

wasser was the creation at Fermilab of a strong ethos of affirmative action, equal employment opportunity, and fair housing. He wrote elegantly about the lab's efforts in an October 1969 *Bulletin of the Atomic Scientists* article called "Science and man: Breaking new ground at Batavia." He enlisted Kennard Williams to be the lab's equal employment and community relations officer. With Wilson, Goldwasser authored a laboratory mission statement that ended, "In any conflict between technical expediency and human rights, we shall stand firmly on the side of human rights. This stand is taken because of, rather than in spite of, a dedication to science."

Goldwasser was responsible for building a network of users and overseeing the planning for the Fermilab research facilities. One key ingredient was summer studies at the Aspen Center for Physics in Colorado. Another was resident theorists brought to Fermilab, among them William Bardeen. In his 1975 letter to Bardeen encouraging him to join, Goldwasser wrote, "I feel strongly that for the laboratory to provide the proper environment for me and others to work, there must be a component of the kind of intellectual activity theoretical physicists provide."

At a difficult time in foreign relations, Goldwasser was central to arranging the first US-USSR high-energy-physics collaboration at Fermilab. That experiment was the first to start when the accelerator came into operation in early 1972.

With a long-term interest in international science, Goldwasser served as a member and chairman of the Commission on Particles and Fields of the International Union of Pure and Applied Physics, the International Committee for Future Accelerators, and the American Physical Society's Committee on International Freedom of Scientists.

Persuaded in 1978 to return to university life in Urbana-Champaign, Goldwasser served first as graduate dean and then as vice chancellor of academic affairs. Among his contributions was implementing the administrative fabric of the National Center for Supercomputing Applications. His skillful administration and thoughtful, effective engagement earned the deep respect of members of the university community.

In 1986 Goldwasser again left Illinois to become associate director for develop-

ment at the Superconducting Super Collider Central Design Group at Berkeley. When the group moved to Texas, Goldwasser returned to Illinois, where he directed several campus programs until his retirement in 1988.

During 1993–94 Goldwasser worked at Caltech on the development of the detector for the Laser Interferometer Gravitational-Wave Observatory. LIGO, with a powerful Caltech-MIT contingent, had built a strong technical program that exploited the two sites, and Goldwasser brought extensive project-management expertise.

Goldwasser was an avid bike rider and tennis player. And in every place he worked and lived, his wife of 76 years, Lizzie, was a cohesive factor in integrating colleagues into the community.

In 1978 Fermilab director Wilson gave perhaps the best appreciation of Goldwasser: "The successes of the laboratory, the firm foundation for the future, the cultural ambience, the spirit of opportunity for all, the international importance of our work, are all monuments to his sense of the value of science and its place in our society."

Richard A. Carrigan
Fermilab
Batavia, Illinois

Ralph O. Simmons
University of Illinois at Urbana-Champaign



Kerson Huang

Kerson Huang, a professor emeritus at MIT who was best known for his contributions to statistical physics, died of cancer on 1 September 2016 in Danvers, Massachusetts.

Huang was born on 15 March 1928 in Nanning, Guangxi Province, China. After the Japanese invaded in 1937, he and his family moved to Manila, the Philippines. Following the end of World War II, he went to the US, where he obtained his BS in 1950 and his PhD in 1953, both in physics and both from MIT. His earliest research was on the *zitterbewegung* ("trembling motion") of the Dirac electron. Victor Weisskopf was his thesis adviser, but Huang worked more closely with Sidney Drell on meson field theory. He learned the pseudopotential method from Weisskopf and applied it to the study of the



Kerson Huang

quantum mechanical problem of hard spheres.

In the fall of 1955, Huang went to the Institute for Advanced Study in Princeton, New Jersey, for his postdoc and introduced to Chen Ning Yang the pseudopotential method. Together with Tsung-Dao Lee, they collaborated on the problem of dilute hard-sphere bosons and demonstrated the superfluidity of dilute Bose gases due to Bose-Einstein condensation. Huang presented that work at the institute to an audience that included Eugene Wigner, Freeman Dyson, J. Robert Oppenheimer, and Wolfgang Pauli. Pauli slept during the seminar and only woke up to comment that he did not like the pseudopotential because it is not Hermitian. However, he said later that Huang's work was *nicht dumm* ("not dumb"). Fifty years later the work was confirmed by experiments on Bose-Einstein condensation in alkali gases.

Huang returned to MIT in 1957 as an assistant professor and continued his studies in both many-body problems and particle physics. Ranging from high-energy to low-temperature physics, his research covered numerous topics, including pion decay, muon capture, high-energy scattering, bootstrap solutions, and imperfect Fermi and Bose gases. MIT mathematician John Nash frequently engaged Huang in discussions about the fundamentals and philosophy of quantum mechanics.

