Obituaries
Prepared by the Historical Astronomy Division

JOHN LOUIS AFRICANO III, 1951–2006

The orbital debris, space surveillance, and astronomical communities lost a valued and beloved friend when John L. Africano passed away on July 27, 2006, at the young age of 55. John passed away in Honolulu, Hawaii, from complications following a heart attack suffered while playing racquetball, which was his avocation in life. Born on February 8, 1951, in Saint Louis, Missouri, John graduated with a B.S. in Physics from the University of Missouri at Saint Louis in 1973, and received a Master's degree in Astronomy from Vanderbilt University in 1974. John had a real love for astronomical observing and for conveying his many years of experience to others. He encouraged many young astronomers and mentored them in the basics of photometry and astronomical instrumentation. John was author or co-author on nearly one-hundred refereed publications ranging from analyses of cool stars to the timing of occultations to space surveillance. He was honored for his contributions to minor planet research when the Jet Propulsion Laboratory named Minor Planet 6391 (Africano) after him.

John held operational staff positions at several major observatories including McDonald Observatory in Texas, Kitt Peak National Observatory in Arizona, and the Cloudcroft Telescope Facility in New Mexico. He observed at numerous observatories worldwide, including Cerro Tololo Inter-American Observatory (CTIO) in Chile, developing a worldwide network of friends and colleagues. John's ability to build diverse teams through his managerial and technical skills, not to mention his smiling personality, resulted in numerous successes in the observational astronomy and space surveillance arenas.

As an astronomer for Boeing LTS Inc., he worked for many years at the Advanced Maui Optical and Space Surveillance site (AMOS) on Maui, Hawaii, where he contributed his operational and instrumental expertise to both the astronomy and space surveillance communities. He was also the co-organizer of the annual AMOS Technical Conference whose attendance expanded dramatically during his tenure. John moved to the NASA Johnson Space Center, Houston, Texas, in 1998 to work full time on orbital debris projects including the 3.0 meter Liquid Mirror Telescope and the CCD Debris Telescope in Cloudcroft, New Mexico. In 2000 he moved back to Colorado Springs, Colorado, to be closer to his family. From there he continued to support both the NASA Orbital Debris Program Office (ODPO) and AMOS. John was very instrumental in establishing cooperative programs between the ODPO and AMOS, which will benefit both organizations for many years to come. John left an indelible mark on his programs and all those who knew and loved him. The impact of his untimely departure will reverberate for many years. As John's wife Linda put it, "John is now visiting the stars and galaxies he adored from afar."

John is survived by his wife, Linda Ann Africano; two sons, James Keith and Brian Michael; a daughter, Monica Lynn Africano; a sister, Diana Smith; and four grandchildren.

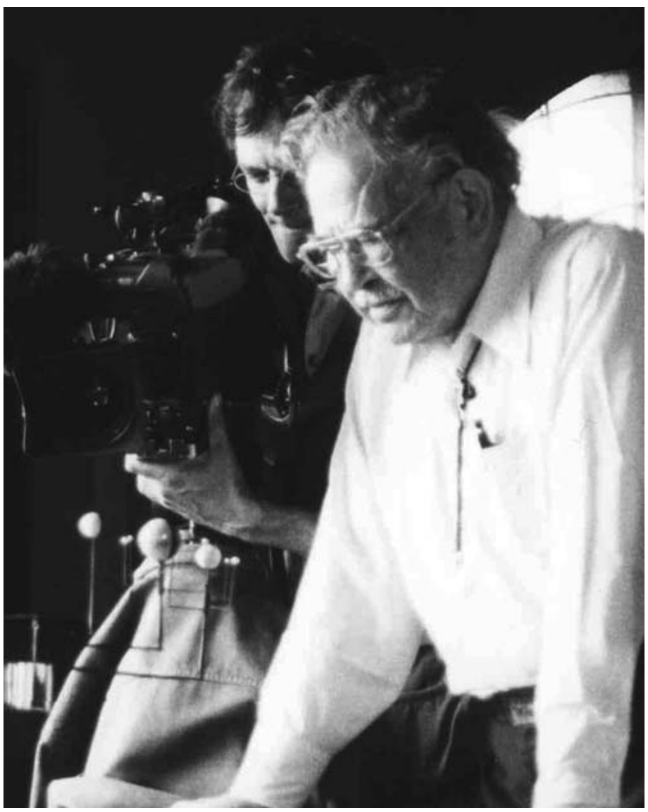
The photograph was taken at CTIO in February 2004, and is courtesy of Eugene Stansbery. The author acknowledges valuable input from Brian Africano (University of Colorado at Colorado Springs), Eugene Stansbery (NASA), Mark Mulrooney (NASA contractor), Tom Kelecy (Boeing LTS, Inc.), Paul Sydney (Boeing LTS, Inc.), Kira Abercromby (NASA contractor), and Patrick Seitzer (University of Michigan).

Edwin S. Barker
National Aeronautics and Space Administration

RALPH ASHER ALPHER, 1921–2007

Ralph Asher Alpher, noted cosmologist, physicist, and educator, died on August 12, 2007, in Austin, Texas. Alpher developed the first model for primordial nucleosynthesis in the hot early Universe and, with Robert Herman, first predicted the cosmic microwave background radiation. During his long and productive career, he published over one-hundred papers, a book translation, chapters in a number of books (primarily in cosmology), and *The Genesis of the Big Bang*, a book about his life in cosmology, co-authored with Robert Herman. Ralph's work has been cited by the American Physical Society *News* as one of the Top Ten Astronomical Triumphs of the Millennium.

Born in Washington, D.C., on February 3, 1921, Ralph was the youngest of four children of building contractor Samuel and Rose Maleson Alpher, immigrants from Russia and Latvia. He attended Roosevelt High School in Washington, graduating at the age of sixteen. A scholarship was offered by the Massachusetts Institute of Technology, but then



Ralph Asher Alpher

suddenly withdrawn after a meeting with an alumnus. (Ralph would wonder all his life whether the withdrawal was due to his Jewish background.) Instead, he attended evening classes at George Washington University while working full time, earning his B.S. in 1943, his M.S. in 1945, and his Ph.D. in 1948.

Ralph's master's thesis on the sources of energy in stars was completed with mentor George Gamow. Gamow then accepted him to work on a Ph.D. dissertation on the formation of galaxies, studying the growth of condensations in a relativistic homogeneous and isotropic expanding medium. Ralph found that such condensations would not grow, but before he finished writing, E. M. Lifshitz independently published similar results in 1946. Ralph started anew, this time modeling the buildup of elements by neutron capture in the hot, early phase of the Universe. Despite the approximations necessary in the pre-computer age, he found consistency with observed abundances of hydrogen and helium. The results were published in the famous Alpher-Bethe-Gamow paper in the *Physical Review* of April 1, 1948. Gamow, known for his sense of humor, added Bethe's name to the paper, resulting in the abbreviation $\alpha\beta\gamma$. The physics-based approach to a non-static cosmological model of the Universe was viewed with excitement and over three-hundred people attended Ralph's dissertation defense. The story was picked up by the press, with the *Washington Post* headlining that the "World Began in 5 Minutes, New Theory" based on Ralph's answer to a question about how long primordial nucleosynthesis would have taken.

At the same time that he was working on his revolutionary cosmological results, Ralph was hard at work during the day at the Department of Terrestrial Magnetism (1938–1940), the Naval Ordnance Laboratory (1940–1944), and the Johns Hopkins Applied Physics Laboratory (1944–1955). As a physicist contracted to the Navy, he made significant contributions to the development of technology to protect ships against magnetic mines and to magnetically detect submarines from the air. At the Applied Physics Laboratory, he developed a magnetic gradiometer proximity exploder for air-launched torpedoes and worked in programs to develop ground-launched antiaircraft guided missiles. After the war, he worked on supersonic gas dynamics and later cosmic radiation in a group headed by James A. Van Allen. In 1945, Ralph received the Naval Ordnance Development Award in recognition of his work.

It was at the Applied Physics Laboratory in 1944 that Alpher met his longtime collaborator and friend Robert Herman, a specialist in molecular spectroscopy, with whom he would collaborate until Herman's death in 1997. Together Alpher and Herman reevaluated the nucleosynthesis calculations and further probed the physics of an early, hot Universe, publishing numerous papers between 1948–1955. The final paper, published in 1953 with James Follin, Jr., established the methodology used for dealing with physical conditions in the early Universe prior to nucleosynthesis. Early on, Alpher and Herman realized that if the expanding Universe began in a hot phase, relic radiation from the era when radiation and matter decoupled should fill the Universe. They published this result in *Nature* in 1948, predicting that the current temperature should be 5 K. In talk after talk, and in a series of papers, they publicized their work and urged observers to start looking for this radiation, but without result. At the time, the model of the hot, expanding Universe, scornfully christened "Big Bang" by Fred Hoyle in 1950, was far from accepted by the cosmology community, especially since the measured value of the Hubble constant produced a very small evolutionary age. Even if the Big Bang model was correct, the consensus was that the relic radiation would be much too faint to detect.

Dismayed by the lack of interest in their results, both Alpher and Herman decided in 1955 to give up academia, turning down positions offered at the University of Iowa with James van Allen, and instead accepting jobs at General Electric (GE) and General Motors. Both had families by that time. Ralph had met his wife, Louise Ellen Simons, in 1940. They married January 28, 1942, and had two children, Harriet and Victor. Ralph worked for 32 years at GE Research and Development Center in Niskayuna, New York, on a variety of projects including high-speed aerodynamics, theoretical problems involving the physics of television projection systems, magnetohydrodynamic methods, and, eventually, strategic planning and technology forecasting.

The papers about the relic radiation languished in the literature, but Alpher and Herman kept up with developments in cosmology. One can imagine their excitement and gratification when they learned of the serendipitous detection of the cosmic microwave background by Arno Penzias and Robert Wilson in 1965 and found that their model temperature (with updated values of cosmological parameters) was in agreement with the 3K measurement. Their excitement soon turned to dismay as a flurry of resulting publications, most notably those of Robert Dicke, P. James Peebles, and collaborators at Princeton, reproduced their results but neglected to mention Alpher & Herman (1948). For much of the rest of their lives they waited for proper recognition of their prediction. The Nobel Prize of 1978 went to Penzias and Wilson, but Penzias cited Alpher and Herman in his acceptance speech. Gradually recognition came, although Gamow was often credited equally with Alpher and Herman, even though Gamow had not participated in the original calculations and had published independent calculations later shown to be incorrect.

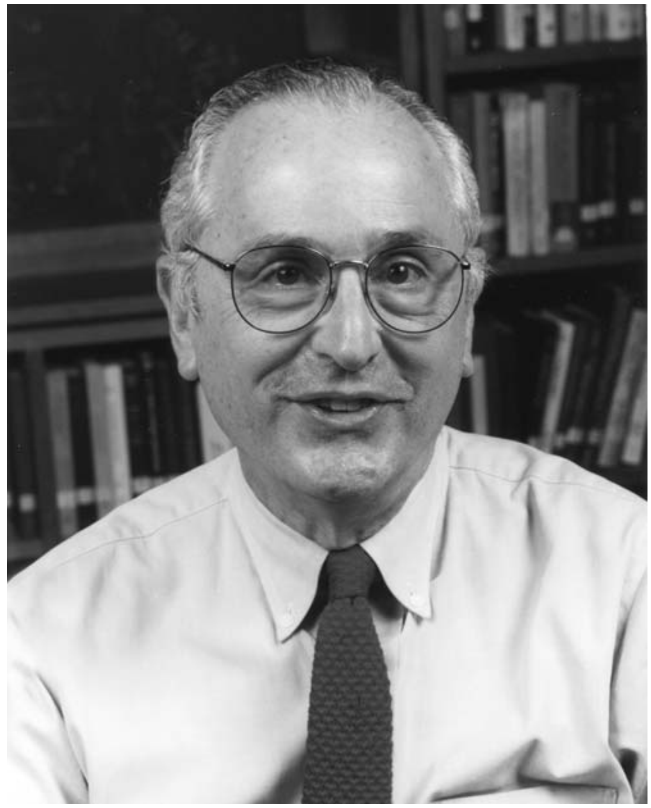
Ralph retired from GE in 1987. He taught from 1986 to 2004 at Union College as distinguished research professor, retiring in 2004. Students and faculty remember him fondly for his contributions to Union and his kind nature. Ralph was a member of the board of directors of Dudley Observatory and was its Administrator from 1987 to 2000. He was generous in donating his time to the community, serving on the board of the local public television station WMHT—including a two-year term as its president—and as mentor to the Boy Scouts. (He was an Eagle Scout himself at age twelve).

Among the awards Ralph earned are the Magellanic Premium of the American Philosophical Society, the George Vanderlinden Prize of the Belgium Royal Academy of Sciences Letters and Fine Arts, the George Wetherill Medal of the Franklin Institute, and the Mathematics Prize of the New

York Academy of Sciences. In 1993, Alpher and Herman were awarded the Henry Draper Medal of the National Academy of Sciences for their early work on the Big Bang model, nucleosynthesis, and the prediction of the cosmic microwave background radiation. Steven Weinberg wrote in his 1993 book, *The First Three Minutes*, that Alpher carried out "the first thoroughly modern analysis of the early history of the Universe." Most recently, Ralph was awarded the 2005 National Medal of Science "for his unprecedented work in the areas of nucleosynthesis, for the prediction that universe expansion leaves behind background radiation, and for providing the model for the Big Bang theory."

Rebecca A. Koopman
Union College

JOHN NORRIS BAHCALL, 1934–2005



John Norris Bahcall

John Norris Bahcall, one of the most creative and influential astrophysicists of his generation–a scientist who helped prove what makes the Sun shine and helped make the Hubble Space Telescope a reality–passed away in Pasadena, California, on 17 August 2005. Bahcall died peacefully in his sleep from a rare blood disorder. For the past 35 years, Bahcall was the Richard Black Professor of Natural Sciences at the Institute for Advanced Study in Princeton, New Jersey, where he created one of the leading astrophysics programs in the world. Active and working to the end, Bahcall said that he was always grateful for a full and happy life that exceeded his wildest expectations. Bahcall died as he lived, surrounded by the family he loved, embracing life to its fullest, happy, working and joking to the end.

Bahcall's stellar career encompassed seminal contributions in numerous fields of astrophysics as well as extraordinary leadership on behalf of the scientific community, including the American Astronomical Society, the American Physical Society, the National Academy of Sciences, NASA, and Congress. Bahcall's contributions made him one of the scientific leaders of his time. He had been recognized by numerous awards including the 1998 National Medal of Science from President Clinton, the Gold Medal of the Royal Astronomical Society, the Medal of the Swedish Royal Academy, the Dan David Award, the Fermi Award, the first Hans Bethe Prize, the Franklin Medal, the Comstock Prize in physics, NASA's Exceptional Scientific Achievement Medal, NASA's Distinguished Public Service Medal, and the top awards of the American Astronomical Society–including the Russell Award, the Heineman Prize, and the Warner Prize. Bahcall was elected to the National Academy of Sciences in 1976 and to the American Philosophical Society in 2001. He was the recipient of Honorary Degrees from numerous universities around the world.

Bahcall's scientific interests and expertise ranged from neutrino physics and the structure of the Sun and other stars, to galaxy models, quasars and the intergalactic medium. His more than 600 scientific publications, on an enormous array of subjects, received nearly 20,000 citations. Many established fundamental paradigms in their fields, while others provided the clearest and most comprehensive overview of them. Bahcall's *Neutrino Astrophysics*, one of eight books he wrote or edited, has been the most popular book in the field, used by most students and experts.

But Bahcall did, in fact, continually return to one core scientific issue: the solar neutrino problem. He realized very early in his career that we should be able to detect the flux, or stream, of these shadowy fundamental particles as they pass through the Earth after escaping from the center of the Sun, where they are produced in prodigious numbers. He clearly saw that a definite detection, or non-detection, of these neutrinos would have major implications both for understanding the Sun and for fundamental particle physics. For decades, he encouraged and supported scientists throughout the world in studying this problem and was most successful in his collaboration with Raymond Davis Jr., who ultimately won the Nobel Prize in 2002 for detecting the solar neutrino flux.

It was Bahcall's persistent work that proved definitively that the low flux found by the solar neutrino experiments of Davis and others could not be explained by errors in our model for the Sun. Neutrinos seemed to be missing: either they were not made at the rates required by standard nuclear physics, or they were made but then somehow "lost" in transit between the Sun and the Earth. The latter explanation–neutrino mixing, in which one type of neutrino changes into another at some rate, and in which the neutrino must have a small but finite mass–is now known to be true, and it is surely due to Bahcall's tenacity and insight that this important and surprising modification to the standard model of particle physics was uncovered.

A fuller idea of his exceptional scientific scope is indicated by the fact that the standard model for a massive black hole surrounded by a cluster of stars is still called the

Bahcall-Wolf model; the most widely quoted model for our Galaxy was for decades the Bahcall-Soneira model; the now common use of quasars as flashlights to illuminate and study the intervening intergalactic medium was originated by Bahcall and Salpeter; and the most accurate models for the solar interior were those developed by Bahcall with Roger Ulrich, Marc Pinsonneault, and others.

John Bahcall was born in Shreveport, Louisiana, on 30 December 1934, to Mildred and Malcolm Bahcall. Mildred was a pianist, and both parents worked in business. John Bahcall had one brother, Robert Bahcall, now deceased. At Byrd High School in Shreveport, John became interested in sports, especially tennis; with persistence and dedication–traits he exemplified throughout his life–he became the tennis champion of his state. John continued to play and love tennis his entire life. As a high school senior, Bahcall became interested in debate and joined the school's Debate Team. With the same persistence, dedication, and hard work, Bahcall became a National Debate Team winner–the first time ever for this Louisiana high school. Bahcall's debate skills served him well throughout his life, as all of those who tried to debate him know well.

Bahcall's love of physics had a non-traditional beginning. He never took science classes in high school; he was excused to play tennis in the afternoons when science courses were offered. After one year at Louisiana State University, Bahcall transferred to the University of California in Berkeley on a tennis scholarship and support from an uncle who saw the promise in the young Bahcall. At Berkeley he began studying philosophy. Berkeley's graduation requirement of a science course led Bahcall to take a physics class, the first science class he ever took. "I fell in love with Physics," he said, "and it changed my life." Bahcall graduated from Berkeley in 1956 with a degree in Physics. He received a master's degree from the University of Chicago, followed by a 1961 PhD in Physics from Harvard University. After a Research Fellowship at Indiana University working with Emil Konopinski on nuclear weak interactions, Bahcall received an invitation in 1962 to the California Institute of Technology (Caltech) to work with William A. Fowler, a Nobel Prize winner and expert in the field. Bahcall was working with Willy Fowler and others at the time and place that "nuclear astrophysics" was invented. There he became engaged with neutrino work and to Neta Assaf (then completing her PhD at Caltech)–the two constant loves of his life. John met Neta on a trip to Israel in 1965. She was a young physics graduate student "with a beautiful smile that stole my heart," he said. He spoke no Hebrew and she little English. After a dozen rejections, he got a date with her. They fell in love immediately and their love and friendship lasted a lifetime. "Marrying Neta was the best thing that ever happened to me," John frequently said. Safi Bahcall, their older son, recollects: "The persistence and never giving up was the theme for my dad; solar neutrinos, the Hubble Space Telescope, and the quest for scientific excellence are just a few other examples."

Bahcall's first paper from Caltech, a one-page letter to the editor of the *Astrophysical Journal*, dated 1 December 1962 and entitled "The Solar Neutrino Flux" (written with Fowler, Icko Iben, and Richard Sears), proposed an experiment that might "provide a valuable experimental limit on the effective temperature for neutrino generation in the Sun." That paper set the course for a lifetime of research.

The writing of scientific papers was, however, only one of Bahcall's many contributions to world science. He was an educator who changed the nature of postdoctoral training, and a scientific statesman of unusual and beneficent influence. Bahcall moved to the Institute for Advanced Study (IAS) at Princeton in 1968 and soon established that institution as a magnet and model for postdoctoral training. A significant fraction of the world's most distinguished astrophysicists benefited from his tutelage and the intellectually fertile atmosphere that he established there. The eminent British scientist Sir Martin Rees describes himself as fortunate to have been one of the first IAS postdoctoral fellows in astrophysics in 1969. Every fellow's birthday and important family events were celebrated. The intellectual atmosphere was intense, and the weekly Tuesday lunches, with John presiding, to which the whole Princeton physics community was invited, were legendary (now named the Bahcall Lunches). Bahcall's postdoc program was the one that astrophysics institutions worldwide emulated. At the IAS, young scientists were selected and recruited in the most exacting manner and then were free to work on whatever they wanted, with whomever they wished. Bahcall mentored over 200 young astronomers in his four decades at the IAS.

While maintaining a scientific and educational program that would have exhausted most, Bahcall also demonstrated extraordinary scientific leadership. He was president of the American Astronomical Society, president-elect of the American Physical Society, led the team that produced the 1990 National Research Council "Bahcall Report" that set the scientific and instrumental priorities for astrophysics in the United States for a decade, and worked (with Lyman Spitzer, Jr.) with tireless effectiveness in public and in private to have the Hubble Space Telescope and the Space Telescope Science Institute (STScI) built and maintained as one of the world's pre-eminent scientific facilities.

