graphite susceptors for use up to 3,400° C, particle accelerators, high-power microwave absorbing elements, super-refractories for magneto-hydrodynamic power generators, and ceramic-to-metal seals for atomic energy applications.

The book is excellently produced and the text is well illustrated. The wealth of new material presented will commend it primarily to the specialist. However, due in great measure to the care with which the contributions to the symposium have been transcribed and edited, most of the text will be found very readable, even by the non-specialist, who could well draw inspiration from the ingenuity brought to bear on some of the problems encountered. For example, the use of (very rapid) 'plunge sintering' in order to utilize the heat of an exothermic reaction for sintering uranium monocarbide; and again, the elegant method used to avoid contamination during the nitriding of aluminium, by levitating the latter in a radio-frequency field. There are, of course, numerous points of fundamental significance; to name but two—rate-determining processes in sintering, and the filamentary, electrically conducting paths observed in rutile, apparently related to the time-dependence of conductivity in the unique crystal direction. B. E. WAYE

COMETS

The Nature of Comets

By Dr. Nikolaus B. Richter. Translated and revised edition by Dr. Arthur Beer. With an Introduction and Additional Contributions by Dr. R. A. Lyttleton. Pp. xli + 221. (London: Methuen and Co., Ltd., 1963.) 63*s*. net.

IN 1954, J. A. Bath of Leipzig published *Statistik und Physik der Kometen* by Dr. N. B. Richter. The monograph summarized the main observational and theoretical features of the nature and behaviour of comets and did much to stimulate interest in a rather neglected field of enquiry. Since then cometary investigations have acquired greater importance, due in part to the rapid development of space research and also to the interest aroused by the appearance of Comet 1957 III Arend–Roland and Comet 1957 V Mrkos.

In this, the first English edition of Richter's monograph, the original text has been brought up to date by extensive revision and the addition of new material. Further, it contains a challenging introduction by Dr. R. A. Lyttleton, well known in cometary astronomy for his accretion theory of the structure and origin of comets. In this, Lyttleton presents his personal views and criticisms of the present state of cometary theory. He makes it clear that he does not agree with all the conclusions of Richter, Oort and Whipple. According to Richter, almost the entire mass of a comet resides in its comparatively small nucleus, which consists of solid material ranging from dust particles to chunks of meteoritic size. As the nucleus approaches close to the Sun, solar radiation causes it to emit gases. These gases form the coma, while radiation pressure and corpuscular radiation drive out the cometary tail. Lyttleton, however, remarks that once the existence of large chunks of rock is postulated it becomes necessary to explain why none of them ever get into meteor streams. During a rich meteor shower, millions of small meteors are injected into the Earth's atmosphere, but so far without a single large object of meteoritic proportion coming in at the same time on the same path. He also considers that Richter's analysis amounts to convincing proof of the inadequacy of solar heating to account for the great longevity of certain large tail-producing comets.

According to Oort the Sun is encompassed by a very distant spherically distributed swarm of comets. On the very rare occasions when stars pass sufficiently close to the shell they perturb a comet so that it leaves the shell, falls towards the Sun, and becomes visible from the Earth. So rarely does this happen to a single individual comet that to meet the observed actual supply some 10^{11} comets are assumed to reside in the shell. Lyttleton considers that the hypothesis of the cometary shell is valueless. It cannot (as yet) be verified by observation; does not serve to correlate observations; in no way explains the origin of comets, and thus provides no clues whatever as to their structure. Whipple's theory has similar limitations. It postulates a cometary nucleus in the form of a conglomerate of ices and meteoritic particles. Under the action of the Sun's heat, volatile compounds in the ices are evaporated and sufficiently irradiated to exhibit the emission lines observed in cometary spectra. Lyttleton claims that both theories are merely speculative descriptive schemes which have no foundation for their hypotheses in either established astronomical fact or attested theory. The way in which he arrives at this conclusion and then resolves certain objections levelled against the accretion theory shows a nice appreciation of the value and importance of the principles of scientific method.

After giving a short account of the historical development of cometary research, Richter proceeds to describe statistical results regarding orbital forms, inclinations and aphelion distances, the perturbations produced by Jupiter, the 'capture hypothesis', comets with planetary orbits and comet groups. Section 3 deals with the structure of comets, that is, with the progress made in determining the dimensions, masses, densities and nature of cometary nuclei, heads and tails. Section 4 is of particular interest since it gives a preliminary summary of the work done on the two bright comets of 1957. Both objects were subjected to extensive photometric, polarimetric and spectrographic observations. Richter's discussion of the available material helps towards clarifying the problems opened up in the last four sections, namely: comets as processes of cosmic decay; the origin and formation of comets; cometary problems for future research work; a typical model of a comet. A number of valuable cometary tables, a generous bibliography and adequate name and subject indexes complete the monograph. Dr. A. Beer has made an excellent job of the translation. The text reads well and is embellished with a well-chosen set of reproductions of photographs of comets. A book so interesting and informative deserves the widest possible readership. It may not achieve this, but it will, at least, be read with pleasure and profit by all astronomers, professional and amateur alike. H. C. KING

THEORY OF ELECTRICAL MACHINES

Electric Machine Analysis using Matrices

By Dr. W. J. Gibbs. Pp. vii + 70. (London: Sir Isaac Pitman and Sons, Ltd., 1962.) 17*s*. 6*d*. net.

METHODS of analysis for the investigation of the behaviour of electrical machines began to be developed in the 1880's. For alternating current machines the technique of the vector diagram, the equivalent circuit and the utilization of complex numbers in circuit analysis achieved universal application in the first two decades of the present century. Each type of machine was analysed individually.

What is now termed the 'generalized theory of electrical machines' has been developed during the past thirty years. Expressed in terms of the basic equations of an idealized machine and utilizing matrix or tensor methods for their manipulation, it is possible to establish a general theory of electrical machines which will comprehend the behaviour of practically all types of machine under all conditions of operation. This unified theory was propounded and developed by Gabriel Kron. It is with this subject that Dr. Gibbs's book deals.

The book aims to present the mathematical basis of the theory as simply and clearly as possible. A short introductory chapter describes the purpose of the general-