to the older work. Among them are two interesting light theory problems prepared by Professor Brand. One problem is concerned with the necessary and sufficient conditions for minimizing the length of a ray of light from one point to another after reflection at a point on the surface $F(x, y, z) = 0$. The other is a refraction problem in which the time between two points is to be a minimum. Hadamard's determinant problem is also included.

Throughout the book are many examples and problems illustrating points in the theory, some worked out in detail.

A. R. CRATHORNE.

From Nebula to Nebula, 4th Edition. By GEORGE HENRY LEPPER. Pittsburgh, Pa., privately printed, 1919. 401 pages.

(FROM the introduction) "The object of this work is two-fold: (1) to present a revaluation of the time-honored doctrines upon which modern theoretical astronomy is based, and (2) having shown wherein they are defective, to propose a new and far more comprehensive system, revealing the entire visible universe in the philosophic aspect of a single unit coordinated throughout, as *a priori it must be*, by a single dynamical force."

It is not possible, within the limits of available space, to give a complete analysis of this book. A few quotations will indicate some of the author's conclusions, but the proofs which he gives must be omitted. These quotations are so chosen that the lack of context need do no injustice to the author.

"(The earth . . .) is generously endowed with liquid oceans, which she is compelled to shift constantly from the sunlit side in her efforts to preserve her center of gravity at the lowest point. It is this struggle for equilibrium . . . which I assign as the major cause of the earth's diurnal rotation."

"I contend, with Aristotle, that rest is the natural state of matter."

"I have been enabled . . to demonstrate the sun's path to be that of an immense spiral with a diameter of 1,530,000 million miles and a total coil length of nearly seven trillions."

"Paradoxical as it may sound, . . . I contend that the sun and not the moon is the *vera causa* of the tides."

After attempting to prove that tides cause the rotation of

the earth the author states: " . . . it becomes quite evident that the earth is not turning on its axis simply 'because it can not stop a motion that never was started,' but because Nature intelligently supplies a quarter quadrillion horse power engine to do the work."

This review may well end with the following quotation which Lepper himself gives, ascribing it to the director of the Smithsonian Institute, and which is illustrated by this volume. "Every large scientific institution or observatory has almost daily communications from persons of very moderate attainments who presume to question, nay rather to spurn, the most well-attested facts of human knowledge. . . . No argument can refute them because they have not the requisite learning to comprehend it, which is no disgrace but which should make men *modest* enough to have faith in *those who excel them immeasurably.* . . ."

<div align="right">F. H. SAFFORD</div>

A Treatise on the Analytical Dynamics of Particles and Rigid Bodies; with an Introduction to the Problem of Three Bodies. By E. T. WHITTAKER. Second edition. Cambridge, University Press, 1917.   xii + 432 pp.

THE second edition differs from its predecessor mainly in that references to more recent researches are given together with a brief outline in certain cases.

The book is invaluable as a condensed and suggestive presentation of the formal side of analytical dynamics. There is serious need for a complementary type of treatise in which the main emphasis is laid upon the deeper qualitative side which has played an increasingly larger part since the work of Poincaré.

As a single instance of the incompleteness of Whittaker's treatment in this respect, the fact may be mentioned that in his final chapter he treats the trigonometric series precisely in the spirit of Delaunay and does not even mention that these series are generally divergent nor refer to their asymptotic properties.

<div align="right">G. D. BIRKHOFF.</div>