Neta Bahcall, a professor of astrophysics at Princeton University, was his love, his best friend, and his scientific colleague throughout. She took a leading scientific role at the STScI and wrote over 30 papers with him on subjects ranging from solar neutrinos to binary X-ray sources. They also collaborated in raising three talented children, Safi, Dan, and Orli, who are themselves now establishing significant scientific careers. Said Neta, "Our forty years together were the best, most joyous years of our lives. I could not have imagined a better life, a better husband. We lived a life full of love, of care, of joy. We worked, we shared, we played. We could not have asked for more." "He was a quiet giant of science and a good friend," said Raymond Orbach, Director, Office of Science, United States Department of Energy, a colleague and friend. "John devoted himself to the betterment of mankind. His leadership in astronomy, cosmology, and in the many societies that he served so well has left a lasting influence. We shall owe so much to this remarkable colleague. John created a legacy of imagination and precision, of creativity and rigor. His passing lessens us all."

Bahcall's passion for science and for life, his enthusiasm, his integrity, his persistence and dedication, his tremendous will, his high standards for excellence, his love of family and of people, and his wonderful sense of fun were the hallmark of his scientific and personal life. “We all have a deep desire to know what exists out there,” said John. “A desire so basic, so beautiful, and so much fun, that it unites all mankind.”

But no listing of achievements can convey the impression of the man: the wit, the mischievous energy, the passion. Jerry Wasserburg, his old Caltech friend, portrays Bahcall in 1965: “John, running around in white tennis shorts, very sportive and competitive in both creative science and tennis, trying out and enthusiastically arguing every new idea in astrophysics, was the dynamo of the Institute.”

Jeremiah P. Striker and Neta A. Bahcall
Princeton University

PAUL BARR, 1955–2005

Paul Barr, an extragalactic astronomer and spacecraft mission planner, died on 19 October 2005 at his home in Noordwijk, the Netherlands, at the age of 50. Although his scientific interests ranged from AGN to X-ray binaries, he will perhaps best be remembered for his mission planning skills on EXOSAT, ISO, and Integral. Many hundreds of observers have benefited from his ability to juggle seemingly impossible observing constraints and arrive at the optimum observing program. A rare talent.

Barr was born in Sunderland, England, on 28 July 1955. After attending Saint Aidans Grammar School, where his father was the headmaster, he obtained his Bachelors Degree in astronomy from the University of London (June 1976) before moving to the Mullard Space Science Laboratory. There he obtained his Doctorate in X-ray astronomy in February 1980, using data from the Ariel V and Copernicus satellites. After a Post-Doctoral position at London University, where he did research into ultra-violet emission from AGN and X-ray binaries using IUE, Paul joined ESA in 1983. He worked on a wide range of missions including EXOSAT, ISO, and Integral. These observatories spanned the wavelength range from the Infra-red to the gamma-ray, giving insight into Paul’s flexibility and ability to contribute in many areas. On ISO, Paul oversaw the scientific development and use of the very successful observation scheduling system–this topic became his specialty. As ISO operations became routine, he took up the challenge of space-borne gamma-ray astronomy and moved in 1997 to Integral where he worked in the Science Operation Centre (ISOC), at ESTEC in the Netherlands, as senior mission planner. He worked with the gamma-ray imager (IBIS) instrument team to ensure that operations of their instrument were properly supported by ESA and supported preparations of announcements of opportunity. In early 2005 the ISOC moved to Europe’s Space Astronomy Centre (ESAC) just outside Madrid, Spain. Paul, however, decided to stay put physically, but move on scientifically, and transferred to the Ulysses mission where he joined the software development team.

We miss a uniquely flexible scientist in these days of increasing specialization and a colleague with an infectious enthusiasm for all things to do with Sunderland, especially the football club.

Arvind Parmar
European Space Agency

HANS ALBRECHT BETHE, 1906–2005

One of the unquestioned giants of physics and astrophysics, Hans Bethe, died on 6 March 2005, at the venerable age of 98, in his home town of Ithaca, New York. Seven decades of contributing to research and a Nobel Prize for his work on stellar hydrogen burning make a listing of his honors superfluous (besides being impossible in this space).

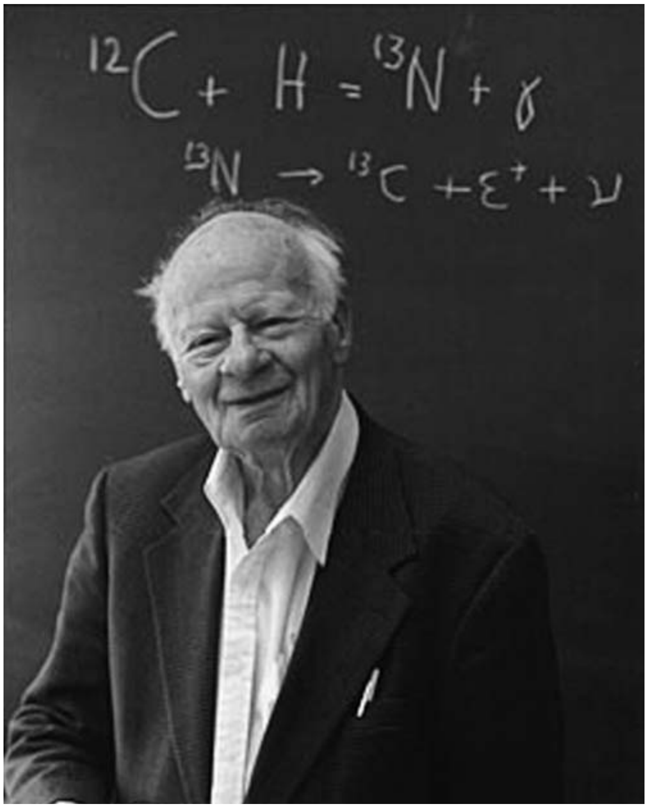
Bethe was born in Strassburg, in then German Alsass Lothringen, on 2 July 1906. His father, Albrecht Julius Bethe (1872–1954), taught physiology at the University, and his mother, Anna Kuhn (1876–1966), was a musician and writer. Both his grandfathers were physicians. He spent his youth in Strassburg, Kiel, and Frankfurt, and some time in sanatoria due to tuberculosis. Hans’s first scientific paper, at age 18, was with his father and a colleague, on dialysis. His education and early career in Germany brought him into contact with many top stars in the quantum revolution.

Starting in Frankfurt in chemistry, Bethe soon switched to physics, taught there by Walter Gerlach and Karl Meissner, among others. In 1926, he successfully applied to join Arnold Sommerfeld’s group in Munich, where he met one of his later long-term collaborators, Rudolf Peierls. Bethe considered his entry into physics to have come at an ideal time, with the new ideas of wave mechanics being developed and discussed right there; it was certainly also at an ideal place. His doctoral thesis was on the theory of electron diffraction by crystals, following the experimental work by Clinton Davisson and Lester Germer and the work on X-ray diffraction by Max von Laue and Paul Ewald.

The newly minted doctor went from there briefly to Frankfurt and then to Ewald in Stuttgart, where he felt at home academically and personally. In 1939, Bethe would marry Ewald’s daughter Rose. Not much later, though, Sommerfeld recalled him to Munich, where Sommerfeld created a Privatdozent position for him. There he worked out the solution for a linear chain of coupled spins by what we now call the “Bethe Ansatz.” Soon after his acceptance of an assistant professorship at Tübingen in 1932, he had to flee Hitler’s Germany because his mother was Jewish. Bethe went to the Bragg Institute in Manchester, England, where he worked again with Peierls. In 1934, Cornell University unexpectedly offered him a position as part of R. Clifton Gibbs’s expansion of the physics department; he accepted and stayed there for the rest of his life.

Right from the start, Bethe enjoyed America and its atmosphere very much. His first activity there was to write the “Bethe Bible:” three articles in *Reviews of Modern Physics* to educate his colleagues in theoretical nuclear physics. Then he did the work that astrophysicists will still appreciate him most for, and which brought him the 1967 Nobel Prize.

Having worked with George Gamow’s student Charles Critchfield (at Gamow’s suggestion) on the proton-proton chain for nuclear fusion in the Sun (published in 1938), Bethe was initially a bit discouraged with Arthur Eddington’s estimates of the Solar core temperature; their calculations did not agree well with the observed solar luminosity. However,



Hans Albrecht Bethe

at the Washington conference in 1937, he heard of Strömgren's new estimates of the solar interior, which brought his and Critchfield's theory into much better agreement with the data. Fairly soon after the meeting, Bethe also worked out the process whereby more massive stars must accomplish hydrogen fusion, in what we now call the CNO cycle.

Curiously, Bethe held up its publication briefly in order to compete for a prize for the best unpublished paper on energy production in stars. He did win, and used the money in part to bring his mother to the United States; eventually, the paper appeared in *Physics Review* in 1939, and founded a whole branch of astrophysics.

The war brought Bethe to the Manhattan project, of which he became one of the intellectual leaders. He ploughed through problems theoretical and practical by attacking them head-on and not allowing himself to be side-tracked by those who would deem the problem be much more complex and difficult, moving straight forward like an intellectual battleship ("The H.A. Bethe Way," as his collaborator Gerald E. Brown would dub the style). Bethe's involvement in the Project brought to light his abilities in the managerial and political arena, which he used later to much effect to influence the wider world; he was among those who fought hard during the Cold War to contain the impact of the terrible weapons he had helped invent. As his two children, Henry and Monica, were born, the war years also made him a family man. As his father did with him, he often took them on long walks, in the hills around Ithaca or further afield; he much enjoyed walking, and mountains.

Just after the war, during and following the June 1947 Shelter Island Conference, Bethe made another of his great contributions to physics–some might say his greatest. The experiments by Willis Lamb and Robert Retherford, on what came to be known as the "Lamb shift," were discussed, and during the meeting the assembled crowd (Richard Feynman, Julian Schwinger, and Hendrick Kramers among them) got stuck on the infinities of QED. During the train ride home, Bethe managed to compute the correct answer by realizing that the complex QED machinery could be bypassed, the H.A. Bethe Way.

His 1967 Nobel Prize spurred a brief revival of Bethe's interest in astrophysics, but his work in the following years continued to focus on nuclear physics and dense matter (and disarmament and nuclear power, of course). In 1978 he re-entered astrophysics with a bang: Bethe was losing interest in nuclear physics and, after a few years of trying, Gerry Brown lured him back to astrophysics during a stay at the Nordic Institute for Theoretical Physics (NORDITA). The refugee from Hitler and the refugee from McCarthy jointly attacked the problem of supernova collapse. Bethe had the crucial insight that the low entropy of massive stellar cores would cause them to collapse to well above nuclear density, contrary to prevailing opinion. With James Applegate and James Lattimer, they published their finding in the BBAL ('"babble") paper of 1979.

After that, astrophysics never quite left Bethe again, and with Brown (his "junior collaborator"), he took an interest in the fate of massive stars and black holes more generally. The series of papers on formation of black holes, gamma-ray bursts, and gravity-wave sources continued until close to his death. These papers are done very much the H.A. Bethe Way, often finding simple approximations to much more complicated work of others, and are quite straightforward.

An inevitable part of the Bethe-Brown collaboration was a January stay in California; during the 1999 edition I had the good fortune of becoming a small footnote to the great Bethe story. Gerry and Hans invited me to join them for a while, to discuss issues of binary star evolution and population synthesis. I have to admit to being rather taken aback by the way in which the 93-year old gave me a good intellectual runaround every day. And yet, as many others have commented, there was nothing facetious or overbearing in his manner: He made me feel like a valuable colleague and welcome guest. Good meals were an essential part of Hans's every day, and during a dinner prepared by Rose Bethe and Betty Brown, the old stories surfaced. I could not resist asking about the legendary story of Rose and Hans's evening walk under the stars. Hans, so says the story, tried to impress his fiancée by commenting that at that moment, he was probably the only person on Earth who understood why the stars shine. Hans grinned a bit sheepishly, but Rose roundly confirmed the story with a big smile. Not too impressed, she had replied: "That's nice." And so it was.

Ralph Wijers
University of Amsterdam

RICHARD B. DUNN, 1927–2005

Dr. Richard B. Dunn, astronomer emeritus at the National Solar Observatory, died of a heart attack on September 29,

2005. He was recognized as one of the foremost experimental solar physicists. His innovative designs for telescopes and instruments led to many important discoveries in solar physics.

Born in Baltimore, Maryland, in 1927 and raised in Minneapolis, Minnesota, Dick's parents were Dr. Halbert L. Dunn and Katherine Brandner. Halbert (MD, Ph.D., F.A.P.H.A.) was an physician who became Chief of the National Office of Vital Statistics, Public Health Service. He published a paper "High Level Wellness for Man and Society" that became the founding paper of the field of wellness health care. After their divorce in 1942, Katherine moved to New York and became a social worker. Dick had two older brothers who died before him, Halbert (born in 1921, who became a civil engineer) and Robert (born in 1924, who became an architect).

Dick earned a BS in mechanical engineering and an MS in astronomy at the University of Minnesota. At the end of World War II he served in the United States Army in Japan. For his master's degree, Dick undertook the design and construction of a Lyot-type birefringent filter for observations of solar prominences. This early work led to his acceptance at Harvard, where Professor Donald Menzel encouraged him to continue his work with the 15-inch Cambridge telescope.

In 1951 he conducted part of his doctoral thesis work at the fledgling Sacramento Peak Observatory in southern New Mexico. The observatory director, Dr. John Evans, was impressed with Dick's outstanding instrumental talents and invited him to join as one of the first scientific staff members. During his first few years at Sac Peak, Dick developed two more birefringent filter systems including one with an integrated coronagraph. With this system, he produced the best prominence and spicule observations ever obtained.

Dick's career was dedicated to obtaining solar observations of the highest possible spatial resolution, having unparalleled quality that would reveal the underlying physics. Only by studying the small magnetic structures near the surface, he thought, could we understand such phenomena as the solar flares that periodically disturb the Earth. Many of his instruments were designed with this aim in mind and he was proven correct in the end.

Preeminent in Dick's achievements is the design concept for the Vacuum Tower Telescope, which was commissioned in 1969. It is a completely novel telescope that incorporates several daring engineering concepts. It was the first tower telescope with an evacuated light path, to eliminate internal seeing. It was one of the first to utilize an alt-azimuth mount, under computer control. Upon his retirement in 1998, the telescope was rededicated in his honor as the Richard B. Dunn Solar Telescope (DST).

In the DST, Dick pioneered the concept of the telescope as an integrated observing system; it was the first to incorporate telescope guidance and control and digital data recording operations in a single computer control system. Dick appreciated the advantages of such computer control a decade before the astronomical community generally accepted these concepts. His innovations led the way to similar advances in astronomy as a whole.

The DST achieved Dick's aim of providing high-

Richard B. Dunn

resolution solar images and great flexibility in combining analyzing instruments. The DST continued as the preeminent high-resolution solar telescope in the world for the next three decades and remains a powerful and versatile system that allows simultaneous measurements using multiple cameras to record high-resolution imaging of solar features and activity, as well as high-sensitivity spectral, polarimetric and other kinds of data, and now incorporates a very effective adaptive optical system.

Another of Dick's major projects was the design of a U.S. Air Force network of solar telescopes. These five identical systems were deployed around the world to give continuous monitoring of solar activity. He was involved with many other instruments, projects and systems. Notable among these was the design of an early solar space telescope and pioneering work in solar adaptive optics.

Dick made several important discoveries with his novel instruments. His early narrow-band filter observations with the DST showed that solar spicules cover only a small area of the solar surface and reside mainly on the super-granule network. He discovered that photospheric magnetic fields emerge in kilogauss strength from sub-arcsecond "filigree."

Dick gained an international reputation for his design expertise and his willingness to help other astronomers. His advice and direct help were eagerly sought, and freely given. One can hardly visit any solar observatory in the world without hearing,"Yes, that was a Dick Dunn design." He was awarded the Hale Prize by the Solar Physics Division of the American Astronomical Society in 1998, "For his bold and imaginative innovation of instrumentation for solar physics, his discovery of important new phenomena on the Sun, and the impact of his contributions on solar physicists worldwide."

But Dick's life and work at the observatory constitute far more than simply that of a skilled experimenter who carried out new kinds of groundbreaking observations with his special instruments. He was the embodiment of those rare individuals with scientific instrumental skills who generate totally new types of systems, their work marked by extremely clever, creative and innovative ideas. In Dick's case, this profile was coupled with the ability to apply enormous energy, patience, commitment and enthusiasm to any instrumental challenge. Over the years his contributions advanced the careers of a whole generation of solar astronomers.

Dick died in his home in Las Cruces, New Mexico, after a long fight with Parkinson disease. Dick is survived by his wife of 55 years, Alice Dunn. Alice was very involved in music and had a beautiful voice. She did Russian translations, worked with the blind (which got Dick interested in developing the translator and printer mentioned below, and remains highly involved in the music scene in Las Cruces.

Dick was a person of many talents and interests, including music, sculpture and sailing, and for example, worked hard to develop an automated Braille translator and Braille printer. He was fascinated with renaissance musical instruments, acquiring a substantial collection, which he later donated to the El Paso Symphony Orchestra. He achieved much enjoyment from his hurdy-gurdy, happily entertaining anyone within earshot! Dick built several musical banks that would play elaborate tunes when a coin was inserted. The coin then rolled along ramps, striking a note each time it fell to the next level, with the length of the ramps determining the timing between notes.

Stephen L. Keil and David Dooling
National Solar Observatory

KENNETH L. FRANKLIN, 1923–2007

Kenneth L. Franklin

Renowned astronomer and astronomy popularizer Kenneth L. Franklin died early Monday morning, June 18, 2007, in Boulder, Colorado, two weeks after undergoing heart surgery. He was 84 years old.

Kenneth Linn Franklin, the only child of Myles and Ruth (Houston) Franklin, was born March 25, 1923 in Alemeda, California. Ken obtained his Ph.D. in astronomy in 1953 at the University of California, Berkeley. From 1954 to 1956 he was a research fellow in radio astronomy at the Department of Terrestrial Magnetism, Carnegie Institution of Washington, DC. While there, he and Bernard F. Burke discovered radio emissions from the planet Jupiter. They announced their find on April 6, 1955, at a meeting of the American Astronomical Society (AAS).

In 1956 Ken joined the staff of the American Museum-Hayden Planetarium, where he later served as chairman and chief scientist. Over the course of thirty years he wrote and/or presented innumerable sky shows for the planetarium sky theater, taught popular and technical courses in astronomy, and answered questions from the public. Ken was frequently consulted by local industries engaged in the space program, as well as by the news media and publishers. He was often interviewed on local and national radio and television, especially when a celestial event of special interest was due to occur.

On the first page of the November 1966 issue of *Sky & Telescope*, in comments about the upcoming Leonid meteor shower, Franklin stuck his neck out. Based on some calculations that he'd made, he said he felt we were going to be in for a "interesting display." His was one of the few forecasts that suggested the '66 Leonids might be memorable. As it turned out, he was right–that year observers experienced the now-legendary Leonid meteor storm.

From 1973 to 1979, Ken was the AAS's public-affairs officer. For two decades he also served in the society's Harlow Shapley Visiting Lecturer Program, speaking at one or two colleges each year. Ken was an active member of many professional organizations and was elected a fellow of the American Association for the Advancement of Science, the Royal Astronomical Society, and the Explorers Club.

Ken served as astronomy editor of the World Almanac from 1970 to 1995, and from 1980 to 1992 he provided all of the astronomical calculations for the Farmer's Almanac through his association with the Hart Wright Company of Lewiston, Maine. He also contributed daily almanac information to the New York Times from 1975 to 1997 and launched that paper's weekly Sky Watch feature in the science section.

Asteroid number 2845 is named Franklinken in his honor.

Since 2004 Ken and his wife, Charlotte, have resided in Loveland, Colorado. In addition to Charlotte, Ken is survived by his daughters Kathleen Williams, Christine Redding, and Julie Jones.

The photograph of Kenneth Franklin is provided by the American Museum of Natural History and *Sky & Telescope* magazine.

Joe Rao and Neil deGrasse Tyson
American Museum of Natural History and Hayden Planetarium

KENNETH INGVARD GREISEN, 1918–2007

Cornell University Emeritus Professor of Physics, Kenneth I. Greisen, died on March 17, 2007 of cancer at the Hospicare residence in Ithaca, New York. He was 89 years old. Prof. Greisen was well-known for his participation in the Manhattan Project at Los Alamos and for his many contributions to the study of cosmic ray physics. More quietly, Prof. Greisen also made significant contributions to the teaching of Physics at the high school and university levels. He was of service to the Cornell and Ithaca communities in many ways both during his university career and after his retirement.

Kenneth Ingvard Greisen was born in Perth Amboy, New Jersey, on January 24, 1918, to Signa and Ingvard Greisen. Ken attended Wagner College 1934–1935 and then Franklin and Marshall College, where he ran on the track team and graduated summa cum laude with the prestigious Henry S. Williamson Medalist award in 1938. Ken then entered graduate school in physics at Cornell University, where he became the first American student of the eminent Italian physicist Bruno B. Rossi. Together they carried out a study that yielded quantitative verification of the relativistic dilation of time intervals and an improved estimate of the mean life of mesotrons at rest. Their review article on “Cosmic Ray Theory” in 1941 was a standard for many years. Ken’s Ph.D. thesis entitled “Intensity of Cosmic Rays at Low Altitude and the Origin of the Soft Component,” along with related articles, appeared in 1942 and 1943. During this very productive period, Ken also married Betty Chase, a Cornell biology graduate student.

