# HISTORY OF THE UH-MANOA PHYSICS DEPARTMENT

compiled by Vincent Z. Peterson

Prior to 1923: A Department of Physics as a separate entity did not exist. Rather, physical sciences were taught by individuals in General Science who had various specialties, such as seismology, or chemistry, or biology. The fragmentary data available indicates that recruitment for a full-time physicist arose when the physicist/seismologist Thomas Jaggar who had covered both physics and seismology decided to move to the Big Island and work with the Volcano Observatory.

First Full-time Physicist: Paul Kirkpatrick. Kirkpatrick's autobiography ["Some personal actions and reactions", 1971 Autobiography, American Institute of Physics Project on Recent Physics] reveals that he was offered the job of becoming a "one-man physics department" at the University of Hawaii shortly after he received his PhD in Physics from the University of California, Berkeley. The recent departure of Jaggar from Oahu to the Big Island meant that UH had no-one to teach physics! Although Kirkpatrick had received an offer from the "Southern Branch" of the University of California, he turned it down since the prevalent opinion was that this fledgling outpost of UC (which grew into UCLA!) would "never amount to anything". Since the pay offered by the University of Hawaii ($3600/year) was better than offers made to his Berkeley peers, Kirkpatrick took the UH job!

Arthur Dean was then President of UH, there were only five buildings on campus, enrollment was about 300, and the entire faculty numbered only 50 members. The "physics department" was a one-man operation; it wasn't until 1931 that the Department had three full-time faculty teachers. Physical Science was located in the first floor of Gartley Hall. Engineering occupied the basement, and Chemistry the second floor. Kirkpatrick's Berkeley PhD thesis was in the field of x-rays and his natural inclination was to continue with x-ray research at UH. Since there was no x-ray equipment at UH, he improvised with some disused pieces of hospital radiological apparatus to extend his previous studies of the polarization of x-rays. It was very difficult to do research at Hawaii, with no other physics PhD within 2000 miles. It was only later that an enthusiastic student (Iwao Miyake), capable in shop work, joined Kirkpatrick and helped construct apparatus for polarization measurements. (Later on, Miyake graduated, went on to obtain an MS degree at UH, and became a regular member, and later Chairman, of the UH Physics Department.)

Occasional contacts with visiting physicists (e.g. Prof. David L. Webster of Stanford), were stimulating to Kirkpatrick. Otherwise, Kirkpatrick felt that his long-term future at UH could become "pleasurable scientific suicide". He applied for a National Research Council fellowship, but did not get it. He filled a summer quarter appointment at UCLA in 1924 (and saw that the "Southern Branch" was growing!). On the return boat trip

to Honolulu he met a young woman who later became his wife. After returning to Hawaii Kirkpatrick (with Miyake's help) made some progress in research: they built a Bragg spectrometer and obtained results on x-ray polarization. Kirkpatrick wrote to Arthur Holly Compton (later to win a Nobel Prize in physics) who. encouraged him to submit his polarization paper to the Proceedings of the National Academy of Sciences; it was accepted and became the first" basic research" publication from the UH Physics Department.

In 1928 it became possible to hire another physicist for teaching and Kirkpatrick hired a young man named Willard "Jack" Eller, a fresh PhD (in physics) from UC-Berkeley. UH students in physics were mainly from engineering. Eller pitched in with enthusiasm to improve the laboratory courses.

During his stay in Hawaii, Kirkpatrick assisted in the founding of the Hawaiian Academy of Sciences and served as its first Secretary. He invented several practical devices (e.g., a so-called "generating voltmeter", the precursor of present-day vibrating reed voltmeters). He was finding life in Hawaii --family, social, professional -- more pleasant than it had ever been elsewhere, and his autobiography states: "it is likely that I should have remained at the University of Hawaii to the age of retirement had not external and unsolicited challenges interposed".

After 6 years at UH, in 1929, Kirkpatrick was in line for a sabbatical, which he took at Cornell, at the invitation of Prof. F. K. Richtmyer. He found this Cornell year (1929-30) very stimulating, especially interactions with physicists such as Ernest Meritt and E. L. Nichols (founders of the American Physical Society), Richtmyer, and G. P. Thomson. Sir George P. Thomson (son of J.J. Thomson, discoverer of the electron) was then visiting at Cornell. He introduced Kirkpatrick to the mysteries of wave mechanics and dazzled him with demonstrations of x-ray diffraction from crystals.

The Dirac-Heisenberg visit to UH in summer 1929: Kirkpatrick's success in having his x-ray polarization work published by the National Academy of Science, and his stimulating contacts with visiting physicists led him to encourage other well-known physicists to stop at UH whenever possible. In early 1929 he learned that two world-famous physicists, P.A.M. Dirac and Werner Heisenberg (both later to win Nobel prizes in physics), were planning A joint round-the-world trip in the summer of 1929 and their boat had a stop at Honolulu. Kirkpatrick promptly invited them to stop at UH, and expressed the hope that they could be willing to lecture on their work while in Honolulu.

