Paul taught physics courses at all levels with interest, and he treated his students with high regard. In 1981, early in his career, he was honored with the Outstanding Teacher Award from the university's Institute of Technology. More important, perhaps, is that a group of his students presented him with a certificate that proclaimed that the three greatest British imports were the Beatles, Monty Python, and Paul Ellis.

With his family, Paul enjoyed many activities, especially walking, boating, swimming, golfing, and traveling. He liked steam locomotives, and he collected calendars and screen savers with their photos. He had a very strong belief in human rights and in freedom and democracy. He and his wife took great pride in participating in state and national political activities and campaigns. Paul was also a strong advocate for the safe and humane treatment of animals.

The atmosphere Paul projected around him was so magical that one immediately felt at ease and could talk about anything with him. He made people feel equal and included, and he always supported his friends and colleagues in a kind and gentle yet unswerving way. The community has sustained a great loss. This extraordinary gentleman will be missed for years to come.

Joseph Kapusta
Yong Qian
University of Minnesota
Minneapolis

Edward Walter Hart

Edward Walter Hart, a theoretical and experimental physicist who was well known for developing the universal equation of state for mechanical deformation of solids, died on 22 December 2004 in Lancaster, Pennsylvania.

Born in Easton, Pennsylvania, on 14 January 1918, Ed graduated from the City College of New York in 1938 and then received MS and PhD degrees from the University of California, Berkeley. During World War II, he worked for the US Navy in Washington, DC, where he invented magnetic compass correctors and a better ship compass—work for which he received a Meritorious Civilian Award. He next spent 25 years at the General Electric Research and Development Laboratory in Schenectady, New York, before becoming a joint professor in the materials science and engineering department and in the theoretical and applied mechanics department at Cornell University in 1976. His research years at Cornell, from 1976 to 1988 when he became emeritus, were particularly productive.

Ed invested four decades of research on micromechanics of materials and, specifically, on the microscopic nature of failure and inelasticity. Beginning with his early research in 1952 on state-variable modeling of inelastic deformation, a tremendous amount of effort has been invested in linking a material's microstructure (including grain-boundary and dislocation motion) and its mechanical properties. He is rightfully famous for his theoretical work in the modeling of inelasticity, fracture, precipitation hardening, dislocation motion, self-diffusion, grain-boundary motion, and the mechanics of superplasticity.

The typical senior-level textbook on the mechanical properties of materials has a detailed section on the generalized equation of state, which can be obtained from a tension test and then applied to plastic deformation processes for all time-independent combinations of stress and strain. The last two decades of Ed's work were dedicated to adding time dependence to the equation-of-state approach. The input again was the tension test, but Ed added time as a variable along with the results from stress-relaxation tests at points of fixed generalized strain. His highly cited 1967 *Acta Metallica* paper "Theory of the Tensile Test" and numerous papers on load relaxation and creep led to a generalized time-dependent equation of state that could be obtained from experiments. A complement and challenge to those theorists who attempt to use atomic terms to describe point defects, dislo-

Edward Walter Hart

cations, planar defects, second phase particles, and so on, the universal equation of state has led to enormous elucidation of time-dependent inelastic and permanent deformation. Ed was awarded an Alexander von Humboldt Senior Scientist Award by West Germany in 1982.

Ed was a Renaissance man. As a young man, he studied composition under Aaron Copland. He played guitar, viola, and piano and directed a choir and a chorus. He studied modern dance with Welland Lathrop, and he was a founder of the Schenectady Civic Ballet Co and served as its president from 1960 to 1963. A lover of nature, mountain climbing, and camping, he was a long-time member of the Adirondack Mountain Club. Ed enriched the lives of many, and he is sorely missed by his family and friends.

