and quantum molecular foundations of nonequilibrium thermodynamics. Significant results included the derivation of the Langevin equation with one of us (Oppenheim) and the classic paper on harmonic oscillator systems by George Ford, Mark Kac, and Mazur, which was published in the *Journal of Mathematical Physics* (in 1965). Mazur's work in the 1950s and 1960s culminated in the publication of *Nonequilibrium Thermodynamics* (North-Holland and Interscience, 1962), written by de Groot and Mazur. This book, translated into several languages, became a classic in the field and was later republished as a series of classic monographs.

Mazur's work in subsequent years addressed a variety of problems in statistical mechanics. He had a good nose for problems ripe to be investigated. To describe diffusion of large particles in fluids, he introduced, together with one of us (Bedeaux), the concept of induced forces in 1974. This concept was used to derive generalizations of Faxen's theorem and to develop a theory for the viscosity of a suspension. In 1976, Mazur, with Bedeaux and Alfonso Albano, gave the first systematic formulation of nonequilibrium thermodynamics for surfaces. This formulation opened a new field, which is still in active development. And Mazur, Wim van Saarloos, and Carlo Beenakker developed an algebraic method around 1982 to successfully describe hydrodynamic interactions between arbitrary numbers of particles using induced forces. This was a breakthrough in the field.

After retiring in 1988, Mazur remained active. In 1991, he derived, with Bedeaux, the Langevin equation for a Brownian particle using only causality and time-reversal invariance. From 1994 to 2000, Mazur, together with J. Miguel Rubi, used the method of internal degrees of freedom to describe fluctuations in the context of nonequilibrium thermodynamics. In 2001, he and Bedeaux developed nonequilibrium thermodynamics for quantum systems.

Many of Mazur's colleagues and students have good memories of his flamboyant lecture style and the often heated discussions in front of the blackboard. He insisted on a crystal-clear introduction followed by a detailed derivation of the results. And he thoroughly disliked sentences such as, "It can be easily shown that. . . . " It was great to work with him.

Mazur served on the boards of the International Union of Pure and Applied Physics (1966–84) and the Dutch Foundation for Fundamental Research of Matter (1970–85). In 1987, Queen Beatrix made Mazur a Knight of the Order of the Netherlands Lion.

Mazur was an excellent scientist, and superb teacher and colleague, whose knowledge and interests encompassed not only science, but almost all fields of intellectual endeavor. A great man, he was devoted to his family, friends, and colleagues. We will miss him dearly.

**DICK BEDEAUX**
*Leiden University*
*Leiden, the Netherlands*
**IRWIN OPPENHEIM**
*Massachusetts Institute of Technology*
*Cambridge*

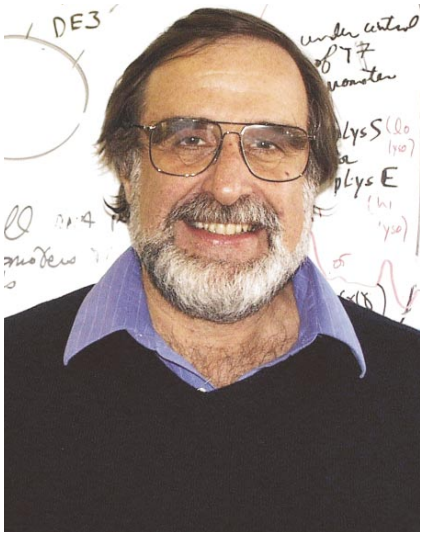
# Robert Alexander Mendelson Jr

Robert Alexander Mendelson Jr was among a wave of physicists who sensed the changes in biology in the 1960s and went on to define molecular biophysics and structural biology during the latter half of the 20th century. He died in San Francisco, California, on 5 August 2001 of lung cancer.

Born in Los Angeles on 24 January 1941, Bob earned an AB in physics in 1962 from Occidental College in Los Angeles. He received his PhD in physics from the University of Iowa in 1967 under the direction of his thesis adviser Raymond T. Carpenter. For his thesis, Bob studied the excited states of nuclei.

Bob moved in 1968 to pursue postdoctoral research in nuclear physics at the University of California, Berkeley. During his period as a postdoc, he decided to bring the precise experimental and theoretical approaches of nuclear physics to the study of biological processes. Perhaps he sensed that biophysics was about to flourish in an unprecedented way.

In 1970, he moved across the Bay and joined Manuel Morales's group at the University of California, San Francisco. Morales, one of the leaders studying the molecular physiology of muscle contraction, had the vision to see the power of physical methodologies. Bob established nanosecond techniques for following fluorescence in muscle proteins. His was probably the second nanosecond rig to work on biological macromolecules. He expanded his research to include the measurement of fluorescence in different time domains and the use of fluorescence to measure the structure



ROBERT ALEXANDER MENDELSON JR

and orientation of organized biological systems. Bob later (1984) attained the rank of professor of biophysics.

During the late 1970s, Bob started what was to become his major research focus: the use of small-angle solution scattering techniques to study the structure, dynamics, and organization of biological macromolecules. Initially, scientists in his laboratory used small-angle x-ray scattering to study the muscle motor protein myosin. They were among the earliest users of the synchrotron facility at the Stanford Synchrotron Radiation Laboratory. Bob then pioneered, in 1984, the application of small-angle neutron scattering to the study of complexes of muscle proteins and how the structures of the individual proteins change while executing their function. These structural studies, together with other work, form the basis for our current understanding of how protein molecular motors generate force and are regulated.