Upon graduation, Ken joined the Manhattan Project in Los Alamos, New Mexico. He was among the leaders of the group that designed and built the explosive charge that initiated the nuclear reaction in the first atomic bomb. Witnessing the July 16, 1945 Trinity explosion, he provided an eyewitness account that has become an important historical record. After the explosion, in a remark typical of him, he is widely quoted as saying “My God, it worked!” Following the war, Ken, along with Hans Bethe and other scientists, sent a letter to the President strongly advocating only non-military use of nuclear research.

Ken and family returned to Cornell University and Ithaca, where he remained, except for sabbatical periods, for the rest of his life. He spent the next years studying cosmic rays and the showers of particles produced by them in the atmosphere and various absorbers. An array of scintillators atop Cornell buildings allowed both the direction and intensity of air showers to be determined. Detectors 600 m underground, in a salt mine near Ithaca, detected only mesons with sufficient energy to penetrate so much material. In summers, detectors at a range of altitudes from the bottom to the top of Mount Evans (Colorado) provided altitudinal studies of cosmic-ray air showers and attracted an article in *Life* magazine.

Kenneth Ingvard Greisen

In early 1966, Ken realized that cosmic ray protons at energies above 6×1019 eV will interact significantly with the extremely low energy photons of the Cosmic Microwave Background, which had recently been discovered. If the sources of such extremely high-energy cosmic rays are at cosmological distances, this interaction should cause a sharp cutoff in the cosmic ray spectrum. The effect has been named the GZK cutoff after Greisen’s paper and an independent, slightly later paper by Georgi Zatsepin and Vadim Kuzmin.

Ken’s paper also predicted a small dip in the cosmic-ray spectrum at energies of 1018 – 1020 eV, due to pair production by the thermal photons.

Cosmic rays of such high energies cause the Earth’s atmosphere to fluoresce, making the Earth itself into a detector. Beginning in the early 1960s, Ken and his group developed instruments to measure this fluorescence and implemented them, in a “fly’s eye” configuration, in the hills surrounding Ithaca. The concept was taken around 1970 to the clearer skies of Utah, where a University of Utah group has extended and improved on the Cornell ideas to create the High Resolution (HiRes) Fly’s Eye detector. Two weeks before Ken’s death, the Utah collaboration reported observations of the high-energy cosmic ray spectrum clearly showing the GZK cutoff as well as the predicted dip at lower energies. The Pierre Auger Observatory, currently nearing completion in Argentina, will also use fluorescence detectors as one of two methods of studying the high-energy end of the cosmic-ray spectrum.

In the late 1960s, Ken’s research interests extended to the field of gamma-ray astronomy. These led to a number of high-altitude balloon flights carrying large-area gamma-ray telescopes. One such flight found pulsed emission synchronous with the Crab Nebula NP0532, providing the first observation of high-energy gamma rays from a pulsar. As his studies became more astronomical in nature, Ken joined the AAS in 1966, and, in 1968, Ken was named to the AAS organizing committee that established the High Energy Astrophysics Division (HEAD) of the AAS. Ken was selected as HEAD's first Chair for 1970 and 1971. Ken was also on the organizing committee that helped establish IAU Commission 48 on High Energy Astrophysics, also in 1970. He was subsequently elected to the National Academy of Sciences in 1974.

Ken devoted much of his efforts to teaching. In the late 1950s, he contributed to the work of the Physical Sciences Study Committee at MIT, which was the source of the PSSC high-school physics curriculum. At Cornell, Ken developed and taught for many years a course fundamental to the preparation of students to be professional physicists. Beginning in 1969, he presided over a team from the Physics and Science Education Departments to completely redesign the teaching of introductory physics, producing an innovative, self-paced, auto-tutorial course that retains that format today. Ken regularly concerned himself with the overall structure of physics courses at Cornell, assigned himself early hours for his courses so that his students could take popular courses in other departments, and heavily supported the careers of those faculty members who distinguished themselves as teachers.

Ken served on many national committees, was university Ombudsman 1975–1977, was Chairman of the Astronomy Department 1976–1979, and was Dean of the Faculty 1978–1983. He was granted an Emeritus professorship in 1984 and retired in 1986. The affection his colleagues felt for Ken was perhaps best illustrated when a Japanese Post-Doc and lifelong friend named his first child Kenichi. Comments received at his death emphasized his "great competence" as a scientist; his kindness, generosity, and concern for his students; and his "thoughtful human values" and "great integrity" as a "man of character."

Ken loved music, attending many concerts, playing flute and recorder, and singing in church and senior choirs. He greatly enjoyed hiking, boating, golf, and other outdoor activities, including, in his retirement years, the bicycle and month-long vacations in Kauai and Florida. Ken viewed retirement as a reason to leave university life behind, but not to cease providing service to those about him who needed help. In retirement, Ken volunteered in a variety of activities to assist those less fortunate than himself. In his later years, he engaged in a nearly daily "hobby" of writing checks to numerous charities.

Ken was preceded in death by his parents, younger brother Sigurd Greisen, older sister Agnita Dupree, first wife of 34 years Elizabeth Chase Greisen, second wife of 20 years Helen Wiltberger Greisen, and stepson Bruce Wiltberger. He is survived by his long-time companion Tommie Bryant of Ithaca; daughter Kathryn Greisen of Columbus, Ohio; son Eric Greisen of Socorro, New Mexico; step children Heather Wiltberger of Marshall, Virginia, Paul Wiltberger of Arlington, Washington, and Lois Wiltberger of Arlington, Massachusetts; and several step-grandchildren.

Eric W. Greisen
National Radio Astronomy Observatory

HERBERT GURSKY, 1930–2006

Dr. Herbert Gursky, Acting Associate Director of Research for the Naval Research Laboratory's (NRL's) Systems Directorate, and formerly Superintendent of the Space Science Division and Chief Scientist of the E. O. Hulburt Center for Space Research. Dr. Gursky died following a long illness on late Friday afternoon, December 1, 2006. Dr. Gursky was a great friend, valued colleague, and distinguished researcher who will be missed greatly.

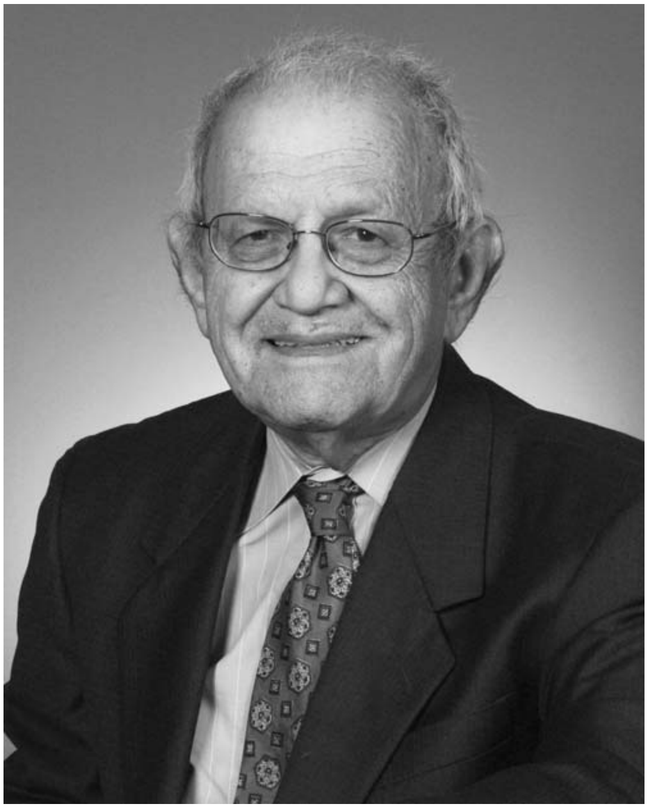
Dr. Gursky was born in Bronx, New York, on May 27, 1930. He was educated in secondary schools in Miami, Florida, and received a Bachelor's Degree from the University of Florida in 1951. He did graduate work in physics at Vanderbilt University (Master's degree in 1953) and Princeton University (Doctorate degree in 1959). His first professional position was at Columbia University as an instructor in the Physics Department from 1958 to 1961.

In 1961, he joined American Science and Engineering, Inc. (AS&E) in Cambridge, Massachusetts, as a senior scientist and rose to the position of Vice President, Space Research in 1967. In 1973 he joined the Smithsonian Astrophysical Observatory (SAO) as a supervisory astrophysicist. In 1974, Dr. Gursky was appointed Professor in the Practice of Astronomy at Harvard University and in 1976 was named Associate Director of the Center for Astrophysics for the Division of Optical and Infrared Astronomy. In 1981, Dr. Gursky joined NRL as Superintendent of its Space Science Division and Chief Scientist of the E. O. Hulburt Center for Space Research. He moved to the position of Acting Associate Director of Research for NRL's Systems Directorate in 2006.

Dr. Gursky's primary research interests were in the area of X-ray astronomy. He published more than 100 articles in this area and edited two books on the subject. Before arriving at NRL, he was the principal investigator for NASA-sponsored space programs on the Astronomical Netherlands Satellite (ANS) and the High Energy Astrophysics Observatory (HEAO)-1 satellite, and a co-investigator on numerous other rocket and satellite experiments.

At AS&E, Dr. Gursky managed research activities encompassing solar physics and magnetospheric research, and at SAO, he managed programs of ground-based astronomy and infrared astronomy. At SAO, he oversaw the completion of the Multiple Mirror Telescope, a joint program of SAO and the University of Arizona, comprising a 4.5-meter (equivalent) telescope of novel design that is situated at Mount Hopkins in Arizona.

Dr. Gursky's work at NRL involved direction of a broad-ranging research effort involving about fifty Ph.D. scientists conducting investigations in the areas of high-energy astronomy, solar physics, solar terrestrial effects and atmospheric science. NRL is the corporate research laboratory for the Navy and has the responsibility for assuring that future Navy systems take full advantage of all available technology and scientific understandings.



Herbert Gursky

Dr. Gursky had the ability to distill and seize the most important nuggets from any research program and envision its application to a variety of new problems and directions. In numerous areas of atmospheric, solar and space science technology, Dr. Gursky recognized key scientific issues and their potential DoD applications.

In solar physics, he spurred the development of semi-empirical modeling to predict solar storms that has been successfully transitioned to operational systems. He also supported participation in all NASA and other agency Sun-Earth connection orbiting space programs which resulted in a succession of spectacularly successful experiments in solar physics such as the high resolution rocket spectrograph and its flight on the NASA Spacelab 2, the Solar Ultraviolet Spectral Irradiance Monitor (SUSIM) on the NASA Upper Atmosphere Research Satellite, the Bragg crystal spectrometer solar flare experiment on the Japanese Yohkoh spacecraft, and the Large Angle and Spectrometric Coronagraph Experiment (LASCO) and extreme ultraviolet imaging telescope (EIT) on the ESA/NASA Solar and Heliospheric Observatory. These experiments have shed considerable light on how solar activity affects the near-Earth environment with many potential space weather applications.

In high-energy astronomy, Dr. Gursky made many contributions. He provided scientific oversight for the Advanced Research and Global Observation Satellite (ARGOS) Space Test Program spacecraft that contained five NRL instruments: the Unconventional Stellar Aspect (USA) experiment, the Global Imaging Monitor of the Ionosphere (GIMI), the High Resolution Airglow/Aurora Spectroscopy (HIRAAS) experiment, the Extreme Ultraviolet Imaging Photometer (EUVIP), and the Coherent Electromagnetic Radio Tomography (CERTO) instrument.

He continued his interest in X-ray astronomy with the USA experiment, which obtained observations of many celestial sources such as galactic binary X-ray sources and pulsars. Always with an eye toward applications, Dr. Gursky was interested in using X-ray sources, specifically X-ray pulsars, as precise clocks to provide spacecraft with autonomous timing and navigation. Dr. Gursky also supported research in gamma ray astrophysics, such as the development of NRL's Oriented Scintillation Spectrometer Experiment (OSSE) for the NASA Compton Gamma Ray Observatory (CGRO) satellite, and analysis of solar flare gamma ray spectra obtained from the NASA Solar Maximum Mission.

In atmospheric science, Dr. Gursky particularly encouraged practical applications of basic research. He recognized the importance of remote sensing for space weather, which resulted in the development at NRL of operational ultraviolet sensors on Defense Meteorological Satellite Program (DMSP) spacecraft that are now providing environmental data products to the Air Force Space Weather Agency. He initiated a program in middle atmosphere research that has been enormously successful and has spawned numerous experimental and theoretical advances, such as the Middle Atmosphere High Resolution Spectrograph Investigation (MAHRSI) to measure trace constituents in the middle atmosphere such as the hydroxyl radical (OH). Dr. Gursky supported the development of theoretical middle atmosphere models such as the Mountain Wave Forecast Model that was used to predict flight conditions for allied aircraft during operations Southern Watch, Enduring Freedom, and Iraqi Freedom, which has been a boon to stratospheric flight operations over mountainous terrain. He also supported the HIRAAS experiment on ARGOS.

Dr. Gursky provided outstanding leadership in the continued development of the United States space program. Under his stewardship, the NRL Space Science Division substantially expanded its leadership role in understanding the space environment and its effects on military and civilian systems. The Laboratory and the world are now witnessing the newest results of his scientific acumen and sound decision-making as exemplified in the very recent successful completions and launches of these major Space Science Division instruments:

Delivery of GLAST LAT (September 2006): Delivery of the collaborative NRL Large Area Telescope (LAT) for the NASA Gamma Ray Large Area Space Telescope (GLAST) satellite integration; when deployed, GLAST will measure the most energetic processes in the universe–from X-ray bursts, black holes, neutron stars, and solar flares–and has the potential to discover previously unknown relics of the Big Bang;

Launch of SOLAR-B (September 2006): The Japan Aerospace Exploration Agency's Hinode (Japanese for *Sunrise*, formerly known as SOLAR-B) launched September 23 carrying NRL's collaborative Extreme-ultraviolet Imaging Spectrometer (EIS), which achieved first light on October 28. EIS is now observing emission lines produced by highly ionized elements in the solar coronal and upper transition region of the Sun's atmosphere. Space Science Division scientists expect much exciting science concerning the coupling of solar activity to the near-Earth space environment to be produced by the EIS instrument; and,

Launch of STEREO (October 2006): NASA's Solar Terrestrial Relations Observatory (STEREO) launched 25 October, carrying the collaborative NRL Sun-Earth Connection Coronal and Heliospheric Investigation (SECCHI) instruments suite, which is currently successfully functioning in the pre-commissioning phase. The instruments onboard STEREO's twin spacecraft will make observations to help NRL researchers construct the first-ever three-dimensional views of coronal mass ejections, vital data–in complement with the long-operational NRL-built NASA LASCO–for understanding how the Sun creates space weather Perhaps Dr. Gursky's most personal research successes were as a member of the group that made the discovery of cosmic X-ray sources in 1961, his work with sounding rockets that culminated in the optical identification of the bright X-ray source Scorpius X1 in 1966, his work on clusters of galaxies and the diffuse X-ray background from the Uhuru Satellite and the discovery of X-ray bursters on the ANS satellite.

George Doschek and Jill Dahlburg
Space Science Division, Naval Research Laboratory

TOR HAGFORS, 1930–2007

Tor Hagfors

Tor Hagfors, a world leader in the use of radar techniques to observe ionospheres, surfaces and interiors of planetary bodies, died of heart-failure on 17 January 2007, in Puerto Rico, at the age of 76. He was born on 8 December 1930, in Oslo, Norway, and received his education there and in Trondheim, where he graduated with exceptionally good grades with a degree in technical physics from the Norwegian Institute of Technology (NTH) in 1955.

Hagfors was then until 1963 employed at the Norwegian Defence Research Establishment (NDRE) where he worked mainly on scattering of high-frequency radio waves in the Earth's ionosphere. This work earned him a PhD in physics from the University of Oslo in 1959. With leave of absence from NDRE, he worked as a Research Associate at Stanford University in 1959/1960, developing a fundamental theory on incoherent scattering of radio waves from electrons in the ionosphere and also participating in radar studies of the Moon's surface in preparation for the later lunar landings.

Back in Norway Hagfors continued his scattering studies but, finding that the opportunities for experimental work were limited there, he accepted in 1963 a position at the Massachusetts Institute of Technology's Lincoln Laboratory where he stayed until 1971, interrupted by two years as Director of the Jicamarca Radio Observatory near Lima in Peru 1967–1969. There he gained a reputation as a very inspiring and efficient leader who handled difficult negotiations with the Peruvian military junta very well. In 1971 Hagfors was appointed Director of Operations of the Arecibo Radio Observatory in Puerto Rico, a position that he held and executed in an excellent way until 1973.

Although Tor had by now become a United States citizen with a brilliant scientific career, he chose to return to his alma mater, NTH, in Trondheim, where he worked as a Professor of Electronics between 1973 and 1982. From 1975 to 1982 he also served as Director of the European Incoherent Scatter Association (EISCAT) and was in charge of the construction of its radar facilities in Scandinavia. In 1982 Tor was back in USA as Director of the National Astronomy and Ionosphere Center (NAIC), which manages the Arecibo Observatory. At the same time he was Professor of both Astronomy and Electrical Engineering at Cornell University in Ithaca, New York.

In 1992 Hagfors accepted a call as Director of the Max-Planck Institut für Aeronomie in Lindau, Germany, where he remained until his retirement in 1998. During this period he was also Adjunct Professor at the Institute of Theoretical Astrophysics, University of Oslo, where he helped to start research projects in space research. The University of Tromsö, Norway; University of Nagoya, Japan; and University of Lancaster, UK, also benefited from visits by Tor as a Guest Professor.

Hagfors was widely valued as a member of many national and international scientific committees and unions, *e.g.*, as head of a committee on space research for the Norwegian Research Council. He received many honors, notably the Van der Pol Gold Medal (1987), a Senior Humboldt Fellowship (1989), Membership in the Norwegian Academy of Science (1995), Extraordinary Membership in the Royal Astronomical Society (1998), the Sir Granville Beynon Medal (2002), a Doctorate Honoris Causa from the University of Oulu (2002), and a Honorary Doctorate from the University of Tromsö (2003).

Tor Hagfors had very wide interests; he was a brilliant researcher who published around 170 scientific papers. His many achievements in radio astronomy, in addition to what is already mentioned, included determination of the dielectric constant of the Moon's surface, radar mapping of the surfaces of Venus and of rapidly rotating planetary bodies, scattering studies of the surfaces of the Galilean satellites and of the interiors of comets and asteroids by radio sounding, and lastly the search for water on Mars by means of Mars Express data. He had a profound knowledge of not only the underlying physics of the phenomena that he studied, but was also a very skilled engineer who gave important contributions to antenna designs and equipment.

Tor was an inspiring scientist who gave generously of his time as teacher and adviser in fields such as information theory, plasma physics, radio astronomy, and antenna designs. He loved to socialize with friends and colleagues and he enjoyed outdoors activities, especially skiing. Despite his many accomplishments, he was a modest and friendly person who will be sorely missed.

Kaare Aksnes
University of Oslo

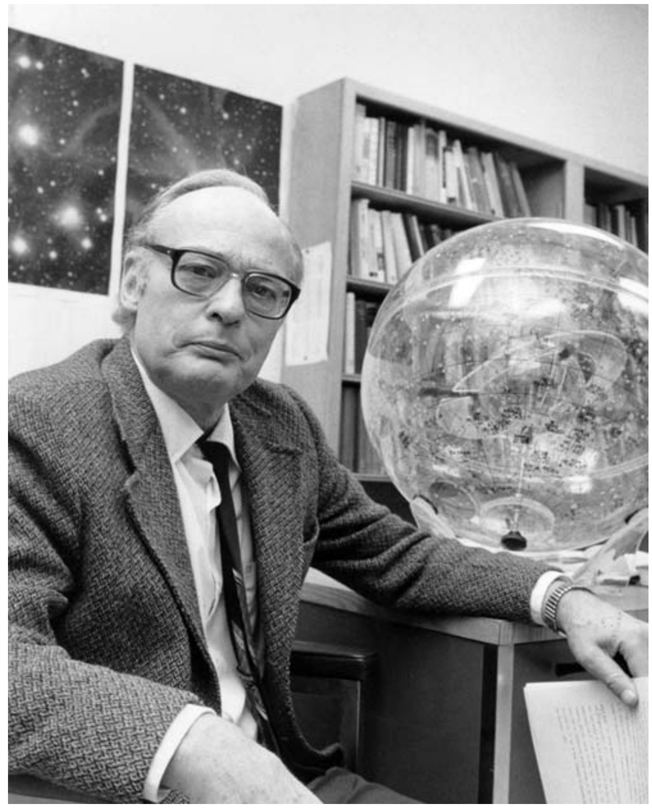
EDWARD R. (TED) HARRISON, 1919–2007

Cosmologist Edward R. (Ted) Harrison, emeritus Distinguished University Professor of Physics and Astronomy at the University of Massachusetts Amherst, died on 29 January 2007 in his retirement city of Tucson, Arizona, where he was adjunct professor at the Steward Observatory, University of Arizona. The cause of death was colon cancer. He is survived by a sister, brother, and daughter. (A son died in 2000.)

Perhaps best known for his work on the growth of fluctuations in the expanding universe and his books on cosmology for the dedicated layperson, Ted had extremely broad interests, and he published more than 200 papers in space sciences, plasma physics, high-energy physics, physical chemistry, and, principally, many aspects of astrophysics. He was a Fellow of the American Physical Society, the American Association for the Advancement of Science, the Royal Astronomical Society, and the Institute of Physics (UK).

