because the degree of functionalization is not controlled. At the CRPP (Centre de Recherche Paul Pascal), we have developed a new method for functionalizing the CNTs. It enables control of the amount of functional groups grafted to the sidewall of CNTs and it is applicable to wide ranges of chemical functions. These points are fundamental for most applications using the extended π-system of CNTs. We are currently working on carbon nanotube functionalization with chromophores.</p> <p>Collaborating with the Nanotube Research Center of the AIST, within the JSPS summer program, we want to elucidate the optical properties of functionalized CNTs, and fabricate and characterize FET devices based on such functionalized CNTs.</p>	
7. Research implementation and results under the program	

Title of your research plan:

Optical characterization of functionalized single walled carbon nanotubes (Fc-CNTs), and functionalized CNT based FET fabrication.

Description of the research activities:

Depending on the way the graphene layer is rolled up to make the carbon tube, defined by the chiral index (n,m) , the geometry and the electronic structure will change. The electronic structure the nanotubes can be probed by optical spectroscopy such as optical absorption, photoluminescence and Raman. Therefore, knowing the absorption wavelength and the photoluminescence emission wavelength, we can be identified the chiral index (n,m) of the nanotubes and predict their properties.

In the project :

- 1) First, we have investigated the optical properties of functionalized CNTs synthesized using a unique method developed at CRPP and using a unique photoluminescence spectrometer developed at AIST. We have focused our attention on one type of perylene functionalized carbon nanotubes (Figure) with different degrees of functionalization. The latter are highly soluble in 1,2 dichlorobenzene without sonication, which is known to damage the tubes.
- 2) Then, we have dispersed the functionalized CNTs with polyfluorene in toluene to selectively extract semiconducting CNTs using a method developed at AIST.
- 3) Finally, we have utilized these CNTs to fabricate CNT based transistors (using the nano-fabrication facilities at AIST), and we have measured their photoelectric response.

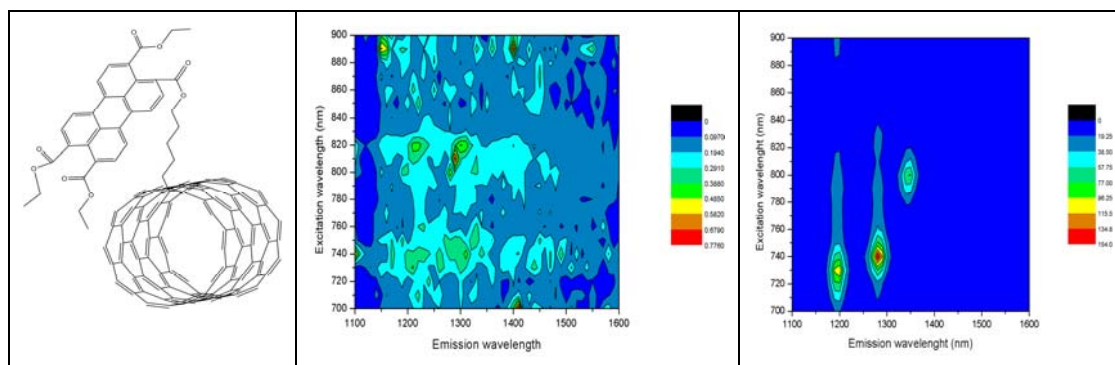


Fig.1 shows the molecular structure of functionalized CNTs, and the photoluminescence maps of functionalized CNTs as synthesized at CRPP and after treatment at AIST.

The experiments carried out at AIST have demonstrated that the soft chemistry approach and the precise control of the degree of functionalization is essential to

preserve the electronic structure and the optical signatures of the CNTs such as photoluminescence. This conclusion was made possible through this cooperation between the CRPP and AIST.

As shown previously by AIST, semiconducting nanotubes can be isolated with high purity by dispersing carbon nanotubes with polyfluorene into toluene followed by one step of sonication and several steps of ultra-centrifugation. The same process has been performed on perylene-functionalized CNTs. After extraction, the optical absorption spectra don't show any presence of metallic tubes. However from optical measurements it is difficult to conclude if the perylene groups are still grafted to semiconducting CNTs. To overcome this problem raw unfunctionalized semiconducting CNTs have been prepared during this project and will be functionalized at the CRPP.

The field effect transistors (FETs) made from these materials have been fabricated and characterized at AIST. Pre-patterned silicon wafer have been made in clean room and the functionalized semiconducting CNTs were drop-casted onto the Si wafer. Various transistors have been prepared varying the preparation conditions. We found that FETs made using as-prepared perylene-functionalized CNTs do not operate because they still contain metallic CNTs. In contrast FETs based on extracted semiconducting CNTs can operate. We will continue our cooperation between the CRPP and the AIST on these issues.

In addition, we have started to study the photoelectric/photocurrent response of semiconducting CNTs extracted from perylene-functionalized CNTs. In the future we will cooperate on the development of organic photovoltaic solar cells.

8. Please add your comments (if any):

I would like to thank the JSPS for this wonderful opportunity. I have learned a lot during these few weeks at the AIST (Nanotube Research Center). I am also grateful to my host supervisor. I hope to continue this collaboration between CRPP and AIST.

9. Advisor's remarks (if any):

I would like to thank the JSPS and Damien Voiry for the quality of this research. I hope that this cooperation between CRPP and AIST can be extended for instance in the framework of the SAKURA program.

RESEARCH REPORT

1. Name: PAUL FERDINAND BAUMEISTER	(ID No.: SP09301)
2. Current affiliation: Institute for Advanced Simulation, Forschungszentrum Jülich, 52425 Jülich, Germany	
3. Research fields and specialties: Humanities Social Sciences Mathematical and <u>Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Department of Precision Science and Technology, Osaka University, Suita, Osaka 565-0871, Japan	
5. Host researcher: Prof. Dr. Kuwahara	
6. Description of your current research <p>Large scale <i>ab-initio</i> calculations for the simulation of realistic materials are the gateway towards understanding and predicting the functionality of nano devices. In the past, highly symmetric and pure crystal structures have been investigated using density functional theory (DFT). Functionality however is introduced by breaking these symmetries as for example by doping with impurities. A less symmetric structure needs a larger number of atoms to be taken explicitly into account which means that the computational costs will increase (usually in a non-linear fashion). Today's supercomputers can tackle this demand using a reasonable amount of time. However, the trend of supercomputing has moved from increasing the processor clock rate to increasing the number of processors in one parallel computer. The quantity that measures, how efficient an application can run on a parallel computer is called speed-up (or soft scaling). The best parallel efficiency is gained, when the task of the computation are fully independent and thus the parallelization does not introduce additional communication operation between the processes.</p> <p>Density functional theory allows to compute the ground state total energy of an atomic configuration and the forces acting onto the atoms (as long as the structure is out of equilibrium). The main equation to be solved is called Kohn-Sham (KS) equation. Its structure is similar to the Schrödinger equation whereas the potential is an effective potential. Common methods solve the KS equation in Fourier space. The effective potential however needs evaluation in real space. To translate between these two, the Fourier transform is required. In terms of parallelization, the Fourier transform (FT) needs a lot of communication between the processes which makes the parallel efficiency drop rapidly when it comes to larger system sizes. The real-space finite-difference (RSFD) methods, however, does not require FT, so that its speed-up is close to ideal (twice as many processors take half the time). Therefore, the combination of the RSFD methods and massively parallel computers is a powerful tool towards larger system sizes.</p>	

7. Research implementation and results under the program

Title of your research plan: **Implementation of the Non-Local energy functional for a Real-Space Finite Difference code**

Introduction: Density functional theory provides structure predictions of many classes of materials. The chemistry of ionic, covalent and metallic bonds is reproduced accurately, however, systems dominated by soft bonds that rely on non-local interactions are poorly described by the semi-local and local density approximations (GGA/LDA). The systems are often called van-der-Waals type. The non-local functional by Dion *et al.* promises to make up for this lack and yield quantitatively and qualitatively correct results.

Description of the research activities:

The research plan consisted of three sequential steps: 1) Implementation of the NL functional and its kernel, 2) testing of the functional and the convergence w.r.t. the cutoff parameters on a realistic system and 3) parallelization of the routines according to the domain decomposition scheme of the RSFD code.

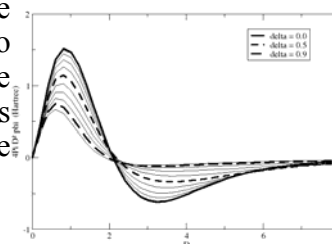
1) Implementation:

The non-local functional proposed by Dion *et al.* [1] computes the correlation energy arising from the polarizability of each infinitesimal element of the electron density. In terms of the density given on a equidistant real-space grid, this corresponds to a double summation over grid points.

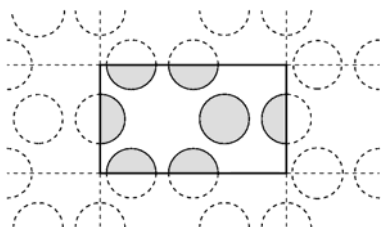
$$E_c^{nl} = \frac{1}{2} \int d^3\vec{r} d^3\vec{r}' n(\vec{r}) n(\vec{r}') \phi[n, n', |\vec{r} - \vec{r}'|]$$

Because of the double summation, the computational costs scale quadratically with the number of grid points and so with the volume. To tackle this enormous amount of computations efficiently, we calculate the NL kernel function in advance and use an interpolation scheme in the later calculation, since each value of the kernel function required several seconds on a regular PC to be evaluated.

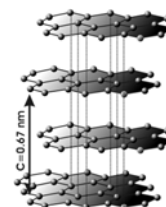
For very large values of the argument D , an analytically given asymptotic formula is applied (Equation 17 in [1]) that reproduces the D^{-6} of the van-der-Waals interaction. Due to its fast convergence to zero, one may introduce a cutoff radius R_{cut} , neglecting the interaction of grid points with a larger distance than this parameter. Of course, intensive tests about the convergence behavior of R_{cut} have to be performed.



2) Application

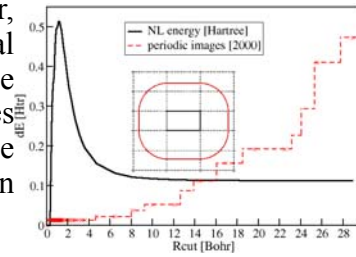


Graphite:
honeycomb carbon films in AB
stacking,
DFT calculation
4.245 x 2.451 x 6.7 Å
8 atoms,
32 valence electrons
grid 24 x 14 x 36
 E_{cut} 86 Ry

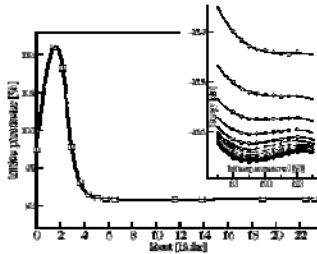


In periodic systems, the unit cell of the computational volume and thus the number of grid points may be small but periodic replicas of the same cell have to be taken into account in real space. The minimum number of periodic repetitions is 1 to each side, which introduces a factor of at least 27 for three periodic boundary conditions.

One can see, that for cutoff radii larger than 2.0 Bohr, the value of the energy correction given by the non-local correlation contribution starts to converge monotonously. However, the computational effort scales cubically with the cutoff radius (red graph) because more periodic copies of the unit cell have to be taken into account.



Therefore, it is of interest, how strong the effect of error cancellation can be exploited within small cutoff radii. Instead of looking at the total energy, we will now regard the change of the equilibrium lattice parameter c_0 i.e. the energy minimum.



The graph shows that the energy minimum of the corrected energy curve converges faster w.r.t. R_{cut} than the total value of the energy correction. This gives us converged results for lattice constants already from cutoff radii as small as 6.0 Bohr which means affordable calculations. However, the corrected value of the lattice parameter (91%) is wrong. In these

calculations the numerically difficult local contributions $\phi_0(\mathbf{r} = \mathbf{r}')$ have been neglected. These results show their importance. The implementation of the ϕ_0 contribution will hopefully make up for this lack.

3) Parallelization

One aim was to create a module calculating the non-local correlation energy that could be embedded into the main RSFD density functional code [2]. This code works on the basis of a 3-dimensional domain decomposition into several MPI-processes. The parallelization concept was adopted for the MPI-parallelization of the non-local module, such that the N^2 operations are equally distributed among each process. If only the total energy correction is of interest, one could be cheaper by factor 2 because the double summation is symmetric under exchange $i \leftrightarrow j$, but then the locally resolved correlation energy density $E_{nl}(\mathbf{r})$ is not found at the same time. The theoretical prediction for this parallelization scheme is a linear speed-up (ideal soft scaling), whereas the scaling of the total number of tasks is quadratic. However further investigations are needed in order to explore the load balance profile. The pre-calculation of the kernel was also MPI-parallelized and can run on any number of processors.

[1] M. Dion, H. Rydberg, E. Schröder, D.C. Langreth, and B.I. Lundqvist, *Van der Waals Density Functional for General Geometries*, PRL **92**, 246401 (2004)

[2] K. Hirose, T. Ono, Y. Fujimoto, and Sh. Tsukamoto. *First-Principles Calculations in Real-Space Formalism*. Imperial College Press, London, 2005.

RESEARCH REPORT

1. Name: Susanne Beckers (ID No.: SP09302)
2. Current affiliation: University Bremen
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: The University of Tokyo, Graduate School of Mathematical Sciences
5. Host researcher: Prof. Masahiro Yamamoto
6. Description of your current research <p>The transport and diffusion of liquids in porous media is highly complex, caused by strong velocity gradients and scale dependent correlations. These properties appear because of the inhomogeneity of the media. In this kind of media, the dispersive flux is not constant, but dependent on time and space.</p> <p>This type of transport is for example groundwater flux, where the water, including pollutant, diffuses through the soil. The question is now, however, where the water flows to and how fast it will get there.</p> <p>By the aid of the Caputo-Differential Operator a fractional differential equation can be set up, which is a good model for flux in porous media, depending on the order of derivative in time.</p> <p>The solution for this differential equation can be approximated by different algorithms.</p>
7. Research implementation and results under the program Title of your research plan: The fractional diffusion equation for fluids in porous media – possible solution schemes and their comparison.

Description of the research activities:

The fractional diffusion equation in general has the following form

$$(1) \quad {}^c D_t^\alpha P(x,t) = \frac{\partial^2}{\partial x^2} P(x,t) \quad , x \in \Omega \subset \mathfrak{R}, t \in (0,T).$$

Additionally, initial and boundary values should be given, for the unique existence of the solution. E.g.

$$(2) \quad P(x,0) = a(x) \quad , x \in \Omega$$

$$(3) \quad P(x,t) = g(x,t) \quad , x \in \partial\Omega, t \in (0,T),$$

where a and g can be any function. The Caputo-derivative of order $\alpha \in (0,1)$ for a differentiable function u is given as

$$(4) \quad {}^c D_t^\alpha u(x,t) = \frac{1}{\Gamma(1-\alpha)} \int_0^t (t-\tau)^{-\alpha} \frac{\partial}{\partial \tau} u(x,\tau) d\tau \quad , x \in \partial\Omega, t \in (0,T)$$

An iterative algorithm can be used to approximate the solution of (1) with initial and boundary conditions as above. Since the solution is approximated with time steps of size k and steps in space of size h, the approximated solution shall be called P_{hk} .

Assuming the solution to be differentiable with respect to time twice, an implicit scheme can be set up as

$$(5) \quad P_{hk}(x, t_{n+1}) = P(x,0) + \frac{k^\alpha}{\Gamma(\alpha+2)} \sum_{j=0}^n a_{j,n+1} (CP_{hk}(x, t_j) + F(x, t_j)) \\ + \frac{k^\alpha}{\Gamma(\alpha+2)} (CP_{hk}(x, t_{n+1}) + F(x, t_{n+1}))$$

where C is an operator for the central difference of the spatial derivatives and F a function for the boundaries, here simply

$$(6) \quad F(x,t) = \begin{cases} g(x,t) & \text{for } x \in \partial\Omega \\ 0 & \text{else} \end{cases}$$

Rearranging (5) to explicit form leads to

$$(7) \quad P_{hk}(x, t_{n+1}) = \left(Id - \frac{k^\alpha}{\Gamma(\alpha+2)} \right)^{-1} \left(P(x,0) + \frac{k^\alpha}{\Gamma(\alpha+2)} F(x, t_{n+1}) \right. \\ \left. + \frac{k^\alpha}{\Gamma(\alpha+2)} \sum_{j=0}^n a_{j,n+1} (CP_{hk}(x, t_j) + F(x, t_j)) \right)$$

Using this scheme, the solution looks quite similar to the solution obtained by the predictor corrector scheme, with which I dealt in Germany (See "Numerical algorithm for the time fractional Fokker-Planck equation" by Weihua Deng, published in the Journal of Computational Physics, Vol. 227, Issue 2, Dec. 2007, P. 1510-1522)

The following results are calculated with an initial value function $a(x) = \Gamma(x)$, approximated by 1000 at $x=0$ and zero elsewhere and the zero boundary condition.

For $\alpha=0.9$, $T=0.1$ and $\partial\Omega = \{-1\} \cup \{1\}$, Figure 1 and 2 show a numerical result.

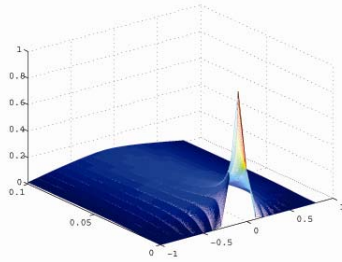


Figure 1: Solution of predictor-corrector scheme

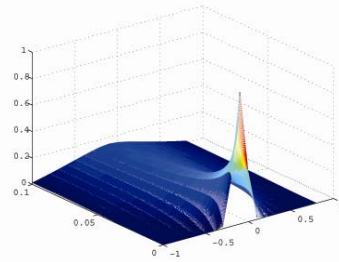


Figure 2: Solution of the implicit scheme

I have applied an implicit scheme too and for the same case as above, Figure 2 shows a numerical result.

The both schemes give similar numerical performances as Figure 3 indicates.

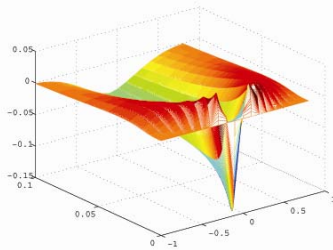


Figure 3: Difference between the solutions

The predictor corrector scheme may be more accurate, but it requires some strong

conditions. For determination of the algorithm, k , h and α must fulfill $\frac{k^\alpha}{h^2} < C$ for a

suitable constant C .

The advantages of the implicit scheme are the lower costs in calculating time and memory. Additionally, since there is no condition for stability, it is much easier to solve the equation for smaller α .

8. Please add your comments (if any):

I was kindly supported by my host researcher Prof. Yamamoto. He gave me the opportunity to visit the Fudan University Summer School (Shanghai) as well as the Hokkaido University. I got a good inside view, how Japanese mathematicians work and what there everyday life is like. I will keep in touch with the researchers I met and I hope, I can come back one day.

9. Advisor's remarks (if any):

Ms. Susanne Beckers has studied numerical methods for fractional diffusion equations which model anomalous diffusion of underground contaminants for example. Thus the fractional diffusion equation is an important model equation for quantitative environmental engineering. In spite of such practical importance, there are not many theoretical and numerical researches and she aimed at numerical methods and she has obtained very good initiating results (see item 7 above) for continuing toward the doctoral thesis. Moreover she was invited to the summer school on inverse problems at Fudan University in Shanghai, China, and has studied various topics of inverse problems, and also to Kimitsu work of Nippon Steel Corporation to discuss problems in the steel manufacturing process with Chief Researcher Mr. Junichi Nakagawa. Moreover she is interested in Japanese cultures and I believe that during the stay, she has greatly learnt them to become more familiar with various Japanese elements.