As it turned out, their passage across the Pacific was delayed (to arrive in Japan for a conference in Kyoto in early September). By late August 1929 Kirkpatrick had already left Honolulu to begin his sabbatical at Cornell. However, he had briefed the Acting Chairman, Prof. Willard Eller, on the expected visit by Dirac and Heisenberg. Teaching physics was Eller's major activity at UH; he was not involved in any research, nor did he attempt to keep up with the Physics literature. Hence when these two young physicists (Heisenberg was 28, Dirac 27) showed up at UH, Dr. Eller did not recognize them; apparently he had forgotten

Kirkpatrick's briefing. However, according to Dirac, Eller was "quite hospitable". According to J. H. Van Vleck of Harvard (also a Nobelist and a friend of Heisenberg, "when Dirac and Heisenberg met the chairman of UH Physics and told him their names, he informed them that if they would like to attend some of the physics lectures at the University, they would be most welcome!".

Van Vleck's story has been a source of embarrassment to later generations of UH physicists. However, neither Dirac (who visited Hawaii again in 1935, and then once more in 1975) nor Heisenberg (who was invited to pay a visit in 1974, but was unable to do so) was very concerned. Professor San Fu Tuan, who was recruited to UH in 1965 from the Institute for Advanced Study to direct the Theory program in High Energy Physics, was intensely interested in this episode and corresponded with both Dirac and Heisenberg. Dirac described the episode as follows: "We were just tourists on holiday, and I do not think that the question of lecturing was ever mentioned." In 1974 Dirac delivered a well-attended lecture in Kuykendall on his relativistic quantum theory (which led to the discovery of anti-particles). Heisenberg was also invited back to Hawaii in 1974, but demurred on grounds of his advanced age.

For a detailed account, see S. F. Tuan's paper "Dirac and Heisenberg in Hawaii", included in the UH Archives section under" History of the UH Physics Department".

Kirkpatrick leaves for Stanford: Kirkpatrick returned to Hawaii in Fall 1930, in spite of two invitations to apply for Mainland posts, and settled back into his earlier routine. In mid-academic-year 1930-31, however, he received an urgent cablegram from Webster (Stanford) urging him to accept a one-year appointment to fill a sudden vacancy in the small (four-person) Stanford department of Physics. After arranging for a teaching replacement for the remainder of that year, Kirkpatrick left Hawaii to join Webster at Stanford.

Kirkpatrick never came back to Hawaii: he remained at Stanford for 28 years, during which time he served for a number of years as Chairman of Stanford's Department of Physics. He died in 1993 at the age of 98, a revered campus figure.

Willard Eller becomes Chairman: 1931: When it became clear that Kirkpatrick would not be returning from Stanford, Willard Eller was appointed as head of the Physics Department in 1931. The focus of effort at UH continued to be on teaching, and Eller devoted himself to this goal with enthusiasm. Iwao Miyake claims that Eller discouraged attempts at research as being a diversion of scarce resources. Eller enjoyed working with his hands and built much of the equipment for the teaching laboratory. Walter Steiger, a later contemporary of Eller, remembers him as an excellent teacher, if a hard taskmaster for the students. Teaching was the dominant focus of effort in Physics at that time, although a Masters Degree program was instituted in 1935.

During Prof. Eller's 26-year (1931-19571) tenure as Department Chairman he was occasionally able to secure an additional teaching position for Physics, allowing some

research on the side. One such person was Stanley Ballard (UH instructor, 1935-37, Assistant Professor, 1937-41) who came from Berkeley with a degree in Physical Chemistry. Initially his research was on spectrochemical analysis of plant materials for the Hawaii Sugar Planters Association (HSPA); later he applied his spectroscopic abilities to analysis of volcanic gases. At that time the faculty of the Physics Department consisted of Eller, Miyake, and Ballard. Ballard was active in the Hawaiian Academy of Science and helped to found the Hawaii chapter of Sigma Xi. He was recruited into the military in World War II and did not return to UH, instead taking a position at Florida State University.

During the World War II period, and for some years thereafter, the size of the Department of Physics remained essentially constant and undergraduate teaching continued as the main function.

Second phase of Eller-era (1953-1963): The Department of Physics gradually became involved with astronomy and astrophysics as the result of adding Walter Steiger to the faculty in 1953. Steiger graduated from MIT in 1948 and decided to return to his "adopted home" of Hawaii in hopes of finding a teaching job. Instead he became a graduate student in physics and landed a Teaching Assistant position with Prof. Eller. Eller encouraged Steiger to work for advanced degrees in physics; after earning a MS in Physics at Hawaii, Steiger went on to obtain a PhD in Physics at the University of Cincinnati (1953). Prof. Eller then offered Dr. Steiger a position as Assistant Professor of Physics at UR. Physics Steiger accepted and became the third faculty member at UH.

