Néel's industrial friends. Néel's difficulties with antiferromagnetism and inconclusive discussions in the Strasbourg international meeting of 1939 fostered his skepticism about the usefulness of quantum mechanics; this was one of the few limitations of this superior mind.

JACQUES FRIEDEL
Paris, France

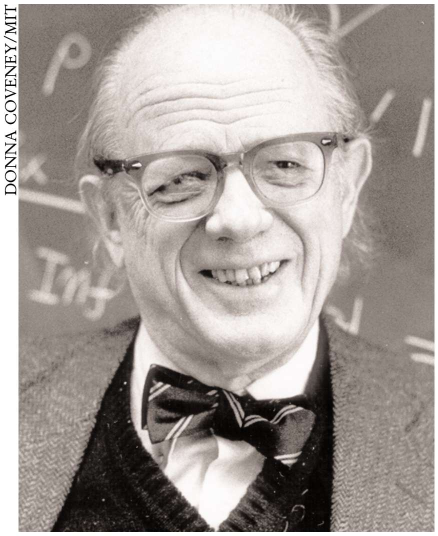
Herman Feshbach

Herman Feshbach, a leader in the field of nuclear physics from the 1940s to the end of the century, died on 22 December 2000 in Cambridge, Massachusetts, of congestive heart failure. He was renowned and respected for his seminal work in nuclear theory, his leadership in the international physics enterprise, and his commitment to world peace and human rights.

Born in New York City on 2 February 1917, Herman received his SB in 1937 from the City College of New York, with his lifelong friend Julian Schwinger as a classmate. Herman obtained his PhD in physics at MIT in 1942. His thesis, under the supervision of Philip Morse, approximately derived the properties of tritium from nuclear forces, a difficult task at the time. Herman remained at MIT, rising through the ranks to institute professor in 1983. He also was a founder and director of MIT's Center for Theoretical Physics from 1967 to 1973 and head of the physics department from 1973 to 1983.

In 1954, Herman, Charles Porter, and Victor Weisskopf developed the cloudy crystal ball model, which revolutionized the treatment of nuclear reactions, initially providing a detailed description of the scattering of neutrons from nuclei. The model's characterization of the nucleus as a complex "optical" potential combines the independent nucleon aspect embodied in the shell model with the excitation of dense compound nuclear levels postulated by Niels Bohr to explain many aspects of nuclear reactions.

Herman's subsequent (1958) development of a general nuclear reaction theory, based on the projection of the nuclear state into direct and compound channels, resulted in such intuitive and important concepts as doorway states and multistep reactions. These methods are the backbone of complex nuclear reaction calculations today. A specific application of this theory is the inelastic multichannel Feshbach resonance, which is now of importance in atomic



DONNA COVENEY/MIT

HERMAN FESHBACH

Bose–Einstein condensation.

The compound nucleus channels require a statistical description of the level distribution, a subject to which Herman gave much attention. With Arthur Kerman and Steven Koonin, he developed during 1977 to 1980 a statistical treatment of multistep compound and direct reactions. In the years just preceding his death, this research was extended, with Alfredo Molinari and others, to the properties of nuclear matter by developing a statistical theory of the mean field.

Herman, with Kerman in 1966, noted that recoilless (K^-, π^-) reactions would efficiently produce heavy hypernuclei. As a result of this finding, Harry Palevsky and Robert Chrien initiated experimental programs.

Eugene Wigner's R-matrix theory is frequently used to express the effect of the degrees of freedom appropriate within the nuclear radius on the longer range wavefunction. Herman realized that this separation into two regions connected by a boundary condition was relevant to the interactions of hadrons. He successfully interpreted, with one of us (Lomon), the nucleon forces up to intermediate energies in this way. Because of the simple properties of quantum chromodynamics at short distances, the R-matrix method can incorporate the quark and gluon degrees of freedom in hadron reactions.

Herman, together with Francesco Iachello, initiated another and very different approach to nuclear structure and reactions in the interacting boson model in which the large number of single fermion degrees of freedom are approximated by a few bosonic degrees of freedom. Since the formulation of this approach in 1973, there have been extensions to nuclei with an odd atomic number and the powerful use of dynamic symmetries. Herman expected the model to be more limited in scope; he watched its later successes bemusedly from the sidelines.

The role of symmetries in nuclei always intrigued Herman. Beyond the many well-known applications of rotational symmetry, Herman considered the effect of SU(3) symmetry in hyper-nuclei. In particular, he showed, with Carl Dover in 1987, that the symmetry could lead to observable widths of Σ hyper-nuclei despite the expected rapid transition to a Λ hyper-nucleus. In the last year of his life, he applied his reaction theory, together with Mahir Hussein, Kerman, and Oleg Vorov, to understanding the large parity violations seen in thermal neutron reactions in heavy nuclei as being due to the coherent effects of the doorway states, and predicting the effects of time-reversal symmetry breaking.

Herman's great service to physics was not limited to research. Many of his students are well known and respected in the field. His leadership in the MIT physics department extended to national and international physics. In the 1960s, he, Allan Bromley, and Heinz Barschall organized the American Physical Society's division of nuclear physics, which he chaired from 1970 to 1971. In 1969, he was elected into the National Academy of Sciences. He was a consultant to the White House Office of Science Policy in the early 1970s. An initiator of the nuclear science advisory committee to the US Department of Energy and NSF, he was its first chairman from 1979 to 1982. He was president of APS in 1981 and president of the American Academy of Arts and Sciences from 1982 to 1986.

