Carnegie Mellon University. Cliff was a much-loved father of his field.

Ralph M. Moon
Oak Ridge National Laboratory
Oak Ridge, Tennessee
Robert J. Birgeneau
University of Toronto
Toronto, Ontario, Canada

Louis Néel

Louis Néel, an impressive figure in the French scientific scene after World War II, who received the Nobel Prize in 1970 for research in magnetism, died of a stroke in Brive-la-Gaillarde, France, on 17 November 2000.

Born in Lyon, France, on 22 November 1904, Néel obtained, in 1928, the first rank in the *Agrégation de Physique* at the Ecole Normale Supérieure (Paris). He then went directly to Strasbourg to prepare a thesis in the laboratory of Pierre Weiss. His thesis was entitled "The Effects of Magnetic Fluctuations of a Molecular Field on the Magnetic Properties of Objects" (1932).

Néel was indeed a worthy successor to the French tradition of research in magnetism initiated by Pierre Curie, Paul Langevin, and Pierre Weiss. But he is better known in France as the one who developed Grenoble into a major international center of research after the war. With a large center for nuclear energy, a laboratory for semiconductor developments, two international instruments that use synchrotron radiation and neutrons, and the many university and CNRS (French National Center for Scientific Research) laboratories he developed, Néel profoundly changed, in only 20 years, the atmosphere of a provincial town with good industrial activities but poor research facilities before and during World War II.

Néel's successes in research and scientific administration were helped by circumstances; they came mostly from a clear awareness of his aims and possible limitations, and were stimulated by a great willpower. His sharp mind concentrated on scientific models of his own, simple enough to be developed on the back of an envelope, but powerful because they were well adapted to the problems at hand and general in nature. His greatest successes came against the stream of fashion. He published to the last in French; his work during the war was poorly published and thus hardly known.

In committees, he was a massive and impressive chairman, awake in daylong sessions to the last minute, when he often tried to realize his dearest wishes in the general tiredness. He liked lively discussions, however, and only respected determined opponents. Despite many honors and connections worldwide, Néel kept a quiet and happy family life with his wife, a teacher in philosophy, and their three children.

Néel's research centered on the arrangements of the magnetic moments in solids, at atomic and larger scales. In Weiss's laboratory in Strasbourg, Néel questioned the accepted Curie–Weiss law for susceptibility, which had been deduced from distance-independent interactions. Werner Heisenberg's work on exchange had just shown that short-range effects should be expected. Between 1931 and 1933, Néel observed those effects in the susceptibility of iron and alloys and in the specific heat of nickel. Then, assuming that short-range interactions could be antiparallel, Néel developed the concept of antiferromagnetism, in which two interpenetrating atomic lattices are treated in a molecular field approximation. Manganese and chromium showed the predicted susceptibility, with a peak at what became known as the Néel temperature. These proposals, made in 1936, were confirmed in 1938 on manganese oxide, an insulator with no possible contributions from metallic paramagnetism.

To describe antiferromagnetism, Lev Landau and Cornelis Gorter suggested quantum fluctuations to mix Néel's solution with that obtained by reversal of moments. But in a macroscopic crystal with magnetocrystalline anisotropy, the nucleation would involve a magnetic wall of high energy. Using neutron diffraction, Harry Shull confirmed (in 1950) Néel's model.

This model had been extended in 1947 to describe ferrimagnetism of spinel ferrites: Néel assumed that the atoms of the two lattices have different moments. In 1956, rare earth garnets were discovered in Grenoble, where the ferrimagnetism of Fe ions is coupled to the rare earths. This flexible family led to hard (noncubic) magnets and to soft and lossless (cubic) ones. At a dinner held to celebrate Néel's receipt of the Nobel Prize, his friend Hendrik Casimir stressed that these contributions were essential to Philips research laboratories' development of ferrite-based devices. Bell Laboratories and Japanese firms could have made similar statements.

Applications were at the root of Néel's work, which looked at larger scales. His interest in hysteresis dated from the war: Indeed, he personally supervised the magnetic protection of all main vessels of the


CEA

Louis Néel

French navy, during the spring of 1940, from magnetic mines by applying a short strong field, opposite in direction to Earth's, thus reducing the ships' magnetization due to Earth's field. Hysteresis in polycrystals or with diffusing impurities came to be of central interest in Grenoble, where Néel took refuge in 1940.

During the war, Néel developed reasonably hard magnets by compressing soft Fe powders. When smaller than the thickness of Bloch walls, each grain is a single domain; at low temperatures, its form factor blocks its magnetization along a specific axis. Cooling under an applied field produces a stable remanant magnetization. This model was later applied to hard cobalt–nickel steels and to ceramics and basalts cooled down under the influence of Earth's field. Néel was proud of this last work, which opened the possibility of relating the continental drift to the rate of reversal of Earth's field.

During or just after the war, Néel predicted the main features observed later in magnetic configurations near various surfaces, notably in thin sheets. In thin sheets that lack large magnetocrystalline effects, he pointed out that magnetization is parallel to the surfaces. In a "Néel wall" between domains in such sheets, magnetization rotates with an axis normal to the sheet; a singular line separates two parts of the wall that have opposite rotations, as indeed in a Bloch wall but with a different structure.

Néel was gifted with his hands and relaxed by making furniture. But, in Grenoble, his experiments were mostly done by collaborators, notably Louis Weil and Felix Lewy-Bertaut, two Jews protected during the war by

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

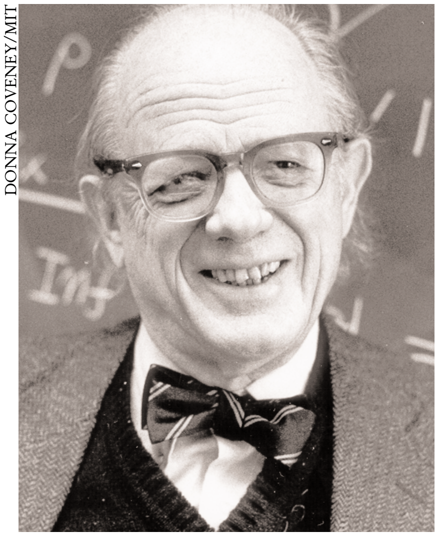
Herman Feshbach

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