RESEARCH REPORT

1. Name: Philipp Dressel	(ID No.: SP09303)
2. Current affiliation: Technische Universität München	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences <input type="checkbox"/> Interdisciplinary and Frontier Sciences	
4. Host institution: Nagoya University	
5. Host researcher: Professor Kensaku Mori	
6. Description of your current research <p>Using computer systems to support medical procedures has substantially improved the quality of medical care in many areas. Technologies such as Computed Tomography, Magnetic Resonance Imaging, 3D and 4D ultrasound imaging and even surgical robot systems provide invaluable support to physicians today.</p> <p>My research currently focuses on endobronchial lung biopsies, where a flexible bronchoscope is inserted through a patient's mouth into the lung. A video camera system provides the operator with feedback on the proceedings, while a working channel allows for the insertion of tools into the patient's lung tissue. Using this system, a tissue sample from a region of suspected cancer can be taken in a minimally invasive and effective way.</p> <p>The human lung is a complex system of branching tubes, thus the video image alone is often not enough for the physician to reliably estimate the position of the target region for a biopsy. For this reason, special bronchoscopes exist which incorporate a miniature ultrasound imaging device next to the camera, to aid in the location of the biopsy site.</p> <p>By upgrading such a system to allow for 3D ultrasound images to be taken, and subsequently augmenting interesting tissue regions directly in the video images of the camera, I hope to further improve the accuracy of these interventions.</p>	

7. Research implementation and results under the program

Title of your research plan: Calibration of endobronchial ultrasound and camera

Description of the research activities:

During my stay in Japan, I constructed a calibration phantom specifically designed for the Olympus bronchoscope of Professor Mori's research group. For this, I used established calibration methods for optical cameras and ultrasound devices in conjunction with an electromagnetic tracking solution. Based on this data, a virtual model of the bronchoscope was built. From this virtual model, I was able to derive suitable geometrical design properties of the calibration phantom. The particular challenge was to find a construction that would give sufficient features to be detected in both the video and ultrasound images, while at the same time not obstruct the field of view of either imaging modality.

One particular problem that arose during the measurements was the high optical distortion of the bronchoscopes camera, caused by the miniature size of the optics. A similar problem was encountered for the ultrasound imager, which operates on a much smaller scale than traditional ultrasound devices. I evaluated several different mathematical approaches for the calibration with numerical simulation to find a promising method.

I was able to successfully construct a working calibration phantom and recorded the resulting data, which I will subsequently process and incorporate into my diploma thesis.

RESEARCH REPORT

1. Name: Carsten Grabow (ID No.: SP09304)
2. Current affiliation: Max Planck Institute for Dynamics and Self-Organization, Goettingen, Germany
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Computational Neurophysics, RIKEN Brain Science Institute, Wako City, Japan
5. Host researcher: Dr. Markus Diesmann
6. Description of your current research <p>I am working on the interplay of topology, interactions and local dynamics of Networks Dynamical Systems. Especially, I am interested in understanding synchronization phenomena in natural systems, which seems promising in view of the recent theory of complex networks. My paper in preparation deals with the question of whether small world networks synchronize fastest: these small worlds interpolate between fully regular and fully random topologies and simultaneously exhibit large local clustering as well as short average path length. It has therefore been suggested that small world topology supports network synchronization. Here we study the asymptotic speed of synchronization in dependence on the degree of randomness of the network topology. We find that small worlds do indeed synchronize faster than regular networks - but still substantially slower than fully random networks that exhibit small path length along with very low clustering. These features seem to be attributable to the average path length that also decreases monotonically with increasing randomness. However, in ensembles of networks with the same average path lengths we find that small worlds even exhibit slowest synchronization, contrary to common intuition that small world topology supports the synchronization process.</p>

7. Research implementation and results under the program

Title of your research plan:

Stability of synchronized spiking in neuronal networks with recurrent excitatory and inhibitory interactions

Description of the research activities:

Patterns of precisely timed and spatially distributed spikes have been experimentally observed in different neuronal systems. These spike patterns correlate with external stimuli and are thus debated as key features of neural computation. Their dynamical origin, however, is unclear.

Mean field theory predicts statistical features of spiking activity in recurrent sparse neuronal networks with balanced excitatory and inhibitory activity. Nevertheless it does not tell under which conditions patterns of precisely timed spikes may exist in such networks. The theory of spike patterns has recently experienced substantial progress but key analytical results are still restricted to networks with only excitatory or only inhibitory interactions.

In my research at RIKEN Brain Science Institute I studied the exact spiking dynamics in networks that exhibit a mixture of excitatory and inhibitory neurons.

At first I focussed on simple synchronous and almost synchronous spike patterns with the objective to clarify the ranges of stability numerically. Therefore I had to implement the neuron model I had planned to use for my simulations - pulse-coupled Mirollo-Strogatz oscillators – into NEST. This is a simulation system for large networks of biologically realistic (spiking) neurons. It is best suited for the simulation of large networks of spiking point-neuron models. The internal dynamics of these models may be arbitrarily complex (or simple). This took longer than expected since I had to manage to get into the structure of all the different modules that contribute to the simulation as well as into the C++ programming language. Nevertheless this work was extremely fruitful for me since I had the chance to directly work together with the developers of NEST. Here besides my host researcher Markus Diesmann I especially want to thank Abigail Morrison and Susanne Kunkel who kindly delivered insight into various aspects of NEST.

In particular, this will be a starting point for further studies in my research back at home as well as for future collaboration between my Network Dynamics Group at the Max Planck Institute for Dynamics and Self-Organization, Goettingen, Germany

and the Computational Neurophysics Research Unit at RIKEN Brain Science Institute, Wako City, Japan. In addition I hope that my working group at home could also profit from my gained knowledge of the NEST software. Building on those results, I started to analytically access small networks of simple structure as well as large random networks. Therefore I had to read and understand various papers about foregone results: again I was lucky to be able to directly communicate to one of the authors of a key paper for my planned studies, special thanks to Michael Denker.

To summarize, the desired final results have not yet been completely obtained, but the basis for future successful studies in this direction has been established. In the end this will aid our understanding of spike patterns in networks with biologically relevant structure of mixed excitatory and inhibitory neurons and therefore pave the way towards revealing potential mechanisms of spike-based computations in the brain. Besides my personal studies I had the chance to participate in the weekly working group meetings and journal clubs as well as to attend the lectures of the RIKEN summer school and other symposia at BSI RIKEN.

8. Please add your comments (if any):

The stay in Japan was very intense and fruitful in all respects, but turned out to be too short to carry out all my research ideas. I was cordially received by my working group and besides scientific talks I also experienced much of Japanese life and culture and have met many interesting people.

Finally, I want to thank JSPS and my host researcher Markus Diesmann as well as my supervisor at home Marc Timme for making this wonderful and unforgettable experience possible.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Matthias Jeschke	(ID No.: SP09305)
2. Current affiliation: University of Rostock	
3. Research fields and specialties:	
Humanities	Social Sciences
Chemistry	Engineering Sciences
Agricultural Sciences	Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences	Mathematical and Physical Sciences
	Biological Sciences
	Computer Science
4. Host institution: RIKEN Advanced Sciences Institute	
5. Host researcher: Prof. Makoto Taiji, Dr. Koichi Takahashi	
6. Description of your current research	
<p>My research focuses on the efficient (spatial) simulation of biochemical systems at the micro- and mesoscopic abstraction level and is part of the interdisciplinary graduate school “dIEM oSiRiS”. The current and past work can be separated into different approaches for achieving efficient simulations:</p> <p>The implementation and evaluation of existing simulation algorithms using the simulation framework JAMES II that has been developed at the university of Rostock. The plug-in concept supported by this framework allows an easy exchange of the algorithm (or parts of it) used for a specific experiment, making it convenient to compare different algorithm implementations. First studies show the dependence of several algorithms from others, e.g. random number generators or event queue.</p> <p>The enhancement of current algorithms, e.g., to support spatial models where molecules can move by diffusion throughout the volume. Another project is aimed at a parallel implementation of an existing algorithm to utilize clusters of computational resources.</p> <p>The development of new algorithms, e.g., that combine different levels of abstraction to provide higher model details only where it is required and that use a lower resolution for the rest of the model.</p>	

7. Research implementation and results under the program

Title of your research plan:

Parallel particle simulation based on the eGFRD algorithm

Description of the research activities:

The eGFRD algorithm, an enhanced version of the GFRD method, is an asynchronous, event-driven Brownian dynamics algorithm and was developed at the RIKEN institute. It efficiently combines the propagation of particles with the reactions between them into a single step. The task at the RIKEN institute was to design and implement a parallel version of the eGFRD algorithm. For a first prototype, the model volume is partitioned into several sub-models that are independently simulated on different computational units. The difficult part arises from the movement of particles across the border of the sub-models. During the first three weeks the sequential algorithm was modified to support the exchange of messages (e.g. the position update of a particle near the border or the movement of a particle across the border separating two sub-models) and the storing of the model's state right before an event gets executed, with the last as a required part for the optimistic event scheduling method. Here each sub-model executes events and sends messages without synchronizing with other sub-models, which might result in a message that arrives in a sub-model's past, leading to a causality error. If this is the case, the sub-model has to restore a state right before this message arrives and restart the computation. The problem is that this can occur frequently, so the sub-model might process a time interval several times. The remaining time was spent with checking the prototype for errors and performing tests with increasing model sizes and a higher number of computational units (eight at the end of this project). Currently the prototype is working but it is still unoptimized, so a parallel simulation takes longer than a sequential run. As this is only a first step towards a parallel implementation, hopes are that by optimizing the code and several simulation parameters the parallel variant will eventually run faster than the sequential one when confronted with large models.

8. Please add your comments (if any):

RESEARCH REPORT

1. Name: Michael Kraus	(ID No.: SP09306)
2. Current affiliation: University of Augsburg, Germany	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba	
5. Host researcher: Dr. Tatsuo Hasegawa	
Description of the research activities: <p>Organic electronics has attracted considerable attention in recent years. Thin-film transistors based on organic semiconductors represent an important field of study in organic electronics due to their potential application in low-cost electronic devices. Possible applications are RFID-tags and devices built on flexible plastic substrates. However, fundamental understanding of charge carrier transport in organic thin-film transistors (OTFTs) is necessary, prior to the use as electronic components.</p> <p>Our group in Augsburg is working on the investigation of a variety of typical organic semiconductors including copper-phthalocyanine (CuPc) and fullerene (C₆₀). The research is mainly focused on charge carrier injection and transport in organic semiconductors as active layers of OTFTs.</p> <p>The first aim of my work was to control the charge carrier type in an OTFT with CuPc as active semiconductor layer by varying the electrode material. In this way, the work function of the electrodes can be tuned which causes the injection of holes, electrons or both charge carrier types. As demonstrated in our latest publication [A. Opitz, M. Kraus, M. Bronner, J. Wagner and W. Bruetting, <i>New Journal of Physics</i> 10 (2008) 065006] it is possible to fabricate transistors which reveal unipolar electron transport (<i>n</i>-type) with calcium or aluminum contacts, unipolar hole transport (<i>p</i>-type) with gold or silver contacts combined with the strong organic electron acceptor F₄TCNQ or transport of both carrier types (ambipolar) with pure gold or silver contacts. The resulting field-effect mobilities of holes and electrons, respectively, show an interesting behavior: they are independent of the electrode material.</p>	

7. Research implementation and results under the program

Title of your research plan:

Bipolar charge transport in copper-phthalocyanine field-effect devices

Description of the research activities:

My research activities in the course of the JSPS summer program can be separated into two parts: First I tried to optimize the surface treatment of the substrates and then I introduced a new material system as electrodes for controlled carrier injections in CuPc-based OTFTs.

The transistors consist of heavily p-doped silicon wafers acting as gate electrode with a thermally grown silicon-dioxide layer on top. An adequate surface treatment of the pristine SiO₂ surface traps is crucial for obtaining good and stable device characteristics. The surface treatment acts as a passivation layer and provides a trap-free interface for ideal charge transport. That is why the first part of my work was concentrated on finding the optimal kind of treatment. I fabricated CuPc-based OTFTs with a variety of different passivation layers. Passivation layers were spin-coated from solution of various kinds of polymers, including polymethylmethacrylate (PMMA), polystyrene (PS), or deposited out of the gas phase in a vacuum-chamber like tetratetracontane (TTC) or parylene. These materials form layers with a thickness of several tens of nanometers. Other materials only form a highly hydrophobic monolayer with a much lower thickness – e.g. hexamethyldisilazane (HMDS). Among them, we were successful to achieve stable charge carrier transport for electrons and holes with reproducible charge carrier mobilities of OTFTs based on PMMA, TTC and parylene. These passivation layers have been characterized by capacitance and atomic force microscopy (AFM) measurements. It has been found that TTC features the best transport properties, although the surface of TTC shows some columns with a height in the order of 100 nm in contrast to the much smoother surfaces of parylene or PMMA. We believe that the flat and very smooth terraces between the columns should provide the best performance of CuPc-based OTFTs. Consequently, our following devices are based on TTC.

As a next step I fabricated transistors with top-contacts of so-called organic metals. This material class consists of compounds formed by the combination of electron donor molecules such as tetraselenafulvalene (TSF), tetrathiafulvalene (TTF) and its

derivatives and electron acceptor molecules such as tetracyanoquinodimethane (TCNQ) or its fluorinated derivatives $F_n\text{TCNQ}$ with $n = 1, 2, 4$. They exhibit metal-like conductance and can be thermally evaporated. By combination of different types of donors and acceptors the Fermi level of the organic metal and thus its work function can be controlled. Transistors with TSF- $F_2\text{TCNQ}$, TTF-TCNQ, TTF-FTCNQ and TTF- $F_2\text{TCNQ}$ top contacts were successfully fabricated.

Nevertheless electron transport could not be observed although the work-function of these materials is comparable to that of gold which shows ambipolar transport. This could be explained by the fact that the work function of the organic metals is well aligned to the HOMO level of CuPc which causes good hole injection, although the large band gap of CuPc hinders electron injection. Electron injection with gold contacts might be explained by the thermal exposure of CuPc during deposition of the gold electrodes. This may cause diffusion of gold into the CuPc layer and formation of certain complex compounds where electron injection becomes possible.

As an important result, devices with TSF- $F_2\text{TCNQ}$ electrodes revealed hole mobilities that are comparable to those with Au electrodes. We found from the transfer length model (TLM) method that the contact resistance is lowest in the device with TSF- $F_2\text{TCNQ}$ electrodes. This indicates that the carrier injection into the active layer is improved by the TSF- $F_2\text{TCNQ}$ contacts. Further investigations regarding the contact resistance are still in progress.

In summary we succeeded in fabricating OTFTs with CuPc and organic metal contacts and found out that the devices with TSF- $F_2\text{TCNQ}$ contacts provide better hole injection than those with gold contacts.

8. Please add your comments (if any):

I would like to thank Dr. Hasegawa for giving me the opportunity to work in his lab, all members of Dr. Hasegawa's group for their support and the JSPS for the possibility to come to Japan.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Imke Lüders (ID No.: SP09307)
2. Current affiliation: Ph.D. student Institute of Zoo and Wildlife Research, Alfred Kowalke Straße 17, 10315 Berlin Germany
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Tokyo University of Agriculture and Technology (NOKODAI) 5. Host researcher: Prof. Kazuyoshi Taya, Prof. Gen Waranabe
6. Description of your current research Titel: Ultrasonographic and endocrinological description of the luteogenesis during the estrous cycle and the pregnancy of the Asian elephant Elephants have the longest estrous cycle of all mammals studied to date lasting 3-4 months. Furthermore their pregnancy is the longest in the animal kingdom with 22 months. During the last 20 years conservation efforts for this endangered species increased, nevertheless many questions concerning their reproductive physiology remained unanswered. With my Ph.D. thesis I aim to describe the ovarian events during the cycle and pregnancy of the elephant. Therefore, 8 Asian elephants were ultrasounded in a Safaripark in Canada on a regular base. At the same time blood was taken to analyse for hormone secretion. On the ovaries the functional structures were observed three times a week and measured. Follicular growth and the first signs of luteinization (transformation of granulosa cells around the follicle into luteal cells) were detected. The dataset of ultrasound visualizations were correlated to progesterone (pregnancy maintaining hormone) and will be connected to other reproductive associated hormones, which we aimed to measure in Japan..
7. Research implementation and results under the program Title of your research plan: The role of Inhibin and prolactin during the estrous cycle and the pregnancy of the Asian elephant.

Description of the research activities:

About 1500 serum samples from 8 Asian elephants were taken to Japan for analysis in the lab at the NOKODAI.

I measured two hormones: Inhibin and Prolactin

Therefore Radioimmunoassays (RIA) were used. Each time about 250 samples could be analyzed. The assay ran each time for 4 consecutive days with the great help of two other Japanese Ph.D. students, before getting results. After pipetting the samples the first day, the three next days the 1. and 2. Antibodies were added.

After measuring all samples of pregnant and cycling elephants, the hormone concentration of prolactin and inhibin was related to the ultrasound data which were already retrieved earlier.

The results strongly suggest that inhibin is secreted by early luteal cells of luteinizing follicles. Because the first appearance of luteinization in the ultrasound was connected to the rise in inhibin concentration (see graph 1 showing one cycle as example)

Prolactin levels did highly increase during pregnancy (graph 2), but very low and fluctuating during the cycle.

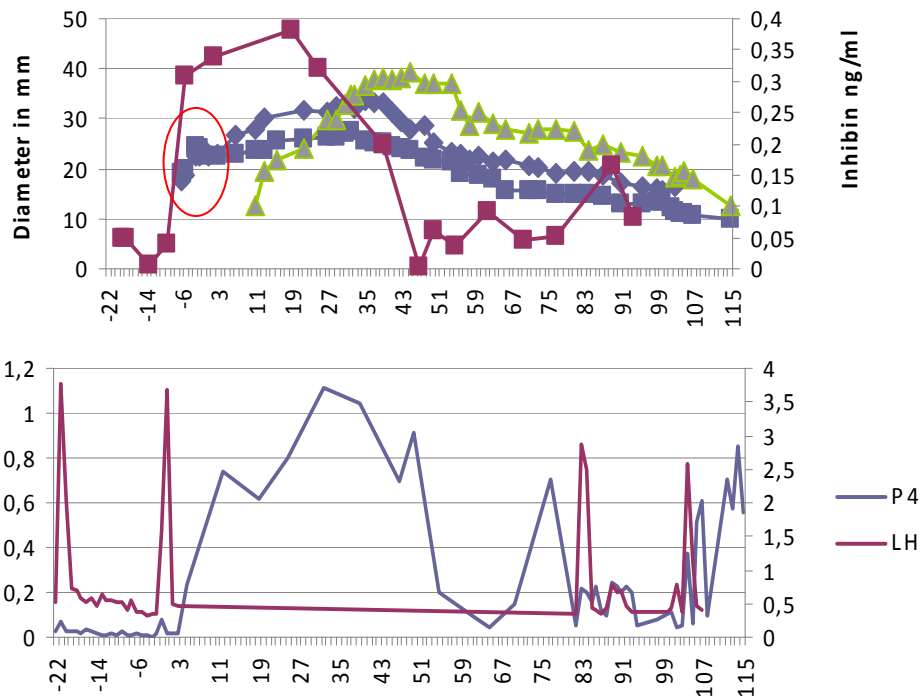
The method of combining the hormone measurement with ultrasound of the ovaries gives new insights of the reproductive physiology of the female elephant and has never been done before in this manner.

Beside the lab work, I was invited to give seminars at different zoos in Japan.