Arthur L. Ruoff
Cornell University
Ithaca, New York

Norman Myles Kroll

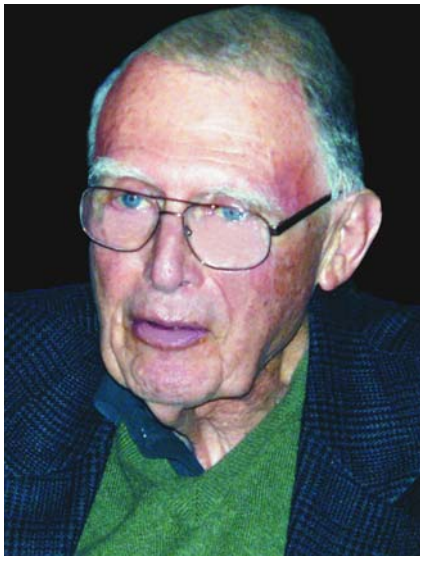
Norman Myles Kroll, an emeritus professor of physics at the University of California, San Diego, and one of the pioneers of the field of quantum electrodynamics (QED), died in La Jolla, California, on 8 August 2004 after a brief illness.

Born in Tulsa, Oklahoma, on 6 April 1922, Kroll attended Rice University in Houston, Texas, from 1938 to 1940, then received his BA in physics and mathematics and his MA (1943) in physics from Columbia University. During World War II, he joined fellow scientists in radar research for military applications. He followed with graduate studies at Columbia, where he worked with his mentor, Nobel laureate Willis Lamb, on the theoretical explanation of the Lamb shift. Kroll received his PhD in physics in 1948. He collaborated with Lamb on their famous paper "On the Self-Energy of a Bound Electron," which was published in 1949 in the *Physical Review* and reprinted by Dover Publications in 1959 as part of *Selected Papers on Quantum Electrodynamics*. Based on Kroll's thesis work, the paper provided the first theoretical explanation of the Lamb shift in QED and became one of the most important landmarks of the field.

Kroll continued at Columbia as an assistant professor, associate professor, and full professor of physics, and quickly became a world leader in the field of QED. While at Columbia, Kroll pioneered important new calculations in QED using sophisticated theoretical tools in the evaluation of Feynman diagrams in higher orders of perturbation theory, tools used by generations of theorists in the last five decades. He was a Fulbright Scholar and Guggenheim Fellow in 1955–1956.

In 1962, UCSD recruited Kroll to become one of its physics department's founding members and thereby bring to UCSD the prestige and recognition of a world leader in research. During his four decades at UCSD, Kroll continued his research in QED, developed with Marshall Rosenbluth a theory of the free electron laser, and participated in the design of particle accelerators. In addition, he made numerous contributions to the development of UCSD as one of the nation's leading research universities and twice served as chair of UCSD's physics department, from 1963 to 1965 and from 1983 to 1988. After retiring from teaching in 1991, Kroll continued as professor emeritus and research physicist until his death.

During his retirement years, Kroll kept a very active working relationship with SLAC, to which he commuted weekly until the fall of 2000. At SLAC, he was instrumental in developing the mathematical foundation for the design of a next-generation linear collider, a project that is among the highest priorities for particle physicists.



Norman Myles Kroll

Kroll's career included visiting appointments to many other prestigious institutions, including the Institute for Advanced Study in Princeton, New Jersey; Cornell University; the European Organization for Particle Physics in Geneva; the Niels Bohr Institute in Copenhagen; and the University of Rome.

A member of the National Academy of Sciences and the American Academy of Arts and Sciences, Kroll was very highly regarded by his colleagues. He was a brilliant theoretical physicist with deep physical insight and broad scientific interests. In addition to making significant scientific contributions, Kroll served on a committee that advises UCSD's chamber music series; he is remembered by friends and family for his lifelong interest in opera and chamber music. He also had a passion for gourmet food and fine wine and enjoyed ocean swimming, boogie boarding, hiking, and observing and identifying wildflowers. We at UCSD will miss his keen intellect and wise counsel.

Marvin Goldberger
Julius Kuti
University of California, San Diego

Boris Petrovich Zakharchenya

Boris Petrovich Zakharchenya, who made substantial contributions to modern condensed matter physics, died on 10 April 2005 in St. Petersburg, Russia, after a courageous yearlong fight against cancer.