He returned to Harvard in 1938 to work on cosmic rays with Curry Street, and he received his PhD in 1943.

During World War II he worked on radar projects, at first at Harvard on countermeasures and then, from 1944 to 1945, in the southwest Pacific as a technical adviser for radar. At the end of the war he returned to cosmic-ray physics as a research associate at MIT with Bruno Rossi. In September 1946 he went to Washington University in Saint Louis to start his own group in cosmic-ray physics. He became a full professor there in 1952.

Sard's group at Washington University used a variety of techniques, including cloud chambers and fast coincidence circuits with neutron detectors. In 1951–52 Sard proposed using a neutron coincidence trigger for the cloud chamber experiments and collaborated with Patrick Blackett's group at Manchester, the group that first observed "strange" particles.

In 1961 he came to the University of Illinois to join the groups studying particles produced in high-energy accelerators. His colleagues included Giulio Ascoli, Richard Brown, Robert Klanner, Ulrich Kruse and David Mortara.

From 1971 to 1972 he joined a group at CERN in Switzerland to collaborate in experiments at what was then the world's highest-energy accelerator, at Serpukhov, near Moscow.

On returning to Illinois he continued to analyze data from Serpukhov in productive collaborations with Georgian Soviet scientists. In the 1980s he became part of an Illinois group that joined the large Collider Detector Facility collaboration at the Fermi National Accelerator Laboratory, in Batavia, Illinois, which in April 1994 announced evidence for the top quark (PHYSICS TODAY, June 1994, page 17). Although he was increasingly physically debilitated by neuropathy during the last few years of his life, Sard's mind remained excellent, and he took a great deal of pleasure from having been a member of the CDF collaboration.

Sard was a scholar with an excellent memory. Combined with his broad experimental experiences, this memory gave him a profound knowledge of the history of physics, and for about four years he was an associate editor of the *History of Physics Newsletter*.

Bob was a thoroughly old-world gentleman in many respects. His students had many occasions to appreciate his patience and his caring attention. He cared deeply about science, music and political rationality and was never quite reconciled to how the world was run on either side of the Iron Curtain. Toward the end of his life he told his son David that he was proud of having been "a soldier of physics." His friends and colleagues will miss his thoughtful, gentle honesty.

▶MICHAEL WEISSMAN
▶ALBERT WATTENBERG
University of Illinois, Urbana–Champaign

Joseph Callaway

Joseph Callaway, Boyd Professor of Physics at Louisiana State University, in Baton Rouge, died on 17 June 1994, two weeks before his 63rd birthday. He was an internationally recognized physicist in both condensed matter and atomic scattering theory.

Joe was born in New Jersey. He graduated with a degree in physics from the College of William and Mary in 1951 and received a PhD in physics from Princeton under Eugene Wigner in 1956. As a graduate student, in addition to writing several papers on general relativity, he calculated the electronic structures of germanium, potassium and iron. The electronic structure of materials became his lifelong work.

After Princeton, Joe went to the University of Miami in Florida. During a summer at Westinghouse Research Laboratory in 1959, he developed the theory of phonon scattering in insulators that remains the standard theory of thermal conduction in the insulating state of solids.

Joe's second academic appointment, in 1960, was at the University of California, Riverside, where he was one of the prime architects of the physics department's graduate program. His first book, *Electronic Energy Bands in Solids* (Academic Press), was published in 1964. During his years at Riverside Joe became seriously interested in the theory of magnetism, in both metals and insulators. One of Joe's great attributes was that he did calculations that could easily be compared with experimental results.

In 1967 Joe moved to Louisiana State, and in 1970 he became the chair of the department of physics and astronomy. Four years later he was made Boyd Professor, a research chair. At LSU he put together a small army of students and postdocs that has been prolific in developing methods for determining the electronic structures of many materials, formulating the theory of itinerate magnetism in metals, studying electron–hydrogen scattering and performing calculations of the properties of high-temperature superconductors from their electronic structures.

Joe wrote *The Quantum Theory of the Solid State* (Academic Press, 1974) and its several revisions. It is both a standard reference and student text.

In all of Joe's choices for places to live and work, there was one underlying condition: They had to be near the ocean. Joe was a sailor, and he enjoyed sailing with his family on weekends and on longer outings.

Joe was always actively engaged and (loudly) heard in committees, both at LSU and nationally. His voice, although now stilled, will be remembered by the physics community for years to come.

▶ROY G. GOODRICH
▶A. RAVI P. RAU
Louisiana State University
Baton Rouge

Charles Louis Critchfield

Charles Louis Critchfield died on 12 February 1994 at his home in Los Alamos, New Mexico, after leading an active life in his final six years despite a battle with cancer.

Critchfield was among the first physicists to come to Los Alamos in 1943 to work on the atomic bomb.

Born in 1910, "Critch" received his MA and his PhD in 1939, both from George Washington University, in Washington, DC. Critchfield's graduate education at George Washington was unique. The first—for a time, the only—graduate student of Edward Teller and George Gamow, he learned much in the homes of these two men, who often played host to such luminaries as Hans Bethe, Niels Bohr and Enrico Fermi. Critchfield's thesis, on field theory and strong coupling, was one of the first to deal with elementary particles. Teller and Critchfield later published a joint paper on strong coupling.

After graduation Critchfield accepted an offer from Victor Weisskopf to teach optics at the University of Rochester. A year later Critchfield became a National Research Council Fellow at Princeton, where he followed up on his work on strong coupling, working with Eugene Wigner.

Critchfield then taught for a year at Harvard before returning to Washington, DC, and a job in the Department of Terrestrial Magnetism of the Carnegie Institute. There he concentrated on the use of *sabots*, a technique for firing small-caliber projectiles from large-caliber bores. His work, published in several National