JOSEPH WEBER

conference of the Institute of Radio Engineers in Ottawa, Canada, and published the first open-literature paper on what is now called quantum electronics. His efforts were acknowledged by the IRE when they awarded him a fellowship (in 1958) "for his early recognition of concepts leading to the maser." The development of operating maser and laser devices was achieved by Charles Townes, Nikolai Basov, Aleksandre Prokhorov, Theodore Maiman, and Arthur Schawlow.

Weber spent the 1955–56 academic year as a fellow of the Institute for Advanced Study in Princeton, New Jersey, where he immersed himself in general relativity. In 1961, he joined the physics department at the University of Maryland as a full professor.

During the early 1960s, Weber turned his attention to testing the general relativistic prediction of gravitational waves from collisions or collapses involving strong gravity. In typical fashion, he first studied the field, published a beautiful and concise monograph on gravitational waves in 1961 (Interscience Publishers), and then set about developing a detector that might be able to measure displacements smaller than the size of the nucleus in a macroscopic-sized object. He was alone in charting these unknown waters: His first paper on how to build a gravity wave detector was published in 1959 and the second, in 1960. Weber developed an experiment using a large suspended bar of aluminum, with a high resonant Q at a frequency of about 1 kH; the oscillation of the bar after it had been excited could be measured by a series of piezoelectric crystals mounted on it. The output of the system was put on a chart recorder like those used to record earthquakes. Weber studied the excursions of the pen to look for the occasional tone of a gravitational wave passing through the bar. The signals seemed to show the presence of gravitational waves. He published his results in *Physical Review Letters* (1969), claiming evidence for observation of gravitational waves in 1969 based on coincident signals from two bars separated by 1000 km. These and subsequent observations by Weber were greeted with great excitement in the early 1970s; however, the strength implied by his signals was very much in excess of what was expected. In the following years, various experimenters built more sensitive bars, including low-temperature bars, and looked for signals, but it was difficult to see gravitational signals without ambiguity. Even so, the Weber gravitational detector stands as an important milestone in the development of gravitational wave astronomy.

When Weber first reported the possible observation of gravitational signals by his bar detectors, Sandy Wall and one of us (Yodh) immediately suggested to him that we should determine whether energetic cosmic-ray showers could produce observable pulses in his bars. We carried out (in 1970) a coincidence experiment with a cosmic-ray telescope consisting of scintillation counters above and below Weber's room-temperature detector. We showed that the observed coincidences with cosmic-ray events were consistent with being accidentals, thus eliminating cosmic-ray showers as being necessarily a source of the signals. Nearly three decades later, the Rome (Italy) group again studied the problem using the sensitive NAUTILUS detector, a 2300-kg bar at 100 mK. The group reported observing events that may be attributed to cosmic-ray showers in the bar. Weber continued doing coincidence experiments with several bar detectors, some at the University of Maryland and another at Argonne National Laboratory in the 1970s, and later with bar detectors built by the Rome group. Experiments to observe coincident events are currently being carried out by the International Gravitational Event Collaboration, which consists of low-temperature bars in Australia, the US, and Europe. None have yet been observed, and new upper limits for amplitude and rate of gravitational wave bursts have been set.

Weber also proposed the idea of doing an experiment to detect gravitational waves using laser interferometric techniques. Robert Forward, Weber's student and postdoctoral associate, did the first laser interferometric gravitational wave experiments while at Hughes Research Laboratories in Malibu, California.

The pioneering work of Weber spawned a new and vibrant field: the search for gravitational waves. The international physics community is now constructing more sensitive detectors for gravitational wave signals using interferometric techniques, such as the US project for the Laser Interferometer Gravitational Wave Observatory (LIGO); the French–Italian VIRGO experiment; the Japanese 300-m TAMA interferometer; and GEO-600, the 600-m German–British interferometer. Planning is under way for future space-based interferometers, such as the Laser Interferometer Space Antenna (LISA), a NASA–European Space Agency collaboration, to explore the low-frequency window.

Weber loved the outdoors and was an exercise enthusiast. He was an ardent and able rock climber. One of us (Yodh) remembers climbing with him on the rocks flanking the Potomac River in Carderock, Maryland. He also jogged and swam regularly and was in fit condition until his last few years. He would say that "health is the most important thing for a physicist to have, for you cannot do physics once you are dead." He set a great example to students and colleagues in colloquia and seminars by keeping a good, written record in a hardbound logbook. His workbooks were very carefully kept and cross referenced. He was married to astronomer Virginia Trimble, who is a professor at the University of California, Irvine, and at the University of Maryland. After 1973 until before his death, he split his research time between the University of Maryland and UC Irvine. Weber was a dedicated scientist and an inspiration to many who interacted with him.

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Teijo Erik Vilhelm Åberg

Teijo Erik Vilhelm Åberg, originator of seminally unifying insights into atomic theory, died in Helsinki, Finland, on 29 December 2000, after a long illness.

