

lines, touches on chronographs and synchronisation of clocks, and gives extracts from the annual trial-numbers from the Greenwich volumes, showing the improvements makers have been able to secure in the last sixty odd years.

W. W. B.

### COSMICAL PHYSICS.

*Researches on the Evolution of the Stellar Systems.*

By Prof. T. J. J. See. Vol. ii., "The Capture Theory of Cosmical Evolution, founded on Dynamical Principles and Illustrated by Phenomena Observed in the Spiral Nebulæ, the Planetary System, the Double and Multiple Stars and Clusters, and the Star-clouds of the Milky Way." Pp. viii+734. (Lynn, Mass.: T. P. Nichols and Sons; London: W. Wesley and Son, 1910.)

IT is with mingled feelings that, after reading through this immense volume of Dr. See's, the reviewer attempts to present it fairly to the readers of this journal. This book and the theory presented therein is "the culmination of continued labor extending over more than a quarter of a century." It calls therefore for a full and careful discussion. It is a great pity that the writer over and over again by loose dogmatic statements repels the critic, and that he so frequently makes claims as to the rigorousness of the methods he employs, claims which a careful examination quite fails to endorse. As an example of the former fault we choose the extraordinary statement on p. 152, which comes at the end of an account of some quite inconclusive mathematical work on the effect of a resisting medium. The italics are the author's.

*"Whatever doubt may arise as to the effect of the resisting medium in the present state of the solar system, there can be no possible doubt as to its power in our system at the epoch when the planets were formed. The observed roundness of the orbits of the planets is an everlasting witness to the presence of a resisting medium against which these bodies revolved for immeasurable ages. There is no other admissible explanation of this phenomenon, and as the resisting medium is a vera causa, on the secular effects of which all mathematicians are agreed, we may hold that it has as surely rounded up these orbits as if we had witnessed the transformation within the short period of human history covered by exact observations."*

For the author's claims to mathematical rigorousness of treatment reference may be made to pp. 237, 259. The answer to these claims is twofold. On the one hand rigorous proof is from the nature of the case impossible in cosmogony. Too many uncertainties are necessarily involved in the premises for any amount of exact mathematical reasoning to lead to a rigorous proof, and even in this mathematical reasoning Dr. See is by no means perfect. It is a pity that his reply to the mathematical point raised by Mr. Brodetsky in the *Astronomische Nachrichten* (No. 4408) should be limited to the suggestion that "Mr. Brodetsky is unfortunate in writing from Cambridge." If Dr. See's views do not meet with the

full attention that he desires for them (or to do them justice, that they deserve), the fault lies partly with his method of presenting them.

After these strictures we may turn to the more pleasant task of dwelling on the theory that Dr. See has built up. In his view the solar system has developed from a spiral nebula. Condensations round various nuclei have gradually developed into planets. The resistance of the medium through which these bodies have revolved about the central condensation or sun, has led to the gradual falling in and rounding of their orbits, and also to the capture by the planets of all their satellites. Thus the moon, which originally revolved outside the present orbit of Neptune, was captured by the earth while in the process of falling into the sun through the slow decrease of its orbit. The theory is supported by arguments adduced from many branches of astronomical research. Some of the material which Dr. See has brought together to support his views is of very decided interest, notably chapter ix. on the capture of comets, and chapter xxi. with its welcome extracts from the papers of Herschel. Dr. See has been very generous in the extracts he quotes from the work of other people. It is not obvious, however, why chapter xii., with its long extracts on lunar motion, should figure in this work. There is no independent criticism made of the controversies referred to, and a bare statement of the results arrived at, with references, should have amply sufficed. In some of his criticisms of other contributions to cosmogony, Dr. See is much happier than in his own constructive work. Thus some of his criticisms of Messrs. Chamberlain and Moulton on p. 106 are distinctly to the point; while independently of other workers in the same field, he has brought forward some cogent reasons against the nebular hypothesis of Laplace in its ordinary form; he also criticises some conclusions frequently drawn (though not always correctly) from the papers of Sir George Darwin.

Many points of detail offer themselves for criticism in the treatment accorded by Dr. See to all the problems discussed in his book. But we have said enough to give the general scope of the work. While not able to accept Dr. See's views as to the important part played by the resisting medium in the evolution of our system, we are prepared to find in this resisting medium a *vera causa* the effect of which has been frequently overlooked by other workers. This book is an exaggeration. It may serve to restore the true balance of forces.

It remains to be added that the book has been very well prepared for publication. It is produced in a manner that does credit to its author and publishers alike. The photographic reproductions are very good. The moon, nebulae, and star-clouds are well represented in a series of very fine plates. It is a pity that the headings used were added to the fine photographs by Barnard. A useful summary of the whole book is added in chapter xxiv., which gives a formidable list of problems explained by the theory.