Ted Harrison was born 8 January 1919 in London, England. His parents were Robert Harrison and Daisy Harrison (*nee* White). His education at Sir John Cass College, London University, was interrupted by the Second World War, during which he served for six years with the British Army in various campaigns, ultimately acting as Radar Adviser to the Northern Area of the Egyptian Army. It was during the latter service that he met his wife Photeni (*nee* Marangas).

Following the War, Ted became a British Civil Servant, at first with the Atomic Energy Research Establishment in Harwell and then at the Rutherford High Energy Laboratory. During this period he acquired the equivalent of university degrees, becoming a graduate, then an Associate, and finally a Fellow of the Institute of Physics. His somewhat unorthodox education may have contributed to his broad interests and his very intuitive and physical approach to scientific problems. The latter became the bane of generations of graduate students, who might find themselves asked on their physics qualifying exams to calculate "the length of a wild goose chase" (how far do *you* think a goose can fly on a meal?) or "the inductance of a wedding ring."



Edward R. (Ted) Harrison

Ted came to the USA in 1965 as a NAS-NRC Senior Research Associate in the Theoretical Division at NASA's Goddard Space Flight Center. In 1966 he became one of the three founders of the Astronomy Program within the Department of Physics and Astronomy at the University of Massachusetts. Over the next 30 years he also was instrumental in the revival of the Five College Astronomy Department, which links the University to Amherst, Hampshire, Smith, and Mount Holyoke Colleges, and he played a key role in the growth of the corresponding astronomy graduate program to international recognition. His two PhD students remain active in academia, Allan Walstad at the University of Pittsburgh, Johnstown, and Alice Argon at the Center for Astrophysics.

Ted loved to play chess and was a very skilled player. He was also a remarkably talented oil painter.

Ted's research in cosmology included a series of papers discussing the physics of the early universe and the evolution of galaxies from primordial fluctuations, in which he was the first person to identify several of the key processes. His work led to what came to be called the Harrison-Zeldovich spectrum for density fluctuations. But Ted turned his hand to any physical problem that caught his interest, from thermonuclear power, to the origin of galactic magnetic fields, to the acceleration of pulsars, to the diffusion of dust in molecular clouds. He even managed to combine cosmology and astrobiology, suggesting that if there exist a multitude of "universes," those like our own with intelligent life may be the result of natural selection (*QJRAS*, **36**, p. 193, 1995).

Ted was a wonderful writer, whose books frequently illustrate points of physics or cosmology with references to poetry or to classical history and philosophy. They have been translated into several languages, including German, French, Finnish, and Japanese. He was fascinated with Olbers' Paradox (which he pointed out had not been discovered by Olbers and was not really a paradox, but a riddle), the question of why the sky is dark at night if the universe is filled with bright stars and galaxies. His book, *Darkness at Night*, points out that this is not primarily because the universe is expanding, nor because light is absorbed, but rather because the stars and galaxies have had only about 15 billion years to radiate and indeed do not have enough energy to keep radiating for much longer. He points out that this conclusion was anticipated in the writings of Edgar Allan Poe!

Ted's monograph, *Cosmology: The Science of the Universe*, has gone through some seven printings and two editions. Again typical of his command of the history of science, he describes the problem of the "cosmic edge" of the universe by quoting fifth-century BCE soldier-philosopher Archytas of Tarentum, who asked what happens to a spear that is hurled across the outer boundary of the universe?

But to many of us, Ted's most intriguing book is *Masks of the Universe* (second edition published just three years ago). Is our present cosmology, with ordinary matter, dark matter, and dark energy, but another mask obscuring a Universe which will remain perforce forever unknown? Will the ΛCDM model be looked upon some day in the same way that we now view the medieval, the geometric, or the mythic universes of earlier eras? Read the book and form your own opinion!

William M. Irvine and Thomas T. Arny
University of Massachusetts Amherst
Virginia Trimble
University of California-Irvine

MARTHA LOCKE HAZEN, 1931–2006

Martha Locke Hazen

Longtime Harvard Curator of Astronomical Photographs and AAVSO officer Martha Hazen passed away on 23 December 2006 at Hingham, Massachusetts, after a short illness due to acute myelogenous leukemia.

One of four children of Harold Locke and Katherine (neé Salisbury) Hazen, Martha was born in Cambridge, Massachusetts, on 15 July 1931, and raised in the Town of Belmont, near Cambridge, where she lived for most of her life. Her father coined the term "servo-mechanism" while serving as an engineering professor and dean for graduate students at the Massachusetts Institute of Technology. Her mother majored in chemistry at Mount Holyoke College.

After receiving an A.B. in astronomy from Mount Holyoke College in 1953, Martha earned a Ph.D. in astronomy in 1958 from the University of Michigan, defending a dissertation on the distribution of intensity in elliptical galaxies in the Virgo cluster. Martha's marriage to William Liller in 1959, and the births of two children, inevitably slowed down her progress in observational astronomy. As a research fellow of the Harvard College Observatory, Martha continued to observe two to three weeks a year in Chile, and to reduce those observations and publish the results for sixteen years.

Martha's first publication, at least as far as Astrophysics Data System includes the literature, was with Alice Farnsworth on the 1952 occultations of stars by the Moon, published in the *Astronomical Journal* (1953). In 1958 she joined L. R. Doherty and D. H. Menzel on a short note about the calculation of line profiles in a stratified atmosphere, her only theory paper.

Martha's most cited paper is "The Distribution of Intensity in Elliptical Galaxies of the Virgo Cluster," (*ApJ*, **132**, p. 306, 1960). There she acknowledges Allan Sandage for suggesting the problem and providing some of the data. Her second most cited paper is "Photometric histories of QSOs-Two QSOs with large light amplitude," (Liller, M. H. & Liller, W., *ApJ (Letters)*, **199**, p. L133–L135, 1975). Progressing to smaller objects, other frequently cited papers are on eta Carinae and spectroscopic binaries in the globular cluster M3. All of these, and most of her other papers, involve photographic photometry, mostly using archival data.

In 1969, Harvard appointed Martha Curator of Astronomical Photographs, placing her in responsible charge of the world renowned Harvard Plate Archives. Under attack during the mid-1950s because it occupied too much physical space, the collection had been neglected for over a decade when Martha assumed this additional responsibility. Though she continued to observe for a few years thereafter, her stewardship of the invaluable plate archives gradually demanded her full attention, which it held until her retirement in 2002.

In her thirty-three years as curator of the plate stacks, as the archive is popularly known, Martha made numerous friends in both the professional and amateur communities. Astronomical researchers on a wide variety of topics relied on her detailed knowledge of the collection to guide them to important discoveries or discovery confirmations on the old plates, and to historical understanding of results in which some detail of origin needed clarification. Martha researched and documented the characteristics of nearly a hundred separate telescopic cameras used to take the plates archived in the collection. Much of this information was ephemeral, having been passed orally from observer to observer and was in danger of passing from human memory. This was, in itself, an enormous and valuable undertaking as it ensures the utility of the plates for future research. More importantly, Martha conserved and catalogued the all important logbooks that record the date, time, and other exposure circumstances for each of the plates in the collection. The full measure of Martha's long-term contribution in this regard undoubtedly will be realized as the digitization of the entire collection of plates is completed. The Digital Access to a Sky Century from Harvard (DASCH) project will owe much to Martha's efforts in this regard.

Another important contribution to progress in astronomy from the plate stacks came as Martha engaged in what she called Forensic Astronomy. Over the years, a great many variable stars that had been discovered on the Harvard plates had since been "lost," *i.e.* could not be found or verified. At the request of Nikolai Samus, General Editor of the *General Catalogue of Variable Stars (GCVS)*, Martha found the original discovery plates on these stars together with sufficient relevant information from other sources, and was successful in re-establishing credible identifications and accurate coordinates for 1,174 of the nearly 1,200 "lost" variable stars on the *GCVS* list. This required looking at multiple plates of the field involved to sort out whether the problem was an erroneous identification, inappropriate coordinates for the star, or some other problem. Many astronomers, professional and amateur, have relied on Martha to teach them the now arcane skills of photovisual photometry using a time series of plates and a "fly swatter" to discover variable stars, confirm a period or period change, or simply to construct a historical light curve to fit with modern observations.

The range of co-authors on Martha's many publications illustrates how useful her chosen specialization was to the field. She served as a portal to otherwise difficult-to-access but very valuable (and irreplaceable) data, particularly the Harvard Plate Collection.

In the 1970s, when interest in improving the status of women in astronomy arose, along with the desire to recruit more women into astronomy, Martha was appointed as Harvard College Observatory's representative to a university-wide coordination committee on the status of women in university life generally. Working with Ursula Marvin, who had similar responsibilities for the Smithsonian Astrophysical Observatory, Martha played a leadership role in the field for several years, helping to organize the first Space for Women conference in 1975.

Martha's long term support for the American Association of Variable Star Observers (AAVSO) was a natural consequence of her earlier work as an observational astronomer as well as curator of the plate stacks. She joined AAVSO in 1975, and was first elected to the Council in 1984, became a vice president, and eventually became president in 1992. When long-term AAVSO secretary Clinton Banker Ford (obituary, *BAAS*, **26**, p. 1602–1603, 1994) passed away in February 1993, Martha was elected secretary to replace Ford, and served in that capacity for over ten years. Her services to AAVSO went well beyond those years in elective offices, however, and cannot be fully understood only in those terms. Martha also served a vital role as a friend and mentor for Janet Akyüz Mattei ((obituary, *BAAS*, **36**, p. 1681–1682, 2004) throughout the latter's tenure as the director of AAVSO. The proximity of the plate stacks and AAVSO offices made it convenient for them to spend frequent lunch hours together, almost invariably discussing problems in administering the AAVSO. Both the authors of this obituary can testify, as former AAVSO presidents, to the importance of Martha's support and advice for Janet, and to the importance of her role behind the scenes in AAVSO activities for many years. AAVSO honored Martha for this service by presenting her their 37th Merit Award.

After her first marriage ended in divorce in 1982, Martha married Bruce McHenry, a retired career professional from the National Park Service, in 1991. That their relationship was a happy and fulfilling one is attested by the many friends Bruce made among Martha's astronomical associates. Their extensive travel together frequently involved Bruce's continuing professional interest in natural-history interpretation, but also touched many astronomical bases. Their travels also took the happy couple to the sites of many old canals, an interest they shared, as well as to quilting exhibitions, another of Martha's many interests. Martha's life long contributions to astronomy were recognized by Smithsonian Astrophysical Observatory colleagues through the naming of an asteroid, (10024) Marthahazen in her honor. She is survived by Bruce; three siblings, Stanley Hazen, Nathen Hazen, and Anne Bowen; her son, John Liller and daughter, Hilary Ward; and five grandchildren.

Thomas R. Williams
AAVSO
Lee Anne Willson
Iowa State University

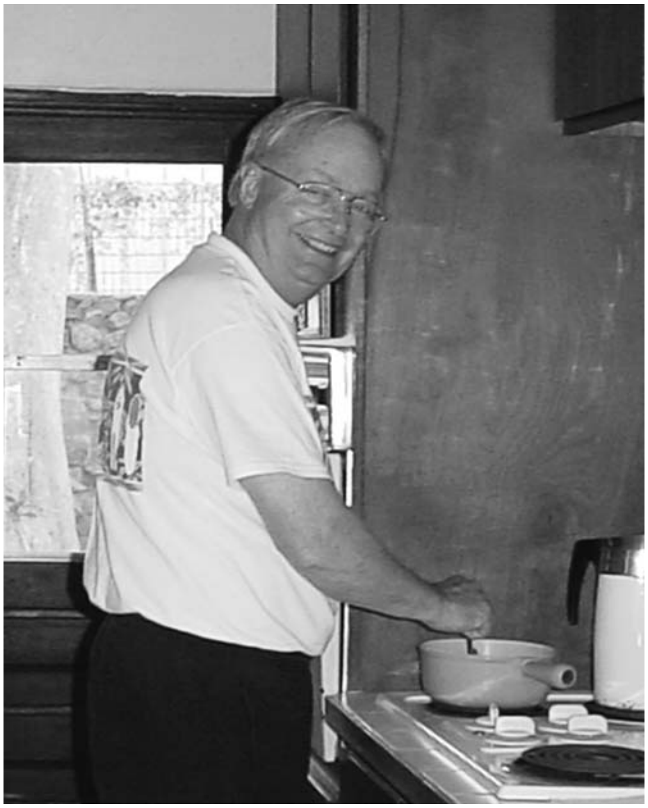
WAYNE CARLOS HENDRICKSON, 1953–2007

Wayne Carlos Hendrickson was born on born 4 December 1953 in Alhambra, California. He earned a BA/BS in Physics from the University of California at Irvine circa 1975. His PhD in astrophysics was earned in 1984 at the University of Texas at Austin. Hendrickson worked at Raytheon Corporation, for most of the rest of his life, on classified research. He died 8 August 2007.

Virginia Trimble
University of California-Irvine

JOHN J. HILLMAN, 1938–2006

John J. Hillman, a dedicated NASA civil servant, spectroscopist, astrophysicist, planetary scientist, and mentor, died on February 12, 2006 of ocular melanoma at his home in Columbia, Maryland. His professional and personal interests were wide-reaching and varied, and he devoted his ca-



John J. Hillman

reer to the advancement of our understanding of the beauty and wonder in the world around us. His love of nature, art, and science made him a true Renaissance man.

John was born in Fort Jay, New York, on November 22, 1938, and was raised in Washington, D.C. He received his B.S., M.S., and Ph.D. degrees in Physics from American University in 1967, 1970, and 1975, respectively. He began working at NASA's Goddard Space Flight Center, then in its infancy, in 1969, juggling a full-time position as a Research Physicist, the completion of his M.S. and Ph.D. degrees, and a young family. His background in molecular spectroscopy enabled him to apply his skills to numerous disciplines within NASA: infrared and radio astronomy; electronic, vibrational, and rotational structure of interstellar molecules; solar and stellar atmospheres; and planetary atmospheres. He published more than 70 journal papers in these disciplines. He was a frequent contributor to the Ohio State University International Symposium on Molecular Spectroscopy, and possessed a rare ability to bridge the gap between laboratory and remote sensing spectroscopy, bringing scientists from different disciplines together to understand our Universe.

The last fifteen years of John's career were devoted to the development of acousto-optic tunable filter (AOTF) cameras. He championed this technology as a low-cost, low-power alternative to traditional imaging cameras for in situ or remotely sensed planetary exploration. It was within this context that I got to know John, and eventually worked closely with him on the demonstration and application of this technology for planetary science using ground-based telescopes in New Mexico, California, and Hawaii.

John's interest in AOTF technology did not stop at planetary science: he cleverly applied this powerful tool to some of his other areas of interest, including art and history. Hyperspectral imaging, when applied to oil paintings, can reveal drawings underneath a "finished" work of art, and John was keen to learn more about his favorite artists by making spectral image cubes of their famous paintings. He also participated in an effort by the National Museum of American History to preserve the Star Spangled Banner flag that motivated Francis Scott Key to pen our national anthem. Perhaps John's most famous "observing run" was conducted at the Smithsonian, on the Mall in Washington, D.C., with an AOTF camera mounted on scaffolding in front of the flag. Spectral imaging revealed locations on the flag with signs of deterioration not visible to the unaided eye. In yet another example of John's amazing ability to bring together people from various disciplines, the team of people who worked on the flag project included planetary scientists, molecular spectroscopists, textile conservators, and agricultural scientists with expertise in the proteins of wool and cotton.

John was deeply committed to the scientific community, as demonstrated by his numerous service contributions. He spent two terms at NASA Headquarters, once in 1983–1985 as a Discipline Scientist for Planetary Astronomy, and once in 1999–2001 as a Discipline Scientist for the Planetary Astronomy and Planetary Atmospheres Programs in NASA's Solar System Exploration Division. He also served as a frequent reviewer for journals in planetary science, astrophysics, and molecular spectroscopy and served on numerous review panels for NASA and Goddard Space Flight Center.

Although John spent the vast majority of his career at a NASA center, he loved teaching and working with students. He was occasionally called upon to teach an astronomy course at the University of Maryland, which he thoroughly enjoyed, and for the last several years of his career he was a Co-Director of the College Park Scholars program at the University of Maryland. There he had an opportunity to share his love of science with college freshmen and provide them with unique educational experiences such as small seminars, individualized attention, and field trips. Even at Goddard, John maintained contact with numerous graduate students, many of whom he brought to Goddard as postdoctoral fellows funded through the National Research Council Resident Research Associateship Program. He was a natural mentor, providing leadership, advice, and friendship to the junior scientists who worked with him over the years.

One of the most exciting things about John was that he had numerous interests outside of astronomy. He enjoyed painting, and was a copyist at the National Gallery of Art. He was a skilled floral designer and won floral design contests in addition to owning a flower shop with one of his daughters. He was a gourmet chef, and could make a delicious meal out of the most basic of ingredients. He loved to ski, travel, garden, work on old cars, and read thriller novels. Most significantly, though, John was a deeply dedicated family man. He frequently shared stories about his adventures with his wife of 47 years, Patricia, his five children, his twelve grandchildren, and their extended family. With all of the professional accolades and successes he had received by the time he retired from Goddard, he viewed his family as his most significant accomplishment.

The astronomical community suffered a great loss in the passing of John Hillman. His commitment to professional service, his dedication to mentoring younger scientists, and his ability to bring together scientists from widely varying disciplines to work on a problem enabled him to make unique contributions to our field. Those of us who knew him miss his outgoing, friendly, inquisitive, and generous personality. John greeted each day with optimism, as a discovery and an adventure waiting to happen.

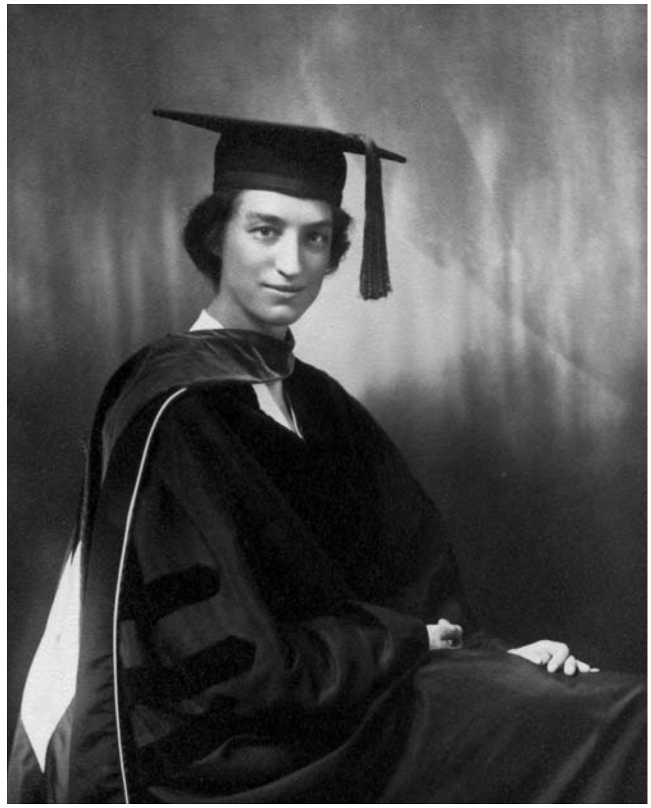
Nancy Chanover
New Mexico State University

E. DORRIT HOFFLEIT, 1907–2007

For Ellen Dorrit Hoffleit, who died on 9 April 2007 in New Haven, Connecticut, shortly after her 100th birthday, World War II, in which she did at least her fair share of the work, was "the war," but she also lived through World War I ("the Great War" until she was well into her 30s), Korea, Vietnam, the first Gulf War, and (we hope) most of Iraq.

Hoffleit's early years were difficult, and she described her own life as having led "From Early Sadness to Happy Old Age" (Comments on Astrophysics, 18, p. 107, 1996), with a late autobiography entitled Misfortunes as Blessing in Disguise(American Association of Variable Star Astronomers, 2002). The name Dorrit came from Dickens, but her parents, who called her Dorchen in childhood, were German immigrants, and some of her classmates refused to play with her "because she's German!" Home oscillated between a failing farm in Florence, Alabama, where she was born on 12 March 1907 and rented space in the railroad town of New Castle, Pennsylvania, where her father was a bookkeeper for the Pennsylvania Railroad. Older brother, Herbert (1905–1981) was, perhaps inevitably, the favored child, a precocious student (Harvard PhD at 22) and devoted to that most respectable subject, Latin language and literature, of which he was a professor at UCLA from 1927 (when it was the Southern Branch of the University of California) until his retirement. He took the teaching part of his career more seriously than the research part (though he was not the most memorable of the three Latin professors I had there), but, at a time when Dorrit's publications outnumbered Herbert's by something like fifty to one, she remarked, a little sadly, that the only thing about her that her mother, who lived until 1974, really approved of was her long hair.

Dorrit soon started catching up! She was the only member of the Radcliffe class of 1928 who had taken a graduate course in mathematics. She turned down a better paying job as a statistician to start work the next year as a research assistant (later research associate) at Harvard College Observatory, then directed by Harlow Shapley, about whom her opinion was much warmer than that expressed by Cecilia Payne Gaposchkin. Dorrit's immediate supervisor at Harvard was Henrietta Swope, daughter of the President of General Electric, and eventually best known for work at Mount Wilson Observatory with Walter Baade on variable stars in the Magellanic Clouds, published in papers that continued to appear long after Baade's death.



