solutions of difficult nuclear explosives experimental problems." Fortner designed instrumentation for experiments on the basic physics of nuclear explosions, particularly for experiments on nuclear-driven x-ray lasers. He has worked on the Electron Beam Ion Trap, a device to study highly ionized atoms and their transitions, and he led the development of a short-pulse laser facility.

Fortner received his PhD in physics from the University of Notre Dame in 1968. He then joined the staff of Livermore, where he is associate director for nuclear test experimental science.

Linford's citation commends his "outstanding scientific contributions and personal leadership in the development of magnetic confinement for fusion power applications." In the mid-1970s Linford found the basic requirements for field-reversed configurations in compact toroids, which he showed had desirable features in potential fusion applications. He and his experimental group examined another compact toroid configuration based on minimum energy states. Linford and his colleagues systematically analyzed nontokamak fusion reactors in a study to help guide ongoing research programs.

Linford got his PhD in electrical engineering from MIT in 1973. He then became a researcher at Los Alamos, where in 1991 he was named director for nuclear systems.

Smalley was cited for his "bold and innovative research and consistent leadership in the generation and characterization of atomic clusters and, in particular, for the discovery of C_{60} (Buckminsterfullerene) and its related compounds." In 1985 Smalley and his colleagues Robert Curl of Rice and Harold Kroto of the University of Sussex, England, identified the composition and structure of C_{60}, a soccer-ball-shaped molecule, by analyzing carbon clusters synthesized from the condensation of carbon vapor. With other fullerenes such as C_{70}, the molecule is the third elemental form of carbon, after graphite and diamond. In subsequent experiments Smalley and other coworkers created fullerenes with metals trapped inside.

In 1973 Smalley received his PhD in chemistry from Princeton University. He was then a postdoc at the James Franck Institute at the University of Chicago until 1976, when he joined the chemistry department at Rice. Since 1990 he has also been a physics professor there.

VanDevender will receive the Lawrence award for his "outstanding contributions to the generation of pulsed power. He has demonstrated new concepts and designs for magnetically insulated transmission lines, dielectric and magnetic pulse-forming switches, and magnetically inhibited flashover and has played a central role in the design of new accelerators generating high-intensity, short pulsed beams." VanDevender has experimented both with triggerless multichannel water switch systems and with efficient, magnetically insulated transmission lines for use in inertial confinement fusion and in high-power, short-pulse x-ray and gamma-ray testing. Among other fusion research efforts, he directed the development of a lithium ion source for the second Particle Beam Fusion Accelerator.

VanDevender earned his PhD in physics in 1974 from Imperial College of Science and Technology in London. He then became a staff member at Sandia, where he has been director of pulsed power sciences since 1984.

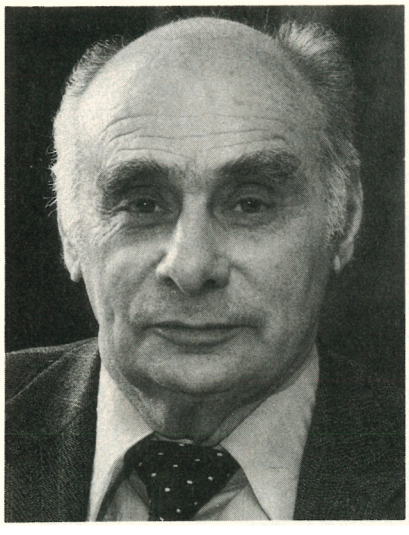
OBITUARIES

Georgy Nikolayevich Flerov

Academician Georgy Nikolayevich Flerov, an outstanding Soviet physicist and a scientist of world renown, died suddenly on 19 November 1990.

Flerov started his scientific career in 1938 at the Leningrad Institute of Physics and Technology and belonged to the famous Soviet scientific school of Academician Abram F. Ioffe. Flerov did basic research in a number of fundamental and applied areas of nuclear physics. He discovered the spontaneous fission of uranium in 1940.

Georgy Nikolayevich Flerov



From 1941 to 1952, Flerov, together with Igor V. Kurchatov, participated in investigations linked directly with strengthening the defense potential of the Soviet Union and with creating the basis for the nuclear power industry. Flerov's name is associated with the development of a new scientific direction—heavy-ion physics. From 1960 to 1988 he was the director of the Laboratory of Nuclear Reactions (now the Flerov Laboratory of Nuclear Reactions) at the Joint Institute for Nuclear Research, and he was the founder of a scientific school.