In the 1960s and 1970s, Huang worked on the dual resonance model. During a

weekend vacation at his log cabin in New Hampshire in 1970 with colleague Steven Weinberg, Huang mentioned the concept of ultimate temperature, above which adding energy to a system only produces particles instead of raising the system's temperature. Weinberg immediately realized its importance in the early universe. They spent the weekend doing calculations, and soon after they published an influential article on the subject.

Huang made many substantial contributions during the development of the standard model in particle physics. By considering the possibility of asymptotic freedom in scalar field theories, he challenged the common perception that only non-abelian gauge theories are asymptotically free. He and his student Kenneth Halpern showed that some scalar theories could become asymptotically free provided that what's now known as the Halpern-Huang potential is used to describe the interaction.

Huang also devoted great effort to physics education. He wrote eight physics books, including *Statistical Mechanics* (Wiley, 1963; 2nd edition, 1987), *Introduction to Statistical Physics* (Taylor & Francis, 2001), and *Quantum Field Theory: From Operators to Path Integrals* (Wiley, 1998; 2nd edition, 2010), which continue to be widely used as textbooks and references.

Huang became a professor emeritus in 1999 and remained with the Center for Theoretical Physics at MIT until 2005. He then became a visiting professor at Tsinghua University in China and at Nanyang Technological University in Singapore. His interests shifted to biophysics and quantum cosmology. Huang proposed a conditioned self-avoiding walk model and wrote a MATLAB program to study the problem of protein folding. In quantum cosmology, he proposed a superfluid-universe scenario for inflation, matter creation, dark matter, and dark energy. He also suggested using a vortex boundary layer, now known as the Kerson layer, to solve the matching problem in the gravitational collapse of rotating black holes. Of his more than 100 research articles, about one-fifth were written in his last decade.

Besides his physics accomplishments, Huang was famous for his translations, in particular *The Rubaiyat of Omar Khayyam: A Rendition in Classical Chinese Quatrains* and *I Ching, the Oracle*. He also wrote many English and Chinese poems

and published several books of original poetry; people in the poetry community referred to Huang as "a poet [who] also did physics research."

Chi Xiong

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Arthur Hinton Rosenfeld

Arthur Hinton Rosenfeld, widely considered the father of energy efficiency, died on 27 January 2017 after a brief illness. Charming, witty, and enthusiastic, he motivated many students, postdocs, and researchers to investigate ways to improve energy efficiency through technology and persuaded legislators to turn those ideas into policy.

Born in Birmingham, Alabama, on 22 June 1926, Art grew up in Egypt, where his father was a consultant for the sugarcane industry. At 18 he graduated with a BS in physics from Virginia Polytechnic Institute. After serving in the US Navy during World War II, he went to the University of Chicago, where he became Enrico Fermi's last graduate student. He received his PhD in physics in 1954.

Art then joined the physics department at the University of California, Berkeley, and worked in Luis Alvarez's particle-physics group at Lawrence Berkeley National Laboratory (LBNL). He was group leader from 1969 to 1974.

In response to the oil embargo of 1973, Art began questioning many energy practices. Among them were keep-

ing office lights on at all hours, even when no one was in the buildings, and the widespread practice by utility companies of giving customers free 200 W light bulbs. He wanted to know what activities and devices were using energy, how much they consumed, and how much they actually needed, per the laws of physics, to perform their functions.

Art and several colleagues took a revolutionary approach to addressing those and other concerns. They reframed the energy issue, asking not how enough energy can be supplied but how can desired services be delivered as efficiently and cheaply as possible. They challenged and changed most people's perception that energy consumption and economic growth always increased in lockstep.

After spending a sabbatical year away from particle physics in 1974 exploring energy demand and energy efficiency, Art continued working on energy-efficiency issues, with a concentration on buildings. He founded LBNL's Center for Building Science and led it from 1975 to 1994. Under his leadership, the center created numerous groundbreaking energy-efficiency technologies, including the electronic ballasts that power compact fluorescent lamps and a transparent coating to block heat from passing through window glass. In 1978 Art led his team in designing a series of computer programs, known as the DOE-2, that for more than 25 years served as the standard for energy analysis and design of buildings. The center became a magnet for innovative, talented researchers interested in energy and environment studies, and it inspired many Berkeley students to study energy efficiency and to help build the energy-efficiency industry after they graduated.

Art began working on policy in 1975. At that time, utilities in California had requested permits for new power plants that would provide an additional 17 GW by 1987. A 1975 report by Ronald Doctor and colleagues of RAND Corp projected a need for adding 150 GW of power plants by 2000, equivalent to putting a 1 GW power plant every 3 miles between San Diego and San Francisco. But by 1987 the state's power needs had grown by only 3 GW. Art worked with legislators, regulators, and the nascent California Energy Commission to implement much less expensive efficiency policies that made the extra plants superfluous. California's per capita

LAWRENCE BERKELEY NATIONAL LABORATORY



Arthur Hinton Rosenfeld