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The Science of Mechanics in the Middle Ages by Marshall Clagett

Review by: C. Truesdell

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English) rules for word order, punctuation, and capitalization frequently prevail. Subsequent volumes in this series deserve better treatment.

Chartae Latinae Antiquiores is bound to become a standard work of reference. Its descriptions and transcriptions are apparently accurate, its facsimiles excellent, and its judgments generally sound. It will be invaluable to palaeographers, diplomatists, historians, and philologists. We look forward to further volumes in the series.

LESLIE W. JONES
Berkeley, California

MARSHALL CLAGETT, *The Science of Mechanics in the Middle Ages*. (University of Wisconsin Publications in Medieval Science, 4.) Madison, Wisconsin: University of Wisconsin Press: Oxford University Press, 1959. Pp. xxix, 711; 9 plates. \$8.

IN his *Mécanique Analytique*, published in 1788, Lagrange included a history of mechanics which dominates the historical remarks and attributions still current in the teaching of physics. Most of the early references in Mach's romance, *Die Mechanik in ihrer Entwicklung, historisch-kritisch dargestellt* (1883) are those given before by Lagrange, and it is from notices and footnotes in Mach's coloring that the history of mechanics is inferred by students today. Let anyone who doubts this try to convince a physicist that the laws of uniformly accelerated motion were well known in the Middle Ages. Lagrange said of Archimedes and Galileo that "the interval which separated these two great geniuses disappears in the history of mechanics." In 1675/6 Newton had written to Hooke, "If I have seen further it is by standing on ye shoulders of Giants." In the century between Newton and Lagrange, the memory of the giants had shrivelled until even their names were forgotten. Newton's statement has been interpreted as an early example of the false modesty which has become an accepted norm of behavior today, but Newton was a man loth to say more when less would serve.

Only to one can it be given to discover a whole period of history, and for mechanics in the Middle Ages this one was Duhem. While to the physicist in the laboratory or classroom the mediaeval period is still a vanishing interval, Duhem made it for the historian of science or the student of thought a period of rich and intense analysis and creation. The concepts typical of the western approach, namely: function, inertia, and assignable force, owe their origin to the Middle Ages and are developments of mediaeval ideas. As Professor Clagett writes, "So rich were Duhem's investigations . . . that . . . the succeeding study of medieval mechanics has been largely devoted to an extension or refutation of Duhem's work."

The task of the aftercomers is necessary but not dramatic. As Clagett writes, Duhem in the exuberant disorder of discovery "made extravagant claims for the modernity of medieval concepts. . . ." Also, none could gainsay his inferences, since he used manuscript sources, awkward of access even to those who can profit from them, and he cited "only parts of crucial passages" and "only in French translation." This is not to say Duhem was wrong or unjust; it only shows where the task of consolidation lies.

First, the essential texts must be published, both in Latin, so that the few who are competent to judge interpretations may do so, and in a modern language, so that members of a wider public may get for themselves some notion of what mediaeval science was like. The great bulk of manuscript material in European libraries has to be searched also for other relevant works unknown to Duhem. Finally, more deliberate study must mature a view of the subject.

All this Professor Clagett undertakes in the present volume, which may be regarded as a summary of historical researches by Miss Maier, Professor Koyré, and himself, as well as an anthology of texts. The mediaeval authors represented by liberal selections in English, with the Latin also in cases when there was no modern edition, are Jordanus de Nemore, Johannes de Muris, Albert of Saxony, Trivisano, Gerald of Brussels, Thomas Bradwardine, William Heytesbury, Richard Swineshead, John of Holland, John Dumbleton, Oresme, Giovanni di Casali, Jacobus de Sancto Martino, Blasius of Parma, Franciscus de Ferraria, Franciscus de Marchia, John Buridan, Marsilius of Inghen. In combination with Moody and Clagett's *Medieval Science of Weights* (Madison, Wisconsin, 1952), the present book makes up the main corpus of source material in handy modern print. As such, it will be the invaluable companion of every student of the history of physics or of mediaeval thought.