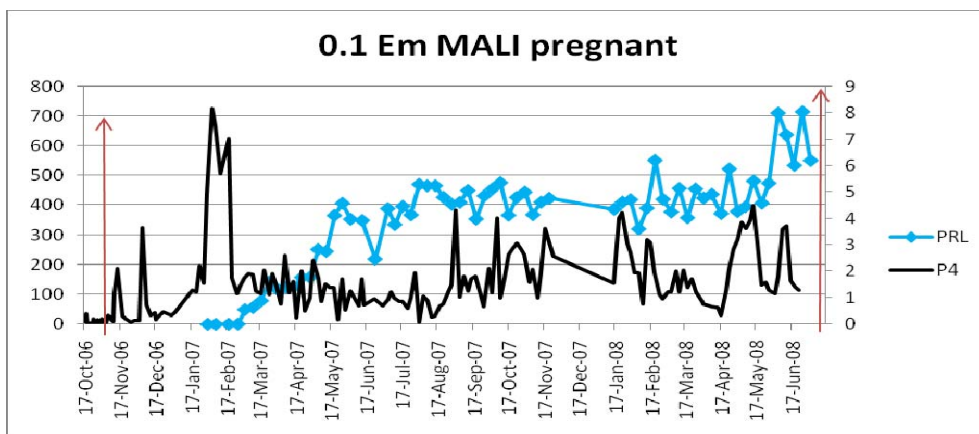
I went to Gunma Safari Park, the Tokyo Ueno and Tama zoo as well as the Kyoto zoo and Kamagawa Seaworld.

I gave talks on elephant reproduction and the zoo staff and veterinarians were very interested. We had long discussions and I was really overwhelmed how great I was welcomed in all the different zoological institutions. Japanese zoos are very interested in elephant reproduction since the captive population is very small. Improvement of breeding is very much needed and therefore we had a good exchange of ideas.

Picolo cycle 1 acCL1 acCL2 ov CL Inhibin
CL growth, Inhibin, P4 and LH in relationship



Graph1 showing: 1. Corpus luteum growth (blue and green) and the inhibin measurement (purple squares) and 2. Progesterone (P4) and Luteinizing hormone (LH) secretion during one cycle. Inhibin secretion starts with luteinisation.



Graph 2. Prolactin increase (blue) during the pregnancy (progesterone in black) in 1 Asian elephant female

8. Please add your comments (if any):

This research stay was incredible! I am very pleased with the results. Also the experience at the university with the great exchange of ideas between students really was amazing.

I would like to thank JSPS for the support. I hope to come back for more projects!

RESEARCH REPORT

1. Name: Gesche Nahrwold	(ID No.: SP09308)
2. Current affiliation: Institut für Angewandte Physik, Universität Hamburg	
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Institute for Chemical Research, Kyoto University	
5. Host researcher: Professor Teruo Ono	
6. Description of your current research: <p>The motion of magnetic micro- and nanostructures is one of the recent main topics in the development of new storage devices (S. S. P. Parkin, M. Hayashi, and L. Thomas, <i>Science</i> 320, 190 (2008)). My current research is called “Sputter Deposition of Permalloy Nanostructures Optimizezed for Radio-Frequency Experiments”. Experiments where magnetic domain-walls are moved by a current pulse out of the bend of a curved Permalloy wire of 200 nm width were successfully carried out. The samples used for these experiments were fabricated in a two-step electron-beam lithography process with evaporated Permalloy. Sputter deposition of Permalloy films on heated substrates was intensively studied and showed very promising results in terms of specific electric resistance which is very important for the experiments described above in order to reduce Joule heating and to decrease magnetic depinning fields (G. Nahrwold, L. Bocklage, T. Matsuyama, B. Krüger, J. M. Scholtyssek, U. Merkt, and G. Meier, <i>J. Appl. Phys.</i> 105, 07D511 (2009)). Furthermore none of the other crucial exigencies of Permalloy were found to be adversely affected by sputtering the material onto heated substrates.</p> <p>However, the fabrication of samples for succesful domain-wall depinning experiments from Permalloy sputtered on heated substrates is not straight forward. The regular lift-off techniques are no longer possible because resists that were heated to temperatures above 150 °C suffer structural changes and will thus stick very strongly to the surface. Furthermore sputtering is in general not the best choice for the deposition of nanostructures because the anisotropic direction of the deposition may alter the shape of these in an uncontrollable way. For this reason a new, substructive way of fabriacting</p>	

samples for radio-frequency experiments is needed.

7. Research implementation and results under the program

Title of your research plan: Fabrication of Curved Permalloy Nanowires by Subtractive Ion-Milling

Description of the research activities:

Permalloy films sputtered on heated substrates were brought from Hamburg in order to fabricate curved Permalloy nanowires in a subtractive way in the laboratories of Professor T. Ono. Together with Professor Ono and Kondou Kouta we first discussed that the fabrication of the samples from the Permalloy film should be a three-step electron-beam lithography process. In the first step marks are defined and then deposited by sputtering 5nm titanium as an adhesive layer followed by 100 nm of gold. In the second negative-resist step the sample is then aligned with the help of the marks from the first step and the curved wire is defined. By ion-milling the sample all Permalloy on the substrate that is not covered with resist is then removed and so the wire is formed. In the third step the electrodes are defined and then sputter deposited of again 5 nm titanium and 100 nm of gold. The sample fabrication was assisted by Kondou Kouta and Gen Yamada. During the fabrication we had to face some problems. First the samples I brought from Hamburg had a size of 0.7 cm x 0.7 cm but the electron-beam-lithography system in Professor Ono's lab is built for samples of the size of 1 cm x 1 cm. This makes the mark detection in the system very difficult and leaves only a very small regime on the sample that can be processed. We also had to determine the rate of ion-milling for Permalloy and to find the accurate dose for the e-beam-lithography exposure. Finally we had problems with the lift-off of negative resist after the ion-milling which led to broken electrodes. Nevertheless we were able to fix all these problems and finally able to fabricate 12 samples, each consisting of four curved Permalloy wires with electrodes. I will take these samples back to Hamburg to perform measurements on domain-wall depinning there. I am very hopeful that these samples will lead to very interesting results for my work.

8. Please add your comments (if any):

I am very impressed and thankful for the invaluable help and time that Kondou Kouta and Gen Yamada offered me. I would have not been able to finish the samples without their effort. I am also very thankful that Professor Ono gave me the chance to work in this environment and to use the facilities in his laboratory.

9. Advisor's remarks (if any):

Gesche Nahrwold is an excellent student not only in science but also in humanity. Gesche's amusing personality brightened up my laboratory, leading to the success of the fabrication of samples. I am very happy to have a chance of collaboration with such an excellent student, and hope she will have nice results for the samples she prepared with my students.

RESEARCH REPORT

1. Name: SANFTL, Florian	(ID No.: SP09309)
2. Current affiliation: University of Regensburg / DESY Hamburg	
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Tokyo Institute of Technology, Ookayama Campus	
5. Host researcher: Prof. Toshi-Aki Shibata	
6. Description of your current research <p>Currently I am working on my final diploma thesis which is dealing with several phenomena in Quantum Chromodynamics (QCD). QCD is the theory of the strong force describing the interaction of quarks and gluons in hadrons, e.g. the proton or neutron. The thesis is thematically divided into two parts.</p> <p>In the first part I am measuring single-spin asymmetries (SSAs) at the HERMES experiment at the DESY accelerator facility in Hamburg. The deep inelastic scattering experiment HERMES (“HERa MEasurement of Spin”) used the spin-polarized lepton beam provided by the HERA storage ring (German: “Hadron-Elektron-RingAnlage”). HERMES was a forward spectrometer that was especially designed to study the spin structure of nucleons. For this purpose the electrons were scattered at energies of 27.5 GeV at an internal gas target (hydrogen and deuterium). In the years from 1995 to 2001 the target was longitudinally polarized to the lepton beam, in the years from 2002 to 2005 it was operated in the transverse polarization mode. In the latter a lot of effort was made to extract the transversity distribution function which could however not be achieved up to date. The reason is its chiral-odd nature which requires the combination with another chiral-odd object in helicity conserving processes. One possibility to access transversity is the semi-inclusive deep-inelastic scattering process in which the distribution functions are combined with fragmentation functions. The combination of the transversity distribution function and the Collins fragmentation function causes a left-right asymmetry in the cross-section for a transversely polarized nucleon. Another mechanism causing a left-right asymmetry leads back to the so-called Sivers distribution function. This function is describing the correlation of the transverse momenta of the quarks with the transverse spin of the nucleon. The investigation of the Sivers function is motivated by the requirement of non-zero angular momentum of the quarks for the existence of this</p>	

distribution.

In my diploma thesis I am investigating the SSA A_{UT} in inclusive measurements of charged mesons (especially kaons and pions) which were produced in quasi-real photo-production events on a transversely polarized target, i.e. with a squared transferred momentum of $Q^2 < 1 \text{ GeV}^2$. Predictions based on perturbative QCD do not predict any significant asymmetries in this low energetic kinematic region. During my thesis I am trying to extract a reliable physical signal of the measured asymmetry. This means to remove or to minimize detector and background effects, which dilute the signal of any measured observable in the detector. A non-zero asymmetry would predict higher order QCD effects.

In the second part of my diploma thesis I am performing non-perturbative lattice QCD calculations which are dedicated to the internal structure of the lightest baryon containing a strange quark, namely the Λ^0 -Baryon. This particle is of major importance as it can serve as an intermediary of the spin polarization of the proton. Due to its parity violating weak decay into a positive charged pion and a proton, the polarization is easily accessible via the asymmetric decay distribution of the secondary particles. So far Λ^0 polarizations have been determined in different experiments, like at the Z^0 pole in e^+e^- -annihilation, in deep-inelastic scattering of polarized leptons and unpolarized protons and also in charged-current neutrino-nucleon interactions. A completely unsettled puzzle is the very strong polarization in unpolarized $p+N$ reactions. The knowledge of the internal spin structure is certainly a necessary ingredient for any explanation. Furthermore the comparison between the proton and the Λ^0 allows for a test of the relevant SU(3) flavor-symmetry breaking effects.

So far, unfortunately only model-based approaches to the description of the spin structure exist. My calculation uses a non-perturbative approach for the calculation of the internal spin structure of the Λ^0 , namely lattice QCD (LQCD). LQCD is nothing else than pure QCD but formulated on a discrete Euclidean (in contrast to Minkowskian in pure QCD) space time grid with lattice spacing a . The discretization serves naturally as an ultraviolet regulator which thus prohibits infinities in the calculation of physical observables. In addition renormalized physical quantities have a well behaved continuum limit, i.e. $\bar{a} \rightarrow 0$. The transcription of QCD onto a space-time lattice allows the simulation of LQCD on the computer using methods analogous to those used for Statistical Mechanics systems.

My simulations are performed at the John von Neumann-Institute for Computing (NIC) located at DESY in Zeuthen/Berlin. In my simulation so called dynamical $n_f=2+1$ gauge configurations are used for the calculation of the various expectation values. This means that the simulation accounts for QCD vacuum polarizations including up, down and strange quarks.

7. Research implementation and results under the program

Title of your research plan:

Monte-Carlos Simulations on inclusive Hadron Production in Deep Inelastic Scattering on a transversely polarized target and flavor asymmetry of the nucleon sea

Description of the research activities:

During my stay at Tokyo Institute of Technology I was dealing with two projects. In the first one, I was investigating some candidate models for Single Spin Asymmetries in inclusive hadron production. During summer 2009 some progress on the theoretical description of these processes was made by a theoretical group in Turin/Italy. It could be started to implement these results in the Monte-Carlo-Code of the HERMES Experiment at DESY/Hamburg.

The second project was dealing with theoretical aspects of the flavor asymmetry in the nucleon sea. In an upcoming experiment at the Fermilab National Laboratory at Chicago/USA, a more sophisticated measurement of the ratio up anti-up and anti-down quarks will be performed from Mid 2010. But so far, there only exist a few models which are candidates to explain the mechanisms to explain such a flavor asymmetry in the nucleon. We were dealing with the evaluation of these models for the upcoming experiment E906 in Chicago.

8. Please add your comments (if any):

RESEARCH REPORT

1. Name: Sarah M. SCHLACHETZKI (ID No.: SP09310)
2. Current affiliation: Institute for Art History, University of Zurich, Switzerland
3. Research fields and specialties: <input checked="" type="checkbox"/> Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Department of Evolutionary Studies of Biosystems, Sokendai (The Graduate University for Advanced Studies), Hayama
5. Host researcher: Dr. Kenji ITO
6. Description of your current research <p>My research project focuses on new media art and its implications in science and technology. An initial interest was ignited by the striking boom of residency programs all over the world, enabling artists to visit laboratories, cooperate with scientists, and develop art works at the borderline between art and science. My research is principally focused on discourse analysis of this kind of electronic art. Methodically, my thesis shall comprise several case studies of artists and artistic cooperations with scientists at the outcome of which stand artworks that are embedded in the art/science field. Fundamental literature in science studies, sociology and the popularization of knowledge serves as a theoretical background.</p> <p>For several case studies, I have been zooming in on the so-called ‘nano art’ – artworks that are concerned with the representation of phenomena at the nano-scale. Examples are Ken Goldberg, pioneer in microelectronic art, currently at Berkeley University, the media artist Victoria Vesna cooperating with nanoscientist James Gimzewski, both at UCLA, or Christa Sommerer and Laurent Mignonneau, formerly Institute of Advanced Media Arts and Sciences, Gifu, Japan, now Linz, Austria.</p>  <p>Fig.1) ‘Nanoart’ by Victoria Vesna & James Gimzewski, UCLA Art/Sci Center: <i>Zero@wavefunction</i>, interactive installation.</p> <p>At this stage of my PhD research, I understand this focus on science popularization</p>

through art as one way of reflecting the media arts' role in contemporary society and their link to science and technology. It is evident that new media art is a field in which science, technology and artistic approaches come close. The enormous interest in its promotion from the media art scene (centers like ars electronica in Linz, Austria or the ZKM in Karlsruhe, Germany), the academy (Zurich University of the Arts with their Swiss artists_in_labs program; or SymbioticA at the University of Western Australia), and the industry (Bell Labs and their artists program, USA; or NTT InterCommunication Center, Tokyo, Japan) attests to the media arts' importance in the current setting of our 'information societies'.

7. Research implementation and results under the program

Title of your research plan:

New Media Art in Japan – Art between the Lab and the Gallery

Description of the research activities:

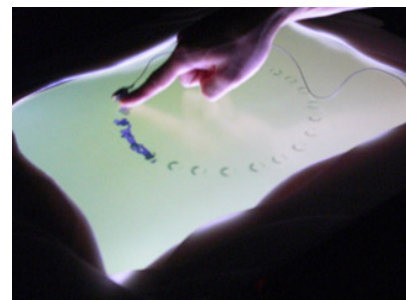
During my stay in Japan, I gathered data in form of mostly informal, qualitative interviews with members of the media art scene, i.e. artists, curators, professors, festival organizers etc. Another part of my research consisted in having access to published material on the media arts in Japan, which meant visiting archives and libraries, file through the relevant material and enter it into a publication database.

The interviews served to obtain a better understanding of the new media art scene in Japan, specifically with a focus of my research interest in media art's interface with science and technology. My initial plan to find out more about artistic projects in Japan which were proof of the artist's deeper interest in scientific concepts (such as I had been analyzing in my research so far) had to be altered due to very scarce amount of such artworks. Instead and not less interestingly, it turned out that the media art scene's implication in technological matters was much more striking and that the funding situation and breeding grounds for media artistic projects seem to be quite unique in Japan. I subsequently gathered more and more information about the institutional set up and promotion of the media arts in Tokyo.

Fig. 2) Between technological research and art festivals:

Junji Watanabe et al.: *Touch the Invisibles*, 2008

Due to the amount of material obtained through interviews and reading, results at this point can be only preliminary and have to be given more reflection. It can be stated, however, that there are two particularities to the current media art scene in Japan. The first one, the



unique funding situation through industry (former Canon Inc. ARTLAB, NTT InterCommunication Center, former L'ORÉAL Art & Science of Color Prize) and engineering departments of universities is interrelated with the second one: the currently booming promotion of something labeled 'Device Art' as a specificity to Japanese media art.



Fig. 3) 'Device Art': *Bitman* by Ryotu Kuwakubo

Both aspects touch upon the historical status of 'art' in Japan ('art' and 'fine arts' being a Western conception introduced in Japan only in the late 19th century) and the notions that go along with that until today. Also, Japan's postwar history of rapid technological advancement and its gadget industry today are of far-reaching importance in this context yet to be evaluated. The promotion of media art in Japan is thus related to the promotion of technological progress and innovation on the one hand, and to Japan's 'contents industry' and the conception of media art as a cultural export on the other hand.

During my JSPS research stay in Japan, I was happy to be granted the opportunity to establish contact with several scholars in the field of media art, in academia (art and engineering departments) as well as in the art context (curators, artists and festival organizers) and am thankful for the many fruitful interviews and insights provided. The research stay allowed me to obtain yet another perspective on media art in the broader societal context and its link to technology and scientific progress. Next to the 'micro study' of individual media art projects at the borderline to science, this stance might allow some extrapolation on the media arts' significance in other societal settings and their function in and beyond the art field.

8. Please add your comments (if any):

I am truly thankful for this unique opportunity provided by the Japan Society for the Promotion of Science to stay in Japan and be able to foster my PhD research. I owe many thanks to my host researcher, Dr. Kenji Ito, who kindly accepted me as a research fellow and with whom I enjoyed many a fruitful discussion, in which I benefited from his knowledge. I was also kindly welcomed by my host institution Soken-dai in Hayama and I want to thank every one involved in rendering my stay in Japan a very instructive and unforgettable experience.

RESEARCH REPORT

1. Name: Daniel Schuetze	(ID No.: SP09311)
2. Current affiliation: Starting PhD in October 2009 at the University of Bonn	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: National Institute for Materials Science, Tsukuba	
5. Host researcher: Dr. Kitamura, Dr. Hatano	
6. Description of your current research <p>During my diploma thesis at the Heinrich Hertz Stiftungslehrstuhl of the Deutsche Telekomstiftung at the University of Bonn, I was working with lithium niobate nanoparticles in the group of Prof. Dr. Buse. Lithium niobate has a large scope of electrical and optical properties resulting from the crystal structure making it very feasible for various applications. The goal of my diploma thesis was to create and investigate new hybrid materials containing lithium niobate nanoparticles for future applications in optical devices. During my PhD starting in October 2009, this work will be continued.</p>	

7. Research implementation and results under the program

Title of your research plan:

Light-induced pyroelectric effect in iron-doped lithium niobate

Description of the research activities:

Lithium niobate is a ferroelectric material. It exhibits spontaneous polarization along its z-axis. This results from charge displacement within the crystal which is due to the crystal structure.

The spontaneous polarization leads to an electric polarity of the +z- and -z-faces of the crystal. This polarity is compensated by ambient charges collecting on the crystal surface. If the temperature of the crystal is changed, the spontaneous polarization changes leaving an excess of compensation charges on the crystal surface. If the +z- and the -z-face of the crystal are electrically connected, this results in a current called pyroelectric current.

Pyroelectric devices are well-known from everyday life: they are used as motion detectors. Since the pyroelectric effect is very strong, the heat radiation emitted by a human body is sufficient to produce an observable signal.

During my research in Japan, we were interested in inducing the pyroelectric effect in iron-doped lithium niobate optically using a frequency-doubled Nd:YAG pulse laser with pulse duration of about 10 nanoseconds (1 nanosecond = 10^{-9} seconds). The heating takes place by optical excitation of electrons from iron-sites to the conductive band and then energy transfer from the excited electrons to the lattice.

A major challenge was to design a setup with which it was possible to measure the pyroelectric signal since it was very small and of very short duration. After accomplishing this, we were able to calculate the absorption coefficient of the iron-doped lithium niobate sample we used from the measured pyrocurrent. Transmission spectra of the same sample confirmed that both our measurements and the assumed theory were reliable.

