ASTRONOMY AND COMPOTUS AT OXFORD UNIVERSITY
IN THE EARLY THIRTEENTH CENTURY:
THE WORKS OF ROBERT GROSSETESTE

A Dissertation

Submitted to the Graduate School
of the University of Notre Dame
in Partial Fulfillment of the Requirements
for the Degree of

Doctor of Philosophy

by

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June 2003

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This dissertation examines two works of Robert Grosseteste (c. 1169–1253), his astronomical textbook, the *De spera*, and his computistical work, the *Compotus correctorius*. Through the use of a technique labelled exposition, the texts are presented to the reader through a means that combines elements both of translation and of extended commentary, thereby introducing these works in detail in English for the first time. The texts are also analyzed in terms of their medieval context, specifically the goals Grosseteste wished to accomplish in constructing them and their place in higher education.

The first portion of the dissertation provides an intellectual and institutional context for Grosseteste's work, outlining the translation movement and the rise of the universities, especially Oxford, as they pertain to the questions of this dissertation. Grosseteste's biography is also considered, though certain facets of it are unsettled. By the end of the dissertation, it is suggested that Grosseteste's time spent in Hereford was formative for his later work in astronomy and compotus, and that his work in these areas was important for the development of natural philosophy at Oxford.

It is argued that the *De spera* was a basic introduction to astronomy, incorporating the newly recovered science of the Greeks and Arabs. The astronomy presented in this text does not achieve a high degree of sophistication, but rather is directed at presenting various

features of the created world. In relation to the astronomical work, other texts by Grosseteste are examined in order to delineate his interest in astrology.

The *Compotus correctorius*, it is argued, was also composed as a textbook, though it contains information that probably was not taught to all students. The technical sophistication of the astronomy revealed in this text demonstrates the value of the newly translated Greek and Arabic science to Christian goals, namely, correcting the calendar. The fundamentally theological orientation of the work in maintaining the Christian calendar is also considered.

To Amy

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ACKNOWLEDGEMENTS

I have received aid in completing this dissertation from a number of sources.

Intellectually, I have benefitted from the community of Notre Dame, most especially from the faculty and graduate students of the Program in History and Philosophy of Science. I have also appreciated the support and friendship of members of the Medieval Insitute, the Program of Liberal Stuides, and the Departments of History, Philosophy, and Theology. I am also grateful to the community of historians who have attended the Biennial History of Astronomy Workshops at Notre Dame.

My advisor and friend, Michael J. Crowe, has been an unending source of support, patience, practical advice, and encouragement. I also wish to thank the other members of my committee, Dan Sheerin, Phil Sloan, and John Van Engen, for their help in improving this dissertation. Special thanks also go to Mike Shank, who generously gave of his time to read portions of the text and make valuable suggestions to improve them.

Financially, my work as a graduate student has been generously supported by the Program in the History and Philosophy of Science. I also received a grant from the Zahm Research Travel Fund for purposes of travel to England to conduct some of the research for this project. While there, John Hedley Brooke of Harris-Manchester College found me an affordable place to stay.

I was also helped by the staffs of numerous libraries. Foremost among these was the staff of the Library of the University of Notre Dame, who have always been extremely accomodating and helpful. I also wish to acknowledge the aid of library staffs of the Bodleian in Oxford, The British Library, the University Library of Cambridge, and the

librarians of the following colleges: at Oxford, Corpus Christi and Merton Colleges, and at Cambridge, St John's College.

The most important source of aid and succor has been my family. The support of my parents, Jim and Betty Dowd, was constant, as was that of my parents-in-law, Lois and the late Doug Halvorsen. Most important was my wife Amy, without whose love and patience I could never have completed this journey.

PREFACE

ASTRONOMY IN THE MIDDLE AGES

Recent highly regarded books that view the history of astronomy as one long narrative tend to treat the Middle Ages in two parts.[1] Around the middle of the fifth century, the story goes, the collapse of the Roman Empire began a dark period in the history of astronomy. Knowledge of astronomy in the Latin West after this time is characterized as being essentially limited by the contemporary sources. Because a knowledge of Greek was not present, only Latin sources were available. Four sources were particularly popular for astronomy: Calcidius's commentary on Plato's *Timaeus*, Macrobius's *Commentary on the Dream of* Scipio, Martianus Capella's *Marriage of Philology and Mercury*, and Pliny's *Natural History*.[2] These sources contained only qualitative information and did not offer explanation of the methods by which such information had been originally assembled, and thus limited the potential for Latin scholars to advance the science of astronomy. The main use of astronomy of a more technical nature in this period was on behalf of compotus, or the science of determining the correct dates for Christian festivals, especially Easter; Bede's

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[1]Examples include *The Cambridge Illustrated History of Astronomy*, edited by Michael Hoskin, Cambridge: Cambridge University Press, 1997; John North, *The Norton History of Astronomy and Cosmology*, New York: W. W. Norton & Co., 1994; and *Astronomy Before the Telescope*, edited by Christopher Walker, New York: St. Martin's Press, 1996, especially Olaf Pedersen, "European Astronomy in the Middle Ages," 175–186.

[2]See, for example, Bruce Eastwood, "Astronomy in Christian Latin Europe *c*. 500–*c*. 1150," *Journal for the History of Astronomy* 28 (1997): 235–258.

The Reckoning of Time stands out as the great achievement in Latin compotus and astronomy in the early Middle Ages.

The view that astronomy had such a limited role relies mainly on a historiographical program that insists that astronomy should be characterized by quantitative analysis of the motions of the heavenly bodies. Neugebauer, for example, expresses a very low opinion of the astronomy of the early Middle Ages.[3] Some historians of astronomy who investigate this period, however, have identified other research agendas. Bruce Eastwood, for example, has noted that Carolingian scholars attempted to work with the limited Latin sources to investigate the problems of the orbits of Venus and Mercury.[4] Steven McCluskey has noted a variety of uses of astronomy in the early Middle Ages, including the replacement of pagan solar festivals with Christian festivals and monastic timekeeping.[5] And Valerie Flint has argued that the early Middle Ages was characterized by the attempt of the Church to "rescue" astrology for its own purpose.[6] So the history of astronomy in the middle ages need not be a history merely of technical achievement.

The second part of the medieval period in the history of astronomy is generally said to begin in the eleventh or twelfth centuries. In the eleventh century, the first astrolabes, as

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[3]See his *A History of Ancient Mathematical Astronomy*, part 2, New York: Springer-Verlag, 1975, especially Book 5, Part C, pp. 942ff.

[4]See, for example, his "Astronomical Images and Planetary Theory in Carolingian Studies of Martianus Capella," *Journal for the History of Astronomy* 31 (2000): 1–28; and "Plinian Astronomical Diagrams in the Early Middle Ages," in *Mathematics and Its Applications to Science and Natural Philosophy in the Middle Ages*, edited by Edward Grant and John E. Murdoch, 141–172, Cambridge: Cambridge University Press, 1987.

[5]See his *Astronomies and Cultures in Early Medieval Europe*, Cambridge: Cambridge University Press, 1998.

[6]See her *The Rise of Magic in Early Medieval Europe*, Princeton: Princeton University Press, 1991.

well as astronomical tables, came to Western Europe.[7] With the importation of these devices, astronomy could again become quantitative. To understand fully the basis for the astrolabe and tables, however, required the translation of Arabic and Greek works and the development of theoretical astronomy. For two centuries, Latin scholars, often in collaboration with Arabic or Jewish assistants, translated such works into Latin. In addition, they wrote original works to assist in the teaching of astronomy, such as Sacrobosco's *Sphere*. The combination of new instruments, revised astronomical tables, and translated and original works of a theoretical nature, brought a new maturity to the science. This more mature science would be developed and propagated through the institution of the university, where astronomy was a part of the curriculum of the arts. Thus every student who progressed to one of the higher faculties, as well as many who never went past the undergraduate level, would be introduced to the advancing science.

Recently, some modern scholars have suggested that, in the twelfth and thirteenth centuries, a desire for astrological knowledge led to a renewed interest in astronomy. That is, understanding the motions of the heavenly bodies may not have been enough motivation to pursue the difficult tasks of translating works from Greek and Arabic and gaining a higher degree of quantitative knowledge. Instead, medieval scholars who pursued astronomical sophistication did so in order to develop their abilities in astrology.[8] Even if this motivation

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[7]See Hoskin and Gingerich, "Medieval Latin Astronomy," in *The Cambridge Illustrated History of Astronomy*, pp. 72ff; or Olaf Pedersen, in *Early Physics and Astronomy, A Historical Introduction*, revised edition, Cambridge: Cambridge University Press, 1993, pp. 219ff.

[8]For example, Roger French argues that English medical practitioners wanted to gain the practical benefit of foretelling the future, as well as increasing their reputation by having knowledge of the heavenly influences on the physical body; see his "Astrology in Medical Practice," in *Practical Medicine from Salerno to the Black Death,* edited by Luis García, et.al., 30-59, Cambridge: Cambridge University Press, 1994, and "Foretelling the Future: Arabic astrology and English Medicine in the Late Twelfth Century," *Isis* 87 (1996): 453-480. Hoskin and Gingerich acknowledge the "incentive" of astrology; see their "Medieval Latin Astronomy," p. 73. Pedersen, in his "European Astronomy in the Middle Ages," p. 183, suggests that medieval scholars interested in astronomy had little recourse to pursue their interest in

was not universal, it was recognized contemporaneously as a benefit by Roger Bacon, who argued that education and research in the West must include astrology so as to benefit the Church.[9]

How, then, does this current research project on the astronomical and computistical works of Robert Grosseteste fit into the history of astronomy? In one sense, it clearly fits into the traditional story as one instantiation of the incorporation, after the translation movement, of sophisticated astronomical knowledge into the educational program of the university. In this light, the project can be seen as a case study in the ways in which the new scientific texts gained from the translation movement made an impact on the educational content of astronomy as one of the liberal arts and as a portion of natural philosophy. In addition, investigation of the level of astrological material presented to undergraduates furthers the agenda of explaining the place of astrology in the medieval understanding of astronomy.

In other ways, however, my project intends to accomplish a different kind of goal from the traditional historiography. Rather than seeing the medieval period in the context of "recovery" of Greek astronomy and the increasing "sophistication" of Latin astronomy, this project will concentrate on understanding the creation of new Latin texts for the medieval context itself. I will be interested not in determining whether medieval astronomers got the science "right," but will instead focus on the content of the science and the purposes for which it was taught to students. In order to accomplish this, I will make use of a methodological approach of "assimilation."

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academic circles, and instead needed to seek employment as court astrologers or 'mathematicians.'

[9]See especially his chapter on "Mathematics" in his *Opus maius*, translated by Robert Belle Burke in *The Opus Majus of Roger Bacon*, 2 vols, Russel and Russel, Inc.: New York, 1962. Bacon defends the reality of astrological influences, argues that doctors of the Church have delineated precisely the limits of acceptable astrological prognostication, explains the medical benefits of astrology, and notes various benefits of knowing the future for economic and military activities on behalf of the Church.

A. I. Sabra has argued that a great deal of the modern scholarship on translation movements has been of a 'kinematic' sort.[10] He describes such publications as those that give an account

> of the transmission of scientific knowledge from one culture to another … [and] a description of movements of scientific products (texts, concepts, theories, techniques, etc.), in abstraction from the forces underlying these movements. The principal aim of such a description would be to state when and where the transport of these products took place, and thus to determine the path of their movement.[11]

While this type of work is a necessary part of the process of describing a historical situation, it cannot give a full picture of that situation. Sabra suggests instead of such a kinematic approach, which he labels 'transmission,' that historians of cultural exchange adopt the analytical category of 'appropriation.' This word highlights the notion that what is under investigation is not merely the text, but also the manner in which the text was used within the cultural milieu. Adoption of the category of appropriation forces one to confront complex issues of use, motivation, and diffusion and modification of ideas and theories.

Roger French has raised similar concerns regarding the recovery of Aristotle's works. While recognizing the value of knowing what texts of Aristotle were grouped together at different times, French argues that further questions must be asked: who used them, what they did with them, and so forth.[12] "So the central story of the introduction of Aristotle's texts into the teaching of the new universities is about why they were there and

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[10]A. I. Sabra, "The Appropriation and Subsequent Naturalization of Greek Science in Medieval Islam: A Preliminary Statement," *History of Science* 25 (1987): 223–243.

[11]Sabra, "The Appropriation and Subsequent Naturalization of Greek Science in Medieval Islam," p. 223.

[12]Roger French, "Teaching Aristotle in the Medieval English Universities: *De plantis* and the Physical *Glossa ordinaria*," *Physis* 34 (1997): 225–296.

how they were understood."[13] As with Sabra's methodology, the central question becomes how the text was incorporated into the milieu in which it was used.[14]

This dissertation will use a methodology that combines these two approaches. I will be examining texts as they were used in the context of thirteenth-century teaching at an advanced level, either in a university or some other institution. The need for examining the context of educational institutions, and indeed arguing that the texts were intended for that purpose, is thus clear. Using the category of assimilation, this investigation will consider the content of texts, as well as for what purpose they were intended. It is here that the project will depart from the typical historiography of the "advance" of astronomy. Rather than attempting to demonstrate the increasing sophistication of astronomical theory, or greater precision in tables, for example, I will instead focus on the content of the science as it was presented, not as a part of a narrative of getting the science "right."

Issues such as these are particularly relevant to the history of medieval science for two reasons, first, because of the significance of being 'medieval,' and second, because of the problematic term 'science.' To recognize the context as medieval is to emphasize the radical differences from today's society. Medieval Europe was Christian in a way that no society is today. Not only did the Roman Church play a greater role in society and culture, Christian concerns impacted heavily on nearly all aspects of life. In the educational system, for example, decisions on curriculum were influenced by how course material would contribute to an education relevant to a Christian society. Natural philosophy, knowledge of the world, then, was useful so far as it contributed to Christian aims. Astronomy, one branch

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[13]French, "Teaching Aristotle in the Medieval English Universities," p. 226.

[14]French also elaborates on his methodology in "Foretelling the Future," and in the book he co-authored with Andrew Cunningham, *Before Science: The Invention of the Friars' Natural Philosophy*, Brookfield, VT: Ashgate Publishing Company, 1996.

of natural philosophy, contributed, for example, by maintaining the calendar (and especially finding the proper date for Easter) or revealing the workings of God in creation. To promote astronomy for its own sake, to value increasing sophistication of quantitative analysis of celestial motions as a contribution to science, would be a foreign ideal.

This brings us to the second problematic term: science. The word ‘science,’ if taken to mean a unified body of knowledge about the natural world and incorporating a methodology of experimentation and verification within a profession dedicated to that task, did not exist in English until the middle of the nineteenth century.[15] In the Middle Ages, the Latin word *scientia* referred to a body of knowledge with a sure foundation, and included many fields that do not fit under the modern term. To lump knowledge of the natural world into a category by itself, and suggest that the task of a scholar dedicated to such fields of endeavor was simply to increase our understanding of natural phenomena, would be foreign to the medieval mind.[16] This does not mean that individuals in the Middle Ages could not be interested in better understanding the world around them, but never in terms of contributing to some body of knowledge, restricted to the natural world, labelled ‘science.’ Typically, such investigations were meant to bring about practical benefits: improved medical care, appreciation of the Creator, and so on. Dangers of such investigations were typically seen in theological terms: warping God’s intention for the world, or underappreciating the role of the Creator by focussing solely on the creation.

What, then, was the situation of astronomy in the context of a medieval university? It was one of the liberal arts, and a part of natural philosophy, and thus formed at least of

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[15]Regarding the term ‘science,’ see Sydney Ross, “Scientist: The Story of a Word,” *Annals of Science* 18 (1962): 65-85.

[16]It can be argued that such an attitude developed during the Scientific Revolution, or at least in the nineteenth century when the profession of ‘scientist’ was being created.

portion of nearly every undergraduate's education. It had certain benefits: understanding the motions of the heavens, ordering the calendar, aiding biblical exegesis, and, in some circumstances, predicting astrological influences on the world. Other claims about astronomy, such as its increasing sophistication on the theoretical level or the role of observation,[17] can be foreign to this context.

Trying to understand, wholesale, the place of astronomy within the medieval university would be too large a task for a research project of this magnitude. Instead, I have chosen to focus on one particular scholar of the era: Robert Grosseteste of England. Grosseteste makes a fascinating subject, for his interests were manifold, and among them were astronomy, astrology, and compotus. He has also been the subject of a number of modern studies, some concentrating on his contributions to natural philosophy, and many on his philosophy and theology more broadly, but few on the astronomically-related aspects of his thought. Another reason to chose him as a figure of study is that he was closely associated with and very influential in the development of natural philosophy at one of the earliest universities: Oxford. Thus understanding his approach to astronomy and compotus will aid us in understanding the place of those sciences within the fledgling university. The first two chapters of this dissertation will set the context for his work, covering, respectively, the intellectual and institutional developments of the twelfth and early thirteenth centuries, and the biography of Grosseteste.

