Book Reviews

Galilean Studies at the Quadricentennium

Metaphysics and Measurement. Essays in Scientific Revolution. ALEXANDRE KOYRÉ. Essays iii, v, and vi translated from the French by R. E. W. Maddison. Harvard University Press, Cambridge, Mass., 1968. x + 165 pp. $7.

Galileo Galilei. His Life and His Works. RAYMOND J. SEEGER, Ed. Pergamon, New York, 1966. xii + 286 pp., illus. Paper, $5. Selected Readings in Physics Series.

Galilée. Aspects de Sa Vie et de Son Oeuvre. Presses Universitaires de France, Paris, 1968. x + 382 pp., illus. Paper, 24 F. Centre International de Synthèse: Histoire des Sciences.

Galileo. Man of Science. ERNAN MCMULLIN, Ed. Basic Books, New York, 1968. xiv + 557 pp., illus. $15.

Even in the 17th century, the crucial significance of Galileo's role in the progress of modern science was obvious. History never lost sight of him, and with the rapid development of the history of science as a discipline during the last two or three decades the stream of literature devoted to him has swelled to a veritable torrent. The torrent in turn became a deluge in 1964 on the occasion of the quadricentennial of Galileo's birth. A reviewer is not even surprised to find himself considering in a single review four separate books devoted to Galileo.

The first two, which belong to the normal torrent rather than the extraordinary flood, offer an instructive contrast. *Metaphysics and Measurement: Essays in Scientific Revolution* contains six papers by the late Alexandre Koyré, four of which are devoted to Galileo and his immediate legacy. No single work has done more to shape the history of science as it is now practiced than Koyré's *Études galiléennes,* which has never been translated into English. These essays offer in our tongue a résumé, as it were, of the longer work. All have been published before and some more than once, but I have only to open the volume and come again into contact with Koyré's lucid mind to appreciate their reappearance in handily accessible form. I shall not attempt to review the essays, much less to criticize them. The very discipline of the history of science as it now exists testifies to their quality; as a practitioner of that discipline I have been molded by them to the extent that I cannot see them objectively. As the editor asserts, there is no better introduction to the intellectual challenge of the subject.

I intend no insult when I contrast Raymond Seeger's *Galileo Galilei: His Life and His Works* with the Koyré volume. Primarily a set of selections from Galileo, introduced by Seeger, it shares with the other work the function of making material that is available elsewhere handily accessible. The editor himself suggests the contrast with Koyré in his rather tendentious comments on philosophers and historians of science. It is obvious that Seeger has studied Galileo closely, and I do not doubt that any historian of science who is less competent in physics (as most of us are) will attend carefully to the insights his competence offers. Equally I suspect that most historians of science will want to suggest with me that if we have much to learn from Seeger as a physicist, we as historians have something to give in return. The format of his collection is such that he runs the constant danger of looking in Galileo for passages that conform most closely to the conclusions accepted by physics in the 20th century. His introductions, which derive the same conclusions in modern analytic form, tend even more in the same direction. Not only does such an approach threaten to remove Galileo from his proper historical context—a matter of no great moment, perhaps, although it offends my sensibilities as a historian—but it loses what I consider to be the major justification for the history of science. It is not clear to me that any benefit is to be expected from merely reading a conclusion in the original (or an early) form in which it was published. Seeger's introductions are more succinct and more clear than the passages from Galileo, and the conclusions they share are more easily learned from the introductions. The history of science performs its unique function when it follows the process whereby the conclusions were drawn and helps us to recognize science not as a tedious correlation of numerical data, like an undergraduate laboratory course, but as man's greatest adventure in creative thought. Conceived in these terms, the history of science requires both the understanding of the scientist and that of the historian, if possible combined in the same individual. As one who considers his supply of the latter to be greater than his supply of the former, I am saddened and mildly annoyed when Seeger, as a physicist, appears to lay claim to the entire discipline. We shall progress farther working together than fighting each other, and if Seeger's volume contributes to the understanding of Galileo, the Koyré volume demonstrates that mere historians have an equally necessary, though different, contribution to make.

The other two volumes, products of the quadricentennial, demonstrate the same conclusion. The year 1964 was punctuated with symposia devoted to Galileo. At least two volumes deriving from such symposia have appeared already; two more now join them—*Galileo: Aspects de Sa Vie et de Son Oeuvre,* the proceedings of a symposium organized by the Centre International de Synthèse in Paris, and *Galileo: Man of Science,* the proceedings of a symposium at the University of Notre Dame enriched by some additional papers. Among other things, the two volumes reveal how far the demands of a Galileo can strain a young discipline. Three men appear in both volumes, and while their papers in the two are not identical, neither are they always easy to distinguish. Some of the other papers appear to have been composed while the plane was approaching the runway in Paris or South Bend. Happily the same cannot be said of all or of most of the papers. Between them, the two volumes advance the discussion of Galileo to a new level. The Notre Dame volume especially, through the effort of its editor, Ernan McMullin, to combine significant articles by earlier scholars with the con-

tributions to the symposium, so that the volume systematically considers every major aspect of Galileo's work, is an important addition to the literature which will exercise considerable influence over continuing scholarship.

