came President Nixon's science adviser and the director of the Office of Science and Technology, where he worked on several projects concerning satellites, the space shuttle, the national cancer program, energy research and technology policy. In 1973, David became executive vice-president of Gould Inc and president of that company's laboratories. He moved to Exxon Corporation in 1977, becoming president of Research and Engineering. He served as the president of the American Association for the Advancement of Science in 1978.

Pimentel was honored for "his experimental work in matrix-spectroscopy and in the realization of the chemical laser." In the early 1950s, Pimentel began developing the method of matrix separation, in which highly reactive molecules are stabilized for spectroscopic study in a matrix of frozen inert gas. His technique made possible the detection of many previously unknown, highly unstable molecules. In addition, he developed rapid scan techniques for infrared spectroscopic studies of transient gaseous molecules. These techniques found direct application on the 1969 Mariner mission in an infrared spectrometer that was used to determine the atmosphere of Mars. In 1964, while conducting studies of photochemical reactions, Pimentel and his student, J.V.V. Kasper, discovered the first chemically pumped laser, based on the production of hydrogen chloride molecules from the reaction of hydrogen atoms with chlorine molecules.

Pimentel joined the faculty of the chemistry department of the University of California, Berkeley, upon receiving his PhD from that institution in 1949; in 1959 he was made a full professor. Pimentel served as deputy director of NSF from October 1977 to June 1980. He then became the director of LBL's chemical biodynamics laboratory and head of an organized research unit of the University of California's chemistry department.

Bethe receives NSF Vannevar Bush Award

The National Science Foundation has presented the Vannevar Bush Award to Hans Bethe (Cornell University) for "pioneering with vision and boldness, the exploration, charting and settlement of new frontiers in science, education and public service."

Bethe received his PhD in physics under Arnold Sommerfeld from the University of Munich in 1928. He taught at several European universities: Frankfurt (1928–29), Stuttgart (1929) and Munich and Tübingen (1930–33). During 1930–32, he worked

with Rutherford at Cambridge and with Fermi in Rome; in 1933 he was dismissed from his assistant professorship at Tübingen because his mother was Jewish. He then taught at Manchester (1933–34) and at Bristol (1934–35) before becoming an assistant professor at Cornell University, where he has remained. Bethe was made a full professor at Cornell in 1937 and was named the John Wendell Anderson Professor of Physics in 1945.

Bethe's initial research in the late 1920s and the early 1930s focused on the quantum theory of metals and other crystals and on collisions between energetic charged particles and atoms. While in England he wrote extensively on nuclear physics and radiation theory, including a paper with Heitler on electron–positron pair production. In 1936 he made the first calculations of level densities in nuclear spectra.

In 1938 and 1939, Bethe published two classic papers detailing the mechanism of energy production within stars. After considering the relative abundances of the different elements in stars, estimated stellar lifetimes and observed temperatures, Bethe concluded that only two processes would satisfy all requirements: the proton–proton chain and the carbon cycle. For most large stars, the carbon cycle appears to be the chief source of energy: It leads to the fusion of four protons into an alpha particle, with a C^{12} nucleus serving as a catalyst— that is, the cycle starts with the absorption of a proton by a C^{12} nucleus, and after several decay and absorption steps, concludes with the reaction of a proton with N^{15} to produce a C^{12} nucleus and an α particle. The cycle liberates about 26 MeV, which escapes from the star only after many cycles of photon absorption and emission. This slow escape, which Bethe estimated to be on the order of a million years, is responsible for the high temperatures found in stellar interiors; the high temperatures in turn maintain the reactions. Bethe also established the temperature dependence of the two processes, concluding that the proton–proton chain (which he worked out with Charles Critchfield) was predominant in cooler stars while the carbon cycle predominates in hotter stars of temperatures of at least 10^7 kelvins. For this work, Bethe was awarded the Nobel Prize for Physics in 1967. Carl Friedrich von Weizsäcker in Germany had also proposed the carbon cycle in 1938, but had not investigated its rate in stellar interiors. Much of Bethe's work was later elaborated and confirmed—particularly in work by William Fowler (see PHYSICS TODAY, January 1984, page 17).

During World War II, Bethe worked

on the Manhattan Project; in 1943 he was appointed chief of the theoretical physics division of the newly established Los Alamos Lab by its first director, J. Robert Oppenheimer. After the war, he returned to Cornell and began theoretical studies of the quantum theory of electromagnetic interactions. In 1947 he was the first to apply the concept of mass renormalization, which had been proposed earlier by Hendrik A. Kramers, to the 2s and 2p Lamb shifts in hydrogen that had just been measured by Willis Lamb and R. C. Retherford. Interpreting the displacement as a result of the electron's interaction with the radiation field, Bethe calculated (nonrelativistically) the self-energy of an electron bound in an atom. Relativistic calculations of these energy shifts were later made by Julian Schwinger, Richard Feynman and others. In 1955, Bethe turned his attention to the nuclear many-body problem and to the saturation of nuclear forces. Since his retirement in 1975, he has focused on problems in stellar evolution, in particular, on the nature of supernovae.

Bethe served on the President's Scientific Advisory Committee from 1956 to 1959. As a proponent of the peaceful uses of atomic power, he served as a technical adviser to the US delegation to the International Conference on Peaceful Uses of Atomic Energy in Geneva in 1955. He was much involved in the negotiations that finally led to the 1963 test ban treaty. His concern over the oil crisis has led to his appointment as chairman of Americans for Energy Independence, a nonprofit corporation that seeks to educate the public on all energy sources. Bethe has written *Elementary Nuclear Theory* (1947); *Quantum Mechanics of One- and Two-Electron Atoms*, with E. E. Salpeter (1957); *Splitting of Terms in Crystals* (1958); and *Intermediate Quantum Mechanics* (1964). His main work, however, is contained in over 200 papers in scientific journals.

obituaries

Robert Ta-pang Poe

Robert Ta-pang Poe died in Taipei, Republic of China, on 15 December 1984 while attending a project review meeting on the Synchrotron Radiation Source Facility being planned in Taiwan.

Poe was born on 25 April 1935 in Bejing, China. He came to the US in 1953 and earned his PhD in theoretical atomic physics at Berkeley in 1963. He started his postdoctoral career at the Lawrence Berkeley Laboratory, working in experimental high-energy physics in Wilson Powell's group. In 1964, he joined the physics department at the University of California in Riverside. He served as chairman of the department from 1976 to 1981, and at the time of his death was the director of the University's energy sciences program. Poe was a born teacher—his presentations were always lucid, well organized and lively. For years he taught the graduate-level classes in quantum mechanics and classical mechanics and gave the incoming graduates a solid grounding not only in theoretical physics, but also in basic research procedures. Poe took much interest in physics students at all levels; his enthusiasm in research, and his guidance and advice, influenced the careers of many young physicists.

Poe's research interests were extremely broad. He was one of the pioneers in the application of the diagrammatic many-body perturbation method to the study of atomic systems. He made significant contributions to the knowledge of electron–atom scattering, the hyperfine structure, single and double photoionization, the fine structure of Rydberg atoms, and the multiphoton process. In addition, he conducted studies of vibrational and rotational excitations in electron–molecular scattering, helped develop the three-dimensional T-matrix approach for reactive scattering, and investigated, both experimentally and theoretically, electron scattering from laser-selected excited atoms. In particle physics, Poe was involved with pioneering works on spin-parity analysis of

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