E. Dorrit Hoffleit

Hoffleit's first ten papers were also on variable stars and appeared in Harvard Observatory publications. But the MA she completed in 1932 was on the light curves of meteors and was published in the Proceedings of the United States National Academy of Sciences. By this time, Dorrit had established a work pattern that was to persist right up to retirement–at least 40 hours per week on whatever the current boss thought she should be doing, and another 20 or so on other astronomical research that interested her.

Hoffleit had supposed that an MA would be her highest degree, but Shapley urged her to go on for a PhD, with, it would seem, a bit of urging on both sides from Bart Bok, who informed her that "if God recommends that you do something, it is your duty to do it." The thesis (PhD 1938) was on yet a third topic, spectroscopic parallaxes. This means determining the luminosities of stars, hence their distances, from line width and ratio diagnostics in their spectra. The pioneer was Antonia Maury, whose insights were not appreciated by Shapley's predecessor, E. C. Pickering. Another valuable Hoffleit mentor was Ernst Öpik, on a three-month visit to Harvard in 1934, from whom Dorrit learned stellar statistics and half a dozen other things. The thesis also provided her "break out" paper into the Astrophysical Journal (on CN as a giant/dwarf discriminator).

Hoffleit began to branch out into astrometry, comets, and other parts of astronomy and, starting in 1941, began writing about eighty short news notes per year for Volumes 1-15 of the newly formed Sky & Telescope. And then there was a war. Women were not, of course, drafted nor required to find state-side war work to avoid deployment overseas, but Dorrit, still mindful of her German heritage, volunteered. After about six months working under Zdenek Kopal on preparation of firing tables for Navy cannons, she returned briefly to Harvard, having been employed (and paid) at roughly the high-school student level by the Navy. But soon it was on to the Ballistic Research Laboratory of the Army's Aberdeen Proving Ground and another computing job, this time for trajectories of anti-aircraft missiles. The other job opportunity was to measure missile tracks on photographic plates, which she would have preferred, but this would have placed her in the department headed by Edwin P. Hubble. No love was lost between Harvard's Shapley and Mount Wilson's Hubble, partly due to scientific differences, but also partly due to their very different views on what scientists should do in war time, so perhaps is was just as well she ended up in the computing section.

There was another stage of fuss and bother to be got through before Dorrit received an appropriate, "professional" (meaning with PhD) rank and the commensurate salary. To the Colonel who complained that women were forever leaving their jobs to get married, she mentioned only her age, and not her early resolve never to marry or to have children, because of a deep worry that they might inherit the mental instability that had led to her maternal grandmother's institutionalization and early death.

By the end of the war, her position, salary, and responsibilities a good match to her skills and credentials, Dorrit willingly put in another three years with the Army, working on reduction of records of "DOppler Velocity and Position" data for the captured V-2s being flown from White Sands Missile Range. But it was not the astronomy she loved, and late 1948 saw her back at Harvard (though with a consultant's appointment at Aberdeen for another ten years), salary cut back by a factor two, but with tenure as an astronomer, a bigger office, and an enormous pile of plates from the Blömfontein station to be measured for spectroscopic parallaxes. She undertook that and a wide range of other projects, with full support from above as long as Shapley was director.

It must mean something that the next director, Donald H. Menzel, who eventually precipitated Hoffleit's departure from Harvard, had also been born in a Florence (Colorado, rather than Alabama), but what really mattered was that he wanted to move Harvard in the direction of his own field of astrophysics and saw no good reason to maintain extensive plate files or people who extracted data from them.

Dorrit went job hunting, and, when the dust had finally settled, she was ensconced in two positions that she would occupy officially for the next twenty years (and unofficially long beyond that). It was in those two contexts that most of us came to know her. Hoffleit became, half-and-half, both director of the Maria Mitchell Observatory from 1957 to 1978 and a research astronomer at Yale (1956 to official 1975 retirement) under its long-term director Dirk Brouwer, where her primary task was to be preparation of astrometric catalogs.

The Observatory directorship first. Maria Mitchell (MMO) was (and is) a small, private observatory on Nantucket Island (Massachusetts) founded as a memorial to the first woman astronomer in the USA by her family and friends. The primary instrument was a 7.5" refractor used (1912–1995) primarily for photographic monitoring of variable stars. Hoffleit proposed to work on some hundreds of her Harvard discoveries, employing for the first time during each summer a small group of undergraduate women to acquire additional plates, measure them, determine periods, and so forth, the results eventually to be published, often in the Journal of the American Association of Variable Star Observers, where MMO papers still turn up, though perhaps not so many as in Dorrit's day. She would also continue education and public outreach activities in the local community that her predecessor, Margaret Harwood, had established.

Summer research experience for undergraduate opportunities have become common, but they were rare in 1957, especially for women students, and the ones who came to MMO (more than one hundred over her term) were undoubtedly very strongly motivated. They left even more so, with the striking result that about 25 of the Hoffleit students became professional astronomers. A few of the earliest are now retired; many remain in stellar astronomy, but others have spread across the Solar System and the galaxies. According to a list compiled by Dorrit, with minor additions, these are, in chronological order: Margo Friedel Aller, Andrea Knudsen Dupree, Barbara Welther, Gretchen Luft Hagen Harris, Nancy Houk, Martha Safford Hanner, Diane Reeve Moorhead, Nancy Remage Evans, Catherine Doremus Garmany, Jane Turner, Jean Warren Goad, Karen Alper Castle, Marcia Keyes Rieke, Judy Karpen, Karen Kwitter, Esther Hu, Bonnie Buratti, Harriet Dinerstein, Melissa McGrath, Constance Phillips Walker, John Briggs, Deborah Crocker, Edward Morgan, and Karen Meech. The program went co-ed shortly before Dorrit handed it over to Emilia Belaserne).

A special paragraph must go to Janey Akyüz Mattei. She came to MMO in the summer of 1969 upon the recommendation of Paris Pişmiş, an Armenian-Turkish-Mexican astronomer who had known Janet in Turkey and was a very old friend of Dorrit's (and of mine). Janet's own obituary sadly appeared in these pages (*BAAS*, 36, pp. 1681–82, 2004), the last 30 of her only 61 years having been spent as the director of AAVSO. Among the many important things Janet did in that directorial capacity was to persuade Dorrit Hoffleit to write up the story of her life for publication by AAVSO in 2002, from which much of this material has been taken.

And then there was Yale. "Dorrit Hoffleit?" "You know. The Yale Bright Star Catalogue." Indeed the Yale Bright Star Catalogue: the Third (1964) edition on her own; the Fourth (1982) with Carlos Jaschek; the 1983 Supplement; and the Fifth (1987) Edition with W. H. Warren. The value of these would be hard to overestimate. They were cited one hundred or more times per year from 1985 to 1999 (compared, to about twenty citations per year to Annie J. Cannon's HD catalogues and about 600 per year to the multiplet tables of Charlotte E. Moore during the same period). But there were also her contributions to a number of other Yale catalogues of positions and proper motions, and, especially, the 4th edition of the General Catalogue of Trigonometric Parallaxes with W. F. van Altena and J. T. Lee, plus a large number of papers based on subsets of the stars in these catalogues and compilations.

Dirk Brouwer, who had chaired the search committee that selected Hoffleit as director of Maria Mitchell, was also department head and observatory director at Yale when she arrived there. Late in 2006, when Dorrit had become even more forthcoming than in her autobiography, she admitted in an extended phone conversation that he had been a very traditional director, not just primarily committed to positional astronomer (one of her own loves) but also of the opinion that the staff should work primarily on his projects. Yet the unexpected death of Brouwer in January 1966 could have been a disaster. The newly appointed acting director, Rupert Wildt (of H-minus opacity fame) made clear that the future of the department would lie with astrophysics, and he did some firm "deaccessioning" of non-tenured staff in celestial mechanics and astrometry. But when Pierre Demarque took up the chairmanship, making clear that it would not be for the rest of his life, he was very glad to have Hoffleit's programs continue and, in fact, gave her a good deal more freedom to choose then than had Brouwer.

Dorrit used part of that freedom to begin writing about the history of astronomy, first book reviews and obituaries, but soon also articles on the history of variable star astronomy, a long 1993 article on women who had worked in the field (and she included supernovae!), and, most notably, the 1992 volume Astronomy at Yale 1701–1968. Eventually her historical interests were bound to overlap her own lifetime, and her last publication was the written version of a talk she gave at the April 2000 meeting of the American Physical Society on the pioneering women of stellar classification-Fleming, Maury, and Cannon (Physics in Perspective, 4, pp. 367–495, 2002).

Among the honors bestowed upon Hoffleit, primarily rather late in her life, were two DSc's (Smith College 1984, Central Connecticut State University 1998), the George van Biesbroeck Prize (American Astronomical Society and University of Arizona, 1988) for extraordinary service to the astronomical community both as a mentor and as a cataloguer, and an asteroid (3416) in 1987.

With no children or grandchildren of her own, Dorrit established close relationships with her brother's two children, many of the Maria Mitchell "girls," and the children of her younger Yale colleague Robert Zinn. In a slightly more ideal world, this piece would have been written either by Janet Mattei of AAVSO or by Martha (Liller) Hazen, whose friendship with Dorrit went right back to the plate stacks of Harvard. Both predeceased her.

Dorrit once said of Annie J. Cannon that she (AJC) was the happiest person that she (EDH) had ever known. I am not quite sure we can say that, in turn, about Dorrit Hoffleit, but she certainly was in the running. And part of what it made it so wonderful to encounter her was not just that you were glad to see her, but that she was glad to see you.

Virginia Trimble
University of California-Irvine

MICHAEL WILLIAM JOHNSON, 1949–2007

Michael W. Johnson was born on 1 September 1949. He received his B.S. (Physics) from the University of San Francisco in 1971, his M.S. (Physics) from the University of Toledo in 1974, and his Ph.D. (Astrophysics) from the University of Pennsylvania in 1981. His doctoral thesis was entitled, "HEAO A-1 Observations of X ray Emitting Clusters of Galaxies," and he was an author of a 1983 catalog of X-ray emitting clusters.

Johnson was on the science faculty at Maryville University, in St. Louis, Missouri, where he lectured on physics and astronomy. He was husband of attorney Delores M. Johnson and had three daughters. Michael Johnson died on 13 April 2007.

Thomas Hockey
Historical Astronomy Division

FRANK CULVER JONES, 1932–2007

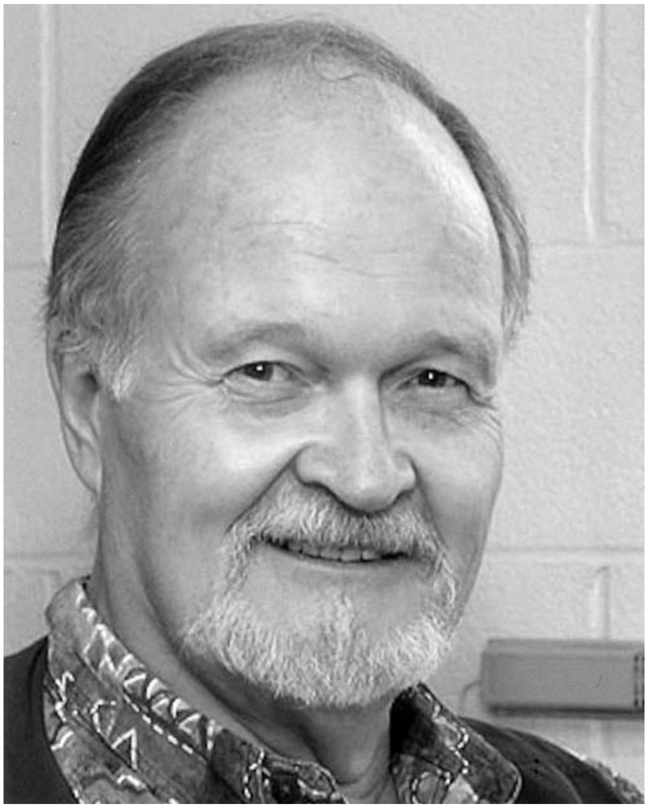
Frank C. Jones, an emeritus theoretical physicist at NASA, died May 2, 2007 at age 74 after a struggle with a rare form of cancer. He died at his home in Silver Spring, Maryland, surrounded by his family.

Frank was born July 30, 1932 in Fort Worth, Texas, the oldest of three boys. His parents were Kenneth Hugh and Nancy Culver Jones. Frank's father was a lawyer, and his grandfather was a Methodist minister. Frank graduated from Rice University in 1954 and earned a master's degree in 1955 and a doctorate in 1961, both in physics, from the University of Chicago. He did his graduate work with Prof. John Simpson.

Dr. Jones began his professional career as an instructor in physics at Princeton University before joining NASA's Goddard Space Flight Center in 1963 as a National Research Council associate. He subsequently became a member of the Theory Division and the Laboratory for High Energy Astrophysics. His area of expertise was the origin, transport, and electromagnetic interactions of cosmic rays. His particular focus was the stochastic physics related to the diffusion of particles in random fields, plasma turbulence, and the shock acceleration of charged particles in collisionless plasmas.

From 1993 to 1995, Frank was head of Goddard's Theoretical High Energy Astrophysics Office and continued to serve as Head of the Theory group. In 2003 he served as Acting Chief of the Laboratory for High Energy Astrophysics. He retired in 2005 and continued his affiliation with NASA as an emeritus scientist at Goddard until his death.

As a youngster, Frank showed the signs of curiosity and initiative that indicated he might become an experimentalist. At the memorial service for Frank, his brother related the stories of how Frank had rigged a hidden microphone to play through the family television as his brother courted a young woman on the front porch swing, and how one of Frank's early chemistry experiments caused all the family silverware to turn black. Although Frank started his professional career as an experimentalist, his wife Ardythe says he didn't become really happy until he turned to theoretical work after his postdoctoral appointment at Princeton. Frank, with characteristic good humor, was not averse to telling his experi-



Frank Culver Jones

mentalist friends that, after attempting balloon-borne experiments, he decided he was better suited to theoretical work.

In more than four decades of research at NASA, Dr. Jones made a number of pioneering contributions to his area of expertise, regularly attending and presenting his work at the biannual International Cosmic Ray Conferences sponsored by the International Union of Pure and Applied Physics (IUPAP). He was known among his colleagues for his low-key presentations that demonstrated his deep understanding of the fundamentals of broad areas of physics far removed from cosmic radiation. This knowledge, combined with his friendly, generous, and open personality, meant that he was much sought after for his insight, advice, and wisdom on physics generally. He authored a paper on Compton scattering—the decrease in energy of a high energy photon when it interacts with matter—that is still widely used (Jones, F. C. *Physics Review*. **167**, p. 1159, 1968). His works on acceleration of particles at oblique shocks with M. Baring and D. Ellison (*Advances in Space Research*, **15**, #8/9, p. 397, 1995 & **Astrophysical Journal Supplement**, **90**, p. 547, 1994.) are essential references in the field. Frank's review paper with D. Ellison in *Space Science Reviews* is considered one of the classics in the field of particle acceleration (*Space Science Reviews*, **58**, p. 259, 1992).

Frank was never afraid to look at an unconventional idea. When scientists were searching for evidence of tachyons, Frank looked into the kind of Cherenkov radiation they might produce (Jones, F. C. *Physics Review D*, **6**, p. 2727, 1972).

Don Ellison, Professor at North Carolina State University and one of Frank's most productive graduate students, told us that Frank had an astonishing memory. Don said he used to visit with Frank after lunch to discuss progress on his dissertation and get advice. He would think that Frank was dozing off and not listening to his report. However, he would find that many weeks or even months later Frank would remember the conversation and quote it back to him long after he had forgotten the encounter. Frank's colleagues were also the beneficiaries of this recall ability in informal settings. An avid fan of vintage movies, Frank could recall a scene from movies released long ago to draw an analogy or encapsulate a pertinent idea for any point of discussion that happened to be on the table.

Frank was elected a Fellow of the American Physical Society in 1974 and a Fellow of the American Association for the Advancement of Science in 1996, being cited for "theoretical investigations of propagation and acceleration of cosmic rays in the interstellar medium."

Frank took his turn at public service duties. He was elected by his peers to a three-year term on the Executive Committee of the Cosmic Physics Division (now the Astrophysics Division) of the American Physical Society (APS) in 1980. He served the APS as Council Member from 1994 until 1997, as a member and chair of the Committee on Constitution and Bylaws 1996–1998, and as its Chair in 1997. Frank chaired the Publications Committee responsible for the volumes of the 19th International Cosmic Ray Conference in La Jolla, California, in 1985, as well as serving on the conference steering committee. In 1987, when *COSNEWS*, the *Newsletter of the Cosmic Ray Commission of the IUPAP*, needed a new Editor and Publisher, Frank volunteered and served until 2002.

Frank loved computer technology and was highly regarded in the laboratory as a helpful expert on this new technology as it grew and personal computers came to be found in every office. These sometimes incomprehensible new devices were well understood by Frank. He was always providing helpful advice to everyone from technicians to scientists and managers. This generosity resulted in his becoming the first senior research scientist to be honored with the Laboratory's Peer Award.

Survivors include his wife of 52 years, Ardythe Grube Jones of Silver Spring, Maryland, two children, Cheryl Mattis of Columbia and Timothy Jones of Silver Spring, two brothers, and four grandchildren.

Johnathan F. Ormes
University of Denver
Robert E. Streitmatter
NASA

LYMAN FRANCIS KELLS, 1917–2004

Lyman Francis Kells was born in Seattle, Washington, on 19 May 1917. He earned a 1938 BS in Chemistry from the University of Washington. He received a PhD. in 1944, also from the University of Washington.

Kells held research positions at the Carbide and Carbon Chemicals Corporation of New York, New York, from 1944 through 1946; the Standard Oil Development Company of New Jersey, from 1946 through 1948; and Allied Chemical Corporation of Morristown, New Jersey, from 1951 through

1961. His wartime work involved the separation of Uranium isotopes by gaseous diffusion, based on a method developed in part by Harold Urey.

Kells was on the faculty of Hunter College 1948–1949, an Assistant Professor at Iona College 1949–1951, a Special Lecturer at Newark College of Engineering in 1961, an Assistant Professor of Chemistry at East Tennessee State University 1962–1964, and a Professor of Chemistry at Westmar College 1964–1974. He died on 4 November 2004 in Seattle, Washington.

Kells was a member of the American Association for the Advancement of Science, the American Chemical Society, the Astronomical Society of the Pacific, and the New York Academy of Science, as well as this Society. He was a Unitarian. Kells is survived by his daughters Leila Stefani Newcomb and Christina V. Cohen.

Thomas Hockey
Historical Astronomy Division

DONALD ALEXANDER MACRAE, 1916–2006

Donald Alexander Macrae

With the passing of Donald Alexander MacRae on 6 December 2006 at age 90, the astronomy community lost a visionary scientist and a great educator in the field.

Don MacRae was born in Halifax, Nova Scotia, on 19 February 1916, to Donald Alexander and Laura Geddes (Barnstead) MacRae. His father was originally a classics scholar and preceptor of Greek and Latin at Princeton, but at the time of Don's birth in 1916 he was Dean of the Dalhousie Law School in Halifax. The family moved to Toronto, Ontario, in 1924 when his father joined the faculty of Osgoode Hall Law School in Toronto as a Professor of Law.

After the family moved to Toronto, where he received most of his early education, he obtained his undergraduate degree in Mathematics and Physics in 1937 from the University of Toronto (U of T). He obtained the degree of A.M. in 1940 and of Ph.D. in 1943 from Harvard University under the mentorship of Bart Bok in the field of galactic structure. During his early career he worked briefly at the University of Pennsylvania, Cornell University, and Carbide and Chemical Corporation at Oak Ridge, Tennessee. For Don the latter work was a brief and somewhat uneasy association with the Manhattan Project. In 1946, he obtained a position at Case Institute of Technology (now Case Western Reserve University), where he worked until 1953. In 1953, he accepted a position at the U of T, replacing Ralph Williamson, who had earlier introduced Don to the emerging field of radio astronomy while they both were at Cornell.

Don's primary research field was stellar spectroscopy, but his interests were much broader than this, and he possessed an abiding ability to interest students and faculty in new and emerging ideas. In the early 1960s he developed a strong interest in the nature and origin of the lunar surface, and discussed these extensively with colleagues. Many of his ideas on this subject were later confirmed by the lunar exploration program. Don's continuing interest in radio astronomy led him to introduce this subject area into the Toronto graduate research and teaching curriculum. In collaboration with the Department of Electrical Engineering, he established a radio astronomy observing site at the U of T's David Dunlap Observatory (DDO) in 1956. This was at a time when few astronomers took this subject seriously. The DDO work led to the precise determination of the absolute flux density of Cas A at 320 MHz, a radiometric standard as important today as it was when it was reported in 1963. On behalf of the University of Toronto, he subsequently participated in radio astronomy activity at the National Research Council's (NRC's) new Algonquin Radio Observatory in Algonquin Park. The radio astronomy program that Don established was an early stimulus for the first successful experiment in Very Long Baseline Interferometry in 1967, a collaboration among the University of Toronto, Queen's University, and NRC.

