Peter Mansfield

(1933–2017)

Physicist who developed MRI, revolutionizing medicine.

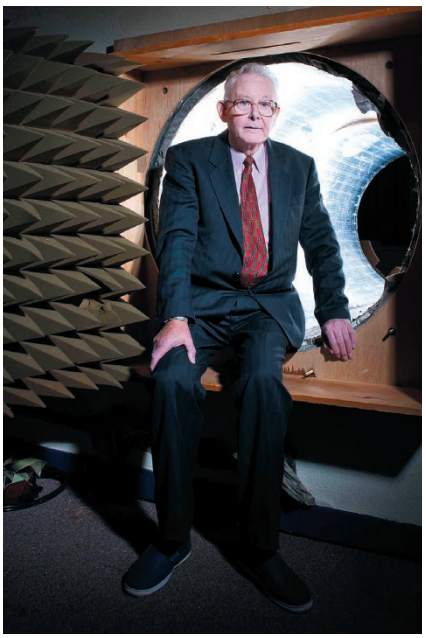
Millions of people have benefited from an insight that Peter Mansfield had in 1972, which led to the development of magnetic resonance imaging (MRI). A classically trained physicist, Mansfield realized he could exploit the phenomenon of nuclear magnetic resonance (NMR) to create cross-sectional images of living tissue. The safe and non-invasive technique he developed images soft tissue and organs in a 'slice' of an organism in spectacular detail, revolutionizing medical diagnosis and changing how the human brain is studied. The work won him a share of the 2003 Nobel Prize in Physiology or Medicine.

Mansfield, who died on 8 February, was born in London in 1933, in the most ordinary of circumstances. His father was a gas fitter, his mother a waitress. His school education, disrupted by war, ended at age 15. Working in a printing firm, he continued his schooling at evening classes, and later worked in the rocket-propulsion department of Britain's wartime Ministry of Supply in Westcott. After a stint in the army, Mansfield studied science in part-time courses that took him into a physics degree at Queen Mary College, London, at the age of 24.

Here, he established an enduring link with NMR physicist Jack Powles. NMR exploits the fact that nuclei of certain atoms, including hydrogen, act like tiny bar magnets and line up in a magnetic field. Subjected to pulses of a radio-frequency magnetic field, their alignment is disturbed, and a signal can be detected as their magnetization returns to equilibrium. From this, the structure of the molecules in which the atoms sit can be inferred.

In 1959, as a PhD student, Mansfield discovered an unexpected 'solid echo', observable in some solids following a pair of NMR radio excitation pulses. The finding required sophisticated quantum mechanics to explain, and caught the attention of NMR pioneer Charles Slichter, who invited Mansfield for a postdoc at the University of Illinois, Urbana. Soon after he was recruited by Raymond Andrew, his PhD examiner, to the physics department at the University of Nottingham, UK, where he remained for the rest of his career (and where we met).

In 1972, Mansfield was struck by the possibility that NMR could be an alternative to X-rays for studying crystal structures. He realized that he could formulate spin physics in 'k-space', a mathematical concept used in crystallography, to image the spatial distribution of spins. In a key experiment, he applied a magnetic field gradient (an uneven field) to a sample of millimetre-thick layers of camphor, a waxy material, between plastic sheets, and measured the NMR spectrum. The field gradient spread out the NMR signal into an unmistakable diffraction pattern of the layers. This information could then be reconstructed as an image using the well-known mathematical Fourier transform.



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Mansfield learned that Paul Lauterbur (who later shared the Nobel prize) had almost simultaneously shown that rotating a magnetic gradient could produce crude NMR images of liquids. So he, too, moved to imaging liquids, given the potential for imaging living tissue with its high water content. Mansfield invented a way to select a slice of a material to be imaged, and a key concept, 'line-scan imaging', to create the image. This work was part of a succession of groundbreaking papers and the first book on MRI, *NMR Imaging in Biomedicine* (Elsevier, 1982).

In 1977, Mansfield's team created the first MRI image of a live human body part, a cross-section of a student's finger. This enabled the group to obtain funding for a magnet large enough to scan the entire human body. In 1978, Mansfield and his team were confident enough in the scanner they had built to image a human — although they had concerns that the large magnetic field could induce a heart attack. Mansfield was the brave guinea pig, and became the first person to have their abdomen imaged using the relatively speedy technique of line-scan MRI.

Imaging speeds concerned Mansfield, and in 1977 he developed echo-planar imaging (EPI) to address the problem. EPI requires rapidly switched magnetic field gradients to collect the data needed to form an entire image in a fraction of a second, about 100 times faster than earlier methods. Mansfield developed this mainly for cardiac imaging, producing the first real-time MRI observations of coronary vessels.

The first MRI scanner for clinical use was built in 1980 at the University of Aberdeen and was on the market by 1984. The technique's non-invasiveness and excellent soft-tissue contrast led to dramatic developments in diagnostic radiology, driving a new industry.

In the late 1980s, having been recruited from Mansfield's Nottingham lab to the US National Institutes of Health, I showed that EPI could instantaneously map changes in cerebral blood oxygenation, which led to functional MRI (fMRI) techniques, now used to probe human brain activity in real time.

Mansfield was elected a fellow of the Royal Society in 1987 and knighted in 1993. He held many patents and felt it important that inventors were properly rewarded. Significant patent royalties and increased research funding led to the opening of the Sir Peter Mansfield Imaging Centre, dedicated to MRI research, at Nottingham in 1991.

Peter (always known to his team as 'PM') retired in 1994 but continued to collaborate with colleagues. His leadership, enthusiasm, meticulousness and scholarship set a high standard. Always devoted to the experiment, he was happiest in the lab. He also loved languages, and once arranged for a postdoc to teach his research team Arabic. Warm and generous, he nurtured a steady flow of talented PhD students to supply the burgeoning field of MRI science. Many remember fondly his profound unpretentiousness — his often-repaired spectacles and worn-out shoes — and his wry smile. ■

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