The research Flerov and his disciples carried out at the Laboratory of Nuclear Reactions over three decades resulted in the synthesis of new heavy elements, the production of a large number of new nuclei on the border of stability, and the discovery of new types of radioactivity and new mechanisms of nuclear interaction. The state register of the USSR included ten discoveries made by Flerov and his colleagues. Along with solving fundamental problems of nuclear physics, Flerov did much for the application of nuclear physics to other fields of science and technology.

Flerov devoted much effort to developing and strengthening international scientific collaboration and to the organization of science. He was a tutor for dozens of scientists who are now working fruitfully in the countries of the former Soviet Union and in other countries. For many years Flerov was the chair of the USSR Academy of Sciences scientific council on the application of nuclear physics to neighboring spheres of science. He also was a member of several other scientific councils of the Academy of Sciences and served on the editorial boards of several scientific journals.

Flerov's prestige was immense both in the Soviet Union and abroad, and his reports at major international scientific conferences always attracted general attention. He received recognition from a number of national academies and universities in other countries.

YURI T. OGANESSIAN
Joint Institute for Nuclear Research
Dubna, Russia

Robert V. Pyle

Robert V. Pyle, a retired senior staff scientist at Lawrence Berkeley Laboratory and professor in residence at the University of California, Berkeley, died unexpectedly on 12 September 1991, just three weeks short of his 68th birthday.

After graduating with a bachelor's degree in physics from the University

of California, Los Angeles, in 1944, Bob served in the Army Signal Corps. In 1951 he earned his PhD from Berkeley and began his professional career at what was then called the University of California Radiation Laboratory (now LBL). He helped design accelerators that could rival nuclear reactors as neutron sources. Bob worked on the electron version of what has since become known as the alternating-gradient cyclotron.

Upon the conclusion of this accelerator development program in 1956, Bob joined Project Sherwood, the US Atomic Energy Commission's program on controlled thermonuclear fusion. He carefully verified that the neutrons generated in high-current discharges in deuterium gas could not be taken as evidence for high-temperature thermonuclear conditions, but rather resulted from directional bombardment, indicating pinch instabilities, exactly as Soviet scientists reporting on similar work had claimed. This finding was one of those that led to the 1958 worldwide declassification of magnetic fusion energy research.

In 1971 the fusion group at LBL began developing a new system for using intense, energetic neutral deuterium beams to heat a plasma. This project, originally oriented toward the magnetic-mirror experiments at Lawrence Livermore National Laboratory, required the invention of large ion sources coupled with the design, construction and testing of high-performance electrostatic accelerators and of charge-transfer neutralizer channels. Bob was a natural choice as chief scientist for the last two tasks, and he proved to be a talented project manager as well.

Many other fusion experiments came to use this heating technique. In particular, LBL designed, built and tested the prototype multimegawatt injector for the Tokamak Fusion Test Reactor project at the Princeton Plasma Physics Laboratory. Bob and his team led this effort, which culminated with the "common long-pulse source" adopted by all major magnetic fusion energy projects in the US.

Bob was also a faculty member in the nuclear engineering department at Berkeley. He started as a lecturer in the 1960s and was appointed professor in residence in 1981. He collaborated with Lawrence Ruby, another member of the department, in the measurement of nuclear fusion cross sections of the light elements. Bob's joint Berkeley–LBL status allowed him to sponsor and participate in studies of several problems peripheral to the development of large

neutral-beam injectors.

In his roles as investigator, program manager, graduate research supervisor and friend, Bob impressed everyone with his understanding, patience and stimulating intellect. He is warmly remembered by his students and colleagues.

KLAUS BERKNER
WULF KUNKEL
Lawrence Berkeley Laboratory
Berkeley, California
LAWRENCE RUBY
Reed College
Portland, Oregon

Robert Hugh Cole

Robert Hugh Cole, professor emeritus of chemistry at Brown University, died on 17 November 1990 at the age of 76. He was known for his seminal contributions to the chemical physics of dielectrics.

While an undergraduate at Oberlin College, Bob wrote his first research paper with his older brother, Kenneth, an established physiologist. Their collaboration continued for ten years and yielded publications on what is now called the Cole–Cole plot. This method of representing dielectric data has been used since its development in 1941 to yield analytical forms for the frequency dependence of the dielectric permittivity.