Faced with nearly 40 separate articles, the reviewer has no alternative but to discuss those few which particularly catch his eye as relevant to issues he himself is currently concerned with. I might remark that in every case the enduring influence of Koyré is evident. Whether scholars agree with him or disagree, they are discussing Galileo within the context that he established. Inevitably mechanics bulks large in any set of papers devoted to Galileo. The Notre Dame volume opens with a long essay by the editor, one of the finest discussions of Galileo it has been my pleasure to read, which focuses primarily on the historical development of his mechanics. Partly as a result of Koyré's work, we have been accustomed to think of a two-stage development—the mechanics of *De motu* and the mechanics of the *Dialogue* and the *Discourses*. McMullin urges persuasively that in fact four distinct stages can be isolated, the development after *De motu* proceeding through three stages which can be identified in the *Dialogue* and the different segments from which Galileo composed the *Discourses*. Departing again from Koyré, he also maintains that a concept of rectilinear inertia is implicit in the *Discourses*. Much as McMullin's paper impresses me, I do not think he sustains the latter point. Nor do I now think that it can be sustained. I remain with Koyré—Galileo's natural horizontal motion is comprehensible only as motion on a spherical plane everywhere equidistant from a gravitating center. Whereas McMullin agrees with Koyré that the major progress embodied in Galileo's contribution to mechanics was conceptual, Thomas Settle advances the argument that experimentation with inclined planes led Galileo to abandon the position of *De motu* and to embrace the concept of uniform acceleration. Settle may be regarded as the leading advocate today of what was the orthodox interpretation of Galileo before Koyré wrote. Skillfully though he defends his position, I am unable to judge his effort a success. The expressions he finds himself forced to employ are suggestive of an inherent weakness of the argument—"one may surmise . . . ," "it seems safe to say . . . ," "he may have tried . . . ," "it would seem. . . ." To me "it seems safe to say" that surmise is the refuge of an uncertain argument whereas solid evidence concludes in positive statements. One other article on mechanics deserves mention. Whereas Koyré's influence has stressed the determinative role of Copernicanism in Galileo's mechanics, Émile Namer attempts to reverse the roles and to make dynamics the central factor in Galileo's endorsement of Copernicanism. Although the continuity of *De motu* with the later mechanics can scarcely be denied, I think it is impossible to contend effectively, as Namer tries to do, and as his argument demands, that a celestial dynamics (beyond a couple of very general hints) can be found in Galileo.

Perhaps the core of Koyré's interpretation of Galileo was the role of Platonism in determining his approach to nature. Both volumes of essays make it evident that the question of Galileo and Plato, far from being settled, is the livest topic of discussion concerning him. In addition to its passing appearance in any number of papers, it forms the central theme to which four are devoted. Edward Strong and Thomas McTighe attack the thesis that Platonism molded Galileo's distinctive approach to nature; Ernst Cassirer and Aron Gurwitsch defend it. One thing appears certain—Koyré's statement of the Platonistic interpretation requires some modification. If Galileo was a Platonist, he introduced a new element into Platonism when he brought geometry down from the realm of the eternal into terrestrial physics. On this point everyone seems to agree. Strong and McTighe contend that the new element was so contradictory to the Platonic tradition as to constitute its negation. Both Cassirer and Gurwitsch, however, stress what Strong and McTighe seem to ignore, that "nature" to Galileo was not the world of appearance but an ideal world of which the material one is only an imperfect realization. His "natural" motions, horizontal and vertical, are motions confined to that ideal realm where friction and resisting media do not exist. To the extent that they ignore what is the central feature of the Platonistic interpretation, Strong and McTighe engage in knocking down straw men. McMullin, who also enters the lists, argues that a science of motion, that is, a science of change, would have been a contradiction in terms to Plato. Is this entirely correct? Was there not a science of astronomy, and did not ancient astronomy build on the Platonic injunction that only the perfect figure, the circle, expresses the immutable perfection of the heavens? One central feature of Galileo's thought was the abolition of the distinction between the mundane and celestial worlds, expressed in the repeated assertion that the earth has become a heavenly body in the Copernican system. His insistence on the uniformity of natural motions embodied a concept of unchanging change similar to that which had long been the foundation of astronomy. In the case of horizontal motion, uniform motion became equivalent to rest in his eyes and participated in the eternal perfection of circularity. Such a concept could have provided the bridge which led from a geometrical conception of reality to a science of terrestrial motion. I will not, however, presume to settle a vexed and hotly debated question in this limited space. If I can manage it without giving offense, let me point out to Raymond Seeger that asserting the influence of Platonism on Galileo is not equivalent to calling him a "Platonic dreamer" or denying that he was a physicist. Just because he did more than correlate experimental data he remains an everlasting object of interest and inquiry, as these latest additions to the literature testify.

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Astronomy

Nebulae and Interstellar Matter. BARBARA M. MIDDLEHURST and LAWRENCE H. ALLER, Eds. University of Chicago Press, Chicago, 1968. xxii + 835 pp., illus. $27.50. Stars and Stellar Systems, vol. 7.

Some 40 years ago a distinguished astronomer deduced from the colors of galaxies that the upper limit for the absorption of light in space was about 0.00015 magnitude per kiloparsec and suggested that astronomers need not disturb themselves further about this question. At about the same time Trumpler, in discussing the diameters of open clusters in the galactic plane, derived a value of the interstellar absorption some 5000 times larger, and astronomers have been increasingly disturbing themselves over this question ever since. The ques-