Physics and Homi Bhabha

Rudolf Peierls

Homi Jehangir Bhabha: Collected Scientific Papers. Edited by B. V. Sreekantan, Virendra Singh and B.M. Udgaonkar. *Tata Institute, Homi Bhabha Road, Colaba, Bombay 400 005, India:1986. Pp.1,023. Institutions Rs 500; individuals Rs 250. Outside India $150.*

HOMI Bhabha was a highly talented scientist, and also a painter of distinction. But he will be remembered above all for the part he played in the development of science and atomic energy in India.

Bhabha came from a well-to-do and sophisticated Parsee family. After studying mechanical sciences at Cambridge, he started research in theoretical physics in 1930. This was an exciting time for physicists and Bhabha became attracted by the phenomenon of cosmic rays. He wrote his first paper on this subject, which remained his dominant interest thereafter. He developed the theory of cascade showers (simultaneously with Carlson and Oppenheimer) which explained many of the otherwise mysterious observations, and led to the conclusion that the penetrating component could be explained only by a breakdown of the quantum theory, or by a new particle, which indeed turned out to be the muon. His many papers on other subjects, such as electron–positron collisions ("Bhabha scattering"), new kinds of wave equations, and meson theory, all had potential applications to cosmic rays, which he kept clearly in mind.

By the late 1930s Bhabha was well established in Cambridge, while also visiting many other European institutions. We do not know how long he would have continued in Britain, but he happened to be in India on holiday when the Second World War broke out and prevented his return. He became a Reader, and later a Professor at the Indian Institute of Science in Bangalore, and built up a strong group, mainly on cosmic-ray research.

Bhabha, however, was also endowed with formidable administrative energies. He saw the need for a national institute devoted to fundamental research, and on his initiative the Tata Institute was founded, with him as director. It became an institution of high standard and exerted a profound influence on science in India. Later he realized the importance for India of nuclear power and persuaded the government to set up the Atomic Energy Establishment in Bombay, of which he was put in charge. He also became the chairman of the Indian Atomic Energy Commission. As he was also chairman of the Scientific Advisory Committee to the Cabinet, devotees of Gilbert and Sullivan might well have thought of him as the "Poo-Bhabha"! But he managed to carry out all these functions efficiently.

He did not, however, regard science from a narrow, national point of view — he was also concerned with the international relations between scientists. For three years he was president of the International Union of Pure and Applied Physics, he chaired the Geneva Conference on the Peaceful Uses of Atomic Energy in 1955 and also served in the International Atomic Energy Agency. Bhabha's death at the age of 56 in a plane crash on Mont Blanc was thus a sad blow not only to India, but also to international science.

On the 75th anniversary of his birth the Tata Institute has published this commemorative volume, most of which is taken up by his scientific publications. Some of these are familiar today, because they have become part of our recognized knowledge of physics, while others were exploring new paths which the development of physics did not follow. The collection is therefore not likely to become a research tool, but it is of great interest to the historians of physics, and to readers who want to appreciate the work of a remarkable man. Only his strictly scientific papers are included, and one hopes that Bhabha's speeches and writings on science policy and other general matters will be published separately.

Three introductory articles by B.V. Sreekantan, Virendra Singh and B.M. Udgaonkar outline Bhabha's work in cosmic-ray physics, general theory and science policy. Tributes to Bhabha at a memorial service by Cockcroft and M.G.K. Menon, and Penney's Biographical Memoir, are added as appendices.

I would have liked to see inclusion in this attractively presented book of reproductions of one or two examples of Bhabha's paintings. There is only a drawing of Blackett, hardly typical of Bhabha's work. □

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Scanning standard

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Scanning Electron Microscopy: Physics of Image Formation and Microanalysis. By Ludwig Reimer. *Springer-Verlag:1986. Pp.457. DM112.*

IN HIS preface to *Transmission Electron Microscopy* (Springer Monographs in Optical Sciences No.36), Ludwig Reimer stated that the scanning method would be covered in a complementary volume. He has now fulfilled this promise some two years later. In the present book (No. 45 in the same series), he uses the same approach as in the previous volume (*Nature* **309,** 186). But perhaps this is not surprising, as both books evolved from lectures given at the University of Münster. Translated into very readable English, with the aid of the guest editor, Dr P.W. Hawkes, *Scanning Electron Microscopy* matches the standard of its predecessor to give an authoritative and up-to-date account of the subject.

Most aspects of the subject are dealt with, except for the applications of the scanning system, which were included in an earlier text of Reimer's (*Elektronenmikroskopische Untersuchungs–und Präparations–Methoden*), and are to be found in several congress reports that have since appeared. Special attention is here given to the physical basis of scanning microscopy. The detailed processes involved in beam-specimen interaction and in image formation are first considered. Naturally there is a degree of overlap with the previous volume in respect of the former, but rather less emphasis is placed on the wave nature of the electron. A quantum mechanical treatment is given of elastic scattering and inner shell ionization, but multiple scattering and (in thicker specimens) diffusion enter frequently into scanning microscopy, and here the electron appears as a particle, especially in secondary and backscattered imaging. The simple concepts of mean free path and mean energy loss are consistently invoked. The consequences of the Bethe and other models are displayed, and compared with experiment. The emission of X-rays is fully discussed, in relation to microanalysis and to some extent with diffraction. There is a good exposition of the theory of electron diffraction and its part in channelling patterns.

Other chapters deal with cathodoluminescence, electron beam induced current, detectors and signal processing, but there is no detailed description of apparatus for microscopy or microanalysis. The author's aim is to make clear what happens inside them, and especially in image formation and interpretation. As he says in the preface: "Many SEM users do not give much thought to the origin of contrast, but when the signals are to be used more quantitatively it becomes necessary to know more about the physics of SEM". In this aim he has succeeded admirably, and his book is likely to become the standard work for all users of the instrument. Especially to be commended is the list of references (running to 140 pages) which closes it. □

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