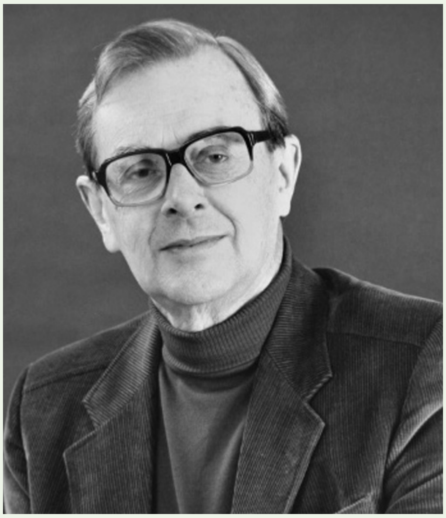
OBITUARY

Brian Pippard (1920–2008)

Low-temperature physicist who excelled in subtle intuitive concepts.



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Brian Pippard, who died on 21 September, had many achievements, but will be remembered particularly as the first experimenter to map the Fermi surface of a metal, for his non-local theories of the response of normal metals and superconductors to electric fields, and as dynamic head of physics at the University of Cambridge from 1971 to 1982.

Pippard grew up in Bristol, UK, and at school proved exceptional in music as well as science. He entered Clare College, Cambridge, in 1938, and, doubting his mathematical ability, chose first to study chemistry, before switching to physics to make himself useful during the Second World War. He worked at the Great Malvern research establishment on a radar device for tracking mortar projectiles, returning to Cambridge for his PhD in 1945.

He was already familiar with the skin effect, the restriction of microwave fields to a thin surface layer in metals, and his supervisor David Shoenberg encouraged him to study it in superconductors — materials that mysteriously lose all electrical resistance below a sharply defined transition temperature. In 1935, Fritz and Heinz London had hinted that a superconductor might be a quantum fluid, a system of many electrons governed by a wavefunction similar to that of a single electron, as though they were all in the same quantum state. In such a system, the inertia of the superelectrons should lead to a purely inductive conductivity at high frequencies. By measuring the frequency and bandwidth of microwave resonators made of tin and mercury, Pippard successfully observed this effect when he cooled the resonators through their superconducting phase transitions.

Pippard's experiments were models of simplicity. For instance, the frequency of his klystron microwave source had to be stable to one part in a million, yet he achieved this using no more than draught protection, a micrometer tuner with a weight and pulley to eliminate backlash, and a stack of carefully aged high-voltage batteries as power supply.

In 1940, Heinz London had noticed that the microwave surface resistance of normal metals, instead of falling steadily with falling temperature as the resistivity did, reached a limit. Pippard confirmed this 'anomalous skin effect' in his own samples and realized that it occurred when the electron free path became larger than the skin depth, and that only those electrons moving parallel to the sample surface remained effective in responding to the electric field. This idea led quickly to a complete theory of the effect, published in 1948 by Harry Reuter and Ernst Sondheimer, and Pippard's simple ineffectiveness concept was later applied in understanding many other phenomena, such as cyclotron resonance and ultrasonic attenuation in metals.

After his doctorate, Pippard became interested in the stability of normal metal–superconductor (NS) boundaries, and introduced the idea that their energy was determined by a characteristic coherence length. This length was later identified with that of the celebrated Ginzburg–Landau theory, and proved crucial in understanding the physics of type II superconductors, used in making superconducting magnets.

Pippard's work on the anomalous skin effect encouraged him to wonder whether, just as in normal metals the current at a given point depends on the electric field at neighbouring points through which the electrons had travelled since last being scattered, the superconducting current might likewise depend on the electric field at distant points — the range being limited by an electromagnetic coherence length. In 1953 he proposed a model of this non-local effect. It proved entirely successful; and in 1957, when John Bardeen, Leon Cooper and Robert Schrieffer published their revolutionary theory of superconductivity, they were at pains to demonstrate that it confirmed Pippard's model.

In 1954, Pippard pointed out that in the anomalous skin effect, the surface impedance of a metal is related to its Fermi surface — the theoretical boundary in momentum-space within which the conduction electrons of a metal reside — and in fact provides a measure of the curvature of this surface near the effective electrons. In 1955, during a sabbatical year at the University of Chicago, Pippard measured the surface resistances of single-crystal samples of copper in various orientations, and on his return to Cambridge used his data to map out the Fermi surface of copper, a widely recognized tour de force. He was elected to the Royal Society in 1956.

In 1962, Pippard's student Brian Josephson independently proposed a theory of quantum tunnelling between superconductors, which subsequently earned him a Nobel prize (in 1973). Pippard was not directly involved, but later enthusiastically took up the study of the physics of SNS Josephson junctions, and of the peculiar phenomena that occur when the superconducting current is converted to normal current at an SN interface. During the same period, his book *Dynamics of Conduction Electrons* established him as an expert on all aspects of Fermi-surface phenomena, especially magnetoresistance, helicon waves, and magnetic breakdown in which electrons tunnel through momentum space from one part of the surface to another.

In 1966, Pippard became the first president of Clare Hall, informal and happy home of graduates and distinguished visitors, and of his wife Charlotte and their three daughters. In 1971, he was elected to the Cavendish chair in the department of physics, but even before that had been the moving spirit behind the much needed transfer of the Cavendish Laboratory to new buildings.

As head of department from 1971, he encouraged innovative research and tried persistently — though not always successfully — to close down areas he judged to be less worthy. He was proactive in the reform of undergraduate teaching, and insisted on lecturing ability in staff appointments. He was himself always a stimulating teacher, and his perceptive *Elements of Classical Thermodynamics* and challenging *Cavendish Problems in Classical Physics* excited and tormented generations of students. He was president of the Institute of Physics during 1974–76.

Brian could be idiosyncratic. He was suspicious of mathematical formalism, and once, when invited to deliver a keynote speech to an international audience, selected as its title 'The cat and the cream', and startled his listeners by announcing the imminent demise of solid-state physics. He was capable of great kindness, but also relished being boyishly clever: his inaugural lecture as Cavendish professor was planned around an intriguing series of bench experiments whose outcomes the assembled practitioners, young and old, were invited to predict, by show of hands. We duly got most of our predictions wrong, as he intended.

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