books

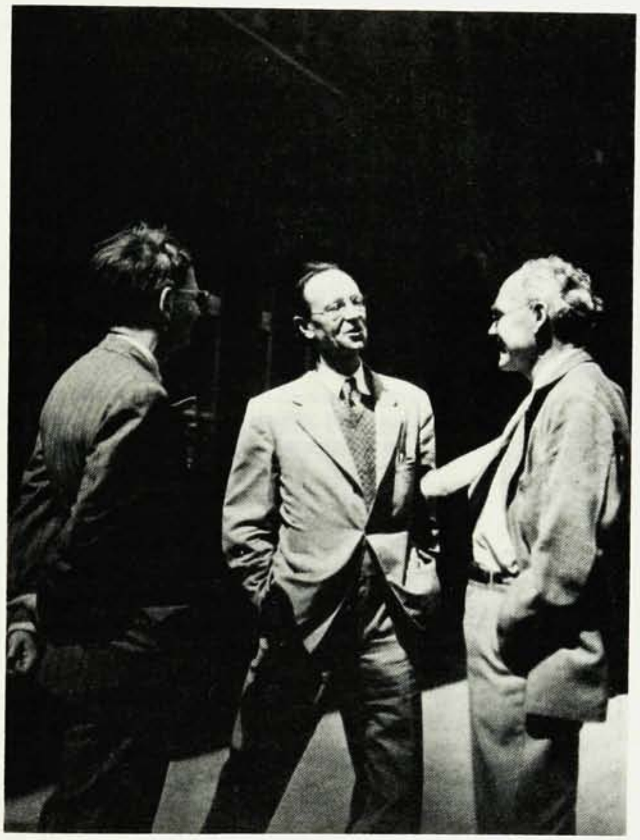
An instructive odyssey through physics

Bird of Passage: Recollections of a Physicist

Rudolf Peierls

350 pp. Princeton U.P., Princeton, N.J., 1986. $29.50

Reviewed by Hendrik B. G. Casimir



Discussion at Cambridge in 1947: from left, Rudolf Peierls, James Chadwick and G. I. Taylor. (Photo courtesy of Rudolf Peierls.)

Rudolf Peierls, born in 1907, belongs to a generation of theoretical physicists who began their scientific careers just after the birth of quantum mechanics, absorbed the new discipline simultaneous with and sometimes even before classical mechanics and contributed much to its further development and to its applications. A German of Jewish descent, Peierls turned his back on Germany when Hitler came to power. He found a new home in England, thus becoming part of the exodus that deprived Germany of many of its best brains and that contributed significantly to the intellectual supremacy of the English-speaking countries.

He was born near Berlin, of a well-to-do family. His father was managing director of a factory of AEG (the German General Electric) and later became a board member of that company. Peierls began his academic studies at Berlin, but after two semesters he left home and studied successively at Munich with Arnold Sommerfeld, at Leipzig with Werner Heisenberg and at Zurich with Wolfgang Pauli, who in 1929 appointed Peierls as his assistant. Peierls stayed with Pauli until the summer of 1932. (It so happens that I was his successor.) In the meantime he did much traveling: to Holland, to Denmark, to Russia, where he met his future wife. Although Peierls traveled more than most young physicists, such *Lehr- und Wanderjahre* (years of apprenticeship and travel) were not unusual in Germany.

In 1932 he went to England. There he lived on various grants and temporary appointments until 1939, when he became a professor of mathematical physics at Birmingham. He had hardly settled down there when war broke out. In his case this led to a period of intense activity, but also to an interruption of his more fundamental work. Together with Otto Frisch he analyzed the conditions for a nuclear explosion in uranium-235, and he also studied the various methods of isotope separation. From 1943 to 1945 he worked in the United States, both in New York and in Los Alamos. After the war he returned to Birmingham; he stayed there the next 17 years, but continued to travel a lot, combining business with pleasure. In 1963 he moved to Oxford as Wykeham Professor, and he remained at Oxford after his retirement in 1974. Such are the rough outlines of a very active and varied life, a life that he writes about in considerable detail, with modesty, objectivity and a dry sense of humor.