The astronomical and computistical works of Grosseteste have received some attention in the secondary literature, but much remains to be done. In the third and fourth chapters, I will examine Grosseteste's works. They have never been translated into English,

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[17]For a balanced treatment of the issue of observation, see Bernard R. Goldstein, "The Status of Models in Ancient and Medieval Astronomy," *Centaurus* 24 (1980): 132–147, and "Theory and Observation in Medieval Astronomy," *Isis* 63 (1972): 39–47, reprinted in Goldstein's *Theory and Observation in Ancient and Medieval Astronomy*, London: Variorum Reprints, 1985.

though they are available in Latin in printed versions. In this dissertation, I will provide what I have labelled an "exposition" of the texts. This is not a straightforward translation; it is my opinion that many of the technical details of the works require explanation for modern audiences (and, indeed, probably for medieval ones, as well). Thus my expositions will provide explanation for the content of the works, while at the same time preserving certain aspects of the text, such as the order of the material as it was presented by Grosseteste. In some cases, this may be confusing, as he sometimes uses terms or concepts that he has not explained in the text; it is for such reasons that I wish to provide commentary on the text, and so incorporate it through the use of exposition. In many places, I will also present a close translation of the wording of the Latin to preserve the flavor of what the text is like in the original language; in some cases, this will result in somewhat awkward English, but I have chosen not to eliminate certain cases of this because of the desire to present something akin to a translation. Where the meaning of the text is obscure or uncertain, I will provide the Latin for the benefit of the reader. I will also provide technical Latin terms in order to bring out the vocabulary of the science. It is my hope that this practice of exposition will thus serve the purposes of both translation and commentary without strictly speaking being identical to either one of them.

In addition to the exposition of the texts, I will provide analysis of them. It is in these sections that I hope to accomplish further the task of understanding the assimilation of the texts into their cultural context. By the conclusion of the dissertation, I will have more general comments to make regarding the place of astronomy and compotus in the early thirteenth century, comments that would be out of place here, before the texts have been exposited and analyzed. I will also suggest that certain biographical details of Grosseteste's life will need to be modified because of my analysis of these texts. In particular, I believe that he began the work of assimilating Arabic and Greek science during the 1190s while he was in the Hereford and Oxford region. Finally, I will also discuss the place of astronomy

and compotus at the University of Oxford, based upon Grosseteste's influence.

This dissertation will thus contribute to a number of research areas. Foremost among these is the presentation of texts, not merely in a strict translation, but in a more valuable exposition, combining aspects of translation and commentary. I will also analyze these texts under the methodological approach of assimilation, concentrating on the means by which and the purposes for which the texts were produced. I will thereby also contribute to the understanding of the life and works of one of the most fascinating figures of medieval science, Robert Grosseteste.

CHAPTER 1

INTELLECTUAL AND INSTITUTIONAL BACKGROUND TO THE STUDY OF GROSSETESTE'S ASTRONOMY AND COMPOTUS TEXTBOOKS

The twelfth century was a time of great change in Europe. Charles Homer Haskins went so far as to call it a 'renaissance,'[1] thereby placing it with the great movements of the Italian and Carolingian Renaissances. Among the achievements of the period he listed the rise of cities, the emergence of vernacular literatures, the revival of Latin literature, the origins of the universities, and the recovery of Greek science and philosophy, as well as the Arabic additions to those fields.[2] While the notion of renaissance may not be as popular in scholarly circles as it once was, it is hard to deny that the twelfth century saw significant changes in Western, Latin Europe.

In this chapter, I survey the intellectual and institutional developments of the twelfth and early thirteenth centuries, especially in England, that are significant to understanding the intellectual context in which Grosseteste composed his textbooks in astronomy and compotus. My survey will necessarily be selective, because certain developments of the twelfth and early thirteenth centuries are more clearly relevant to the topic. I begin with a general survey of the notion of an English renaissance during the twelfth century, noting its

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[1]Charles Homer Haskins, *The Renaissance of the Twelfth Century*, Cambridge, Mass.: Harvard University Press, 1927.

[2]Haskins, *Renaissance*, p. vi. See also the table of contents for a list of the topics his book covers.

peculiarities within the more general picture of a Latin or European renaissance. Following that, I discuss two areas that saw important developments during this period: the translation movement, especially the changes it produced in scientific fields of study, and the growth of the university. In both cases, the emphasis will be on the English experience of these trends. Finally, I devote a section to Oxford and the rise of its university. With this background material, the reader will be able better to understand the acheivement of Grosseteste in creating his texts.

1.1. England and the Twelfth-Century Renaissance

Haskins pictured the twelfth-century Renaissance as being fundamentally different from both the Carolingian and Italian Renaissances because it was not centered upon any one court or country.[3] Italy and France he credits with the most significant contributions to the changes that century saw, whereas Germany and England were largely the recipients and purveyors of advances begun elsewhere. Spain, as a frontier to the Islamic world, was a significant link in the process of translating the Greek and Arabic materials that Latin scholars sought.

Was England merely a passive recipient of the changes occurring in other parts of Europe? Haskins's treatment certainly supports that picture. For the most part, he presents English scholars who went to the continent for schooling, translators who travelled abroad, and the assimilation of new methods and ideas in courts and monasteries. R. W. Southern repeated this characterization when he described England as "a colony of the French intellectual empire, important in its way and quite productive, but still subordinate."[4]

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[3]Haskins, *Renaissance*, p. 11.

[4]R. W. Southern, "The Place of England in the Twelfth-Century Renaissance," in *Medieval Humanism and Other Studies*, 158–180, Oxford, Basil Blackwell, 1970; the quotation is on p. 158.

Southern himself, however, qualified this characterization by arguing that England did produce interesting and novel changes in four particular areas. Those areas included history, science, wonders, and government. In all cases, however, the key to English originality lay with the Conquest by the Normans in 1066. After this important event, certain aspects of English culture changed drastically. The new political leadership placed demands on English insitutions, especially the monasteries, that led to significant changes. The Norman rulers required an unprecedented level of proof of the monasteries' right to exist as corporate entities, leading the monks to increase their output of historical writing to defend their right to hold their property. Thus the monks, the main purveyors of history in twelfth-century England, developed their historical scholarship to meet the demands of a changing society. Similarly, Southern argued, the increasing concentration on wonders, marvels, and miracles was a product of the Norman pressure brought to bear on the monasteries to defend their past as the grounds by which they should continue to exist. Wonders demonstrated the validity of the monastic communities in which they had occurred.

The Conquest would change English life in the royal courts as well, especially in the field of intellectual treatments of government. Again, as in the monasteries, a practical advantage was to be found for those men who pursued these new studies; they found that such interests could lead to advancement within the governmental structure. But more than this, Southern argues, an innate interest among the English prompted them to produce literature of a type unprecedented elsewhere in Europe. "It was only in England that the complexities of secular government were a matter of anxious thought by men of high ability, and only England produced a literature of detailed elucidation…on government…."[5] So in addition to practical requirements, Southern also allowed that idiosyncratic intellectual trends could cause changes in scholarly output.

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[5]Southern, "The Place of England," p. 179.

Southern credited the development of science in England during the twelfth century to innate interest among the English coupled with innovations brought from the continent by the Normans. On the one hand, Southern wrote, the monasteries of England until the time of the Conquest had a near monopoly on education. Secular schools were almost non-existent until after the conquest, when a great number of secular schools were founded and staffed by masters educated in France.[6] This left England somewhat behind France regarding the establishment of scholastic education, though schools did multiply rapidly during the twelfth century. On the other hand, Southern also recognized a native interest among the English in scientific subjects, at least among the monastically educated. It was not a progressive interest, according to Southern, but it was valuable nonetheless. "There was no idea of new knowledge, but there was a foundation of technical accomplishment."[7]

Thus the English were in a good position to take up the scientific advances brought by the Normans. In the field of astronomy, especially, there was already an interest among the English both to increase and to improve the store of knowledge. Even before the twelfth century, Walcher of Malvern was interested in establishing greater precision of measurement regarding the moon's motion and position. And in the third and fourth decades of the twelfth century, the monks of Worcester were recording celestial phenomena and beginning to use the tables of al-Khwarizmi.[8] Thus, when the translation movement

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[6]Southern has elsewhere stressed that these schools offered only basic instruction in grammar, singing and chanting, and that Englishmen who wanted instruction in more complex subjects had little choice but to go to schools on the continent. See R. W. Southern, "From Schools to University," in *The History of the University of Oxford*, vol. 1, *The Early Oxford Schools* (hereafter *HUO1*), edited by J. I. Catto, 1–36, Oxford: Clarendon Press, 1984, especially pp. 2–3.

[7]Southern, "The Place of England," p. 166.

[8]Southern, "The Place of England," pp. 166–169. For more on Walcher, see Charles Homer Haskins, *Studies in the History of Mediaeval Science*, Cambridge, Mass.: Harvard University Press, 1927, pp. 113ff; and Charles Burnett, "Mathematics and Astronomy in Hereford and Its Region in the Twelfth

began in earnest, England was in a position to take advantage of it, and their nascent interest in the subject material provided fertile ground for the new science that blossomed in Latin Europe throughout the twelfth century. As it turns out, however, it was not in the monasteries that the new science would take hold. Many of the major impulses for accepting and utilizing the new science came from scholars in the southwest of England. We will return to this aspect of the story below.

In explicit response to Southern's treatment of England's place in the twelfth-century renaissance, Rodney Thomson suggested important modifications to Southern's theses.[9] First, Thomson argued that England should not be considered separately from northern France, stating, "A description of intellectual and cultural life in twelfth-century England and northern France must emphasize its shared character, its commonality."[10] Thomson pointed out that many of the leading proponents of scholasticism in the twelfth century came from England, but were educated in France. Rather than making this non-English, as Southern would do, Thomson emphasizes the shared culture of Anglo-Norman England and northern France. Thus the contributions to history and science made by English writers, Thomson argued, lay within the broader intellectual trends of continental Europe, and should not be seen as uniquely English. At the same time, however, Thomson did argue that the English in particular made important intellectual contributions in two fields neglected by Southern: the study of the literature of pagan Rome, and the production of books and libraries, especially among religious houses.

In the final analysis, though, Thomson did not equate Anglo-Norman English and

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Century," in *Medieval Art, Architecture and Archaeology at Hereford*, edited by David Whitehead, 50–59, Leeds: The British Archaeological Association, 1995.

[9]Rodney M. Thomson, "England and the Twelfth-Century Renaissance," *Past and Present* 101 (1983): 3–21.

[10]Thomson, "England and the Twelfth-Century Renaissance," p. 4.

northern French intellectual life in the twelfth century. Instead, he emphasized that, despite their commonalities, which must be recognized to gain an historically accurate picture of the era, they could be differentiated in important ways. England was both a frontier and had a smaller population than France. In addition, the centralized government and the vigor of the monasteries affected the character of English intellectual life. One significant effect of these differences was the delay in England of developing scholasticism: it happened earlier in France than in England.[11]

One final theme of the twelfth-century renaissance in England comes from Warren Hollister.[12] He agreed with, and indeed expanded upon, Southern's treatment of English innovation after the Conquest in the realms of historical writing and government. But in addition to the changes that the Normans brought to England, Hollister suggested that a new idea surfaced in the twelfth century that contributed to the changes of that era. He stated that the twelfth-century renaissance was the birthplace of a "new idea of a divinely ordered cosmos open to human reason."[13] In the field of historical writing, for example, a "new interest in naturalistic cause and effect may well have made the writing of history a far more intriguing enterprise than before."[14] He argued that systematic thinking of this kind also changed the way governments operated.

Hollister did not deal with the issue of science that Southern and Thomson had both

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[11]But Thomson also notes that Oxford by 1200 and Cambridge by 1220 accounted for two "of the five major *studia generalia* in Europe." Thomson, "England and the Twelfth-Century Renaissance," p. 20.

[12]Warren Hollister, "Anglo-Norman Political Culture and the Twelfth-Century Renaissance," in *Politics and Religion in Ancient and Medieval Europe and China*, edited by Frederick Hok-ming Cheung and Ming-chiu Lai, 127–146, Hong Kong: Chinese University Press, 1999.

[13]Hollister, "Anglo-Norman Political Culture," p. 135.

[14]Hollister, "Anglo-Norman Political Culture," p. 135.

broached, but his thesis does have application to this issue. The ability to consider new scientific ideas is fostered in an environment that sees the world as open to rational investigation, and indeed provides an impetus for such investigations to be carried out. Advanced studies in astronomy, received largely from the Arabic world, would demonstrate the power of human reason to unlock the mysteries of the created order. Haskins's examples of Walcher's attempt to provide "precise measurements … as a necessary basis for systematic calculations,"[15] as well as his use of an astrolabe in 1091, show a pre-existent desire for and expectation of order in nature that quantitative analysis can further illuminate. At the same time, with this expectation in place, the study of new ideas in science receives the boon of anticipated benefit. The translation of Arabic and Greek works into Latin was not just an expensive gamble, but was expected to provide a return. A study of the translation movement, then, is not simply a list of what was translated when and by whom, though it must necessarily include that information. It also becomes a story of why particular works were translated, why scholars travelled for hundreds of miles into foreign lands to seek them out, and what benefits they expected to achieve. In similar fashion, we will have cause to ask why Grosseteste chose to write his textbooks, and will be especially interested in the goals of the texts as evidenced through their contents.

1.2. The Translation Movement and the Growth of Science in England

For the purposes of this chapter, I shall not attempt to tell a complete story of the translation movement. The story has been told before, and in greater depth than I can devote to it here.[16] But I shall discuss some of the more important aspects of the translation

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[15]Southern, "The Place of England," p. 167.

[16]One of the most significant studies of the translation movement is still Haskins, *Studies*, though it must now be supplemented by Marie-Thérèse d'Alverny, "Translations and Translators," in *Renaissance and Renewal in the Twelfth Century*, edited by Robert L. Benson and Giles Constable with

movement as it applies to Grosseteste's textbooks, concentrating my efforts on examining the situation in England. Even Thomson, who pointed out the commonalities between Anglo-Norman English and northern French culture during this period, argued that there were differences between the two geographic areas. The historiography of the importation of science into England, discussed below, also maintains a uniqueness for England, due mostly to its geographic isolation at the edge of Europe.

I shall also maintain the separation of English and French culture because of the situation of Grosseteste. As will become evident in the next chapter, it is unclear that Grosseteste himself ever went to France until late in his life.[17] While his education in science may have been influenced by the works of French masters, merely because English education was heavily influenced by the French, I shall argue that the most important aspects of the translation movement in regards to Grosseteste's work in astronomy and compotus came from the native traditions of England. Thus while we will remain aware of the French connection among English intellectual circles, for the purposes of understanding Grosseteste's context, we must know the situation in England.[18]

Carol D. Lanham, 421–462, Toronto: University of Toronto Press, 1991, originally published by Harvard University Press, 1982. Another useful introduction to the topic is David C. Lindberg, "The Transmission of Greek and Arabic Learning to the West," in *Science in the Middle Ages*, edited by David C. Lindberg, 52–90, Chicago: University of Chicago Press, 1978.

[17]An older tradition of biography assumed Grosseteste went to Paris for portions of his education, but this is now under question. He did travel to the continent as a bishop, but this was too late in his life to have an impact on the astronomy and compotus textbooks.

[18]Footnotes in the following section will demonstrate my reliance on the work of other scholars in determining the contributions of particular contemporary authors. For a more general picture of the extent and impact in England of the twelfth-century translation movement, see Charles Burnett, *The Introduction of Arabic Learning into England*, London: The British Library, 1997, and "The Introduction of Arabic Learning into British Schools," in *The Introduction of Arabic Philosophy into Europe*, edited by Charles E. Butterworth and Blake Andrée Kessel, 40–57, Leiden: Brill, 1994; R. W. Hunt, "English Learning in the Late Twelfth Century," in *Essays in Medieval History*, edited by R. W. Southern, 106–128, New York: St. Martin's Press, 1968; and Josiah C. Russell, "Hereford and Arabic Science in England about 1175–1200," *Isis* 18 (1932): 14–25.

Even before the more concerted efforts of translation in the twelfth century, England had seen tantalizing glimpses of the advanced nature of Arabic science, especially in the region of Hereford.[19] Robert, Bishop of Hereford from 1079 to 1095, is known for a computistic work suggesting a revision of the Dionysian era (i.e., the numbering of the years), as well as for being an abacist and an astronomer. Walcher of Malvern, mentioned previously, is known for his astronomical work, including his treatise on the moon—which is also relevant to the calendar—and for his use of the astrolabe. He is known also for a work on eclipses, which may be a translation from Arabic performed with the help of Petrus Alphonsus, a converted Jew from Spain, living in England.[20] In addition to these texts, Burnett has shown that texts on the astrolabe, rhythmomancy (a genre used for teaching mathematics), and the abacus had come to the southwest of England, probably through Lorraine in France. Reinforcing Southern's notion of a nascent interest in science among the English, Burnett has shown that, before the twelfth century, English scholars had already begun to appreciate the benefits of Arabic science. Yet even more sophisticated works in mathematics and astronomy were to be had, and the later stages of the translation movement would introduce great changes to the study of these sciences in England.

The twelfth century saw two main trends in translation: those directly from Greek, and those from Arabic, the latter either originally Greek works translated into Arabic or

[19]The following material is drawn from Burnett, "Mathematics and Astronomy in Hereford." Burnett also has a brief notice of this period as an early stage of the importation into England of Arabic science in his "Introduction of Arabic Learning."

[20]On Petrus, see Haskins, *Studies*, pp. 113ff. The information contained in this chapter of *Studies* was previously presented as "The Reception of Arabic Science in England," *English Historical Review* 30 (1915): 56–69. See also Burnett, *Introduction of Arabic Learning*, pp. 38ff.

original works written by Arabic authors.[21] This, however, is a categorization of modern scholars. There was no systematic organization among the translators of the twelfth century. Decisions on what would be translated appear to have been based on opportunity and the desires and whims of the translators.[22] Little is known of the translators themselves, or even of their mode of operation; we can only conjecture, for example, on how they earned their livelihood, or how they worked with assistants. To understand the situation in England, then, we must work our way backwards, from what was available in Grosseteste's day to the sources by which translations made their way into England.

