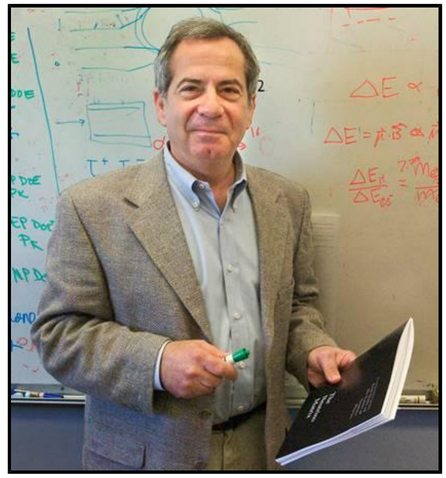

IN MEMORIAM

Stuart Jay Freedman
Professor of Physics
UC Berkeley
1944 – 2012

Stuart Jay Freedman, a professor in the Department of Physics at the University of California, Berkeley, a nuclear physicist with Lawrence Berkeley National Laboratory, and a world- renowned investigator of fundamental physical laws, died suddenly on November 9, 2012, while attending a scientific conference in Santa Fe, NM. He was 68.

“Stuart was a truly remarkable scientist, with extraordinarily diverse interests, and still very much at the height of his powers,” said James Symons, Director of Berkeley Lab’s Nuclear Science Division. “It is somehow fitting that he spent his last few days with close friends, actively engaged in discussing new ways to make fundamental measurements requiring deep insight and ingenuity. We have lost a great physicist, but I can’t imagine that he would have wanted to leave us in any other way.”

Freedman’s friend and long- time associate, Berkeley Lab physicist Robert Cahn (PhD ’72), recalls that “Stuart started as a particle theorist but became an extraordinarily versatile and creative experimentalist, with a reputation for getting the right answer, often when others didn’t.” Among his contributions was the establishment of the parameters of the weak interaction in the coupling of weak currents to the neutron. Because these measurements are essential to understanding nuclear fusion, according to Cahn “they make it possible for us to determine the temperature at the center of the sun.”

These qualities were already evident when Freedman, while still a graduate student at UC Berkeley in 1972, used the radioactive decay of calcium atoms to rule out “local hidden variable” theories. This was the first persuasive experimental demonstration that there is no escaping the non- deterministic nature of quantum mechanics. He went on to exclude a number of other possible excursions from standard physics, including the existence of naked quarks, faster- than- light particles, and very light Higgs bosons. He also shot down surprising but widely heralded results that seemed to point to very heavy neutrinos, supposedly having a mass of 17 kilo electron volts (17 keV) – about 100,000 times heavier than current expectations.

“He loved people with crazy ideas, if only for a good argument, and he was a source of brilliant ideas himself,” says Berkeley Lab’s Brian Fujikawa, who worked closely with Freedman since 1984 and helped him perform the decisive 17- keV neutrino experiment. “Stuart used a spectrometer that eliminated likely sources of error, and on top of that he created a small ‘fake’ signal by mixing carbon-14 into the sulfur-35 source whose decays we were measuring. Since we could detect that fake in the data, if there had been a real signal in the beta spectrum at 17 keV we would have seen it.”

Some searches were less conclusive, however. Leading theorist Roberto Peccei of the University of California at Los Angeles, whose work with Helen Quinn led to the proposal of particles called axions, recalls writing an early paper with Freedman in 1978 when both were at Stanford that was called, appropriately, "Do axions exist?" We are, incidentally, still asking the same question today." Peccei confirms that Freedman "was not afraid to go against orthodoxy. In fact, he relished this role! The world has lost a wonderful physicist, but his impact on our field will remain."

"Discussing physics with Stuart was always fun and exciting; physics has lost an exceptional individual who has left an indelible imprint on the subject," adds Eric Adelberger of the University of Washington, a friend of Freedman's with a similar predilection for challenging received ideas. "Stuart was such an intense and vivid personality, who had a deep and broad love of physics that reminds me a bit of Richard Feynman."

After teaching at Stanford, Freedman joined Argonne National Laboratory in 1982 and later became a professor in the University of Chicago's Fermi Institute where, according to University of Chicago cosmologist Michael Turner, "he provided a crucial link between Argonne and the university." During a time when Turner and others were establishing the connections between cosmology and particle physics, nuclear physics, and astrophysics, "Stuart provided the key connection to weak- interaction physics with his important experiments on the properties of neutrons and neutrinos. Turner added that "Stuart was not only a brilliant experimentalist but a wise person who gave sage advice gently, often using his wonderfully wry sense of humor. We will sorely miss Stuart's scientific contributions, his friendship, and wise counsel."