Steiger plunged into undergraduate teaching, and founded a chapter of the physics honor society (Sigma Pi Sigma) which encouraged student achievement. This group also sponsored social events, such as dinners with faculty members and picnics at Ala Moana Park. Departmental files include a few photographs taken from this period, which reflect a low-key, friendly atmosphere.

Steiger also wanted to undertake some research, so he joined Iwao Miyake in developing electrofishing: attracting fish by establishing a pulsed-DC electric field in the water. Early tests in a fresh water tank at the Waikiki Aquarium were very encouraging. However, when tested in a salt-water tank at Coconut Island, the low resistance of the salt water required such a powerful DC generator that the method proved to be impractical.

Steiger's primary interest was in solar physics and the establishment of a solar observatory on Haleakala. In this he worked closely with leading solar astronomer Dr. Walter Roberts of the High Altitude Observatory at the University of Colorado. Hawaii's high mountains and very clear atmosphere provided ideal conditions for observations of the solar corona. As detailed in Steiger's A Brief History of Astronomy in Hawaii, this led to the establishment of the Haleakala Solar Observatory on Maui, funded by the National Science Foundation.

Steiger and Miyake were both involved in the activities associated with the 1957 -

58 International Geophysical Year. Steiger collaborated with the cosmic ray group headed by Dr. Robert Brode (UC-Berkeley) to establish a neutron-monitoring station at Makapuu Point. Solar observations were also made at Makapuu during the period when the Haleakala Observatory was under construction. Miyake set up a radio receiving apparatus to measure radio noise from the sun.

During the brief period (1955-1957) when Paul Bachman was President of UH, there were several significant moves to strengthen research on campus. Dr. Robert Hiatt, who had developed a successful Marine Biology program at Coconut Island, was brought to the Manoa campus as Dean of the Graduate School and Director of Research. His proactive attitude favored expansion in the natural sciences, including physics.

Recruitment of Kenichi Watanabe: Dean Hiatt encouraged the Department of Physics to persuade Dr. Kenichi Watanabe, an outstanding physicist formerly at UH, to return to the Islands and UH. Watanabe had spent two years as an undergraduate in physics at UH before transferring to CalTech. He then completed his BS in physics (1936) and PhD in physics (1940) at CalTech. Watanabe returned to UH in 1940 to teach in the Mathematics Department, remaining until 1947. He then moved to the mainland, first to teach physics at Wabash College (1947-48), and then to do research at the Naval Research Laboratory (Anacostia, DC) where he pioneered studies of the upper atmosphere using rocket techniques (1948-1951). He then moved to Cambridge, Mass. to be Chief of the Section on Atmospheric Composition at the Air Force Research Lab. During this period he steadily gained recognition for outstanding scientific ability and productivity.

Ken and Betty Watanabe's love for Hawaii was a strong factor in persuading him to return to UH in 1955 to help build up a program in physics research. Watanabe's research field of UV spectroscopy, important in the field of planetary astronomy, was strongly supported by the US Space Program. Dean Hiatt helped Watanabe to obtain funds for equipment in UV spectroscopy.

The triumvirate: Willard Eller retired in 1957, after 29 years dedicated to teaching physics at UH. The "triumvirate" of senior members of the Department (Miyake, Watanabe, and Steiger) then agreed to take turns handling the administrative responsibilities of Departmental Chairmanship. The records indicate that the rotation was as follows:

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| Miyake | 1957-1959 |
| Watanabe | 1959-1961 |
| Steiger | 1961-1963 |

During Miyake's tenure as Chairman, he recruited Janos Kudar, a former student of Erwin Schrödinger (originator of wave mechanics), to teach quantum mechanics at UH. Kudar was then teaching in Brazil. Several famous Hungarian physicists, including E. P. Wigner, maintained contact with Kudar during his career at UH.

Kenichi Watanabe continued to lead the Department of Physics in a vigorous

expansion of research in physics during this period, while Walter Steiger urged the Department to take advantage of Hawaii's natural advantages in astronomy. Watanabe recruited Howard McAllister (PhD, 1959 Univ. of Colorado) in 1959 to strengthen the UV spectroscopy program. William Pong (PhD, 1954, Univ. of Cincinnati) was recruited in 1960 to begin a program in UV photoelectron spectroscopy. Using the vacuum ultraviolet light source developed by Prof. Watanabe, Pong and his students were able to make measurements of electronic structure o solids in the photon energy range 10 - 23 eV. In 1997 Prof. Pong retired from UH.

The growing physics program led to the need for more space for research as well as teaching. Physics had expanded its activities to occupy both the Basement and First Floor of Gartley Hall. Plans for a new Physical Science Building were drawn up and funding was sought from the State. (Iwao Miyake's brother, Noboru Miyake, was an important State Legislator and was kept well-informed on the needs of the growing Physics program.) By late 1961 the new "PSB" building was ready for occupancy.

