

from Cornell to serve as acting head of the accelerator section at Fermilab. Although the accelerator had operated at a near-design energy, frequent component failure and intermittent operation made it a difficult time for both the lab and the particle physics community. Mac threw himself into the fray with his usual enthusiasm. Thanks to his leadership, by the end of the year the accelerator was working as it should. According to Wilson, who directed Fermilab at the time, “this bravura performance demonstrated Mac’s skill for leadership as well as his celebrated sixth sense for finding sources of trouble and fixing them.”

In November 1974, Mac sensed that the discovery of the J/ψ , the first charmonium meson, signaled an abrupt change in the frontier of particle physics research. With a bold stroke, he convinced his colleagues to abandon their program of electron synchrotrons of ever-increasing energy and instead upgrade the existing 10-GeV synchrotron into an 8-GeV electron-positron collider using the synchrotron as an injector and adding a storage ring in the same tunnel. That radical and risky proposal, if it worked, would significantly reduce the cost and construction time and make its funding possible. Mac convinced NSF to support the project and threw himself heart and soul into the job of making it work. The gamble succeeded, and the rich treasure trove of 25 years of b-quark physics that it uncovered was the ultimate reward for the daring, innovative, and low-cost style of physics practiced by Mac, Wilson, and their Cornell colleagues.

After his retirement in 1985, Mac remained active at CLNS and played important roles in both the Cornell Electron Storage Ring and the CLEO collaboration. In addition, he served on many advisory and visiting committees for NSF and the US Department of Energy. He was a trustee of the Associated Universities (1963–75) and Universities Research Association (1971–77); a member of the DOE’s High Energy Advisory Panel (1975–78); and a member of the Superconducting Supercollider Board of Overseers (1984–91), which he chaired for part of this period. He was elected to the National Academy of Sciences in 1981. His modesty, integrity, and sound judgment, and his passion for life, physics, and making things work were widely recognized and admired by the scientific community.

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Gordon James Stanley

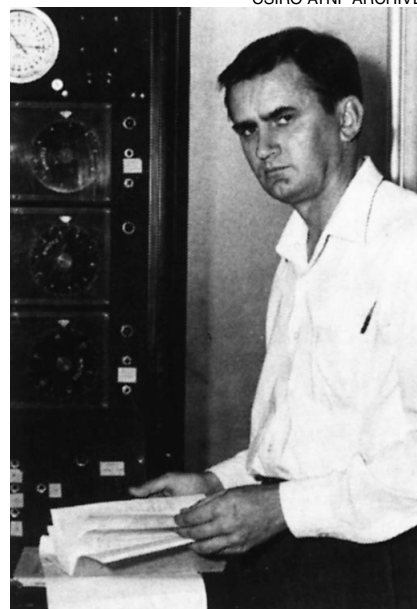
Gordon James Stanley, one of the pioneers of radio astronomy, died on 17 December 2001 in Monterey, California, of complications from progressive supranuclear palsy.

Stanley was born in Cambridge, New Zealand, on 1 July 1921, and, at age six, moved with his parents to Australia. He completed his engineering studies at Sydney Technical College, now part of the University of New South Wales, and received the degree of Associate of the Sydney Technical College in 1945.

In 1945, he joined the receiver group of the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO) Radio-physics Laboratory, where he developed some of the earliest equipment used to study the radio emission from the Sun and the Galaxy. He teamed up with John Bolton and Bruce Slee in 1947 for a series of novel experiments to make the first accurate measurements of radio source spectra. The team convincingly demonstrated the nonthermal nature of cosmic radio noise, which later was understood to be synchrotron radiation from energetic electrons spiraling in weak cosmic magnetic fields. But as the celestial coordinates of the radio sources were not well determined, there were no known optical counterparts to the increasing number of cosmic radio sources being detected.

During World War II, shipboard radar operators sometimes noticed that the return signals from airplanes flying close to the horizon showed an interference pattern. The reflected signal from the surface of the ocean combined with the direct signal to give alternately constructive and destructive interference as the angle to the aircraft changed. Stanley, together with Bolton and Slee, exploited that effect using sea interferometers on cliffs along the coasts of Australia and New Zealand to measure the size and accurate position of four strong radio sources. This work led to their identification in 1949 of one of those sources with the Crab nebula. Two of the other sources were identified with galaxies located beyond the Milky Way. It was difficult for Bolton, Stanley, and Slee to accept the enormous radio luminosity implied by their results, and it would be several years before the astronomical community would acknowledge the extragalactic nature of radio stars.

Nearly all of the early investigations in radio astronomy were pursued by scientists who, like Stanley,



Gordon James Stanley

had a strong background in radio and electronics rather than in astronomy. But the sea interferometer observations attracted the attention of astronomers—such as Jan Oort in the Netherlands—and astrophysicists, and marked the beginning of modern radio astronomy.

Stanley left Australia in 1955 to join Bolton, who had been asked to start a radio astronomy program at Caltech. Following what he later described as a “frustrating search” throughout southern California for a site free of manmade radio interference, Stanley found the ideal location for a radio telescope in the Owens Valley. In 1955, he developed the first radio interferometer operating above a few hundred megahertz and earned a reputation as someone who could design, build, and fix just about anything that involved electronics. His low-noise receivers, which were affectionately known as Stanley Steamers, made the Caltech interferometer the most sensitive radio telescope in existence at the time. He taught me how to repair a noisy receiver by tapping the 1N21 diode mixer with a hammer or, if no hammer was available, by throwing the diode on the floor. Most of the time, this resulted in the diode’s not working at all, but in a few cases, the original very-low-noise performance was miraculously restored.