Translation from the Greek took place largely in Italy, Sicily, and Spain. Patristic texts and Greek medical, philosophical and scientific works, including much of the Aristotelian corpus, were the most common items chosen for translation from the Greek. Translation from Arabic began in the eleventh century when Constantine the African, working in Italy, translated a number of medical texts. In the twelfth century, Toledo in Spain became a center for translations, attracting numerous scholars.[23] Some scholars have proposed that a school of translators worked there in an organized fashion under the patronage of archbishop Raymond, but this picture has been questioned.[24] It seems more likely that Toledo offered a congenial atmosphere for translation activity, and enjoyed a reputation as a place where Latin scholars could find both the works they wished to translate

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[21]There were also some translations made from Hebrew sources. These tended to be in the area of biblical scholarship.

[22]Lindberg makes similar points in the conclusions of his article "Transmission," pp. 75ff.

[23]For a list of translations made in Spain, both in Greek and Arabic, see George F. Hourani, "The Medieval Translations from Arabic to Latin Made in Spain," *The Muslim World* 62 (1972): 97–114; a table of translators and translations is on pp. 109–113.

[24]See, for example, d'Alverny, "Translations and Translators," pp. 444ff.

and linguistically adept assistants.[25] Astronomy and astrology, as well as various forms of magic, were popular topics for scholars working in Toledo. And as it turns out, Toledo was a very significant place for the translations that eventually reached England.

Those with a geographic understanding of medieval Europe will be aware that the places mentioned so far were on the borders of Latin Europe. Italy and Sicily, with their easy access to the Mediterranean, benefitted from contacts with the Islamic Empire through North Africa, and with the Byzantine Empire to the East. In Spain, large portions of territory had recently been taken by Latin forces from the Islamic rulers who had been in control since the eighth century; Toledo had been taken (relatively peacefully) in 1085. As the borders were pushed to the south, Arab and Latin speakers had more frequent contact, and the changing borders meant that interaction between the two cultures could persist. Because all these regions were outside England, scholars who brought translations to England necessarily had to travel.

One of the earliest of these travelling English scholars was Adelard of Bath,[26] who flourished in the first half of the twelfth century. As a young man, he travelled to France

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[25]For more on Toledo as a place of translation activity in the twelfth century, see Charles Burnett, "The Institutional Context of Arabic-Latin Translations of the Middle Ages: A Reassessment of the 'School of Toledo,'" in *Vocabulary of Teaching and Research Between the Middle Ages and Renaissance*, edited by Olga Weijers, 214–235, Turnhout: Brepols, 1995; and "The Coherence of the Arabic-Latin Translation Program in Toledo in the Twelfth-Century," *Science in Context* 14 (2001): 249–288. Burnett offers evidence that the cathedral was an important center, at least for patronage or support of translators, and may have had a cathedral school, which employed the scholars who performed translations, but that there is no evidence of a school organized solely for the sake of translation.

[26]The bibliography on Adelard is fairly large. Haskins devoted chapter 2 of *Studies*, pp. 20–42, to Adelard. A more recent introduction and bibliography can be found in Louise Cochrane, *Adelard of Bath, The First English Scientist*, London: British Museum Press, 1994. More detailed studies can be found in *Adelard of Bath, An English Scientist and Arabist of the Early Twelfth Century*, edited by Charles Burnett, London: Warburg Institute, 1987. A brief introduction to Adelard's life and writings can be found in Marshall Clagett, *Dictionary of Scientific Biography*, vol. 1, pp. 61–64, edited by Charles Coulston Gillespie, New York: Charles Scribner's Sons, 1978.

where he studied and taught. He later continued his travels, going to Sicily, Italy, Greece, and the Near East before he returned to England in about 1116. In England, he probably received assistance in making his translations from Petrus Alphonsus, who had already made his own translations of Arabic scientific texts, and had taught astronomy to Walcher of Malvern,[27] as mentioned above. Adelard wrote two philosophical treatises, *De eodem et diverso* and *Quaestiones naturales*, a treatise on falconry, and the *Mappae clavicula*, a collection of chemical recipes. He is better known, however, for his mathematical and astronomical/astrological translations and writings. He wrote works on arithmetic: the *Regule abaci*, written before his travels to find Arabic science, and perhaps the longer *Liber ysagogarum Alchorismi in artem astronomicam a magistro A. compositus*, a work in five chapters, three on arithmetic, and the other two on geometry, music and astronomy.[28] In the field of mathematics, he is best known for his translation of Euclid's *Elements*, which was probably the first complete rendering of the *Elements* into Latin. In fact, Adelard's translation exists in three distinct versions, including in some of them additonal proofs and commentary.[29]

His contributions to astronomy and astrology were also significant. He wrote a work on the astrolabe, *De opere astrolapsus*, and translated the *Centiloquium*, a set of astrological aphorisms attributed to Ptolemy, and Abu Ma'shar's *Shorter Introduction to*

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[27]On Petrus's relationship with Adelard, see Charles Burnett, "Adelard of Bath and the Arabs," in *Recontres de culture dans la philosophie Médiévale; tradutions et traducteurs de l'Antiquité tardive au XIV^e siècle*, edited by Jacqueline Hamesse and Marta Fattori, 89–107, Louvain: Université Catholique de Louvain, 1990, especially pp. 105–106.

[28]Adelard's authorship is not clearly attested, but the dating and provenance of the work makes his authorship possible. See Haskins, *Studies*, p. 24.

[29]It is not clear that Adelard was directly responsible for each of the versions. See Hubert L. L. Busard and Menso Folkerts, *Robert of Chester's (?) Redaction of Euclid's* Elements*, the So-called Adelard II Version*, Basel: Birkhäuser, 1992.

Astronomy, which was known as *Ysagoga minor Iapharis matematici in astronomicam per Adhelardum bathoniensem ex arabico sumpta*. The latter would be supplanted when the *Greater Introduction* was translated, but may have served as an important first step towards the assimilation of Arabic astronomy. Adelard also translated the astronomical tables of al-Khwarizmi.[30]

A near contemporary to Adelard was Robert of Chester.[31] An Englishman by birth, he was in Spain in 1141 when he was commissioned with his associate Hermann of Carinthia to make a Latin translation of the Qu‘ran. Robert, however, also had an interest in mathematics and astronomy. He translated the *Algebra* of al-Khwarizmi, wrote a treatise on the astrolabe, and converted the astronomical tables of al-Zarqali and al-Battani, as well as Adelard's translated tables of al-Khwarizmi, to the meridian of London.

Another important figure in making Arabic science available to the English was Daniel of Morley.[32] Though not a translator of works himself, he travelled to Toledo where he met Gerard of Cremona.[33] Gerard was a prolific translator during his years at Toledo, where he was perhaps a member of the clergy of the cathedral.[34] He was credited nearly

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30For a translation and commentary on the tables, see O. Neugebauer, *The Astronomical Tables of al-Khwarizmi*, *Historisk-filosofiske Askrifter udgivet af Det Kongelige Danske Videnskabernes Selskab*, Bind 4, nr. 2. The translation is from Adelard's Latin version of the tables.

31On Robert of Chester, also known as Robert of Ketene and Robert of Ketton, see Haskins, *Studies*, pp. 120ff.

32On Daniel of Morley, see Charles Singer, "Daniel of Morley, an English Philosopher of the XIIth Century," *Isis* 3 (1920–1921): 263–269; Lynn Thorndike, *A History of Magic and Experimental Science*, vol. 2, pp. 171–181, New York: Macmillan, 1923–58; and Theodore Silverstein, "Daniel of Morley, English Cosmogonist and Student of Arabic Science," *Mediaeval Studies* 10 (1948): 179–196.

33On Gerard, see Richard Lemay, "Gerard of Cremona," *Dictionary of Scientific Biography*, vol. 15, 173–192. This biographical article also includes a list of the translations and texts attributed to him.

34See Burnett, "The Coherence of the Arabic-Latin Translation Program," p. 252.

contemporaneously with translating over seventy works, and a dozen more are ascribed to him. He also composed a handful of original works. He translated numerous astrological and astronomical works, including Ptolemy's *Almagest* and works by al-Farghani, Masha-allah, and Thabit ibn Qurra. He was apparently assisted in his translation activity by a number of companions, and presented public lectures, perhaps as a means to provide an income in order to continue his work.

Daniel of Morley had left England for study in France, but found the method of the schools there to be vacuous.[35] In hopes of learning more, he travelled to Spain, where he heard the lectures of Gerard. After spending some time in Toledo, he returned to England, famously bringing with him a large number of books he had obtained in Toledo, almost certainly including some of Gerard's recent translations. In addition, Daniel wrote a work entitled *Liber de naturis inferiorum et superiorum*, which presented a great deal of Arabic science to a Latin audience, including high praise for the astrological benefits that Arabic astronomy confers on its practitioner.[36] Daniel relied heavily on Adelard's work, but also on translations from the Arabic of Abu Ma'shar's *Introduction to Astrology* and other

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[35]In an oft-quoted passage from the introduction to his *Liber de naturis inferiorum et superiorum*, Daniel refers to the masters of Paris as '*bestiales*,' marking up their books, but knowing nothing. A translation of the autobiographical portion of the text can be found in Burnett, *Introduction of Arabic Learning*, pp. 61–62.

[36]For a Latin edition of the *Liber de naturis*, also known as the *Philosophia*, see G. Maurach, "Daniel von Morley, *Philosophia*," *Mittelateinisches Jahrbuch* 14 (1979): 204–255. For an earlier edition, on which much scholarship has been based, see Karl Sudhoff, ed., "Philosophia magistri Danielis de Merlai ad Johannem Norwicensem episcopum," *Archiv für die Geschichte der Naturwissenschaften und der Technik*, Band 8 (1917–1918): 6–40, and a subsequent article by A. Birkenmajer, "Eine neue Handschrift des *Liber de Naturis inferiorum et superiorum* des Daniel von Merlai," *Archiv für die Geschichte der Naturwissenschaften und der Technik*, Band 9 (1920): 45–51. For analyses of the *Liber de naturis*, see Richard Lemay, *Abu Ma'shar and Latin Aristotelianism in the Twelfth Century: The Recovery of Aristotle's Natural Philosophy through Arabic Astrology*, Beirut: American University Beirut, 1962, especially chapter 4, pp. 313ff.*;* Silverstein, "Daniel of Morley…"; and Roger French, "Astrology in Medical Practice," in *Practical Medicine from Salerno to the Black Death,* edited by Luis García, et.al., 30–59, Cambridge: Cambridge University Press, 1994, especially pp. 37ff.

Arabic-Aristotelian works.[37]

By the end of the twelfth century, it should now be clear, a large portion of the mathematical and astronomical sciences of the Greeks and Arabs had been brought to England. The translations and original treatises of the earlier years would continue to bear fruit in the work of later scholars in England. One of the most important of these figures was Roger of Hereford.[38] It is not clear that he ever travelled outside of England, nor is it certain that he could translate directly from the Arabic, but he certainly made use of the Arabic science flowing into the borderland regions of southwest England. Most of Roger's writing took place in the 1170s. He wrote a *Compotus*, suggesting ways in which the calendar could be reformed and making use of the Arabic science that had recently been translated.[39] He also created a set of astronomical tables for the meridian of Hereford based upon Raymond of Marseilles's Latin version of the Toledan Tables[40] composed by ar-

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[37]See Burnett, *Introduction of Arabic Learning*, pp. 63ff, and Lemay, *Abu Ma'shar and Latin Aristotelianism*, pp. 319ff. Abu Ma'shar was known to Daniel through Hermann of Carinthia's translation. Burnett notes especially the Aristotelian works *De ortu scientiarum* and *Liber celi et mundi* as significant sources.

[38]Relatively little is known of Roger's life. For a summary of what we know, as well as the sources for this information, see Roger French, "Foretelling the Future: Arabic Astrology and English Medicine in the Late Twelfth Century," *Isis* 87 (1996): 453–480, especially pp. 459ff.

[39]On Roger's *Compotus*, see Jennifer Moreton, "Roger of Hereford and Calendar Reform in Eleventh- and Twelfth-Century England," *Isis* 86 (1995): 562–586. See also further discussion below in chapter 4 of this dissertation.

[40]For a modern commentary on the Toledan Tables, but not an edition or translation, see G. J. Toomer, "A Survey of the Toledan Tables," *Osiris* 15 (1962): 5–174.

Zarqala.[41] He also wrote a number of astrological tracts;[42] the works attributed to him include: *Theorica planetarum*, *De quator partibus astronomie*, *De ortu et occasu signorum*, *Liber de tribus generalibus*, and *De iudiciis astronomie*.

As we shall see in the next chapters, Grosseteste made use of many of the works that the translation movement of the twelfth century had brought to Europe. Astronomical texts and tables will play an obvious part in the creation of his textbooks. Arithmetic and geometry, important for his astronomical and computistical work, as well as his natural philosophy, were in large measure available to him because of the works of his predecessors. But to stop here would be to misunderstand the situation of the twelfth century. The circle of translators discussed above certainly did not produce their translations nor compose their original treatises simply so that future scholars could incorporate them into their textbooks. By examining their motivations, we will better understand the milieu of translators and scientific authors from which Grosseteste came.

Roger French has identified one of the most significant reasons that Latin scholars sought out the science of the Arabs: the ability to fortell the future through astrological means.[43] Thus the men who translated Arabic astrological works and wrote their own original treatises were the very same men who translated works of mathematics, explained the use of the astrolabe, and prepared astronomical tables for English meridians. All these latter accomplishments contributed to the preeminent goal of foretelling the future. Tables

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41The Arabic tables had been made in 1080, and Raymond's Latin version in 1141. Burnett, "Mathematics and Astronomy in Hereford," p. 55.

42The original extent of the treatise or treatises is unclear, because portions of texts appear under his name in a variety of manuscripts. See French, "Foretelling the Future," pp. 465–466.

43This is the main thesis of his "Foretelling the Future." He argues there that Roger of Hereford wrote his astrological treatises with the hopes of predicting the future, while William of England was one of the first to attempt to use this newfound ability on behalf of medicine.

provided vital data on planetary and other celestial motions, mathematics supplied a way to manipulate the data, and the astrolabe was a tool both to calculate with and to collect new data, while the astrological works of the Arabs offered the keys to understanding how the influences of the stars exerted themselves in the terrestrial region.

Recognizing this situation leads us to a better understanding of the work of the medieval translators, but we must be cautious not to make a significant mistake. Our modern distinction between astronomy and astrology was not recognized in the twelfth century; the two were inextricably intertwined. So to say that translators sought out astronomical material in order to improve their astrology would be a categorical mistake. In order to foretell the future, a variety of information was needed. The tables and instruments to collect data, mathematical tools to manipulate it, and the theoretical principles to engage in divination were all necessary components. Though astrology has been discredited in the modern scientific world-view, to the medieval scholar, it was still very much a viable prospect. Though religious objections had been raised in late antiquity by various patristic writers, most notably Augustine, the theological debates had not yet been resolved, and the practice of astrology would continue for centuries.

It is convenient that the theological issues surrounding astrology have arisen here, for it leads us to another significant point about the context of translators in England. Many of them were prominent ecclesiastics, often monks or bishops. On one level, this is not surprising, as literacy was not widespread, and Church officials accounted for a significant portion of the literate population; if *anyone* was going to translate from the Greek or Arabic, there was a good chance that they would be clerics. But beyond this basic relationship of literacy and religious office, we can detect from the examples above a more significant reason why ecclesiastically-minded individuals would seek out Arabic and Greek astronomical works: for the benefit of compotus. Late in the eleventh century, Robert, the bishop of Hereford, wrote on the subject, while Roger of Hereford, who may have entered a

monastery in his later years, did so again in the 1170s; we shall see in a later chapter that Grosseteste, too, was interested in Arabic and Greek astronomy because it could be used to correct the calendar. All of these writers had a concern not merely to explain the calendar, but to improve it, to reform it. In other words, the translated works of the Arabs and Greeks offered a solution to calendrical problems, and thus provided an additional impetus to the study of these works.

Is it reasonable, then, to say that many of the translators had a religious goal in mind when they translated the astronomical works of the Greeks and Arabs? Andrew Cunningham has argued that the categories of science and religion are inadequate to understanding the situation of the middle ages.[44] In many respects, his thesis is directed to what he perceives as modern misuses of medieval history,[45] but he has nonetheless presented a thesis that is significant to the way we ought to understand medieval science. Cunningham concentrates on the categories of nature and creature, and demonstrates that they were understood differently by educated medieval men, such as St. Francis of Assisi, than they are today. Ultimately, this means that there was no conception of 'science' in the middle ages akin to our own. And this leads us to yet another important characterization of the motivations of the translators of the twelfth century.

There was, of course, disciplinary differentiation in the middle ages. Astronomy had a certain relationship to other sciences, such as theology. But this is not the same distinction

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[44]See especially his two part article, "Science and Religion in the Thirteenth Century Revisited: The Making of St. Francis the Proto-Ecologist, Part 1: Creature Not Nature," *Studies in History and Philosophy of Science* 31 (2000): 613–643, and "Science and Religion in the Thirteenth Century Revisited: The Making of St. Francis the Proto-Ecologist Part 2: Nature Not Creature," *Studies in History and Philosophy of Science* 32 (2001): 69–98.