It is quite unique to induce pyroelectric currents with laser pulses of such a short duration. So it was an important issue to observe and understand differences compared to long-pulse experiments. Usually, the pyroelectric signal should be symmetric: heating leads to a positive current, and when the heating stops, cooling takes place leading to a negative current. Yet the signal we observed was highly asymmetric: we found a high current upon heating, while the cooling current was almost not observable. This can be explained by the fact, that the value of the current is not determined by the total temperature by which the crystal is heated or cooled (which is the same for heating and cooling), but by the temperature gradient, which is the temperature change divided by the time in which it takes place. In our experiment, the heating current is so much larger than the cooling current, because

heating is induced by optical excitation and takes place in about 10 nanoseconds during the duration of the laser pulse. Cooling however is done by heat transfer through the crystal which is a totally different mechanism with much longer timescale. From our measurements, we estimate the cooling time to be 300 nanoseconds. So the cooling current must be about 30 times smaller than the heating current, which agrees well with our experiments.

The mechanism of how the optical energy is converted into lattice vibration and thus changes the spontaneous polarization is not known exactly. Thus short-pulse induced pyroelectric measurements offer the opportunity to investigate this phenomenon by providing a time-resolved image of the effect.

8. Please add your comments (if any):

The work with Kitamura-sensei and Hatano-sensei was very fruitful and enjoyable. I was able to gain a great scope of experimental experience, obtain scientifically valuable results and work with fascinating and friendly people. I would like to use this opportunity to thank Kitamura-sensei and Hatano-sensei for hosting me and for the great efforts they have made to help and assist me and to make my experience in Japan unique and rememberable.

9. Advisor's remarks (if any):

The work with Daniel was very enjoyable and fruitful for us as well. He showed interest in the research theme and related subjects. He pursued his job actively and succeeded in observing very short period pyroelectric current by pulse-laser excitation. This result connects to new scientific interest and opens capability to new application fields of the pyroelectric effect. We hope his JSPS experience in Tsukuba will assist his near future PhD course research activity starting from October at Bonn University.

Dr. Hatano

RESEARCH REPORT

1. Name: Fabian Wenzlau	(ID No.: SP09312)	
2. Current affiliation: Universität Karlsruhe (TH)		
3. Research fields and specialties:		
Humanities	Social Sciences	Mathematical and
Physical Sciences		
Chemistry Sciences	Engineering Sciences	Biological
Agricultural Sciences	Medical, Dental and Pharmaceutical Sciences	
Interdisciplinary and Frontier Sciences		
4. Host institution: National Institute of Advanced Industrial Science and Technology		
5. Host researcher: Dr Yasuto Kuwahara		
6. Description of your current research		
<p>Seismic waves are routinely used in applied geophysics for the determination of subsurface structures and they are of uppermost importance for characterising hydrocarbon reservoirs. For this purpose, the interpretation of wave traveltimes and seismic attenuation requires a good understanding of the interplay between wave motion and petrophysical rock properties, such as rock compliance, grain density, fluid saturation, porosity or permeability. The aim of <i>rock physics</i> research is to establish links between waves and rock properties, using theoretical estimates, laboratory experiments and numerical modelling tools.</p> <p>In particular, the theory of dynamic poroelasticity provides a framework for the quantitative description of wavefields in porous reservoir rocks. Based on Biot's theory, the dispersion and attenuation behaviour of fluid-saturated rocks are derived by solving a set of coupled wave equations.</p> <p>The main achievement of the thesis is the development and implementation of a new velocity-stress finite-difference (FD) scheme for simulating wave propagation in heterogeneous, poroelastic structures. It solves Biot's equations of poroelasticity for a wide range of frequencies. An accuracy analysis reveals that in order to obtain accurate results, small-scale diffusion processes must be resolved simultaneously with the propagating wavemodes, which is particularly challenging at low frequencies.</p> <p>By finite-difference modelling of the dynamic Biot equations contributes essentially to investigating the combined effects of macroscopic wave scattering and coupled fluid flow within heterogeneous reservoir rocks. This is particularly important at sonic frequencies used in acoustic borehole measurements and at ultrasonic frequencies such as applied for laboratory experiments. A velocity-saturation relation measured in the laboratory has been simulated successfully, which contributes to the interpretation of the data.</p>		

7. Research implementation and results under the program

Title of your research plan:

Characterisation of permeable fracture zones using tube wave analysis

Description of the research activities:

The purpose of this research project was to develop a computer simulation tool for the calculation of poroelastic wavefields in the vicinity of vertical boreholes. The two classes of wave types are body waves that propagate in three dimensions within the subsurface rock formation and tube waves that are confined around the borehole axis and propagate in one dimension, i.e. up- and downward. All wave types can be calculated as solutions of the coupled poroelastic wave equations using a numerical finite-difference scheme.

For this purpose, the existing finite-difference scheme I developed within the project "Seismics of porous media" in Germany has now been extended. Symmetry conditions at the left model edge are implemented to ensure that horizontal displacements and gradient of all field variables vanish at the borehole axis. Then, the poroelastic field equations are rewritten in cylindrical coordinates. Equivalently to the elastic case, additional terms arise formally in the field equations that are inverse proportional to the distance from the borehole axis. These terms reflect the dependence of the strain in tangential direction on the radial displacement field. In addition to that, a coupling exists between the stress component in tangential direction and the radial component of the momentum equation. This coupling does not exist in the case of plane strain conditions.

As an example, Figure 1 shows the fluid pressure fields at three different times (375, 875, 1375 microseconds) that are calculated for a borehole with a diameter of 10cm surrounded by a sandstone formation. The borehole axis is on the left and the dashed line shows the borehole radius. A pressure source with 5 kHz center frequency is used to excite a tube wave, and the simulation results also show a body wave that is radiated from the source. The tube wave propagates in downward direction and shows strong velocity dispersion.

The new simulation tool can now be applied for investigating the effects of wavemode conversion between body waves and tube waves near active fault zones as well as for the attenuation of tube waves in the presence of permeable fractures. First test simulations have shown that the accurate calculation of body waves in the seismic frequency range is computationally very expensive, and special care has to be taken to reduce the effects of the upper and right boundaries on the simulation results. By using the technique of parallel computation on a computer cluster, the simulation times can be reduced significantly. However, at the moment, it seems more feasible to concentrate further investigations on frequencies about 1kHz that are less expensive in terms of computation time. The simulation tool is useful for analysing the attenuation of tube waves at sonic logging frequencies in the presence of permeable fracture zones.

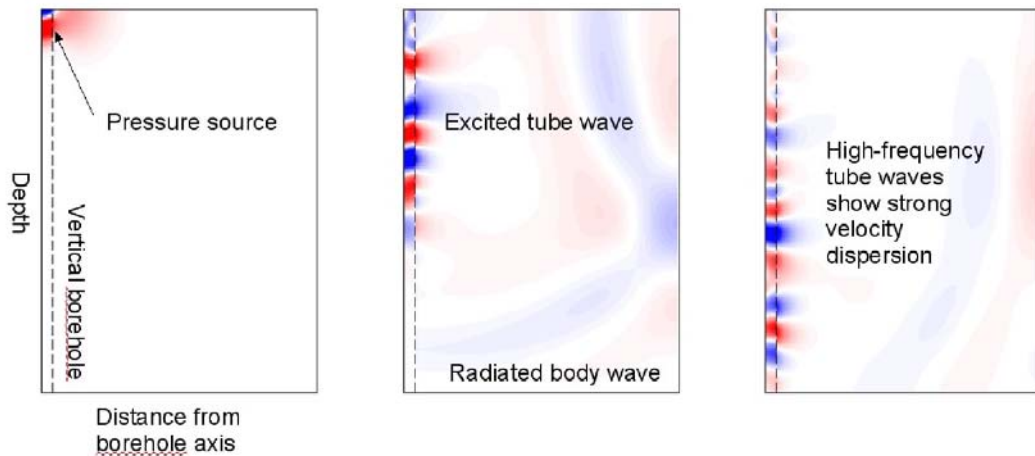


Figure 1: Computer simulation of a tube wave that is excited by a pressure source inside a borehole (diameter 10 cm) surrounded by a sandstone formation. The subplots show wavefield snapshots at 375, 875 and 1375 microseconds.

8. Additional comment regarding the Shizuoka earthquake

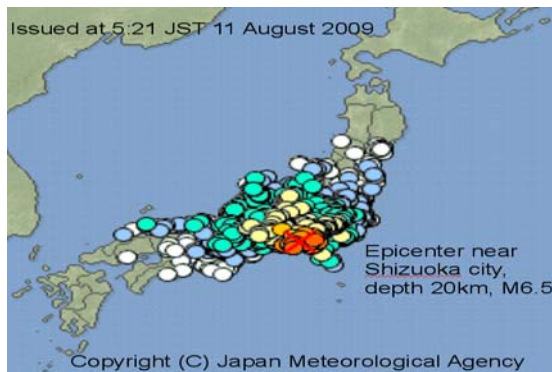


Figure 2: Seismic intensity of the Shizuoka earthquake between 1 (white) and 6- (dark orange).

Many JSPS fellows in Central Japan may have felt the earthquake that occurred on August 11 in the Shizuoka Prefecture. With magnitude 6.5 it was a major seismic event that left one person dead and 120 injured according to AFP. After a landslide, it took four days to repair the Tomei highway between Tokyo and Osaka, resulting in traffic jams during the Obon season.

In the same area, the Tokai region, Japanese researchers expect a very large earthquake (>M7.5) in the near future that may cause large damage to urban agglomerations such as Osaka and Nagoya. Therefore, every seismic activity in the region is carefully analysed immediately in order to reevaluate the earthquake risk and, if possible, to predict the occurrence of an extreme event.

9. Advisor's remarks:

I realize that Dr Wenzlau has enough basic scholastic abilities to extend his research fields. He also shows his cross-culturally competence in living in Tsukuba town. I believe he could make many Japanese friends. Our research topic in Tsukuba still needs more time to wrap up, although some important parts of our scheduled plans are accomplished. I would like to have future chances to work with him.

RESEARCH REPORT

1. Name: Simon Zeidler (ID No.: SP09313)
2. Current affiliation: Astrophysical Institute and University Observatory Jena
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Department of Earth and Space Science, Graduate School of Science, Osaka University
5. Host researcher: Prof. Akira Tsuchiyama
6. Description of your current research <p>In my current research I investigate the effects which appear in heated solids with an unordered inner structure (so called amorphous materials). It is well known that amorphous materials become crystalline after heating but still it is unclear how the inner composition influences the crystallization and the kind of materials that develop. Our aim in the current research was it, to search for differences in the crystallization process of two materials with the same chemical composition ($Mg_{0.8}Fe_{0.2}SiO_3$) but different production ways, a glassy material and a material made by the sol/gel method, and also to know more about the general crystallization of iron containing silicates with SiO_3 composition, which is important as a candidate material of cosmic dust.</p> <p>In the last years, those kind of crystallization studies have been performed intensively by the department of Earth and Space Science of the Osaka University. Especially the group around Profs. A. Tsuchiyama and C. Koike were very successful in investigating the basic processes of the crystallization of Sol/Gel-materials by thermal annealing. Many new results have already been published. The time evolution of the degree of crystallization of the used samples could be estimated and compared with theoretical approaches. Besides, it became clear that the annealing temperature has an important influence on the crystallization process; an amorphous starting material becomes more crystallized with higher temperature applied for the same time.</p> <p>In general it is of great importance for astrophysics to know more about the chemical and physical development of amorphous materials, since most of the solid material in space is non crystalline and these materials are supposed to be precursor material for planetary systems and almost all crystalline matter which develop in circumstellar dust disks.</p>

7. Research implementation and results under the program

Title of your research plan: Crystallization Effects in Circumstellar Dust Grains

Description of the research activities:

As mentioned above, we have used two different amorphous materials with the same composition ($Mg_{0.8}Fe_{0.2}SiO_3$) for our investigations. One, already produced at my home institute in Germany, was made via melting a powder in a high temperature furnace and quenching the melt after that by rotating copper rollers. This material can be called a glassy material. The other material was produced during the first two weeks of my stay in the host institute in Osaka.

The production process used for the material made in Osaka differs from the glassy one. We used the so called Sol/Gel method for making the second amorphous sample where we started with a solution of magnesium, iron and silicon together with ethanol and HNO_3 . After putting ammonium nitride in the solution the gelling process starts. Now the whole time the solution has to be kept in motion by a magnetic stirrer. The gelling process is finished after the whole solution became a brownish gel, which was the case after approximately three days. Since the gel was still wet from the ethanol and the water in the solution, it needed to be dried in special vacuum drier, which has taken another day. For finishing the production process, the dried gel, which has become now a porous solid, has still to be annealed to remove organic remains and rests of water. To do that, the material had to be heated up to $400^\circ C$ for 10h. After that, the brownish gel changed its color to a dark grey.

Both, the glassy and the Sol/Gel sample, had to be grinded to sizes smaller than $10-20\mu m$. Since we are using infrared spectroscopy in wavelength ranges from $10-200\mu m$ for the characterizing, this is necessary to prevent scattering effects in the resulting spectra.

After all these processes the materials were prepared for the crystallization experiments. To perform the experiments we used an electrical furnace with a vertical tube as entrance for the samples. As envelopes we took platinum foils, bended to small cases, in which approximately 10mg sample mass has put in each. Since our materials contain Iron in form of Fe(II)-Ions, we had to take care, that no reaction with the oxygen in the air to Fe(III)-Ions appear during the heating. To do that, we produced a special atmosphere of H_2 and CO_2 which took the place of oxygen and prevented an oxidation of our samples in the furnace. A list of all performed experiments in dependence of temperature and duration can be seen in the table below.

	10min	12min	15min	20min	1h	2h	24h
$650^\circ C$	X			X	XO		
$750^\circ C$	O		O				
$780^\circ C$	XO	X	X	X	X		
$800^\circ C$	XO				XO	XO	XO

X – glass O – Sol/Gel

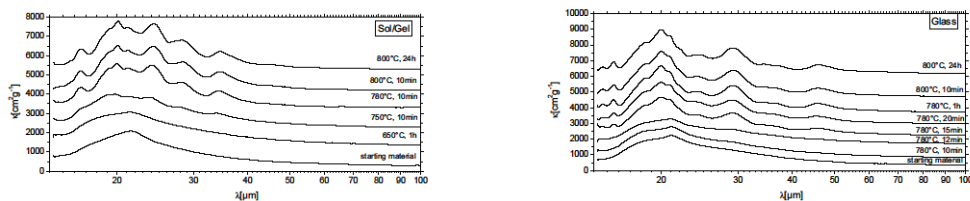
After the experiments were done, the samples had to be analyzed. First, X-ray diffraction (XRD) measurements, for characterizing the principle composition and structure, and after that infrared (IR) absorption spectroscopy in the wavelength range of $14-200\mu m$ have been performed. For the IR spectroscopy, we embedded the samples in molten polyethylene (PE) and pressed the mixture to pellets with

approximately 2cm diameter and 1mm thickness. This is necessary, since the sample particles must not influence each other and have to be separated. PE is predestinated for measurements in mid IR to far IR wavelength range, because it shows almost no absorption behavior in that region.

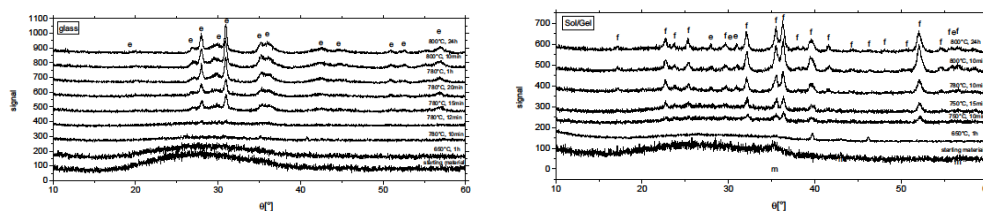
We could confirm that there are differences in the crystallization behavior of glass and sol/gel materials with iron content. While glass becomes a crystal with the same chemical composition as the precursor material (Pyroxene), the sol/gel sample gets a different structure and crystallizes as a mixture of a small amount of Pyroxene and big amount of a crystal with another chemical composition (Olivine) as the precursor material. This is a very interesting and also important result for astrophysics, since until now it was suggested that glass and sol/gel materials of the same composition become also the same crystal after heating. Of course this needs to be confirmed by other experiments but it seems that the knowledge for the development of crystalline matter in space has been increased due to the results.

The sol/gel sample also starts its crystallization earlier than the glass, which can be affiliated to a stronger nucleation rate due to the production process. Pictures of the materials, taken with an electron microscope, have also shown that the sol/gel grains have a much more porous structure than the glass, which could be a cause for the earlier crystallization, too, since this decreases the density.

A comparison of the IR-spectra and the XRD analyses can be seen in the pictures below.



1 IR-spectra of the measured samples in dependence of the temperature and the duration of the crystallization experiments



2 XRD results of the measured samples. The letters e and f stay for typical positions of special kinds of Pyroxenes (Enstatite - e) and Olivine (Forsterite - f).

8. Please add your comments (if any):

Although we made the materials very carefully, we cannot be completely sure that they suffice the wanted composition accurate, of course. But unfortunately, for the necessary measurements, to clear that issue, was no time left.

9. Advisor's remarks (if any):

Two months were very short, but he got enough spectroscopic data set. These experiment data are very fundamental and important to discuss the crystallization mechanism of cosmic dust in circumstellar environment.

RESEARCH REPORT

1. Name: Julia Janzen	(ID No.: SP09314)
2. Current affiliation: Helmholtz Center Munich, Germany	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: University of Kyoto, Department of Molecular Medicine	
5. Host researcher: Professor Shigekazu NAGATA	
6. Description of your current research <p>During infection, in vertebrate organisms antibodies provided by adaptive immune system build a very sufficient shield against viruses and pathogens. A bone marrow derived type of leucocytes called B cells is designed for generation of vast amounts of highly specific antibodies, once an immune response is required. This mechanism, on the one hand indispensable for the survival, puts the organism on risk on the other hand since the affinity maturation process that makes the antibodies specific for the given pathogen requires mutagenesis of the host's DNA. Even though we developed several protection mechanisms during evolution to keep our DNA undamaged deregulation of the pathway of antibody maturation that is carried out by the mutagenic enzyme called AID can lead to lymphomagenesis. Regulation mechanisms of AID protein and its stability are the main focus of our research where we try to understand the cause and development of AID-derived diseases.</p> <p>In our study we are interested in physiological interaction partners of AID inducing and/or facilitating degradation of the mutagenic AID. My major project however is the search for extrinsic or intrinsic biological signals triggering the degradation of AID that is expressed only in Germinal Centers upon stimulation of the immune system by foreign antigen. I use human lymphoma cell lines with deregulated expression pattern of AID to test the potential of several DNA damaging agents (mimicking the AID action) to induce the disruption of the protein. Since DNA damage induced cell death (apoptosis) I am interested in the work of Nagata lab which is one of the leading groups in this research field in the world. The methods I learned in his institution will provide me a powerful tool to conduct my further research on posttranslational modifications of AID.</p>	

7. Research implementation and results under the program

Title of your research plan:

The role of MFG-E8 and Tim4 proteins in clearance of apoptotic cells in Germinal Centers upon B cell activation in respective single knock-out and double knock-out mice models.

Description of the research activities:

Apoptosis is one of three possible forms of cell death. This process is required for development, growth and several others crucial mechanisms of all living organisms. In mammals, once a foreign antigen is recognized by host adaptive immune system a quick response is provided by production of highly specific antibodies produced by leucocytes called B cells (infection). As soon as the infection reaction is over antibody-producing cells are swiftly removed.

Deregulated apoptosis or insufficient engulfment of dead leucocytes by macrophages during immune response can induce autoimmune diseases in mammals. Therefore it is of high medical interest to know which proteins and molecules are involved in this process and can be used as potential targets for drug therapies.

