

OBITUARIES

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Lincoln Wolfenstein

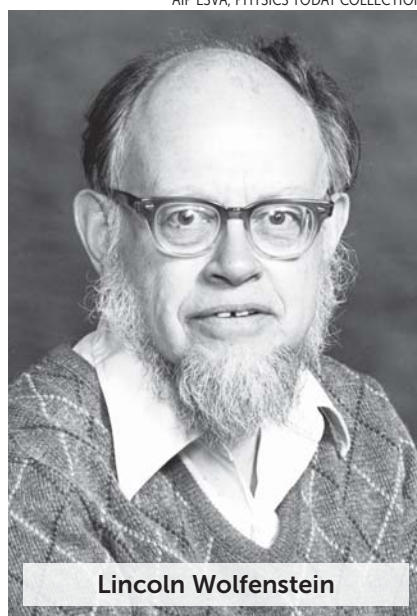
Theoretical particle physicist Lincoln Wolfenstein died of cancer on 27 March 2015 in Oakland, California. Internationally recognized for his research on neutrino physics, he was also well known as a political activist who advocated for the elimination of nuclear weapons and the use of diplomacy rather than war.

Born in Cleveland Heights, Ohio, on 10 February 1923, Wolfenstein went to the University of Chicago, where he earned his BS in 1943, his MS in 1944, and his PhD in 1949. He defended his thesis, titled "Theory of proposed reactions involving polarized protons," before a committee that included Edward Teller—his adviser—and Enrico Fermi. Their efforts in creating the atomic bomb as part of the Manhattan Project may have partially influenced Wolfenstein's belief and work on nuclear disarmament.

Wolfenstein joined what is now Carnegie Mellon University (CMU) as a faculty member in 1948, when the physics department was part of the Carnegie Institute of Technology. His PhD students included well-known theorists Barry Holstein and Lalit Sehgal.

Wolfenstein is best known for his contributions to our understanding of neutrinos. In a 1978 *Physical Review D* article titled "Neutrino oscillations in matter," he suggested that such oscillations would be different from oscillations in a vacuum. Based on that and his other work on weak interactions, he was awarded the 1992 American Physical Society's J. J. Sakurai Prize for Theoretical Particle Physics. The neutrino-oscillation research that earned the 2015 Nobel Prize in Physics was closely related to the work Wolfenstein had described in his article more than three decades earlier.

In what is now known in particle physics as the Mikheyev-Smirnov-Wolfenstein, or MSW, effect, Stanislav Mikheyev and Alexei Smirnov applied Wolfenstein's theory to the problem of missing solar neutrinos. The theory has been used by researchers in studying oscillations of neutrinos traveling through Earth, an essential aspect of recent long-



Lincoln Wolfenstein

baseline experiments using beams of neutrinos produced by accelerators. Those experiments are especially important for testing symmetries such as CP and time-reversal violations. For their work, Wolfenstein, Mikheyev, and Smirnov were awarded the Bruno Pontecorvo Prize by Russia's Joint Institute for Nuclear Research in 2005.

A great communicator, Wolfenstein was devoted to teaching, training PhD candidates, and helping faculty members, postdoctoral fellows, and graduate students understand particle theory related to neutrinos and symmetries. He also taught courses at the CMU Osher Lifelong Learning Institute on such topics as the universe's evolution, Earth's future, and the future of nuclear weapons and power. He based the courses not only on his broad experience in particle physics and cosmology but also on his devotion to working for peace.

Because he was so steadfast in his commitment to peace, Wolfenstein became politically active and campaigned for responsible science, for human rights and social justice, and against nuclear weapons proliferation. He compellingly argued in his writing and in his teaching that nuclear weapons have no place in any country's military arsenal. He

helped found the Pittsburgh chapter of the Committee for a Sane Nuclear Policy and was a member of the Union of Concerned Scientists. His work led the Thomas Merton Center in Pittsburgh to present Wolfenstein with its 1986 New Person Award, which honors local peace and justice activists.

When he could, Wolfenstein combined his work with his love of travel. He was instrumental in the founding of the Aspen Center for Physics in Colorado in 1962. On his many visits to CERN in Geneva, he studied tests of symmetries.

Wolfenstein retired in 2000 after 52 years at CMU, but he continued going to his office and teaching classes. In 2004 he published an article in the *Annual Review of Nuclear and Particle Science* entitled "The strength of the weak interactions," in which he discussed his career as a theorist and an activist warning of the danger of nuclear weapons.

A devoted family man, Wolfenstein moved to Oakland with his wife, Wilma, in 2014 to be closer to their children and grandchildren. Because he was still motivated by physics research, he made weekly visits to Lawrence Berkeley National Laboratory until about a month before his death.

