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978-0-521-56762-6 - The Foundations of Modern Science in the Middle Ages: Their Religious, Institutional, and Intellectual Contexts

Edward Grant

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Contrary to prevailing opinion, the roots of modern science were planted in the ancient and medieval worlds long before the Scientific Revolution of the seventeenth century. Indeed, that revolution would have been inconceivable without the cumulative antecedent efforts of three great civilizations: Greek, Islamic, and Latin. With the scientific riches it derived by translation from Greco-Islamic sources in the twelfth and thirteenth centuries, the Christian Latin civilization of Western Europe began the last leg of the intellectual journey that culminated in a scientific revolution that transformed the world.

Four essential factors enabled medieval Europe to prepare the way for the new science of the seventeenth century: translations into Latin of Greek and Arabic scientific texts in the twelfth and thirteenth centuries; the development of universities, which were uniquely Western and used the translations as the basis of a science curriculum; the adjustments of Christianity to secular learning; and the transformation of Aristotle's natural philosophy. This study reviews the accomplishments of medieval science and also carefully considers how they looked forward to the Scientific Revolution.

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THE FOUNDATIONS OF MODERN SCIENCE IN THE MIDDLE AGES

*Their religious, institutional, and
intellectual contexts*

EDWARD GRANT

Indiana University



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To
my colleagues
past and present
in the
Department of History and Philosophy of Science
Indiana University-Bloomington

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Preface

Twenty-five years have passed since the publication of *Physical Science in the Middle Ages* in 1971 in the John Wiley History of Science Series, and nineteen years since Cambridge University Press assumed responsibility for the series in 1977. In the early 1980s, I was asked to revise the book, but other duties and responsibilities made the task unfeasible. When I finally had the opportunity a few years ago, the prospect of doing a revision no longer seemed inviting. Too much had happened in the interim. Merely expanding the old version with new material – and there has been much of it since 1971 – while retaining the earlier structure and general outlook was, frankly, unappealing. My sense of the medieval achievement in science and natural philosophy and my understanding of the intellectual environment that produced it, as well as my perception of the relationship between medieval science and the Scientific Revolution, had all been fundamentally transformed.

Between 1902 and 1916, Pierre Duhem, a famous French physicist turned historian, wrote fifteen volumes on medieval science. Duhem was the first to blow away the dust of centuries from manuscript codices that had lain untouched since the Middle Ages. What he discovered led him to make the startling claim that the Scientific Revolution, associated with the glorious names of Nicholas Copernicus, Galileo Galilei, Johannes Kepler, René Descartes, and Isaac Newton, was but an extension and elaboration of physical and cosmological ideas formulated in the fourteenth century, primarily by Parisian masters at the University of Paris. Duhem regarded medieval scholastic natural philosophers as Galileo's precursors. By his numerous publications, Duhem made medieval science a respectable research field and placed the late Middle Ages in the mainstream of scientific development. He thus filled the hiatus that had existed between Greek and Arabic science, on the one extreme, and early modern science in seventeenth-century Europe, on the other. For the first time, the history of science was provided with a genuine sense of continuity.

Duhem's claims seemed extravagant to most historians of science, and even to many medievalists, who often suffered from an inferiority com-

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plex about the expression “medieval science,” which, until the appearance of Pierre Duhem, was regarded by many scholars as an oxymoron. Medievalists bold enough to pursue Duhem’s approach, or to try other ways, also had to contend with the charge of “Whiggism,” namely, that they were selecting from the mass of medieval science and natural philosophy ideas that sounded modern and that could be proclaimed as anticipations of things to come. Medieval claims were further subverted by Alexandre Koyré, a preeminent historian of the Scientific Revolution, who insisted that the classical science of the seventeenth century was in no way a continuation of medieval physics, even when medieval ideas and concepts were strikingly similar to ideas proposed in the Scientific Revolution. It was, he argued, a “decisive mutation” (*mutation décisive*).¹ The ideas and concepts were embedded in radically different intellectual contexts. Or, to use language made famous by Thomas Kuhn in *The Structure of Scientific Revolutions*, the respective *normal paradigms* of medieval and seventeenth-century physics were *incommensurable*. The physics and cosmology of the Middle Ages, it was argued, were based wholly upon Aristotelian natural philosophy, which was incompatible with the new science that emerged in the seventeenth century. Indeed, Aristotelian natural philosophy was viewed as the major obstacle to the birth of the new science. Only by its repudiation could the Scientific Revolution have succeeded.