[45]The misuses are, respectively to the two parts of his article, the misappropriation of St. Francis of Assisi by modern ecological movements, and an anachronistic distinction between science and religion on behalf of the Catholic Church in the nineteenth and twentieth centuries.

moderns make between 'science' and 'religion.' The scholars we have been discussing would not have seen a dichotomy between their religious belief and their scientific work. In fact, if we take their religious beliefs seriously, as I am wont to do based on their commitment to church offices, then we can view them comparably to Cunningham's analysis of St. Francis. Their attempts to understand Arabic and Greek astronomy were attempts to understand the created world. The study of the disciplines we think of as scientific were in fact part of a theological need to understand the world. I am not aware of a translator of the twelfth century who made the link between religious calling and astrological study as explicitly or as polemically as did Roger Bacon in the latter half of the thirteenth century,[46] but certainly the perceived need to reform the *ecclesiastical* calendar offers evidence for their purposes in engaging in translation and composition of original treatises. To understand the natural—and created—world was of theological import, and the translation of scientific works recognized contemporaneously as superior to existing Latin traditions was motivated not by nascent 'scientific' views of the world, but by theological concerns.

I believe the same basic motivation was essential to the recovery of the corpus of Aristotelian natural philosophical works. This leads us to an additional portion of the narrative of the twelfth-century development of science in England, and one in which Grosseteste played a part. Though the present study focusses on Grosseteste's astronomical and computistical textbooks, Grosseteste was also a significant figure in the progress made in the thirteenth century of the appropriation of the Aristotelian corpus into the intellectual life of England and the university community in Oxford. Here, too, I believe, we can understand one aspect of the impetus for translation as arising from the religious

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[46]See especially his *Opus maius*, translated by Robert Belle Burke in *The Opus Majus of Roger Bacon*.

motivation to understand the created world. The Aristotelian corpus provided a unified and relatively complete natural philosophy, albeit needing a few modifications to fit into a Christian understanding of the world. The remainder of this section, then, will be devoted to a brief examination of the translation of Aristotle's works and the incorporation of Aristotelian thought in the English context.

Very little of Aristotle's philosophy was known in Europe before the twelfth century. Latin translations of two logical texts, the *Categories* and *De interpretatione*, had been made by Boethius early in the sixth century A.D. Some principles of his natural philosophy were present in the encyclopedic authors of late antiquity, but the translation of Calcidius's commentary on the *Timaeus* provided Latin readers with a Platonic physics and cosmology.[47] Alexander Birkenmajer, in a famous paper in 1928,[48] argued that interest in Aristotle's natural philosophy in the Latin West was renewed among the doctors and naturalists of the twelfth century. Danielle Jacquart has verified Birkenmajer's suggestion that doctors in Salerno made use of Aristotle in their medical texts,[49] while Richard Lemay has shown that Aristotelian natural philosophy also made its presence felt in Western Latin Europe through the Latin translations of Abu Ma'shar's *Introduction to Astrology*.[50]

Lemay's thesis is especially significant for England, where, as we have seen, Arabic

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[47]Charles Burnett, "The Introduction of Aristotle's Natural Philosophy into Great Britain: A Preliminary Survey of the Manuscript Evidence," in *Aristotle in Britain in the Middle Ages*, edited by Jon Marendon, 21–50, Turnhout, Belgium: Brepols, 1996; see especially p. 22.

[48]Alexander Birkenmajer, "Le rôle joué par les médicins et les naturalistes dans la réception d'Aristote au XII[e] et XIII[e] siècles," in *La Pologne au VI[e] congrès international des sciences historiques, Oslo, 1928* (1930): 1–15, reprinted in *Etudes d'histoire des sciences et de la philosophie du Moyen Age*, *Studia Copernicana* 1(1970): 73–87.

[49]Danielle Jacquart, "Aristotelian Thought in Salerno," in *A History of Twelfth-Century Western Philosophy*, edited by Peter Dronke, 407–428, Cambridge: Cambridge University Pres, 1998.

[50]Lemay, *Abu Ma'shar and Latin Aristotelianism.*

astronomical and astrological texts were prevalent.[51] It seems quite likely that the hints of Aristotelian natural philosophy that were a part of those works led contemporary scholars to seek out the philosophical works that would give them a more complete understanding of the natural philosophy that underlay, and therefore reinforced, astrological science. This thesis is supported even more by the fact that the earliest translators of Aristotle were part of a circle of scholars associated with Hereford, where astrology was a prominent goal of translation activity.

The general outlines of the importation of Aristotle into the West are well established.[52] Early in the twelfth century, more of Boethius's translations of Aristotle's logical works were recovered, namely, the *Prior Analytics*, *Topica*, and *Sophistici elenchi*. In the middle of the twelfth century, James of Venice translated a number of works: the *Posterior Analytics* (which completed the logical corpus), the *Physica*, *De anima*, *Metaphysica*, and some of the *Parva naturalia* treatises, as well as some commentaries. In addition to James, Henricus Aristippus, Gerard of Cremona, and other, anonymous scholars had translated large portions of the Aristotelian corpus, and added Pseudo-Aristotelian treatises as well. Outside of the logical texts, however, there is not a great deal of evidence that the Aristotelian works achieved widespread use until the thirteenth century.

Two English figures in particular stand out in their early use of Aristotle's

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51It may be that Adelard of Bath had some acquaintance with Aristotle's works during his travels, and especially through his contacts with Salerno. See Charles Burnett, "The Introduction of Aristotle's Natural Philosophy."

52See Bernard G. Dod, "Aristoteles Latinus," in *The Cambridge History of Later Medieval Philosophy*, edited by Norman Kretzman, Anthony Kenny, and Jan Pinborg, 45-79, Cambridge: University of Cambridge Press, 1982.

philosophy: Alfred of Shareshill (or Sareshel)[53] and Alexander Nequam (or Neckham).[54] Interestingly, both of these authors are tied into the circle of Hereford, though Alfred is known to have travelled to Spain. Alfred dedicated his translation of the Pseudo-Aristotelian *De plantis* to Roger of Hereford, and his original work *De motu cordis* to Alexander Nequam. So in addition to the interest in astrology and compotus evident with persons associated with Hereford, there was also an interest in the works of Aristotle.[55] The latter interest was, given Lemay's thesis, self-fulfilling; that is, because of an interest in astrology, the scholars naturally sought out Aristotelian texts in order to understand the basis of their astrological science.

Alfred is known both for translating and for writing commentaries on Aristotelian and Pseudo-Aristotelian works. In addition to translating the *De plantis* mentioned above, Alfred also translated the *De mineralibus*, which became attached to the fourth chapter of translations of Aristotle's *Meteora*. He may have translated other works from the *libri naturales* of Aristotle,[56] and he almost certainly wrote commentaries on them. Many of the

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[53]For Alfred, see James K. Otte, *Alfred of Sareshel's Commentary on the* Metheora *of Aristotle*, Leiden: E. J. Brill, 1988, pp. 3–15; the information is also present in Otte "The Life and Writings of Alfredus Anglicus," *Viator* 3 (1972): 275–291.

[54]For a more complete account of Alexander's life and works, see R. W. Hunt, *The Schools and the Cloister, The Life and Writings of Alexander Nequam (1157–1217)*, Oxford: Clarendon Press, 1984. This book was published posthumously, after being edited and revised by Margaret Gibson, from Hunt's doctoral thesis of 1936, a work that was frequently cited before the publication of the revised version.

[55]Roger French argued that Alfred, as well as Alexander, was part of an "English circle," which included Roger of Hereford, and perhaps Daniel of Morley and Robert Grosseteste, among others. See French, "The Use of Alfred of Shareshill's Commentary on the "De plantis" in University Teaching in the Thirteenth Century," *Viator* 28 (1997): 223–251, especially pp. 224–226

[56]Burnett, "The Introduction of Aristotle's Natural Philosophy," p. 31.

commentaries are no longer extant. He wrote a commentary on the *Meteora*,[57] and he refers to his own commentary on the *De generatione et corruptione*, though this has not yet been identified.[58] A 1664 catalog of Beauvais Cathedral also lists commentaries on *De caelo et mundo*, *De generatione et corruptione*, *De anima*, *De somno et vigilia*, *De morte et vita*, and *De colore celi*,[59] and in his extant works he cites the Aristotelian texts of most of these works, as well as the *Physica*, *Methaphysica*, *Ethica*, and a handful of others.[60]

Alexander, on the other hand, is part of this narrative not because he translated Aristotle's works, but because he was one of the earliest English writers to make use of the translations of Aristotle. He certainly gives high praise to Aristotle, writing that it is as superfluous to commend Aristotle's genius as it is to aid the sun with torches.[61] In fact, however, it is uncertain that Alexander had great familiarity with Aristotle's works outside of the logical works. It is also significant that Alexander was associated with the fledgling university of Oxford, and may have been one of the first to read Aristotle there. We shall return to Alexander, as well as other lecturers on Aristotle at Oxford, such as John Blund and Edmund of Abingdon, in a later section of this chapter.

During the thirteenth century, the natural philosophical works of Aristotle began to take on a standard form. By the middle of the thirteenth century, a body of texts, which

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57In a critical edition in Otte, *Alfred of Sareshel's Commentary*.

58Burnett, "The Introduction of Aristotle's Natural Philosophy," p. 32.

59Otte, *Alfred of Sareshel's Commentary*, p. 13, and Burnett, "The Introduction of Aristotle's Natural Philosophy," p. 32.

60Though Burnett is confident that he knew directly only the *Metaphysics*, *De caelo et mundo*, *Ethica vetus*, and *De causis*. See Burnett, "The Introduction of Aristotle's Natural Philosophy," p. 32–33.

61Paraphrased by Hunt, *The Schools and the Cloister*, pp. 67–68, from Alexander's *De naturis rerum*.

modern editors refer to as the *corpus vetustius*, had been established. This corpus included the major natural philosophical works, though they did not include the biological works.[62] Dod gives the following list of works, which includes some pseudo-Aristotelian texts, for the *corpus vetustius*: *Physica*, *De caelo* (also known as *De caelo et mundo*), *De generatione et corruptione*, *De anima*, *De memoria (et reminiscentia* is sometimes added to the title), *De sensu*, *De somno (et vigilia*), *De longitudine*, *De differentia spiritus et animae*, *De plantis*, *Meteorologica*, *Metaphysica*, and *De causis*.[63] By the late thirteenth century, after the translation activity of William of Moerbeke, the corpus was somewhat revised, and formed the *corpus recentius*.[64] But this takes us beyond the limits of what is necessary to our tale here.

In what way did the works of Aristotle become a part of the intellectual milieu of the thirteenth century? In large part, this was accomplished through the university, and the teaching of philosophy in the arts curriculum. At this point, however, it is best that we turn to the development of the institution of the university; we shall return later to the role that Aristotle's works played within the university curriculum, and especially at Oxford.

1.3. The Birth of Universities

As we saw in the previous section, a large number of scholars in England were interested in the benefits that Arabic and Greek science could lend to the study of astronomy and compotus. In that respect, Grosseteste might be seen as merely one more

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[62]Though there is evidence that Alfred of Shareshill knew of Aristotle's biological works. See Burnett, "The Introduction of Aristotle's Natural Philosophy," p. 33.

[63]Dod, "Aristoteles Latinus," p. 50. Dod also includes the translators of the texts that made up this corpus.

[64]Dod gives the contents of the *corpus recentius* on p. 51 of "Aristoteles Latinus."

interesting figure to add to the list of English scholars. I shall argue, however, that Grosseteste must be differentiated from those who came before him because of his role in introducing into English universities the first textbooks to make extensive use of the newly available Arabic and Greek astronomical material. It will be worthwhile, therefore, to devote some attention to the development of the university system at the end of the twelfth century.

The European university has been widely and deeply studied, and this brief introduction will by no means do justice to the volume of scholarly activity that precedes it.[65] My particular goal in is to introduce the reader to some of the basic characteristics of the medieval university so that the context for which Grosseteste produced his textbooks will be more clear. I will avoid many particular historiographic themes, such as arguments over primacy of founding, and will instead deal with broad characterizations of the university.[66] My account will neglect the great disparity in practices that can be found among the various instantiations of the general trends below; this is, unfortunately, an unavoidable result of the brevity of my sketch. I will not entirely forego the particulars of the development of universities, however. In the final section of this chapter, I shall discuss the development of the university at Oxford, clearly the institution that is most relevant to the story of Grosseteste.

One other warning is pertinent. The founding eras of the earliest universities date from the end of the twelfth century and the beginning of the thirteenth. Many of the developed features of university life that I shall discuss below can be clearly identified only

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65A study of the universities still begins with the magisterial work of Hastings Rashdall, *The Universities of Europe in the Middle Ages*, 3 vols., revised and edited by F. M. Powicke and A. B. Emden, Oxford: Oxford University Press, 1936. The best modern work to deal with the medieval university in general is H. De Ridder-Symoens, *A History of the University in Europe, Vol. 1, Universities in the Middle Ages*, Cambridge: Cambridge University Press, 1992, hereafter *HUE*.

66For a summary treatment of many of the historiographical themes of studies on the university, see Walter Rüegg, "Themes," in *HUE*, pp. 3–34.

at later dates. In Grosseteste's case, we are dealing with a university in its infancy, and indeed a period in which no university has reached the fully developed forms that will be in place by, say, the fourteenth century. Thus we will always have to be aware that, when we discuss the context of Grosseteste's textbooks, we must to some degree project backwards traditions and institutions that can confidently be placed only in later periods. For this reason, it is difficult to make strong arguments about such facets of Grosseteste's experience teaching at Oxford as how lectures were conducted, precisely how much of his texts would have been covered in lectures, and so forth. Nevertheless, even though arguments related to the university context must be made carefully, we can tentatively sketch a picture of the state of the university in the first quarter of the thirteenth century.

What was the university? Though a seemingly straightforward question, there is no simple answer, for the very concept of the university was still being worked out in the thirteenth century. In one respect, however, the university was an institution distinct from the more general, smaller-scale 'school,' places where a master taught students. Of these there were many in the twelfth century. These could be schools for the young, teaching basic grammar, or more advanced schools, teaching, for example, theology. Schools could be either secular or religious, based within cities or within cathedrals or monasteries. Hereford in the second half of the twelfth century probably housed quite a large school, perhaps at the cathedral.[67] According to a poem by Simon du Fresne, the seven liberal arts, as well as *fisis* (probably best understood as natural philosophy), were taught at Hereford,[68] while Roger

[67]See Russell, "Hereford and Arabic Science," p. 21; French, "Foretelling the Future," pp. 460–1; and Alan B. Cobban, *The Medieval English Universities: Oxford and Cambridge to c. 1500*, Berkeley: The University of California Press, 1988, pp. 27–28.

[68]For the poem, see Hunt, "English Learning," pp. 121–122.

of Hereford intimates that theology was taught there as well.[69]

The school of Hereford, as described by its contemporaries, presents a very similar picture of subjects available for study as will be the norm for universities, namely, the seven liberal arts, plus some level of philosophical instruction, and at least one of the higher faculties of theology, law, and medicine. Yet Hereford is never mentioned among the universities of the medieval period.[70] This is due in the main to a self-conscious contemporary identification of universities as something different from the schools that preceded them. In my opinion, this is best understood by considering the 'corporate identity' of universities that developed throughout the thirteenth century.

In the schools of the twelfth century, the master perpetuated his own position by successful teaching. The secular master collected fees from the students and was, in some respects, reliant on the goodwill of the city in which he conducted his business. The religious master, teaching for example in a cathedral, was not an independent master in the sense that the later university masters would be; he was an employee or member of the particular cathedral at which he worked. At larger schools, the presence of numerous masters helped to solidify the reputation of the school, and also gave the school greater economic viability within the community. The school of Hereford was probably of this type. Yet even these kinds of schools had not yet developed a sense of being something different from what had come before.

One significant factor in the development of the university as an institution was in response to the social pressures that teachers and students felt. A corporate identity was

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69Russell, "Hereford and Arabic Science," pp. 20–21, quotes from the preface of Roger of Hereford's compotus.

70Similar comparisons could be made to the school at Chartres. The phenomenon of an advanced school that never developed into a university is not limited to England.

formed as the masters, sometimes with the students, sometimes not, presented themselves as a group that deserved the protection of the crown or the church. By gaining the protection of a king or the pope, for example, and by securing privileges from the governing body of a city, the members of the university set themselves apart as a group. In tandem with the self-identification of the university's faculty and student-body as a corporate entity, the physical trappings of a corporation also developed. Rules and regulations for student conduct, statutes listing required curriculum, means of evaluating students, and the certification of teaching rights are among the details that were worked out as the corporate identity developed and sharpened its focus.

The practical benefits of corporate identity, however, do not tell the whole story of the university. The protection of Church and crown would not have been granted *to* the university were there not benefits to be had *from* the university. On one level, there was the purely practical result that numerous individuals were educated in matters that ecclesiastical and governmental bodies found useful, thus continuing a trend that had begun with the twelfth-century renaissance. But the universities were never merely trade schools.[71] In addition to the usefulness of the education, there was a spirit of learning within the early universities. As Stephen Ferruolo puts it, "[f]rom its very beginning, the university was established more as the embodiment of an educational ideal than a workable means to organize learning and teaching."[72] He acknowledges that other factors contributed to the rise of the university, such as the relationships that were established with governmental and

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[71]Alan B. Cobban stresses the practical side of university training as a key component of its survival as an enduring institutional form. See his "Reflections on the Role of Medieval Universities in Contemporary Society," in *Intellectual Life in the Middle Ages, Essays Presented to Margaret Gibson*, edited by Lesley Smith and Benedicta Ward, 227–241, London: Hambeldon Press, 1992.