Professor Clagett's general conclusions, expressed in the last chapter, are summarized under twenty propositions, many of them quoted from mediaeval authors. Some, like Bradwardine's law, $V \propto \log F/R$, are intermediate steps, erroneous principles later to be rejected. Others, like the Merton definitions of uniform speed, of uniform acceleration, of speed in general, and the theorems concerning uniformly accelerated motion, are permanent discoveries, essential elements of the mechanics later developed by Galileo. Some, like Buridan's statements about falling bodies, are self-contradictory. Others, like Buridan's assertions regarding impetus, introduce concepts intermediate between ancient and modern ones. The last, Oresme's principle of relativity, seems the most modern of all but may be in fact a revival or clarification of an ancient doctrine.

Professor Clagett generously and justly wishes us to form our own conclusions from the sources, but he knows how hard these are for the uninitiated to follow. Thus the texts are presented as appendices to the ten descriptive chapters, and each text is followed by a commentary as well. The chapters themselves concern particular groups of problems, such as "The application of two-dimensional geometry to kinematics" and "The free fall of bodies." Copious footnotes in addition give the volume a formidably scholarly appearance, sustained by the scholarly style of the writing itself. It may seem low to carp at the production of a book so carefully printed and above all so cheap, but something about the spacing and arrangement helps to make it a difficult tome to penetrate. There is plenty of blank paper here and there, but almost none in the margin; all kinds of type are more or less the same size and style, so that apparatus criticus fades into text, and on some pages there is more space between paragraphs than between text and notes or between title and text.

What about the physicist who thinks mechanics stopped dead between

Archimedes and Galileo? Can we put this definitive book into his hands? I fear we should do mediaeval science little service. Professor Clagett's work cannot be too highly praised as reading for the initiate, but it is hard reading. Coming to it with a predilection of the subject, I read every word, but in small doses, fought out against many a yawn. Despite Professor Clagett's immense erudition, it might still be better counsel to the physicist to read Duhem, exaggerations and inaccuracies and all.

It would of course be unfair to expect of any historian the genius which shines from behind Duhem's writings. Duhem was not only the discoverer of mediaeval mechanics; he was also a creator himself, and a great one, in rational mechanics and theoretical physics. Such a man will sometimes jump to a conclusion that must later be abandoned; he may commit slips in translation, and he will not edit texts. He gives us, however, a depth and a grasp that comes from the habit of creative thought; sometimes, because he knows how scientists think, he comes closer to the creator than does a more painstaking, scrupulous historian. Even in the gross carelessness of Mach we sometimes see flashes of historical insight. In this day when scientists, each in his little, tightly organized field, must conform to the accepted norm of a "real" scientist, and historians of science, likewise organized and eager to promote specialized departments for themselves, are establishing equally tight social norms, it may be futile to try to draw closer to the unity of man, thought, and nature that was the Middle Ages.

But there is something else I miss in Professor Clagett's book. It is about the Middle Ages, but a Middle Ages different from any other I have encountered. Jordanus de Nemore wrote when Walther von der Vogelweide had sung, and Joinville was crusading with the Saintly King; San Zeno at Verona had been standing for a century, and, fifty years before, Antelami had finished the Deposition at Parma; not long after the Merton kinematical theorems had been proved and John Buridan had completed his lectures on dynamics at Paris, Guillaume de Machault wrote his Coronation Mass. This life, this color, this drive, is the Middle Ages, but it is not to be found in Professor Clagett's book. Does that mean that science in the Middle Ages was really a dull university game, thought divorced from life and art? It would be most un-mediaeval to think so, and I do not.

Rather, I conjecture that there is much of mediaeval science still to be discovered. When many more admirable compilations and close studies such as those of Miss Maier and Professor Clagett are made available, perhaps the picture of scientific thought as a part of mediaeval action will come to life.

C. TRUESDELL
Indiana University

RICHARD B. DONOVAN, *The Liturgical Drama in Medieval Spain*. (Studies and Texts, 4.) Toronto, Canada: Pontifical Institute of Mediaeval Studies, 1958. Pp. 229, one folded map. \$5.50.

INTENDED primarily as a vehicle for the publication of all extant Latin dramatic texts in Spanish MSS, the implications of this monograph are by no means limited to Spain. Like Karl Young, on whose work he is building, Father Donovan dif-