In 1991 Freedman and his wife Joyce, who had led the sponsored research office at the University of Chicago, moved to Berkeley, joining Berkeley Lab and the Department of Physics faculty while maintaining his affiliation with Argonne and Chicago. His fame for neutrino work grew, notably following the 2003 confirmation from the (Kamioka Liquid Scintillator Anti- Neutrino Detector) experiment in Japan that different neutrinos have different tiny masses and oscillate from one "flavor" to another. KamLAND benefited from detector technology and signal processing contributed by U.S. participation, inaugurated and led by Freedman.

"The KamLAND oscillation result was one of Stuart's proudest accomplishments," says Jason Detwiler, now an assistant professor at the University of Washington who met Freedman during the construction of KamLAND and subsequently worked with him at Berkeley Lab for many years. While the SNO (Solar Neutrino Laboratory) experiment in Canada had established that neutrinos change flavor while traveling from the sun to Earth, "KamLAND was designed to capture antineutrinos produced by nuclear reactors, and it was Stuart's kind of experiment – a laboratory- style experiment in which both the source and the detector were controlled. The upshot was that KamLAND produced the first clean signature of actual oscillations." Detwiler characterizes Freedman's experimental style as "like a Grand Master in chess, always thinking many steps ahead. He always had the clearest view of the science and the experiment's essential rationale."

Spencer Klein, Deputy Director of Berkeley Lab's Nuclear Science Division, says, "Stuart was a driving force in our division, in the physics department on campus, and in the international neutrino community." Besides neutrino oscillations, Freedman's contributions to neutrino science include KamLAND's detection of "geoneutrinos" originating from radioactive decays inside the Earth, and his role as U.S. spokesperson and U.S. construction project manager of the CUORE (Cryogenic Underground Observatory for Rare Events) experiment at the Gran Sasso underground laboratory in Italy, a search for the as- yet- undetected process of neutrinoless double- beta decay, which if found would indicate that neutrinos are their own antiparticles.

Freedman was known as a great mentor and advocate for his students, conveying the big picture of physics research and discovery. Lindley Winslow (BA '01; PhD '07), now an Assistant Professor of Physics at UCLA, says of Freedman, "I had the benefit of his mentoring as both an undergraduate and a graduate student. First, his love of the subject was infectious, and while he may have mentioned the 'Freedman Inequality' once or twice, he did not necessarily stick to quantum mechanics all of the time. As a graduate mentor, he was fairly hands- off. He gave us a lot of freedom to pursue our own projects within the framework of our thesis experiment. This included the freedom to fail at some level, which I appreciate more now than I did at the time. He believed in surrounding us with good people to help us pursue these projects."

Freedman contributed widely to the nuclear science community, including co- chairing the National Academy of Science's decadal survey, Nuclear Physics: Exploring the Heart of Matter (2012) co- chairing the National Research Council report, Scientific Opportunities with a Rare- Isotope Facility in the United States (2007); and co- chairing the American Physical Society's magisterial neutrino study, The Neutrino Matrix (2004).

At the time of his death, he was the leader of the Weak Interaction Group based in the Nuclear Science Division, a wide- ranging program bringing together international collaborations like KamLAND and CUORE and smaller- scale experiments like the optical trapping of short- lived radioactive isotopes at the 88-Inch Cyclotron, to examine the weak interaction between electrons and neutrinos and the quarks that constitute protons and neutrons.

“Somehow, Stuart just kept growing as a scientist,” says Gerald Garvey of Los Alamos, an experimental nuclear physicist and expert in science policy whose collaborations with Freedman began over 30 years ago. “Most of us start slowing down after 50, but Stuart continued to get stronger and stronger.”

Freedman was born in Los Angeles on January 13, 1944 and received his education at UC Berkeley, graduating with a B.S. in Engineering Physics in 1965, a M.S. in Physics in 1967, and a Ph.D. in Physics in 1972. His teaching career took him from Princeton to Stanford, and then in 1982 to Argonne and the University of Chicago. In 1991 he assumed joint appointments as Faculty Senior Scientist in Berkeley Lab’s Nuclear Science Division and Professor in UC Berkeley’s Department of Physics.

In 1999 Freedman was named to the Luis W. Alvarez Memorial Chair in Experimental Physics at UC Berkeley. His numerous awards and honors include election to the National Academy of Science in 2001, election to the American Academy of Arts and Sciences and named a Fellow of the American Association for the Advancement of Science (both in 2006), and the 2007 Tom W. Bonner Prize for Nuclear Physics from the American Physical Society.

Freedman, a resident of Berkeley, is survived by his wife, Joyce; his son, Paul, and daughter- in- law, Emily; his sister, Ina Jo Scheid; nephew Jason Sturman; and two grandchildren.

Robert
Cahn
2013
Yury Kolomensky
Paul Preuss
Lindley Winslow