[72]Stephen Ferruolo, *The Origins of the University, The Schools of Paris and Their Critics, 1100–1215*, Stanford: Stanford University Press, 1985, p. 3.

ecclesiastical authorities, but he agrees that the key to the establishment of the university was the establishment of a corporate identity. He cites other views that have been advanced to explain this identity: a shared notion of *amor scientiae*, a love of knowledge; a concept of the unity of knowledge derived from the recently translated Aristotelian works; or the desire for fame and money, or more simply for employability. But he concludes that it was primarily for the goal of teaching that the masters bonded together into a corporate entity. He bases his conclusion upon the fact that the earliest statutes of Paris deal with matters of teaching: what will be taught, in what manner, and by whom.

> Does this not suggest that the professional identity that the masters shared and that motivated them to form the university was based above all on their consciousness of their duties and responsibilities as teachers?[73]

As we shall see in the next chapter on Grosseteste's life, as well as in the chapters that analyze his textbooks, the motivation to teach was indeed a strong one for Grosseteste. It is no surprise that he found a home within the university system.

What would masters and students experience during their time within the university system? A contemporary term used for the universities was *studium*, and this best describes the general sense of what the universities were seen as: schools with organized faculties.[74] The faculties included teachers of the arts, who were frequently themselves studying towards a degree in a higher faculty, and typically at least one of the higher faculties of theology, law and medicine.

[73]Ferruolo, *The Origins of the University*, p. 311

[74]The term *studium* was used throughout the thirteenth century. In the second half of the century, the phrase *studium generale* became common, *generale* indicating that students were drawn from places outside of the local environment. Eventually the phrase *studium generale* would achieve legal status, denoting imperial or papal patronage and conferring certain rights to the institution and its members. See A. B. Cobban, *The Medieval Universities: Their Development and Organization*, London: Methuen & Co. Ltd., 1975, pp. 23ff. Also note that the term *universitas* was not used until the late fourteenth century; thus the institutions of the early thirteenth century that I call 'universities' would have been referred to by contemporaries as *studia*.

Students usually entered university at about the age of fourteen or fifteen, though they could be older, and were expected to know how to read and write Latin, have a basic understanding of Latin grammar, and probably the ability to deal with elementary arithmetic.[75] No formal requirements of age, social status or preliminary education were in place in the early university, though generally the student needed to commit himself to the guidance of a particular master, who could choose whether or not to accept a student.[76] At this early stage of their career, students were known as undergraduates, and could typically be from any social or economic class. Students at this level might have a variety of goals: to study with a master in preparation for higher education, for example, or to gain schooling for whatever personal motivation the student had. During this time, the student heard lectures in the arts curriculum: the trivium of grammar, logic, and rhetoric; the quadrivium of arithmetic, geometry, music, and astronomy; and the three philosophies: natural, moral and metaphysical. The lectures that a student heard would depend on his own interests, what was available to him, and eventually on the statutory prescriptions of the university. Many a student at this stage would be a *scholaris simplex*, a student who is not taking examinations and will not progress to a degree.

A student wishing to progress further, or to take a degree, would spend about two to two-and-a-half years in study and examination. A student who did so could achieve a bachelor’s degree in the arts. Many students would leave the university at this time, if they had made it this far, and use the degree for personal advancement, perhaps in courtly or

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[75]A general picture of student progression in the university can be found in Rainer Christoph Schwinges, “Student Education, Student Life,” in *HUE*, pp. 195–243.

[76]For more information on the standards for enrollment at a university, see Rainer Christoph Schwinges, “Admission,” in *HUE*, pp. 171–194.

ecclesiastical office.[77] Those who wished to study further, either at the same university or at another, spent an additional two to three years hearing more lectures in the arts, participating in disputations, and delivering their own lectures to undergraduates. Eventually, a student could achieve a master's degree, which often carried with it the obligation to teach in the arts faculty for a further two years. At this stage, he might progress to a study in a higher faculty, often teaching while doing so, and perhaps holding administrative positions within the university. In fact, however, some masters remained in the arts faculty to teach, without the intention of achieving a higher degree. Those who did study further might go on to achieve a licentiate in a higher faculty, and thereby the right to teach in that faculty.[78]

All the various steps in the progression of students cost a good deal of money, in payments to both masters and the university, as well as for the cost of living in a university town.[79] To achieve the higher degrees required substantial economic support from somewhere. Those from the upper-class might have been able to get by on their own wealth, while relatively poor students would probably have to rely upon patronage to be able to study for a long enough period of time to achieve degrees. In some places, the privileges

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[77]For more on what a university degree could do for a student, see Peter Moraw, "Careers of Graduates," in *HUE*, pp. 244–279. Careful studies of the graduates of Oxford have been made; see, for example, Jean Dunbabin, "Careers and Vocations," in *HUO1*, 565–605, Oxford: Clarendon Press, 1984; and Guy Fitch Lytle, "The Careers of Oxford Students in the Later Middle Ages," in *Rebirth, Reform, and Resilience*, edited by James L. Kittelson and Pamela J. Transue, 213–253, Columbus: Ohio State University Press, 1984.

[78]Schwinges, "Student Education, Student Life," notes an atypical progression for a limited class of aristocratic students. They are especially associated with law faculties and, because of their high social rank, rarely taught in the arts.

[79]On the costs of university education, see Schwinges, "Student Education, Student Life," pp. 235–241. Southern summarizes some of the privileges granted to scholars at Oxford by a legatine award of 1214 in "From Schools to University," p. 30, which include controlled rates on rents and food; the legatine award is also discussed in Graham Pollard, "The Legatine Award to Oxford in 1214 and Robert Grosseteste," *Oxoniensia* 39 (1974): 62–71. Nonetheless, life at university would still cost a substantial amount of money.

granted by a city to its university included financial support for poor students through, for example, scholarships or occasional feasts.

Students did not always comport themselves with the highest degree of scholarly restraint. Schwinges describes the opinion held by many townspeople of university students:

> Students are bawling and brawling, carousing and whoring, singing and dancing, playing cards and chess, are addicted to dice and other games of chance, are up and about town day and night, are swanking around in inappropriate, fashionable clothing, are behaving provocatively to burghers, guild members, and town law-and-order forces, are carrying arms, and are even making use of them. It is not the university and knowledge which attract them but the diversions and seductions of town life.[80]

University life, then, was not simply attending lectures and taking examinations, but was also a time in which students enjoyed themselves, sometimes perhaps more than was good for them.[81]

Nonetheless, learning was accomplished at the universities. The majority of students and masters were involved with the arts program, at least in the universities of northern Europe, such as Oxford and Paris.[82] In some places, the arts program was seen as preparatory to higher education, whereas in other locations the arts were deemed less important; similarly, different portions of the liberal arts received greater or lesser emphasis

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[80]Schwinges, “Student Education, Student Life,” p. 223.

[81]Schwinges, “Student Education, Student Life,” describes other aspects of student life, such as the development of colleges, student lodging, social life, holidays, regulations to restrict behavior, and the ordinary problems of life, such as food and clothing. See especially pp. 211–231.

[82]See Gordon Leff, “The *Trivium* and the Three Philosophies,” in *HUE*, pp. 307–336, especially pp. 308–310. He argues that the emphasis on the arts in northern Europe was two-fold: the requirement for entering a theology faculty of either having passed through the arts faculty or being in a mendicant order, and the tradition from monastic and cathedral education to subordinate the arts to theology.

in different universities.[83] In a general sense, however, the arts were seen as the basic, introductory components of a university education. The seven liberal arts were in large part a descendant of the Greco-Roman educational system, and had persisted in the schools that existed prior to the universities. The translation movement, however, presented new opportunities and challenges to the university. Of the works translated from Greek and Arabic, Gordon Leff writes that,

> This new body of knowledge had a transforming effect upon the existing state of knowledge, of which the emergent universities were the direct recipients. It not only radically changed the content and enlarged the structure of the liberal arts,…it also challenged many Christian conceptions about the nature of the world and of man, and accordingly involved a redefinition of Christian belief in relation to philosophy, particularly the three philosophies, which were principally those of Aristotle, accompanied and mediated by Arabic interpretations.[84]

The thirteenth century, then, saw the appropriation of a great deal of previously unknown works into the framework of a traditional educational system.

There is not room here to discuss the various fields of the liberal arts and the philosophies, nor to disentangle the variations that certainly were present in the way these fields were taught at different times and places.[85] An additional complication is that, even if we can establish a curriculum (either as practiced or a contemporary idealization) for the completion of a degree, we do not know whether all students attended university for the full length of time required to receive a degree, and thus we cannot know what each individual student might have learned. For determining what was taught, however, three sources of information are most valuable. First, attestations of what particular individuals were teaching can establish to a minimal degree what was available to a university student. The relevance

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[83]See Leff, "The *Trivium* and the Three Philosophies," pp. 308ff.

[84]Leff, "The *Trivium* and the Three Philosophies," p. 311.

[85]For basic introductions to each field of the liberal arts, see David L.Wagner, ed., *The Seven Liberal Arts in the Middle Ages*, Bloomington: Indiana University Press, 1983.

of this type of evidence, however, is restricted to a limited time and place, and is not of itself sufficient to establish generalizations. We will make use of this kind of evidence in the final section of this chapter, which deals with the particular situation at Oxford. The second type of evidence is the textual evidence that has passed down to us in the form of contemporary works: treatises, textbooks, quaestiones, and so forth. Because this kind of evidence for the earliest decades of the thirteenth century is spotty, no general synthesis has yet emerged; that is, few manuscripts that are dateable to this era and that were clearly used in the university are available. Yet texts that were written in this period, even if available for the most part only in later editions, are of obvious worth, for they reveal the interests of scholars within the university context. In fact, the basis for the present research project is the examination of two of these works. The value of this approach, it is hoped, will be demonstrated in the relevant chapters of this dissertation.

The third source of information on the curriculum of the early university is the statutes of the period. These texts represent documents created by members of the university, and are thus of obvious value. Even these texts, however, must be approached with caution. In the first place, there are few that date from before the middle of the thirteenth century. We shall see that distinct changes occur by the end of the century, and so we can make only reasonable guesses about the situation prior to this period. We will also see that, in the case of Oxford in particular, curricular statutes are found only for a relatively late period. This raises the additional question: how far back can we draw inferences from statutes? That is, can a statute from 1268 or 1340 tell us anything about the curriculum at the beginning of the thirteenth century? And does the fact that something is not mentioned, such as the study of the quadrivium, necessarily imply that that particular subject was not studied at all?

An additional complication is that statutes are not straightforward witnesses for the practice of the period. They require interpretation. For example, we must ask whether they

establish already standard practice as normative, and thus accurately reflect what was being taught, or whether they are attempts to regulate practice, implying that a variety of practices were in fact in existence? In addition, the texts that were written during this period often attest to emphases different from what the statutes would suggest. The implications of this fact will resurface in the analysis of Grosseteste's textbooks in subsequent chapters. Nevertheless, we shall attempt to draw a few conclusions about the university arts curriculum from the sources available to us.

The earliest set of university statutes detailing the requirements for a master's degree in the arts comes from Paris, and dates from 1215.[86] In this case, it is quite clear that the statutes were promulgated in order to prescribe proper activities in the university. They were officially granted by the papal legate, Robert de Courçon, and probably embody the principles agreed upon at a prior meeting of university and papal representatives.[87] In addition to various other topics, the statutes of 1215 prescribe for a course of study in the arts: the *Organon* of Aristotle and the *Isagoge* of Porphyry in logic, the two books of Priscian (*Priscianus maior* and *Priscianus minor*) in grammar, the *Barbarismus* of Donatus and the *Topica* of Aristotle in rhetoric, and Aristotle's *Ethica vetus* and *Ethica nova* (portions of the *Nichomachean Ethics*). No books are prescribed for the study of the quadrivium, and Aristotle's *Metaphysica* and books on natural philosophy are expressly forbidden. Pearl Kibre points out that the only mention of the quadrivium in the 1215 statutes is that "no books other than those of the philosophers, rhetoricians, and

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86See Hastings Rashdall, *The Universities of Europe in the Middle Ages*, vol. 1, 2nd edition edited by F. M. Powicke and A. B. Emden, Oxford: Clarendon Press, 1936, pp. 439ff.

87Gordon Leff, *Paris and Oxford Universities in the Thirteenth and Fourteenth Centuries*, New York: John Wiley & Sons, Inc., 1968, p. 25.

quadriviales, might be lectured on in feast days."[88] This seems to imply that quadrivial subjects were indeed taught, but the statute provides no details of topics or texts. Clearly the emphasis was on the trivium and moral philosophy. This is due in part to a strong reaction against the newly translated natural philosophical works of Aristotle (even though, as seen from the list above, the logical and ethical texts were utilized). But the proscription against Aristotle was not enacted at Oxford, for example, and so we can see that statutes can mislead us if we generalize uncritically from them.

Statutes from a few decades later show that major changes occurred at Paris, either in practice or at least in what was considered proper for inclusion in the curriculum. Statutes of 1252 from the English nation[89] for attaining the bachelor's degree require the same books as the 1215 statutes, but also include Aristotle's *De anima* (formerly prohibited), Boethius's *Divisiones* and *Topica*, and Gilbert de la Porrée's *Sex principia*. But these statutes were only for the bachelor's degree; in 1255, a statute regarding the books on which a master was to lecture include not only the previous works, but also nearly the entire Aristotelian *corpus vestutius* plus the *De animalibus*. At some point in the intervening four decades, then, Aristotle's works had again achieved favor and were recognized as being part of the proper curriculum of the university. The arts of the trivium, clearly, were valued throughout the period. What of the quadrivium? The statutes for Paris from the thirteenth century essentially neglect this portion of the arts, but it is clear from other sources of evidence that the quadrivium was not being neglected by all members of the university. In

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[88]Pearl Kibre, "The *Quadrivium* in the Thirteenth Century Universities (with Special Reference to Paris)," *Actes du quatrième congrès international de philosophie médiévale*, published as *Arts libéraux et philosophie au moyen âge*, 175–191, Montreal: Institut d'études médiévales, 1969. The quotation, from p. 175, is her translation of the Parisian statute.

[89]The 'nations' were student organizations within the university; see Pearl Kibre, *The Nations in the Medieval University*, Cambridge, MA: Mediaeval Academy of America, 1948. For the statutes of 1252, see Rashdall, *The Universities of Europe,* vol. 1, pp. 441–442.

addition, as we shall see below, it certainly was not being neglected at Oxford.

One source of evidence that the quadrivial arts were actively pursued is that scholars associated with the University of Paris were producing books on the quadrivial subjects during the first half of the thirteenth century. In addition to these original treatises, two other sources are particularly relevant: guides or manuals produced for the benefit of students, and *quodlibeta* and *questiones disputatae* on quadrivial topics.[90] An anonymous guide written by a Parisian master for students in the arts lists works for each of the quadrivial arts: Boethius's paraphrase of Nichomachus of Gerasia's work for arithmetic; Euclid's *Elements* as the text for geometry; Boethius's *De musica* for music; and Ptolemy, at least the *Almagest*, for astronomy.[91] In addition, quodlibetal questions exist for some of the quadrivial arts, though these tend to date from later in the century.[92] Kibre also emphasized that Roger Bacon, writing during the third quarter of the century, insisted that mathematical sciences are an essential part of a proper university curriculum;[93] this vociferous master, at least, promoted the quadrivial arts, as well as other mathematical science.

Original works in the areas of the quadrivial arts and mathematical sciences were being produced in large numbers, and masters did not rely upon only the translated works mentioned in the anonymous guide. Alexander of Villedieu's *Carmen de algorismo* and John of Sacrobosco's *Algorismus* both date from the first half of the thirteenth century, and both deal with the use of Arabic numerals in an elementary fashion suitable for university

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[90]Kibre, "*Quadrivium*," p. 176ff.

[91]Kibre, "*Quadrivium*," pp. 181, 183, 186, and 187.

[92]For example, see Kibre "*Quadrivium*," p. 187.

[93]Kibre, "*Quadrivium*," pp. 177ff.

instruction.[94] Sacrobosco also composed an astronomical textbook, *De spera*, with which we shall deal at greater length in a later chapter, and a compotus, as well as tracts on the astrolabe and quadrant. Later in the thirteenth century, masters such as Albertus Magnus, Thomas Aquinas, and Roger Bacon would stress the need for instruction in the quadrivial arts, as well as the proper relationship between the different sciences. It would be difficult to construct a reasonable scenario in which the degree of interest among contemporary masters, demonstrated by their creative work, did not impact the teaching at the university, even if those interests are not reflected in the statutes.

The late thirteenth and fourteenth centuries saw even further increase in the attention paid to the quadrivial arts. As the number of works by university masters on these subject areas grew, the statutes began to list texts that were required. At Oxford, for example, in 1350, statutes list Euclid for geometry, Boethius for arithmetic, and require that works be read in compotus, algorismus and astronomy.[95] The judgement of modern scholars, however, is that Oxford had a stronger tradition during the thirteenth century for teaching the physical sciences, and so the general relevance of this statute is not clear.[96] We shall return to Oxford in the final section of this chapter.

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[94]See Guy Beaujouan, "Él'nséignement de l'arithmétique élémentaire à l'université de Paris aux XIII^{e} et XIV^{e} siècles," in *Homenaje a Millás-Vallicrosa* 1, 92–124, Barcelona: Consejo superior de investigaciones cientificas, 1954, especially pp. 106ff.

[95]The statutes list Euclid's and Boethius's names explicitly, but for the other quadrivial arts list only the names of texts, "*Compotum* cum *Algorismo*, tractatum *De spera*," in *Statuta Antiqua Universitatis Oxoniensis*, edited by Strickland Gibson, Oxford: Clarendon Press, 1931, p. 33. It is assumed by virtually all modern scholars that the *De spera* referred to is Sacrobosco's, but no convincing argument has been presented to explain why the statute must refer to Sacrobosco's work, and so the assumption is unwarranted.

