

reviews

What then is time?

G. J. Whitrow

Time and Man. By L. R. B. Elton and H. Messel. Pp. 114. (Pergamon: Oxford, New York, Toronto and Paris, 1978.) Hardback £4.50; paperback £1.95.

THIS is a wide-ranging book written at a semi-popular level on a subject that has long puzzled and intrigued mankind. On the title page the authors include a famous quotation from St Augustine: "What then is time? If no-one asks me, I know; if I am asked to explain it, I do not know". In other words, we all of us have an intuition of time, but we find great difficulty in accounting for it and deciding what time actually is.

The authors begin with our experience of the passage of time. When we are infants this is first associated with rhythmic changes in our bodily condition and then with movement and speed. Later we gradually become aware of the succession of events and of the role of time in social behaviour through ideas such as punctuality. Later still we learn to associate time with the great questions of philosophy and religion, and we come to feel that time is something 'absolute' over which we have no control.

Mention might have been made in this first chapter of learning to tell the time by the clock, particularly as in the next chapter the authors introduce the operational definition of time in terms of numbers and a measuring device. This approach to the question of time is by no means universal, but is characteristic of certain civilisations, notably modern industrial civilisations in which peoples' lives are ruled by the clock because of the need to make precise timings.

The authors devote a chapter to various practical devices that are used for measuring time, culminating in the development of atomic clocks. They then go on to discuss the synchronisation of clocks at different places, pointing out that no signal is instantaneous and that this particularly affects the relationships between clocks in relative motion. Discussion of the velocity of light and its measurement is followed by an elementary account of the special theory of relativity and a neat derivation of the formula for time dilation. The experiment by Hafele, in which atomic clocks were flown round

the Earth both eastwards and westwards to test this formula, is described, but no mention is made of the gravitational effect that was also involved in this experiment.

In a chapter on the unidirectional nature of time, the authors describe the objections to the statistical explanation of time's arrow. After discussing time and the interactions of elementary particles, they go on to consider the Universe as a whole. They show that the most satisfactory resolution of Olbers's paradox of the dark night sky is through the concept of cosmical expansion. Hubble's law is described, and its simplest interpretation is shown to lead to a rough value of 18,000 Myr for the age of the universe.

A chapter that contains much of interest on geological time, biological evolution and biological rhythms precedes the final chapter in which the authors revert to the subject of "time

and man" with which the book began. Piaget's investigations on the development of the child's idea of time are described, followed by consideration of time and the adult mind, and a number of literary quotations relating to man's concern with time. In this chapter the authors make the point that philosophers who wish to go beyond physics in their investigation of time should at least take notice of where physics has got to.

The book ends with a useful list of books and references. Although in places it is inevitably somewhat superficial, this book contains much of interest and can be recommended as a useful and stimulating introduction to the general subject of time. □

G. J. Whitrow is Professor of the History and Applications of Mathematics at Imperial College, University of London, UK.

Applied group theory

Induced Representations in Crystals and Molecules (Point, Space and Non-rigid Molecule Groups). By S. L. Altmann. Pp. 369. (Academic: London, New York and San Francisco, 1978.) £18; \$32.25.

THE appearance of yet another book on applied group theory calls, as its author admits, for some justification. Dr Altmann claims that his book meets the need for a comprehensive and comprehensible account of certain mathematical techniques which "have recently been found important in the discussion of point groups (Altmann, 1963a) and non-rigid molecules (Altmann, 1967)". The modestly anonymous flyleaf claims that "this monograph provides a unified and rigorous treatment of the theory and its applications" and that "no single book has dealt with the subject so completely and in so much detail . . . The fully worked examples provided for each theoretical step will come as a welcome relief for those frustrated by the unintentional obscurities in many high level texts", and so on.

Unfortunately these appetising promises are not fulfilled by the quality of the text. In his very first paragraph the author describes the first four or

five chapters as only "fairly" self-contained, and his working definition of symmetry operations, so far from being "rigorous", is inexcusably sloppy. This does not matter much for the purely mathematical developments, but his provisional identification of symmetry operations as rigid displacements (translations, rotations, and so on) makes the transition from crystals to non-rigid molecules painful in the extreme. As for the "unintentional obscurities" to be found in the works of other authors, the wild proliferation of symbols in the later chapters of this book makes the arguments almost impossible to follow, and the "carefully worked examples", particularly that of the octahedral group, show just how much mess can be created by using a theoretical steam-hammer to crack an elementary problem.

The last chapter, on the symmetry groups of non-rigid molecules, is distressingly confused and confusing. It reminds one all too vividly of Dr Altmann's 1967 paper, which in its time clouded the subject with a fog which took theoretical spectroscopists some years to dispel. The main source of confusion is Dr Altmann's failure to appreciate the main purpose served by the concept of molecular symmetry in,