Following his graduation from Oberlin in 1935, Bob went to Harvard University as the only experimenter (as far as we know) to work with John van Vleck. After getting his PhD in 1940, Bob was appointed an instructor in physics at Harvard, but he left the following year for Woods Hole Oceanographic Institution as a research supervisor in the Underwater Explosives Research Laboratory. He later became a trustee of Woods Hole. His first book, *Underwater Explosions*, published in 1948, was based on his research there.

Because of Bob's expertise in dielectric phenomena, the chemistry department of Brown University recruited him in 1947 as an associate professor, even though Bob's formal training in chemistry was limited to just one course. He was made chair in 1949 and was promoted to full professor two years later.

In 1960 Bob was named the Jesse H. and Louise D. Sharpe Metcalf Professor of Chemistry, the position he held until he retired in 1985. He also served as chair of several Gordon Research Conferences devoted to dielectric phenomena and the physics and chemistry of liquids, and he organized a symposium in 1963 in honor of Peter Debye.

Paramount in Bob's research on the gas phase were the precise measurements of permittivity that revealed the negative dielectric virial coefficient of helium in addition to producing some of the most reliable multipole moments of both polar and nonpolar molecules. His measurements on the solid hydrogen halides elucidated the differing molecular roations in their various solid phases. A notable example of his work on liquids is the experimental confirmation of the Hubbard–Onsager kinetic depolarization theory with the dielectric measurements of sulfuric acid.

A few of Bob's contributions to precision measuring techniques include the transformer ratio arm admittance bridge, the low-frequency amplifier bridge and a cyclic expansion method for the measurement of both the dielectric and *PVT* second virial coefficients. For the last 15 years he was one of the leaders in the development of time-domain spectroscopy theory and measurements. His contributions to the theory of dielectrics are evidenced by his papers on linear dielectric theory, correlation function theory and the Kerr-effect relaxation in axially symmetric polar molecules.

Bob always wanted to learn more, and he believed in learning through research. He held dual citizenship in his field as an experimenter and a theorist, and he succeeded in being at its frontier until his death. We shall remember him and miss him as a warm friend and colleague and a superb scientist.

JOHN BERBERIAN
St. Joseph University
Philadelphia, Pennsylvania
PEDER ESTRUP
Brown University
Providence, Rhode Island

Arnold M. Karo

Arnold M. Karo died on 16 June 1991 at age 63, after a yearlong battle with leukemia. He was a theoretical chemist and solid-state physicist with the chemistry and materials science department at Lawrence Livermore National Laboratory.

Karo received bachelor of science degrees in both chemistry and physics from Stanford University in 1949 and his PhD degree in physical chemistry from MIT in 1953. Following a period of employment on the research staff of the solid-state physics division of MIT's Lincoln Laboratory, he spent two years with the US Army Chemical Corps at the Dugway Proving Ground, Utah. During that time he was also associated with the University of Utah as a lecturer in the department of chemistry. In 1955 he joined the solid-state and molecular theory group in the department of physics at MIT as a postdoctoral fellow.

In 1958 Karo joined Livermore as a theoretical chemist and solid-state physicist. While there he did pioneering work in atomic and molecular orbital theory; the solid-state physics of specific lattice dynamic models; the theoretical investigation of infrared absorption and Raman scattering properties of crystals, leading to the first detailed calculations relating structure in the observed spectra to critical features of the phonon densities of states; and the development of techniques used in quantum chemistry in calculations of the electronic structure of molecules. He also organized and headed a theoretical chemistry group.

More recently Karo worked on the vibrational relaxation of hydrogen molecules upon impact with a cold metal surface and the recombination of hydrogen molecular ions on surfaces into vibrationally excited hydrogen molecules. This work has been crucial to understanding the kinetics of hydrogen (deuterium) negative-ion generators.

In parallel with this later work Karo pioneered in the application of molecular dynamics to the study of shock-induced behavior in condensed matter, including initiation and detonation phenomena in energetic (explosive) materials.

Karo's capabilities as a scientist were matched by his human qualities. The term "gentleman" seems to come first to most colleagues' minds when asked to describe him, and he did much of his work as part of several long-term collaborations. A result of one such collaboration, with John Hardy, was the book *The Lattice Dynamics and Statics of Alkali Halide Crystals.*

All of us will miss Arnold and the insight he provided—both in scientific matters and in our relations with our fellow humans. One always anticipated with pleasure a scientific discussion with him in his office or by telephone, or a social evening in his home. It is hard to realize that this is no longer possible.

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