[96]For example, see Edward Grant, "Science and the Medieval University," in *Rebirth, Reform, and Resilience*, edited by James L. Kittelson and Pamela J. Transue, 68–102, Columbus: Ohio State University Press, 1984, especially p. 71, where he cites the work of James Weisheipl, which I shall cover in greater detail below.

In the area of astronomy in particular, the thirteenth century saw the production and incorporation of a great deal of new material into the university context. Olaf Pedersen, in a survey of manuscripts, has shown that a *corpus astronomicum* developed during the latter half of the thirteenth century.[97] He examined in particular manuscripts that he argued could "be taken as representative of the scientific interests of successive generations of teachers."[98] While this does not imply that all of these texts were actively taught in the university, it would require a torturous explanation to account for the prevalence of these texts if interest in astronomy were not strong in the universities. The corpus, as Pedersen saw it, began in its earliest stages with the inclusion, in the same manuscript, of works on algorismus, compotus, and a basic work on astronomy, usually Sacrobosco's *De spera*; frequently, a calendar, treatises on astronomical instruments, and some astronomical tables were also included. By the fourteenth century, the corpus had expanded to include *theorica planetarum* (works on the planetary motions), a greater number and variation of astronomical tables, more texts on instruments, and translated texts by Arabic authors (which had before been present only implicitly in the introductory works that made use of them). It is not clear that these manuscripts represent *curricular* changes in the university, but certainly they are suggestive that astronomy was an important science within university circles, just as it had been among the English translators of the twelfth century.

Before we move on to discuss the situation at Oxford, it will be worthwhile to spend a little time describing the methods of instruction in the university. We do not have a clear glimpse into the experience of students in the classroom, but we can make a few reasonable

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97Olaf Pedersen, "The *Corpus astronomicum* and the Traditions of Medieval Latin Astronomy" in *Astronomy of Copernicus and Its Background*, edited by Owen Gingerich and Jerzy Dobrzycki, *Studia Copernicana* 13 (1975): 57–96.

98Pedersen, "*Corpus astronomicum*," p. 74.

generalizations.[99] The two main kinds of classroom activity were lectures and disputations. Undergraduate students would attend numerous ordinary lectures, given by masters, often in the morning, in which the standard texts were read and then commented upon. Cursory lectures were given by bachelors as part of their training, and generally supplemented the ordinary lectures. Masters might also offer extraordinary lectures, which were frequently on texts not demanded by the curriculum but for which there was interest among the students. More advanced students would also attend and participate in disputations,

> in which set questions were debated, and objections and replies presented by successive opponents and respondents, ending with a final resolution or determination, which always seems to have been the prerogative of masters, except during the bachelors' period of determining or disputing during Lent.[100]

Participation in disputations came at a later stage in a student's education, and thus might never have been experienced by those students who left university early or who did not seek a degree. When a student had heard the required lectures and participated as required in disputations, a course of study that normally took about four years, he could choose to determine, in other words become a bachelor and enter the course of study towards the master's degree. He had to swear he had attended the prescribed lectures and disputations, and to bring forth witnesses to testify that he had done so. After this process, the student would attend and participate in further disputations, as well as present cursory lectures. After another three or four years, the student could be presented by his master for inception. This began another process of testifying that he had fulfilled the requirements, and testing by other masters to ensure that his education had been sufficient. After completing certain ritual requirements, such as presenting an inaugural lecture and presiding at a disputation, the student finally became a master.

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[99]See Leff, "The *Trivium* and the Three Philosophies," pp. 326ff.

[100]Leff, "The *Trivium* and the Three Philosophies," p. 326.

We now have a general picture of the early years of the medieval university. The generalizations of the previous section have been intended to give the reader a sense of the context in which Grosseteste operated. Each university, however, was unique, and the experience of one would have been different from the experience of another. We shall thus end this chapter with a brief history of the early decades of the University of Oxford so that we can better place Grosseteste in his proper environment.

1.4. The Growth of the University of Oxford, with an Emphasis on the Teaching of Quadrivial Subjects and Natural Philosophy

The city of Oxford in the twelfth century probably seemed an unlikely place for one of the preeminent—not to mention earliest—universities of the middle ages to arise. It had no cathedral, was merely an archdeaconry, and lacked any great tradition of monastic education. It had some strategic significance, but was not particularly important to the crown. It was merely one of many English towns that hosted masters and schools during the twelfth century, a modest town within the large diocese of Lincoln.[101] And according to Daniel of Morley, around 1180, it was Northampton, not Oxford, that had a reputation in England for the teaching of the arts.[102]

We do not know a great deal about the schools at Oxford during the twelfth century. According to Southern, we have evidence for two masters who taught in the first half of the

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[101]Southern says that it was "one of three or four medium-sized towns in the diocese of Lincoln," and that it had fallen from its place as the sixth or seventh largest English town after depopulation following the Norman Conquest, "From Schools to University," p. 4.

[102]Southern, "From Schools to University," p. 11. For more on Northampton, see H. G. Richardson, "The Schools of Northampton in the Twelfth Century," *English Historical Review* 56 (1941): 595–695. See also Cobban, *The Medieval English Universities*, pp. 29ff.

century.[103] Theobald of Etampes taught in Oxford from shortly before 1100 until the 1120s. His extant correspondence suggests he was interested in theological matters, but it is not clear that he taught anything more than elementary subjects. Robert Pullen taught in Oxford for about five years, lecturing on the scriptures, before he departed for Paris. In the same period, that is, around 1135, a few other prominent scholars were in Oxford, though it is not clear whether they were teaching.[104]

After 1135, however, Oxford "sinks from sight as a scholastic centre,"[105] and remained so for about fifty years. In other respects, however, Oxford was growing, becoming more prominent as an English town. When England experienced civil wars during this period, military leaders realized that Oxford was strategically important during such times of crisis.[106] It was centrally located in the kingdom: it was at the crossroads of a number of important routes, connecting London, Southampton, Northampton, Cambridge, Bristol, Winchester, Bedford, Buckingham, Worcester, and Warwick, and offered access to the southern coast, Ireland, and the continent.[107] There was a castle in Oxford, as well as a royal mint, and a royal palace had been built at nearby Woodstock in 1100. In addition, two

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103Southern, "From Schools to University," pp. 5ff, and Cobban, *Medieval English Universities*, pp. 37–38.

104Examples of scholars active at Oxford at this early date include the historian Geoffrey of Monmouth; Walter of Coutances, the archdeacon of Oxford; and Robert de Chesney, later bishop of Lincoln. See Southern, "From Schools to University," p. 8.

105Southern, "From Schools to University," p. 8. Southern admits that positive evidence is lacking, but that a few clues suggest that Oxford was not a significant place for schools during this period.

106See Southern, "From Schools to University," p. 12; Cobban, *Medieval English Universities*, pp. 34–35; and Leff, *Paris and Oxford Universities*, pp. 76–77.

107Its location on the river Thames has also been suggested as an important part of its strategic importance, but Cobban points that the Thames is not easily navigable at Oxford, and it was not an important region for river traffic. See *Medieval English Universities*, p. 35.

guilds, those of the weavers and leatherworkers, were present in the city, suggesting a favorable economic climate.

Ecclesiastically, too, Oxford's importance grew. The Augustinians were there in force, in the college of secular canons at St. George-in-the-Castle, founded 1074; the Priory of St. Frideswide, begun in 1121; and Osney Abbey, made a priory in 1129, and an abbey in 1154. In addition, a Benedictine nunnery was in nearby Godstow from 1132.[108] Ecclesiastical courts also became very prominent in Oxford in the last decades of the twelfth century. Not only were its central location and easy land access significant to its becoming a convenient place for courts to meet, but the litigation between the Augustinian houses at St. Frideswide and Osney was abundant. As a central location for the courts, it brought dignitaries and their retinues to Oxford, benefitting the community financially and intellectually. Combined with increasing royal attention, Oxford was on its way to prominence.

There was no reason, however, that a university need have developed in Oxford simply because the location was convenient. London, for example, was a prominent city, significantly larger than Oxford, yet a medieval university did not develop there. The key to the development of a university in Oxford, according to Southern, was the presence of the courts.[109] The active courts at Oxford drew lawyers to the city. To supplement their income, they probably turned to teaching. Law, as a profession and as a subject for teaching, required both classroom instruction in theoretical principles and observation of courts in session. Oxford was in a position to offer both. In 1190, Emo of Friesland came to Oxford

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[108]Cobban, *Medieval English Universities*, p. 35.

[109]Southern, "From Schools to University," pp. 17ff. Rashdall, in *Universities of Europe*, vol. 3, pp. 12ff, argues that Oxford was the site to which a number of English masters migrated from Paris when Henry II recalled English scholars from France in 1167. The case for this supposed migration is slim; see H. E. Salter, "The Medieval University of Oxford," *History* 14 (1929–1930): 57–61.

to study law. Emo was not a particularly significant individual in his own day, but he was the first foreign student that we know by name who came to Oxford to study law. Oxford had finally achieved an international reputation for teaching.

It was not with the teaching of law, however, that Oxford's reputation would become entrenched during the thirteenth century. It was instead in the areas of the arts and theology that Oxford would achieve prominence. This is surprising given Paris's preeminence in those two areas. Southern suggests that war between France and England, especially from 1193 to 1204, made it very difficult for English students to travel to France for an education.[110] In the same period, present in Oxford were certain prominent lecturers in theology and the arts whose reputations undoubtedly brought students to Oxford. It is not clear, unfortunately, why these masters were in Oxford. For now, we are limited to assuming that the vicissitudes of circumstance played a large part in their residence, leaving us with the situation that Oxford's rise as a *studium* was due in no small measure to chance.

The reputation of the Oxford *studium* at this early stage in its development was simply not sufficient to attract masters and students. Instead, it was the reputation of individual masters who brought students to Oxford. One of the most important of these early masters was Alexander Nequam, whom we met above as one of the earliest teachers to use the newly translated Aristotelian works. Alexander lectured in theology and preached frequently in Oxford, beginning in about 1190, before he entered the monastic life sometime around 1200.[111] It is difficult to know precisely on what he lectured and which among his works were written later, though Southern suggests that even later works reflect the topics

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[110]Southern, "From Schools to University," p. 21.

[111]See Hunt, *The Schools and the Cloister*, pp. 9ff.

with which he was concerned while teaching.[112] He commented widely on the scriptures; some of these commentaries include examples of disputations, which likely were drawn from his teaching experiences.[113] He wrote a theological work, the *Speculum speculationum*, as well as scientific treatises, the most famous of which are *De naturis rerum* and *Laus divinae sapientiae*. It is especially in these latter works that his use of Aristotle and other translated scientific works becomes clear.[114]

Two other prominent masters lectured on Aristotle while teaching in the arts during the earliest years of Oxford. Edmund of Abingdon lectured on the *Sophistici elenchi*, and his biographer insisted that he had a deep attraction to the quadrivial arts.[115] John Blund lectured on the *libri naturales* of Aristotle while in the faculty of Arts.[116] We unfortunately know very little of the content of Blund's lectures beyond the fact that Aristotle was of central importance. In both cases, they probably received their own education at Paris before coming to Oxford to teach, and both studied theology while there. But their use of Aristotle while teaching at Oxford clearly indicates a growing body of students at the levels of undergraduate and bachelor with an interest in philosophy and, correspondingly, the arts.

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[112]Southern, "From Schools to University," p. 23.

[113]See Hunt, *The Schools and the Cloister*, pp. 102–103.

[114]The extent of his knowledge of Aristotelian and pseudo-Aristotelian works is in question. D. A. Callus confidently asserts that Alexander knew *De caelo et mundo*, *Metaphysica*, *De generatione et corruptione*, *De anima*, the *Ethica vetus*, and the *Liber de causis*; see his "Introduction of Aristotelian Learning to Oxford," *Proceedings of the British Academy* 29 (1943): 229–281, p. 236. Hunt, on the other hand, in *The Schools and the Cloister*, questions Alexander's knowledge of the Aristotelian corpus except the logical works; see especially pp. 68ff.

[115]As stated by Callus, "Introduction of Aristotelian Learning to Oxford," p. 244.

[116]Regarding Blund, I have relied heavily on Callus, "Introduction of Aristotelian Learning to Oxford," pp. 241–252.

The pattern represented by these two masters is indicative of the general picture of university learning by Englishmen at the beginning of the thirteenth century. They received their elementary education in England, but then went to Paris for advanced training in the arts. They returned to England, for reasons not entirely clear to us, and taught in the arts while studying for a theological degree. A similar path has also been suggested for another prominent master of Oxford, Robert Grosseteste. But as we shall see in the next chapter, he may have taken an alternative route to teaching at Oxford, a route that is relevant to his early interests in astronomy and compotus.

When did Oxford truly become a university, as opposed to a mere gathering of masters? Its origins lie in the last decades of the twelfth century, but a significant symbolic date is 1214. Rashdall and Southern both present evidence for the presence of a number of teaching masters in the late twelfth century, and lectures on Aristotle were there in the first decade of the thirteenth century. Further evidence of an active school comes from 1209.[117] A woman was killed by a scholar in Oxford; in response, some townsfolk raided the hostel in which the scholar had been living, and two or three scholars were seized and executed. A *suspendium clericorum*, a cessation of teaching, was declared, and scholars dispersed from Oxford.[118]

It was not until 1214 that the matter was settled. A papal legate reached an agreement with the king and the city of Oxford to bring back the masters and students. Among other privileges, the award controlled rents and food prices for scholars, stated that arrested

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117Rashdall, *Universities of Europe*, vol. 3, pp. 33–34; Leff, *Paris and Oxford Universities*, p. 78; Cobban, *Medieval English Universities*, pp. 44–45.

118Rashdall claimed that many of the scholars migrated to Cambridge, and began the university there; Rashdall, *Universities of Europe*, vol. 3, p. 334; see also Cobban, *Medieval English Universities*, pp. 50ff. Rashdall also notes Matthew Paris's claim that 300 scholars left Oxford at this time; even if the number is exaggerated, which is not certain, his claim implies a very large body of students and masters were in residence in Oxford in 1209.

scholars would be handed over to the bishop of Lincoln, required the city to adopt a charter enforcing the articles of the award, and spelled out a penance to be performed by those responsible for executing the scholars five years previously.[119] With this legatine award, the University of Oxford had sealed in writing its corporate identity. Many of the features of a *studium* reach back into the twelfth century, but with the document of 1214, it is incontrovertible that a university was present in Oxford.

A significant feature of the University of Oxford is that it enjoyed a reputation for greater attention to the mathematical and quadrivial arts than any other thirteenth-century university, Paris included. We have already seen that Aristotle's works were present at an early stage of the university's development. In addition, tantalizing hints of connections between one of the earliest Oxford masters to know Aristotle, Alexander Nequam, and the circle of scholars at Hereford, with their interests in Arabic and Greek science, suggest possible routes by which new scientific texts and ideas made their way into the Oxford community.

Even though we can only conjecture about the sciences in the earliest years of the university, we can stand on firmer ground regarding the rest of the thirteenth century. J. A. Weisheipl has gathered much of the evidence for the teaching of scientific subjects at Oxford.[120] As he points out, texts were available from the translation movement of the previous century. Mathematics and astronomy had been of keen interest to the translators, and texts in these subject areas could fit neatly into the quadrivial arts. The *libri naturales* of Aristotle were available in the early decades of the thirteenth century, and the commentaries of Averroes were probably available after 1230. These texts did not fit into the traditional

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[119]Pollard, "The Legatine Award," summarizes the award with a list of eleven injunctions on p. 64.

[120]See J. A. Weisheipl, "Science in the Thirteenth Century," in *HUO1*, 435–469.

arts of the quadrivium or trivium, and so led to the incorporation of natural philosophy into the arts curriculum. These texts certainly represent what was available, but not necessarily what was taught; if nothing else, there was not sufficient time for the typical student to study all these texts.[121]

Nonetheless, we do know that a number of masters at Oxford were interested in the quadrivial arts and natural philosophy. Weisheipl states clearly where this interest began:

> Without doubt the most important figure in Oxford science in the early thirteenth century was Robert Grosseteste, whose long life…dominated the Oxford scene even into the fifteenth century. And Oxford science throughout the thirteenth century can be understood and appreciated only in the light of Grosseteste's ideals, inspiration and influence.[122]

We shall discuss Grosseteste's intellectual development in more detail in the next chapter, but it is worth noting here that Weisheipl mentions three areas in which Grosseteste's influence was most heavily felt. First, he made use of the new Aristotelian works now available in the university setting. Second, he developed his philosophical and theological doctrines about light. And, third, he emphasized the need for mathematical training, especially geometry, to understand the behavior of light.[123] James McEvoy, in agreement with Weisheipl's high opinion of Grosseteste's influence at Oxford, writes of Grosseteste that

> his writings and his fame helped to establish at Oxford an interest in scientific and mathematical learning that flourished in the fourteenth century, and which might well not have got off the ground without his inspiration.[124]

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[121]Weisheipl, "Science in the Thirteenth Century," pp. 439–440.

[122]Weisheipl, "Science in the Thirteenth Century," p. 440.

[123]Weisheipl also notes that Grosseteste began to study Greek late in life, but the relevance of this portion of his life to developments at Oxford is not clear.

[124]James McEvoy, *The Philosophy of Robert Grosseteste*, Oxford: Clarendon Press, 1982, pp. 18–19. For more on Grosseteste's lasting influence at Oxford, see A. C. Crombie, *Robert Grosseteste*

Grosseteste's importance is thus clear.

