

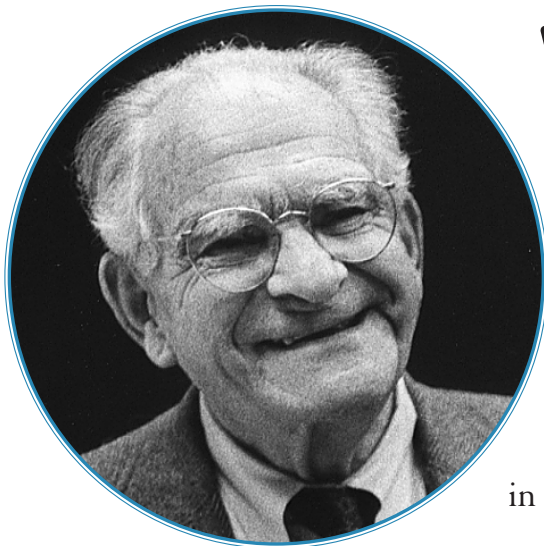
# In Remembrance

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## Victor F. Weisskopf (1908–2002)

by Kurt Gottfried

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Victor Weisskopf, who died on April 21 at the ripe age of 93, had, as he liked to put it, “lived a happy life in a dreadful century”. He knew what he was talking about. He had been a major player in a great voyage of discovery, and was always at the centre of a loving family and a vast circle of good friends. But he had also seen totalitarianism in Germany and Russia, and witnessed the first man-made nuclear explosion.

In 1928, Weisskopf left his native Vienna to study physics at Göttingen, Germany, where quantum mechanics had been born just three years before. It was already clear that the new mechanics could describe, at least in principle, any phenomenon involving particles moving with velocities that are small compared with the speed of light. Now the question was whether a successful marriage of quantum mechanics with relativity could be arranged. Paul Dirac had responded by inventing quantum electrodynamics (QED), but it was soon realized that this theory faced potentially fatal problems. It was to this fundamental issue that Weisskopf repeatedly devoted himself. Today, QED and the theory of gravitation are the most accurately tested theories of physics—an outcome due in good part to Weisskopf’s contributions. Willis Lamb, who did the most important experiment in the history

Photo: Donna Coveney/MIT

of the subject, wrote that he based his analysis on “the 1927–34 formulation of QED due to Dirac, Heisenberg, Pauli and Weisskopf”.

Weisskopf’s first landmark result concerned the spectral lines resulting from the radiation emitted by electrons in the atom. The intrinsic width of spectral lines is due to the interaction of the atomic electrons with the radiation they emit. Working with Eugene Wigner, and at the age of just 22, Weisskopf devised the quantum theory of this effect.

The energy of a charge under the influence of its own field posed a much deeper problem. In 1934, with some help from Wendell Furry, Weisskopf discovered that in QED this ‘self-energy’ is far better behaved as the diameter of the charge shrinks to zero than it is in classical physics. This behaviour is central to today’s highly successful ‘standard model’ of elementary particles. Another vital contribution by the young Weisskopf was the demonstration, with Wolfgang Pauli, that relativity and quantum mechanics do not require charged particles to have spin—until then, this had been a misconception widely inferred from Dirac’s theory.

After Göttingen, Weisskopf had perhaps the most spectacular postdoctoral career of modern physics, holding appointments with Werner Heisenberg, Erwin Schrödinger, Pauli and Niels Bohr. In 1937, he left Europe for a position at the University of Rochester and began a long-term involvement with nuclear physics. This culminated in the book *Theoretical Nuclear Physics*, written with John Blatt and published in 1952, which for decades was the undisputed bible of the subject. But what had begun as a harmless intellectual pursuit assumed a very different tone when he joined the atomic bomb project at Los Alamos. There he became deputy to Hans Bethe, head of the theoretical-physics division.

At the war’s end he joined the faculty at Massachusetts Institute of Technology. Here, students and postdocs were exposed to Weisskopf’s exceptional talent for the intuitive argument, and also enjoyed the warmth of the atmosphere he created. New experimental techniques had emerged from the wartime radar project, and among the first consequences was Lamb’s discovery that the hydrogen spectrum was in stark conflict with existing theory. Weisskopf and his student Bruce French made the first complete calculation, but it disagreed with the slightly later result found by the young geniuses Richard Feynman and Julian Schwinger with their powerful, separate reformulations of QED. Weisskopf, who suffered from a lack of confidence in mathematics, did not publish,

## Personal Remembrances of Viki Weisskopf

“**Viki will be remembered** as a true giant of physics, and nowhere more so than at CERN....physicists who were not even born then [Weisskopf was CERN’s Director from 1961–65] still speak of him with reverence.... Viki created the spirit of CERN and established traditions that the laboratory still holds dear. His idealism helped to make CERN more than a physics laboratory....he turned it into a meeting place for people from widely different political cultures. A place where tolerance and understanding are the order of the day.”