Physical Science in the Middle Ages was written with the conviction that this interpretation was essentially correct, and that the Middle Ages had not contributed significantly to the Scientific Revolution of the seventeenth century. True, there were some medieval anticipations of later achievements, especially in problems concerning motion. But these were insufficient to prompt me, and most historians of medieval science, to attribute any meaningful role to medieval science and natural philosophy in bringing about the new science of the seventeenth century.

A few years ago, it occurred to me that perhaps we – historians of medieval science and of the Scientific Revolution – had interpreted the medieval contribution too narrowly. We had judged the Middle Ages in terms of the specific influences it might have exerted on this or that science, usually physics, and on whether it had played a role in reshaping scientific methodology. But the significance of these alleged influences, or contributions, was often called into question, although a number of them will be cited in this study. Because it was difficult to demonstrate that these medieval “anticipatory” ideas had actually exerted any direct influence, most scholars found little reason to assume a medieval contribution. The case seemed closed.

My attitude changed dramatically, however, when, some years ago, I asked myself whether a Scientific Revolution could have occurred in the seventeenth century if the level of science in Western Europe had re-

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mained what it was in the first half of the twelfth century. That is, could a scientific revolution have occurred in the seventeenth century if the massive translations of Greco-Arabic science and natural philosophy into Latin had never taken place? The response seemed obvious: no, it could not.² Without the translations, many centuries would have been required before Western Europe could have reached the level of Greco-Arabic science, thus delaying any possibility of a transformation of science. But the translations did occur and so did the Scientific Revolution. It follows that something happened between approximately 1200 and 1600 that proved conducive for the production of a scientific revolution. If these medieval facilitations did not occur in the exact science themselves, then they must be identified elsewhere.

Although scholars are still at work determining whether specific medieval discussions and achievements in physics (here I am thinking especially of concepts of motion and matter theory) and cosmology contributed to the new science of the seventeenth century, some of which will be mentioned later, the claims in this study do not depend on such specific influences. Even if the Middle Ages made few significant contributions to the advancement of the sciences themselves, or none at all, the claims made here should stand on their own. But if no noteworthy medieval contributions were made to help shape specific scientific advances in the seventeenth century, in what ways did the Middle Ages contribute to the Scientific Revolution and, more to the point, lay the foundations for it? Whatever these contributions may have been, they had to be of a permanent nature and also had to be new to Western Europe, in the sense that they did not exist prior to the twelfth century. What these foundational elements were will be described and elaborated in chapter 8.

In light of my radically altered perception of the significance of medieval science and natural philosophy, nothing less than a new book seemed appropriate, the burden of which is to validate the new claims. Nevertheless, I have included some material from the earlier work, especially material from chapter 4 ("The Physics of Motion"). But the approach in this book is radically different. Indeed, this volume might even be viewed as supplementing the earlier book. Where *Physical Science in the Middle Ages* sought to convey the essential and substantive features and contributions of medieval science, while acquiescing in the old interpretation, the present study, though not challenging the old, narrow interpretation, expands the discussion to a much broader canvas. It views the substantive achievements of the Middle Ages within a broad societal and institutional setting that includes the translations, Christianity, and the universities. What emerges is a new interpretation that attributes a major role to the Middle Ages in the generation of early modern science, a role that is independent of whether or not medieval scholars made

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identifiable contributions to the transformation of the exact sciences in the Scientific Revolution.

I intend this study to be a relatively brief, interpretive essay for a broad audience. Therefore, I have limited footnotes almost exclusively to the identification of quotations. Also, I would like to thank the anonymous reader who reviewed my manuscript for the Cambridge University Press. Despite our radically different attitudes toward history in general, and the Middle Ages in particular, I profited from a number of helpful suggestions and corrections and am still awed by the diligence and dedication with which he or she carried out this difficult assignment.