JAMES C. KECK

1924–2010

Elected in 2002

"For developing innovative, widely used new concepts for modeling coupled chemical and physical phenomena in engine combustion and high-temperature flows."

BY RONALD F. PROBSTEIN

JAMES C. KECK, known for his landmark developments in the understanding of automotive engine combustion for the purpose of minimizing noxious emissions, died on August 9, 2010, at the age of 86.

Jim was born in New York City on June 11, 1924, the son of famed sculptor Charles Keck. He spent his early years in Greenwich Village, where his father's studio was located, but financial losses resulting from the Great Depression forced the family to leave Manhattan and move to their country home in Carmel, New York.

He graduated from Carmel High School in 1942 and then went to Cornell University where he majored in physics and minored in mathematics. An outstanding student in physics, in 1944 he was drafted into the Special Engineering Detachment of the U.S. Army, given the rank of technical sergeant, and sent to Los Alamos to work on the atomic bomb project as part of the Manhattan Project. Years later Jim told me, "I can't understand how they picked me because I was just a kid and hadn't been at Cornell that long to know enough physics to be useful." I never had any doubt that was a usual understatement by Jim who was an outstanding student. This was confirmed to me some years afterwards by his supervisors at Cornell,

Hans Bethe, who in 1943 became director of the Theoretical Division of the Manhattan project at Los Alamos and later won the Nobel Prize for his contributions to the theory of nuclear reactions, and mathematics professor Mark Kac, who was the developer of modern mathematical probability theory and its applications to statistical physics.

Jim left Los Alamos in 1946 and returned to Cornell to complete his studies in nuclear physics, receiving his B.S. in 1947 and his Ph.D. in 1951. Among his many life-changing events at Los Alamos was his meeting another physicist, Margaret Ramsey, one of the few women scientists employed on the Manhattan Project, which she joined in 1945. She also left the project in 1946 and went to Indiana University to pursue a master's degree, which she completed while working in physics at Cornell. She and Jim were married in 1947. They both were employed in the physics department at Cornell through 1952, where Jim conducted pioneering experimental investigations of photo-nuclear reactions on a 300-Mev synchrotron he assisted in developing. He then went to the California Institute of Technology for three years as a senior research fellow, where he continued his studies of photo-nuclear reactions on the 500-Mev Caltech synchrotron.

In 1955, at the height of the Cold War, Arthur Kantrowitz, a professor at Cornell, had become convinced that the most important problem facing America was the need to develop intercontinental ballistic missiles (ICBMs). He foresaw Russia's threatening missile development, which was confirmed dramatically two years later with the launching of the Sputnik satellite. To counteract the Russian program, he decided to set up a research laboratory in Everett, Massachusetts, under the umbrella of the Avco Corporation for the purpose of providing the research needed to develop ICBMs that could reenter the atmosphere without burning up. He had not known Jim from Cornell but had heard from Victor Emanuel the head of Avco that Jim was brilliant, a fact passed on to him by his son who did know Jim. Kantrowitz very much wanted Jim and in 1955, at a time when Jim was prepared to go to Princeton, convinced him, along with a number of other Cornell alumni, to join

the new Avco-Everett Research Laboratory to help protect America from Russian domination in ICBM development.

Jim started at the Avco-Everett Laboratory as a principal scientist, where he carried out both experimental and theoretical studies of the chemical kinetics, radiation, and ionization of gases heated by high-intensity shock waves. Such shock waves are associated with the very high Mach number speeds of reentry of ICBMs. He also had general responsibility for the laboratory's associated programs in atomic physics. His experimental and theoretical contributions in the areas of nonequilibrium rate processes and the radiation of neutral gases and plasmas obtained wide recognition. His pioneering work on the variational theory of reaction rates laid a foundation for the theoretical description of thermally induced gas-phase reactions, which received wide acclaim in the field of physical chemistry.

In 1960, Jim was appointed deputy director of the laboratory but resigned that position in 1963. He had told me "the responsibilities of running the Lab aren't compatible with my doing my own creative research and that's what I want to do." I was a consultant to the laboratory at the time, and it was clear that his brilliance, coupled with his devotion to try to understand scientific and engineering problems at their basic level, made him far more suited to a university environment than to an industrial laboratory. With little effort I convinced my colleagues at the Massachusetts Institute of Technology that we should invite him to join us, and in 1965 Jim accepted the position of Ford Professor of Engineering in the Department of Mechanical Engineering at MIT.