The late 1950s was also a time of rapid change in the Hawaiian economy due to the introduction of jet aircraft and expansion of tourism. Territorial revenues increased substantially. Hawaii became a State in 1959. In the 1960 election, Territorial governor William Quinn (Republican) defeated Democratic candidate John Burns, by running on an "Education" platform. Quinn had promised to strengthen the University. He then appointed a new Board of Regents (chaired by Herbert Corneulle) to search for a new President of UH to replace retiring Lawrence Snyder. The new BOR recruited Thomas Hale Hamilton, then head of the State University of New York. By the time Hamilton came on board (1963), a new election had been held and John Burns this time defeated Bill Quinn for Governor.

The new BOR and President Hamilton were committed to expansion of the University, including research and PhD-level graduate study. Robert Hiatt was elevated to the position of Vice-President. New deans were recruited for Arts and Sciences and the Graduate Division; an Office of Research Administration was organized, and new faculty (with research experience) were to be recruited.

Physics was encouraged to also recruit additional faculty for introductory physics teaching and laboratory instruction. Watanabe was aware of the outstanding teaching record of Katashi Nose at Kauai High School, as well as Nose's remarkable ability in ham radio. Eventually (by 1961) Nose was persuaded to accept a position at UH Physics, where he took charge of the undergraduate physics laboratories. He also organized NSF-funded summer institute courses for high school teachers. His previous advanced degree was in Sugar Technology, but he now went to Harvard to earn a Master's Degree in Education (1961). Nose's life-long interest in ham radio continued in Honolulu, with his daily columns on ham radio in the Star-Bulletin.

Kenichi Watanabe, as the best known researcher of the "triumvirate", was urged (by Vice-president Hiatt and others) to press ahead vigorously in expanding the research capability of the Department of Physics and establish a PhD program. In 1961 Watanabe

visited California Institute of Technology (his PhD alma mater) in search of an experienced researcher/teacher in the field of nuclear physics. The CalTech Synchrotron was then a decade old, nearing the end of its useful research life. Thus the CalTech physicist-professors associated with the Synchrotron project were open to new opportunities elsewhere. Watanabe succeeded in persuading Vincent Peterson of the CalTech department of Physics to visit Hawaii and consider a position with the UH. Eventually Peterson agreed to join the UH Department of Physics, with the understanding that the 1962-63 year would be spent on leave at Va-Berkeley in order to launch the first Hawaii-Berkeley Collaboration experiment in high energy pion-nucleon interactions. It was also understood that Peterson's recommendation for recruitment of two additional UH Physics faculty members (later chosen as Robert J. Cence and Victor J. Stenger) would be given serious consideration by the Department.

Watanabe continued his active recruiting for UH Physics, searching for an experienced physicist-administrator to succeed the "triumvirate" as Chairman of the Department of Physics. Although Watanabe himself was the popular choice to lead the Department on a long-range basis, he intensely disliked administrative duties. Thus, during an American Physical Society meeting at USC in 1962, he held discussions with John R. Holmes, who was then retiring as Chairman of the USC Physics department, and sought to persuade Holmes to come to Hawaii. Holmes initially stated that he had "had enough of being chairman" (at USC), and was not anxious to again chair a department. However, Watanabe countered that a reluctant candidate was the "best person to carry out the job effectively". Holmes eventually was persuaded to come to UH, after completing a 1962-63 Fulbright year in Spain.

Holmes had an extensive background in research, beginning with wartime R&D at Berkeley's Radiation Laboratory and later in optical spectroscopy at USC. In coming to UH, he brought with him Air Force contract support for research in atomic physics using lasers. This helped to support a small number of graduate students working in laser spectroscopy over the years.

Thus Watanabe was able to recruit four additional UH Physics faculty members, adding to the 1961-62 roster of six Physics faculty members (Watanabe, Miyake, Steiger, Kudar, McAllister, and Pong). With the arrival of Peterson, Holmes, Cence, and Stenger in 1963-64 the Department of Physics had suddenly grown to 10 full-time faculty!

## BUILDING A PHD PROGRAM IN PHYSICS (1963-1971):

The new faculty in Physics introduced new approaches in both teaching and research, and attracted graduate students seeking the PhD in Physics. The basic courses in physics were revised, shifting from large lecture courses to smaller sections, for closer student-teacher contact. More rigorous material in atomic and nuclear physics and quantum mechanics was introduced. New laboratory courses were introduced (e.g., an upper division lab which included cosmic ray particle detectors, lasers, and experiments in radioactivity.).