Grosseteste was especially influential among the Franciscans at Oxford.[125] His influence can be seen among such notables as Adam Marsh and Bartholomeus Anglicus, and into the next generation with Roger Bacon and John Pecham. Roger Bacon, in fact, insisted that it was only in English schools that mathematics was truly appreciated, in the eminent persons of Grosseteste and Marsh, who were "perfect in divine and human wisdom."[126] Bacon also claimed that Grosseteste, Marsh and unnamed others—in the words of a modern author—"revived the tradition of applying mathematical explanations in diverse fields to discover causes."[127] Of Grosseteste, Bacon wrote that he "was the only one above all men to know the sciences."[128] And a large treatise entitled *Summa philosophiae* was written around 1265–1270 and was faithful to Grosseteste's legacy, suggesting that his influence was still a major factor three decades after he had departed the university community.[129]

Weisheipl does not, however, credit Grosseteste as the key figure in the

and the Origins of Experimental Science, 1100–1700, Oxford: Clarendon Press, 1953, pp. 135–188.

[125]See, for example, McEvoy, *Robert Grosseteste*, Oxford: Oxford University Press, 2000, pp. 154–159.

[126]Quoted in McEvoy, *The Philosophy of Robert Grosseteste*, p. 14.

[127]McEvoy, *The Philosophy of Robert Grosseteste*, p. 14.

[128]Solus dominus Robertus…prae aliis hominibus scivit scientias. Quoted and translated by Weisheipl, "Science in the Thirteenth Century," p. 443.

[129]The work was often attributed to Grosseteste. The author is still unidentified, and is usually referred to as pseudo-Grosseteste. The work is contained in *Die philosophischen Werke des Robert Grossteste, Bischofs von Lincoln*, edited by Ludwig Baur, 275–643, *Beiträge zur Geschichte der Philosophie des Mittelalters*, Band 9, Münster: Aschendorffsche Verlagsbuchhandlung, 1912. See also, C. K. McKeon, *A Study of the* Summa philosophiae *of the Pseudo-Grosseteste*, New York: Columbia University Press, 1948.

incorporation of Aristotle into the curriculum.[130] As we have seen above, Oxford masters were lecturing on Aristotle in its early years. Statutes from 1268 required a determining bachelor to have heard lectures on the *Physica*, *De anima*, and *De generatione et corruptione*, and, in certain circumstances, the *Meteorologica*.[131] In addition, a number of masters are known to have lectured on the *libri naturales* throughout the thirteenth century. Weisheipl devotes a great deal of attention to both Adam of Buckfield and Geoffrey of Aspall, demonstrating a strong tradition of lecturing in natural philosophy in the faculty of arts.[132] This interest in natural philosophy at Oxford continued well into the fourteenth century.[133]

The quadrivial arts, too, were important. Later chapters of this dissertation discuss the presence of Grosseteste's astronomical and computistical works at the university, but we have already seen from Weisheipl that geometry and optics were important for those who were influenced by Grosseteste. We also possess a great deal of evidence that the quadrivial arts were important in the early part of the fourteenth century. Among the earliest statutes of the university is the requirement that the following books on the quadrivial arts be heard for determination: "six books of Euclid, the *Arithmetica* of Boethius, a *Compotus* with

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130McEvoy credits Grosseteste with a greater role in the establishment of Aristotle at Oxford. He writes, "without the stimulus of his [Grosseteste's] commentaries and translations the Aristotelean [*sic*] movement at Oxford would not have become what it did, or at least not so quickly." McEvoy, *The Philosophy of Robert Grosseteste*, p. 19.

131Weisheipl, "Science in the Thirteenth Century," p. 461.

132Weisheipl, "Science in the Thirteenth Century," pp. 462ff. For more on Aspall, see Enya Macrae, "Geoffrey of Aspall's Commentaries on Aristotle," *Mediaeval and Renaissance Studies* 6 (1968): 94–134.

133See John North, "Natural Philosophy in Late Medieval Oxford," in *The History of the University of Oxford*, vol. 2, *Late Medieval Oxford* (hereafter *HUO2*), edited by J. I. Catto and Ralph Evans, 65–102, Oxford: Clarendon Press, 1992.

Algorismus, [and] the treatise *De spera*."[134] These statutes dates from before 1350, but cannot be dated more precisely. Those statutes also list the amount of time that should be allotted to each topic: five weeks for Euclid, three weeks for the *Arithmetica*, and eight days for the *Compotus*.[135] Statutes that may date from later in the century also require eight days for the *Algorismus* and *De spera*.[136]

Weisheipl has noted a number of other works that were used in the Oxford community, though he cannot be sure which, if any of them, were used in teaching.[137] In arithmetic, he notes in addition to Boethius's *Arithmetica* and the *Algorismus* of the statutes, that books seven through ten of Euclid, devoted to the properties of numbers, might have been used, as well as a summary of Boethius by Thomas Bradwardine. Geometry may have been supplemented by a number of different treatises, and that texts in *perspectiva* (a science closely related to optics) probably would have been treated as geometrical. Astronomy, in addition to the *De spera*, might have included both the *Almagest* and *Tetrabiblos* of Ptolemy, works in the tradition of *Theorica planetarum* (at least by the fourteenth century), astronomical tables, a treatise on the quadrant, and works of Bradwardine. He also believes that Grosseteste's *Compotus* was used throughout the thirteenth century, but was supplanted by Sacrobosco's *De anni ratione* in the fourteenth. So while Weisheipl is unable to establish definitively that any of these texts were used in

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[134]…sex libros Euclidis, *Arsmetricam* Boycii, *Compotum* cum *Algorismo*, tractatum *De spera*…audierunt competenter. Strickland, *Statuta Antiqua*, p. 33, ll. 17–20.

[135]Strickland, *Statuta Antiqua*, p. 33, ll. 31–32 and 37–38; and p. 34, ll. 1–2..

[136]Strickland, *Statuta Antiqua*, p. 33, ll. 33–36. Strickland gives a date of before 1407.

[137]See James A. Weisheipl, "Curriculum of the Faculty of Arts at Oxford in the Early Fourteenth Century," *Mediaeval Studies* 26 (1964): 143–185.

teaching, their survival suggests that there was a great deal of interest in the quadrivial arts at Oxford during the thirteenth century. Certainly in the fourteenth century, mathematics and astronomy were flourishing at the University of Oxford.[138]

The reader now has a basic introduction to the first century of the university at Oxford. The attention given to the quadrivial arts and natural philosophy has not presented a full picture of the university, but such is not necessary. Our interest here has been to understand the environment in which Grosseteste worked, as well as the environment he helped to create through his work. The foci of the present study are his astronomical and computistical textbooks, and so we have sacrificed attention to certain aspects of the medieval university that were contemporaneously important, but which are not relevant to the questions that will arise in the following chapters. Before we move on to his textbooks, however, let us examine his life, so that we may more fully understand the milieu from which he came, for his life was by no means restricted to the university of Oxford.

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[138]See John North, "Astronomy and Mathematics," *HUO2*, 103–174.

CHAPTER 2

A BIOGRAPHICAL SKETCH OF ROBERT GROSSETESTE

Robert Grosseteste stands as one of the most significant figures of medieval science. Despite the fact that he has been the subject of a number of important modern studies, portions of his biography remain uncertain; yet because modern authors have already deeply mined the primary sources, my own account will be largely a synthesis of the fine work that has preceded it.[1] This chapter will provide the reader with the basic outlines of Grosseteste's life, including those portions on which we are forced to speculate to a greater or lesser degree. Though primarily intended to familiarize the reader with Grosseteste's life in order to place his astronomical and computistical textbooks in their proper context, this chapter will also stand on its own as an introduction to the life and works of this important scholar, teacher and bishop. The first two sections of the chapter will follow Grosseteste's life chronologically, from his early activities through his time at Oxford. The third section will shift focus to examine his writings, and trace the attempts of modern authors to create a chronology of his scientific works. The final section will return to his activities in a later stage of his life, discussing in brief his tenure as the bishop of Lincoln. The chapter ends with a table summarizing Grosseteste's biography, while

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[1]The works on which I have drawn most heavily for Grosseteste's biography include D. A. Callus, "The Oxford Career of Robert Grosseteste," *Oxoniensia* 10 (1945): 42–72, and "Robert Grosseteste as Scholar," in *Robert Grosseteste, Scholar and Bishop*, edited by D. A. Callus, 1–69, Oxford: Clarendon Press, 1955; James McEvoy, *The Philosophy of Robert Grosseteste* and *Robert Grosseteste*; and R. W. Southern, *Robert Grosseteste: The Growth of an English Mind in Medieval Europe*, Oxford: Clarendon Press, 1986.

simultaneously conveying what aspects of his life are better or less-well known.

Whereas the first chapter offered a picture of his intellectual environment, this chapter will show the reader what Grosseteste accomplished in this environment. This outline of his life will be vital to the tasks of later chapters, as I both attempt to place the composition of the textbooks into this chronology and to argue that an examination of the textbooks allows us to elaborate further on his biography.

2.1. Grosseteste's Early Life

Our knowledge of a given period of Grosseteste's life is in inverse proportion to his age during that period. His final years as a bishop can be reconstructed accurately through the official documents he prepared while in office, whereas his time at Oxford, immediately preceding his tenure as a bishop, is understood only partially. His activity in his later years at Oxford, as a theological master and as an instructor to the Franciscans, is better understood than his earlier associations with the university. The paucity of surviving pieces of documentary evidence from the earliest years of his life leaves his biography during that period known only sketchily. Attempts to reconstruct his biography contain a great deal of conjecture, and have produced very different pictures of his life.

Thirteenth-century sources for Grosseteste's biography include Matthew Paris, the St. Albans chronicler who had a mixed opinion of Grosseteste,[2] and the otherwise unknown friar Hubert, a witness from within Grosseteste's household, who composed in verse a brief and personal account of Grosseteste as a lament following his death.[3] Roger Bacon can also be added to the list, for his works includes numerous references to Grosseteste's activity at

[2]For more on Matthew Paris's opinions of Grosseteste, see Southern, *Robert Grosseteste*, pp. 6–13.

[3]For more on Hubert's account, including translated portions of the lament see McEvoy, *The Philosophy of Robert Grosseteste*, pp. 40–42. See also Southern, *Robert Grosseteste*, pp. 19–20

Oxford,[4] but it is uncertain whether Bacon himself ever knew Grosseteste; he may have learned about him only secondhand through Grosseteste's pupil Adam Marsh. No concerted effort to write Grosseteste's biography was made until 1330, when John of Schalby wrote his *Lives of the Bishops of Lincoln*. A much longer account was written in 1502, a *Life* of Grosseteste, by Richard of Bardney, an abbey near Lincoln. Its late date certainly does not qualify it as contemporary, but Southern believes it deserves greater attention than has heretofore been given.

It is certain that Grosseteste died in 1253 after eighteen years as the bishop of Lincoln, the largest diocese in England. The date of his birth, however, is much contested. Modern authors date it anywhere from 1160 to 1175.[5] This variety of dates implies that he was between the ages of seventy-seven and ninety-three when he died. His chroniclers agree that he lived to be quite old, but do not provide any precise dates. An established tradition of his biography used to place his birth as late as possible, probably based on the advanced age at his death that an earlier date would imply. All modern authors agree that the key source for his date of birth is a charter that he signed while a member of the household of Hugh, Bishop of Lincoln. The dating of this charter is problematic. Southern states that it must date before 1192, but after 1189,[6] whereas McEvoy dates it between 1186 and 1190.[7] In

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[4]For a list of such references, see McEvoy, *The Philosophy of Robert Grosseteste*, p. 13, n. 17. For more on Bacon's opinion's of Grosseteste, see Southern, *Robert Grosseteste*, pp. 13–19.

[5]For example, Jeremiah Hackett, in his article on Grosseteste for the *Dictionary of Literary Biography*, vol. 115, *Medieval Philosophers*, edited by Jeremiah Hackett, 225–235, Detroit: Gale Research, Inc., 1992, gives a date of "circa 1160." Lynn Thorndike, in *A History of Magic and Experimental Science*, vol. 2, p. 436, provides a date of "about 1175." A. C. Crombie, in his article on Grosseteste for the *Dictionary of Scientific Biography*, vol. 5, pp. 548–554, splits the difference at 1168.

[6]Southern, *Robert Grosseteste*, pp. 63–64, see especially n. 2.

[7]McEvoy, *The Philosophy of Robert Grosseteste*, p. 4.

any event, the difference is not overly significant because the document still does not allow us to calculate Grosseteste's precise age at the time. He simply signs as *Magister Robertus Groteste*, which does not allow us to compute his age. The problem is to understand this title of *magister*.

Callus advanced the argument that the title of *magister* implied that Grosseteste was a master of the arts as one would find coming out of the university setting, thus putting him in his early twenties when he signed the charter, and pushing his date of birth back to about 1168.[8] Southern, on the other hand, prefers as late a date of birth as possible, based in part on Grosseteste's journey to the papal court in 1250, a difficult journey for a man in his eighties. In addition, Southern argues, if he were a full-fledged master of the arts from a university such as Paris, Grosseteste would more likely have been in his mid-twenties, pushing his birth back to the first half of the 1160s. In order to avoid this, Southern suggests that a later date of, say, 1170, would make him only a little over twenty when he signed the charter. If this were the case, then the title of *magister* may refer merely to teaching activity, rather than a formal title gained from university schooling.

Grosseteste was born in the county of Suffolk, perhaps in the village of Stow,[9] to lowly parentage. We know of one sister, Ivette, who became a nun.[10] His family was

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[8]See Callus, "Robert Grosseteste as Scholar," pp. 3–4. McEvoy explicitly repeats Callus's argument, *The Philosophy of Robert Grosseteste*, pp. 4–5.

[9]Suffolk is given as his birthplace by Hubert; see McEvoy's translation in *The Philosophy of Robert Grosseteste*, p. 41. The reference to Stow comes from Richard of Bardney, who does not mention Suffolk; see Southern, *Robert Grosseteste*, p. 77. Southern notes that there are three Stows in Suffolk.

[10]McEvoy, *The Philosophy of Robert Grosseteste*, p. 6. McEvoy also mentions two kinsmen who came across his path when he was a bishop, but we do not know their precise relationship. See also Grosseteste's letter to Ivette, letter VIII in Robert Grosseteste, *Epistolae*, edited by Henry Richards Luard, London: Luard, Green, Longman and Roberts, 1861 (hereafter *Epistolae*), pp. 43–45.

probably Anglo-Norman, as the French derivation of his name suggests.[11] Beyond this, we have little secure knowledge of his childhood. Though many sources agree that he came from humble beginnings, Richard of Bardney presents a picture of destitute poverty, becoming an orphan at an early age, begging successfully for patronage in Lincoln, and receiving schooling in Lincoln and Cambridge. Richard's account suffers from a variety of problems, not the least of which is its late date of composition, two and a half centuries after Grosseteste's death. But Southern, following the lead of J. C. Russell, believes Richard's account can be taken seriously in its general outline, even if not in its more marvelous anecdotes, such as Grosseteste's horse, which was said to have conveyed him from England to Rome in a single night.[12] Southern's main reason for taking this account seriously is that there is little about the details that are overly romantic, or that serve a purpose in 1502 that Richard would be promoting. The only exception I see to this is that the city of Lincoln figures in significant fashion in Grosseteste's early life, both as the place he found his initial patronage and where he received his early education; the work was written for the bishop of Lincoln, and hence in a small way glorified Lincoln as a source of influence in Grosseteste's early years, and not just as the place of his eventual bishopric.

Even though this objection is not overwhelming, I still find it difficult to accept Richard's account as especially significant, at least in its particulars. The late date of its

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[11]McEvoy is confident of this because of the poem, *Château d'Amour*, composed by Grosseteste in the Anglo-Norman French dialect, and a few other pieces of writing in that tongue. McEvoy, *Robert Grosseteste*, p. 20.

[12]Southern, *Robert Grosseteste*, pp. 75ff. He cites J. C. Russell, "Richard of Bardney's Account of Robert Grosseteste's Early and Middle Life," *Medievalia et Humanistica* 2 (1943): 45–55. A few other details of the account are problematic, as Southern points out, such as the fact that Grosseteste was said to have begged to the mayor of Lincoln, though Lincoln had no mayor until 1205. On the other hand, Southern also points out some of the embellishments that might have been added could have their source in other places; the first mayor of Lincoln, Adam of Wigford, was supposed to have taken in a handicapped child, and so perhaps the story of Grosseteste was conflated with some other story.

composition, even if it does get certain details right,[13] weighs heavily against it. Southern's best guess is "that Richard of Bardney had access to sources of a period much earlier than his own day."[14] At the same time, however, there is little to corroborate Richard's account, certainly in its details, and perhaps even in its general outline. Southern, however, has a clear goal in using Richard's *Life* of Grosseteste: to paint a picture of a poor man, educated in England, who would eventually achieve fame during his years at Oxford, rising to the position of bishop on his own merits rather than through the wealth of his family. Southern's account also discounts any role for Paris as the source of Grosseteste's education.

We do know, based upon his signature on the aforementioned charter, that Grosseteste was associated with the household of the bishop of Lincoln sometime between the years of 1186 and 1192. When signing that charter, he used the title *magister*. Callus, as mentioned above, believed that this implied that Grosseteste had been educated in the university system, specifically at Paris. Richard of Bardney's account makes no mention of Paris, but instead states that Grosseteste had been educated in Lincoln and Cambridge. Even if Richard's account cannot be believed straightforwardly, it seems unlikely that Grosseteste could have received an education in the arts at Paris. As discussed in the previous chapter, reaching the rank of *magister* was an expensive undertaking. We have no evidence that Grosseteste had this level of financial support. On the other hand, other members of the bishop's household who signed the same charter *had* received an education in Paris,[15] so it

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[13]Southern is particularly impressed by Richard's account of Grosseteste's position of friendship with the young King Henry III; see his *Robert Grosseteste*, pp. 80–82.