As a teacher, Don was highly regarded by his students, whom he engaged with his characteristic wit and frequent anecdotes. His lectures always were well prepared and organized, and endowed with an underlying belief that the ideas and principles of physics were most easily understood by applying them first to the stars. As an innovative teacher, he was the first professor at Toronto to teach computer programming at the university, recognizing early that students would need such skills in their scientific careers. Similarly, he was a strong advocate for public outreach. He was featured in the Oscar-nominated short film "Universe" produced in 1960 by the National Film Board of Canada. He also was instrumental in the establishment of the McLaughlin Planetarium, which opened in Toronto in October 1968. In honor of his strong record in education, the U of T established an undergraduate scholarship in Don's name in 2003 to reward promising undergraduates in the astronomy program.

In 1965, Don became Head of the Department and Director of the DDO, and continued in these positions for thirteen years. During this period, he presided over a major expansion of the Department, which made it the major center of astronomical activity in Canada. This included the establishment in 1971 of a 24-inch telescope at the site of the Carnegie Southern Observatory at Las Campanas, Chile. The clear weather and excellent seeing conditions at Las Campanas attracted many graduate students to study astronomy at the U of T. It was also used by many astronomers from other institutions.

Don MacRae was an active participant in the establishment of national observing facilities for all Canadian astronomers. He supported the establishment the Algonquin Radio Observatory in the 1960s to serve the growing community in the emerging field of radio astronomy. He participated in the planning and development of the Canada-France-Hawaii-Telescope (CFHT) on Mauna Kea, Hawaii, in the 1970s, and served as one of four Canadian astronomers on the Board of the CFHT Corporation from 1973 to 1979. He was appointed as Board Chair in 1978 for the last year of his term. During the 1970s Don was elected to the Board of Trustees of the Universities Space Research Association (USRA), dedicated to promoting cooperation between NASA and North American universities. He served as USRA Board Chair in 1973. Don was also an active member of the AAS since 1943, and served as AAS Councilor from 1963–1966.

Although Don retired in 1982 and was appointed Professor Emeritus in the Department, he continued his interest in departmental activity for many years after. During the 45 years I knew Don, both as his graduate student 1961–1966, and later as one of his colleagues, I shared with his friends and associates an enduring respect for his wisdom, generosity, sense of humor, powers of observation, and rigorous attention to accuracy and detail. He maintained an abiding ambition to create a leading department and to help in establishing a world-renowned astronomical community in Canada. His legacy is that he succeeded in both areas.

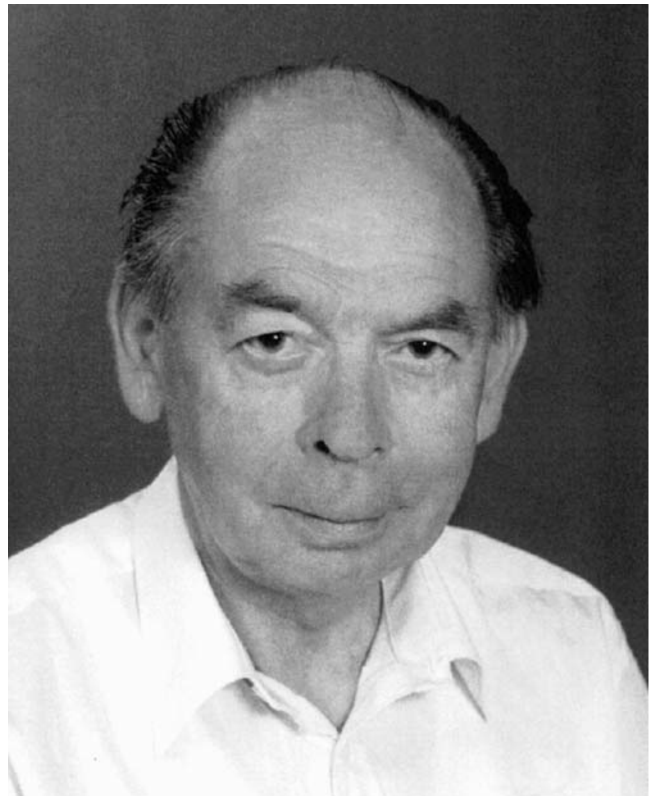
Don enjoyed a life-long interest in photography, carpentry and woodworking. In retirement, he spent a great deal of time on family genealogy. He possessed a strong "do-it-yourself" philosophy, manifested for example in clearing land and building a cottage on Georgian Bay, a family project during his younger years.

Don died in Toronto of natural causes. He is survived by his older sister Jean Borden, and his three sons David, Charles, and Andrew. Don's wife Betty predeceased him by about one year. He is also survived by his four granddaughters and two grandsons, in all of whom he delighted, as well as nieces and nephews who were particularly dear to him.

E.R. Seaquist
University of Toronto

PER E. MALTBY, 1933–2006

Professor Per Maltby, prominent Norwegian Solar Physicist at the Institute of Theoretical Astrophysics, University of Oslo, Norway, died on 24 May 2006. Lung cancer was diagnosed in February, but he was expected to improve. Until the end of March he came to his office every day, got recent papers off the web, and followed his field closely as he had always done.



Per E. Maltby

Per Maltby was born in Oslo, Norway, on 3 November 1933. He started his studies at the University of Oslo in 1952 and took his candidate degree in 1957. Between 1955 and 1958 he was a research assistant at the Institute of Theoretical Astrophysics in Oslo. In 1960 Maltby became an assistant professor (*amanuensis*) at the University of Bergen and from January 1963 he held a corresponding position at the University of Oslo. He became an associate professor in 1967, and from 1983 until he retired in 2003 he was a full Professor at the Institute of Theoretical Astrophysics, University of Oslo.

Per Maltby is survived by his wife Elisabet (*née* Ruud), whom he married in 1956. They had two children. The daughter, Bente, is a medical doctor and gynecologist serving as a section head at the district hospital in Kristiansand in southern Norway. Their son, Lars, holds a doctoral degree in engineering, specializing in the properties of powders. He is currently managing director in the Norwegian division of the French multinational company Saint Gobain. As a father Per Maltby expressed pride in his children and was pleased with their progress in life. He also enjoyed his five grandchildren.

As a scientist, Per Maltby was versatile and productive. In the early 1960s he visited the California Institute of Technology where he did pioneering studies of the distribution and time variation of the radio emission from active galaxies, using the Owens Valley Radio Observatory. His work with Alan Moffet contributed to revealing the secrets of these remote objects. Their results drew attention and were indeed mentioned in the pages of *Time* magazine.

However, Maltby's lifelong interest was in our Sun, and most of his more than 200 published articles and presentations are within the field of solar physics. Throughout his career, and into his years as an emeritus professor, he obtained significant results, results to which colleagues all over the world will continue to refer.

In 1964 Maltby took his doctoral degree (Doctor Philosopiae) on a study of the Evershed effect. He elegantly demonstrated that the flow was predominantly radial with only minor vertical and azimuthal components and that flow speeds increased all the way to the edge of the penumbra where the flow seemed to abruptly disappear. This disagreed with conventional knowledge at the time. His results are, however, confirmed in all later investigations.

Per Maltby highly valued his work with colleague Gunnar Eriksen. They studied the effect of progressive sonic and Alfvén waves on the profiles of spectral lines. The results demonstrated the characteristic spectral signatures of such waves and laid the foundation for a proper use of line profiles as a diagnostic tool for waves in solar and stellar atmospheres.

Sunspots continued to be a main interest. For twenty years Per Maltby and his students measured the relative intensity of sunspots at a number of wavelengths from blue and into the infrared. The infrared measurements represented entirely new knowledge, giving access to the deepest layers in the sunspot photospheres. This refined series of spectral sunspot measurements stretched over two eleven-year activity cycles and resulted in his models of the umbra and penumbra of spots, models that have served as standard reference models until this day.

Already before the start of the SOHO era in solar physics, Per Maltby had shifted his attention to the conditions in the transition region and coronal layers above sunspots. Together with his collaborators he studied rapid down flows, often at supersonic speeds, from the corona into sunspot umbrae. He rediscovered sunspot plumes, the dense, cold pillars of gas rising above sunspot umbrae and penumbrae into the corona, and mapped their properties.

In his last works Maltby unambiguously showed that the transition region over sunspot umbrae were filled with upward propagating sound waves that penetrate into the corona under certain conditions. This result deserves special attention since many have believed that such penetrations must take place, but nobody was earlier able to demonstrate it observationally in a convincing manner.

Per Maltby was always looking forward and always aware of new possibilities. He was an influential member on the Norwegian government committee that recommended Norwegian membership in the European Space Agency (ESA), and was the force behind securing sufficient domestic government funds to allow Norwegian scientists to participate in SOHO and Cluster. He took part in SOHO from the earliest planning stages and later played a prominent role in the Norwegian SOHO project. Through his activities, Norwegian space research came to life, introducing new and rich possibilities for research in astronomy and geophysics in Norway.

Maltby played important roles in many national and international advisory groups and committees. For a number of years he was a member of several of ESA's advisory groups. He served as leader of the Institute of Theoretical Astrophysics in Oslo in 1976–1977, and in 1976–1981 he was a member, and later the chairman, of the project selection committee for natural sciences for the Norwegian Foundation of Science and the Humanities. Finally, Maltby was instrumental in securing a Norwegian role in the Japanese solar space observatory Hinode, which will be a rich source for Norwegian solar physics in the years to come.

Per Maltby had a remarkably wide scientific orientation. His papers most frequently describe observations and their interpretation. He had an enormous respect for what is "real," the solid and measurable. But he combined this with deep theoretical insights that he demonstrated in his interpretations and theoretical papers.

Per taught his students a rational, scientific way of thinking and encouraged their curiosity. He was open and always dedicated to develop the best scientific cooperation. And he was generous, which was always important to his young collaborators. He might appear quiet and reserved, but showed his warm heart and appreciation when you got close to him. His death is a sad loss for his colleagues and for our discipline.

Olav Kjeldseth-Moe
Institute of Theoretical Astrophysics, Norway

TIMOTHY P. MCCULLOUGH, JR., 1910–2004

Timothy Pendleton McCullough Jr., 93, a retired research physicist who was a pioneer in the measurement of microwave radiation from planetary surfaces, died of cardiac arrest on 19 November 2004, at Inova Fairfax Hospital. He lived in Springfield, VA.

McCullough, who was principally a radio astronomer, published 22 scientific research papers while working in the Atmosphere and Astrophysics Division of NRL, from 1946 until his retirement in 1975.

He spent the early part of his career in planetary observation and was among the first in his field to use radio astronomy to measure the surface temperature of Venus. He also studied Mars and Jupiter. Later, his interest turned to supernovas, galaxies and solar flares.

He was an emeritus member of the American Astronomical Society and a member of the Sigma Xi Scientific Research Society.

McCullough was born on 9 December 1910 in Vardaman, Mississippi. His father, Timothy P. McCullough, was a farmer and bookkeeper. His mother, Annie W. McCullough, was a homemaker. Timothy McCullough, Jr.'s parents, as well as two sisters and a brother, are deceased.

McCullough graduated from the University of Mississippi in Oxford in 1936 and received a master's degree in physics from North Carolina State University in Raleigh. He taught physics and aviation navigation before entering the Navy during World War II. He instructed Russian sailors on antisubmarine warfare. McCullough left the Navy at the end of the war, but continued to serve in the Naval Reserve.

He was recalled to active duty during the Korean War and

Timothy P. McCullough, Jr.

Thomas Robert Metcalf

was stationed at Potomac River Naval Command, where he wrote technical documents on electronic warfare systems.

McCullough retired from the Naval Reserve in 1969 with the rank of commander. He was a charter member of First Baptist Church in Springfield and a former deacon and Sunday school teacher at First Baptist Church in Alexandria.

Survivors include his wife of 63 years, Virginia Ball McCullough of Springfield; three children, Robert E. "Gene" McCullough of Denver, Jane Ball Phillips of St. Matthews, S.C., and Charles E. McCullough of Clifton; seven grandchildren and four great-grandchildren.

[The preceding article expands upon one published in the NRL *Labstracts* of 18 April 2005 and is used with permission.)

Charles McCullough
NRL

THOMAS ROBERT METCALF, 1961–2007

The astronomy community lost a good friend when Tom Metcalf was killed in a skiing accident on Saturday, 7 July 2007, in the mountains near Boulder, Colorado. Tom was widely known for prolific work on solar magnetic fields, hard-X-ray imaging of solar flares, and spectral line diagnostics. He was often characterized as "one of the nicest guys in science."

Born October 5, 1961 in Cheverly, Maryland, to Fred and Marilyn, Thomas R. Metcalf joined his sister, Karen, two years his elder, in a close family that loved sailing, inquisitiveness, and the natural world. Sibling rivalry (usually a Tonka truck intruding on Barbie's sub-table "castle") melted when Tom and Karen collaborated on elaborately engineered room-sized blanket-forts. Tom confidently signed up at age of three to crew for his family's sailboat; when the family moved to California in 1966, as Tom's father took a Professor of Mathematics position at the University of California Riverside, Tom's love for sailing was well-established. Week-long cruises or short trips in the harbor were all fun; when school friends came aboard, it was even better—if "only *slightly* too crowded" from the adults' points of view.

Tom's introduction to astronomy began one cold, very clear, December night in the early 1970s, on a family camping trip to Death Valley. The "Sidewalk Astronomers of San Francisco" had lined the sidewalk near the visitors' center with all sorts of telescopes for public viewing. Soon after, Tom and his boyhood friend Jim O'Linger were building their own scopes, attending "Amateur Telescope Makers" conferences, and Tom was setting up *his* scope on a sidewalk for public viewing. In 1986, Tom set up his telescope on the bluffs above Dana Point Harbor, and gave numerous strangers a stunning view of Halley's Comet.

His interest in physics and mathematics became evident during Tom's last years in high school (Poly High in Riverside), and as a senior he qualified to take freshman Physics at the University of California-Riverside (UCR). Computers entered Tom's life then as well: In a 1970s example of technological generation-gapping, he learned to program his father's new desktop computer. Soon, he was exploiting UCR's time-shared machines for that honorable endeavor, writing computer games. Those "great games that Metcalf wrote" brought Tom's father quite a reputation amongst the undergraduates.

Tom earned his B.A. in Physics from the University of

California-San Diego (UCSD) in 1983. He continued at his alma mater for graduate school in 1984, and joined the "solar group" there headed by Dr. Richard C. Canfield. After earning an M.S. in Physics in 1985, Tom moved to the Institute for Astronomy (IfA) of the University of Hawai′I, with Dr. Canfield's group, in 1986. Tom completed his Ph.D. through UCSD in 1990, "Flare Heating and Ionization of the Low Solar Chromosphere," then stayed at the IfA as first a Post-Doctoral Fellow and then Associate Astronomer. While at the IfA, his participation in Mees Solar Observatory operations and Yohkoh mission support developed along two themes: the observation, analysis, and interpretation of solar magnetic fields, and hard X-ray imaging of solar flares. Tom was a key member of the group that demonstrated the hemispheric "handedness" trend in the twist of solar active region magnetic fields. He applied his considerable mathematical expertise to the application of a "pixon" algorithm for hard X-ray image reconstruction. To this day, this approach remains the algorithm of choice for the Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI) mission, on which he was a Co-Investigator.

Tom moved to the Lockheed-Martin Solar and Astrophysics Laboratory (LMSAL) of Palo Alto, California, in 1996, once again sharing an office with Dr. Jean-Pierre Wülser, his old office-mate from the IfA. During his tenure at LMSAL, Tom became a Co-Investigator on several space experiments: the X-Ray Telescope (XRT) on the Japanese Hinode mission, and the Atmospheric Imaging Assembly (AIA) and Helioseismic and Magnetic Imager (HMI) on the Solar Dynamics Observatory (SDO). During this time Tom continued work on interpreting solar magnetic fields, specifically the pioneering use of the Na-D2 spectral line to map the solar chromospheric magnetic field.

In 2005, Tom joined the growing solar group at NorthWest Research Associates' (NWRA) division in Boulder, Colorado. Tom was an integral part of efforts comparing algorithms for magnetic field data analysis and coronal diagnostics afforded by the spectacular new data from *Hinode*. Of note were his work on 180° disambiguation algorithms for vector magnetic-field data and non-linear force-free extrapolation methods for modeling the coronal magnetic field.

Tom's professional interests were so wide and varied that colleagues who survive him are continually uncovering projects to try to bring to closure. Every meeting brings new heartfelt condolences and shy inquiries, "…if you don't mind, Tom had some data for me … could you …???" He developed a navigation package using Hewlett-Packard calculators, still used by many sailors. Tom's IfA-vintage hurricane-tracking website still sees visitation spikes when major storms threaten. At the time of his death, Tom had 77 publications with easily over one hundred colleagues, including his father. Tom represented NWRA/Colorado Research Associates at the recently formed "Boulder Solar Alliance;" through it, a new National Science Foundation Research Experience for Undergraduates program was funded, and many Boulder-area research groups, including NWRA, hosted students in its 2007 inaugural summer.

Tom was routinely teased as a "closet granola-head" by friends and family; as he moved inland his interests switched to mountain bike riding, rock climbing, and year-round skiing. Tom would eagerly join in any new adventure that sounded interesting. He was an avid bike commuter who relished the challenge of learning to ride in snow and ice. He recycled *everything*.

Tom is survived by his daughters Shanon Brower, Alyssa Metcalf, and Keri Metcalf to whom he was a devoted father, their mother Janet Biggs, his parents Fred and Marilyn Metcalf, and his sister Karen (Metcalf) Swartz. A vast array of friends, colleagues, and extended family will also sorely miss him.

To honor Tom's long-standing support for young researchers in solar physics, Tom's family and the Solar Physics Division of the AAS have established a travel fund for young scientists, to which contributions are most welcome:

The Thomas Metcalf SPD Travel Fund
American Astronomical Society
2000 Florida Ave., NW Suite 400
Washington, DC 20009–1231, USA https://members.aas.org/contributions/Thomas_Metcalf_SPD_Travel_Fund.cfm

K.D. Leka
NorthWest Research Associates

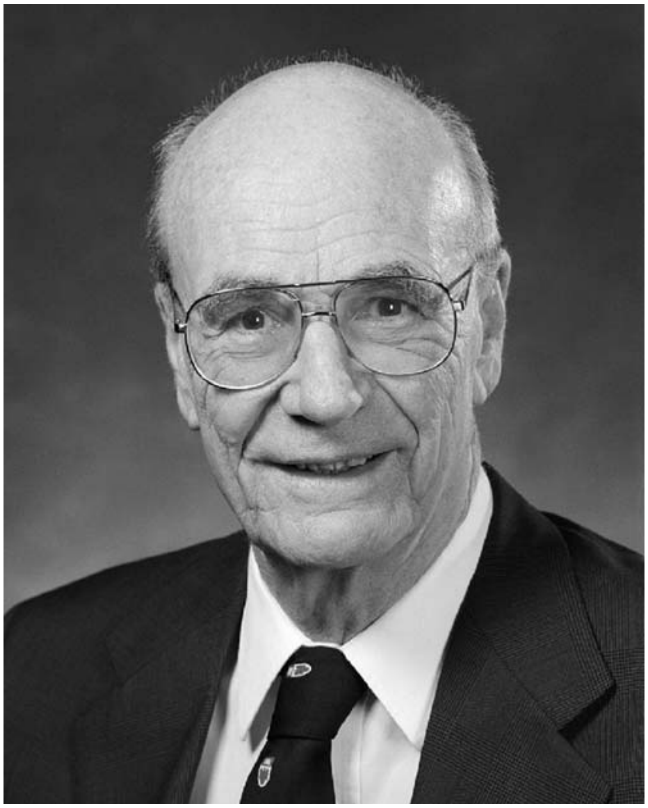
DONALD EDWARD OSTERBROCK, 1924–2007

Donald Edward Osterbrock, one of the leading figures of post-World War II astronomy, died suddenly of a heart attack on 11 January 2007, while walking near his office at the University of California, Santa Cruz. He was 82 years old. His initials spelled D.E.O. (God in latin!), but he was known simply as Don to his many friends and colleagues.

Don's long and productive career spanned five decades. His scientific work helped shape our understanding of lower main-sequence stars, the ionized interstellar medium, and active galactic nuclei. He was also a highly respected historian of astronomy who shed new light on 19th- and 20th-century astronomy.

Don was born in Cincinnati, Ohio, on 13 July 1924. Both of his parents were of German descent and valued hard work, education, and science. They both completed their high-school education at night while working full-time during the day. His father eventually became a professor of electrical engineering at the University of Cincinnati. Don's plan to become an astronomer was put on hold when the Japanese attacked Pearl Harbor in 1941. After graduation from high school, Don joined the United States Army and trained as a meteorologist, taking all of the physics and mathematics courses required for a bachelor's degree in physics from the University of Chicago. He was eventually sent to islands in the Pacific Ocean but never was in harm's way. After three years of service, Don returned to Chicago to obtain his bachelor's degree in 1948, his M.S. in astronomy in 1949, and a Ph.D. in astronomy in 1952.

Don's years at the University of Chicago and the University's Yerkes Observatory in Williams Bay, Wisconsin, were pivotal for his career and personal life. He came in contact with such luminaries as Otto Struve, Bengt Strömgren, Subrahmanyan Chandrasekhar, and William W. Morgan. At Yerkes, he also met and married Irene L. Hansen, a native of



Donald Edward Osterbrock

Williams Bay, who was employed as a member of the Yerkes staff. They had a son, William, now living in Santa Cruz; two daughters, Laura of Seattle, Washington, and Carol of Santa Cruz; and three grandchildren.

