

of Nature if some outstanding event were to occur before the book reached a second edition. Perhaps one may hope that when the stage is set and the space station exists, mankind may be offered the spectacle of another supernova in his own galaxy.

W. E. BURCHAM

A NEW APPROACH TO GENERAL RELATIVITY

Relativity

The General Theory. By J. L. Synge. (Series in Physics.) Pp. xv+505. (Amsterdam: North-Holland Publishing Company; New York: Interscience Publishers, Inc., 1960.) 110s.

THIS massive treatise is no mere conventional text-book of Einstein's theory of gravitation. On the contrary, although by a master of that subject, it is a highly individual work. For, although the author claims that the book is conservative in so far as it deals mainly with Einstein's theory in its original form, leading up to the famous triad of empirical tests, the mathematical treatment is novel. This treatment derives from Synge's conviction that, great as was Einstein's achievement, the true revolution in mental perspective was due to Minkowski, although this has not yet been fully appreciated by most students of the subject.

In accordance with a recent tendency among some students of relativity, Synge will have nothing to do with the principle of equivalence. Instead, he maintains that in Einstein's theory the existence of a gravitational field depends entirely on whether or not the curvature tensor does not or does vanish. This is an absolute property of space-time and does not depend on the observer. Synge accordingly endorses Minkowski's protest against the use of the word 'relativity' to describe a theory based on an 'absolute' (space-time). Indeed, he remarks that if Minkowski had lived to see the general theory of relativity he would have repeated his protest in stronger terms.

Although Synge's outlook is geometrical, in the sense that it is based on a thorough-going acceptance of the space-time way of looking at things with its fixed diagrams which are "easier to deal with" than the kinematical pictures of Newtonian mechanics, the peculiarity of his approach lies in combining this point of view with a deep conviction that time is the only basic measure, distance being essentially a derived concept. Consequently, Synge's version of general relativity is based on what he prefers to call Riemannian 'chronometry' rather than 'geometry'. This leads him to make general relativity more 'operational' (in Bridgman's sense) and thus more closely related to special relativity than has previously been customary. In this respect, I believe that Synge has been indirectly influenced by the pioneer example of kinematic relativity.

In considering the geodesic world-line of a particle in free fall, Synge interprets gravitational acceleration as a consequence of the curvature of the world-line of the observer. He is thus led to develop a new method of gravitational analysis based on a function first introduced in 1931 by H. S. Ruse. This function, which Synge calls the 'world-function,' is, to within a trivial factor, the square of the geodesic distance between two events in space-time, regarded as a function of the eight co-ordinates concerned. His

use of this function has the advantage of combining the power-series technique with that of the tensor calculus.

Among the many topics discussed are Fermi transport, the material continuum and field equations, integral conservation laws and equations of motion, special universes, gravitational waves and geometrical optics. There is an extensive bibliography with references to reviews. The print is clear and the formal mathematics is relieved from time to time by the author's irony and wit. Irrespective of whether one accepts his point of view, his book will be found original and stimulating.

G. J. WHITROW

NEW HANDBOOKS FOR LUNAR STUDIES

Structure of the Moon's Surface

By Dr. Gilbert Fielder. Pp. xiii+266. (London and New York: Pergamon Press, 1961.) 50s. net.

Surface of the Moon

Its Structure and Origin. By V. A. Firsoff. Pp. 128+10 plates. (London: Hutchinson and Co. (Publishers), Ltd., 1961.) 21s. net.

Orthographic Atlas of the Moon

Compiled by D. W. G. Arthur and E. A. Whitaker. Edited by Gerard P. Kuiper. Edition "A" showing the Standard Orthographic Coordinate Grid. Part 1: Central Area. (Contributions, Lunar and Planetary Laboratory, No. 1.) Pp. 3+31 plates. (Tucson: University of Arizona Press, 1960.) n.p.

RESEARCH into the nature of the Moon's surface has become increasingly intensive in recent years. This increase can partly be ascribed to the advances in 'space-science', in particular the Russian achievement in photographing the Moon's 'other face'. However, new ideas had begun to appear before this. Spurr's *Geology Applied to Selenology* was published between 1944 and 1949; although neither Dr. Fielder nor Mr. Firsoff subscribe to Spurr's speculative theories, they both believe that terrestrial geology is of prime importance in interpreting the appearance of the Moon's surface. They also share the view that the morphology of the surface features is a more rewarding line of research than the recording of ever smaller minutiae.

Dr. Fielder's book is a complete handbook to the Moon. It is divided into two parts: the first describes the methods used to determine the physical properties of the Moon's surface and discusses the available observations. The second part is devoted to the morphology of the lunar surface, where the author's own researches play a more prominent part. Ray systems, the grid system, rilles and wrinkle ridges, and the distribution and frequency of craters are subjects well fitted to this approach. The book concludes with a chapter on the origin of the Moon's surface. This does not support any particular theory but is confined to what may reasonably be inferred from observation. Dr. Fielder has covered his subject completely and thoroughly—the only faults are occasional lapses into irrelevance.

For many years there have been two rival theories for the formation of lunar craters—the meteoric, which explains them as the result of meteors striking the surface, and the volcanic, which identifies them with extinct volcanoes. Mr. Firsoff's book is