this she has been most successful in epitomizing the essence of Landau as a scientist. I have only one objection. No mention is made of the analogous and simultaneous experimental work of Allen and Misener at Cambridge, or of the theoretical work of F. London and of Tisza, who predicted second-sound several years ahead of Landau. The work of Landau was hardly influenced by these parallel developments, but the reader should know of them and that Landau's work, important though it was, was neither the only nor the final step towards a theory of superfluidity.

The final chapter, "Dau Away From Physics", recounts some amusing anecdotes but is hardly profound analysis. When I knew Landau at Copenhagen in 1930 and 1931 he was in a state of transition from shyness and reticence to the sociable and self-assured man of later years. He was then already classifying all things. Physicists, people in general and girls in particular, books, poems, motion pictures, they all received marks from one to five (one the very best, five the worst and three just acceptable). Such grading also entered into his discussion of human relations. A couple where the man was a five, whereas the wife ranked a full three was unsatisfactory and should be broken up. In retrospect such considerations seem to me the immature and not even very witty self-defence of a sensitive and vulnerable man. Livanova takes them more seriously. In those faraway days Landau was not a happy man. Livanova mentions his claim that by his rational approach to human problems he succeeded in teaching himself to be happy. Did he really? I wonder. □

H.B.G. Casimir studied theoretical physics at Leiden, Copenhagen and Zürich, worked in low temperature physics at Leiden and later joined the Philips Company at Eindhoven. He was for several years President of the European Physical Society.

Emilio Segrè on physics and on physicists

John Stachel

From X-Rays to Quarks: Modern Physicists and Their Discoveries. By Emilio Segrè. Pp.337. (W.H. Freeman: 1980.) Hardback $20, £11.80; paperback $9.95, £5.40.

EMILIO Segrè is one of that group of extraordinarily gifted physicists that gathered around Enrico Fermi in the late 1920s, a group whose members contributed so much to the development of nuclear and elementary particle physics in the ensuing decades. Like Fermi, Segrè came to the United States in 1938 and worked on the A-bomb project during the Second World War. After the War he returned to Berkeley, where he worked primarily in high-energy physics. An experimentalist, he shared the 1959 Nobel Prize in physics with Owen Chamberlain for the discovery of the anti-proton.

Eight Nobel prize winners at the 1960 Rochester meeting. From left: E. Segrè, C.N. Yang, O. Chamberlain, T.D. Lee, E. McMillan, C.D. Anderson, I.I. Rabi and W. Heisenberg.

This book is based on lectures in which, as he says, "I tried to show not only the main discoveries but also the way they were reached, the personalities of the leading physicists and the errors committed before the right path was found". A prospective reader should not be misled by the title: the book is about the development of atomic, nuclear and elementary particle physics and ". . . does not pretend to be a history of modern physics. It is, rather, an impressionistic view of the events as they appeared to me during my scientific career . . .".

Segrè gives fascinating accounts, from his perspective, of the discovery of the electron, X-rays, radioactivity; the old and new quantum theories and special relativity; nuclear structure and nuclear energy; particle accelerators and high-energy physics. The discussion is quite ample until about 1960. More recent developments, and accounts of related areas of physics, are treated in much less detail. For example, quantum electrodynamics, lasers and masers, the Mössbauer effect, superconductivity, astrophysics and biology are crowded into one chapter of 20 pages. In a final chapter, "Conclusions", Segrè points out trends toward greater specialization, industrialization, abstraction, and growing ties with technology in the current development of physics.

While an attempt is made to make the achievements of the major physicists "understandable to the layman", "Some knowledge of physics . . . is necessary". Most formulae, however, are relegated to ten appendices ranging from "Stefan's law; Wien's law", to "Quantum Mechanics in a Nutshell".

Most semi-popular survey books of this type seem to be written either by theoretical physicists or non-physicists, and tend to overemphasize theoretical achievements and/or adopt an overawed attitude towards modern experimental techniques. It is therefore valuable to have a book written by such an eminent experimentalist. While he does not neglect the theoretical developments or the theorists, there is a better sense of balance, and of the interplay between experimental achievement and theoretical advance, than in similar books I have read. Since it is an avowedly personal account, Segrè does not hesitate to give his evaluations of the styles of work and personalities of the physicists he is discussing, or to illuminate the text with personal anecdotes and reminiscences. The book is also enlivened by numerous well-chosen illustrations, which really add a great deal of impact to the text. A reader comparing photographs of laboratories and sketches of experimental set-ups in the first few and in the last few chapters, for example, cannot avoid being struck by the growing industrial-

ization of experimental research in particle physics, also apparent from the text:

> With a pun of dubious taste, I could say that it is no longer sufficient to be a Rutherford, but one must be a Ruther-Ford, meaning that the physicist must have at least some of the qualities of an industrialist and of a businessman [p.294].

Clearly, Segrè identifies "the physicist" here with the elite of the scientific community. He does not note that if some scientists are to be industrialists and businessmen, this implies that many other scientists and technicians must be workers and wage labourers. To carry his pun a step further, today there is a Reuther-Ford division among scientists (Walter Reuther was the head of the US Auto Workers trades' union).