In Prof. Nagata's lab we currently try to characterize recently identified proteins involved in phagocytosis of apoptotic B cells in mouse splenic tissue and peritoneal cavity. For this purpose knock-out mice lacking the candidate genes (single knock-out and double knock-out mice models) were generated and are now analyzed in regards of the binding efficiency of dead cells and the subsequent engulfment rate by macrophages localized to the germinal center structures in the white pulp of the spleen.

We used biochemical (TAP purification), cell biological (viral infection, gene transfection) and immunological (immunohistochemistry) and microscopy methods to analyze two candidates MFG-E8 and Tim4 in terms of their physiological function, involvement and interplay on the molecular level in the immunological pathway of phagocytosis of apoptotic cells. After intensive studies of the proteins' role we now have convincing data confirming our initial hypothesis of both proteins being strong candidates involved in phagocytosis. Furthermore we found out that they both are parts of the same molecular pathway and we have initial data on the kinetics and priorities in use of those molecules in the process of recognition, binding and engulfment of dead B cells.

8. Please add your comments (if any):

The organization of the program was doubtlessly the best I have ever experienced. Once I am back in Germany I will definitely highly recommend this program to everybody I know. The mixture of home-stay experience, language classes, research in the Japanese lab and traveling around this gorgeous country made this trip to the best I have ever had.

9. Advisor's remarks (if any):

Even though the English language skills of my Japanese colleagues were sometimes poor, they always tried their best to help me (quite successfully!) not only in the lab but also in my daily life in Japan. My supervisor Hanayama-san took all the time I needed and did a great job in sharing all his rich knowledge with me.

RESEARCH REPORT

1. Name: Simon Banville (ID No.: SP09402)
2. Current affiliation: Department of Geodesy and Geomatics Engineering University of New Brunswick, Canada
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Electronic Navigation Research Institute (ENRI)
5. Host researcher: Dr. Kazuaki Hoshinoo and Dr. Takeyasu Sakai
6. Description of your current research <p>In order to be safe and reliable, air transport is subjected to strict rules and regulations. Accurate positioning of airplanes is one of the numerous crucial aspects to be considered, and the Global Positioning System (GPS) is now an indispensable instrument serving this purpose.</p> <p>Still, GPS signals propagating through the atmosphere are delayed by electrons, which can cause important positioning errors. To reduce this effect and to warn users of potential threats, GPS should only be used in conjunction with “augmentation systems” for aeronautical navigation.</p> <p>The Electronic Navigation Research Institute (ENRI) in Japan has been involved in the development of MSAS, the Japanese augmentation system. One of their primary objectives is mitigating the impacts of electron irregularities in the ionosphere, such as plasma bubbles and scintillation, which can reduce the reliability of GPS.</p> <p>In the context of my graduate studies, I am involved in the development of a space mission aiming at studying interactions between the ionosphere and the thermosphere using GPS. In collaboration with ENRI, we will be looking at ways to improve monitoring of the ionosphere using GPS as a sensing instrument. While this research should improve the information gathered on the state of the atmosphere, it should also benefit GPS users aiming at improving their positioning accuracy.</p>

7. Research implementation and results under the program

Title of your research plan:

Analyzing the Impacts of Local-Scale Ionospheric Irregularities on Aeronautical GPS Navigation

Description of the research activities:

While the global positioning system (GPS) is a well-known device for computing one's position at the surface of the Earth, it can also be used as a tool for analyzing the electron density within the ionized part of the atmosphere (the ionosphere). However, ionospheric irregularities often lead to challenging signal tracking conditions for GPS receivers. Hence, those irregularities limit the capacity to study the atmosphere, as well as reliable positioning.

During my stay at ENRI, I developed an approach aiming at minimizing the impacts of signal tracking interruptions on atmospheric studies using GPS. The method provided promising preliminary results, but more work is required to deal with severe ionospheric scintillation events. A reliable approach would not only improve our knowledge of physical phenomenon occurring within the ionosphere, but also eventually lead to safer aeronautical navigation using GPS.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Etienne Caron	(ID No.: SP09403)
2. Current affiliation: Institute for Research in Immunology and Cancer, Université de Montréal	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Systems Biology Institute	
5. Host researcher: Dr. Hiroaki Kitano	
6. Description of your current research <p>Cell surface MHC I molecules are associated with self peptides that are collectively referred to as the self MHC I immunopeptidome (sMII). The sMII is shaped by the interplay of protein synthesis and degradation. Importantly, mTOR has emerged as the most prominent pathway responsible for regulation of protein translation and degradation. Moreover, mTOR is the most frequently amplified oncogenic pathway and has attracted a broad interest in clinical studies. Thus, our first objective is to elucidate how the mTOR pathway affects the molecular content of the dynamic sMII. In my Ph.D. project, we inhibited the mTOR pathway of EL4 lymphoblastoma cells with rapamycin for various time durations. By using a label-free highthroughput mass spectrometry approach that we developed recently, 425 MHC I peptides were quantified across individual time points. Remarkably, temporal MHC I peptide expression profile revealed that ~ 70% of peptides were progressively overexpressed upon rapamycin treatment. Importantly, we observed that a subset of 74 peptides was most drastically overexpressed due to posttranscriptional mechanisms. Using STITCH database to explore functional associations, we provided evidence that changes in expression of this peptide subset selectively reflect dysregulations of source proteins related to the mTOR functional network. We concluded that inhibiting mTOR drastically influences the composition of the dynamic sMII. In addition, we propose that analysis of sMII-derived data provides a unique perspective on protein economy in general and on the cellular response to mTOR inhibition in particular.</p>	

7. Research implementation and results under the program

Title of your research plan:

A comprehensive map of the mTOR functional network

Description of the research activities:

An important goal of systems approaches in biology is to understand how genetic changes or environmental perturbations influence the behavior of an organism at the molecular level and ultimately its phenotype. High-throughput technologies to interrogate the transcriptome, proteome, protein-protein and protein-DNA interactions represent powerful tools to accomplish this goal (1). However, each of these individual datasets captures an incomplete picture of the global cellular response. Therefore, new approaches are needed. Current strategies include exploration of other dimensions in functional genomics (2). Based on our previous observations described above, we propose a novel approach based on exploration of sMII-derived data.

Our approach consists of 4 distinct steps: 1. To define a comprehensive map of the mTOR signaling network, drawn from previous genetic and biochemical research. 2. To integrate into this map large scale biological data that we have been generating so far in response to rapamycin perturbation: 1) MHC I peptide expression profiling, 2) mRNA expression profiling (total and ribosomes-associated mRNA) and 3) protein-protein / protein-DNA and other known physical interactions from freely available databases. 3. To demonstrate that integration of immunopeptidomic data to other large-scale expression measurements and databases allow us to refine and expand the mTOR signaling network. 4. To formulate new hypotheses that could not be predicted by the initial model and design additional experiments to test these hypotheses.

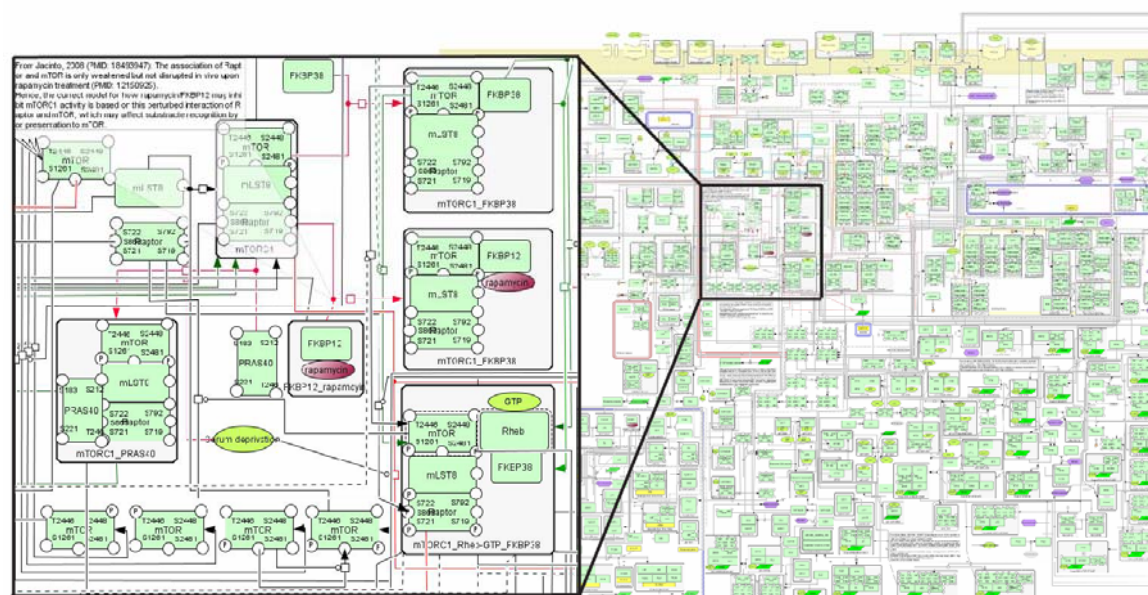


Figure 1. A comprehensive map of the mTOR signaling network.

In Dr. Kitano's group, I have been able to accomplish the first step. Indeed, I manually assembled molecular interactions based on published papers and constructed a comprehensive mTOR map that incorporates the possible pathways in mammals using CellDesigner, a modeling support software, and the Systems Biology Graphical Notation (SBGN), a new standard in systems biology (3). Another goal of creating such a map is to initiate a community-wide interactive process for creating a more accurate and information-rich map. Indeed, Kitano's group is currently developing PAYAO (<http://celldesigner.org/payao/payaopreview.html>), a community site to tag gene-regulatory and biochemical network models.

Here, a comprehensive view of the mTOR network has been created based on over 400 published articles. This network comprises over 600 species and 500 reactions (Figure 1). In addition, this mTOR map has been integrated into PAYAO in order to enable a community to work on the same mTOR model simultaneously, exchange comments, record the discussions and eventually update the model accurately and concurrently.

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2. Pratt, J.M., J. Petty, I. Riba-Garcia, D.H. Robertson, S.J. Gaskell, S.G. Oliver, and R.J. Beynon. 2002. Dynamics of protein turnover, a missing dimension in proteomics. *Mol Cell Proteomics* 1:579-591.
3. Kitano, H., A. Funahashi, Y. Matsuoka, and K. Oda. 2005. Using process diagrams for the graphical representation of biological networks. *Nature biotechnology* 23:961-966.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Laura Davis	(ID No.: SP09404)
2. Current affiliation: University of Ottawa	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Keio University Hospital	
5. Host researcher: Dr. Toshifumi Hibi and Dr. Tadakazu Hisamatsu	
6. Description of your current research <p>Cluster of Differentiation 14 (CD14) protein is found in relatively high doses in human milk at 25µg/mL in comparison with 2.5µg/mL in human serum. For this reason, it has been speculated to aid the innate immune system in protecting the feeding infant from invading bacteria. CD14 is able to detect and bind to lipopolysaccharide (LPS) which is found on the surface of Gram-negative bacteria. With the aid of lipopolysaccharide binding protein (LBP), CD14 can interact with LPS, MD-2 and TLR4 to stimulate an immune response. This entails the upregulation of proinflammatory cytokines which can help clear a bacterial infection.</p> <p>Due to the presence of proteolytic enzymes in the human digestive system, it is possible that CD14 is being completely degraded upon consumption. This may affect its ability to stimulate an immune response in the newborn infant. Therefore, I have designed a neonate rat model to further understand this issue. This model includes the development of a new method to radiolabel proteins using Carbon-14 for protein tracer studies. It also involves the determination of gastrointestinal transit time of 10-day old Sprague Dawley rats.</p>	

7. Research implementation and results under the program

Title of your research plan:

The role of soluble rCD14 in sequestering lipopolysaccharide (LPS) from interacting with Toll-like Receptor 4 (TLR4)

Description of the research activities:

It can be argued that CD14's high concentration in human milk can have detrimental effects to the infant. It may cause excessive inflammation in response to colonizing intestinal bacteria, although this has not been previously observed. I have hypothesized that the kinetics of unbound CD14 interacting with the MD-2/TLR4 complex blocks and outcompetes LPS-bound CD14 from binding with this receptor unit. This would occur only when soluble CD14 is found in excessive concentrations in comparison with its ligand (LPS). These are the potential conditions of the newborn gut when it is exposed to human milk. Therefore at Keio University hospital, I have isolated peripheral blood mononuclear cells (PBMC) and stimulated these cells with various LPS and recombinant CD14 conditions. This was performed to investigate the cytokine response of CD14⁺ monocytes when exposed to LPS, LPS-bound CD14, and recombinant CD14. I then looked for the production levels of cytokines TNF- α , IL-6 and IL-8.

Macrophages (M Φ) are essential leukocytes in the innate immune system. They have phagocytic capabilities and can recognize receptors on the surface of microbes, playing an important role in defense. This induces the activation of transcription factors, which in turn can lead to the upregulation of cytokines. Many of the cytokines produced result in inflammation, however antiinflammatory cytokines such as IL-10 and TGF- β help maintain a balance. The gastrointestinal tract hosts over 100 trillion commensal bacteria that help maintain homeostasis and therefore is essential that M Φ do not induce unnecessary inflammation. It is hypothesized in inflammatory bowel disease (IBD) patients that the response of the innate immune system is disrupted in response to commensals. Keio University has detected CD14⁺ macrophages in the lamina propria of intestinal tissue in Crohn's disease patients, which is not normally observed in these elevated quantities. These M Φ have typical morphology, however produce larger quantities of IL-23 and TNF- α in comparison with normal patients, potentially leading to inflammation.

I have acquired many new techniques and skills at Keio University Hospital's Inflammatory Bowel Disease lab, as well as pursuing my own research project. I have learned to inspect and grade human intestinal samples based on inflammation

and further distinguish between different morphological tissues. In mesenteric tissue, I have learned to identify lymphatic nodes and from intestinal tissue, I have learned to culture lamina propria monocytic cells (LPMC) and epithelial cells. I have further applied these techniques to IL-10 knockout mice acting as an inflammatory bowel model. I hope to use these new techniques I have acquired on the neonate rat model I have designed at the University of Ottawa to further understand digested CD14's influence on the innate immune system of the newborn gastrointestinal tract.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Philippe Gannon (ID No.: SP09405)
2. Current affiliation: Université de Montréal – CRCHUM – Institut du cancer de Montréal
3. Research fields and specialties: Humanities Sciences Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences <u>Biological Sciences</u> Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Kyoto University – Institute for Frontier Medical Sciences
5. Host researcher: Dr. Shimon Sakaguchi
6. Description of your current research <p>The principal goal of my Ph.D. thesis is the characterization of the immunological microenvironment in human prostate cancer. Prostate cancer is the most commonly diagnosed cancer in Canadian men et the third leading cause of cancer-related death after lung and colon cancers. Therapies for the advanced stages of prostate cancer remain palliative. Androgen-deprivation therapy (ADT), or hormone therapy, results in significant but temporary improvement of symptoms associated with advance prostate cancer. Yet, within 24 months following ADT initiation, most patients develop hormone refractory prostate cancer, the lethal form of the disease. Novel therapy, such as immunotherapy, aim to target the advance stages of prostate cancer. However, little is known about the immunological microenvironment in prostate cancer patients. Gaining information regarding the activation status of the immune system is essential in order to improve the clinical efficacy of immunotherapies targeted at prostate cancer.</p> <p>Our previous work demonstrated that the presence of prostate cancer lymph node metastasis was associated with the development of an immunosuppressive microenvironment (Gannon et al. The prostate. 2006). By immunohistochemistry, we observed that, compared to non-metastatic lymph nodes, metastatic lymph nodes contained less activated lymphocytes and less macrophages, which are central for the development of the anti-tumoral immune response. Metastatic lymph nodes also displayed significantly less histopathological characteristics of immunologically active lymph nodes and were smaller in size than non-metastatic lymph nodes. Altogether, our results showed that lymph nodes in patients with metastatic prostate cancer are immunosuppressed. Lymph nodes are indispensable for the development of the anti-tumoral immune response during an immunotherapy. As such, it is essential to better understand the mechanisms involved in this immunosuppression.</p> <p>Currently, most prostate cancer patients treated by immunotherapy have received ADT and developed hormone refractory disease. However, little is known about the immunological consequences of ADT in prostate cancer patients. Thus, we sought to determine whether ADT could modify the immune infiltrate in the primary tumor. We observed that ADT-treated patients had significantly higher densities of T</p>

lymphocytes and macrophages within primary tumor samples (Gannon et al. J. Immunol. Methods. 2009). The densities of other immune cells populations (B lymphocytes, NK cells, FoxP3+ T lymphocytes) were not affected. This study highlighted the immunosuppressive potential of androgens in prostate cancer with regards to specific immune cell populations.

Finally, we evaluated whether androgens could promote the expression of immunosuppressive molecules by prostate cancer cells. Our hypothesis was that, by removing androgen, ADT would eliminate an androgen-regulated microenvironment, which might be partially dependent on the expression of immunosuppressive molecules by prostate cancer cells. We observed that androgens regulated the expression of immunosuppressive arginase 1 and arginase 2 by hormone-sensitive prostate cancer cells. This was observed *in vitro* and *in vivo* in prostate cancer patients. Interestingly, only hormone-sensitive prostate cancer cells and not hormone refractory cells expressed arginase 2. We further determined that the androgen receptor was not implicating in this process therefore suggesting a non-genomic role of the AR in this process. This study demonstrated an immunosuppressive mechanism of androgen in prostate cancer, which involves the upregulation of immunosuppressive molecules by prostate cancer cells.

Altogether, our work support the notion that advanced prostate cancer is associated with the development of an immunosuppressive microenvironment, which is dependent on the presence of androgens. Our data highlight the direct contribution of cancer cells to the tumor-driven immunosuppression. Importantly, we observed that molecules involved in the immunosuppressive microenvironment of hormone-sensitive prostate cancer might not be the same as in hormone refractory prostate cancer. This is of value as it could help improve current immunotherapies to specific stages of prostate cancer progression.

7. Research implementation and results under the program

Title of your research plan:

Regulation of T lymphocyte and macrophage differentiation.

Description of the research activities:

Recent work from the laboratory of Dr Shimon Sakaguchi demonstrates a crucial role for cytotoxic T lymphocyte antigen-4 (CTLA-4) in the suppressive functions of regulatory T cells (Tregs) (Wing et al. Science. 2008). Tregs are essential for maintaining the homeostasis of the immune system and preventing the development of autoimmune disease. In a knock-out mouse model in which CTLA-4 expression was specifically inhibited in Tregs, mice developed autoimmune disorders caused by the absence of Treg functions due to the lost of CTLA-4 expression. With the help of a Ph.D. student, our project was to further characterize the implication of CTLA-4 in the differentiation of T lymphocyte and of macrophage populations using mouse models and *in vitro* culture systems.

In our *in vitro* system, we co-cultured macrophages and lymphocytes harvested, respectively, from peritoneal lavages and lymph nodes of wild-type mice. Specific immune cell populations were enriched using MoFlow cell sorter or MACS column. Cells were then incubated in the presence of anti-CTLA-4 blocking antibody and various lymphocyte-differentiating stimuli. Similarly, T lymphocytes from CTLA-4 knock-out mouse were incubated in the presence of wild-type macrophages. Macrophage and T lymphocyte differentiation was then monitored by flow cytometry. Moreover, we analyzed the expression of genes implicated in T lymphocyte differentiation by real-time PCR. Finally, protein expression and cellular localization was evaluated by immunocytofluorescence.

For *in vivo* experiments, the same anti-CTLA-4 blocking antibody was injected in Rag2 ^{-/-} or SCID mice in the presence of non-activated wild-type T lymphocytes. Rag2 ^{-/-} and SCID mice do not have lymphocytes and act as an empty reservoir for T lymphocyte proliferation. T lymphocyte differentiation was again monitored by flow cytometry. Altogether, our work suggests that CTLA-4 might be implicated in T lymphocyte differentiation and macrophage activation.

