design of the magnet structure, vacuum system and power supply. Indeed, this accelerator was the first to be constructed on the basis of a careful scientific analysis and a completely engineered design. All later accelerators, including the newest high-energy synchrotrons, have been influenced by the early work of Kerst. The betatron was thus not merely a valuable instrument in itself but a milestone in the development of particle accelerators generally. For example, the radial and vertical oscillations of the beam in a circular accelerator are now universally called betatron oscillations, after the pioneering work of Kerst and Robert Serber, who in 1941 published the first theoretical analysis of such oscillations as they occur in the betatron.

Kerst went on to construct a series of betatrons of successively higher energies, culminating in the 300-MeV flux-biased betatron at Illinois, with its 400-ton magnet. Kerst and his students used these machines to carry out much of the earliest research in the multi-MeV energy range. The betatron was the first accelerator to provide megavolt x rays for photonuclear studies. In the late 1940s and early 1950s, much of the experimental research on photonuclear reactions, including the discovery of the giant dipole resonances, on photodisintegration of the deuteron, on photoproduction of mesons and on nuclear structure from electron scattering was carried out using the Illinois betatrons. Kerst was also responsible for the first use of megavoltage radiation in the treatment of cancer.

At the time that Kerst was building the 300-MeV betatron, V. I. Veksler in the USSR and Edwin M. McMillan at Berkeley, working independently of each other, discovered phase focusing. They published articles in 1945 proposing the addition of a radiofrequency cavity along the circular path of an electron orbiting in a magnetic guide field to provide the potential to accelerate the electrons to high energies. Accelerators incorporating this principle are called synchrotrons, and most high energy circular accelerators built since then have been synchrotrons. A number of betatrons that had been constructed in laboratories in the US and in England were converted to synchrotrons by the simple addition of rf accelerating cavities.

From 1943 to 1945, Kerst was the leader of the P-7 group at Los Alamos which developed the first homogeneous fission reactor (a "water boiler"). He also used the betatron to study the implosion method for igniting nuclear weapons. One history of Los Alamos calls Kerst's technical achievements among the most impressive at Los Alamos.

On leave from the University of Illinois from 1953 to 1957, Kerst served as technical director of the Midwestern Universities Research Association in Madison, working on advanced accelerator concepts. His vigorous leadership and deep understanding of the physics of electric and magnetic fields and of mechanics were responsible in large part for the many contributions to accelerator technology made by the MURA group during the period. The spiral-sector focusing principle was originated at MURA by Kerst and under his leadership the MURA group invented and analyzed the process of beam stacking by means of radio-frequency acceleration in fixed-field machines. The beam-stacking technique opened the possiblity of achieving intense circulating beams and led Kerst to realize that it was now practical to achieve greatly increased center-of-mass energies through the use of colliding beams. Electron and proton storage rings are a direct outgrowth of the MURA work.

After 19 years at Illinois developing accelerators, Kerst accepted in 1957 a five-year appointment to work on plasma physics in the fusion program at the General Atomics division of the General Dynamics Corporation in La Jolla, California. He brought to this field not only his deep physical insight into magnetic field structures but also his understanding, gained from his accelerator experience, of the importance of careful attention to detail in the design of magnetic structures. These qualities of Kerst are largely responsible for the success of the various toroidal machines that were built under his direction, including a toroidal pinch device at General Atomics and a number of multipole machines. (While at General Atomics, he coinvented, with Tihiro Ohkawa, the latter type of device.)

In 1962 Kerst returned to the University of Wisconsin, Madison, to establish a plasma physics program. The first multipole machines were the toroidal octupoles completed at the University of Wisconsin under his direction and the toroidal octupole begun by him and Ohkawa and completed by Ohkawa at General Atomics. These were the first magnetic confinement devices to achieve a quiet plasma, undisturbed by the instabilities that had plagued previous machines, and to exhibit lifetimes exceeding the Bohm diffusion limit.

Donald Kerst was a well-rounded person. He was a sportsman who enjoyed skiing, deep-sea fishing, white-water canoeing and ocean sailing. He had a low-key sense of humor that often delighted his friends and colleagues.

KEITH R. SYMON
University of Wisconsin, Madison
H. WILLIAM KOCH
University of Denver
Denver, Colorado

Jean Paul Mathieu

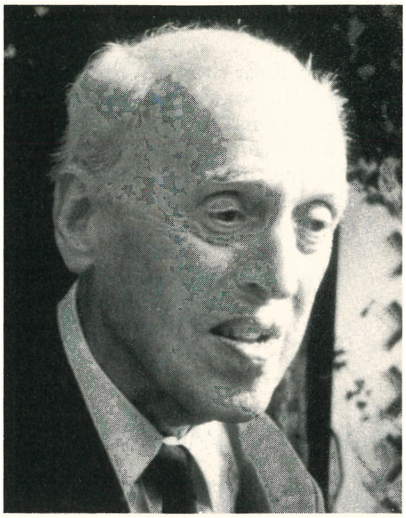
Jean Paul Mathieu, former professor of physics at the Université Pierre et Marie Curie in Paris, died on 18 January 1993 at the age of 84.

Mathieu's father, a physician, insisted that he study pharmacy, but he earned degrees in physics, both from the Faculté des Sciences de l'Université de Paris in 1930. He soon returned to this university to work on his docteur ès sciences physiques, which he earned in 1934.