Extramural funding (initially $125,000) for particle physics research in 1963-64 was obtained by V. Peterson from the Atomic Energy Commission (AEC). This enabled the research group team (Peterson, Cence, and Stenger) to begin an active nuclear physics program, based on spark-chamber experiments planned and analyzed at UH with data-taking at UC-Berkeley's "Bevatron" proton synchrotron. The need for a nuclear physics theorist to join the effort led to the appointment of Peter N. Dobson (PhD,'65, Maryland) in early 1965. (In later years Prof. Dobson's administrative talents would be recognized by appointment as Chancellor at Hilo, and also as Vice-President of the University.)

In the summer of 1965 Peterson organized the first "Hawaii Topical Conference in High Energy Physics", so that Hawaii physicists could interact closely with national and international HEP researchers. Direct support was obtained from DOE and NSF (matching UH support), in order to fund the expenses of a few Principal Lecturers; otherwise attendees came with their own support. A series of ten Topical Conferences were held in alternate years from 1965 through 1985. These Topical Conferences featured a few "superstar" Lecturers (experimental and theoretical) on current topics in High Energy Physics. Other talks were given by "students" (recent postdoctoral researchers in the field). This "summer school" format was later widely imitated elsewhere in the U.S. The "grand finale" (bringing back many previous Lecturers, some now with Nobel Prizes) was held in 1985, and included an historic "Town Meeting" held in a packed Kennedy Theatre.

The interest in Hawaii generated by the First Topical Conference helped in recruiting San Fu Tuan (PhD '58, Berkeley) from Purdue as Visiting Professor in the Fall 1965-66. Later on Prof. Tuan accepted a permanent appointment and led the Theory Group for a number of years.

By 1971 the research program in nuclear physics (now renamed "High Energy Physics") had expanded in effort as well as personnel, enabled in part by a tripling in annual extramural funding (to $375,000).

Another major development during this period was Walter Steiger's recruitment of a trio of experienced solar astronomers (John Jefferies, Frank Orrall, and Jack Zirker), led by Jefferies (a theoretical solar astronomer from Australia). This built upon the establishment of the Haleakala Solar Observatory in 1961 by Steiger. The "academic home" of these new astronomers was the UH Department of Physics, although initially their research was funded through the Hawaii Institute of Geophysics (HIG). However, Jefferies and colleagues soon set their sights upon developing Mauna Kea for optical (and planetary) astronomy. Mauna Kea had been identified (by Gerard Kuiper of Arizona) as a premier site for optical astronomy, especially planetary astronomy. Vice-President Hiatt was determined that astronomy in Hawaii would be run by the University of Hawaii. Within a few years a separate Institute for Astronomy (IFA) was established, headed by Jefferies.

A change of departmental name, to the "Department of Physics and Astronomy", was made in 1964 to include the new astronomy faculty. Courses in astronomy, both at the

undergraduate and graduate level, were instituted. Introductory astronomy courses soon became popular. In keeping with national norms, however, Physics was the basic undergraduate major for graduate work in Astronomy. Despite abortive moves to create a separate Department of Astronomy at UH, the combined Physics and Astronomy academic program has stood the test of time, with a separate Graduate Chairman for Astronomy. IFA organizes and oversees astronomical research, which requires major extramural funding and hiring of specialized staff. (For more detail, see the separate section on Astronomical Research, and IFA.)

In 1967 the Department moved to strengthen solid state physics research and teaching with the appointment of Burton Henke. Henke earned a 1953 CalTech PhD in low energy X-ray physics, and later carried on a productive undergraduate research program in this field at Pomona College. In coming to UH, he agreed to undertake overall direction of the undergraduate physics laboratories. Henke also transferred his low energy X-ray program and equipment to UH. A number of PhD students completed theses with Henke and went on to successful careers in physics. Low energy x-rays are involved in fusion energy as diagnostics of temperature. In 1986 Henke retired from UH to establish a low energy X-ray lab for Lawrence Berkeley Laboratory (LBL) for research projects using synchrotron radiation. Henke arranged for the transfer of his x-ray equipment to LBL, and LBL staffed this lab with Henke's former students.

High Energy Physics programs were strengthened by the addition of Michael W. Peters (PhD, Wisconsin, '64) in 1966, Sandip Pakvasa (PhD, Purdue, '66) in 1967, and David Yount (PhD, Stanford,’62) in 1969. Peters joined with Stenger and Peterson in bubble chamber physics, initially at Stanford's Linear Accelerator Center (SLAC). Yount's experience with electron-beam physics at SLAC bolstered the HEPG experiments utilizing electronic counters at LBL, SLAC, and Fermilab. All of these new faculty members assumed the normal share of teaching both undergraduate and graduate courses in Physics.

The first full-time Research Associate for High Energy Physics was Dr. Frederick A. Harris who was recruited from the University of Michigan in 1970 to join the new neutrino physics program which Hawaii and Berkeley were to collaborate on for many years at the new Fermilab accelerator. After playing a key role in developing the External Muon Identifier (EMI) at Berkeley and Fermilab into a major facility, Dr. Harris was called back to UH to teach and join the regular faculty.

