

Frank established enduring friendships with talented, dedicated scientists, engineers, and technicians. He engaged his friends and colleagues in new projects and continued his work right up to his death. He had a healthy disrespect for authority and followed the rule "Proceed until apprehended" with great success. Also known as NASA's "chef scientist," he loved to entertain and cook for a houseful of colleagues and friends. The last such occasion was just a week before he died.

Tycho von Rosenvinge
Goddard Space Flight Center

Greenbelt, Maryland

Michael Coplan
University of Maryland
College Park

Robert Coleman Richardson

Robert Coleman Richardson, the Floyd R. Newman Professor of Physics and senior vice provost for research emeritus at Cornell University, died on 19 February 2013 in Ithaca, New York, following a heart attack.

A scientist with remarkable talents in the laboratory and on the national and world stages, Bob approached problems

with vigor and enthusiasm. His work ethic, broad interests, and depth of understanding led to an exemplary career. He received numerous honors and awards, including the 1996 Nobel Prize in Physics for the discovery of superfluid helium-3 in 1972, along with Douglas Osheroff, then a graduate student, and one of us (Lee), a fellow professor at Cornell. The trio was also awarded the Institute of Physics's 1976 Sir Francis Simon Memorial Prize and the American Physical Society's 1981 Oliver Buckley Prize in Condensed Matter Physics.

Bob was born on 26 June 1937 and grew up in Arlington, Virginia. He attended the Virginia Polytechnic Institute, where he earned bachelor's and master's degrees in physics before serving for six months in the US Army Ordnance Corps. Following military service, he enrolled in the graduate physics program at Duke University, where he performed pulsed nuclear magnetic resonance (NMR) experiments on solid ^3He for his 1965 PhD in physics; Horst Meyer was his adviser. Bob's thesis work involved landmark studies on exchange effects between ^3He nuclear spins. His research provided an understanding of that system and gave hope that a possible nuclear magnetic phase transition would occur at lower temperatures.



Robert Coleman Richardson

Following his time at Duke, Bob joined the low-temperature physics group at Cornell as a research associate and in 1968 became an assistant professor. When he arrived at Cornell, a program to study liquid and solid ^3He via Pomeranchuk cooling was just getting under way. The method could reach temperatures below 1 mK by adiabatically compressing liquid ^3He into the solid phase.

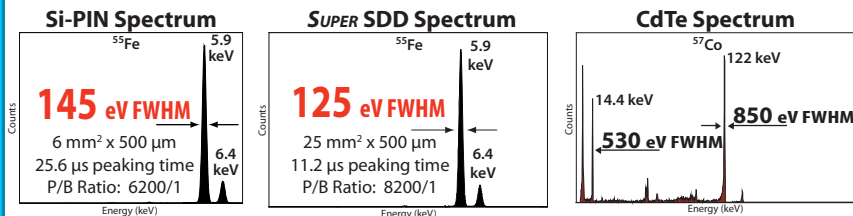
Bob was a skilled experimenter with keen analytical abilities and enormous energy. He was often around the laboratory in the evenings, providing help and advice to graduate students, and thus served as an excellent role model. He made great contributions in early experiments that used Pomeranchuk cooling, including continuous-wave NMR magnetic susceptibility studies of solid ^3He and pulsed NMR studies that provided the first experimental demonstration of the spin-diffusion behavior, known as the Leggett-Rice effect in liquid ^3He . Then one night in late November 1971, Osheroff observed small anomalies along the ^3He melting curve. From then on, it was difficult for anyone to stay away from the laboratory.

At the time of those observations, the combination of extremely pessimistic predictions by various theorists and the failure of John Wheatley's group to observe superfluid ^3He using adiabatic demagnetization had given Bob and his fellow researchers reason to despair of finding it at any attainable temperature. That influenced the team members, who had to consider whether the observed effects were associated with the liquid or with the solid present in the

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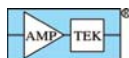
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Pomeranchuk cell. After animated discussions back and forth, they finally decided to attribute the observed effects to solid ^3He . The NMR experiments then in the pipeline would, hopefully, settle the issue. By late spring 1972, Bob and colleagues' NMR measurements clearly indicated that the melting-curve anomalies were associated with two new phases of liquid ^3He .

