search for a unified science of motion expressed in mathematical terms. The *Meccaniche* (about 1595–1600) found a way to do a mathematics of motion that combined Archimedes and Aristotle's *Mechanical Problems* and, in its analysis of the inclined plane, made a fundamental separation between the gravific and motor forces of weight. By seeking a single account of "natural" and "forced" motion, admitting motion in a void, and dissociating weight from natural place, Galileo had already begun to undermine the cosmological bases of the Aristotelian doctrine of motion. In the *Two World Systems* (1632), Galileo defended the Copernican system by setting out new cosmological principles that not only conceded but required a moving earth. By providing a new basis for cosmological order, namely, a uniform circular motion ontologically equivalent to rest, and by using a principle of conservation of that motion (and composition of motions superadded to it), Galileo freed motion from its ties to the moving body (or to the mover) and made it the subject of independent study.

The *Two New Sciences* (1637) represents that study. Since the notion of "change of motion" was no longer self-contradictory, Galileo could treat kinematics as the science of changes in velocity resting on a new definition of acceleration. Despite some interesting thoughts on the infinite and on indivisibles, however, Galileo lacked the mathematical tools to follow through on his essentially "differential" definition and had to turn to the methods (though not necessarily the underlying concepts) of his 14th-century predecessors. With an extensive theoretical kinematics at hand, he could then employ the earlier separation of weight and motive force to argue the equal acceleration of all bodies in a void and thus to link mathematical motion and real motion.

More than a technical achievement, Galileo's science of motion offered a new standard of scientific explanation. By seeking for observed data an abstract model from which the data followed as mathematical corollaries, Galileo found that middle road between pure reason and pure perception that has since become the foundation of modern science.

This summary hardly does justice to the complexity and subtlety of Clavelin's analysis, which is rewarding at every turn. Though it would be caviling to point out occasional errors in fact or questionable interpretations of details, it is worth noting that Clavelin at times, and especially toward the end of the book, undercuts the historical strength of his arguments by comparing Galileo's thought to some "right" or "normal" standard of scientific reasoning, as if Galileo were to be graded on his progress toward the present.

Shapere's book focuses on two aspects of Galileo's scientific thought: first, whether he had the principle of inertia and, second, his attitudes toward and uses of experiment, mathematics, and idealization as methods of scientific inquiry and exposition. None of these questions is new, nor do the mode of analysis and the conclusions reached seem to break any new ground. The discussion takes place on a restrictively conceptual level. In chapter 2, for example, on Galileo's intellectual background, such nonphilosophical determinants as the Renaissance engineering tradition are ignored in favor of a pure Platonism reduced to five basic propositions and an essential Aristotelianism condensed to three basic distinctions. To be a Platonist, Galileo will have to subscribe to the five propositions, both in thought and in literary deed; to be a true founder of classical mechanics and modern science, he will have to reject the three distinctions root and branch. Since we have been told at the outset that the principle of inertia was fundamental in the transition from medieval to modern science and that Galileo did not have that principle, we do not expect him to be freed of the distinctions. The very succinctness of the five propositions serves as an early warning that Galileo will be denied a place in the Academy.

So it turns out. By the end of chapter 4, Galileo has held too tightly to the medieval tradition outlined in chapter 3. Whatever the novel elements of the *Two World Systems* (reduced to five propositions), ultimately Galileo "shied away" (p. 121) from the modern principle in order to preserve the static, spatial order of an Aristotelian universe. And what of his method? Shapere is undecided about the importance of experiment (pp. 143–144) and shares the historian's disappointment over the "scanty and inconclusive" record (p. 86). The importance of mathematics to Galileo cannot be ignored, but it could not derive from Platonism as opposed to Aristotelianism, since Plato and Aristotle essentially agreed on the place of mathematics in natural philosophy (p. 138).