Bob loved experiments and had a passion for developing new instrumentation. He was a hands-on experimentalist until his death. As a physicist, he coupled his experimental prowess with a deep theoretical understanding, analyzing each experimental result with a battery of theoretical and computational techniques. His last work was a tour de force on determining the molecular basis for the regulation of muscle contraction by the troponin system of proteins. The work has all the hallmarks of Bob's style of science: exquisite biochemistry, state-of-the-art neutron measurements, and computationally intense analysis. He worried about all aspects of an experiment. His laboratory worked via dialectical principles,

and Bob often took a contrary position. Although sometimes infuriating to others, his contrary stance often proved crucial. He liked to undertake difficult experiments, breaking new methodological ground.

Bob did not change his lifestyle because of his diagnosis of lung cancer two years before his death. He continued to collect data and write computer programs. He died peacefully, surrounded by his wife and children. Bob will be remembered for his compassion, his integrity, and his honesty.

**PAUL M. G. CURMI**
*University of New South Wales*
*Sydney, Australia*
**DEBORAH BENNETT STONE**
*University of California, San Francisco*

## Rein Silberberg

Rein Silberberg, who was widely admired among his colleagues for his research on the propagation and origin of cosmic rays, died of cancer on 31 August 2001 in Silver Spring, Maryland. His productive career, spanning four decades, was spent at the Naval Research Laboratory (NRL) in Washington, DC.

Rein was born in Tallinn, Estonia, on 15 January 1932. In the aftermath of World War II, his family migrated to Finland, then to Sweden, and then to Canada. In 1950, they arrived in the US. As a boy, Rein attended school in each of those countries, becoming fluent in their languages. In later years, linguistics was one of his hobbies.

At the University of California, Berkeley, Rein joined the group of Emilio Segrè. Guided by Gerson Goldhaber, he studied the interactions of the recently discovered antiprotons, using nuclear emulsions for detection. Rein received his MA in physics in 1956 and his PhD in physics in 1960, both from Berkeley.

As a National Research Council postdoctoral research fellow, he was attracted to the Laboratory for Cosmic Ray Physics at NRL. For Rein, it was a seamless transition. The cosmic-ray lab, founded by one of us (Shapiro) in 1949, had developed advanced techniques for processing stacks of thick photographic emulsions, and had set up a well-equipped microscopy lab for the analysis of particle tracks. These methods were being applied to problems in elementary particle physics and cosmic rays.

Rein took advantage of these facilities, participating in the early 1960s in high-altitude balloon experiments that established the relative abundances of helium-3 and helium-4 in the primary cosmic radiation. The result confirmed the value of the mean-free-path of Galactic cosmic rays, which had been deduced in a prior experiment, by the NRL group, on the relative abundance of the elements lithium, beryllium, and boron among the primaries. The observations had revealed that the "primary" cosmic-ray nuclei must include a substantial component of secondaries. Secondaries were fragmentation products resulting from collisions of parent nuclei in the tenuous gas of the interstellar medium. The question arose: What do the cosmic rays look like when they are first accelerated? With us (Shapiro and Tsao), Silberberg embarked on a program of investigations that revealed the source composition of cosmic rays. This composition provides the principal clues to the origin of the high-energy particles.

The studies also predicted the isotopic composition of the cosmic rays arriving in the vicinity of Earth; this prediction was subsequently confirmed in experiments by other investigators. Another advance flowing from this work was the development of methodology for estimating the "age" of cosmic rays, that is, their mean residence time before escape from the Galaxy.

The program on the propagation and transformation of cosmic rays in the interstellar medium needed cross sections for the breakup of relativistic heavy nuclei into lighter ones. No theoretical, and very few experimental, values of these cross sections were available. In 1967, Rein developed a set of semiempirical equations for deducing the cross sections. Steadily revised and improved for many years (in the light of new measurements at accelerators), these Silberberg–Tsao equations have been an essential and widely used tool for elucidating the propagation and source composition of cosmic rays. Rein was also among the pioneers who showed the importance of cosmic-ray reacceleration.

Rein was active in the nascent field of theoretical neutrino astronomy. Collaborating with one of us (Shapiro) in Project DUMAND (deep underwater muon and neutrino detection) from 1975–85, he calculated the prospects of identifying promising celestial sources of high-energy neutrinos. From 1966 to 2000 at NRL, Rein also contributed to the science of radiation effects, including biological effects of cosmic rays and other radiations, energy deposition by nuclear interactions, and formulation of radiation protection requirements for a lunar base and for manned missions to Mars. This work helped the computer industry and the defense community.

REIN SILBERBERG

By sheer resolve, Rein did not let his physical handicaps impede his productivity. He served for many years as associate director and lecturer in the International School of Cosmic-Ray Astrophysics at the Majorana Center in Erice, Italy.

Rein was generous and considerate to a fault. Despite his single-minded dedication to research, he always found time to help friends and especially younger scientists. Integrity is surely a sine qua non of scientific research; Rein possessed this quality to an admirable degree. He enjoyed spending time at his mountain retreat with his wife Ene and children Hugo and Ingrid. We feel fortunate that he was our friend and collaborator.

**MAURICE M. SHAPIRO**
*University of Maryland, College Park*
**CHEN HSIANG TSAO**
*Roanoke College*
*Salem, Virginia*

## Robert Allen Sparks

Robert Allen Sparks, an x-ray crystallographer who contributed greatly to the use of computers in his field, died with his wife Nonie on 29 July 2001 in a traffic accident on State Route 6 near their home in Tillamook, Oregon. They were returning home after attending the annual American Crystallographic Association (ACA) meeting in Los Angeles.

Born on 16 August 1928 in Hollywood, California, Bob was a friendly, soft-spoken man, passionately interested in crystallographic methods, and liked and respected by all. He pos-