Hence, the author's intention is well executed. I also feel that teachers and students of graduate courses in solid-state physics and quantum mechanics may find parts of this book quite useful. In conclusion this is a theoretical book, welcome on the shelves of experimenters of thermal neutron scattering, and physics, chemistry and material science libraries in universities and research institutes.

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William Henry Bragg 1862–1942: man and scientist. By G. M. CAROE. Pp. xii + 212. Cambridge Univ. Press, 1978. Price £8·95.

When I saw the title of the book *William Henry Bragg* 1862–1942: *man and scientist*, written by his daughter G. M. Caroe, I tried to make guesses about the possible content. With probably many other Europeans on the continent, I shared the belief that English Nobel laureates can grow up only in either Cambridge or Oxford as precious orchids and flourish really well only in a greenhouse under well controlled conditions. On the whole the book proved me wrong.

It is true that WHB spent three years, between 1882 and 1885, at the Trinity College of Cambridge, but in mathematics, not physics. He applied successfully for the post of professor of mathematics and of physics at the then 12-year-old University of Adelaide – it was then 1886 – and had to learn physics in Australia where he was to spend 23 happy years. There are charming stories in the book on the (literally) warm Adelaide atmosphere, on WHB's marriage to Gwendolyn Todd (born there), daughter of Sir Charles Todd, General Postmaster, Inspector (and builder) of Telegraphs and ... astronomer! No wonder that all W. H. Bragg's children were born in Australia, including Sir W. Lawrence Bragg who graduated from Adelaide University.

Of course WHB became perfectly aware of contemporary physics and popularized the newest findings not by presenting equations or photographs, but by redoing the experiments for the largest possible audience. Röntgen's discovery of X-rays was materialized in WHB's laboratory in spite of protests of some members of the clergy against the 'revolting indecency of the invention'. WHB was not only a marvellous teacher but wrote long papers on how and what to teach, which were initially published in the local press, but later developed into government reports. This crusade for education lasted for his entire long life. Education was his favourite subject in his Presidential Address to the Royal Society. His 'Children's Lectures' at the Royal Institution of London became famous and the BBC was keen to use WHB as a popularizer of science until the end. In fact in the series *Science lifts the veil*, organized by WHB, his dialogue with J. D. Bernal on *The problem of the origin of life* was broadcast on Monday 12 March 1942, three days before WHB's death.

Now what about crystallography? You might be surprised to learn that WHB's interest in research arose in the field of radioactivity when he was already over forty. In fact in 1904 he had the courage to start a correspondence with Rutherford, then in Canada. This reviewer does suspect – without any proof – that there were metaphysical links between WHB's stay in Australia and Rutherford's birth in New Zealand. Anyhow there was an everlasting friendship between these men, testified by letters as long as 30 pages! Whilst Rutherford was interested in the transformed atoms, WHB studied the radiation emitted by radioactive materials. At that time the identity of γ-rays from a radioactive emitter and of X-rays from a Röntgen tube was by no means evident. Bragg, to explain the effects of γ-rays, had invented a theory of a 'neutral pair'; for him γ-rays were neutral (whence the doublet) and corpuscular. There was a long fight between Barkla and WHB, which is reported in the book. Whilst Barkla had shown the light-wave-like nature of (soft) X-rays by a beautiful polarization experiment (Nobel prize, 1917), WHB continued to defend with vigour his corpuscular theory, feeling that the light wave was not the whole story. He wrote to Rutherford with imaginative prescience (letter of 18 January 1912) 'the energy travels from point to point like a corpuscle: the disposition of the lines of travel is governed by wave theory'. (Much later Louis de Broglie and Erwin Schrödinger solved the wave *versus* particle dichotomy.) The Barkla controversy darkened WHB's stay in Leeds until he saw the famous paper by von Laue, Friedrich and Knipping, realized its importance and called it at once to the attention of his son William Lawrence (WL).

At this point the educated reader would guess that the Bragg father WHB, a learned mathematician, had discovered the 'Bragg law' $n\lambda = 2d \sin \theta$ and that the Bragg son, WL, had helped with the experiment. It was just the other way around.

There is no doubt that WL had 'his brain wave', says the book, and discovered the famous diffraction equation. There is no doubt either that WHB's X-ray spectrometer was the first reliable tool for elucidating structures and that WHB recognized at once the potential of X-ray crystallography.

In another circumstance it was WHB who originated the idea of representing the electron density by a Fourier expansion and WL who wrote the paper. WL remarks regretfully 'he (WHB) should have published the idea and I should have published the application of diopside'.

In fact their fruitful collaboration lasted only two years, 1912–1914, and brought the Nobel prize in 1915, shared by father and son, a unique event in the history of science. There is no mention about the ceremony itself, 'wartime had stopped them working together suddenly and completely' and, after the war was over, they decided to divide the huge field; WHB would attack the organic part and WL the inorganic crystallography. 'Together they put British X-ray crystallography in a position of pre-eminence which lasted for two generations' says Caroe's book.