In the 1990s, Herman was persuaded by Bromley to chair the nuclear physics commission of the International Union of Pure and Applied Physics. As chair, he organized an international meeting on nuclear physics in Amsterdam with the goal of improving international cooperation for nuclear facilities. It was a politically difficult meeting; Bromley, who was the keynote speaker, remembers that Herman, with his usual diplomacy and flair (including a display of temper that only his close friends recognized to be totally simulated), brought the meeting to a peaceful and constructive close. Herman also served on the boards of governors of the Weizmann Institute of

Science (1978–95) and Tel Aviv University (1987–90).

Herman's publications affected physics. Generations of physicists—and engineers—fueled their mathematical tool kits from Morse and Herman's *Methods of Theoretical Physics,* whose first edition was published in 1953 and the most recent edition, in 1999 (McGraw-Hill). He put much of his energy into modernizing these volumes, including adding a chapter on group theory and its applications. Unfortunately, he did not complete this task before his death. His book, with Amos de Shalit, called *Theoretical Nuclear Physics* (Wiley, 1974), is one of the classics in the field; Herman wrote the sequel, *Theoretical Nuclear Physics: Nuclear Reactions* (Wiley, 1992), which deserves similar status.

Herman's impact on the physics literature went beyond his own writings. In 1957, he and Morse, in reaction to the splitting of the *Physical Review* into subfields and the publication's constraints on lengthy articles, founded the *Annals of Physics* to publish a range and depth of material. Herman succeeded Morse as chief editor.

Passionate about human welfare and rights and about the folly of war, Herman put his energy and talents into rectifying wrongs. He played a critical role in the founding of the Union of Concerned Scientists, served as its first chair, and continued to support it, especially on nuclear arms control. He pursued similar goals as chairman of the APS panel on public affairs (1976–78). In 1980, as APS president, he established a human rights committee to intervene in support of oppressed physicists in the Soviet bloc, Argentina, and Chile, and made major personal efforts on behalf of the dissidents and refuseniks. Of special interest was his fight for the freedom of Andrei Sakharov. On another front, he was instrumental in improving the position of women and minorities in physics and academia.

Herman's fervor for physics and people endeared him to his colleagues, even if his fierceness on behalf of his causes may have sometimes distressed them. He will be sorely missed by the physics community and his many friends.

EARLE LOMON
Massachusetts Institute of Technology
Cambridge
KURT GOTTFRIED
Cornell University
Ithaca, New York
ALLAN BROMLEY
Yale University
New Haven, Connecticut

Hsu-Yun Fan

Hsu-Yun Fan, Duncan Distinguished Professor emeritus in the physics department at Purdue University and a leader in condensed matter physics, died in Lafayette, Indiana, on 5 October 2000 after several years of declining health.

Fan was born on 15 July 1912 in Shanghai, China. He received his BS in electrical engineering at the Harbin Polytechnic Institute in China in 1932. He earned an MS in 1934 and a DSc in 1937, both in electrical engineering, from MIT to which he was attracted by its international reputation. His doctoral dissertation was entitled "The Transition from Glow Discharge to Arc."

From 1937 to 1947, Fan worked at the National Tsing Hua University in Beijing, starting as an assistant professor and then becoming a professor of physics in 1939. Fan's tenure at Tsing Hua coincided with a politically turbulent period during which China suffered Japanese aggression followed by civil war. Indeed, the university was evacuated to Kunming in the Yunnan province during part of this time. During this period, Fan heroically managed to function as a scholar and teacher, and carried out research on the physics of electrical contact between a metal and a semiconductor, photoelectric and thermoelectric emission from metals, and the theory of rectification of an insulating layer.

After a short interlude as a visiting professor in the MIT physics department from 1948 to 1949, Fan was attracted to Purdue by Karl Lark-Horovitz, the head of the physics department and a pioneer in semiconductor physics. Fan joined the department as an associate professor at a most opportune time. As a result of wartime defense research, Lark-Horovitz had realized that the field of semiconductors offered great opportunities for exciting research, mobilized the department's resources, and assembled a team of young scientists to tackle a range of experimental and theoretical problems. Fan became a leader in this group and established, within a short time, an extremely productive line of studies, namely, the optics of semiconductors. He made pioneering contributions to the physics of semiconductors during this period.

HSU-YUN FAN

Fan became a professor in 1951 and the Duncan Distinguished Professor in 1963, a position he held until his retirement in 1978. During the 1950s and 1960s, when semiconductor physics emerged as a major discipline in condensed matter physics and its impact was felt in both basic science and in device technology, Fan made many landmark discoveries. Examples are infrared transparency, absorption edge, and nature of the valence and conduction bands of silicon and germanium; free-carrier absorption in n- and p-type germanium and its complex valence band; and the temperature and pressure dependence of the energy gap of semiconductors. He also found that plasma edge associated with free carriers leads to optical determination of effective masses. His achievements in semiconductor physics are many, including lattice vibrations of covalent and ionic semiconductors, oscillatory intrinsic photoconductivity, and excitonic absorption in the III–V semiconductors. Fan made significant contributions to nearly every branch of semiconductor physics; his papers are standard references in the subject.

Fan maintained an active research program until the time of his retirement. Optical experiments and their analysis continued to occupy his interest. With striking success, he investigated such diverse phenomena as Faraday effect of p-type Ge, two-photon absorption and second-harmonic generation in semiconductors, and light scattering by magnons in magnetic oxides and sulphides.

After retirement, Fan continued to maintain a lively interest in semiconductor physics, the research activities of his colleagues, and the affairs of the department of physics. Based on his many years of teaching, he wrote an