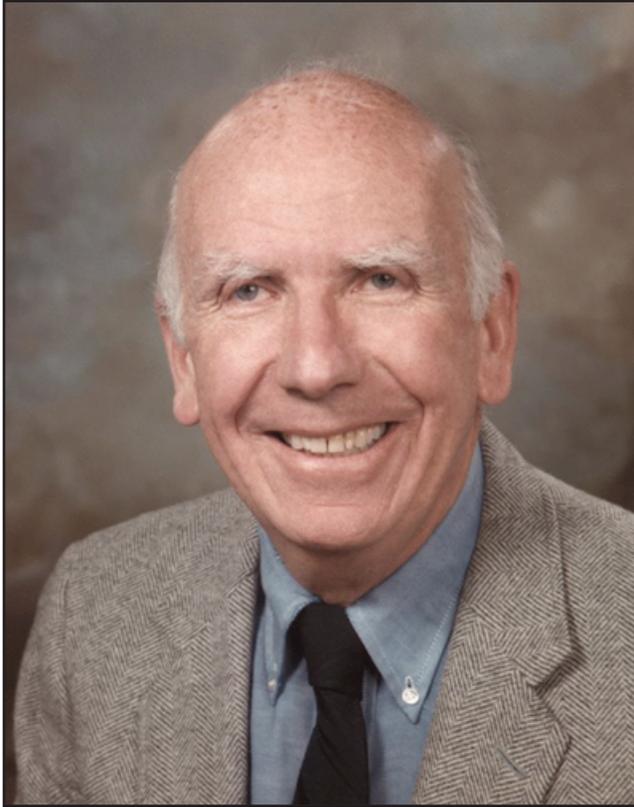


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LEON KNOPOFF



COURTESY OF JOANNE V.C. KNOPOFF

1 JULY 1925 · 20 JANUARY 2011

**A** MAN OF UNUSUALLY wide-ranging interests and talents, Leon Knopoff had the rare distinction of being simultaneously a professor of physics, a professor of geophysics, and a research musicologist at UCLA. The only child of Max and Ray Knopoff, Leon was born in Los Angeles on 1 July 1925, and was the first of his extended family to attend college. He died at his home on 20 January 2011.

As an undergraduate he studied electrical engineering (B.S. cum laude, 1944), and obtained his Ph.D. in physics and mathematics (also cum laude) at the California Institute of Technology in 1949. In 1950 Louis Slichter recruited Knopoff to the Institute of Geophysics at UCLA, where he became professor of geophysics in 1957 and professor of both geophysics and physics in 1961. He was appointed research musicologist in the UCLA Institute of Ethnomusicology shortly after it was formed in 1960. Other appointments included faculty positions at Miami University of Ohio (1948–50) and Caltech (1962–63) as well as visiting academic appointments at Cambridge (three separate year-long visits), Karlsruhe, Harvard, Santiago, Trieste, and Venice. He was awarded an NSF Senior Postdoctoral Fellowship in 1960, and a Guggenheim Foundation Fellowship in 1976.

Knopoff was elected as a fellow of the American Geophysical Union (1962), a member of the National Academy of Sciences (1963), a fellow of the American Association for the Advancement of Science (1964), a fellow of the American Academy of Arts and Sciences (1965), and a member of the American Philosophical Society (1992). A true international scientist, he received the Emil Wiechert Medal of the Deutsche Geophysikalische Gesellschaft (1978), the gold medal of the Royal Astronomical Society (1979), the H. F. Reid Medal of the Seismological Society of America (1990)—thereby becoming an honorary member, the Golden Badge Award of the European Geophysical Society (2001), and a doctorate *honoris causa* from the Université Louis Pasteur, Strasbourg (2004). Leon was elected as a fellow of Selwyn College, Cambridge (1986). He first visited China in the 1970s, and returned often to collaborate with Chinese colleagues. He was named the first honorary professor of the Institute of Geophysics of the China Earthquake Administration (2004).

Leon served as the director of the Institute of Geophysics and Planetary Physics at UCLA for fourteen years, from 1972 to 1986. Among other professional responsibilities, he was founding member and secretary general of the International Upper Mantle Project; founder and chair of the International Union of Geodesy and Geophysics Committee on Mathematical Geophysics; chair of the U.S. Upper Mantle Committee; chair of the U.S. Committee for the International Association of

Seismology and Physics of the Earth's Interior; and chair of the Ad Hoc Committee on Seismology and Aftershocks, Atomic Energy Commission. Knopoff served as editor of *Non-Linear Processes in Geophysics* and associate editor of *Reviews of Geophysics and Space Physics* and *Journal of Geophysical Research—Solid Earth*.

His selfless cooperation was truly global, but nowhere was it more clearly demonstrated than at his own institution in his dedicated teaching of undergraduate and graduate students, his thirty-nine Ph.D. students, forty postdoctoral fellows, and academic colleagues from more than seventeen countries. Knopoff was an inspiring teacher who excelled at simplifying complex topics and encouraging learning through his infectious animation and remarkable patience. It is not surprising that he won the “outstanding teacher award” in the UCLA physics department four times, which for him was a source of great pride. He was also honored as UCLA Faculty Research Lecturer in 1972.

Over the course of a long and extremely fruitful career, Leon authored or coauthored 232 scientific papers in refereed journals, as well as 134 other publications, including original research works in non-refereed journals, book chapters, and other reports and reviews. In addition, he edited or co-edited six books and research volumes.

