Sayers, James

by Linde Lunney and James G. Lunney

Sayers, James (1912–93), physicist, was born 2 September 1912 in Lislabin, Corkey, Co. Antrim, elder of two sons of James Sayers, a prosperous farmer, and his wife Rachel (née Matthews); he probably had an older sister (who may have died young) and a younger sister. James junior was much more interested in science than in farm work; as a boy he constructed an overshot waterwheel on a small river to power a dynamo which supplied the farm with electricity. After attending Ballymena Academy, he studied physics at QUB. Like David Bates (qv), who was almost contemporary at Queen's, Sayers worked with Karl George Eméleus (qv) and developed a lifelong research interest in negative ions and the ionosphere. His sister Nina Dorothy Sayers studied with Eméleus and was awarded a Ph.D. for her thesis on optical spectroscopy, 'Forbidden transitions', in 1951.

In 1935 James Sayers did an M.Sc. thesis on 'Negative ions in oxygen' in Queen's, and continued his postgraduate research in St John's College, Cambridge. In the summer of 1938, when war appeared imminent, he was one of about eighty scientists recruited to work on contract for the Admiralty. He was employed in the University of Birmingham, where a research programme to develop radar had hurriedly been established. A chain of what were at first called radio-location stations had been established round the British coast in the 1930s. The stations could provide limited advance warning of incoming aircraft, but there were many difficulties; at the time, the shortest wavelength on which significant power could be generated was about 1.5 metres. These very long wavelengths operated more like floodlights than like searchlights; range and accuracy were limited. The radio-location stations could not be moved and were vulnerable to attack. In 1936, binoculars were still the only way to detect aircraft over the sea, and airborne and ship-based radar transmitters and detectors were urgently needed.

The team sought ways to produce much shorter wavelengths at much higher power, to enable the development of mobile systems with smaller antennae and efficient power supplies. The stated goal was the development of centimetric radar. Sayers was the only one with much experience of radio, and worked with Professor Mark Oliphant on an existing microwave generator called a klystron. However, in early 1940, their colleagues J. T. Randall and Harry Boot developed the rival transmitter, the magnetron, into a much more efficient device. They seem to have started from the idea of making a three-dimensional version of the famous wire loop resonator associated with Heinrich Hertz, to use as a continuous wave generator. From a solid block of copper, they produced a valve oscillator featuring an evacuated cavity with lobed slots. Electrons emanating from a central cathode were accelerated by a radial electrical field, and held by a magnetic field on a circular path in the cavity, past the slots. The resulting high-frequency resonance produced microwaves (short wavelength radio waves). Randall's and Boot's first model of February 1940 had an output of almost a kilowatt, and it produced radio waves at a wavelength of less than ten centimetres – on both measurements almost one hundred times better than previous radar transmitters. Eric Megaw (qv) was responsible for further developing the cavity magnetron; by May 1940, the magnetron could produce 12kW at 9.5 cm wavelength. Megaw's modifications to the design also made it possible to manufacture the magnetron in industrial quantities and on a production line, at first in the teaching laboratories of Birmingham university.

However, the transmissions of which the new magnetron was capable were prone to frequency instability, making it unreliable and much less useful. In September 1941, after lengthy experiments, it was Sayers who came up with a simple but radical improvement to the architecture by putting copper straps across alternate segments of the valve, which made it possible to stabilise the resonance as desired, and to achieve still more efficiency in output. This modified magnetron produced the version of radar used in British defence and in bomb-aiming and combat for the rest of the war and long afterwards; it was the most important technological breakthrough in the early years of the war. The new device improved the resolution of radar, so that it was even able to pick out details such as gun barrels or periscopes on its targets, and over much longer distances. The scientists worked night and day to make several further changes, such as developing lighter permanent magnets, to make it possible to mount the transmitters and receivers on ships and planes, and the new radar was a decisive factor in securing the Allied victory in the crucial battle of the Atlantic. Later, long after the war, the magnetron technology was used in developing the domestic microwave oven; in the very first demonstrations in Birmingham, it was noted that people's hands holding testing equipment nearby became uncomfortably hot.

In 1943 Sayers was seconded with many other British scientists to work in the United States on the top-secret Manhattan Project, developing the atomic bomb. After the war, he returned to Birmingham in 1946 to become professor of electron physics in the university there. There had been difficulties between Sayers and colleagues, especially with Randall, but his role in the invention of the cavity magnetron was acknowledged in 1949 when he shared with Boot and Randall in a £36,000 award from the royal commission for awards to inventors. They also shared the John Price Wetherill Medal of the Franklin Institute in 1958.

Sayers was a professor in Birmingham until 1972. Even as early as 1942, when he was asked to write a review article in the Institute of Physics journal *Reports on Progress in Physics*, he was well established in the field of ionospheric physics, which was perhaps the most important area of physics research in the period. Immediately after the war, scientists, the military, governments and commercial interests all recognised the crucial importance of enhanced knowledge of various aspects of the upper atmosphere. Newly developed forms of communication-radio, telephony and television broadcasting, as well as radar, were based on electromagnetic waves being reflected by the ionosphere. At the same time, scientists investigating the potential or the threat of nuclear weapons and ballistic missiles, so fundamental to the cold war, needed to understand the atmospheric conditions through which such missiles would pass. Sayers's group was particularly interested in the interaction of solar radiation with the upper atmosphere, and many experiments and publications resulted from their experiments and analyses.

In 1955 Sayers was one of the founding members (along with Bates and Eméleus) of a small sub-committee established by the Royal Society, which mapped out the future of British upper atmosphere research; the British National Committee on Space Research planned for experiments to travel on specially designed rockets. This was the beginning of the UK's space programme. The first Skylark rocket to carry scientific experiments was launched from Woomera in Australia in 1957; it carried a radio-frequency probe from Sayers's group, intended to measure electron density in the atmosphere. The rocket programme continued for years; public interest in its successes and occasional failures was a major feature of British life in the 1960s, with newspaper and other coverage of launches and outcomes; even popular entertainment, music and fashion acknowledged the inspiration of space.

Even as the first Skylarks were sent up, Sayers and colleagues were planning the next generation of probes, and it was decided that the UK should partner the US in constructing satellites to be deployed in near-earth orbit. Sayers was in the small group which in 1959 travelled to America to negotiate with NASA, then newly established. The first international space project, the satellite Ariel 1, was sent up in April 1962, but that same summer, the US tested a nuclear device over the Pacific, and the resultant wave of intense electromagnetic radiation seemingly knocked out part of Sayers's equipment on the satellite. Nonetheless, there were important results from Ariel 1 and later Ariel satellites; using Sayers's Langmuir probe, the Ariel 1 mission discovered a new layer in the equatorial ionosphere.

James Sayers bought back the family farm in Corkey, Co. Antrim, which had been sold by his brother, and lived there in retirement from 1972. He kept bees and did some farming. He had always been painfully shy, and perhaps found it hard to fit in again after so long away, so it seems he was not much involved in the local community in north Antrim. He had married an Englishwoman, Diana Montgomery, in 1943; they had two sons and a daughter. He died 13 March 1993.

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