The physics community and his students and friends in many nations will long remember his contributions to particle physics and to education and his work toward a more peaceful world.

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Ernst K. Zinner

Ernst K. Zinner, a physicist, astrophysicist, and pioneering isotope cosmochemist, died on 30 July 2015 after a heroic 20-year struggle with mantle-cell lymphoma. We who knew him will remember his courage and spirit as he pursued extraordinary scientific goals while undergoing frontier cancer treatments that made him a minor celebrity in medical research.

Zinner was born on 30 January 1937 in St. Peter in der Au, a small Austrian town about 100 miles west of Vienna. He received his undergraduate degree in physics from the Technical University of

Vienna and then moved to the US in the mid 1960s to attend Washington University in St. Louis. In 1972 he became the last person to earn a PhD in high-energy particle physics from the university. Physicist Robert Walker then invited Zinner to join him as a research associate in the university's new laboratory for space physics. Zinner's achievements in physics were intimately entwined with the emergence of that new physics group. About 15 years later he was promoted to research professor in physics and in Earth and planetary sciences.

During the first phase of Zinner's career in space physics, he published significant works on heavy ions in the solar wind, on interplanetary dust particles, and on the lunar surface environment through experimental studies of lunar samples. He also began the work that would define the remainder of his career: a decade-long effort to turn a new and unreliable technique, secondary ion mass spectrometry (SIMS), into a robust tool for chemical and isotopic analysis. His numerous trips to Houston, Texas, enabled him to work on the ion microprobe at the Johnson Space Center.

Zinner took a one-year appointment in 1980 as a visiting professor at the Technical University of Vienna. His purpose was to use and study properties of its new Cameca IMS-3f ion microprobe because Walker had obtained funding for a similar instrument for Washington University. After many tests of their own new microprobe, Zinner and his Washington University team mounted an interplanetary dust particle in the ion probe and showed it to contain a deuterium-to-hydrogen ratio 2.1 times the ratio in terrestrial water. Their 1983 publication in *Nature* began the now unforgettable SIMS era of isotopic discoveries in extraterrestrial samples.

Within two years Zinner had found large excesses and deficits of the isotopes calcium-48 and titanium-50 in small (50 μm) meteoritic hibonite crystals. Those crystals pointed to the existence of presolar stardust grains carrying a fossil record of stellar nucleosynthesis. A decade earlier I had described the probable existence of such grains in interstellar matter and named them stardust. The existence of stardust was also hinted at by the presence of noble-gas isotopic anomalies in bulk meteorites. But those were not stardust itself.



Ernst K. Zinner

To search for individual stardust grains only microns in size, Zinner collaborated with chemists at the University of Chicago who in 1987 produced acid-insoluble residues of bulk meteorites. The residues were rich in silicon carbide grains, graphite grains, and nanometer-sized diamonds. Zinner's SIMS measurements revealed an astonishing range of isotopic ratios within many elements in those grains, only explainable as compositions evolved by nuclear reactions in the interiors of stars. The grains were the sought-after stardust.

Zinner and a host of collaborators quickly improved their techniques. Soon afterward they documented additional types of stardust grains and tied their isotopes to different types of stars, including evolved red giants and supernova explosions. During the two decades following their discovery, Zinner published about 70 papers on stardust and a comparable number on other new isotopic discoveries about meteoritic samples. From the beginning, Zinner worked closely with nuclear astrophysics theorists to extract the maximum information from those grains. From 1990 until his death, Zinner and I organized celebrated annual isotopic-anomaly workshops sponsored by Clemson University and Washington University.

Consider how stunning Zinner's documentation of stardust is. Those tiny stones are literally solid chunks of stars that were born and died before Earth's

existence. We readily accept today what seemed fantastic two decades ago. In terrestrial laboratories, scientists now study stardust as data for astrophysics, nucleosynthesis, and cosmochemistry. Zinner's work qualifies for a Nobel Prize, in this writer's opinion. Although that cannot now happen, we can take satisfaction that in 1997 he was awarded the J. Lawrence Smith Medal, the National Academy of Sciences' top award for investigations of meteoric bodies.

Zinner and his wife, Brigitte, were a generous couple who would host at their home the many students and senior scientists who came from around the world to work in his lab. And he took immense pleasure in mentoring the many students with whom he worked.

A final, poetic narrative illuminates Zinner the man. He loved classical music and from childhood was an accomplished pianist. In St. Louis he played the harpsichord in a baroque music ensemble. And when his 4-year-old son began learning to play the cello, Zinner, at age 55, also took lessons so they could play together.

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