spatially extended non-equilibrium systems near bifurcation points, where dynamical behaviour is expected to be universal.

Nature, however, rarely operates near such points unless artificially encouraged. In other systems showing defect-mediated turbulence, from fluid convection[8,9] to surface catalysis[10] to heart muscle[11], the transition from order to chaos occurs via what seem to be different wave instabilities or entirely different dynamical mechanisms. In most of these systems, and particularly in heart tissue, where electrical-wave turbulence directly affects human health, theory and experiment are yet to meet in a clean and convincing way. A major challenge also lies ahead in characterizing the complex dynamical state that forms after the onset of turbulence. That requires the development of theoretical tools to describe the collective behaviour of defects. Are all these systems really turbulent after an indefinitely long time? Do they behave completely differently, or do they share common behaviours, beyond the superficial fact that they all have topologically similar defects? Can defect-mediated turbulence perhaps be controlled? Much research is now being focused on these questions, and pieces of the puzzle are starting to be assembled. □

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OBITUARY

Stanley Keith Runcorn (1922–95)

THE death of Keith Runcorn, who was murdered in San Diego on 5 December, has shocked geophysicists the world over. Runcorn was a central player in two of the crucial debates in Earth science in the mid-twentieth century — those over the origin of the Earth's magnetic field and the validity of the theory of continental drift. At the time of his death he was on his way to a meeting from the University of Alaska, where he had occupied an endowed chair following his retirement in 1988 from the University of Newcastle upon Tyne.

Lancashire born, Runcorn read mechanical sciences at Cambridge during the Second World War, and then planned to do research on cosmic rays under Patrick Blackett at Manchester. He became a geophysicist almost by accident, by becoming involved in a long-standing controversy over the Earth's geomagnetic field. Blackett was developing a theory to explain the origin of the field, and in 1947 published it in a *Nature* paper entitled "The magnetic field of massive rotating bodies". These ideas were jelled by the addition of H. Babcock's observation that the ratio between the magnetic moment and angular momentum for the star 78 Virginis is similar to that of the Earth, and also to that previously determined for the Sun. Thus magnetic moment was inferred as a fundamental property of all massive rotating bodies. If this theory were correct, the geomagnetic source region must comprise the whole Earth out to its surface. On the other hand, the geodynamo theory of Walter Elsasser and Edward Bullard required the field to originate entirely within the Earth's outer core of liquid iron.

Runcorn decided that it should be possible to distinguish between the two ideas by taking magnetometers down the coal mines of his native Lancashire to measure the variation of geomagnetic field intensity with depth. The result turned out to favour the 'core' principle. Two of the students who worked on the experiment, Raymond Hide and Frank Lowes, subsequently gained eminence for their own contributions to geophysics. Others were to follow.

Blackett had preferred to test his rotating body theory by detecting whether a weak magnetic field existed near a rotating gold sphere, and he designed a highly sensitive astatic magnetometer for this purpose. The result was negative, and he sought another

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Godfrey Argent

use for his magnetometer. With John Clegg, he found that it could measure weak remanent magnetization in sedimentary rocks, and thereafter he became interested in rock magnetism.

In 1950, Runcorn moved to Cambridge and started a research group in palaeomagnetism; Ted Irving and myself were his first research students. The team grew and within a few years showed that the British Isles had been moving relative to the geographical poles throughout the Phanerozoic; the resulting 'polar wander' curve attracted wide public as well as scientific attention. In 1955 Runcorn moved to Newcastle, and after several summers' field work produced a 'polar wander' curve for North America. Irving, working in Canberra, carried out a similar survey for Australia, and from Newcastle I did the same for South America. Alan Nairn worked on rocks from Africa. Meanwhile the Blackett/Clegg group, now in London, worked mainly on India. The upshot was that it became clear that the continents had moved horizontally relative to each other, as well as to the geographical poles, broadly verifying Alfred Wegener's concept of continental drift. But the palaeomagnetic evidence was regarded with suspicion by many geologists, and it took almost two decades for this revolution in the Earth sciences to become generally accepted, even when the evidence from sea-floor spreading and the theory of plate tectonics came along.

Keith Runcorn remained unmarried, which gave him the freedom to devote his life to his science. He was a restless traveller, so much so that at Newcastle he became fondly known as the 'visiting' professor of physics. He took such remarks in good part because he knew, as we all did, that perhaps more than any other person it was he who put the university on the map scientifically. On the other hand, he never showed any interest in university politics, nor did he become much involved in the administration of scientific societies. He did, however, have a vision of a pan-European society for geophysics, equivalent to the American Geophysical Union. This vision has become a reality in the form of the flourishing European Geophysical Society.

For all his achievements and many awards, Keith Runcorn remained modest and unpretentious. His reputation as one of the foremost geophysicists of his generation will remain long after his death, as will memories of his warmth and sincerity. Kenneth M. Creer

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