Dr. Sherwood I. Parker was recruited from Berkeley in the Fall of 1971 as a Research Associate to add experimental expertise to the group, not only at Fermilab but also in parallel programs at UC-Berkeley's BEVATRON and the Stanford two-mile linear accelerator (SLAC). Dr. Parker continues to reside in the Bay Area and continues to lead UH-HEPG efforts in detector development.

Charles Hayes (PhD, West Virginia,'67) and Peter Crooker (PhD, Naval Postgraduate School, ‘67) were recruited in 1967 and 1970, respectively, to provide additional teaching and research in the field of Condensed Matter. Hayes, an outstanding teacher, also has

interests covering a wide range of subjects, including horticulture (fruit fly eradication in papayas) as well as the theory of liquid crystals. Crooker initiated and built up an experimental program of research in liquid crystals at UH. Both Hayes and Crooker later on were elected to terms as Department Chair. Hayes later also served a term as Interim Dean of Natural Science from 1991 to 1994.

The PEACESAT (satellite communication) project began in 1971 with Katashi Nose of the Department of Physics as a key member of the PEACESA T team. PEACESAT depends upon low-cost ground-stations to communicate between Hawaii and various island outposts in the Pacific, using an available NOAA satellite to relay messages between ground stations. Although senior UH personnel in the EE and Communication Depts. provided organization and funding, it was the pragmatic experience and talent of Katashi Nose that developed a system which was cost-effective and reliable. (He assembled the first transmitter-receiver system from a modified two-way taxicab radio!) PEACESAT quickly became operational, and received widespread acclaim for successful achievement of its goals.

Nose also received an Outstanding Teacher award in 1971 for his work training high school teachers, with support from NSF. Nose's efforts also brought praise from Prof. Gerard Holton (Harvard), leader of the Harvard Project in (pre College) Physics teaching. Unfortunately, Nose suffered a stroke in March 1979, and retired due to disability. In April 1994 he passed away at the age of 78.

The continued growth of Physics during this period inevitably led to the need for additional building space for research and teaching. A modern four-story building, now called Watanabe Hall, was completed in 1971. Although Physics continued to rely upon PSB for a lecture Auditorium and for teaching laboratories, Watanabe Hall provided a modern machine shop, many new offices and classrooms, and laboratory space for research. Department office staff and all faculty moved to the new building in the fall of 1971.

In 1969 the Department suffered a major loss in that Kenichi Watanabe died suddenly of a heart attack. The new Physics building was named" Watanabe Hall" in honor of this talented, kind, and selfless man who did so much to build the modern UH Physics faculty and program.

## PHYSICS BASED IN WATANABE HALL: 1972 THROUGH 1980.

The move to Watanabe Hall provided space for expansion of programs in several areas of physics research. During the 1963-1972 period, with Holmes as Chairman, the Physics faculty roster increased by 10 new teaching faculty (six with High Energy Physics interests and four in other fields). By 1972 it was time to consolidate advances in facilities and personnel, revise the curriculum in both undergraduate and graduate programs, and contemplate in what new directions any future expansion should take place. Walter Steiger

was called upon to Chair the Department in this new phase of Physics development.

The only new faculty position added during this period was in Theoretical High Energy Physics, in response to the strong desire of Tuan and Pakvasa to share research with a third colleague. The Energy Research and Development Agency (successor to AEC) was persuaded to provide research backing for such an appointment. Ernest Ma (PhD, UC-Irvine, '70), with postdoctoral experience at University of Oregon, was hired in January 1977 and helped to spark a major increase of productivity in the theoretical program. Unfortunately, Univ. of California (Riverside) wooed him away from UH in 1988.

The Experimental program in High Energy Physics took advantage of new facilities at Fermi National Accelerator Laboratory ("Fermilab") to start a program of neutrino physics: experiments utilizing the large cryogenic bubble-chamber (30,000 liters of liquid hydrogen-Neon) made available as a "national facility" at Fermilab. Competition to utilize this resource was fierce, with national peer review of proposals. However, the UH-HEPG group was successful in winning approval (and continued Federal support) for a series of neutrino-beam experiments using this 15-foot bubble chamber. These experiments provided tens of thousands of neutrino events on film which could be analyzed at remote University laboratories such as Hawaii. Space in PSB was available to install modern scanning and measuring projectors, and student operators were employed. The campus IBM-7040 computer became available for kinematic analysis of events. In 1976 additional extramural funding enabled Hawaii to recruit Dr. Michael D. Jones to join UH-HEPG as a Research Associate.