Don did a theoretical Ph.D. thesis with Chandrasekhar calculating the effects of gravitational interactions between interstellar clouds and stars, but arguably his best known graduate work was observational in nature, helping Morgan map the nearest spiral arms of our Galaxy. Morgan put Don's name on the landmark 1952 paper (Morgan, Sharpless, & Osterbrock, *AJ*, **57**, p. 3, 1952), even though, according to Don's own account in his 2000 autobiography *A Fortunate Life in Astronomy*, the work was mostly Morgan's. This generous gesture by Morgan likely fashioned what was to become Don's own trademark generosity towards his Ph.D. students and colleagues for years to come.

After obtaining his Ph.D. degree, Don spent a single but very productive year as a postdoctoral fellow at Princeton University, becoming interested in the stellar structures of red dwarfs. Using numerical integration methods generously provided by Martin Schwarzschild, Don produced the first models of red dwarfs that took into account their outer convective layers (Osterbrock, *ApJ*, **118**, pp. 529–546, 1953). These calculations also inspired Fred Hoyle and Schwarzschild to successfully model red giant stars with similar convective envelopes.

In 1953, Osterbrock accepted an instructorship at Caltech, joining a young astronomy department led by Jesse Greenstein. Direct access to Caltech's outstanding astronomical facilities on Mounts Wilson and Palomar marked a turning point in Don's career, since it allowed him to pursue his observational interests in gaseous nebulae. Drawing on his expertise in atomic physics, and a very productive collaboration via air mail with young atomic theorist Michael Seaton, he pioneered the use of spectroscopic methods for the study of gaseous nebulae.

In a daring move in 1958, Don left Caltech for the University of Wisconsin, to appease his wife's and his own homesickness for the Midwest. There he continued his work on gaseous nebulae, both observational and theoretical, often as part of the Ph.D. thesis of one of his many excellent graduate students. As time went on, Don became increasingly fascinated by the emission-line spectra of active galactic nuclei (AGN), and this fed a growing need for larger telescope apertures. In 1973, the "lure of the big telescope in the land of clear skies" (his own words from his 2000 autobiography) won out, and he finally accepted the long-pending offer from the Chancellor of the University of California at Santa Cruz to become director of Lick Observatory.

Lick's 120-inch telescope and its unique image-dissector scanner were ideally suited for the spectroscopic AGN survey that Don had in mind at the time. In the decade and a half that followed, Don amassed arguably the best and largest collection of high-quality spectra on AGN in the world, published several seminal papers based on these unique data, and became in the process one of the world's leading authorities on AGN. During that same period, Don published his "little blue book" on the *Astrophysics of Gaseous Nebulae* (1974). This textbook and the two subsequent revisions *Astrophysics of Gaseous Nebulae* and *Active Galactic Nuclei* (1989 and 2005–the later edition, with co-author Gary Ferland) have been the standard references for graduate courses and researchers in the field for more than thirty years.

This prolific period of Don's career was doubly remarkable considering that, from 1973 to 1981, he was the Director of Lick Observatory. This was a time when tough choices had to be made in order to get the 10-meter Keck Telescopes project under way. Don very effectively and diplomatically guided the upper echelons of the University of California, Santa Cruz, through this process. He also served as president of the American Astronomical Society from 1988 to 1990, no doubt having too much time on his hands after stepping down from the Lick directorship!

Don received several awards and honors for his research work. In 1991, he won lifetime achievement awards from the American Astronomical Society and Astronomical Society of the Pacific, two of astronomy's highest honors. In 1997, the Royal Astronomical Society awarded him its Gold Medal, its highest honor, seldom given to an American astronomer. He was a member of the National Academy of Sciences, the American Academy of Arts and Sciences, and the American Philosophical Society. He received honorary D.Sc. degrees from five universities. Over the years, Don produced 21 Ph.D. students who turned out a significant number of today's researchers in AGN and emission line studies.

Mostly after his retirement in 1992, Don authored numerous books, historical studies, and biographies of key figures in 19th- and 20th-century astronomy. He felt that history was too important to be left to historians, and adhered to the "great man" theory of history (that aims to explain history by the impact of great men or women) rather than pursue the deconstructionist approach of historians. In recognition for this work, the AAS's Historical Astronomy Division awarded him in 2002 the Leroy E. Doggett Prize, the highest award given to a historian of astronomy.

Don was a brilliant scientist, a natural leader, and a gifted historian, yet he was also very modest and unassuming. His firm handshake, warm, infectious smile, and congenial personality were hard to resist. He thrived in the companies of his colleagues and students, freely sharing his ideas on science, history of science, or history in general. In his later years, he seemed at his best when observing on top of Mount Hamilton's Lick Observatory, once the Sun had set and the photons from an AGN were quietly and effortlessly being captured for the next exposure. He would then often kick back on "his" La-Z-Boy recliner in the 120-inch telescope control room and take off on one of his many fascinating stories about the history of astronomy. These were truly wonderful moments, and many of us are very grateful to have had the opportunity to share them with him.

Don will always have a very special place in our hearts. He was a great mentor, a wonderful role model, and a true gentleman. Our very fond memories of our time with him will never cease to inspire us. He will always be an Ideal to which to aspire.

Sylvain Veilleux
University of Maryland

BOHDAN PACZYNSKI, 1940–2007

Bohdan Paczynski

Bohdan Paczynski, Lyman Spitzer, Jr. Professor of Astrophysics, died at home in Princeton, New Jersey, on April 19, 2007.

Born in Wilno, Poland (now Vilnius, Lithuania) on February 8, 1940, Paczynski's first encounter with astronomy was in 1954 when he visited Warsaw Astronomical Observatory in Ostrowok. Soon after his visit, he began a program of observing variable stars that led to his publishing his first paper, "Minima of Eclipsing Variables in 1954-56" at age 18. The study of binary star evolution would be a life-long interest. His highly cited 1971 review paper on "Evolutionary Processes in Close Binary Systems" still provides our framework for understanding binary stars. In his final year, Pacyznsk returned to his beloved variable stars and coauthored a paper with Warsaw University Observatory colleagues on "A Model of AW UMa," which has just appeared in *Monthly Notices of the Royal Astronomical Society*.

In 1957, Pacyznski began studies at Warsaw University, where he worked with Stefan Piotrowski. After completing his Master's Degree, he traveled to the United States to become a night assistant at Lick Observatory. After his year in California, he returned to Poland to defend his PhD thesis in 1964 and to marry Hania Adamska, his lifelong companion. During the subsequent decade, Pacyznski's work had a profound impact on our understanding of stellar evolution. In between 1965 and 1967, Paczynski wrote a series of papers, "Evolution of Close Binaries I-V," that describe how nearby neighbors alter the evolution of stars. These papers were the basis for his *doctor habilatus*, a higher degree remarkably earned at age 27. He then spent a year as a Fellow at the University of Colorado's Joint Institute for Laboratory Astrophysics. Primarily during his year in Boulder, he developed "The Paczynski Code." Using this code, Paczynski wrote a series of papers that showed that the cores of stars between 3 and 7 times the mass of the Sun converge to similar behavior. These stars end their life as planetary nebulae and leave behind cooling white dwarfs. This code was made publicly available and was widely used by the international community. The code is still in circulation–most recently, it was made available as a CD in Carl Hansen, *et al.*'s 2004 book on *Stellar Interiors*.

In 1969, Paczynski returned to the Institute of Astronomy as an assistant professor. He would be promoted to associate in 1974 and to professor in 1979.

In the late 1970s and early 1980s, Paczynski and his collaborators wrote a number of influential papers on the properties of accretion disks around black holes. These papers showed that geometrically thick disks of gas could radiate at super-Eddington rates. These "polish donut" models are important tools in our understanding of quasars and accreting X-ray sources.

In December 1981, martial law was declared in Poland. Paczynski and his family were visiting the California Institute of Technology at the time, where he was spending the year as a Fairchild Fellow. Faced with the decaying political situation in Poland, Pacynski decided to stay in the United States. He quickly received offers from many leading universities. In 1982, he joined the Princeton faculty as a Professor in the Department of Astrophysical Sciences. In 1989, Paczynski became the first Lyman Spitzer, Jr. Professor of Theoretical Astrophysics. While not able to visit Poland until the collapse of communism in 1989, Paczynski invited many of his Polish colleagues to visit Princeton and the USA. Throughout his career, he was a vital link between US and Polish astronomy and was an important mentor for many Polish and US astronomers.

At Princeton, Pacynski's interests turned to gravitational lensing and its astrophysical applications. The nature of the dark matter that makes up more than 80% of the mass of our Galaxy is one of the great mysteries of astronomy and physics. Many astronomers suspected that low mass stars could be the dark matter. Paczynski recognized that these stars would act as foreground gravitational lenses and amplify the light from background stars. In a subsequent paper with Princeton graduate student Shude Mao, Paczynski noted that planets would produce a distinctive microlensing signal.

Paczynski's gravitational-lensing papers inspired a host of projects that used large CCDs to study the variable universe. Working with colleagues at Warsaw University and the Carnegie Institution, Paczynski and his Optical Gravitational Lensing Experiment (OGLE) collaborators detected the first microlensing events towards the galactic bulge. While the microlensing surveys detected the expected number of events when looking toward the galactic center, very few events were seen in the direction of the Magellanic Clouds. This low event rate implies that "Jupiters" or low mass stars do not make up most of the mass of our Galaxy and strengthens the case that a new subatomic particle makes up most of the dark matter.

Last year, the OGLE collaboration produced its most dramatic result: the first detection of terrestrial planets around another star. Searches using other techniques have only been able to detect Jupiter-like planets and have not been sensitive enough to detect rocky planets like our own Earth. By following up on OGLE detections in nearly real time with other telescopes, Paczynski and his collaborators made a major step along the path towards find a planet like Earth around a nearby star. Their initial results imply they are common and that many nearby stars harbor rocky planets.

OGLE's variability survey has also uncovered a host of exciting astronomical objects. OGLE discoveries include transiting planets, RR Lyrae stars, and eclipsing binaries. Paczynski recognized the potential value of eclipsing binaries for establishing the distance scale and for testing stellar models.

Paczysnki was a very early, persistent, and effective advocate of the idea that Gamma Ray Bursts were extragalactic. This idea ran counter to conventional wisdom and implied that the energy released in gamma-ray bursts greatly exceeded the energy released in optical light in supernova explosions. Many high-energy astrophysicists found Paczynski's proposal absurd; however, Paczynski emphasized that the astronomical evidence all pointed towards these powerful explosions coming from outside our Galaxy. With improved data from a new generation of high-energy satellites, observers were able to confirm the extragalactic nature of gamma-ray bursts. Paczynski's heresy has become our firmly established understanding.

The astronomy community recognized Bohdan Paczynski with many honors and awards. The American Astronomical Society awarded him the Heinemann Prize and its highest honor, the Russell Prize in 2006. The Royal Astronomical Society recognized his contributions with the Eddington Medal (1987), the George Darwin Lectureship (1996), and its Gold Medal (1999). He won the Astronomical Society of Pacific's Bruce Gold Medal (2002). He was a member of the Polish Academy of Sciences and a foreign member of both the National Academy of Sciences and the Royal Academy of Sciences.

Diagnosed three years ago with inoperable brain cancer, Paczynski bravely fought on and continued his intellectual activities. With his life prolonged by an experimental treatment, he spent his valuable time with his family, his students, and his colleagues. He continued to be a regular presence at department coffee, where he offered wise and witty insights into a wide range of topics in astrophysics.

Paczynski is survived by his wife, Hanka, his daughter, Agnieszka, his son, Martin, and a grandchild.

Paczynski was generous with his time and his thoughts, and colleagues and students sought his scientific insight and personal wisdom. His good spirits during his final struggle was an inspiration to all around him. His conduct as a scientist and as a human being was distinguished by unfailing politeness, good sense, and personal integrity.

I would like to thank Bruce Draine and Jeremiah Ostriker for their assistance in writing this obituary. The photograph is by Robert P. Matthews, Princeton University (1989).

David Spergel
Princeton University

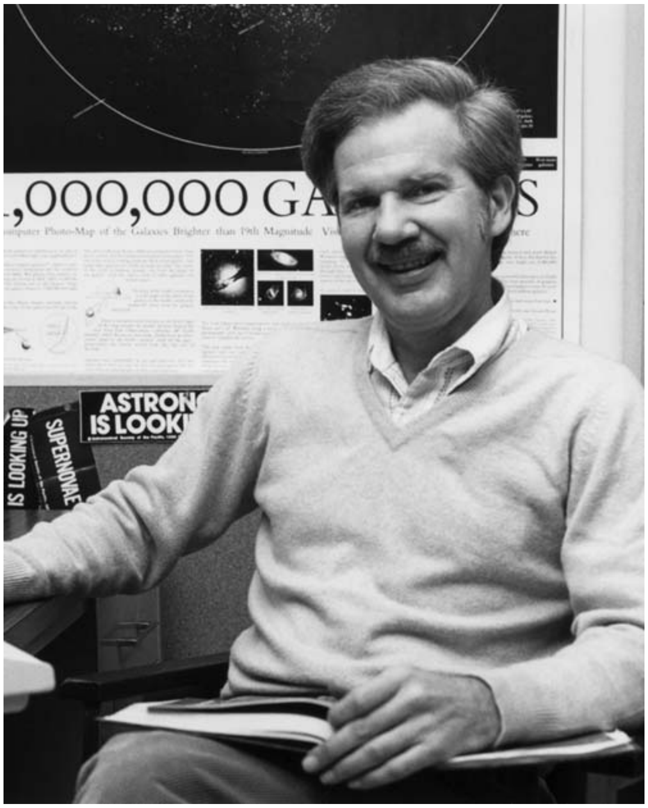
RALPH ROBERT ROBBINS, JR., 1938–2005

Ralph Robert Robbins, Jr., died on 2 December 2005, in Kyle, Texas. His wife, Maria Elena Robbins, his daughters Julia Robbins Kelso and Stephanie Juarez Balles, his son Matthew Juarez, and five grandchildren survive him. Bob was on the faculty at the University of Texas from 1968 until his retirement in 2003.

Bob was born in Wichita, Kansas, on 2 September 1938, the only son of Mildred and Ralph Robert Robbins, Sr. Guided by his high school's policy to provide a practical education to children of working-class parents, Bob began high school with a heavy dose of vocational courses until the results of a test indicated his special talent in mathematics. He was awarded a full scholarship to Yale University, graduating magna cum laude in mathematics in 1960. He won the Warner Prize in Mathematics at Yale that year. He received his Ph.D. in 1966 with a dissertation entitled "The Triplet Spectrum of Neutral Helium in Expanding Nebulae" from the University of California at Berkeley. His interest in college teaching was ignited at this time through summer teaching positions at San Mateo California Junior College and the Ohio State University. Following a year at Texas as a McDonald Observatory Post-doctoral Fellow, Bob taught for a year in the physics department of the University of Houston before returning to the University of Texas at Austin as an Assistant Professor of Astronomy in 1968. He was promoted to Associate Professor in 1972.

Bob's research in the early 1970s on theoretical studies of helium was of vital importance to astronomers for over three decades. These pioneering calculations became vital to observational astronomers in the mid-1990s as interest grew in the primordial helium produced by the Big Bang.

Bob's interest and influence in education was international in scope. In the summers 1968–1970, he was a government consultant in Mathematics in East Pakistan (now Bangladesh). He consulted with the government that was preparing a master plan for technical education. While teaching all the mathematics instructors of the polytechnic institutes of the country, he co-authored a textbook "Polytechnic Mathematics." Bob also was active for many years in Com-



Ralph Robert Robbins, Jr.

mission 46 of the International Astronomical Union, including compiling overviews of educational materials available in English for over a decade and serving on the organizing committee for several international meetings.

In the 1970s, Bob and William Jefferys refined their view of how introductory astronomy should be taught–pioneering a "minds-on, hands-on" approach that emphasized "learning by doing" even in the non-science majors courses. This innovative work in astronomy education led to several coauthored books: a general-level textbook (*Discovering Astronomy*), a book to accompany upper-division laboratory courses (*Modern Astronomy: an Activities Approach*), and a workbook for college teachers (*Effective Astronomy Teaching and Student Reasoning Ability*). Bob also popularized self-paced astronomy courses that demanded in-depth understanding from students as well as requiring observations of the sky and small experiments. Bob was named a Piper Professor in 1972, a statewide award that recognized his teaching excellence. For many years Bob served both as an American Astronomical Society Shapley Visiting Lecturer and as a National Science Foundation Chautauqua lecturer, thus bringing his expertise to colleges and college instructors across the nation.

Bob was fascinated with not only how undergraduate students learn, but also how people of past civilizations learned about astronomy and used it in their lives and rituals. Bob's colleague William Jefferys recalled a 1967 Spring Break trip:

"We got into Bob's white and purple Dodge and went to Mexico with a large tent, big enough for the party of six. We camped on the beach and by the side of the road, got royally bitten by mosquitoes, suffered a broken spring and flat tire on the car (both of which were fixed in Mexico, but the tire expired just as we reentered the US). We also saw many interesting sites, and Bob's interest in archaeoastronomy may have been kindled or at least renewed on that trip."

In the 1980s, Bob became increasingly interested in archaeoastronomy. Being part Cherokee, he honored his own ethnic heritage through his studies and the new courses he developed and taught. His field research covered sites in central Texas, New Mexico, Mexico, and Central America. He regaled his colleagues with tales of his travels through guerilla-infested jungles with a platoon of soldiers as a very essential escort to get to a site of astronomical influence. This interest grew to publications in archaeoastronomy and extended his teaching from the astronomy department to offering graduate classes in the Institute for Latin American Studies on Archeo- and Ethno-Astronomy at the University of Texas.

As an involved faculty member, Bob served on education committees of the American Astronomical Society, the University of Texas Graduate Studies Committee in Math and Science Education for the College of Education, as well as departmental and college committees. He served as undergraduate advisor for two years and chair of the Graduate Admissions Committee for four years for the Astronomy Department. He took special interest in preparing astronomy graduate students, both in formal courses and in mentoring situations, to become better teachers.

Bob's final years of teaching were hampered by the onset of Parkinson's and Lewy Body diseases that forced his retirement. He met his disability with courage and dignity. A gentle person who cared deeply about students and student learning, his friends and family will miss him.

Mary Kay Hemenway, William H. Jefferys, and David L. Lambert
University of Texas at Austin

HUGO SCHWARZ, 1953–2006

Hugo Schwarz died in a motorcycle accident on 20 October 2006 near his home in La Serena, Chile. At the time of his death he was a staff astronomer at Cerro Tololo Inter-American Observatory and President of IAU Commission 50 (The Protection of Existing and Potential Observatory Sites).

Hugo was born on 3 June 1953 in Amsterdam, the Netherlands, to Norbert Schwarz and Petronella Bethem. In a way Hugo considered his existence somewhat miraculous. During World War II, when Holland was occupied by the Nazis, his father, who was Jewish, decided that the best way to hide was in full view. He refused to wear an identifying gold star. Of course, he did not have the right papers. One day he was sailing on a lake with a lady friend who happened to be an opera singer. The wind had died, they could not return to the dock, and it was past the curfew hour. Suddenly, a boat carrying German officers appeared. Norbert's lady friend spontaneously sang a Lied by Franz Schubert entitled "Auf dem Wasser zu singen" (to sing on the water). Instead of demanding to see ID papers, the Germans applauded, wistfully thinking of home, then motored away.

After Hugo's half-brother Frans died when Hugo was an infant, he effectively grew up as an only child. One conse-

Hugo Schwarz

quence was that Hugo became an avid reader. He once estimated that he had read between 3,000 and 4,000 books. He also moved around a great deal. For most of the first seven years of his life, Hugo lived in Venezuela because his father worked for Shell Oil Company. According to Hugo's count, he had a total of 43 different addresses in his life. This gave him experience with different cultures and a facility with several languages. He was fluent in Dutch, German, Spanish, and English, and knew some French. He was very fond of quoting his father's sayings in Dutch and liked to relate stories filled with Chilean-slang to people who understood neither, providing translations that retained the cleverness of the originals.

While on holiday in Scotland in 1974, Hugo decided to enroll in the Glasgow College of Technology, as it was then known. A year later he transferred to the University of Glasgow, where he earned his BSc (1979) and PhD (officially in 1984). From 1982 to 1986 he worked on X-ray detectors for X-ray astronomy at Mullard Space Science Laboratory, south of London.

In 1986 Hugo, his first wife Catriona (Cat), and their two children departed for Chile, where Hugo worked as a staff astronomer for the European Southern Observatory. Over the next nine years he spent over 1,300 nights at La Silla.

A big change occurred in 1995 when Hugo moved to La Palma in the Canary Islands to be Astronomer in Charge of the Nordic Optical Telescope. He was very proud of having organized a team of astronomers and technicians who made the NOT into a valuable research facility with minimal down time.

In October of 2000 Hugo returned to Chile to work at CTIO. After his demonstrated technical, scientific, and social skills drumming the NOT into shape, he was the natural choice to be the CTIO staff member assigned to the 4-m Southern Astrophysical Research (SOAR) Telescope sited at Cerro Pachon. Over the next six years Hugo worked closely with Steve Heathcote and the SOAR technical staff to improve the telescope's operational capacity.

Hugo's scientific work dealt with late stages of stellar evolution, particularly planetary nebulae, and stellar polarimetry. Higher resolution optical and infrared imaging of He 2-104 led to its being known as the Southern Crab Nebula (Schwarz, Aspin, & Lutz, *ApJ*, **L29**, p. 344, 1989). Unlike the northern supernova remnant, this southern object (a nebula surrounding a symbiotic binary) looks very much like a crab. Their images of it appeared in magazines and books around the world.