The strong close-range repulsion between the ^3He atoms in the liquid precluded the possibility of *s*-wave Bardeen-Cooper-Schrieffer pairing. A more favorable choice was *p*-wave pairing with an orbital angular momentum corresponding to rotation of the members of a Cooper pair about one another and, by the Pauli principle, a triplet pairing that leads to a net nuclear spin of one. States suggested by Philip Anderson and Pierre Morel and by Roger Balian and Richard Werthamer were possible candidates. While the NMR experiments were in progress, Bob visited the University of Sussex in the UK and met with Anthony Leggett, who, via sum rules, soon explained the NMR results in terms of superfluid pairing and then developed a complete theory of spin dynamics consistent with the Anderson-Morel and Balian-Werthamer states.

Soon after the discovery of superfluid ^3He , Bob and his graduate student William Halperin, along with Charles Archie, Finn Rasmussen, and one of us (Buhrman), were able to observe the long-anticipated nuclear magnetic phase transition in solid ^3He . All of those discoveries set off a worldwide effort to characterize the newly discovered phases. Bob, his students, and the rest of the Cornell low-temperature and theory groups were strongly involved in the effort. Later on, Bob and his students performed a series of beautiful NMR experiments demonstrating cross relaxation between nuclear moments in liquid ^3He and nuclear moments of fluorine contained in tiny fluorocarbon beads.

In the following years, Bob pioneered the design and construction of a microkelvin laboratory, completed in 1986, that permitted the routine attainment of even lower temperatures. Among his later experiments were studies of "hot" electrons involved in energy transport at millikelvin temperatures and of NMR and nuclear electric quadrupole resonance for absolute thermometry.

As a teacher, Bob made strong contributions to the classroom. He is especially remembered for his public lectures, which included exciting demonstrations of high-temperature superconductivity

and other cryogenic phenomena. With his wife, Betty, and Alan Giambattista, both senior lecturers in physics at Cornell, Bob coauthored a popular introductory physics textbook, *College Physics* (McGraw-Hill, 2004).

In addition to his many contributions to research and teaching at Cornell, Bob served as director of the Laboratory of Atomic and Solid State Physics from 1990 to 1996, vice provost for research from 1998 to 2004, and senior vice provost for research from 2004 to 2007. He was senior science adviser to Cornell's president and provost in 2007 and became senior vice provost for research emeritus in 2008.

Bob was also active on the national scene. For example, he served on the National Academies committee tasked with studying US support for science and chaired by Norman Augustine. The committee's 2005 report, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, had an enormous effect nationally in publicizing the importance of generous support for scientific research and of greater investment in education and graduate training in science, technology, engineering, and mathematics.

Bob has left a legacy of accomplishment in research, education, and science policy. With his wonderful enthusiasm and optimism, he was a true "happy warrior" of science and an inspiration to those fortunate enough to have passed within range of his engaging and welcoming personality. He will be greatly missed by the world scientific community and by his Cornell colleagues and students.

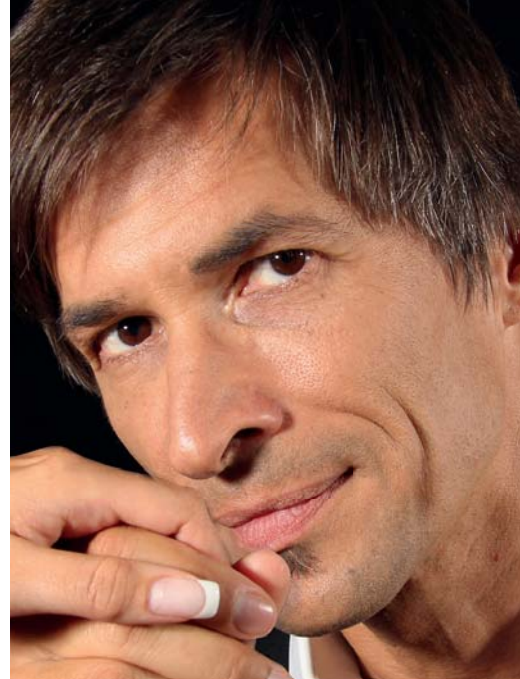
David Lee
Robert Buhrman
Cornell University
Ithaca, New York ■

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