**DUMAND Project**

In the Fall of 1979 the Department of Physics and Astronomy included 21 teaching faculty (17 in Physics, 4 in Astronomy). Additional PhDs were involved in research in Watanabe Hall or at IFA. There were almost 2000 undergraduate students (mainly from engineering) taking physics courses and two dozen graduate student seeking PhDs in Physics or Astronomy. In research, the total extramural funding for physics was close to $800,000; High Energy Physics extramural support alone was $743,000.

UH-HEPG interest in neutrino physics, developed in the 1970s through bubble-chamber experiments at Fermilab, led to Hawaii involvement in the DUMAND (Deep Underwater Muon and Neutrino Project) project. DUMAND's goal was to detect ultrahigh energy neutrinos from astrophysical point sources (e.g., binary star systems, active galactic nuclei), using instrumented regions of the deep ocean as both target and detector. At the first DUMAND Worskhop in 1975 in Bellingham Washington, an international group of cosmic ray experimenters had selected Hawaii as an ideal site. As a result a second workshop was organized in Hawaii by Fred Reines (UCI), John Learned (U. Wis.) and Arthur Roberts (Fermilab), with the latter leading the 1976 DUMAND Workshop. This workshop was a

great success attracting high level scientists from around the world, and resulting in not only formation of the DUMAND Project in Hawaii, but a parallel effort in Lake Baikal, and eventually leading to the large deep underground neutrino experiments, such as IMB (Ohio), HPW (Utah) and Kamiokande (Japan).

Two Hawaii physicists (V. Stenger, V. Peterson) were especially interested in such a "local" project, and sought both UH and Federal support. (By this time, "DOE = Department of Energy" has succeeded "ERDA" with changes in U.S. Presidents.) UHM Chancellor Anderson provided one temporary position for DUMAND, to be matched by one DOE-funded temporary position, in order to conduct a DUMAND Feasibility Study. Dr. John Learned (UC-Irvine) and Dr. Arthur Roberts (recently retired from Fermilab), veterans of previous DUMAND summer studies, were recruited to spend full-time on the Feasibility study starting in 1980. After several years of strenuous effort, involving deep ocean site surveys and development of prototype optical and acoustic detectors, the Feasibility Study concluded that DUMAND was "feasible". A DOE review panel (the" Adair Panel") in 1982 recommended that DOE fund a proposed "Short Prototype String" of detectors, aimed at detecting cosmic ray muons (signature of muon neutrino interactions). The Hawaii DUMAND Center was organized, with V. Peterson as Director, V. Stenger as Deputy Director, and J. Learned as Technical Director. Construction, deployment, and successful operation of the Short Prototype String took until late 1985. This led to a major proposal, for a nine-string full-height array of 216 optical detectors, by a Collaboration involving Japanese, German, and Swiss collaborators as well as UH-HEPG physicists and engineers. The overall proposed budget was $10 Million, approximately half from USA sources. This ambitious project continued until 1995, making slow but substantial progress while overcoming many practical obstacles. The project was eventually cancelled in the wake of the SSC debacle for making too slow progress. In hindsight it appears that the project was simply too technically ambitious for the era, and is now (2006) being carried on by three endeavors in the Mediterranean (NESTOR, ANTARES and NEMO), while the Baikal effort continues, and a related spinoff, the ICECUBE Project is in construction at the South Pole. The DUMAND efforts are recognized as having laid the groundwork for all of these experiments not only in technology, but in stimulating theoreticians to delve into neutrino astrophysics.

**HEPG Accelerator Program**

The HEPG program at Fermilab shifted emphasis from bubble chamber neutrino physics to the proton-antiproton "collider physics" program, involving large, multi-university collaborations using giant detectors. The UH-HEPG was part of the "DO" Detector Collaboration that, along with the CDF experiment, discovered the "top" quark. Hawaii D0 participants made a variety of contributions. Electronics boards for the calorimeter were

tested at UH. The two Hawaii graduate students and post-doc worked on the muon system. M. Peters wrote the software for the event display. He and M. Jones were actively involved in the D0 top physics group and made several contributions to the data analysis. One of the most important was the development of an independent method to determine the top quark mass.

**Particle Astrophysics, Neutrinos and Nucleon Decay**

As considerations of cosmic neutrino sources developed the group realized that high energy gamma ray astronomy (TeV range) was closely related to the prospects for neutrino sources in the same energy region as was being targeted by DUMAND. Initially some of the HEPG (Vic Stenger and John Learned) joined with the Mt. Hopkins air Cherenkov group under Trevor Weekes. UH graduate student Peter Gorham completed his dissertation on studies with the Mt. Hopkins 10m telescope, and subsequently moved to Cal Tech. Another project was started with collaborators from U. Wis (Ugo Camerini group), Purdue (Jim Gaidos) and U. Athens (Leo Resvanis) to build a new generation instrument for deployment in Greece, but ultimately the instrument was placed upon the old site of the Smithsonian satellite tracking telescope on Haleakala (in 1985). This instrument was operated over a period of 5 years and produced 4 UH PhDs. The instrument provided only marginal success in detecting TeV gamma ray sources, since it was aiming at using timing to discriminate between gamma ray and proton initiated showers, and the models turned out not to be adequate in predicting enough useful temporal discrimination. The Mt. Hopkins spatial imaging technique won, and is being employed now in new generation gamma ray telescopes.