In 1992, along with Romano Corradi (a Ph.D. student of Hugo's) and Jorge Melnick, Schwarz published "A catalogue of narrow band images of planetary nebulae" (*A&A*, **96**, p. 23, 1992). This was the first extensive, and still the largest, CCD image catalogue of PNe.

Hugo edited the conference proceedings of a meeting held in La Serena in January 1992 (*Mass Loss on the AGB and Beyond*). The talks and published papers strengthened some of Hugo's ideas about the importance of evolution in binary systems, in particular the interaction of compact stellar companions and the formation of accretion disk winds and their precession in the formation of non-symmetrical planetary nebulae. In a highly cited paper, Corradi & Schwarz (*A&A*, **293**, p. 871, 1995) were able to show that bipolar nebulae are produced from higher-mass progenitors than other morphological classes. Hugo knew that you wanted to model PNe in three dimensions, not just in two. He went on to make 3-D photoionization models of PNe with his final PhD student Hektor Monteiro (Schwarz & Monteiro, *ApJ*, **648**, p. 430, 2006).

One of the projects well along at the time of his death was a collaboration with David Spergel and a number of REU summer students on the measurement of the polarization of 2,000 stars evenly distributed around this sky. This simple set of data being obtained with the NOT, a telescope Hugo helped make fully functional, will, by a factor of two, improve the sensitivity of experiments such as WMAP and Planck to the detection of gravity waves, one of the holy grails of experimental physics.

Because of Hugo's sense of humor, enthusiasm, and perspective, he achieved a good balance between work and play. He could play the diplomat and hobnob with politicians and royalty. He also was proud of the fact that his native language, Dutch, is probably the best language for swearing. He often adopted a Glaswegian accent from his time at university, and would ask you a common question of bartenders there: "So, Jimmy, what's yer name?" He loved fine cigars, particularly the *flojos* (not-so-tightly rolled ones) from his cigar maker in La Palma, which he generously shared with friends. He loved having people over for barbecues, and would often make *paella*. *Which* newspaper was used to cover the large pan was important. It had to be left of center politically, but not too far left. On Hugo's fiftieth birthday a temporary addition was built onto the house, carpeting was laid out on the lawn, and there ensued a sit down dinner for 107 people, complete with live musicians, and many broken glasses.

Hugo is survived by his wife Claudia Sanhueza, his two children Tamar and Jouke Schwarz, his step-children Maria Josefina and Diego Gomez, and his half-brother James Schwarz. More than anyone I can think of, he also leaves behind many friends who considered him their best friend.

Kevin Krisciunas
Texas A&M University

MICHAEL JOHN SEATON, 1923–2007

Professor Michael John Seaton, hailed as the "Father of Atomic Astrophysics," passed away on May 29, 2007. He was one of the few Honorary Fellows of both the American Astronomical Society and the American Physical Society, so honored for his monumental contributions to both physics and astronomy.

Mike Seaton was born on January 16, 1923 in Bristol, England. He attended Wallington County High School. But his leftist political activities, even at that stage, led to his expulsion, though he was eventually allowed to matriculate. He enlisted in the Royal Air Force as a navigator during the Second World War, and flew many dangerous missions. His legendary concentration and precision are reflected in the following anecdote. Once after a bombing mission his aircraft was lost in fog over the Alps. Seaton calculated the position and coordinates in flight to guide the aircraft. When the fog lifted, the crew found themselves flying perilously close to the mountains, but made it safely back. His associates often said, "A Seaton calculation is carried out as if his life depended on it." After the War he was admitted to University College London (UCL) as an undergraduate. Thereafter, he spent all of his professional career at UCL. Seaton received his Batchelor's degree in 1948, and his Ph.D. in 1951. His tenure at UCL coincided with the golden age of atomic astrophysics, for he was largely responsible for it.

Seaton was elected Fellow of the Royal Society in 1967, and as President of the Royal Astronomical Society (RAS) in 1978. He was the recipient of an Honorary Doctorate from the Observatoire de Paris, an Honorary D.Sc. from the Queen's University of Belfast, the Gold Medal for Astronomy by the RAS, the Guthrie Medal by the Institute of Physics, the Royal Society Hughes award for lifetime work by the RAS, and several other prestigious awards. Nevertheless, as Alex Dalgarno recently remarked, Seaton was not part of the establishment because he chose not to be. Though rooted in the idealism of youth, Seaton's early leftist leanings cast a long shadow, including problems with United States immigration. However, he was later disillusioned with communist ideology, with a decisive break from it after the Soviet invasion of Hungary in 1956.

Seaton's groundbreaking papers range over several areas of physics and astrophysics. He was the author of nearly 300 journal publications and many other articles. His pioneering research papers in physics include the non-hydrogenic treatment of photoionization, implementation of the coupled channel approximation, proton-impact excitation of ions, quantum defect theory (based on Seaton's theorem), a precise theory of dielectronic recombination (the Bell and Seaton theory), the widely used Percival-Seaton formula for polarization, and many other contributions.

Seaton's works in astrophysics range from seminal papers on spectroscopic density diagnostics using forbidden lines (developed jointly with Donald Osterbrock), the Seaton extinction curve (the paper has well over 1,000 citations), central stars of planetary nebulae (PNe), early work on PNe using the then newly commissioned International Ultraviolet Explorer satellite, hydrogenic recombination spectra, radio recombination lines in masers, and several other topics. (In this context, a remarkable incident deserves mention. At the tragic death from a motorcycle accident of his graduate student, R. Harman, Seaton said to Harman's parents at the funeral that Harman was working on something important, and would be remembered for it. He is. The so called Harman-Seaton sequence on the H-R diagram refers to hot sub-dwarfs and nuclei of planetary nebulae.)

For almost all of the last quarter century of his life, 1983–2007, Seaton led the Opacity Project (OP), an international team of about thirty atomic physicists and astrophysicists, to carry out highly accurate atomic calculations for radiative transition probabilities and photoionization cross sections that determine stellar opacities. The large-scale calculations revealed extensive features in photoionization such as resonances due to photoexcitation-of-core or PEC (as named by Seaton). The new opacities solved some outstanding problems and have been in use in some major astrophysical applications, recently by John Bahcall and others to explore discrepancies in solar elemental abundances from different models. A National Science Foundation reviewer once hailed the Opacity Project as the "crowning achievement of computational atomic physics."

At an AAS meeting hosted by the Ohio State University in 1992, Seaton named a follow-up project "The Iron Project," focused particularly on the important Fe-peak elements, with many of the original members of the Opacity Project as participants. But Seaton himself remained preoccupied with improvements and applications of opacities. Seaton's most recent work was on radiative accelerations of elements in stars using the Opacity Project data and element diffusion in stellar interiors. Seaton continued to be highly active in research until his death at age 84, even writing large complex computer codes that now form the basis of an electronic database for opacities.

There are precious few scientists who have his unique abilities that ranged from profound theoretical insights to mathematical formulations and highly technical computational developments. Mike Seaton was an immense source of inspiration to all who knew him. There is no doubt that his many students and collaborators, if ever paid a complement on their work, would surely reply: "I learnt the craft from a Master."

Mike Seaton is survived by his wife Joy and their son Tony, and a son and daughter from his first marriage to Olive Singleton who passed away in 1958.

Anil Pradhan and Sultana Nahar
The Ohio State University

GERALD FREDERICK TAPE, 1915–2005

Gerald Frederick Tape, a distinguished science statesman and administrator, died on November 20, 2005. Jerry, as he was known to all, took on many diverse and important responsibilities throughout his life and dealt with them with quiet authority and grace. This was the hallmark of his life. The Board of Trustees of Associated Universities, Inc., which he served for many years, expressed this in its condolences, writing "Jerry personified integrity, thoroughness and dedication. His sensitivity for the views of others, his sincerity, his personal commitment, his calm approach and his unfailing good humor were all greatly admired and respected." Jerry was born in Ann Arbor, Michigan on May 29, 1915 but grew up in Milan, a nearby country farm community, and in Ypsilanti where his father was Principal of Michigan State Normal College, which later became Eastern Michigan University (EMU). It was there that he first became interested in physics. It was there also that he met and courted Josephine Waffen, who later would become his wife for more than sixty-six years and fill their lives with three loving sons, Walter, James, and Thomas.

Upon graduation from EMU, Jerry was awarded a scholarship that took him to the University of Michigan where he earned a Ph.D. in Physics, researching the decay modes of the radioisotopes of iodine. In the Fall of 1939, during the waning days of the Great Depression, he was offered an Instructorship in the Physics Department of Cornell University, a promising start for a fruitful academic career. He brought his bride Jo to Ithaca and joined the cyclotron group under Robert Bacher and Willy Higginbotham while devising a laboratory course in nuclear techniques for graduate students. Bacher and Higginbotham soon left Cornell to join a new wartime laboratory at the Massachusetts Institute of Technology (MIT) and many other colleagues were "drafted" for war work. Bacher persuaded Jerry to join him at the MIT Radiation Laboratory in February, 1942, and the twenty-seven year old physicist started a new career developing microwave radar applications.

In his four years at the Rad Lab Jerry undertook a variety of tasks. His innate management skills were soon noted, and he served as a technical envoy to generals and admirals explaining the capabilities, and the installation and operational requirements, of this powerful new tool. He actively facilitated the installation of transponder beacons on aircraft and naval vessels. Much of his time was spent in England where he became Deputy Director of the British Branch of the Radiation Lab (BBRL). As the war ended, the Rad Lab was preparing to close, and Jerry worked with Leland Haworth, a Lab Division Leader of Radar Groups, in contributing their technical analyses to the massive permanent record of the developments and accomplishments of the past five years.

Wheeler Loomis, the Associate Director of the Rad Lab, left to assume the Chairmanship of the Physics Department at the University of Illinois. Haworth, Jerry, and other lab emeriti also decided to reestablish their careers at this distinguished institution. Jerry became an Associate Professor and returned to nuclear research working with, and upgrading, the Department's cyclotron. It was a productive and rewarding period, but it ended in 1950 when Haworth, who had left Illinois to become Director of Brookhaven National Laboratory (BNL), persuaded him to come to Brookhaven in a management role. Within a year he became Deputy Director of the Laboratory and started a new career in the management of big science.

Gerald Frederick Tape

The decade of the fifties was a period of dynamic growth at Brookhaven. The Cosmotron and the Research Reactor became operational, new programs were initiated, and more advanced facilities were under construction or in the design phase. Jerry had responsibility for the administrative oversight of these activities, and he exercised it with such care and thoughtfulness that he quickly became an indispensable figure in the laboratory's day-to-day operations. Haworth, as Director, was able to focus upon scientific planning and dealing with ever increasing external interactions and pressures.

Brookhaven was founded by an independent scientific management organization, Associated Universities, Inc. (AUI), which in turn had been established for that very purpose by nine major, eastern, research universities. AUI managed and operated the Laboratory under contract with the Atomic Energy Commission. The corporation had a small executive staff and a Board of Trustees comprised of eighteen distinguished scientists and administrators. During the fifties the president of AUI was Lloyd V. Berkner, an active and very effective campaigner for big science projects. In this period, he worked tirelessly to convince the National Science Foundation (NSF) to support a National Radio Astronomy Observatory (NRAO). The proposal was very controversial within the astronomy community and became a divisive issue among many leading astronomers. Success came late in 1956 with NSF's decision to establish NRAO under AUI management. Founding and guiding this new institution became a major new responsibility for AUI and for Jerry Tape.

At the end of the decade, Berkner retired from AUI and Haworth became the President. It was a short-lived tenure, however, because President Kennedy asked Haworth to accept an appointment as an Atomic Energy Commissioner, which he did early in 1961. I. I. Rabi, a founding Trustee, took on the presidency temporarily and brought Jerry Tape into AUI as his special assistant and vice president. After a formal search, Jerry was elected President of AUI in 1962.

It was in these new roles that Jerry Tape had his first responsibility for overseeing the development of the NRAO. His background in radar development was a great asset, and he enthusiastically accepted the challenges that this fledgling organization faced. Of prime concern were the cost and schedule overruns resulting from design and fabrication problems that developed in the 140-foot telescope project. These had to be renegotiated with the NSF, honing skills that Jerry had already developed. In the course of this, he also made an effort to reach out and understand the astronomical community and to mend some of the rifts that accompanied the NSF's first venture into "big science."

This all changed in 1963 when President Kennedy asked Leland Haworth to become the Director of the National Science Foundation and also asked Gerald Tape to take on Haworth's role as an Atomic Energy Commissioner working under the Chairmanship of Glenn Seaborg. All five Commissioners participated in all official actions of the body, but each one had special areas of concentration of effort. With some overlap, this assured fuller and deeper coverage of the broad spectrum of issues they faced. Jerry's special interests were nuclear weapons development; research in the physical, biological, and life sciences; and international cooperation. This menu was a broad one, and for six years of full-time effort it required endless travel to laboratories, conferences, and government-to-government meetings. International delegations involved civil as well as defense programs. Formal civil exchange programs were negotiated with many nations including the USSR. Negotiations on arms control issues involved contacts with the International Atomic Energy Agency (IAEA) and Atoms for Peace conferences. In the national research program area, Jerry became the lead Commissioner for the establishment of what became the Fermi Laboratory and its management organization, Universities Research Association (URA). Fermi Lab soon became, and still is, the primary United States high-energy particle physics institution.

In 1969, Jerry Tape returned to AUI as president where he was welcomed enthusiastically. Both BNL and NRAO had grown and were thriving. Plans were being formulated for major new facilities, a proton collider with superconducting magnets at BNL and the Very Large Array (VLA) at NRAO. Research output was first-class at both institutions. The NRAO was steadily drawing more young astronomers into a field that was just beginning to show its promise and its indispensability.

Jerry took a great interest in the development of the VLA and interacted closely with David Heeschen, the Observatory Director, and with Jack Lancaster, the Project Director. In the middle of the decade, he helped them to steer through some rough waters created by Congressional criticisms that threatened the program. He cooperated closely with NSF and obtained the necessary support to defuse the threat. His last official act for AUI and NRAO was to preside over the grand opening celebration at the site of the VLA. It was on the last day of his presidency, October l, 1980.

Jerry Tape clearly led an exemplary life when traced through the series of successful enterprises that marked his rise to ever increasing responsibilities and contributions. But the full measure of a man is also revealed in the way he filled the smaller but unrestricted periods of time that become available to him. Jerry was first and foremost a family man and was constant in his attention and devotion to this call. The AUI trustees recognized the importance of public service and encouraged his participation in worthwhile causes as long as they did not interfere with his primary duties. The AUI staff was small but dedicated and ably maintained timely and effective communication with him in his absence. Thus, Jerry found the time to contribute to issues and organizations that were of importance in his life.

Through the last part of the sixties, Jerry served for six years as the United States Representative to the International Atomic Energy Agency (IAEA) with the rank of Ambassador. It was a demanding role, not only because of the frequent trips to the Vienna headquarters, but also because there were continuous official requirements for reports and documentation. A few years later, he returned to IAEA as a member of its Scientific Advisory Committee. In the early seventies he became a member of the President's Scientific Advisory Committee (PSAC) and also a member and chair of the Defense Science Board (DSB). For many years he was a member and chair of The Nuclear Intelligence Panel (NIP) of the Central Intelligence Agency. Continuing to serve his country, Jerry soon accepted membership on The General Advisory Committee (GAC) of the Energy Research and Development Administration and in his later years worked as a consultant for the Defense Nuclear Safety Board.

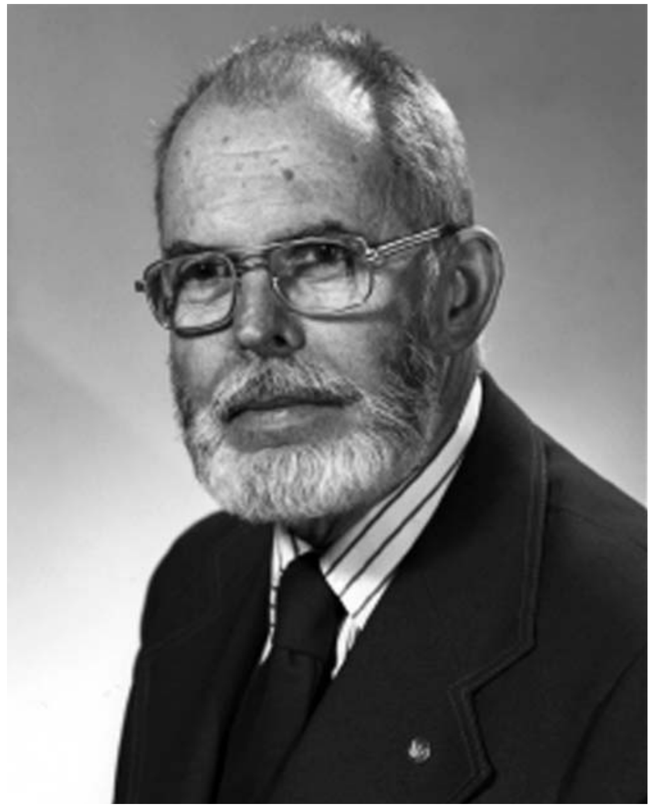
Jerry did not limit himself to serving government institutions and agencies. For more than thirty years he was a Director of Science Service Inc., the organization that so successfully operated the annual Science Talent Search that challenged and energized science-oriented youths around the nation. His long association with the program reflected the great pleasure he found in the annual opportunity to interact with these exceptional young budding scientists. The list goes on: the Advisory Council of the Electric Power Research Institute (EPRI), the University of Chicago Board of Governors for Argonne National Lab, and the Atomic Industrial Forum. Each of these efforts, and others, can be described both as a labor of love and as a fulfillment of a sense of duty.

These contributions did not go unnoticed or unappreciated. Jerry's life was adorned with a stream of accolades, citations, and awards. A short listing will illuminate the respect he commanded for a broad range of achievements: Army-Navy Certificate of Achievement, Meritorious Civilian Service Medal from the Secretary of Defense, Department of

Defense Medal for Public Service, Henry DeWolf Smyth Nuclear Statesman Award, Distinguished Public Service Award NSF, Distinguished Associate Award DOE, Enrico Fermi Award DOE, Fellow of the American Physical Society, and Member of the National Academy of Engineering.

Robert E. Hughes
Cornell University and President Emeritus, AUI

JAMES H. "TREX" TREXLER, 1918–2005



James H. "Trex" Trexler

James H. "Trex" Trexler, Naval Center for Space Technology, a retired scientist and astronomer, with a 50-year career at NRL died of cancer on October 22, 2005, at the age of 87.

Born in Missoula, Montana (May 18, 1918), he grew up in Dallas, Texas, and attended Southern Methodist University (SMU) Engineering School. He combined his interests in astronomy and radio communication and operated the observatory on the SMU campus. Mr. Trexler had a most interesting and rewarding career at NRL, which resulted in notable contributions in scientific and technical developments.

While at SMU, he worked on a government-sponsored project on radio detection and tracking of meteors. This work resulted in a call from NRL in 1942 to join the Navy radio detection effort being mounted against the German submarine Wolf Packs that were harassing our North Atlantic convoys on the supply routes to our European Allies. The program proved highly successful causing the breakup of the German Pack operation, and resulted in the sinking and capturing of many U-boats.

After World War II, Trex and H. O. Lorenzen brought the German Navy's very advanced Wullenweber Direction Finder back to NRL, and rebuilt it at the Washington Coast Guard Station, south of Alexandria. It served as the prototype for the Direction Finder at the heart of the Navy and Air Force intercept networks and later as the first tracker of the Soviet Sputnik. He received the Navy Meritorious Civilian Service Award for his efforts.

In the late l940s, Trex built the radar intercept equipment for the Navy's P4M Airborne Cold War Ferret Program. This capability provided instantaneous frequency and direction of arrival against Soviet radars from high-altitude flights along the Soviet borders.

His Radio Physics Branch developed a surface mobile intercept system deployed to the Near East for which the Navy made the first group cash incentive award. With the beginning of the space age, his branch examined the moon as a possible passive radio relay satellite. Intercept of foreign radars was achieved in 1948, and this led to the large Stump Neck, Maryland Moon Propagation Facility, where voice transmission over the moon circuit was achieved in 1951. Trex received the Navy's Distinguished Civilian Service Award for his intercept work at Stump Neck and the Chesapeake Bay Annex. An immediate outgrowth was the Navy's communication Moon Relay (CMR) system that provided our Navy with satellite communication a decade before the artificial satellites were operational. A demonstration of Doppler navigation using the moon as a navigation satellite was also carried out at this time.

The intercept aspects of the moon technology were pursued at the NRL Sugar Grove, West Virginia, facility from 1958 through 1986. Sugar Grove is now operated by the Navy as a first-class space radio facility. After his retirement, May 1, 1990, Trex continued his space interests. In 1997, he and his wife Fran took a special trip to the Fred Whipple Smithsonian Observatory area, Arizona, to capture some exciting photographs of the Hale-Bopp comet.

Trex served as president of the National Capital Astronomers Club in Washington, DC. Also, he was a member of the Tucson Amateur Astronomical Association, and the Sonora Astronomical Society of Green Valley. He served as a volunteer tour guide for the Smithsonian Whipple Observatory, the University of Arizona Mirror Lab and on the board of the Green Valley Community Church Foundation, an organization that awards college scholarships for general education to young people in southern Arizona.

Ed Barker
NRL