

in the Earth's core, which produces the magnetic field; and the seasonal changes from asymmetry in the atmospheric circulation in the southern and northern hemispheres. The exciting forces which cause the Earth to wobble on its axis are unknown, and this causes some difficulty at present in making reliable inferences concerning the properties of the interior of the Earth from the variation of latitude data.

However, on the whole, all the observations of phenomena so far referred to can be explained without having to assume any very startling new departures in geophysical thinking, and so, as Munk and Macdonald show, a mathematically satisfying and fairly tidy story results. However, for the completeness of their account of the idiosyncrasies of the Earth's rotation, Munk and Macdonald refer to the evidence, which has accumulated in recent years from palaeomagnetic work, that large changes of the relative positions of the axis of rotation and the continents have occurred gradually over hundreds of millions of years. These theories of 'polar wandering' and 'continental drift' were vigorously debated thirty years ago by geologists and geophysicists and were then largely discredited. Munk and Macdonald discuss the possibility of producing large polar wandering, but they baulk at the idea of continental drift. Instead, they take refuge in a somewhat unsympathetic discussion of the palaeomagnetic evidence, although these data are massive in quantity and are probably more statistically significant than some of the other observational evidence which they accept quite happily in the earlier part of their book. The beauty of the book is to show how evidence from such widely different fields as geology and positional astronomy must be woven together to understand this central problem of geophysics.

S. K. RUNCORN

ASTRONOMY IN THE MAKING

The Controversy on the Comets of 1618

By Galileo Galilei, Horatio Grassi, Mario Guiducci and Johann Kepler. Translated by Stillman Drake and C. D. O'Malley. Pp. xxv + 380. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1960.) 48s. net.

AS the links of the new astronomy were being forged in the seventeenth century, controversies, often heated and sometimes polemical, arose among the *cognoscenti*. On one hand the Aristotelian and Ptolemaic universe was upheld, having the respectability of authority and the blessings of the Church behind it; on the other the revolutionary ideas of Copernicus and Tycho Brahe were advocated by Galileo and Kepler, who also had their own novel contributions to make and who were supported by others of like mind. One of the difficulties of looking back on these formative years is so to stimulate the imagination that one can obtain something of the essence of the reality of the problems which had to be solved. It is only too easy to judge with a decision based on what we now know was later to be discovered and proved. Probably the best way out of this difficulty is, where possible, to read the actual arguments which took place and, moreover, to read them in the words of the actual protagonists concerned.

In the autumn of 1618 there appeared three bright comets, visible to the naked eye. The question

arose whether these objects were meteorological in nature or whether they were truly celestial bodies and, if the latter, what really was the nature of their paths. The appearance of the comets aroused wide interest, many pamphlets about them appeared, and Galileo, then aged fifty-four, entered the arena of controversy and produced his brilliant polemic *Il Saggiatore*. This book is important not so much for its scientific content or its literary merit, high though this is, but primarily for an insight into Galileo's approach to scientific matters; modern scientific method is here seen as it was in its early stages.

Yet Mr. Drake and Dr. O'Malley have, in their book, done more than provide, for the first time, a translation of the whole of *Il Saggiatore*, for they have also placed this gem in its appropriate setting. This they have achieved by beginning with a translation of Gassio's disputation on the three comets and giving also his *Libra Astronomica*, which was published under the pseudonym of Lothario Sarsi. Interspersing Gassio's work is a translation of Guiducci's discourse on the comets (and really written by Galileo), and following Gassio's *Libra Astronomica* there is Guiducci's own letter about the matter written to his old professor, Tarquinio Galluzzi. *Il Saggiatore* comes next, and then there are appended Kepler's remarks on it taken from his *Tychonis Brahe Dani Hyperaspistes*. Thus, within the covers of one volume, we have the whole of the controversy over the three comets.

The works given are, of course, eminently readable, for their authors wrote well and the translations which have been made are excellent. Excellent also is Mr. Drake's nineteen-page introduction in which he sets out very clearly sufficient of the ramifications which lay behind the controversy and of the nature of the protagonists to make the translations illustrate their points clearly. Throughout the book there are references to notes which, given at the end of the volume, elucidate various points or obscurities in the main body of the text, and there is also an adequate index. Well printed in England, the price of the book may seem, perhaps, rather high, but nevertheless this excellent contribution to the history of science is much to be recommended. COLIN A. RONAN

THEORETICAL METEOROLOGY

Introduction to Theoretical Meteorology

By Prof. Seymour L. Hess. Pp. xiv + 362. (New York: Henry Holt and Company; London: Constable and Co., Ltd., 1959.) 60s. net.

THIS is an important new text-book written primarily for students, but equally suitable for those desiring an up-to-date review of the subject. The aim has been to provide a reasonably rigorous treatment which is not rendered unnecessarily difficult by advanced mathematical arguments. The first seven chapters are devoted to basic thermodynamics, the properties of water vapour and hydrostatic stability, and the next three chapters to radiation theory and its application to the Earth-atmosphere system. The remaining eleven chapters deal with dynamics, including viscosity, turbulence and modern numerical techniques.

The main emphasis is placed on large-scale properties of the atmosphere. The general circulation and the role of depressions and anticyclones in