BOOK REVIEWS

PROBLEMS OF THE QUASARS

Quasi-stellar Objects

(A Series of Books in Astronomy and Astrophysics.) By Geoffrey Burbidge and Margaret Burbidge. Pp. viii + 235. (San Francisco and London: W. H. Freeman and Company, 1967.) 70*s*.

SOME five years ago several papers were published in one issue of *Nature*, and they were the first to introduce quasars to astronomers and to the scientific public. In his contribution Cyril Hazard showed how the position of the two parts of the radio source 3*C* 273 fitted exactly on to the position of the corresponding optical object. In another paper Maarten Schmidt explained the emission spectrum of part B of the object by assuming that it had been red-shifted by an amount $z = 0{\cdot}16$. Since then astronomers have been wrestling with the problem of the quasars.

The observers have made astonishing progress in their work. Identifications have been made for well over a hundred quasars, with red-shifts that range up to $z = 2{\cdot}22$. The radio astronomers have measured angular diameters and found that many quasars have unresolved components smaller than 0·01 seconds of arc. Infrared observations have shown that 3*C* 273, at any rate, emits most of its energy at sub-millimetre wavelengths. Most puzzling of all is the discovery that many quasars are variable, with relatively abrupt brightenings and darkenings that sometimes occur within one or a few days. Finally, some of the more highly red-shifted objects were found to have absorption as well as emission lines, and although z emission is usually close to z absorption the two values of z seem never quite to coincide.

Clearly the observers have done a vast amount of work, and Margaret and Geoffrey Burbidge, in particular, have contributed very largely to our knowledge of the observed properties of quasars. In this book they have collected together and assessed all the accessible observational results found by themselves and by other astronomers. All future investigations must begin with selected readings of Burbidge and Burbidge to find out what is already known—or rather what was known in early 1967.

But *Quasi-stellar Objects* goes further than this. In addition to describing the observations, the Burbidges give a full account of the attempts of theoreticians to explain the phenomena. If the reader comes away with a confused impression, then this only shows how well the authors have done their work. No one can even be sure how to interpret the red-shifts. Are they cosmological? If so, the energy output of the typical quasar must be exceedingly great and its life-time perhaps as long as a million years. One would expect such an object to be quite large; on the other hand the rapid fluctuations in brightness indicate that in an important sense it has an underlying structure with a much smaller linear scale.

Are the red-shifts gravitational? Schmidt and Greenstein long ago showed that the emission spectra cannot arise on the outside of a body that is massive enough. The resultant gravitational red-shift z would be too small even for 3*C* 273. To make the gravitational theory work one would have to postulate a structure of almost Byzantine complexity and of rather doubtful stability.

Are the red-shifts due to the Doppler effect in a set of local objects rapidly receding from the vicinity of our Galaxy? If so, who can imagine the dynamics of the explosion that sent off individual masses with speeds up to 0·82 *c*, but did not completely disrupt them? Further, where are the groups of quasars surrounding other galaxies, many of which should look to us much brighter than our own quasars and should show considerable blue-shifts? These are only a few of the arguments that the theoreticians have been involved in. The Burbidges give a very good account of them, even if sometimes they plead a little too much on behalf of their own favourite view.

The theoretical situation is indeed fluid, even turbulent. By the discovery of quasars the observers have shown the astrophysicists how far they are from understanding the Universe, just when they were beginning to feel a little too satisfied with their recent successes. Long may such observers continue to provide us with such surprises.

F. D. KAHN

SPECIAL RELATIVITY

Elements and Formulae of Special Relativity

(The Commonwealth and International Library of Science, Technology, Engineering and Liberal Studies: Physics Division.) By E. A. Guggenheim. Pp. x + 63. (Oxford, London and New York: Pergamon Press, 1967.) 21*s*. net; $4.50.

THIS book gives an account of the essentials of special relativity theory. Aberration, mechanics, hydrodynamics, electromagnetism are all covered at a simple level, as deductions from the Lorentz transformation, which is, however, not proved. The book is compact and will suit those who want a compendium of formulae but who do not wish to enquire too deeply into conceptual problems such as: why do we need a relativity of simultaneity, anyway? I have one reservation concerning the author's five and a half page chapter on relativistic thermodynamics. He treats it as if everything were cut and dried in this field. This is, however, misleading, and there is a body of opinion which would not accept all the formulae derived in this chapter.

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POLYMER RELAXATIONS

Anelastic and Dielectric Effects in Polymeric Solids

By N. G. McCrum, B. E. Read and G. Williams. Pp. xv + 617. (London and New York: John Wiley and Sons, 1967.) 160*s*.

WERE it not for the development of polymer science, through exploratory polymer chemistry in particular, the subject of viscoelasticity might have remained little more than an interesting and mathematically speculative curiosity. With the tremendous output of new products in recent decades, albeit often within, rather than from, the research laboratory, there has been a corresponding availability of materials which exhibit this phenomenon to a substantially marked degree and thereby allow for a more extensive study. Perhaps not surprisingly, from the touchstone of the varied demands of characterization, there has been at least a dualistic experimental approach to the subject of viscoelasticity, with some workers on the one hand concentrating more on mechanical features, whereas others have found dielectric properties of greater interest. This book makes a serious attempt to unify the two approaches, and even the nomenclature, by an integration of the relevant mechanical and dielectric aspects of linear viscoelasticity in such a way that it will be of interest not only to chemists and physicists but also to researchers in the fields of chemical, electrical and mechanical engineering.

Following an introductory chapter and a general one on the chemical and physical structure of polymeric solids, there are three, mainly theoretical, chapters on theories