From 1961 to 1975, Stanley directed the research at the Owens Valley Radio Observatory. The precise measurements of radio source positions with the OVRO interferometer led to the identification of new and increasingly distant radio galaxies and the discov-

ery of quasars by Rudolph Minkowski, Maarten Schmidt, and others. Most of the research was done by students and postdoctoral staff, who would later become distinguished members of the astronomical community.

Stanley did not enjoy the administrative responsibilities associated with being the director of a major government-funded university facility. Facing the ever-increasing levels of bureaucratic interference from the Caltech administration and NSF, he retired from Caltech in 1975 to return to his true love—radio engineering. Following several years with the Honeywell Corp, he started his own microwave company, where he developed a variety of novel instruments for the US and other governments.

Stanley, whose career was long and varied, had a strong work ethic, yet he remained modest about his own achievements. Throughout his tenure as director of the OVRO, he did not put his name on any publication of work done with the students or staff of the observatory.

In addition to science and electronics, Stanley enjoyed literature, poetry, art, and politics. He loved music, could quote at length from Shakespeare, and balanced all those interests with a lifelong love of sports.

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Gilbert Shapiro

Gilbert Shapiro, a faculty member in the physics department of the University of California, Berkeley, for almost 40 years, died at his home in Moraga, California, on 5 December 2001. He first came to Berkeley in 1961 as a staff member at the Lawrence Radiation Laboratory (now Lawrence Berkeley National Laboratory) to engage in research in elementary particle physics. His interests and style fit well into the heady, exciting time for particle physics as old concepts were being overtaken by surprising new experimental results. His productive career came to an end while he was still vigorously active in teaching and research, when he succumbed to the cancer that had been first diagnosed two years earlier.

Shapiro was born 19 March 1934 in Philadelphia, Pennsylvania. Following his introduction to science at the Franklin Institute, he began its serious study at Central High School, a long-established Philadelphia public school with extraordinarily de-



Gilbert Shapiro

manding entrance criteria. In 1955, having received a BA from the University of Pennsylvania, he started graduate study in physics at Columbia University.

At that time, Columbia was a leading institute for high-energy physics, and its Nevis Cyclotron Laboratory facility in the Hudson River valley north of New York City was the site of a number of major discoveries. Shapiro was naturally attracted there to pursue research in high-energy physics at Columbia. His PhD thesis advisers were Allan Sachs and Richard Garwin. Results based on his thesis, "Accurate Determination of the μ^+ Magnetic Moment," were published in volume 2 of *Physical Review Letters* in 1959. Most important about that work was its determination of the vacuum dynamic contribution to the magnetic moment of the μ^+ particle, which had been predicted by quantum electrodynamics. He and Leon Lederman refined and expanded measurements of muon mass and magnetic moment in 1960 and 1961.

Upon his arrival in Berkeley, he joined Owen Chamberlain and Carson Jeffries to build the first polarized target for high-energy physics. Its initial use was in a pion-proton scattering experiment in 1963 at the Rad Lab's 184-inch synchrocyclotron. The target was an application of the basic ideas of dynamic nuclear polarization that had been developed by Jeffries and independently by Anatole Abragam. During the following 15 years, Shapiro was a senior member of a research group that carried out numerous experiments with polarized targets at the synchrocyclotron and the Bevatron at the Rad Lab. Later, he continued that work at Fermi Na-

tional Accelerator Laboratory and at SLAC. In 1965, he and his colleagues at Berkeley used the polarized-target technique to determine the intrinsic parity of strange particles. A few years later at SLAC, he used it to search for evidence of time reversal invariance in the scattering of electrons. The polarized target work pioneered by Chamberlain and Shapiro at Berkeley spawned similar developments at nearly all the major high-energy physics facilities in the world, and a whole industry of polarized-target research soon evolved at accelerator facilities in England, France, Japan, the Soviet Union, and Switzerland.

In the 1980s, Shapiro worked with the Time Projection Chamber group that produced important results on high-energy electron-positron and photon-photon interactions at the SLAC storage ring SPEAR. The following decade, he joined the SLAC Large Detector group to determine the properties of the Z boson at the SLAC Linear Collider. This experiment also produced an accurate determination of the weak mixing angle, and thereby a sensitive test of the standard model. In another experiment at SLAC, he and collaborators studied deep-inelastic scattering of polarized electrons to obtain information on the spin structure of the neutron. His last research effort, begun in the late 1990s, was the planning of an imaginative use of cosmic-ray neutrinos to map Earth's density through its mantle and core, in effect a computerized tomography scan of our planet.

Shapiro devoted most of his formal teaching efforts to sharing with a wide lay public his passion for physics and developing in them an appreciation for basic scientific fact and methodology. His characterization of the descriptive Physics 10 courses that he taught as "Physics for Football Players" indicates the kind of audience he wanted to reach. He penned *Physics without Math* (Prentice Hall, 1979) as a descriptive text for this kind of course. He followed that work with *A Skeleton in the Darkroom: Stories of Serendipity in Science* (Harper & Row, 1986), an entertaining account of serendipitous observations. He used that book as the basis for a freshman seminar he taught in the 1990s. Shapiro had no patience for charlatans and others who misinterpreted science, and he delighted in debunking false and misleading claims.

Shapiro savored simple California pleasures, most often with his family, to whom he was devoted. He enjoyed strolling through the redwoods at the Muir Woods National Monument near