Teijo was born on 4 August 1937 in Helsinki. He earned the following degrees at the University of Helsinki: a Nat. Cand. (BSc) in physics and mathematics (1959); Phil. Cand. (MSc) in astronomy (1960); Phil. Lic. (CSc) in physics and mathematics (1967); and Phil. Doc. (PhD) in physics (1969). Subsequently, he held a Nordita fellowship (1969–70) at Uppsala University in Sweden and a postdoctoral fellowship (1971) at the University of Chicago under the late Ugo Fano.

In 1971, Teijo was appointed an associate professor of physics at Helsinki University of Technology, where he spent the remainder of his career, with the exception of periodic visiting professorships at the University of Uppsala; University of Oregon; University Pierre and Marie Curie (University of Paris VI); Kansas State University; and KEK, the High Energy Accelerator Research Organization in Tsukuba, Japan.

Teijo's work has influenced the understanding of electron processes and dynamics in molecular science and in solid-state systems. His scientific work was characterized throughout by deep insight into atomic dynamics, symbiotic integration of theoretical advances with experiment, and an uncanny ability to unify seemingly diverse processes by a common theoretical explanation.

In the early 1960s, work by Manfred Krause and Tom Carlson at Oak Ridge National Laboratory added to evidence that more than one electron can be emitted on absorption of a photon by an atom. Because the photon–electron interaction is described by a one-electron operator, the central-field frozen-core model available at the time did not predict changes of state of more than one electron. It became known only subsequently that direct multiple-excitation processes arise from electron correlation. Teijo was intrigued by this puzzle, which could also lead to an explanation of the origin of long-observed x-ray "satellites" that accompany regular "diagram" lines if the emitting atom is multiply ionized. This question dates as far back as Felix Bloch's work in 1935. Teijo was thus led to formulate a general theory of x-ray excitation, based on the sudden approximation and imperfect wavefunction overlap between initial and final states, calculated invoking closure. This theory, with later elaboration, applies to a wide range of atomic and molecular processes, including radiationless (Auger) transitions.

Teijo expanded upon this comprehensive approach in 1972. Three years later, at an Advanced Study

TEIJO ERIK VILHELM ÅBERG

Institute in Carry-le-Rouet, France, Teijo reported on progress in a talk described as "visionary" by Werner Mehlhorn. Mehlhorn recalled that he "was convinced that Teijo had taken a decisive new step, the second most important since Gregor Wentzel's." In his role as editor, Mehlhorn invited Teijo to write a monograph on the theory of the Auger effect for the *Handbuch der Physik*. The monograph, coauthored by G. Howat, was published in 1982 and still is widely used.

In subsequent years, with assistance from collaborators including Jaakko Juhani "Jukka" Tulkki, Mau Hsiung Chen, and members of the Oregon group, Teijo generalized what started as simple "shake theory" to a comprehensive time-independent resonant-scattering theory. According to the latter theory, the creation of x rays and Auger electrons by photon impact on atoms is treated as a one-step resonant scattering process in which the number of electrons is conserved. The transition matrix amplitude is expressed by what Teijo affectionately called the "Grandfather formula." The comprehensive scheme and its relativistic generalization compose a range of phenomena, including processes previously considered disparate; it thus has become a powerful unifying approach. The theory—the crowning achievement of Teijo's scientific career—elucidates aspects of multiphoton processes, multielectron excitation, postcollision interaction, and resonant inner-shell Raman transitions.

Teijo influenced his students and younger collaborators, who continue to conduct important research. Those who knew and worked with Teijo will recall the clarity of his thinking and exposition, incisiveness, enthusiasm, personal warmth, informality, and patience in helping students and colleagues alike. They will remember happy times working on tough problems or skiing in the Cascade Mountains, where he would amaze them with Telemark turns taught to the Finnish ski troops. Teijo will be missed very much.

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Samuel Newton Foner

Samuel Newton Foner, a pioneer in the science of very short-lived free radicals and highly reactive molecules, died from prostate cancer on 14 October 2000 in Tampa, Florida.

Born in New York City on 21 March 1920, Foner entered the Carnegie Institute of Technology at age 16, obtaining a double BS in physics and mathematics in 1940 and an MS in physics a year later. Before receiving his DSc in physics in 1945, under the direction of Nobel laureate Otto Stern and coadviser Immanuel Estermann, he was an instructor and worked with Stern from March 1944 to July 1945 on a secret program that was a part of the Manhattan Project.

Foner had an exceptional ability for developing simple experiments to resolve complex issues. He brought this talent to the Johns Hopkins University Applied Physics Laboratory (APL), then located in Silver Spring, Maryland, which he joined in July 1945 and where he worked for his entire professional career. For most of that time, he was a member of the research center, founded in 1947. Among his colleagues at the center were Ralph Alpher, Robert Herman, and James Van Allen. Foner conducted and led research in mass spectrometry, trapped free radicals, electron impact ionization, solid propellant combustion instability, and underwater sound.

In the article "Neutral Beam Kinetics," *Nature* (volume 229, page 374, 1971), drew attention to the prolonged and painful evolution of the field, aided not so much by theoretical advances as by exquisitely subtle experimentation that emphasized direct observation. The article credited Foner and his colleague Richard Hudson for ingeniously combining two instruments—the molecular beam apparatus and the mass spectrometer—and using a novel scatter-