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Reviews

Jean Le Rond d'Alembert. Œuvres complètes Série I: Traités et mémoires mathématiques, 1736–1756. Volume 6: Premiers textes de mécanique céleste, 1747–1749.
Edited by Michelle Chapront-Touzé. Paris (CNRS Editions). 2002. 531 pp. EUR 60

In its general outline the history of celestial dynamics (or "physical astronomy") in the first half of the 18th century, as applied to the motion of the Moon, is a well-documented story. The main object of interest was the three-body system consisting of the Moon, Earth, and Sun; the primary body was the Earth, and the motion of the Moon about the Earth was perturbed by the action of the Sun. The gross lunar phenomena to be explained had been known since the time of Hipparchus and Ptolemy in antiquity and consisted of the motion of the Moon's nodes (about 20° a year) and the motion of the Moon's apogee (about 40° a year). Both phenomena were readily visible and their documentation required no special technology or method of observation. Isaac Newton's theory led to a value for the motion of the lunar apogee that was only one-half the observed value, a difficulty that proved persistent and became something of an embarrassment for researchers by the 1740s. In the late 1740s Leonhard Euler, Alexis Clairaut, and Jean d'Alembert worked on this problem using the methods of the calculus and infinite series. The problem of the motion of the lunar apogee was solved by Clairaut in 1749, who showed that the difference between the theoretical and observed values disappeared if one included second-order terms in the calculation. More generally, the work of the three men led to the establishment of classical perturbation theory, perhaps the first fully mathematically articulated theory of modern physical science.

d'Alembert's published contributions to physical astronomy were presented largely in his *Recherche sur la précession des équinoxes* of 1749 and *Recherches sur différens points importans du système du monde*, volumes 1 and 2 of which appeared in 1754 and volume 3 in 1756. (Editions of these works will appear in later volumes of the *Œuvres Série I.*) These works were preceded or accompanied by a substantial body of writings from the period 1747–1749, a few of which were published at the time but most of which remained as manuscripts in the archives of the Paris Académie des sciences and the Bibliothèque nationale de France. It is these writings, both published and manuscript, that are presented in the volume under review.

Especially noteworthy is a lengthy treatise composed by d'Alembert in 1748, titled here simply "Théorie de la lune de 1748." d'Alembert abandoned this work, apparently in response to Clairaut's announcement in May of 1749 of his solution of the lunar apogee problem. The 1748 treatise was unknown until fairly recently and is consequently not cited in traditional d'Alembert scholarship, so its publication now in such an impressively edited edition is very welcome indeed. Chapront-Touzé's critical work is of a high order, with detailed explanatory notes, cross references, correlations with d'Alembert's published work, and a valuable general introduction. The task of organizing the unbound sheets of the 1748 manuscript into their likely original order was no small achievement. The editor has also added diagrams to accompany the text, for which no figures have survived. The glossary produced

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as an appendix to the volume gives definitions of technical terms used in celestial dynamics of the period. The work as a whole compares favorably with the volumes that have appeared in editions of Newton, the Bernoullis, and Euler.

In his *Introductory Treatise on the Lunar Theory*, Ernest W. Brown (1896) observed that "while [Clairaut] worked out his results numerically, d'Alembert considered a literal development and carried out his computations with more completeness." Chapront-Touzé identifies the historical significance of the 1748 treatise as consisting of the first literal theory of the motion of the Moon: "the constants that appear in the coefficients of trigonometric terms are not replaced by their numerical values" (p. lii). In this respect the treatise set the stage for the more extended theory presented in the *Recherches sur le système du monde*, and its publication allows one to follow the development of d'Alembert's thinking at a critical stage in its development. On the particular question of Clairaut's breakthrough, Chapront-Touzé suggests that the solution was well within the resources of d'Alembert's theory, but that he was more concerned with other aspects of lunar motion, such as the motion of the nodes. The significance of what d'Alembert accomplished on a theoretical level compensated for his failure to solve the celebrated apogee problem.

The past results of calculus and algebra are of enduring historical and conceptual interest: they embody perspectives that are different from modern conceptualizations, revealing interesting theoretical possibilities and unexpected points of view. This seems to be less true of celestial dynamics, possibly because this subject is less universally familiar to scientific readers today, and possibly because of the nature of the subject itself. Classical perturbation theory is a somewhat forbidding topic, one that is bound to be of interest primarily to specialists. Although Chapront-Touzé's edition is not a book the average reader is likely to dip into, it is an invaluable resource for understanding d'Alembert's intellectual biography and for the larger project of writing the history of exact science in the eighteenth century.

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