Knopoff began his academic career with a series of laboratory experiments that compared seismic theory with observations. His laboratory skills led to collaboration with George Kennedy and the pioneering of the thermoluminescence dating of clay potshards and related materials—an approach still utilized today in archaeology and art history. In 1956 his work took a theoretical turn, resulting in a famous paper that led to the representation theorem for calculating ground motions arising from body forces and motions on a surface such as an earthquake fault. In that paper, Knopoff extended to the elastodynamic problem Kirchhoff's retarded potential solution to the wave equation, thereby providing the elastic analog to Green's theorem. He often used his sense of humor to emphasize a point. He wrote a famous paper with the shortest title, “Q.” This very complete work describes in detail the attenuation of elastic waves in the laboratory and in the Earth, and then follows with a thorough theoretical analysis of several mechanisms that might explain such attenuation. Published in 1964, “Q” continues to be widely quoted. In a refreshing contrast, he published with John Gardner a paper with the remarkably long title “Is the Sequence of Earthquakes in Southern California, with Aftershocks Removed, Poissonian?” followed by the shortest abstract, “Yes.” Leon was an international leader in the theoretical and seismic exploration of planet Earth, ranging from California to the South Pole and the Alpine-Mediterranean realm—where he first recognized and described the

low-velocity zone in the upper mantle—a lynchpin in the evolution of plate-tectonic theory. He accounted for the contrast in the slower spreading rates of continental versus oceanic plates as related to deep lithospheric keels beneath the continents, slowing their progress through the asthenosphere. He erected a theoretical framework explaining the double-couple model for earthquakes, elucidated the phenomena of self-organization and chaotic behavior in seismic systems, and pioneered pattern recognition in musicology as well as in earthquake frequencies. In avant-garde musical composition, during 1974 he copyrighted his own version of Mahler's "Das Lied von der Erde" in two (Earth) movements, consisting of computer music. The first movement was based on seismicity from the Kern County earthquake, whereas the second was an accelerated digital recording of the normal modes of the Earth.

As Leon's career developed, he moved from the laboratory to the field. He pioneered the installation of temporary long-period seismograph arrays with an experiment in the European Alps reported in 1966. With colleagues, he developed an ultra-long-period seismometer installed at the South Pole, which made the first measurements of solid Earth polar tides and vibrational modes of the Earth unaffected by splitting due to rotation and ellipticity. His group used surface waves to define the main structures of plate tectonics, including the thickening of the oceanic lithosphere with age. In seminal studies pioneering seismic theory, Knopoff garnered many canonical analytical expressions to his name. Of note is his elegant solution to the antiplane crack (1958), which ranks in fame alongside the in-plane Starr crack (1928) and the Eshelby circular crack (1949). He developed efficient algorithms to solve the problem of elastic waves propagating in layered media and to compute seismograms by superpositions of normal modes. He was one of the first to recognize the applicability of modern developments in non-linear science to the earthquake generation problem. The Burridge and Knopoff model (1967) of interacting springs and blocks became the basis for simulating earthquake dynamics. With Yan Kagan, he developed the stochastic branching model of faulting that displays the clustering properties of earthquake catalogues, including foreshocks, aftershocks, and weak clustering of main shocks, providing a theoretical basis for earthquake forecasting.

Extremely dedicated to his academic institution, Leon and his wife, Joanne, created an important endowment in UCLA's College of Letters and Science in 2001. This Career Development Chair—the first basic sciences chair to be endowed by a faculty member during the Campaign UCLA fundraising effort—is named the Leon and Joanne V. C. Knopoff Assistant Professorship in Physics and Geophysics. It supports

the research of a promising young scientist in solid Earth geophysics, encouraging work that will help us to better understand patterns in complex systems in physics and solid Earth geophysics. The gift testifies to Leon's profound belief that institutions of higher learning are the carriers of civilization. Then in 2007, in recognition of the importance of research being conducted under the auspices of the American Philosophical Society, Leon and Joanne established another endowed fund, the Leon and Joanne V. C. Knopoff Library Resident Research Fellowship, for the support of one or more Library Fellows working on-site in the Society's history of science collections, with a preference for the physical sciences, including mathematics.

A man with broad interests, Leon had a deep love of classical music. But instead of choosing a professional career as an accomplished concert pianist and harpsichordist, Leon followed a far more diversified path that involved exploration, appreciation, and advancement of the richness of physics, mathematics, and the Earth, as well as that of music. For many years he delighted in hosting chamber music sessions in his home. His legendary encyclopedic knowledge, spanning the physical sciences and the arts, rendered a conversation with him an illumination, although it was sometimes a challenge to keep pace with him. He is sorely missed both as an intensely warm-hearted scholar and as an intellectual giant. Leon Knopoff also leaves a legacy of teaching and research at the highest levels that serves as a prime example of unselfish cooperation. A remarkable scholar, he effectively spanned the "two cultures," leaving an extraordinarily rich legacy of achievement and a devoted group of students who continue his work.

Leon's frequent backpacking expeditions into the Sierra Nevada and into mountains in remote regions of the globe were among his happiest times. He took a keen delight in international travel, especially with Joanne and their three children, Katie, Rachel, and Michael. They shared a wealth of memorable adventures together. Leon was a superb father and a remarkable husband, greatly beloved by Joanne, Katie, Rachel, and Michael. His strength depended on the deepest love of his life—Joanne, his wife of fifty years. They were ideally suited to one another, and their mutual, supportive devotion was a joy to behold.

Leon and Joanne's regular attendance at the American Philosophical Society meetings in Philadelphia happily accommodated his remarkably diverse scholarly interests. These sessions provided a cornucopia of intellectual discourses, as varied as his own interests in the arts and sciences. Leon much appreciated the erudite lectures, but was delighted also by the evening concerts. His friends and colleagues knew him as a man of integrity, brilliance, humor, generosity, kindness, and modesty.

Ever ready with a broad smile and a hearty laugh, he possessed an enormous sense of fun and adventure. Leon Knopoff was an extraordinary human being and a gift to all who knew him.

Elected 1992

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