Astbury, Bernal, Kathleen Lonsdale (née Yardley), Muller and Shearer were co-workers of WHB. This does not mean that crystallography in organic chemistry ceased with WHB's death. His son, Sir Lawrence Bragg (knighted in 1941), godfathered organic crystal chemistry with quite concrete results, manifested in other Nobel prizes: Perutz, Kendrew (proteins), Dorothy Hodgkin (B12), Crick, Watson and Wilkins (DNA).

In view of the current impact of crystallography in almost all branches of science, it is amazing to learn that in World

War I there was no opportunity to continue research work. Instead WHB was contributing efficiently to the fight against submarines; he invented new acoustic hydrophone detectors and laid the foundations of the ASDIC ('Anti-Submarine Division-ics') techniques, initiated by Langevin in France.

When peacetime returned, WHB was named President of the Royal Institution and brought it back from the decline in which he found it to its present fame: 'RI has produced more fundamental breakthroughs per square foot than any other establishment in the world'.* Eight Nobel laureates have been professors there. With the years, the crystallographer WHB became a 'national figure representing science'. President of the Royal Society from 1935, he had firm views on all aspects of science and education and when World War II came he expressed his views in strong words: 'the authoritarian state tends to decision without enquiry; the democracy tends to enquiry without decision' and Winston Churchill accepted his idea of the SAC (Science Advisory Committee to the government during wartime).

The book fairly reflects the quasi-religious sense of responsibility of WHB proven throughout his whole life. 'He is a great man of science and he is also a very great man.'†

The only criticism addressed by this reviewer to the lucidly written and well documented book on WHB, which G. M. Caroe dedicated to the memory of her brother WLB, is that while the reader is quite happy to see pictures of WHB, of his wife and also of WLB, there are no pictures of the author's other brother, Robert Charles, killed during World War I at Gallipoli (1915) . . . or herself. But this might be the reaction of a French temperament.

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* Sir George Porter, present director.

† Rutherford in a discussion with the anatomist Arthur Keith about who should become President of the Royal Institution.

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An introduction to microscopy by means of light, electrons, X-rays or ultrasound. By T. H. ROCHOW and E. G. ROCHOW. Pp. xvi + 367. New York: Plenum Press, 1978. Price £18·58.

This book offers an introductory account of the various techniques of microscopy of materials. It is completely qualitative in approach and is clearly illustrated with ray diagrams, block diagrams and photographic examples of each of the techniques discussed.

The opening chapters define the various types of microscopy and their characteristics, dealing in turn with the various types of optical microscopy, *e.g.* using transmitted and reflected light, including polarized light. Brief descriptions are given of photomicrography, as well as phase contrast and interferometric techniques.

Later chapters discuss transmission and scanning electron microscopy, again in a wholly descriptive manner, and the book concludes with an outline of field-emission, X-ray and acoustic microscopy.

The book will certainly give a layman an insight into the wide range of microscopical techniques available, although it may be argued that it is of little value to the more serious student. The latter category of reader would require a more critical and up-to-date reference list for further reading than that provided by the authors; this is particularly true for topics such as electron microscopy and field-ion microscopy, where guidance to modern quantitative discussion of the application of these techniques is of paramount importance.

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Introduction to solid state theory. By O. MADELUNG, translated from the German by B. C. TAYLOR. **Springer series in solid state sciences. Vol. 2.** Pp. xi + 486. Berlin, Heidelberg, New York: Springer, 1978. Price: DM 59·00, *ca* US $29.50.

Solid-state science is an enormously broad field, which seems to be growing continuously both in width and depth. Despite the fairly large number of books published in recent years, not least about its theoretical side, there is definitely room for more presentations of the subject, particularly if the perspective is a little unusual.

That is one characteristic of this book by Madelung, which is a revised and partly rewritten translation of three pocket books published in 1972 and 1973 in German. Its strength is the concentration on essential concepts and their relationships. Since, on the other hand, the author's intention was not to write an encyclopedia, a number of topics ordinarily found in other solid-state books had to be left out.

The basic chapters on the one-electron approximation and on elementary excitations fill more than a third of the book. The concept of the quasi-particle is central to the development. In the next four chapters interactions between various kinds of quasi-particles are discussed with reference to those properties of solids which they 'explain': electron–phonon interaction and electrical conductivity, electron–electron interaction and superconductivity, electron–phonon and phonon–phonon interactions and optical properties, and, finally, phonon–phonon interaction and thermal properties.

Part of a chapter is devoted to a field which, strangely enough, receives very little attention in most text-books on solid-state physics, namely, chemical bonding and cohesion in solids. Here there is definitely more than the mere classification into ionic, covalent, metallic and molecular solids. In particular, the discussion on the conceptual difficulties one encounters in this connection is very welcome. On the other hand, it is a bit disappointing to see that the author seems to be completely unaware of the con-