Shortly after joining the MIT faculty Jim assumed primary responsibility for the direction and teaching of thermodynamics in the mechanical engineering department. He emphasized the important, but less well understood, nonequilibrium aspects of the subject, processes in the gas-phase, gas-surface interactions, thermionic energy conversion, and air pollution problems associated with combustion.

As a consequence of his experimental and theoretical research into the combustion processes occurring in spark

ignition engines, he obtained a much clearer understanding of automotive pollution problems insofar as the production of nitric oxide, carbon monoxide, and unburned hydrocarbons are concerned. He also showed the nature of turbulent flame propagation and "knock" in these engines. Taken together his work identified methods by which these pollutants could be alleviated. These studies are regarded as a pioneering contribution to the design of all present-day efficient and clean automobile internal combustion engines.

Until his death Jim worked to develop basic theoretical models to describe elementary atomic and molecular excitation, thermally induced chemical reaction rates, rate-controlled constrained equilibrium, and flame theory, in addition to continuing to understand the nature of engine combustion. He produced outstanding research right up to his last days.

As for his personal happiness, there never was a question for he was a happy fellow who found joy in both his work and his friends at the institute and who was loved by them all. In my many years as a friend of Jim, I never heard anyone say anything about him less than "What a nice fellow. " He devoted himself to his students and was never patronizing to them or his colleagues but rather was always ready to jump into their technical problems because it was fun. He loved science and was forever curious, and it was difficult for him not to start talking to his colleagues without getting involved in their problems or raising issues with his own work because it was fun.

As involved as he was with engineering and science he had a lifelong attachment to his extracurricular activities, among which was his vegetable garden at his home in Harold Parker State Forest in Andover, Massachusetts. This was a serious matter and not on a small scale. Indeed, it required the use of a backhoe, which Jim acquired and used in a way admired by professionals. But no matter what the task, always at the forefront of Jim's behavior were fun and games. As he once expressed to me, "I would rather be loved than famous." He didn't quite get his wish, for not only was he loved by all but was also recognized and honored internationally for his pioneering scientific and engineering studies.

While gardening was a major hobby, Jim also enjoyed individual sports. In the winter it was ice skating and skiing; in the warmer months it was swimming or hiking or bicycling. When his children were growing up, he spent much of his free time with them, encouraging them to pursue their interests, and he was always willing to help them, whether it was building a dark room for his son's photography or putting up fences for his daughter's horse. In later years Jim enjoyed working with his daughter Pat, a sculptor, on the mechanical design of her movable sculptures, teaching her basic mechanics in the process and emphasizing that the simplest design was usually the best. He liked to say, "If you can't explain something simply, you probably don't understand it very well." That was a concept he used in approaching any problem.

Jim enjoyed parties and celebrations and threw himself into the preparations with great enthusiasm. He hosted many parties for graduate students and faculty, with the entertainment as varied as ice skating and sledding to badminton and swimming. He was popular with visiting children because he was always willing to stop whatever he was doing to play games with them or have a croquet match, set up an archery range, or teach them new skills. Adults, meanwhile, enjoyed his talents in mixing martinis. Jim was an optimist and was invariably cheerful and upbeat. He was a joy to live with, and he brought joy to all who knew him.

When he retired from MIT in 1989, he took on some new ventures. First, he designed and built, with the help of his daughter, a two-car garage to replace the one that she had taken over for use as her studio. This was top priority for his wife, who was tired of scraping ice off the cars during the long New England winters. Second, he designed and, again with Pat as helper, built a barn to house two horses and a storage area for garden machinery. From then on, one of his main occupations was improving and maintaining his house and property. He loved the hard physical outdoor work that this entailed, but he also claimed that he got some of his best scientific ideas while mowing the fields with his garden tractor.

In the 1990s, as a result of a chance conversation with a friend, he invented and worked on the development of a device to

monitor septic systems that led to the formation of a company now known as Sepsensor, Inc. He never lost his interest in thermodynamics and continued to work until the end of his life on nonequilibrium thermodynamics and rate-controlled constrained equilibrium, meeting weekly with Northeastern University doctoral students who were interested in pursuing his ideas.

In addition to the honor of his election to the National Academy of Engineering, he was honored by election to the American Academy of Arts and Sciences and was a fellow of the American Physical Society.

Jim is survived by his wife of 63 years, Margaret Ramsey Keck; his son, Robert Keck, of Rochester, New York; his daughter, Patricia Keck, of Andover, Massachusetts; and his brother, Charles Keck, of Andover, Vermont.