News

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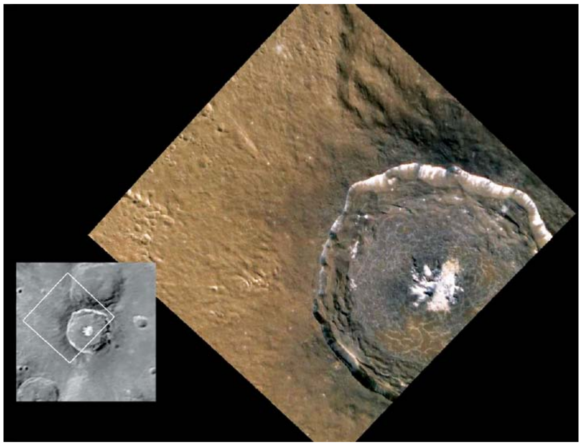


(Right) View of the Mercury's Degas crater, a feature 52 kilometers in diameter centered at 37.1°N, 232.8°E. The image, obtained as a high-resolution targeted observation (90 meters per pixel), shows impact melt coating the crater floor and cracks across the crater. (left) For context, Mariner 10's view of Degas is shown. Image from NASA/Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington.

its flybys. However, he said that since the spacecraft's insertion into orbit, bursts of energetic electrons have been observed during most orbits.

The spacecraft's X-Ray Spectrometer (XRS) has been providing new findings about some elemental ratios. Larry Nittler, staff scientist with DTM, said Mercury "has got lower aluminum and more magnesium relative to silicates, so it has a lower abundance of feldspar, and it clearly has undergone a unique geological history." He added that the XRS has found relatively low abundances of iron and titanium on Mercury's surface and a relatively high abundance of sulfur. Nittler said that the latter almost certainly relates to the planet's origin, "that Mercury most likely formed from building blocks that were fundamentally chemically different from those that formed the Earth and Moon originally."

Data from the gamma ray and neutron spectrometer show that Mercury has a higher than expected ratio of potassium to thorium, which according to Nittler indicates that there seems to be a large amount of volatile elements on the planet. "The ratio of these two elements can provide a great deal of information about thermal and heating processes that occurred in the early solar system," when Mercury and other planets were forming.

Mercury "tells us something about the inner part of the solar nebula. It tells us something about how the terrestrial planets formed ultimately," McNutt said, adding, "This really is the undiscovered country, and we really are for the first time exploring a new world."

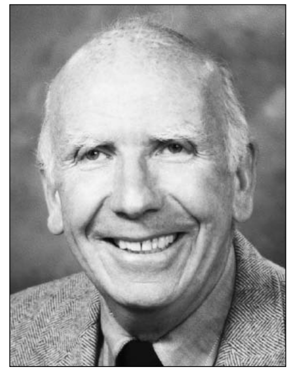
Referring to the terrestrial planets, Solomon noted, "We have in our solar system four experiments in how Earth-like planets evolve once they form under slightly different conditions: different distance from the host star, different mass, different starting composition. What we are learning is that each of those experiments had an extraordinarily different outcome. And one of those experiments we live on. So it really behooves us to understand in a very general way how Earth-like planets form and evolve and operate."

For more information, see http://www.nasa.gov/mission_pages/messenger/main/index.html.

—Randy Showstack, Staff Writer

GEOPHYSICISTS

Leon Knopoff (1925–2011)



Leon Knopoff

Leon Knopoff died at his home in Sherman Oaks, Calif., on 20 January 2011 at the age of 85. A man of wide-ranging talents, he had the rare distinction of being simultaneously a professor of physics, a professor of geophysics, and a research musicologist at the University of California, Los Angeles (UCLA). As an undergraduate he studied electrical engineering and obtained his Ph.D. in physics and mathematics at the California Institute of Technology (Caltech) in 1949. He was recruited to the Institute of Geophysics (now the Institute of Geophysics and Planetary Physics) at UCLA in 1950 by Louis Slichter, where he became a professor of geophysics in 1957 and of geophysics and physics in 1961. He became a research musicologist in the UCLA Institute of Ethnomusicology soon after it was formed in 1960. Other appointments included faculty positions at Miami University in Ohio (1948–1950) and Caltech (1962–1963) and visiting appointments at Cambridge, Karlsruhe, Harvard, Santiago, Trieste, and Venice.