There is a petulance about this book which undercuts its historical, if not its philosophical, value. A tone of argument informs the text, but it is not always clear who is doing the arguing, and with whom. In chapter 3 especially, the passive voice combines with logical inference to compose theories, critiques, and rebuttals that possibly no one in fact held or presented, and the absence of documentation prevents recourse to the sources. At the level of more recent, identifiable controversy, Kuhn, Koyré, and Mach are the frequent targets of Shapere's historical and philosophical thrusts. But Mach seems by now a ragged target, and Koyré's Platonist Galileo has long since become (at least for historians) a Renaissance eclectic. As for Kuhn, before one can rebut his arguments one must understand them, and Shapere does not.

On Galileo, read Clavelin.

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The Cavendish Laboratory, 1874–1974. J. G. CROWTHER. Science History Publications (Neale Watson), New York, 1974. xvi, 464 pp., illus. $50; prepaid, $35.

The subject of this book is a rich and fascinating one, for Cambridge University's Cavendish Laboratory has been a leading center of research during the past century. Construction of the Cavendish was made possible when the chancellor of the university, William Cavendish, Seventh Duke of Devonshire, generously provided the estimated £6300 required for the building and apparatus. Prior to its formal opening in 1874 the laboratory was referred to as the Devonshire Laboratory, but at that time it was given the name of the Cavendish family, which had counted among its members the celebrated 18th-century scientist Henry Cavendish, whose unpublished papers on electricity were edited and published in 1878 by the Cavendish's first professor of experimental physics, James Clerk Maxwell. The original building and the buildings of the New Cavendish Laboratory (in use since 1973) are described by Crowther.

Cavendish scientists have made momentous advances in such fields as

atomic and nuclear physics (J. J. Thomson and Rutherford), molecular biology (Crick and Watson), and radioastronomy (Ryle and Hewish)—all of which the book describes. Last year's award of the Nobel Prize in physics to Ryle and Hewish brought to 24 the number of Nobel laureates associated with the Cavendish. Clearly any author courageously attempting to write the 100-year history of a center of such intellectual excellence and achievement is confronted by many difficulties, not the least of which is the fact that there is material enough for several volumes.

In presenting a history of the Cavendish in one volume, Crowther has in mind "the general as well as the scientific reader." For each the usefulness of the book will be inversely proportional to his familiarity with the many historical works, of which Crowther makes extensive use, which deal directly or indirectly, in part or in full, with the Cavendish and its professors. His own contribution has been to sketch periods, particularly more recent ones, not covered by these other volumes. In his researches he has interviewed many Cavendish scientists, but he has not always fashioned the resultant information into good history. Perhaps the most obvious example of this is chapter 20, "The Cavendish in transition," which is intended to deal with the period between the end of Rutherford's tenure as Cavendish Professor in 1937 and the beginning of W. L. Bragg's tenure in 1938. In particular, the latter part of this chapter reads like a set of notes taken during a rambling oral interview with J. A. Ratcliffe, who entered the Cavendish as a student of radiophysics under E. V. Appleton in 1921 and who later acted briefly as director of the Cavendish following Bragg's departure in 1953. Poor construction is also apparent, although to a lesser degree, in chapters 15 through 19, on the Rutherford era, where again it often happens that the author is controlled by his sources rather than they being dominated and ordered by him.

Crowther has been writing on science since 1926, when he became the first science correspondent of the Manchester *Guardian*, and is the author of a number of other books on science and its history. In view of the fact that some of his earlier historical works have used and given support to a Marxist interpretation of history, his promise in the preface to keep in view "the influence of social factors on the subjects and directions of research" at the Cavendish comes as no surprise. However, after the introduction and the first chapter, where the creation of the Cavendish is explained as a response of the University of Cambridge to needs of the burgeoning scientific-industrial society of 19th-century Britain, this concern drops quickly from sight and thereafter we are given a conventional, if uneven, history of Cavendish life under the successive leadership of Maxwell, Rayleigh, J. J. Thomson, Rutherford, Bragg, N. F. Mott, and, since 1971, A. B. Pippard.

Although this book is not the definitive history of the Cavendish, it should prove to be rewarding reading to many. The reviewer, who is not unfamiliar with the other literature relating to the Cavendish, has profited by reading it, especially in regard to the more recent history. It is handsomely produced, with large type, reads easily, and has 52 illustrations, including portraits of each of the seven Cavendish Professors.

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