Mathieu was interested primarily in two aspects of physics: the use of symmetry properties to understand optical effects, and the use of the inelastic scattering of light by molecules discovered by C. V. Raman in 1928. Mathieu's thesis work led to understanding of circular dichroism in some complexes of transition metals and of the configuration of ligands. In this work he drew on the chemistry he had learned as a student of pharmacy. It was his curiosity about the physical origin of symmetry breaking that triggered his interest in circular polarization.

Mathieu was among the first to recognize that the selection rules for the molecular vibrations of a molecular liquid are not the same as those for its corresponding molecular crystal. He became a pioneer in the use of symmetry properties to predict selection rules, and his first book on the subject, *Spectres de Vibration et Symétrie des Molécules et des Cristaux*, was published in 1945. Some 25 years later, together with Henri Poulet, he wrote a much enlarged second edition, which was translated into English by Gordon and Breach.

After earning his doctorate, Mathieu became a maître de conférences at the University of Lille, Belgium. In 1947 he returned to Paris, joining the Faculté des Sciences. He became a professor in 1950 and worked at the university for the next three decades, testing in detail the selection rules he had de-



Jean Paul Mathieu

veloped for crystals, studying the modifications of the vibrational spectra related to changes of symmetry of the molecules or of their environment, studying their bandwidth and checking their intensity. The very precise measurements he made with Poulet of the intensities of the same band in different geometries in ZnS led them to discover that the electric field associated with longitudinal phonons in piezoelectric crystals was a possible source of Raman activity.

Mathieu played an important role in establishing Raman spectroscopy as a technique to understand the properties of matter and to characterize materials in physics, chemistry and later biology. His pharmaceutical training had taught him how to grow crystals, and whenever possible he would insist that he and his coworkers grow their own crystals to study.

Mathieu had an encyclopedic knowledge of classical physics and was a remarkably clear lecturer. He wrote many important textbooks for students, including a complete series on classical physics with Paul Fleury and a complete dictionary of physics with Fleury and Alfred Kastler.

Long before it became fashionable, Mathieu was a dedicated fighter for human rights, liberty and freedom. He was a *résistant* during World War II and later fought for the freedom of scientists, particularly in Eastern Europe and in the former Soviet Union.

Regretably, Mathieu never visited the US. Early in the McCarthy era, his request for a visa was denied, and he never reapplied.

Mathieu was know for his exceptional courtesy and hospitality to visitors to his laboratory. He was an intellectual in the best, classical sense of the term: fluent in English and German, widely read in general literature as well as science, and extremely fond of chamber music. Transcending these qualities was his human and direct contact with colleagues and friends, for whom his influence will remain as an abiding and happy memory.

ROBERT PICK
HENRI POULET
Université Pierre et Marie Curie
Paris, France
ELIAS BURSTEIN
University of Pennsylvania
Philadelphia, Pennsylvania
JOSEPH L. BIRMAN
City College of the City University of New York

Leo J. Neuringer

Leo J. Neuringer

Leo J. Neuringer, a highly successful research physicist and a pioneer and organizer of biomedical research, died of cancer on 4 May 1993. He was 64. In recent years Leo had been the leader of the molecular biophysics group and the director of the NIH Comprehensive NMR Center for Biomedical Research at the Francis Bitter National Magnet Laboratory at MIT.

Leo received his PhD in physics from the University of Pennsylvania in 1957. He then became a staff scientist at Raytheon, where he remained until 1963. His work at Raytheon included a comprehensive analysis of the performance of infrared detectors, growth of single crystals of GaP and GaAs, design and construction of superconducting magnets and basic experimental investigations of magnetotransport and magneto-optical properties of semiconductors and semimetals.

In 1963 Leo became a staff scientist at the Bitter Laboratory, where he worked until he retired, shortly before his death. During his first decade there he initiated and led a number of research efforts that took advantage of the lab's unique high-field facilities. Leo performed some of the earliest measurements and analyses of the effect of spin–orbit scattering on the upper critical fields of high-field superconductors. With Larry Kaufman he studied magnetic freezeout in InAs. With Ray Milward he studied far-infrared absorption due to photon-induced hopping in silicon. With Yaacov Shapira he did the first study of ultrasonic propagation in high-field superconductors. He initiated work on low-temperature thermometry in high magnetic fields, which was later expanded by Larry Rubin and Howard Sample.

In the mid-1970s Leo changed the course of his scientific career, organizing and leading the nuclear magnetic resonance and biomedical research effort at the Bitter Lab. In this large effort Leo's many exceptional talents—leadership, energy and practicality—became even more apparent. He was able to create a major interdisciplinary research and technology center where researchers and students from leading hospitals and universities in the Boston area do biomedical studies in close proximity with designers and builders of large superconducting magnets for magnetic resonance imaging or of advanced nmr spectrometers. Under Leo's leadership pioneering studies were directed toward understanding the structure and function of biomolecules and cells.

Leo was an open and warm person. Enthusiastic, optimistic and inspiring, he acted as a mentor to many students and young scientists. He was a connoisseur of many aspects of Jewish culture, from which he derived considerable inspiration. His wisdom, humanity and enjoyable company will be remembered by the many people whose lives he enriched.

YAACOV SHAPIRA
Tufts University
Medford, Massachusetts
LARRY RUBIN
Francis Bitter National Magnet Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts
DAVID HOLTZMAN
Children's Hospital
Boston, Massachusetts

Wallace B. Miner

Wallace Miner died on 10 April 1993 in DeKalb, Illinois at the age of 84.