8. Please add your comments (if any):

Due to the sensitive nature of this research and to the international distribution of this report in the JSPS booklet and on the JSPS website, I chose not to include details regarding the results from the experiment successfully conducted during my summer internship.

9. Advisor's remarks (if any):

Despite his short stay in our lab, Philippe studied hard every day with good communication with other lab members. He also kindly reviewed our manuscripts to improve our English writing. We all enjoyed having him in our lab.

RESEARCH REPORT

1. Name: Paul Grouchy (ID No.: SP09406)
2. Current affiliation: The University of Toronto
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Tokyo Institute of Technology
5. Host researcher: Professor Taisuke Sato and Professor Yoshitaka Kameya
6. Description of your current research <p>Computer programs called neural networks, whose design is inspired by the brain structures of animals, are currently being employed to solve a wide variety of challenging computational problems. One such problem is the classification of handwritten digits. Many neural network solutions exist for this problem, however perfect error-free classification has not yet been achieved. Artificial evolutionary techniques can be used to evolve neural networks for this task in a Darwinian manner. As a graduate student at the University of Toronto, I recently developed a powerful new artificial evolutionary method that evolves multiple solutions in parallel. At the Tokyo Institute of Technology, I continued to explore the potential of this method by adapting it to evolve multiple neural networks that will work together through a voting scheme to classify a set of handwritten digits. Classification accuracy was compared with current methods, as well as with a set of voting networks evolved using standard artificial evolutionary methods.</p>

7. Research implementation and results under the program

Title of your research plan:

USING ARTIFICIAL EVOLUTION TO DEVELOP A COLLECTION OF
HANDWRITTEN DIGIT CLASSIFIERS

Description of the research activities:

It was quickly realized that solving the proposed problem using artificial evolution was going to require an infeasible amount of computational time when using the original versions of the code of the various methods being combined for these experiments. Thus much of my research revolved around developing ways to run the methods in parallel so as to take advantage of the state-of-the-art multicore machines I had access to at the Sato Lab. This resulted in some highly parallel code. Through independent research and consultation with members of the Sato Lab, many other code improvements were thought up and implemented as well, eventually resulting in a method that could run in a feasible amount of time.

One of the major achievements this summer came in the form of an improved “crossover” method. In artificial evolution, two “parent” solutions are selected based on fitness (how well they solve the problem at hand) and produce an offspring solution by combining elements of each parent in some meaningful manner, through what is known as crossover. Since identifying handwritten digits requires large neural networks and the methods being used maintain multiple “species” of solutions that can contain neural networks that vary greatly from one another, when inter-species mating occurs using the common crossover method, the resultant offspring will receive many different network connections from both parents. This can result in what is called “bloat,” where networks become unnecessarily large and thus processing them becomes computationally expensive.

A new crossover method was developed that keeps track of which network connections are contributing the most during successful identification of digits. Using these values, the new method chooses the most important subsets of connections from each parent for the offspring to inherit, thus avoiding bloat. It was also found through experimentation that this crossover method produced better results overall compared to the classic method.

However, even the best results produced yielded vastly inferior performance than current non-evolutionary methods, demonstrating that these methods are not well suited for this particular task. It was noted that having different “species” of networks vote on identifying digits did indeed improve performance over that of a

single network, demonstrating that different species develop different, but overlapping, specialties.

Despite the lack of success at solving the proposed problem, much was accomplished this summer. I was able to parallelize large sections of code of my method, allowing for it to fully exploit the power of multicore machines, an improved crossover method for this type of neural network evolution was developed and many other code improvements and experimental techniques were learned or discovered, allowing for future experiments on different tasks to achieve better results in less computational time.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

One of computational advantages in evolutionary computation is parallelism underlying the evolution. The student, Paul, quickly exploited such an advantage to get results within this summer. Unfortunately, these results are not so significant as expected, but he obtained a couple of important insights which, I believe, lead to successful achievements in future work.

-Professor Yoshitaka Kameya

RESEARCH REPORT

1. Name: Karine Gravel	(ID No.: SP09407)
2. Current affiliation: Université Laval, Québec, Québec, Canada	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences <u>Nutrition</u>	
4. Host institution: Okinawa International University, Okinawa, Japan	
5. Host researcher: Dr Donald Craig Willcox	
6. Description of your current research <p>My current research work focuses mainly on the effects of foods on health maintenance and chronic disease prevention. Healthy eating is fundamental to good health and is a key element in healthy human development, from prenatal to later life stages.</p> <p>1) My master's project in nutrition aims to evaluate the effects of legume consumption on the components of metabolic syndrome on women with abnormal metabolic profile. In this 16-week clinical trial, 134 women were randomly assigned to eat 750 ml of legumes (beans, dry peas, lentils and chickpeas) weekly or control meals equivalent in energy and without legumes. Results showed a significant increase in dietary fibers and a significant decrease in dietary cholesterol in pulse group. However, no significant changes occurred in response to the intervention in either the group consuming pulses or the control group. In conclusion, healthy lifestyle (i.e. food and physical activity) is effective to prevent and treat metabolic syndrome and legumes should be considered as an "ingredient" of a healthy eating plan.</p> <p>2) As research coordinator, I work in a study that aims to measure the effects of chocolate consumption on endothelial function and the blood pressure of pregnant women. Preeclampsia and gravid hypertension are potential risk of complications during pregnancy. Chocolate rich in polyphenols (catechins and epicatechins) could have positive effects on endothelial function and blood pressure. In this 12-week clinical trial, 44 women were randomly assigned to eat 20 g of chocolate rich in polyphenols daily or control chocolate without polyphenols. Acute and chronic effects of chocolate consumption were measured. Data analysis is in progress.</p> <p>3) As co-investigator, I work in a systematic review that aims to inform dieticians on interventions that are most likely to enhance their clients' adherence to dietary recommendations. Although many studies have demonstrated the beneficial impact of dietary treatment in strictly controlled experimental conditions, it remains that its full benefit will only be truly observed in practice settings if patients follow the recommended diet closely. However, for chronic disease management, non-adherence rates to medication</p>	

and lifestyle changes are estimated to be between 50-80%. This Cochrane systematic review is in progress.

7. Research implementation and results under the program

Title of your research plan:

Trends in nutrition and energy expenditure in Okinawa: Implications for metabolic syndrome.

Description of the research activities:

To know more about the effects of foods and dietary patterns on health maintenance and chronic disease prevention, I studied the Okinawa diet for my research project. Citizens of Okinawa prefecture are known to have the longest average life expectancy at older ages and highest centenarian ratio within Japan (and likely the world) because they avoid or delay major age associated diseases such as cancer, heart disease, stroke and diabetes. This phenomenon can be explained by a healthy lifestyle, especially the traditional diet. Influenced by China, Japan and Southeast Asia, traditional Okinawa diet is rich in green leafy and yellow root vegetables, sweet potatoes as a dietary staple, and soy as a main protein supplemented by small amounts of fish and meat. Fat intake was low although recent changes have seen increased intake of fatty acids, the most common cooking oil used at present is a canola-soy oil blend, rich in monounsaturated fatty acids and to some extent n-3 polyunsaturated fats. Thus, the traditional Okinawa diet is adequate in most nutrients and high in antioxidant vitamins.

However, Okinawa has experienced changes in its socio-political, socio-economic and socio-cultural conditions during the last half-century that are reflected in the diet. The dietary habits of Okinawans have shifted from “traditional” to a more “westernized” diet, involving processed foods and excessive amount of energy. The higher intakes of fat are particularly pronounced in younger generations who show a distinct preference for a more “westernized” dietary pattern such as hamburgers, fried chicken, curry dishes, white bread devoid of fiber and nutrients and oil-heavy food dishes. The consequences of this dietary shift and the decrease in energy expenditure have led to the emerging problems of obesity and metabolic syndrome.

This research project aimed to examine the trends in food and nutrient intake and in energy expenditure in Okinawa, among three generations (20-39, 40-74 and 75 years and over), from 1949 to 2006. Data from the Prefectural Health and Nutrition Survey in Okinawa and from the National Nutrition Survey in Japan were translated, analyzed and compared. English and Japanese literature on the subject was reviewed and these trends were found to be linked to the emerging problems of obesity and metabolic syndrome in Okinawa. Finally, these trends were discussed from the perspective of health promotion efforts currently being undertaken by Okinawa prefecture. Future activity to follow up this research will be a publication in an international scientific journal.

During my stay in Japan, I had the opportunity to assist at the International

Workshop of the Regional Epidemiology in Okinawa at the University of the Ryukyus. This workshop gave me the opportunity to meet researchers from Japan and throughout the world, experts in social, dementia, chronic disease and nutritional epidemiology. During this workshop, a symposium titled “Healthy Aging in the Community: From the Perspective of Social and Human Networks” took place in Nakijin village. I had the opportunity to be present at interviews with nonagenarians, to observe the traditional support in the village, and to taste traditional Okinawan food.

Finally, I’m very fortunate to have participated at a healthy Okinawan cooking lesson at Yonner Food Cooking Studio in Naha. This unique experience allowed me to learn to cook braised sponge gourd cooking with miso and kudzu starch cake. I would like to thank the registered dietitian 宇栄原千春 (Chiharu Uehara) for this great idea!

8. Please add your comments (if any):

I would like to thank the JSPS and the Canadian Embassy for offering me the privilege of participating in such an informative program in Japan. I also want to express my gratitude towards my host researcher Dr Donald Craig Willcox, as well as his helpful research assistants, 安次嶺優 (Masaru Ashimine), 上村佐保 (Saho Uemura) and 砂川亜紀美 (Akimi Sunakawa) and all the other researchers who made my stay an unforgettable experience in the longevity island!

9. Advisor’s remarks (if any): Ms. Karine Gravel’s research on trends in nutrition and energy expenditure in Okinawa and the implications for metabolic syndrome, an emerging health threat in Okinawa and throughout Japan, is both timely and important. Although she was in Okinawa for only a short period of two months she was able to grasp the trends through analysis of data from past nutritional and health surveys in Okinawa and throughout Japan. Publication of the results in an international journal and presentation of the results at international conferences will be an important outcome of her work. Moreover, Ms. Gavel was able to adapt very well to a culture that is quite different from that of Canada, learn about complex social and cultural factors that help to determine healthy food choices as well as learn some basic Japanese skills--all will help her in future. Her very successful results speak to her flexibility and resourcefulness as well as her suitability as a candidate for this program. We will be sad to see her leave!

RESEARCH REPORT

1. Name: Hubert Jean-Ruel	ID No.: SP09408
2. Current affiliation: University of Toronto, Department of Physics	
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Kyoto University, Quantum Science and Engineering Center	
5. Host researcher: Prof. Jiro Matsuo	
6. Description of your current research <p>The PhD research project I have undertaken is to use femtosecond (fs) electron diffraction (FED) to study with femtosecond time and atomic spatial resolution structural dynamics involved in functional responses of hemoproteins. This project is in the continuity of a long term effort Prof. Miller's group of developing FED, which has the ultimate goal of resolving the structure-function relationship in biological systems.</p> <p>FED is a powerful time resolved technique capable of directly observing transition state processes with atomic level details. A fs laser pulse excites the sample under study and a fs photoelectron bunch probes its structure via diffraction; by varying the time delay between the laser and electron pulses, the recorded diffraction patterns monitor the molecular structural changes. FED has now been successfully used to capture ultrafast structural dynamics in many materials: order-to-disorder phase transition of strongly driven melting in gold, non-thermal lattice collapse of silicon due to electronically driven bond displacement, etc. The focus of my project is to advance the methodology of FED to enable its use for studying protein dynamics. The goal is to directly observe the functionally relevant protein motions as it performs its biological function, aka to make a "Molecular Movie" of a biological function in action. Our first choice of protein on which to carry out the FED study is myoglobin, a hemoprotein found in muscle tissues which has the main function of oxygen storage. Toward achieving this goal, significant efforts will also be put in the study of different organic and organometallic systems showing ultrafast photoinduced structural transitions. These studies are a necessary intermediate step between simple systems such as metals or semiconductors and proteins.</p>	

7. Research implementation and results under the program

Title of your research plan:

Nanoscale Inorganic, Organic, and Organometallic Crystal Fabrication Using Cluster Ion Milling

Description of the research activities:

Due to the high electron-matter scattering cross section, one of the greatest challenges of FED is the requirement for ultrathin crystalline samples. The summer project undertaken was to investigate the use of a high-energy ion beam irradiation system developed in Prof. Matsuo's group for thinning down inorganic, organic, and organometallic crystalline samples to a thickness suitable for performing time-resolved studies of photoinduced ultrafast dynamics using femtosecond electron diffraction (FED). We did not fully succeed in making samples suitable for FED studies, but we made significant steps toward achieving this goal and we believe that we will succeed in a near future.

Prior to using ion milling to thin down the crystals to the required thickness for FED (100 to 200 nm), very flat crystals with parallel faces must be obtained. This is not trivial and this first step became the focus of my research activities. Three methods were explored: microtoming, polishing, and direct growth of 2D crystals. The first two methods require to grow bulk single crystals and to embed them into resin. We successfully grew diarylethene (a photochromic organic crystal) bulk single crystals using the methods of slow evaporation and slow cooling. Two other samples, vanadium(IV) oxide (a photosensitive inorganic crystal) and a copper compound (a photosensitive organometallic crystal), were grown in Toronto and brought here. The samples were embedded into a cold-setting epoxy resin.

Microtoming: The general method is to (1) grow a bulk crystal, (2) embed it into resin, (3) microtome thin sections (thickness between 2 and 20 microns) of the crystal-resin assembly, (4) fix a section on a silicon nitride window, and then (5) mill it down using cluster beam irradiation. Significant efforts have been put in optimizing the microtoming parameters in order to succeed in cutting good quality crystal slices: embedding resin hardness, cutting velocity, sections thickness, size and shape of the sample to be microtomed, clearance angle of the knife, and knife tip angle. Both diamond and steel knives were tested. We did not succeed in cutting good quality crystal slices of any of the samples. Vanadium oxide was too hard to be microtomed at all. The other two samples could be microtomed but the crystals in the thin sections were always broken, resulting in a roughness of the order of a few microns, and thus not acceptable

Polishing: The general method is to (1) grow a bulk crystals, (2) embed it into resin, (3) fix the crystal-resin assembly on a silicon wafer and polish the top side down to the crystal, (4) fix the polished surface of the crystal-resin assembly on a flat polishing sample holder with a depth corresponding to the desired final thickness and polish the second surface down the level of the holder edge, (5) fix the polished section on a silicon nitride window, and then (6) mill it down using cluster beam irradiation. Polishing is achieved by using coarse grit size polishing film first and gradually moving on to finer grit size. Significant efforts have been put in optimizing the polishing parameters: force applied on the sample, relative velocity between the sample and the polishing paper, pattern of polishing, size of the crystal-resin assembly, and use of water on the polishing film. Both hand polishing and a polishing machine were tested. The focus was put on achieving a very flat surface first (step 3) before moving on to polishing the second surface and obtaining a thin section. Encouraging results were obtained with all three samples, in particular with vanadium oxide. It was successfully polished down to features less than 60 nm high on an area of diameter of about 0.1 mm. The diarylethene and copper compound crystals were more difficult to polish, because they are much more fragile, but they could still be polished down to features less than 200 nm high.

Direct growth of 2D crystals: In addition to bulk crystals, very thin (25 to 200 um) and very flat diarylethene single crystals naturally grow by the slow evaporation method. Such crystals can be milled down directly, without mechanical thinning such as polishing or microtoming. Significant efforts have been put in growing such 2D crystals directly on silicon nitride windows, but all methods attempted failed. Instead, the 2D crystals were grown on a glass substrate and then transferred and fixed on a silicon nitride window using epoxy. We performed preliminary tests on cluster ion milling of diarylethene and found suitable milling parameters (ion source, clusters size, acceleration energies, incidence angles, etc.). We ran out of time and of samples for this summer, but we are confident that this method will succeed in providing diarylethene samples suitable for FED

In conclusion, we believe that we have found potential methods to make diarylethene and vanadium(IV) oxide crystalline samples suitable for FED (direct growth of 2D crystals by slow evaporation followed by cluster ion milling, and polishing followed by cluster ion milling, respectively). We will continue our collaboration on this work and we are confident to succeed in a near future.

8. Please add your comments (if any):

This summer program was a tremendously enriching experience, both on a scientific and personal level. I am very grateful towards JSPS, NSERC, and Prof. Matsuo.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Bimal Lakhani	(ID No.: SP09409)
2. Current affiliation: Department of Rehabilitation Science, University of Toronto, Canada	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences <u>Medical, Dental and Pharmaceutical Sciences</u> Interdisciplinary and Frontier Sciences	
4. Host institution: National Rehabilitation Centre for Persons with Disabilities, Motor Control Section, Tokorozawa, Japan	
5. Host researcher: Dr. Kimitaka Nakazawa	
6. Description of your current research <p>My current research focuses on reactive balance control reactions in individuals who have suffered a stroke. Persons with stroke are highly susceptible to falls due, in part, to impairments caused by unilateral limb dyscontrol. Reactive balance control strategies, specifically compensatory stepping responses, are critically important to preventing a fall, are commonly executed in response to instability and become more prevalent among individuals with disordered postural control. The challenges of controlling compensatory stepping are the rapid response times and complex bilateral limb control. Individuals with impaired limb control after stroke are likely to have specific difficulty in executing these important bilateral limb reactions. In spite of the potential importance of these responses, little is understood about compensatory stepping reactions and their effectiveness in maintaining stability in persons with stroke.</p> <p>The purpose of my current research is to investigate the limb preference (affected side versus unaffected side) and timing characteristics of compensatory stepping responses in persons with stroke to understand the specific deficits they may have executing these responses. To date, we have found that individuals with stroke rely on the unaffected limb to step and this may be attributed to challenges in control (muscle weakness / discoordination) that may slow step time or influence the accuracy of foot placement. However, even when stepping with the unaffected limb, the time to foot-off was significantly delayed compared to controls. In general, compensatory stepping reactions are compromised in persons with stroke, as</p>	

highlighted by the delay in timing, and this control challenge is not solved by relying on the non-paretic limb.

Work that we are beginning now will attempt to characterize the limitations of attempting a compensatory step with the affected limb. Clinically, the outcomes of this work have the potential to guide perturbation based balance training interventions to improve compensatory balance control in persons with stroke.

7. Research implementation and results under the program

Title of your research plan:

Robotically assisted passive gait training to improve gait symmetry in individuals with stroke

Description of the research activities:

The most frequent goal reported by individuals with stroke during rehabilitation is the improvement of walking ability. Similar to the asymmetries that we are currently finding in reactive balance control, the unilateral limb deficits encountered after stroke are likely to result in gait asymmetry.

The asymmetry typically manifests itself in the affected limb by an increased swing phase when compared to the unaffected limb. Essentially, the affected limb is used to bear weight much less than the unaffected limb during the gait cycle. The asymmetry is detrimental to the individual with stroke because it often results in decreased gait efficiency (higher energy expenditure and lower ambulatory activity levels compared to healthy controls). In addition, gait asymmetry exposes the unaffected limb to greater vertical ground reaction forces which increases loading throughout the lower limb joints.

At the National Rehabilitation Center for Persons with Disabilities in Japan, researchers have been investigating bilateral lower limb movement during gait in persons with spinal cord injury and are now interested understanding methods of rehabilitation that could be used to improve gait symmetry in post-stroke individuals. Despite attempts to use partial body weight support treadmill training, a method that is readily utilized in individuals with spinal cord injury, there has only been limited success improving gait symmetry in post-stroke individuals.

Improving gait symmetry can increase the efficiency of movement, provide individuals with stroke with the ability to become more ambulatory and reduce the risk of developing secondary musculoskeletal pathologies.