Knopoff was elected a Fellow of AGU (1962), a member of the National Academy of Sciences (1963), a member of the American Philosophical Society (1992), a Fellow of the American Association for the Advancement of Science (1964), and a Fellow of the American Academy of Arts and Sciences (1965). He received the Harry Fielding Reid medal of the Seismological Society of America (1990), becoming an honorary member of that society; the gold medal of the Royal Astronomical Society (1979); the Emil Wiechert Medal of the Deutsche Geophysikalische Gesellschaft (1978); the Golden Badge Award of the European Geophysical Society (2001); and a docteur honoris causa from Université Louis-Pasteur, Strasbourg, France (2004). He was elected Fellow of Selwyn College, Cambridge (1986). He visited China in the 1970s, returning often to collaborate. He was named the first honorary professor of the Institute of Geophysics of the China Earthquake Administration (2004).

Knopoff served as the director of the Institute of Geophysics and Planetary Physics (IGPP) at UCLA for 14 years. He was a founding member and secretary general of the International Upper Mantle Project; founder and chairman 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. He served as editor of *Nonlinear Processes in Geophysics* and associate editor of *Reviews of Geophysics and Space Physics* and *Journal of Geophysical Research-Solid Earth*. Of his 366 publications, 61 were in AGU journals.

His selfless cooperation was truly global, but nowhere was it better demonstrated than at his home institution in his dedicated teaching of undergraduate students, 39 Ph.D. students, 40 postdocs, and colleagues from more than 17 countries. Leon Knopoff was an inspiring teacher who excelled at simplifying complex topics and encouraging learning. 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 began his career with a series of laboratory experiments that compared seismic theory with observations. His laboratory skills led to his codiscovery with George Kennedy of thermoluminescence dating. 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.

Knopoff often used his sense of humor to emphasize a point. A famous paper with the shortest title possible, "Q," is a paper that describes in detail the attenuation of elastic waves in the laboratory and in Earth and then presents a thorough theoretical analysis of several mechanisms that might explain such attenuation. Published in 1964 in *Reviews of Geophysics,* "Q" continues to be widely quoted. In contrast, with John Gardner he published 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." In 1974 he copyrighted his version of Mahler's *Das Lied von der Erde* in two (Earth) movements, composed of computer-generated music. The first movement was based on seismicity from the 1952 Kern County, California, earthquake, and the second was an accelerated digital recording of the normal modes of the Earth.

As his career developed, Knopoff 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 ultralong-period seismometer installed at the South Pole that 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 lithosphere with age of oceanic plates and the very deep roots, or keels, under continental shields.

In seismic theory he has many canonical analytical expressions to his name. Of note is his (1958) elegant solution to the antiplane crack, which ranks in fame alongside the inplane (1928) Starr crack and the Eshelby (1949) circular crack. 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 to the earthquake problem of modern developments in nonlinear science. 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 catalogs including foreshocks, aftershocks, and weak clustering of main shocks, providing a theoretical basis for earthquake forecasting.

An accomplished pianist and harpsichordist, rather than choosing a professional career as a concert musician, he chose a path that explored and appreciated the richness of physics, mathematics, and the Earth as well as of music. His encyclopedic knowledge rendered a conversation with him an illumination, albeit sometimes a challenge to keep pace. He is missed both as a warmhearted person and an intellect, and he leaves a legacy of teaching and research at the highest levels that serves as a prime example of unselfish cooperation.

He is survived by his wife, Joanne; children Katie, Rachel, and Michael; and a grandson.

—Paul Davis and David Jackson, UCLA; E-mail: pdavis@ucla.edu; and Freeman Gilbert, University of California, San Diego