What he writes about his work in physics is sketchy, but sufficient to remind the expert of its main features and to impress experts and outsiders alike with his outstanding facility in mastering new branches of knowledge. At school he managed to get high marks in all subjects without really exerting himself; later he seemed to move equally easily from one special field to another. That characteristic made him an excellent teacher and leader of young theoreticians. His ideas on teaching and his warning against too narrow specialization deserve close attention. He himself never wanted to be considered a specialist in one restricted field. Throughout the years he applied his insight as a theoretical physicist not only to problems in physics but also to the problems of

Hendrik Casimir belongs to the same generation as Peierls. He studied and worked at Leiden, Copenhagen and Zurich. After World War II he became research director of Philips Electrical. Casimir is the author of *Haphazard Reality* (Harper and Row, 1983).

society, especially those of nuclear arms. His views on such matters strike me as sound and realistic.

One gathers that Peierls and his wife Genia took difficulties in their stride also in their practical life. He writes lightheartedly about boats and trains nearly missed, about broken-down cars and about moving house with a six-week-old baby. The generous hospitality of the Peierlses is in line with that attitude.

It is almost unavoidable that a book of this kind, written largely from memory, will contain some inaccuracies. For instance, Hanni Bretscher did not take part in the climb of her husband Egon and Felix Bloch during which Bloch fell down and broke a leg. Liquid helium does not show a strange behavior below 4.2 K (the boiling point), but below the lambda point, 2.19 K. Another criticism might be that the enumeration of a large number of students, coworkers and visitors, often without much detail, is not particularly meaningful to someone who has never met them. But such minor points do not detract from the value of this entertaining and instructive odyssey.

There is one serious omission. In his early work Peierls explained the positive Hall effect. He was the first to show that an unoccupied state near the top of an energy band behaves as a positive particle. That much we find in the book. But the notion of positive holes has become an absolutely indispensable element of solid-state electronics. Without it our present-day computers, calculators, quartz watches and so on could not have been designed. Writers on the history of solid-state electronics often fail to mention that it was Peierls who introduced that notion, and he himself does not stress the point. As a reviewer of his book I consider it my duty to do so.

Accretion Power in Astrophysics

J. Frank, A. R. King and D. J. Raine
262 pp. Cambridge U.P., New York, 1985. $59.50

The process of accretion by celestial objects has gained considerable new interest in recent astronomical research because of the discovery of "compact (binary) x-ray sources." These stellar-sized x-ray emitters are thought to be neutron stars onto which is falling matter from a companion star (around which the compact star is also revolving). Because the gravitational field on the surface of a neutron star is some 10^{11} times that of the Earth, the matter arrives at very high velocities (at substantial fractions of the speed of light). The associated kinetic energy is deposited partly in an "accretion disk" that forms around the neutron star and serves to remove the matter's relative angular momentum, and partly on the stellar surface. The energy lost by friction in the disk and on impact at the surface is radiated mainly at x-ray wavelengths for accreting neutron stars or putative solar-mass black holes, but may be radiated as well at longer (uv and optical) wavelengths for accreting white dwarfs ("cataclysmic variables") or very massive black holes (active galactic nuclei? quasars?).

Accretion Power in Astrophysics, written by researchers in the field, is a first attempt to summarize knowledge of accretion physics, accumulated from hundreds of research papers, in a comprehensive, rather concise graduate-level book. It will provide the student and the interested professional astronomer or physicist with a solid introduction, long overdue, to a fascinating topic.

The book starts off with the basic concepts and such key words in accretion jargon as the "Eddington limit," describes the expected spectra and goes on to summarize gas dynamics, steady spherically symmetric accretion and plasma and shock dynamics before covering accretion of high-angular-momentum matter in binary systems. In this last section the authors discuss the so-called Roche lobe and the all-important sources of viscosity and, subsequently, disk formation. Disk physics is described in some detail: the relevant time scales (dynamical, viscous and thermal); steady, thin disks and their spectra; and instabilities and time-dependent phenomena. The book then takes us from the disk to the compact object itself. It describes boundary layers between disks that extend all the way to the stellar surface (low magnetic fields) and boundary layers for a strongly magnetized neutron star or white dwarf, where the disk terminates outside the star. This is the case when an equilibrium stellar period can be established, at which the accretion torques on the star vanish. A very detailed (perhaps too detailed) discussion of accretion columns comes next, followed by a short (maybe too short) discussion of black holes.

Most of the remainder of the book deals with the large accreting objects that may be the working parts of quasars and active galactic nuclei. The authors describe the basic radiative properties of these objects in a very useful summary and mention briefly three models for the nucleus, along with their pros and cons. Of the three, they suggest, along with many workers in the field, that supermassive black holes are the best models for quasars and active nuclei. They thus go on to analyze the supply of gas for accretion and the possibilities of spherical and