—Professor Luciano Maiani, Director General, CERN

“**He was a friend** to everyone who knew him. His influence here at MIT and in the Center for Theoretical Physics was beneficent and profound. His perpetual curiosity and his enthusiasm for new ideas and young people defined MIT’s style of doing physics. We will miss him.”

—Robert L. Jaffe, Director, MIT Center for Theoretical Physics

“**It is indeed a great loss**, not only for the world physics community but also for those who...try to remove the threat of atomic weapons from human society and seek world peace....I am sure that his eager spirit for physics and world peace shall remain with us forever.”

—Dr. Yoshio Yamaguchi, former President, IUPAP (1963–66)

“**Viki meant much** to very many people—his students, his colleagues at MIT and at CERN, and the wider community of scientists who saw his as a humane voice of reason as well as a brilliant yet practical scientist.”

—J. D. Jackson, Professor Emeritus of Physics, University of California, Berkeley

assuming that he and French were wrong. They were not—the other two had made the same subtle mistake.

The deep wounds inflicted on European science by the Nazis and the nuclear arms race motivated many of Weisskopf's thoughts and actions after the detonation of the atom bomb over Hiroshima. In 1946 he joined a small committee chaired by Einstein, the first of many platforms from which he spoke of the danger posed by nuclear weapons. He was a co-founder of the Federation of American Scientists and the Union of Concerned Scientists. Starting with the first Pugwash conference in 1956, he pioneered relations with Soviet scientists in pursuit of arms control. And it is no coincidence that Pope John Paul II began to make forceful and widely publicized statements against the nuclear arms race soon after Weisskopf's election to the Pontifical Academy.

Weisskopf never severed his strong ties with Europe. He was delighted to be named director-general of CERN (the European laboratory for particle physics in Geneva, Switzerland) in 1961, having answered questions about his administrative experience with “none whatever, my greatest strength”. He proved to be an inspiring and effective leader, not only of CERN but of high-energy physics worldwide. Before long, CERN and European high-energy physics were on a par with competing research in the United States, in good part thanks to his controversial and ground-breaking decision to build the world's first proton–proton collider.

A sketch of ‘Viki’ (as he was known everywhere) as a scientist does not begin to give a picture of the man. He radiated emotional warmth combined with intellectual discipline and breadth—a rigorous romantic. He was an accomplished pianist and loved music as much as physics, playing excerpts from Haydn's *Creation* when giving popular lectures on the early Universe. He called his popular exposition of science *Knowledge and Wonder*. Viki exemplified the vitality and imagination that produced one of history's great intellectual revolutions, and gave it a human face. ●

## In Remembrance

*(The following article originally appeared in the Wednesday, May 8, 2002, issue of MIT Tech Talk, reprinted here by kind permission.)*

### Retired MIT professor Felix Villars dies at 81; was pioneer in biological physics

**P**rofessor Emeritus Felix M. H. Villars, 81, a theoretical physicist who changed directions in mid-career and became a pioneer in biological physics, died of cancer Saturday, April 27 at his home in Belmont.

“Felix was a theoretical physicist of great breadth and versatility,” said John W. Negele, the W.A. Coolidge Professor of Physics, who was director of the Center for Theoretical Physics when Villars retired in 1991. “He was a gifted and caring teacher with an encyclopedic mastery of physics and enviable clarity of mind.

“He had a vision of bringing the concepts and rigor of physics to bear on fundamental problems in medicine and biology. By his tireless efforts in teaching at MIT and Harvard Medical School and in writing a series of textbooks, he played a seminal role in creating a new generation of physician-scientists.”

Villars, who was a member of the MIT faculty for 41 years, played a central role in the development of the Harvard-MIT Division of Health, Sciences and Technology. He embraced the concept that physics and engineering can provide a foundation for advancing medical science. Many classes of medical students and PhD candidates at HST benefited from Villars’ insights.

