OBITUARIES

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Walter Kohn

Walter Kohn, a giant of 20th-century theoretical physics, died at his home in Santa Barbara, California, on 19 April 2016.

Walter was born on 9 March 1923 in Vienna. When Nazi Germany annexed Austria in 1938, Walter was forced to leave Vienna's prestigious Academic Gymnasium, but he was able to enroll in a Jewish gymnasium where two remarkable teachers awoke his interest in science. His studies were interrupted a year later when his parents sent him to England on one of the last of the *Kindertransport* children's rescue trains; his parents later were killed in Auschwitz. As an enemy alien, Walter survived a series of internment camps in England and Canada; after being deemed a "Refugee from Nazi Oppression," he served in the Canadian Army and studied physics and mathematics at the University of Toronto. In 1946 he moved to Harvard University, where Julian Schwinger became his PhD adviser. In just two years, he completed his PhD thesis on the quantum mechanical description of collisions of light nuclei.

After a year's postdoctoral study at the Niels Bohr Institute in Copenhagen, Walter went to the Carnegie Institute of Technology (now Carnegie Mellon University) in Pittsburgh for his first faculty position. He remained there until 1960, when he moved to the newly created campus of the University of California, San Diego. In 1979 he was recruited by the University of California, Santa Barbara, to be the founding director of the Institute for Theoretical Physics (ITP; now the Kavli Institute for Theoretical Physics).

Although his earliest work was in theoretical mechanics and quantum field theory, Walter quickly turned toward solid-state theory. That happened initially under the influence of John Van Vleck, who asked him to teach a course on the subject at Harvard in 1949. An important factor in Walter's growth as a solid-state physicist was his consulting activity for Bell Labs, which brought him into contact with leading condensed-matter and semiconductor physicists such as Philip Anderson and Conyers Herring. It was also at Bell Labs that Walter began his close collaboration with Joaquin "Quin" Luttinger; the two produced, among other important advances, an effective-mass theory of electrons and impurities in semiconductors, a clear formulation of the theory of solids in magnetic fields, and a derivation of the Boltzmann transport equation for quantum mechanical particles. While at Carnegie Tech, he developed his theory of anomalies in the phonon spectra of metals, now known as the Kohn anomalies.

In the fall of 1963, Walter spent a sabbatical semester at the École Normale Supérieure in Paris, in the spacious office of his friend Philippe Nozières. There, in collaboration with one of us (Hohenberg), Walter initiated the work that would become his most famous contribution to science and would lead to his Nobel Prize (in Chemistry!) in 1998—namely, the development of density functional theory (DFT). In their first paper, in 1964, Hohenberg and Kohn presented an exact reformulation of the many-particle Schrödinger equation in terms of the electron density $n(\mathbf{r})$ in place of the external potential $v(\mathbf{r})$.

A year later, after Walter returned to San Diego, he and Lu Sham recast the theory in terms of an exact set of generalized Hartree–Fock equations expressed once again entirely in terms of the electron density. A 2005 analysis of citations in the *Physical Review* journals listed the Hohenberg–Kohn and Kohn–Sham papers as the two most-cited *Physical Review* papers in the journals' 110-year history (see the article by Sid Redner, PHYSICS TODAY, June 2005, page 49). The reason for the enormous impact of their work is that it leads to useful approximate solutions of the many-body Schrödinger equation with no more difficulty than the Hartree–Fock method but with significantly better accuracy. As a result, DFT has been employed in a huge number of calculations of the electronic structure of solids, and since the 1980s it has been used by chemists to predict the properties of atoms and molecules of almost arbitrary complexity.

In addition to being one of the world's most prominent scientists, Walter was a

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Walter Kohn

humanist, a statesman, and an institution builder. He chaired the physics department at San Diego during its early development. Then, as the founding director of the ITP, he created a unique environment for wide-ranging and innovative research and the thoughtful guidance of promising young scientists. Under Walter's leadership, the ITP quickly became a destination of choice for scientists throughout the world. It remains so to this day.

Walter was deeply concerned about issues of political, national, and international significance. He was active in efforts in the scientific community to defend the human rights of scientists worldwide. He was a leader of the (so far unsuccessful) faculty effort to sever the link between the University of California and the US nuclear weapons laboratories at Los Alamos and Livermore. He also was deeply committed to environmental issues. Walter was the executive producer of the 2005 film *The Power of the Sun* (http://powerofthesun.ucsb.edu), in which he, fellow Santa Barbara Nobelist Alan Heeger, and actor and comedian John Cleese, among others, advocate greater attention to the promise of sustainable energy sources.

We end this brief tribute to the life and contributions of a remarkable colleague by describing Walter's impact on our own lives.

Langer: Walter provided an early introduction not just to the beauty of theoretical physics but especially to the joy of scientific discovery. The occasion was a one-on-one reading course in quantum mechanics he gave me as an undergraduate physics major at Carnegie Tech in 1954. Walter also advised me to go to Birmingham, UK, for thesis research with Rudolf Peierls and—25 years later—brought me to Santa Barbara to participate in developing the ITP.

