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."

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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 keeping 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.

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Arthur Hinton Rosenfeld

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

annual electricity consumption has held steady since 1978 at about 7200 kWh, despite increasing per capita incomes.

Art cofounded the American Council for an Energy-Efficient Economy in 1980 and the California Institute for Energy and Environment in 1989. From 1994 through 1999, Art was senior adviser to the US Department of Energy's assistant secretary for energy efficiency and renewable energy. He was appointed in 2000 to the California Energy Commission and reappointed in 2005.

Following the end of his second term on the commission, Art returned to LBNL in 2010 as a distinguished scientist emeritus. Until his death, he advocated internationally for the adoption of high-albedo white roofs and "cool-colored" surfaces, which help reduce urban heat islands and lessen global warming.

Among his many awards are the American Physical Society's 1986 Szilard Award for Physics in the Public Interest, DOE's 1993 Carnot Award for Energy Efficiency, the National Medal of Technology and Innovation in 2013, and the 2016 Tang Prize in Sustainable Development. He felt his greatest honor was in 2006 when he received DOE's award named after his mentor, Fermi.

A prolific writer, Art wrote or cowrote more than 400 book chapters and articles. Although he would maintain that "relaxing makes me nervous," every weekend he took pleasure in jogging, especially with his three children.

Art was disarming and whimsical, and he could debate his ideas, even the controversial ones, while leaving his ego aside. He was friendly and collegial, and his students referred to him as "Art" rather than "Professor Rosenfeld." He projected a sense of wonder and innocence, despite his deep knowledge and ability to follow through on his ideas—from developing the original concept, to conducting research, to advocating for policies that would benefit society at large. We will greatly miss Art and his ability to inspire.

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