atomic and quantum theory is included; this is a great help to the general reader. The book is written with Sir James Jeans's usual clarity of style and facility of expression. It abounds in apt and striking illustrations and analogies; to give but one example, the statement that the temperature at the centre of a star is about twenty million degrees conveys little to the average reader, but the remark that a pin-head of matter at that temperature would emit enough heat to kill anyone who ventured within a hundred miles of it helps the reader to realize something of what such a temperature involves.

There are a few places where a little further explanation would have been helpful to the lay reader. Thus, on p. 33 it is stated that "in 1814 Fraunhofer repeated Newton's analysis of sunlight, and found that the spectrum was crossed by a number of dark lines"; a reader who knows nothing about the spectroscope but is familiar with Newton's experiment, in which a coloured band was formed by overlapping images of the sun, may be left wondering why the spectrum is crossed by *lines*. On p. 65, it is stated that the rotation of the galaxy makes it difficult to believe in a local cluster of stars, because such a cluster could not be a permanent structure; the reader may object that some of the photographs of extra-galactic nebulæ appear to show many such local clusterings.

On pp. 25, 26 it is said that Ptolemy argued that the earth could not be moving through space because this would involve a displacement of the nearer stars relative to the background of more distant stars; this is misleading, because in Ptolemy's time and for many centuries after, it was believed that the stars were all fixed to a sphere. A motion of the earth would have involved changes in the angular separations of the stars, of the nature of proper-motions, and it was through displacements of this type that William Herschel was enabled to detect the motion of the sun relative to the stars.

On p. 204, referring to the hydrogen content of the stars, it should be mentioned whether the stated percentage is by mass or by volume. The statement on p. 253 that the swarm of asteroids can be explained *quite simply* as the broken fragments of a primeval planet is not correct, if it is meant to imply that it has been proved that the asteroids originated in this manner. Nor is the statement that there are several families of comets the members of which follow one another round and round in the same orbit (p. 256) correct. The explanation of comets as part of the *débris* left after the birth of the planets shelves the difficult question of the origin of comets; several comets have been observed to disrupt, and traces of them can be detected by showers of shooting stars when the earth meets the orbit of the disrupted comet; there is no evidence of any comet having entered the solar system from outside; it seems that the formation of comets must be a continuing process in the solar system, though there is no satisfactory theory to account for this.

But these are minor defects in a book of absorbing interest, which carries the reader through space and time, discusses the evolution of the stars and of the universe, and concludes with a fascinating chapter on beginnings and endings. The black-out conditions during the War have enabled many people to see the glory of the heavens for the first time, and this has brought about a greatly increased interest in astronomy. This book should do much to stimulate that interest. H. SPENCER JONES.

ELEMENTARY WAVE MECHANICS

Elementary Wave Mechanics

Introductory Course of Lectures. By W. Heitler. Notes taken and prepared by W. S. E. Hickson. (Hectographed.) Pp. ii+88. (Dublin: Dublin Institute for Advanced Studies, 1943.) 5*s*.

THERE are many elementary treatises on wave mechanics. Their multiplicity is due perhaps to the fact that there are many ways of approach to this subject or perhaps because, as in the case of a disease for which many cures are advertised, the right treatment still awaits discovery.

The present work is based on notes taken on a course of lectures given by the author. It contains features which distinguish it from similar works and which make its publication well worth while.

It is clearly the work of a lucid teacher, and this is to be expected of the author of "The Quantum Theory of Radiation". It is the work of a writer who can keep the physical principles of the subject in the foreground and at the same time introduce the reader to the essentials of the mathematical technique, with some pardonable short cuts.

The book covers a representative range of problems, including the treatment of the hydrogen-like atoms and the problem of two electrons. Welcome additional subjects of study in a work of this scope are the perturbation theory, exchange degeneracy, the spin wave function and the helium atom.

The uncertainty relations are presented in a way which is likely to lead the student to think of them as peculiar to the quantum theory. The sense in which this is true is stated by the author (p. 13), where he writes: "Classical mechanics holds for heavy bodies, the uncertainties are a peculiarity of quantum mechanics which applies to light particles". It is, however, advisable that the student should be aware of Rayleigh's conditions of optical instruments, some simple examples of which can be explained from his knowledge of physical optics. This line of approach has some justification in the history of the development of the uncertainty relations and avoids the tendency towards over-emphasis upon the application in wave mechanics.

It is to be regretted that the wave-length of the particle waves is described as being inversely proportional to the particle velocity although this is true in the limited application considered. It is preferable to describe the wave-length as inversely proportional to the momentum, since this is a true statement both in the classical and relativistic cases.

The author attempts to lead the reader very gently to the idea that the particle velocity has its counterpart in the group velocity and not in the phase velocity of the waves. The attempt seems rather laboured and leads to the strange result that the phase velocity is half the group velocity. This may lead to confusion later on when the question has to be further considered.

The work is to be recommended to degree students who require a clear statement of the principles of the subject and a knowledge of how they are applied in practice. The syllabus chosen is excellent and affords a useful guide to teachers of the subject.

With the correction of some misprints and amplifications here and there, the work will become a valuable introductory text-book. H. T. FLINT.