During my stay in Japan, we investigated the effects of a novel training method for individuals with stroke to improve their gait symmetry. We utilized a robotic gait trainer (pictured at right) which externally drives a symmetric lower limb gait pattern. Measures of gait symmetry and muscle activation were taken both prior to and following a 20 minute intervention using the passive robotic gait trainer. We hypothesized that passive practice of a symmetric gait pattern would provide the individual with proper sensory input associated with normal gait which, at level of the spinal cord and motor cortex, could induce a learning effect to result in improved gait symmetry.



Though we were limited by the two month timeframe, we were able to test our protocol on seven individuals with stroke. Preliminary results show that passive robotic gait training had a variable effect on gait symmetry on a case by case basis. Measures of gait symmetry improved in four of the seven cases and remained relatively unchanged in the other three cases. Further analysis on muscle activation patterns is required to account for the mechanisms that caused the changes in gait symmetry. Our initial results are promising and an ongoing case series analysis will help to identify the specific benefits of passive gait training as well as provide critical information regarding the mechanisms for neurological recovery of gait following stroke.

8. Please add your comments (if any):

Thank you to Dr. Nakazawa & Dr. Kawashima for inviting me to spend time in their lab and for providing excellent guidance and insightful assistance every step of the way, as well as to all the members of the lab for being so welcoming and accommodating. The JSPS Summer Program was an excellent experience and I am truly grateful for having been given the opportunity to participate in it.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Yurai Núñez-Rodríguez (ID No.: SP09410)
2. Current affiliation: Queen's University, Ontario, Canada
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences <u>Interdisciplinary and Frontier Sciences</u>
4. Host institution: Japan Advanced Institute of Science and Technology (JAIST)
5. Host researcher: Prof. Tetsuo Asano
6. Description of your current research <p>Within the field of computational geometry my research focusses on geometric graphs, their combinatorial properties, algorithms, and applications. A geometric graph is defined by nodes and links connecting pairs of nodes. They provide a model for various subjects, including wireless networks. As part of my PhD thesis, I have worked on algorithms for fault recovery, construction of Voronoi diagrams, and efficient traversal of wireless networks. The Voronoi diagram of a network, in short, defines a partition of the space such that every node is associated with an area. They allow problems on the continuum of the space to be addressed in a combinatorial manner, thus remarkably simplifying solutions. These algorithms have implications in the dissemination of information across a network and coverage detection, as in a cell phone network, to name but a few.</p> <p>The latter two topics, Voronoi diagrams and graph traversals, are directly related to my research in Japan. In previous approaches we have focused on the running time of the algorithms and whether the problem could be solved in a distributed manner, that is, with all network nodes simultaneously contributing to the solution. Currently, we are aiming at algorithms that use the least possible amount of computer memory, namely, minimal working space. This issue has received significant recent attention from the research community as network nodes tend to become simpler, cheaper, and have limited memory resources. For instance, we may find sensor networks nowadays.</p>

We have revisited the following problems from a minimal working space perspective: computing the smallest enclosing circle for a set of points (or nodes), which is directly related to a version of the Voronoi diagram, farthest point Voronoi diagram; and traversing graph components in polynomial time, or equivalently, determining connectivity .

7. Research implementation and results under the program

Title of your research plan:

Efficient Computation of Voronoi diagrams and its relatives

Description of the research activities:

The proposed title reflects the topic initially researched on during my stay at the host institution. We explored other topics as our research progressed and other interesting problems appeared. The list of topics follows.

1. The first topic consisted in computing the smallest circle enclosing a set of points using minimal working space (i.e., least possible amount of computer memory). This is related to the farthest point Voronoi diagram, as either problem provides a certain information about the solution of the other. We propose a heuristic algorithm that uses minimal working space and takes time that is only proportional to the input size. Our method relies on recent results on linear optimization. The actual theoretical time bounds are yet to be determined.

2. The second part of my work focused on graph traversals using minimal working space, or equivalently, determining connectivity between pairs of nodes. We developed a very simple, neat algorithm for this problem on sparse graphs. The theoretical results in this area cannot be improved any further, as has been proved by other researchers; however, the algorithm we propose is much simpler to understand (and implement) than previous approaches. It also offers the advantage of even smaller memory requirements, up to a constant factor, depending on the computational model. We are working on a proof that the traversed path is not exponentially long. If this is the case, the result will have a positive impact in the field of graph algorithms and computational complexity theory.

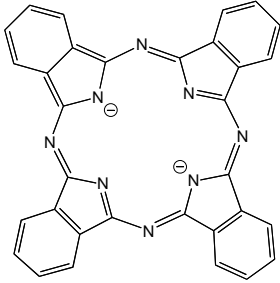
3. As a side project I worked on a geometric problem related to the construction of a synthetic set of points that resembles a certain prescribed distribution. I started working on this topic at the Korean Workshop in Computational Geometry, hosted in Japan by Prof. Asano, during my stay at the host institution. In this workshop I had the opportunity to join a number of lead researchers in the area of computational geometry from different countries. The collaborative effort yielded a small progress towards the solution of this problem, seemingly a hard one. However, this was a great opportunity for meeting researchers in my field and creating new collaborative research links.

8. Please add your comments (if any):

I will continue the work I have started here in Japan. Hopefully some of the results will be accepted for publications. The research environment at JAIST has been very friendly and encouraging. The discussions with Professor Asano have been very productive. I have become acquainted with other local scientists as well as researchers from around the world. The research collaborations that started during my stay in Japan will last for years to come. I would recommend this institute and the host, Professor Asano, to future JSPS fellows.

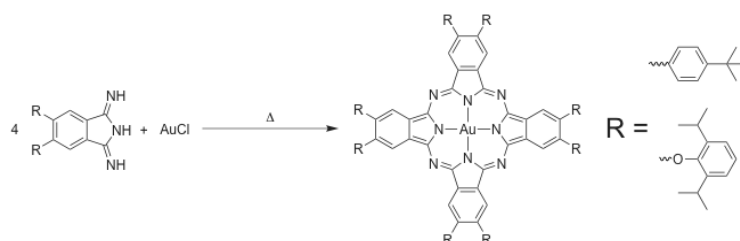
9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Edwin Wong	(ID No.: SP09413)	
2. Current affiliation: Department of Chemistry, Simon Fraser University		
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences <u>Chemistry</u> Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences		
4. Host institution: Tohoku University		
5. Host researcher: Professor Nagao Kobayashi		
6. Description of your current research <p>My research project in Japan involves studying gold (Au) in an unusual +2 oxidation state supported by a phthalocyanine (Pc) ligand. Au^{II}Pc has been reported in the literature, but it was poorly characterized due to its limited solubility. We aim to reproduce the synthesis of Au^{II}Pc and to make more soluble analogues in the hopes that the increased solubility will allow us to obtain pure compounds that we can use to further investigate the chemistry of Au(II). The skills I acquire in making and characterizing air-stable AuPc will be easily adapted to my research in Canada on bond activation with substituted metallophthalocyanines.</p>		 <p>Phthalocyanine</p>
7. Research implementation and results under the program Title of your research plan: Gold Phthalocyanines: Exploring the chemistry of mononuclear Au(II) complexes		

Description of the research activities:

Substituted metallophthalocyanines are commonly synthesized using a cyclotetramerization reaction whereby a mixture of substituted ortho-dicyanobenzene or substituted 1,3-diiminoisoindoline and a metal salt are heated at high temperatures (usually $> 200^{\circ}\text{C}$). In Japan, I focused on synthesizing two different di-substituted diiminoisoindoline starting materials. The first one bearing 4-^tBuPh substituents and a second with 2,6-di-ⁱPrPhO substituents.



The synthesis of the first compound proceeded smoothly and an excellent yield of the desired compound was isolated by following a literature procedure. The synthesis of 2,6-di-ⁱPrPhO substituted diiminoisoindoline proved to be more difficult and the results of a published procedure could not be repeated although many different reaction conditions were attempted. Rather than continuing to struggle with synthesizing starting material, I focused on repeating the synthesis of the originally reported AuPc. I successfully repeated the synthesis of this compound and discovered a method of purifying it. I also repeated the synthesis of (^tBu)₄PcAu that was prepared previously in very low yield by Prof. Kobayashi's students when they visited the Leznoff lab in March 2009. Samples of these two compounds will be sent back to Canada for analysis by electron paramagnetic resonance spectroscopy. Further work will also be done in Canada towards purifying and characterizing these compounds.

8. Please add your comments (if any):

I am grateful to Prof. Kobayashi for allowing me the opportunity to work in his laboratory. I have learned a great deal about the synthesis of phthalocyanines during my stay here. Both the faculty and students made me feel welcome in the lab and did not hesitate to give me a helping hand when I needed it. I am especially grateful to Prof. Kobayashi who took time out of his busy schedule to take me sightseeing on several occasions. Finally, I would like to thank both the JSPS and NSERC for giving me the opportunity to do research in Japan.

9. Advisor's remarks (if any):

It was really a pleasure to accept a student like Edwin who has very nice character. Students in my lab now do not hesitate to speak English, which is good for broadening the horizons of shy students from rural areas. He also worked hard and was refreshing presence in the laboratory. He heightened the mutual understanding between our cultures and stimulated new ideas.

RESEARCH REPORT

1. Name: Andrew Mikhail (ID No.: SP09414)
2. Current affiliation: The University of Toronto
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences <u>Medical, Dental and Pharmaceutical Sciences</u> Interdisciplinary and Frontier Sciences
4. Host institution: The University of Tokyo
5. Host researcher: Dr. Kazunori Kataoka
6. Description of your current research <p>More than 11 million people are diagnosed with cancer and about 8 million people die from the disease every year, according to the World Health Organization (WHO). Current treatment commonly involves radiation and/or surgical tumor resection in combination with chemotherapy. However, the efficacy of current chemotherapeutic agents is often limited by the drug's toxicity to healthy tissues resulting in restrictions to the dose and frequency of treatment. Incorporation of drugs within biocompatible and/or biodegradable nanoparticles, such as block copolymer micelles (BCMs), has been shown to reduce toxicity while increasing drug solubility and site-specific tumor accumulation. Due to the unique physiology of tumors, BCMs are capable of targeting cancer cells by virtue of their small size and by incorporating targeting molecules on their surface which impart an affinity for cellular targets present specifically on or over-expressed by cancer cells. However, as a prerequisite for targeting, BCMs must be sufficiently stable in order to remain intact and in possession of the drug for a prolonged period of time following intravenous administration. In contrast, BCMs that function solely to increase the solubility of the drug but have limited stability and poor drug retention following administration are poor candidates for targeted therapy. There is also increasing evidence that drug resistance and tumor recurrence following treatment are mediated by a drug's limited penetration and distribution within the tumor. Therefore, for chemotherapy to be curative, the drug must be capable of reaching all tumor cells within the three dimensional tumor structure as the survival of a single cancer cell could result in tumor repopulation. To address these important issues our laboratory has generated novel biocompatible BCMs containing docetaxel, a potent chemotherapeutic agent used in the treatment of breast, prostate, and lung cancer, that is chemically bound to the micelle core. These specialized BCMs are capable of loading and retaining large quantities of both physically and chemically entrapped drug and are highly stable. To date, the physico-chemical characteristics and drug loading and release properties of this BCM drug delivery system</p>

have been optimized and it is now ready to be evaluated using *in vitro* cancer cell cultures. However, efficacy results derived from conventional tissue cultures, although useful for observing a drug's interaction at the cellular level, often fail to accurately predict the therapeutic effects *in vivo*. This is largely due to the simplified tissue structure of a monolayer culture which does not reflect the three dimensional nature of solid tumors and the implications of tumor microenvironment on drug diffusion and penetration. Therefore, the use of three dimensional tumor cell aggregates known as multicellular tumor spheroids (MTS) was proposed as a more accurate means for predicting and optimizing the BCM formulation with respect to *in vivo* tumor penetration.

7. Research implementation and results under the program

Title of your research plan:

Block Copolymer Micelles for Drug Delivery: The Influence of Micelle Physico-chemical Characteristics on Tumor Accumulation and Microdistribution

Description of the research activities:

Dr. Kazunori Kataoka's laboratory provided an ideal setting in which to explore the *in vitro* and *in vivo* distribution of BCMs. Under the guidance of Dr. Horacio Cabral, tumor spheroids were generated using human colon adenocarcinoma cells and incubated in culture media containing micelles. In order to determine the influence of the size of micelles on their ability to penetrate and distribute within tumor tissues, BCMs of two different sizes were synthesized and attached to different fluorescent molecules to allow for observation using a confocal laser fluorescence microscope. Following incubation of the BCMs with the tumor spheroids for various lengths of time, images were acquired using the microscope that simultaneously revealed the distribution of both the large and small BCMs throughout the tumor spheroid. Following these observations, *in vivo* experiments were conducted using tumor bearing mice. Fluorescent micelles of different sizes were administered by intravenous injection and their accumulation within the tumor and other tissues and organs was observed in real-time using a novel *in vivo* fluorescent imaging technique. These studies provided insight into the accumulation and distribution of the micelles throughout the body based on their size - critical information for the development of site-specific drug delivery vehicles. Finally, a preliminary biodistribution study was performed in order to validate our *in vivo* imaging results using physical methods and to gain a quantitative evaluation of BCM distribution in various tissues and organs.

The research undertaken this summer has provided useful insight regarding the distribution of BCMs *in vivo* using novel imaging techniques. It is our desire to

continue with this work as we strive towards elucidating critical design criteria for the development of tumor-specific drug delivery vehicles with the ultimate goal of achieving significant advancements in the field of cancer therapy.

8. Please add your comments (if any):

I am extremely grateful for the opportunity to have worked in Dr. Kataoka's laboratory this summer during which time I was fortunate to meet so many gifted researchers. I would like to specifically thank Dr. Cabral for all the time he spent in support of this project. I sincerely appreciate the kindness and hospitality of all the members of the KKlab and I hope that this is only the beginning of a very fruitful collaboration. I would also like to acknowledge the generous funding provided by JSPS and CIHR and to express my gratitude for the privilege of being selected to participate in such a distinguished program.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Arne Stinchcombe	(ID No.: SP09415)
2. Current affiliation: University of Ottawa, Ottawa, Ontario, CANADA	
3. Research fields and specialties: Humanities <u>Social Sciences</u> Mathematical and Physical Sciences Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Advanced Industrial Science and Technology (AIST)	
5. Host researcher: Dr. Toshihisa Sato (Human Ubiquitous-Environment Interaction Group)	
6. Description of your current research <p>The Canadian Institutes for Health Research states that by the year 2015 Canada will, for the first time in its history, have more older adults than young people and that an increase in this demographic will be one of the most noteworthy social forces influencing Canadian society over the upcoming 20 to 30 years. Since the automobile is a key element of Canada's transportation infrastructure, the ability to operate a motor vehicle safely has become a major factor in individual mobility. Unfortunately, older drivers comprise the population segment with the highest crash risk after distance driven is considered, and as such are frequently determined to be unfit to drive. Given the projected increase in this population segment, the severity of this issue will only continue to intensify.</p> <p>Briefly, the goal of my dissertation is to use a driving simulator, with its associated methodological advantages, to develop an empirically-derived and valid video-based driver assessment tool for use by health professionals to assist in determining the driving safety of older adults. This project is being executed in three phases. First, a large set of driving scenarios that replicate common crash characteristics will be administered to a large group of adults (i.e., 100 participants). Throughout each scenario, a visual stimulus is presented in the periphery and participants must make a response as soon as they perceive it. This task is used as a measure of cognitive workload, or the overall level of cognitive resources that are required when completing a task. Next, scenarios that are found to be most challenging will be administered to older drivers (i.e., 65 years and greater) and experienced controls. In the third phase, scenarios that best discriminated between groups will be converted into video format which will include questions</p>	

pertaining to safety, relevant stimuli, and common deficits observed in the second phase. This measure will then be validated by administration to a large sample (i.e., 200 participants), and ability to detect hazards will be examined based on responses.

7. Research implementation and results under the program

Title of your research plan: Validation of a high-fidelity motion-base driving simulator: a pilot study

Description of the research activities:

Alongside Toshihisa Sato, I was able to execute a pilot study that examined the feasibility of conducting a large validation study of a motion-base driving simulator. The driving simulator is produced by Mitsubishi precision, includes a full vehicle cabin and offers the driver a 300 degree field of vision (Akamatsu, Okuwa & Onuki, 2001). We also employed an experimental vehicle that recorded the participants' location, braking, acceleration, steering, and headway distance (Sato & Akamatsu, 2007; Sato & Akamatsu, 2008). We had six experienced mid-aged drivers (Mean age of 41.5 years) repeatedly drive the experimental vehicle on the Tokyo Metropolitan Expressway and, later, we had them drive a simulated course that approximated the same highway in the driving simulator. We hypothesized that we would observe a high degree of correspondence between the variables collected in the experimental vehicle and those collected in the driving simulator, thereby validating the driving simulator as a tool for behavioral research.

Overall, our results were scattered. On the one hand, participants reported that driving the simulator was similar to driving a real vehicle, as determined by a self-report questionnaire. On the other hand, many of the primary behavioural variables such as participants' speed and steering angle differed significantly between the two environments with the experimental vehicle showing greater variation.

We attributed our scattered findings to the challenge of maintaining equivalence between the two environments. More precisely, despite our efforts to ensure both environments were as similar as possible, there were some factors that we had not considered. For example, due to congestion on the Tokyo Metropolitan Expressway, many of the drivers in the experimental vehicle encountered traffic jams where the vehicle would come to a complete stop. This, in turn, led to the real-road drives having lower average speeds, greater variability in speed, more stops, and a closer following distance.

The results of our study showed that the driving simulator and experimental vehicle collect data that can easily be compared to validate the driving simulator. Difficulties arise, however, when replicating the congestion of the real road in the

driving simulator. Given that the primary advantage of the driving simulator is the degree of control the researcher may over exert over the experiment it is not surprising that extraneous congestion on a public road presents a problem. Our pilot study was successful in establishing that, indeed, a pilot study is feasible. However, future studies of this nature would benefit from minimizing the effect of traffic congestion by employing a closed circuit course or by having participants drive at non-peak times. Alternatively, the driving simulation could be adapted so as to present participants with excess congestion and traffic jams.

This pilot study highlights the benefits of using simulated technology in behavioural research as simulators allow for the control of extraneous variables that may serve to confound the experimental manipulation.

References

Akamatsu, M., Okuwa, M., & Onuki, M. (2001). Development of a hi-fidelity driving simulator for measuring driving behaviour. *Journal of Robotics and Mechatronics*, 13, 4, 409-418.

Sato, T., & Akamatsu, M. (2007). Influence of traffic conditions on driver behavior before making a right turn at an intersection: Analysis of driver behaviour based on measured data on an actual road. *Transportation Research Part F*, 10, 397-413.

Sato, T., & Akamatsu, M. (2008). Modeling and prediction of driver preparations for making a right turn based on vehicle velocity and traffic conditions while approaching an intersection. *Transportation Research Part F*, 11, 242-258.

8. Please add your comments (if any):

I feel privileged to have participated in the JSPS summer program. This experience has been incredibly fruitful from both cultural and research perspectives. As part of the program I feel fortunate to have been able to benefit from the advanced technology available in the Human Ubiquitous-Environment Interaction Group at AIST as well as Dr. Sato's superior knowledge and expertise. I extend many thanks to the Canadian Institutes for Health Research as well as to the Canadian Embassy for supporting my application. Thank you also to the Japanese Society for the Promotion of Science for offering this once-in-a-lifetime opportunity.