Hohenberg: Besides the once-in-a-lifetime luck of being forced to share not only an office but also a large *desk* with Walter Kohn and Philippe Nozières and thereby ending up as coauthor of the second most cited paper in the history of *Physical Review*, I received valuable advice from Walter on my subsequent career. Walter suggested that I apply for a job at Bell Labs, an institution I had barely heard of, where I then spent 30 years of my life. Walter also invited me to organize (with Langer) one of the first research programs at the newly created ITP in Santa Barbara.

In science and in the world at large, Walter's influence was broad and lasting. He will long be remembered by colleagues and friends, near and far.

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Endel Lippmaa

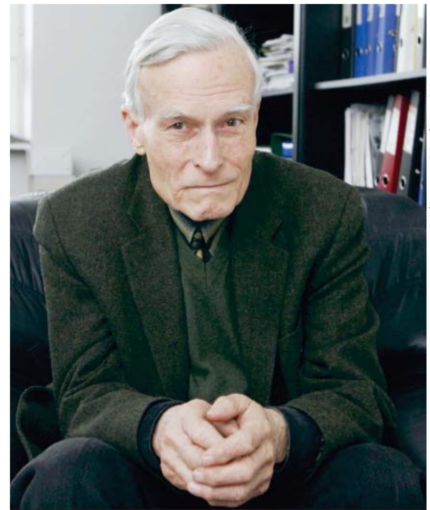
Endel Lippmaa, a prominent Estonian scientist and polymath and one of the early pioneers of NMR and its applications in analytic chemistry, solid-state spectroscopy, and beyond, died on 30 July 2015.

In the late 1950s, when NMR techniques were being rapidly developed in the West, Estonia was isolated behind the Iron Curtain. Nevertheless, using his countless talents, including building vacuum-tube-based electronics, Lippmaa managed to assemble a functional NMR spectrometer. It was the first not only in Estonia but arguably in all the Soviet bloc countries. The hallmark of Lippmaa's approach to science was in creating innovative advanced instrumentation and using it to discover new physics in such apparently diverse areas as petrochemistry, superconductivity, and neutrino physics. That unique legacy continues today, carried out by his many students and by scientists at Estonia's National Institute of Chemical Physics and Biophysics (NICPB). Lippmaa founded that institute in the early 1980s as part of the Estonian Academy of Sciences in the capital city of Tallinn; he served as director until 2001 and chairman of the board until 2005.

Born on 15 September 1930 in Tartu, Lippmaa was the only son of prominent Estonian geobotanist Teodor Lippmaa. Tragedy struck in 1942, when a random aviation bomb dropped on the Lippmaas' home in Tartu and killed everyone in the family except Endel, who was lucky enough to be attending a movie in town.

Lippmaa attended the Tallinn University of Technology; he received his undergraduate degree with a major in oil-shale technology in 1953 and his PhD in chemistry in 1956 under the auspices of Agu Aarna. While performing standard chemical analysis of oil-shale petrochemical samples for his PhD thesis, he realized the enormous potential of NMR in analytic chemistry and in revealing the properties and composition of materials and matter in general. Using his partially self-built NMR instrumentation, Lippmaa and the research group he initiated at the Institute of Cybernetics of the Estonian Academy of Sciences studied the structure of organic compounds. That work led to his doctor of sciences degree in physics and mathematics from the Institute of Chemical Physics of the Academy of Sciences of the USSR in 1969. His thesis was entitled "Overhauser's nuclear effect and structure of organic compounds." In 1971 he was awarded full professorship of chemical physics and physical chemistry at the Institute of Cybernetics.

In the 1970s, when most NMR spectroscopists' attention was focused on hydrogen-1 nuclei, Lippmaa spearheaded the techniques for detecting and analyzing other nuclei, such as carbon-13 and silicon-29. As is now well known, those other nuclei are essential in the study of biological systems and in the spectacular success of modern semiconductor electronics technology. His work on ^{29}Si spectroscopy of silicates remains frequently cited to this day. Another breakthrough achievement of Lippmaa's in the NMR field was the development of a high-resolution solid-state method using specially constructed sample spinners; the method, which he originated at the



Endel Lippmaa

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NICPB, is still in use around the world.

Lippmaa devoted much of his creative energy to bolstering basic research in Estonia, especially by advocating major government investments in the institutes then run by the Estonian Academy of Sciences. At the academy he served in numerous key leadership positions, including as a board member from 1975 to 2014, as academician-secretary from 1999 to 2004, as head of the division of astronomy and physics from 1977 to 1982, and as chairman of the Energy Council from 2007 to 2010.

Lippmaa was a world-renowned expert in chemical physics, applications of petrochemicals, electronics, nuclear and particle physics, and environmental science. In recognition of his achievements, he received Estonia's National Science Prize in 2000, the Order of the National Coat of Arms second class, and other honors.

Among younger generations of Estonians, Lippmaa is most frequently associated with the crucial role he played in the late 1980s and the 1990s in helping their country regain political independence from the USSR and in reestablishing the Republic of Estonia. As an Estonian delegate to the USSR's Congress of People's Deputies in 1989–91, he put his remarkable powers of persuasion to excellent use in making Estonia's break from the union a more palatable idea for Moscow; for example, he pointed out the implications of the infamous Molotov–Ribbentrop pact of 1939. In the years following independence, Lippmaa served as Estonia's minister for Eastern affairs in 1990–91, as minister of European affairs in 1995–96, and as a member of the