When Learned came to UH from having been a visitor at UCI, where he had worked with the Reines neutrino group for several years, the IMB project was just getting started and Learned was one of the seven founders of that project. He continued to be involved, and had a number of excellent graduate students who carried out work with this experiment. This experiment found some of the earliest evidence for muon neutrino oscillations, but could not make the case since ther were alternative hypotheses which at that time could not be rejected. IMB set the best limits on the search for proton decay, eliminating early models of Grand Unification. But the highlight of this experiment was the observation of a few second burst of neutrinos from Supernova 1987A. The results, often termed the “discovery of the decade” were published back-to-back with the observations from the Japanese Kamiokande experiment.

As the IMB experiment wound down in the early 1990’s the group decided to join with their Japanese colleagues in the Super-Kamiokande experiment, 20 times larger than its

predecessor. This experiment, of which UH was a charter member, began data taking in 1996 and plans to continue operations until about 2015. Highly visible results were presented in 1998, indicating for the first time clearly (and subsequently multiply confirmed) that muon neutrinos oscillate with tau neutrinos, and hence that neutrinos have finite, non-zero mass, and that the mixing was as large as it could be. This resulted in a paper which has become the most cited in experimental particle physics, and which was first drafted at UH, along with the first dissertation on these results. The Super-Kamiokande experiment has proved to be a cornucopia of data, and has resulted in many papers bearing upon neutrinos, nucleon decay and searches for exotic particles.

**Personnel Changes, 1980 - 1994**

New UH President Albert Simone's reorganization established a new position of Vice-President for Research and Graduate Education. Prof. David Yount, having served two terms as Department Chair (1979-1985), applied for the position and was selected. During his term as VPRGE (1986- 1994) the thriving UH research-and-training enterprise grew to more than $200,000,000 per year.

The only new faculty member in High Energy Physics in this period was Xerxes Tata (PhD, '82, Texas at Austin), who replaced departing Ernest Ma in 1988. However, new faculty members in Physics were added during this period in the field of Condensed Matter. In Theoretical physics, Chester Vause (PhD, ‘79, Rutgers) was recruited in 1983 and Pui Lam (PhD,'83) came to UH from Berkeley in 1984. In Experimental physics, James Gaines (PhD,'61, Seattle) filled the vacancy left by the departure of Burton Henke for LBL-Berkeley in 1988. Prof. Gaines came from Ohio State University where he had developed a major program in materials science. In addition, the surface study of solids at Hawaii was enhanced in 1988 by the addition of Klaus Sattler (PhD, '75, Zurich) whose research was based on Scanning-Tunneling Microscopy. A number of new graduate students quickly joined these new research programs.

In Fall 1992 Prof. Vince Peterson retired, after 30 years of service at UH. During this period, the High Energy Physics Group had successfully won $32.3 Million in extramural funding from AEC/ERDA/DOE and NSF for experimental and theoretical research in elementary particle physics.

Prof. Peterson's successor as Principal Investigator for High Energy Physics at UH was Stephen Olsen (from Rochester), who was attracted to Hawaii in part by its proximity to Japan. Prof. Olsen had led a USA team-working at the Japanese National Accelerator Laboratory (KEK) in Japan. Thus the Hawaii-Japan collaboration was strengthened by this move. UH-HEPG future experimental research plans are expected to include experiments at the "B-factory" at KEK, in addition to ongoing experiments at Fermilab, SLAC, and in Hawaii (DUMAND).

The following year Prof. Robert Cence also retired, and Dr. Thomas Browder (PhD,

'93, Cornell) was recruited as a full-fledged teaching member of the Department. Prof. Browder's field is in High Energy Physics, with a specialty in electron-positron collider experiments.

Appendix

DEPARTMENT OF PHYSICS CHAIRPERSONS (1923-2007)

| Years | Department Chair |
|---|---|
| 1923 – 1931 | Paul Kirkpatrick |
| 1931 – 1957 | Willard Eller |
| 1957 – 1959 | Iwao Miyake |
| 1959 – 1961 | Kenichi Watanabe |
| 1961 – 1963 | Walter Steiger |
| 1963 – 1972 | John R. Holmes |
| 1972 – 1979 | Walter Steiger |
| 1979 – 1985 | David E. Yount |
| 1985 – 1991 | Charles Hayes |
| 1991 – 1995 | Peter P. Crooker |
| 1995 - 2003 | James R. Gaines |
| 2003 - present | Michael W. Peters |