RESEARCH REPORT

1. Name: Samir SAHLI	(ID No.: SP09416)
2. Current affiliation: Department of Physics, Physical Engineering and Optics, Centre for Optics, Photonics, and Lasers (COPL), Université Laval, QC, CANADA under the supervision of Prof. Yunlong Sheng	
3. Research fields and specialties: Humanities Social Sciences <u>Mathematical and Physical Sciences</u> Chemistry Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: Japan Advanced Institute of Science and Technology (JAIST), School of Information Sciences, Ishikawa ken, Nomi, JAPAN 5. Host researcher: Associate Professor KOTANI Kazunori	
6. Description of your current research As a doctoral candidate in the Centre for Optics, Photonics and Lasers (COPL), my main research deals with detection and recognition of coloured objects in real, complex and uncontrolled environments. This problem relates directly to the objects' appearance. The main obstacle to achieving robust detection of the objects in an image is the great variability of their appearance. It can be drastically altered because of the nature of the light illuminating, especially when specular reflections on the textured surfaces are present. A precise understanding of the physical phenomena at play is needed to compensate or to eliminate effects of these reflections. In the prof. Kotani laboratory, an extensive analysis of the characteristics objects is done in order to solve problems of specular reflections in computer vision.	
7. Research implementation and results under the program Title of your research plan: Physics-based models for color image processing applied to picture quality evaluation	

Description of the research activities:

During this summer program, we had the chance to achieve a better understanding about the problem of specular reflection and colorimetric fluctuation existing in aerial imageries and more specifically for the metallic surfaces.

The reflection phenomenon is the result of microscopic interactions between the matter (surface) and the light. The dichromatic model proposed by Shafer *et al.* is the principal model that explains properly the nature of radiance L of the reflected light on a surface. In fact, the dichromatic model states that the radiance is a sum of two independent parts: *light reflected at the surface* (specular component) and *the light of the surface body* (diffuse component). Our goal is to detect the presence of the specular component in images and compensate it.

In this project, we used aerial images with low resolution; consequently we only considered the macroscopic effects like presence of lobes in the image and the color distortions such as achromatic regions. These effects disturb and modify the appearance of the objects and even their shapes could be altered.

After an intensive state of art, which resulted in a technical report which was submitted to my supervisor at the JAIST, I defined two opposite manners to detect the specular regions in images.

First one consists on a segmentation based on chromaticity properties of images. In fact, we used a Hue-Saturation-Value and Tint-Saturation-Luminance color spaces to extract regions where the specularities are. This method is based on the use of Luminance histogram in an appropriate region which was previously found thanks to the exploitation of combined information of Hue and Saturation channels. This method is robust to the illumination change and only one threshold has to be determined. In order to find this latter properly and automatically, we exploited a modified histogram. When a gap appears in the histogram, the value associated to it corresponds to the appropriate value of the threshold. Consequently, the method developed is totally automatic. Now, we have at our disposition a robust tool which is able to localize the specular reflections in aerial images.

The second method that we explored consists to find a specular free invariant plan in the RGB cube. This method is a source dependant approach and it is assumed that the source is constant for the entire scene. The information of the vector source is not easy to determine in an uncontrolled environment as aerial images. In the literature, many techniques exist to determine the illuminant; however, we proposed a new adaptive method to find the source vector. In fact, the user selects manually a region where specularities are present and the algorithm looks for the appropriate plan that minimizes a cost function. Once the appropriate plan defined, we applied the same transformation at the entire image to obtain free specular image where color regions are more homogenous.

This method does not require segmentation but is based on the assumption that the illuminant source is the same for the entire scene. Unfortunately, after a number of tests, we are forced to note that the previous assumption is a little bit weak.

In the future, we may develop a method to extract locally the illuminant in a first time in the image and in the second time we may apply adaptively the tool developed during this summer program that takes into account the nature of the illuminant.

The work made during this summer contributed to solve an important problem that we meet in my Ph.D. project. A publication of our results may be considered.

8. Please add your comments (if any):

The summer program in JAIST was very interesting. I have to thank the Prof. Kotani for long and interesting discussions that we had about image processing and about the Japanese culture. I have really appreciated the hospitality and the kindness of my Japanese colleague and my supervisor. Plus, I had the chance to visit other laboratory in Japan but also a lot of touristic places. This summer has been a great experience for my career as a researcher and for my personal experiment. Thanks you for all.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Christopher Boyle	(ID No.: SP090417)
2. Current affiliation: Queen's University	
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences Chemistry <u>Engineering Sciences</u> Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences	
4. Host institution: National Institute of Advanced Industrial Science and Technology	
5. Host researcher: Dr. Akira Tezuka	
6. Description of your current research: <p>The internal architecture of bone, known as the trabecular, has long been hypothesised to be an optimal mechanical structure. In 1892, Julius Wolff proposed that bone will functionally adapt to new loads by reorienting the internal trabecular to align with stress trajectories caused by external loads. In addition, he predicted that bone obtains a structure of maximum mechanical efficiency with minimum mass; an optimal structure. This theory is known as Wolff's Law of Bone Remodelling.</p> <p>Over the last several decades, advanced computational methods have been used to quantitatively investigate bone remodelling. Large scale topology optimization, which was recently completed by members of our research group, proved to be quite accurate; however, this work was completed using a simplified two dimensional model. My current research attempts to extend this work to a full three dimensional model.</p> <p>Topology optimization is when a finite amount of material is distributed into areas of highest loadings in a given design domain; thus, the technique is analogous to bone remodelling. This results in a structure with a uniform strain distribution; which means, each part of the structure is doing an "equal" amount of work. The structural change of the trabecular is caused by surface remodelling; specifically, the metabolic activities of bone resorption by osteoclastic cells and bone formation by osteoblastic cells are partially regulated in response to mechanical stimulus in the bone tissue. Conceptually, this respond is based on the same principal as topology optimization; that is, more mechanical</p>	

loading attracts more mass.

The computational bone remodelling simulation is completed in an iterative fashion, beginning with an initial hollow unorganized trabecular pattern. Three combined loads are applied during the optimization, which updates the trabecular based upon the changes in strain energy density. The current numerical simulation of trabecular bone adaption is based upon the two dimensional simplified geometry and loading cases; as a result, it does not consider three dimensional aspects, such as out-of-plane loadings and possible anisotropy. Therefore, the next phase of the computational study is a full three dimensional model, complete with accurate geometry and loadings.

7. Research implementation and results under the program

Title of your research plan:

Computational Study of Wolff's Law using Topology Optimization Algorithm

Description of the research activities:

Over the course of the research period I was able to accomplish my main goal of implementing the parallel computing framework for the large scale topology optimization algorithm. In addition, I was also able to participate in constructive discussion with several other researchers and achieve collaboration with my research group through a computational simulation "side project", which allowed me to extend my knowledge of fluids engineering.

The three dimensional femur simulation will result in an optimization problem with hundreds of millions of design variables. The computational and memory requirements of such a problem are very large, even for high-end server computers using the conventional topology optimization method. Therefore, the main objective of the summer research period was to implement a framework for high performance computing using the Message Passing Interface (MPI) and other computational techniques to reduce computing costs. These measures were implemented into the custom finite element code and successfully tested for a small scale trial; however, further large scale testing will be required in the coming months using the server system at Queen's University.

As outlined above, I was able to implement several significant portions of the topology optimization algorithm; however, more importantly I was also able to meet with other researchers to discuss, examine, and share further directions for my current research. Fortunately, I was able to meet with Dr. Koji Hyodo, an expert in biomedical engineering specializing in sensing and imaging, as well as with Dr. Akira Tezuka for a round table talk. We were able to discuss possible future research directions including bridging the gap of computer simulation to "real world" applications and ways for model validation, such as exterior cortical strain methods. This dialogue

between the two experts and I proved to be exceptionally important and yielded some very exciting concepts that I eagerly anticipate implementing in the coming year.

The final research experience was participation in a fluids simulation “side project” with Dr. Tomohiro Sawada and Mr. Shun Nagahama. Due to the guidance of both researchers, I was able to learn the theory, application, and technical skills to operate their custom Extended Finite Element Method (X-FEM) software. We were able to utilize a 3D Laser scanner to scan an object (a “Tanuki”), convert that object to a finite element mesh and implement it into the fluid grid, and perform several simulations based on different flow conditions to predict resulting drag forces, pressures, and flow velocities. The objective was to test and showcase the powerful user interface of the system, which was straightforward for an unfamiliar user to quickly learn. Though not directly related to my field of research; we were able to share ideas on applications of optimization and brain storm ideas to solve some of the common meshing problems inherent to scanning and meshing of complex 3D objects.

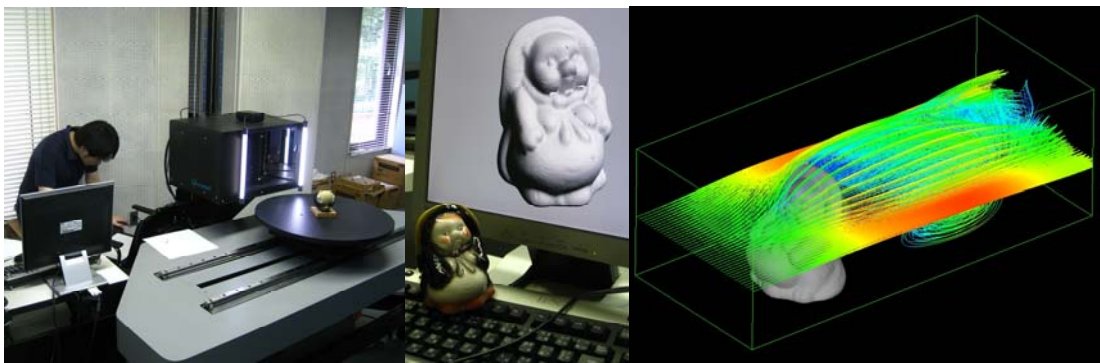


Figure 1 – Laser Scanning of “Tanuki” and Fluid Flow Simulation Results

8. Please add your comments (if any):

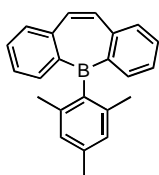
The ability to immerse oneself in a completely different culture to form exceptional friendships and achieve collaboration is truly amazing. Thank you to JSPS, SOKENDAI, and AIST for the opportunity to participate in such a rewarding experience.

9. Advisor’s remarks (if any):

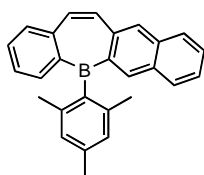
Mr. Boyle seemingly enjoyed the research and the weekend activities in a good balance during his stay with many interests both in research and culture. He has excellent abilities to recognize the key points with the short advice and solved by himself. We’ll keep in touch for the further research and the application. It was a nice setting by JSPS.

RESEARCH REPORT

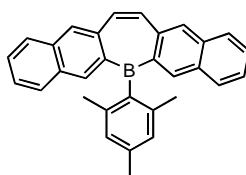
1. Name: Lauren G. Mercier (ID No.: SP09418)
2. Current affiliation: University of Calgary, Calgary, AB Canada
3. Research fields and specialties: Humanities Social Sciences Mathematical and Physical Sciences <u>Chemistry</u> Engineering Sciences Biological Sciences Agricultural Sciences Medical, Dental and Pharmaceutical Sciences Interdisciplinary and Frontier Sciences
4. Host institution: Nagoya University, Nagoya
5. Host researcher: Dr. Shigehiro Yamaguchi
6. Description of your current research <p>Organic materials have found applications in electronic devices such as field effect transistors (OFETs) and light emitting diodes (OLEDs) due to their ability to transport holes (p-type) or electrons (n-type), inexpensive cost and ease of processability. Substitution with heteroatoms like boron, nitrogen and sulfur alter energies of the highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO) energies, as well as the gap between them. Research in the Piers group has focused on the incorporation of boron into linear acenes and recently a seven-membered aromatic ring containing a boron atom, termed “borepin”, has been shown to display unique photophysical properties. (1) Compounds 1, 2, and 3, which can be viewed as analogues of anthracene, tetracene and pentacene, have been prepared and all display strong blue-coloured emissions. A Wittig reaction was utilized to construct the borepin framework and then a common tin-boron transmetallation step was carried out (Scheme 1). Strong blue fluorescence is attributed to an intramolecular charge transfer (ICT) state between low lying filled orbitals centred on the aromatic core and higher energy empty orbitals, which have strong contributions from the boron atom. As conjugation increases from 1 to 3 the gap between these orbitals becomes smaller and the colour of fluorescence shifts to longer wavelengths becoming more “red-shifted”.</p>



1

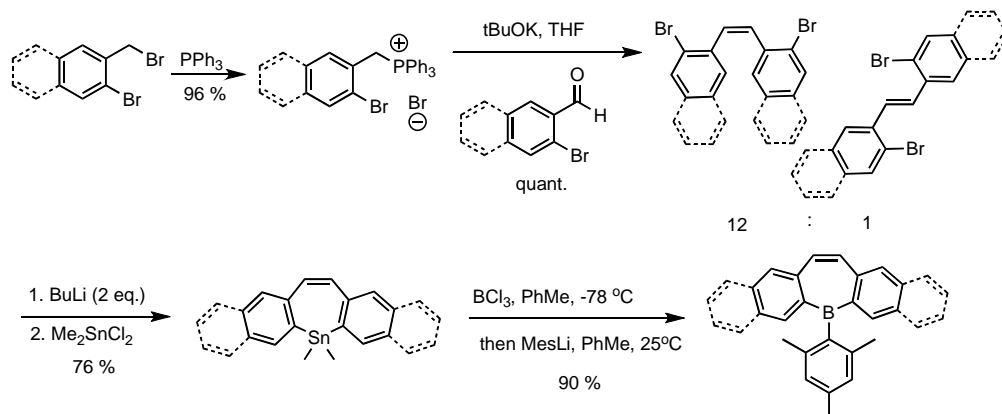


2



3

Scheme 1.



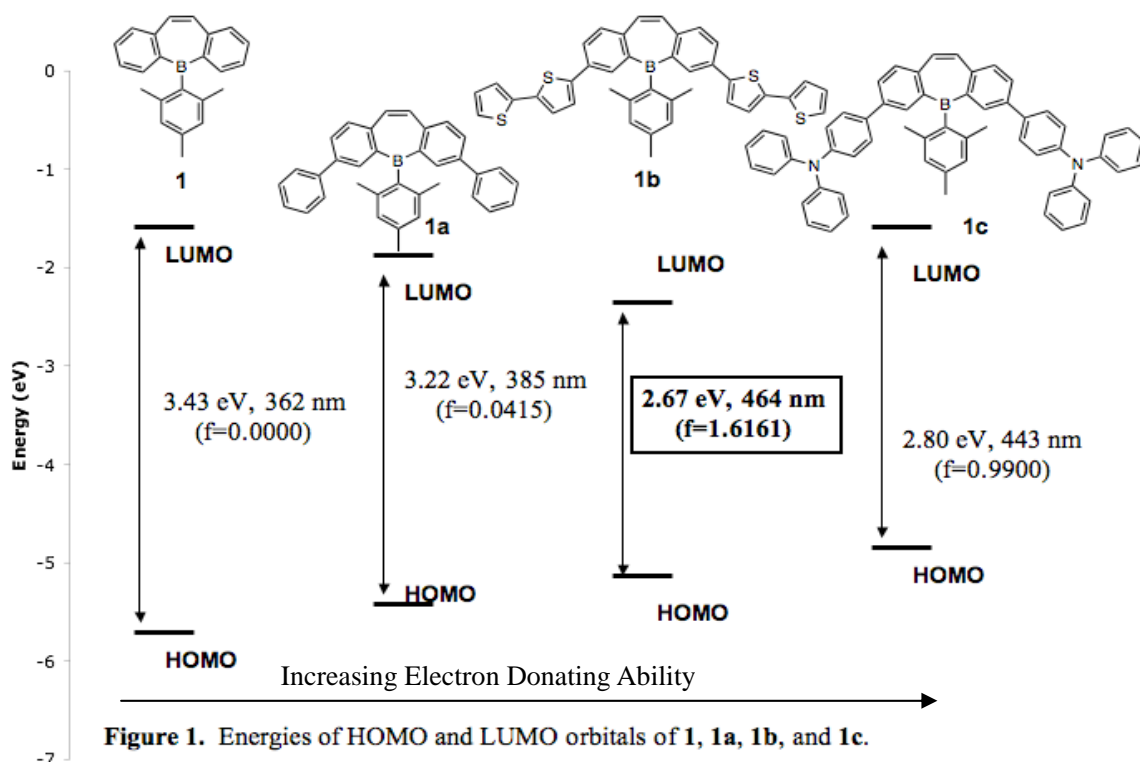
(1) L. G. Mercier, W. E. Piers, M. Parvez, *Angew. Chem. Int. Ed.* **2009**, *48*, 6108.

7. Research implementation and results under the program

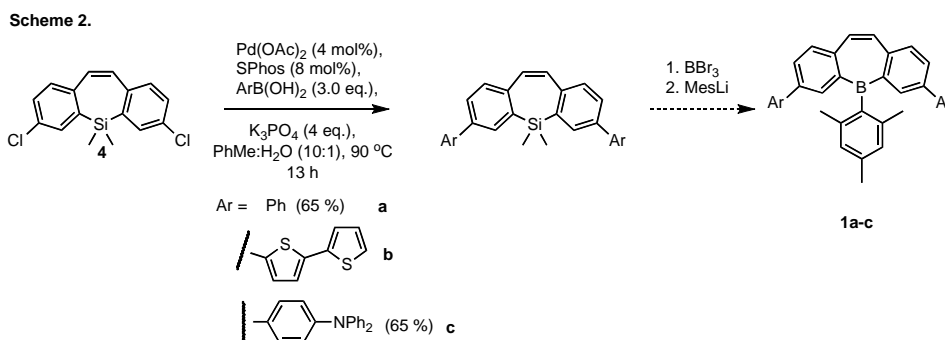
Title of your research plan: “Polycyclic Aromatic Hydrocarbons (PAHs) Containing a Borepin Core”

Description of the research activities:

The goal of the research carried out in the Yamaguchi Laboratory was to synthesize novel PAHs containing a borepin core and to investigate their photophysical properties. Introduction of electron donating groups, such as phenyl (**1a**), bithiophene (**1b**) and *N,N*-biphenylaniline (**1c**) to the position meta to boron of compound **1** were predicted to induce strong charge transfer character and increase the probability of HOMO-LUMO transitions. This would intensify absorption and fluorescence intensities and cause bathochromic shifts in their corresponding photophysical spectra. Gaussian calculations revealed red shifts in all substituted cases (**1a-c**) by the increase in optical band gap, but the oscillator strength (*f*), which is proportional to the strength or intensity of transition, varied. As can be seen in Figure 1, all compounds had higher oscillator strengths for HOMO-LUMO transitions than the parent compound, **1** (*f* = 0.0000), although the trend did not follow that of electron donating ability. Compound **1a**, which had very little charge transfer character, had the weakest oscillator strength (*f* = 0.0415) and the strongly electron donating *N,N*-biphenylaniline group gave moderate transition probability (*f* = 0.9900). The moderately electron donating bithiophene moiety in **1c**, gave very strong HOMO-LUMO correlations (*f* = 1.6161) which implies that strong transfer character comes from matching orbital energies of the electron donating group with that of the dibenzoborepin accepting unit.



Synthesis of **1a-c** and their precursors was carried out using a Suzuki coupling reaction with dichlorosilepin **4** (Scheme 2.). Preliminary results show these compounds to be promising fluorescent materials.



8. Please add your comments (if any)

9. Advisor's remarks (if any):

Lauren Mercier studied the research entitled "Polycyclic Aromatic Hydrocarbons Containing a Borepin Core" for these two months. Despite the short period, she successfully synthesized a couple of fused silepin derivatives, which would be useful compounds as the key precursors for the target borepin derivatives. In addition, she performed theoretical calculations to get deep insights into the effects of the extension of the π -conjugation on the electronic structures in the borepin-cored PAHs. The obtained knowledge would be precious for further molecular designs. I believe that these two months' experience would give the important basis for her further research in Canada. She also well made communications with Japanese students and enjoyed and learned the Japanese culture. I hope this stay would be an irreplaceable experience for her life.