A physicist's portrait gallery

Atomic Histories

by Rudolf E. Peierls

American Institute of Physics Press/Oxford University Press: 1997. Pp. 378. \$32.95, £27.50

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This is a collection of the writings of the physicist Sir Rudolf Peierls from 1940 until the last years before his death in 1995. The earliest of these is the Frisch–Peierls Memorandum, submitted to the UK government in March 1940, which established the feasibility of the atomic bomb and initiated the sequence of events that led to Hiroshima and beyond, and gave Peierls a lasting place in history — added to his pre-eminence in physics.

It is ironic that, although he and Otto Robert Frisch were excluded from secret war work because they were enemy and later “ex-enemy” aliens, they could speculate with impunity on the problem of the atomic bomb and so lay the foundation of one of the most secret projects.

The text of the memorandum is given in full: both the technical part, already included in Margaret Gowing’s *Britain and Atomic Energy*, and a very readable non-technical “executive summary”, previously published only in Ronald Clark’s *Tizard* and containing many wise and even prophetic remarks.

In the technical part there is a footnote prefaced by “Note added March 1994”. It refers to the fission cross-section of uranium-235, which is used for calculating the critical size, and says: “This was a surprising slip. The correct figure is about 3 times smaller and the critical mass is... about 30 times too small” (600 g instead of 20 kg). But this error was soon discovered and for instance Franz Simon’s *Report on the Uranium Isotope Separation Plant* (December 1940) envisaged a production rate of 1 kg of uranium-235 per day and the Maud Report (July 1941) assumed much smaller cross-sections.

It is therefore difficult to agree with the occasionally expressed view that this serious underestimate of the critical mass was largely responsible for the allies’ decision to go ahead with developing the bomb, while the Germans’ gross overestimate of the size explains their lack of effort.

Peierls had a thorough knowledge of the subject and understood the dangers involved from the very first. This is clear from articles such as “The Defence Against the Atomic Bomb” (1946) and “Atomic Energy: Threat and Promise” (1947), and later writings such as “Britain in the Atomic Age” and “Reminiscences of a British Participant”. He was a founding member and vice-president of the Atomic Scientists Association which, in the United Kingdom, optimistically put forward

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the idea of international control of atomic energy but was dissolved in 1959. Later he attended the Pugwash Conferences which concentrated on arms control and disarmament. These articles remind today’s readers that the questions of atomic energy, and of the bomb in particular, were always regarded with deep seriousness by the scientists concerned.

About half the book is taken up by “A Physicist’s Portrait Gallery” — accounts of the life and work of Peierls’ many friends and colleagues. He was born in Germany but he worked in many European countries, the United States and Russia (his wife was Russian). Not for nothing did he call his autobiography *Bird of Passage*. He was acquainted with the cream of twentieth-century physicists.

It is clear that Peierls regarded Werner Heisenberg as one of the greatest physicists of this century. Four articles have Heisenberg as their main subject, including a 20-page article for the *Biographical Memoirs of the Royal Society*. All these articles discuss Heisenberg’s role in Germany’s Atomic Energy Project and Peierls is meticulously fair to him when assessing the reasons for the half-hearted and somewhat ineffectual nature of the German work. But Peierls also criticizes the view that the German scientists knew how to make an atomic bomb but that moral scruples made them all but sabotage the project.

After being told that the Americans had dropped an atomic bomb on Hiroshima, Heisenberg said: “If it has been done with uranium-235 then we should be able to work it out properly. It just depends on whether it is done with 50 or 500 or 5,000 kilogrammes and we don’t know the order of magnitude. We can assume that they have some method of separating isotopes of which we have no idea.” (Quoted from the *Farm Hall Transcripts*.) He said this five years after the Frisch–Peierls recipe for the atomic bomb and Simon’s blueprint of a large-scale plant for isotope separation.

Other portraits in this gallery include those

of Niels Bohr, James Chadwick, Paul Dirac, Lev Landau, J. Robert Oppenheimer and Ernest Rutherford. Some of these are lengthy biographical memoirs written for the Royal Society, others are shorter appreciations, often reviews of the subjects’ biographies. The memoirs on Frisch and Wolfgang Pauli stand out by showing Peierls’ skill in blending the description of the subject’s scientific work with the portrayal of his personality. The scientific explanations are models of clarity and simplicity while the character sketches reflect Peierls’ affection for his subjects. This does not make him blind to their foibles, which are recognized and often made fun of, but the irony, although sharp, is never malicious.

There are many examples of Pauli’s merciless criticism of his students or colleagues. But, as Peierls says, “the remarkable thing is that, although the victims often felt hurt at the time, none of them bore a grudge for long”. Peierls might have mentioned the occasion when he himself was the subject of a savage attack by Pauli after a seminar talk. Pauli then turned to Peierls with a disarming smile and asked: “Would you not have said the same thing if I had given the talk?” Peierls replied: “Yes, but I would have said it more politely.”

Frisch was an experimental physicist of great ingenuity. It was he who suggested the term ‘fission’ when, with his aunt Lise Meitner, he correctly interpreted the Hahn–Strassmann experiment. Peierls’ portrait of Frisch shows him as a gentle, modest person, happy in his lab, happy with his physics, and happy with his music. He was a pianist of near professional standard who demonstrated the power of music over physical frailty. He was a bad sailor and yet I recall that, during a stormy Atlantic crossing in December 1943, when to be upright was agony, he gave a superb rendering of Chopin’s “Barcarole” — but had to be back in his bunk before the applause had died down.

This collection of some of the writings of one of this century’s most versatile and influential physicists makes wonderful reading and gives one a feel for nearly seven decades of physics and for its practitioners. The book is full of quotable passages, so let us finish with one from Peierls’ pen that shows his whimsical humour, his willingness to poke fun at himself and his utter lack of pomposity.

In 1955 Peierls published *The Laws of Nature*, a book intended for the non-specialist reader. It was dedicated “To the Treasurer of Somerville College, Oxford and the Bursar of Gonville and Caius College, Cambridge, but for whom this book would not have been written”. The treasurer of Somerville was puzzled by the dedication but the bursar of Caius saw the joke: Peierls wanted the royalties to help with the education of his daughter Gaby and his son Ronnie.

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