Willis Lamb Jr., 94, Dies; Won Nobel for Work on Atom

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Willis E. Lamb Jr., who shared the 1955 Nobel Prize in Physics for the discovery of a slight and subtle discrepancy in the quantum theory describing how electrons behave in the hydrogen atom, died on Thursday in Tucson. He was 94.

- Willis E. Lamb Jr.

The cause was complications of a gallstone disorder, according to the University of Arizona, where Dr. Lamb was an emeritus professor of physics and optical sciences.

Although the discrepancy, which became known as the Lamb shift, in the hydrogen atom was slight, it was one of the first direct experimental signs that empty space is not empty. Instead, empty space roils with “virtual particles” that pop into and out of existence too quickly to be detected. The Lamb shift results from the virtual particles’ bumping into an electron orbiting in the hydrogen atom and altering its orbit slightly.

The discovery of the Lamb led to a rethinking of quantum mechanics and the development of quantum electrodynamics, which incorporated the virtual particles into the modern theory of electricity and magnetism.

Dr. Lamb’s research crossed many subjects in theoretical physics, including lasers, the scattering of neutrons off crystals and how to make the most precise measurements of objects or processes, given the intrinsic uncertainties of quantum mechanics.

His laser work, for instance, predicted another effect that bears his name, the Lamb-Bennett dip. The dip describes how the intensity of a laser drops under certain circumstances. It turned out that a colleague, William Bennett, had already observed that effect experimentally. The Lamb-Bennett dip has been used to set laser frequencies with great precision.

“Lamb would take the process apart in his mind,” said William Wing, a professor of physics and optical sciences at Arizona. “Often he would discover new effects by careful thinking at a very deep level.”

Willis Eugene Lamb Jr. was born on July 12, 1913, in Los Angeles. He received a bachelor’s in chemistry from the University of California, Berkeley, in 1934 and a doctorate in theoretical physics, also from Berkeley, in 1938.

He then became an instructor and, later, a professor at Columbia. At Columbia in the summer of 1946, he came up with the idea for the experiment that discovered the Lamb shift.

Physics of the 20th century revolved around two theories: quantum mechanics, which described how the smallest bits of matter behave, and relativity, which describes the odd effects that occur at speeds close to that of light. In the 1920s, Paul Dirac, an English physicist, combined the two in a relativistic quantum theory of hydrogen, the simplest of atoms, with a single electron orbiting a single proton. The theory predicted much of the observed behavior of hydrogen, in particular the energies that the orbits of the electron could be pushed into.

One prediction of Dirac’s theory was that two of the excited orbits would have exactly the same energy. Other scientists, who were thinking about virtual particles, suspected that there might be a difference.

To test that theory, a graduate student, Robert C. Retherford, built the experiment, which used microwave technology developed in World War II for radar. In April 1947, the experiment found there was indeed a slight difference in energy between the two orbits generated by differences in how the electrons interacted with the ephemeral virtual particles.

Dr. Lamb shifted universities several times in his career, to Stanford in 1951, to Oxford in 1956, to Yale in 1962 and to the University of Arizona in 1974. He retired in 2002.

He was a member of the National Academy of Sciences and received the National Medal of Science in 2000.

His first wife, Ursula Schaefer Lamb, died in 1996. A marriage to Bruria Kaufman, a physicist he met at Columbia in 1941, ended in divorce. He married Elsie Wattson, whom he met 27 years ago, on Jan. 26. Also surviving is a brother, Perry, of Maine.

It was in November 1955 that an early morning call from Stockholm announced that Dr. Lamb had won the Nobel. He went back to bed and slept two more hours.

He shared the prize, and the accompanying $36,720, with Polykarp Kusch, who discovered other effects of the virtual particles in a different experiment.