The comments of a leading physicist such as Segrè on men and events, his views on the development of physics and its place in the scheme of things have an intrinsic interest. But the question naturally arises: how reliable is such an unashamedly personal account? I have the impression that, overall, it is a rather reliable source of information, but have only checked the chapter on Einstein with any care. Judgements of personality will naturally tend to differ. Against Segrè's view of Einstein:

> He was not averse to playing the role of the great scientist; clearly, he enjoyed it. Perhaps this explains some of his affectations, his strange manner of dress, and some habits that may have been for show. After all, he was an admirer and friend of Charlie Chaplin [p.97],

one might want to set that of Leo Szilard, who was more closely associated with Einstein:

> He is a man as free from vanity as I have ever seen. I have heard him talk to an audience of a thousand in German where he was at his best, and he talked to them as he would talk to a few friends gathered at his fireside . . . If you meet him you are struck with his great modesty and his great simplicity of heart [*Leo Szilard: His Version of the Facts* (MIT Press, 1978) p.12].

As to biographical information, the chapter is fairly accurate, but I must report that there are several errors. For example, Einstein's academic career between 1908 and 1912 is incorrectly given on p.88, which also speaks of Einstein as disturbed by "the anti-Semitic atmosphere" in Prague at that time. The account of Einstein's theories is generally quite good, although Segrè gives more of an operationalist twist to Einstein's development of special relativity than I think is justified. More serious is the statement on p.95 that the experimental effects predicted by general relativity "are small and difficult to observe, so that even now there is no absolute and unequivocal confirmation of the general theory of relativity". While certainly true, it seems to imply that Segrè believes that some other theories have been absolutely and unequivocally confirmed. This and other statements (for example the first paragraph of p.292) make it clear that philosophical problems of physics are not Segrè's strong point.

No account of the development of nuclear physics can avoid some discussion of the development of nuclear weapons, and the impact of this development on the modern world as well as on the physics community itself. Segrè gives such an account, and makes a number of interesting comments on the personalities and roles of J. Robert Oppenheimer and Ernest O. Lawrence, for example. His stance is that of an enlightened member of the US scientific establishment; one cannot find any searching criticism of either the scientific or political establishments here. His account would have to be supplemented from other sources by anyone seeking a thorough understanding of the origins of our present nuclear predicament. I do not mean to imply by this that Segrè is not well aware of the problem. In the few pages he devotes to "the influence of science on the human condition", as he puts it, he states his views:

> . . . science enhances human power. It also permits (at least approximately) anticipation of the consequences of certain courses of action. However, the process of decision at both the individual and the state level is dictated not by science but rather by obscure factors that I understand only dimly. They seem to me to be largely irrational, possibly dictated by behavioural forces, evolutionary drives, or subconscious demons. We thus see courses of action that to an outside observer appear totally irrational and destructive in their consequences. The armament race is an outstanding example. Because science enhances human power, it makes these foolish pursuits more and more dangerous, so much so that they may imperil the survival of the species . . . .
>
> While the scientist has the specialized knowledge of his discipline, on other subjects he is pretty much prey to the same dark forces as is anybody else. His training and education may help him to overcome some of his irrational urges, but the idea that the objective, cool scientist is above the crowd is fallacious. This should be recognized by the scientists and by the public at large. Scientists are not priests of a magic religion [pp.288–289].

John Stachel is a Professor at Boston University, currently working at the Institute for Advanced Study, Princeton, New Jersey.

Nuclear technology for the layman

Malcolm C. Scott

Unlocking the Atom: A Hundred Years of Nuclear Energy. By Malcolm Longstaff. Pp. 175. (Frederick Muller: London, 1980.) £7.95.

THE story of the development of nuclear energy is striking, both for the intellectual excitement which it has generated as well as for the intense political and moral arguments which have surrounded its use for weapons and for peaceful purposes. Yet, paradoxically, there have been few books which have attempted to cover these developments, particularly the technical aspects, in a way which makes them accessible to the general reader.

Despite the disclaimer in the preface — ". . . all I have been able to give is a sketchy account of some aspects, and particularly those which interest me most" — the scope of the book is broad. It starts with the discovery of uranium, radioactivity and fission and discusses the work leading to the two atomic bombs dropped on Japan. The post-War development of nuclear reactors for plutonium production is then covered, leading on to the start of the non-weapons orientated reactor programme. The main features of the principal power reactors in use around the world are outlined, followed by chapters on uranium and its fabrication into fuel (including the use of lasers for enrichment), fuel use and reprocessing, and radioactive waste disposal. There are then separate chapters on safety, on energy and the place of nuclear power, and on other uses of nuclear energy. Finally, in "Looking Ahead", the author touches on some of the current arguments relating to nuclear power (for example, the question of the blackmail value of plutonium and the possible role of thorium in separating the peaceful and non-peaceful uses) and outlines the principles of nuclear fusion. Throughout the book there are well-chosen photographs and numerous other figures.

The author keeps to his intention to give "little chemistry and no mathematics", yet, nevertheless, manages to provide a comprehensive technical coverage of the subject. In doing so he defines the terms which he uses in a non-technical way, so that the lay reader should not find it necessary to read with a technical dictionary at his elbow.

There are a few inconsistencies — for example, the abundance of uranium-235 is given variously as 1 part in 140, 1 part in 139 and 0.3% (1 part in 333: this is certainly a