“Professor Villars’ inspirational teaching and curriculum development helped to achieve a major objective of HST, the advancement of the health sciences, by promoting their productive interaction with the physical sciences and engineering,” said Irving M. London, founding director of HST.



Photo: Donna Coveney/MIT

“Throughout my years of contact with Felix, I always found him to be a patient listener, insatiably curious, intellectually rigorous, and always kind and considerate,” said Dr. Richard Cohen, the Whitaker Professor of Biomedical Engineering at HST. “It was a true privilege to have had the opportunity to work with such a preeminent scientist and fine human being. He certainly had a great impact on my career and served as a role model as scientist, teacher and colleague. I will miss him greatly and remember him often.”

#### **BROAD IMPACT**

Villars’ research had impact on diverse areas of physics.

In the infancy of quantum electrodynamics, he and the Swiss Nobel laureate Wolfgang Pauli developed a simple and elegant method to regulate the mathematical singularities in quantum field theory and extract finite physical results. The resulting method, known as “Pauli-Villars regularization,” was widely influential and is known and used by all students of field theory.

In nuclear physics, he was the first to recognize that the exchange of mesons generating the nuclear force also contributes to the electromagnetic properties of nuclei. With this insight, he calculated the magnetic moments of the three-body nuclei helium and hydrogen and laid the foundation for the systematic study of the effects in nuclei of meson exchange current. He also developed the theory governing the collective rotations of deformed nuclei, such as uranium. Building upon these theoretical developments, both meson exchange currents and rotational states in deformed nuclei were fields of active investigation at MIT’s Bates Electron Accelerator Center in Middleton.

Villars collaborated with two other eminent theoretical physicists of his generation at MIT on problems in atmospheric physics. With Institute Professor Victor F. Weisskopf, he studied the scattering of radio waves due to atmospheric turbulence. He and Institute Professor Herman Feshbach studied the effect of the earth’s magnetic field on ionization in the atmosphere.

Later, Villars studied biology and mastered the complexity of biological systems. He then applied rigorous mathematical analysis to elucidate the functioning of biological systems. On the basis of this work, he developed insights not previously discovered by biologists and physiologists who had been working in these areas for years. His mission also included teaching these discoveries.

#### **BRILLIANT LECTURER**

Villars was an extraordinary teacher. He delivered brilliant lectures to both graduate and undergraduate students in nearly every subject offered by the Department of Physics. He had the gift of inventing original and insightful problems, which he formulated with great clarity. Students who solved these problems

developed insight and confidence in the power and usefulness of the principles of physics.

His courses in quantitative physiology and respiratory pathophysiology at HST were master classes for medical students who sought a deep quantitative insight into organ physiology in health and disease.

His undergraduate textbook, a three-volume work titled “Physics with Illustrative Examples from Medicine and Biology,” co-authored with MIT professor George B. Benedek, demonstrated to students at the very beginning of their college careers that the principles of physics could illuminate the inner workings of a broad range of biological and medical phenomena.

“His knowledge was profound, encyclopedic and crystal clear,” said Benedek, the Alfred H. Caspary Professor of Physics. “He freely helped his students and professional colleagues to understand deeply an exceptional range of science. He was a rare intellect and brilliant teacher who elevated those who had the good fortune to know him.”

Born in Biel, Switzerland on Jan. 6, 1921, Villars received the diploma in physics and mathematics from the Swiss Federal Institute of Technology in Zurich in 1945. He was awarded the Kern Medal for an outstanding undergraduate thesis. During World War II, he served in the Swiss army as a meteorologist and then returned to the Swiss Federal Institute to earn his doctorate in 1946.

From 1946 to 1949, he was a research assistant at the Swiss Federal Institute of Technology, where he collaborated with Pauli on their paper on quantum field theory. He married the former Jacqueline Dubois in 1949 and they moved to the United States, where he was a visiting member of the Institute for Advanced Study in Princeton, N.J., for a year before settling permanently at MIT.

He began his MIT career as a research associate in 1950, was appointed assistant professor in 1952, associate professor in 1955, and full professor in 1959. He served as chair of the faculty from 1980 to 1983. He was also a lecturer at Harvard Medical School.

In addition to his wife, he is survived by four children, Fred of Philadelphia, Cecile of Belmont, Monique of the Netherlands, and Philip of Northboro; a brother and sister, Hans and Mireille of Switzerland; and three grandchildren. Burial will be at the family’s summer home on Cape Cod. A memorial service will be held at MIT in the fall. A memorial fellowship fund will be established at MIT. ●