Obituary

# Edward M. Purcell (1912–97)

## Pioneer in nuclear magnetic resonance and in radioastronomy



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Edward Mills Purcell died on 7 March 1997 at his home in Cambridge, Massachusetts, from respiratory failure. The last time he participated in a scientific meeting was in December 1995, when the Golden Jubilee of the demonstration of nuclear magnetic resonance (NMR) in condensed matter was celebrated at Harvard University. Fifty years earlier, Purcell, H. C. Torrey and R. V. Pound had observed the magnetic resonance absorption of hydrogen nuclei in paraffin (caused by a transition from one spin state of the nucleus to another), for which Purcell shared the 1952 Nobel prize for physics with Felix Bloch. The latter had led a group at Stanford University, which independently and almost simultaneously detected nuclear induction in water.

Purcell and Bloch first met, and first discussed NMR, at the April 1946 meeting of the American Physical Society in Cambridge, Massachusetts. They realized that they were studying the same physical phenomenon, albeit with somewhat different methods. While there was a spirit of healthy competition, their cordial relations are apparent from the telegram that Purcell received hours after the announcement of the Nobel prize, "I think it is swell for Ed Purcell to share the shock with Felix Bloch".

A year earlier, Purcell and Harold I. Ewan had discovered that the microwave emission from atomic hydrogen in our Galaxy corresponds to the atom's hyperfine transition at 1,420 MHz (also a consequence of nuclear spin). This experiment was carried out on a shoestring budget. A small, horn antenna pointed out of a window on the top floor of the Lyman Physics Laboratory at Harvard University, and a microwave receiver at a wavelength of 21 cm measured the variation in the effective radiation temperature of the Milky Way as it rotated overhead past the aperture of the fixed horn. In the last year of his life, Purcell confided that he considered this and later contributions to radioastronomy at least as significant as his NMR work.

Edward Purcell was born on 30 August 1912, in Taylorville, Illinois. His father worked for a local telephone company, and as a high school student Ed tinkered with discarded telephone equipment and perused issues of the Bell Systems Technical Journal. He enrolled as an electrical engineering student at Purdue University, where he assisted a faculty member in a project on electron diffraction, and so acquired a taste for physics. He spent a year as an exchange student in Karlsruhe, Germany, before going to Harvard for a PhD working on a spherical electrostatic mass spectrometer, under the guidance of K. T. Bainbridge.

In the fall of 1940, the MIT radiation laboratory was established to further the development of radar technology. I. I. Rabi, the associate director, soon invited Purcell to join, and he became the head of the scientific development group in 1942. He was involved with the successes of X-band radar at a wavelength of 3 cm, and also learned that K-band radar, at 1.25 cm, had not been a military success because of strong absorption by water molecules in the atmosphere.

In the summer of 1945, the scientists of the radiation laboratory could all turn their attention to the question of what physics to do in peacetime. The problem of nuclear magnetic resonant absorption presented itself. Transitions between nuclear spin levels in a magnetic field had been studied in molecular beams, but hadn't been seen in solids. Purcell, Torrey and Pound were still engaged full time at the radiation laboratory, but during evenings and weekends they assembled equipment around a large electromagnet at Harvard, which had been used for cosmic-ray research in pre-war days. They borrowed a radio-frequency generator and receiver, and built a resonant cavity filled with paraffin. They observed proton magnetic resonance on 15 December 1945. Purcell described in his Nobel lecture how he had gained a new insight into the natural world: passing heaps of snow on his way home after the discovery, he wondered about all the protons precessing quietly in the Earth's magnetic field.

In February 1946 Purcell accepted me as a laboratory assistant. He, Pound and Torrey were still employed full time writing volumes of the MIT radiation laboratory series. Having spent the war in the Netherlands, occupied by Hitler's forces, I now had the good fortune to find myself in the right place at the right time. Purcell was most helpful in getting me started — he knew what it was like to be a foreign exchange student from his days in Germany. Purcell, Pound and I concentrated on problems of nuclear magnetic relaxation. We introduced the concept of motional averaging of local magnetic fields, which results in extremely sharp resonances in fluids. We did not foresee the widespread applications that were to follow, including the use of high-resolution NMR spectroscopy in chemical analysis and the development of magnetic resonance imaging in medical diagnostics.

In the 1950s and early 1960s, Purcell served on a number of high-level government committees. As a member of the Presidential Scientific Advisory Committee he twice made a presentation to President Eisenhower on the issues of space technology and space exploration. He was happier, however, when he could again devote all his professional time to teaching and research. He wrote a well-known textbook on electricity and magnetism for a Berkeley physics series. He was artistic, and carefully prepared his own drawings and figures. He did theoretical and experimental work on the search for a magnetic monopole, analysed the motion of interstellar dust particles and studied the locomotion of bacteria in fluids — which resulted in the popular lecture and publication *Life at High Reynolds Number*.

From 1960 on, Purcell no longer wanted to be responsible for a laboratory or graduate students. He preferred to discuss broad scientific issues with colleagues, and work out the details on his own. He was a deep thinker and valued his private life. He was modest and never actively sought recognition, although he enjoyed receiving the honours that were deservedly bestowed on him. It is a privilege to have known him as a person and as a scientist.

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