[14]Southern, *Robert Grosseteste*, p. 82.

[15]Southern, *Robert Grosseteste*, p. 64.

certainly is conceivable that Grosseteste could have as well.

Yet Grosseteste need not have, and there is no positive evidence that he did. By the last quarter of the twelfth century, there were opportunities in England for an individual to receive a good education, just as there were opportunities for someone of Grosseteste's abilities to teach, thereby earning the title of *magister*. Even if we are disinclined to accept Richard's account as evidence that Grosseteste received his education in Lincoln and Cambridge, the picture of a poor young Englishman, natively educated, scratching out a living by teaching, seeking promotion in a bishop's household, is not unlikely. In fact, the weight of evidence is in its favor. Grosseteste's humble beginnings are well-attested, and he seems to have had little luck finding a generous and stable patron, which he likely would have needed in order to study at Paris. I am thus inclined to believe that he spent the first twenty-plus years of his life in England, so that when we find him attached to the bishop of Lincoln, he is a *magister* not from a university, but from local school.

Within a few years of signing the charter, Grosseteste moved on from Lincoln to the household of William de Vere, Bishop of Hereford. During this period we see a number of noteworthy coincidences surrounding Hereford. In 1194 or 1195, Gerald of Wales was in Lincoln, and wrote a letter recommending Grosseteste to William. Describing Grosseteste, Gerald wrote,

> I know that he will be a great support to you in various kinds of business and legal decisions, and in providing cures to restore and preserve your health, for he has reliable skill in both these branches of learning, which in these days are most highly rewarded. Besides, he has a solid foundation of the liberal arts and wide reading, which he adorns with the highest standards of conduct.[16]

This was the same Gerald of Wales to whom Simon du Fresne in 1195–1197 addressed his poem about the school of Hereford, which was discussed in the previous chapter. Simon's description of the teaching at Hereford bears remarkable similarities to the areas of

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[16]Quoted and translated in Southern, *Robert Grosseteste*, p. 65.

knowledge and ability that Gerald attributes to Grosseteste. One can thus easily conjecture that Grosseteste is being recommended not just as an able clerk for the household, but potentially as a teacher as well. It is attractive even to speculate that Grosseteste had been teaching in Lincoln, where Richard of Bardney thought he had been educated, and thus the title of *magister* from the charter could refer not merely to some past employment, but to his activity in Lincoln.

It is interesting to note that Gerald recommended Grosseteste on the basis of two particular areas of knowledge: law and medicine. The former is no surprise, for if he had been a useful member of the Bishop of Lincoln's household, certainly he must have been knowledgeable to some extent of the law and of the conduct of ecclesiastical business. But he was also recommended for his knowledge of medicine, not something for which he is today recognized. But Southern has pointed out that Grosseteste used imagery from the medical realm in some of his writings,[17] and that Richard of Bardney attributed to him knowledge of medicine.[18] Again a remarkable coincidence presents itself: Roger French has pointed out the interest in medicine associated with the circle of scholars around Hereford in the second half of the twelfth century.[19] Gerald's recommendation of Grosseteste's skill in an area for which he did not possess a lasting reputation, but which was consonant with the interests of scholars at Hereford, suggests that Grosseteste was being recommended as a scholar and teacher.

The recommendation of Gerald is also significant for what it does not say. It does not say where Grosseteste was educated. Would he have said more if Grosseteste did

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[17]Southern, *Robert Grosseteste*, p. 65–66 and n. 5.

[18]Southern, *Robert Grosseteste*, p. 78.

[19]French, "Foretelling the Future." And see the previous chapter of this dissertation.

possess an education from Paris? This is impossible to know, but the letter states only that he has a "solid foundation" in the liberal arts, and that he is widely read, a fairly generic description. It must also be admitted that it does not state that Grosseteste was a teacher, though we do know that Grosseteste himself used the title of *magister* prior to Gerald's letter. The statements about Grosseteste's learning stand next to a statement about his good standards of conduct, and so perhaps these statements can be interpreted as only a general description of a person well-suited to become a member of a bishop's household: an educated man who will behave with comportment. As with other aspects of Grosseteste's life, we are limited to constructing a plausible picture, rather than a definitive one.

William de Vere, Grosseteste's patron in Hereford, died on Christmas Eve in 1198. With his death, Grosseteste's support disappeared, for he had never received a benefice, which would have provided him with an income. For the next twenty years or so, only small pieces of evidence for Grosseteste's life are available. There exists a recollection of Grosseteste, told on his deathbed to John of St. Giles and reported by Matthew Paris, that he had heard preaching against the usurers of Cahors while in France.[20] In addition, a document bears Grosseteste's name, as an official involved in a dispute between the monks of Worcester and a local landowner, which occurred between 1213 and 1216.[21] The two other officials named in this document are Hugh Foliot, archdeacon of Shropshire, and an official in the diocese of Hereford. Hugh is especially significant in that he became Bishop of Hereford in October of 1219. Following on the heels of that appointment, Grosseteste's name crops up twice, once as witness to a charter of Hugh, and once in relationship to a

[20]Southern, *Robert Grosseteste*, pp. 66–67. In n. 7, Southern writes that, "the story as we know it does nothing to support (as is often imagined) the view that he was teaching in Paris during these years;" the parenthetical note is Southern's.

[21]Southern, *Robert Grosseteste*, p. 67.

court case, which took place sometime before August of 1220. As Southern has argued, it seems that Grosseteste became "more active in diocesan administration" immediately after Hugh became bishop.[22] This suggests that Grosseteste did not leave the Hereford region after the death of William de Vere, but continued on in some fashion as an ecclesiastical official, perhaps in Shropshire with Hugh, the duties of which may have taken him to France.

A turning point in Grosseteste's ecclesiastical career came in 1225. In that year, he was granted a benefice: the rectory of Abbotsley. The document recording the benefice also notes that he was in deacons' orders at the time.[23] With this appointment, Grosseteste's ecclesiastical career was on the rise, making his economic status secure. In addition, Abbotsley was only a day's ride from Oxford, thus enabling him to care for his parishioners and still be able to give lectures at Oxford, which we know he was doing by that time.[24] In 1229, he became the archdeacon of Leicester, at which time he was in priestly orders, and had a prebend in Lincoln Cathedral. In 1231, he resigned all benefices except the prebend due to illness.[25] By the 1220s, however, Grosseteste had also become associated with the University of Oxford, and to this relationship we now turn.

2.2. Grosseteste's Association with Oxford

As with the earliest years of Grosseteste's life, his first associations with Oxford are unclear. We saw above that he probably received his early education in England and that he

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[22]Southern, *Robert Grosseteste*, p. 67.

[23]Southern, *Robert Grosseteste*, p. 69; McEvoy, *The Philosophy of Robert Grosseteste*, p. 10.

[24]Southern, *Robert Grosseteste*, p. 70.

[25]McEvoy, *The Philosophy of Robert Grosseteste*, p. 10.

was considered knowledgeable in the liberal arts, at least by Gerald of Wales. It is also likely that he had been a teacher at some level. So it is entirely possible that after the end of 1198, when William de Vere died and Grosseteste lost his patron, he spent some of the next twenty years earning a living through teaching, and some of that at Oxford. We have a few pieces of evidence that he acted occasionally as a diocesan official during this time, but those few events do not preclude the possibility that he was engaged in teaching. The cathedral at Hereford, as we saw in the previous chapter, may have provided a location for him to teach. Oxford, too, is in the same general region. Both could have provided a congenial environment for his teaching, as well as further study, of the liberal arts.

We shall see in the next section of this chapter that Grosseteste's earliest interests lay with the liberal arts and various scientific fields. We also know that the latter achieved prominence at Oxford later in the thirteenth century in large part because of Grosseteste's influence.[26] But because he was so influential in establishing Oxford's reputation in the natural sciences, it is not clear that Oxford had a reputation for them before his presence; with this in mind, it is impossible to sustain the argument that Grosseteste went to Oxford because of his interest in science. In fact, it seems very plausible that Grosseteste's inchoate interests in science would have been fueled by the company he could have found in Hereford, where the study of the natural sciences had been promoted during the previous decades.

An additional factor in the equation is that Grosseteste came to the study of Aristotle's natural philosophy relatively late, perhaps not until the 1220s. Had he been at Oxford in the two prior decades, after such notables as Alexander Nequam and John Blund had been teaching from Aristotle's *libri naturales*, it would be curious that his study of

[26]Recall Weisheipl's claim in "Science in the Thirteenth Century," p. 440, and McEvoy's reinforcement of it in *The Philosophy of Robert Grosseteste*, pp. 18–19

Aristotle was so delayed. Another famous teacher of Aristotle, Edmund of Abingdon, was a personal acquaintance of Grosseteste, but recall that his teaching of Aristotle was in the logical works. Arguments from the negative—in this case, that Grosseteste did not study Aristotle's natural philosophy until later because we lack evidence that he knew of them earlier—are not convincing in themselves. Certainly it is not inconceivable that Grosseteste was teaching the traditional liberal arts at Oxford and was oblivious of the Aristotelian natural philosophy being taught by other masters, but this seems unlikely. Yet even at Hereford there was an appreciation of the Aristotelian works, given the circle of scholars there. Definitive statements about Grosseteste's teaching activity, especially about where it happened, cannot be made until further work is completed, especially on the schools at Hereford at the beginning of the thirteenth century. Nor can we currently answer the question of why Grosseteste did not study Aristotle earlier in his career.

How do we even know that Grosseteste was teaching? Two reasons are especially important. First, many of his early works deal with matters that would have been taught in schools, and some are in fact demonstrably written for teaching. We shall deal with these in more detail in the next section and in the next chapter. The other piece of evidence comes from Grosseteste's appointment as chancellor of Oxford. There is much scholarly controversy over this appointment, with which we shall deal momentarily. It is clear, however, that at sometime after 1214, Grosseteste was appointed to a high-ranking position in the university administration after the legatine ordinance of that year unequivocally established Oxford as a university.

At some point in his career, Grosseteste was appointed to the office of chancellor of the University of Oxford, though he was denied the title of chancellor. The evidence for this comes from a statement made by Oliver Sutton, Bishop of Lincoln from 1280–1299. In 1295, while discussing the appointment of a new chancellor of Oxford, Sutton said,

> blessed Robert formerly bishop of Lincoln [i.e. Grosteste], who filled this office while he was teaching in the aforesaid University, said at the beginning of his term as bishop that his immediate predecessor as Bishop of Lincoln [i.e. Hugh of Wells] did not allow him to be called 'cancellarius,' but only '*magister scholarum*.'[27]

The issue of the title that the bishop was willing to bestow on Grosseteste, "master of the schools" or "chancellor," forms the core of the debate over when he held this office. Recall from the previous chapter that Oxford had been under a *suspendium clericorum* from 1209 to 1214, and that it had ended only with the legatine ordinance that had been negotiated with the dispersed masters. Graham Pollard has argued that the denial of the title of chancellor was a slight against the masters of Oxford, because that they had agreed to return to Oxford in exchange for creating a university on the model of Paris, which included a chancellor as the head of a corporate body. When Grosseteste was denied this title, as the consensus selection of the body of masters, the masters were understandably upset, and perhaps threatened to leave Oxford again. In 1215, Geoffrey de Lucy was confirmed by the bishop of Lincoln as chancellor to appease the masters. While this scenario does not explain why Grosseteste was denied the title, it does account for the short tenure Grosseteste must have held if a new chancellor was appointed in the next year. In addition, it requires that Grosseteste was in 1214 an influential man among the Oxford masters, which in turn suggests that he had been teaching there before 1209, of which we cannot be sure.[28]

McEvoy has suggested one possible answer to why Grosseteste might have been

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[27]Quoted and translated in Pollard, "The Legatine Award," p. 63. The parenthetical notes are Pollard's. Note that McEvoy translates *regebat* in this passage, not as 'teaching' but as 'was regent;' McEvoy, *The Philosophy of Robert Grosseteste*, p. 8. This will be significant when we consider where Grosseteste received his theological education. The occasion of Sutton's statement, according to Pollard, was over the issue of whether the masters or the bishop elected the chancellor.

[28]For a fuller explanation of the legatine award and the controversy over Grosseteste's appointment, see Pollard, "The Legatine Award."

denied the title of chancellor.[29] It was regular practice, though not without exception, that the chancellor of a university should be a priest. In 1214, Grosseteste was not, for in 1225 he was only a deacon. The denial of the title, in that case, would not have been due to any incipient power struggles or a mere oversight on the part of the bishop, but was made due to a concern that Grosseteste's ecclesiastical office was insufficient to merit the greater title.

Southern, on the other hand, has argued that Grosseteste's appointment must have come later.[30] In 1214, he suggested, the legatine award was too fresh in everyone's mind, and there was no reason why the bishop would slight the masters in this way. In addition, Southern believed that Grosseteste was not yet in 1214 a suitable candidate for the office, as he thought that Grosseteste's theological education came later. He suggests that Grosseteste would have made a better choice for the office after he had become an established teacher of theology at Oxford, which was not the case until after 1225.

The resolution of this argument hinges on a controversial topic: when and where Grosseteste received his theological education. Normally, the chancellor would have had to have been a master in theology. If the appointment came early, Grosseteste must have been a master of theology and teaching theology in Oxford in 1214, and so must have received his theological education before 1214. The typical assumption, if one defends the early date, is that, like many other masters at Oxford in 1209, Grosseteste went to the continent to study theology at Paris during the *suspendium clericorum*. McEvoy points out that he demonstrated familiarity with the theological course of study at Paris, and knew a number of theologians whom he would have met at that time.[31] However, as Rodney Thomson pointed

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29MvEvoy, *The Philosophy of Robert Grosseteste*, pp. 8–10.

30See Southern, "From Schools to University," pp. 35–36.

31MvEvoy, *The Philosophy of Robert Grosseteste*, pp. 6–7.

out,[32] there had been strong ties between England and northern France since the eleventh century. While this would have made it easy for Grosseteste to travel to Paris for an education—providing he had the financial wherewithal to do so, which is by no means clear—it also would have increased the likelihood that he would be familiar with practices and masters there without actually attending the university in Paris. Grosseteste's Anglo-Norman background, too, could have contributed to his familiarity with continental practices and personages; McEvoy writes that, "[w]hile there is no documentary evidence that he studied or taught at the university of Paris, there are ample grounds for believing that he was no stranger to France."[33] Finally, as pointed out above, whereas Grosseteste was in France for some time during that period, there is no evidence that places him in Paris.

Grosseteste's study of Aristotle's natural philosophy in the 1220s is an additional factor in knowing when he received his theological education. McEvoy has suggested that Grosseteste was first introduced to the *libri naturales* of Aristotle while in Paris for a theological education. Though public lectures on these texts had been forbidden at Paris since 1210, members of the school of theology could examine them in private.[34] Why Grosseteste would have begun an examination of Aristotle under these circumstances, rather than in the more congenial atmospheres of Hereford or Oxford, is not clear. Southern, on the other hand, wanted to place Grosseteste's theological education and his study of Aristotle's natural philosophy into a period spent at Oxford, presumably after 1214. Oxford had no prohibition on Aristotle, and so his introduction to those works could have come at

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32Thomson, "England and the Twelfth-Century Renaissance."

33McEvoy, *Robert Grosseteste*, p. 74. This comment was made in the context of discussing the national tradition of Grosseteste studies in English, but the comment is also apropos to the question of whether or not he studied at Paris.

34McEvoy, *The Philosophy of Robert Grosseteste*, p. 8.

nearly any time in his career, except during the *suspendium clericorum* (unless he studied them privately while teaching was prohibited at Oxford).

Southern has proposed a rather different account for Grosseteste's theological education, suggesting that he could not have lectured in theology before 1225 because he was only a deacon until that time, not a priest.[35] This would rule out the possibility that Grosseteste could have received a theology degree in Paris in or before 1214. Southern does not clearly state the alternative, but presumably Grosseteste must have received a theological education in England, perhaps at Oxford, perhaps completing it sometime around 1225. But McEvoy has pointed out that the assumption that lecturers in theology must be priests is not a secure one, and indeed that we do not know precisely what being a deacon entailed during the Middle Ages.[36]

McEvoy objects to Southern's compression of Grosseteste's university-based theological activity into such a limited span of time (i.e., circa 1225–1235), suggesting that the voluminous theological writings required more years than Southern makes available to a theologically-educated Grosseteste.[37] But it is plausible that Grosseteste's theological education lasted over a longer period, and that some of the works could date from the period during his education, in other words before 1225, rather than being written only after his theological degree had been granted. Without a reliable income or a wealthy patron, neither of which we are certain Grosseteste had before 1225, it could be that Grosseteste progressed slowly in his theological education, perhaps supplementing his income by

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[35]Southern, *Robert Grosseteste*, p. 70.

[36]McEvoy, *Robert Grosseteste*, pp. 24–25.

[37]McEvoy, *Robert Grosseteste*, pp. 25–26. I do not find this argument especially convincing, as Grosseteste has a reputation for being a constantly busy scholar and ecclesiastic.

teaching in the liberal arts. It is possible that his study of theology stretches back to 1214, or even before (though presumably he did not study it at Oxford during the *suspendium*), and that his lecturing did not occur until his final stages of theological study. It is usually assumed that a theological education was taken in the strict pattern of university regulations, but we cannot preclude the possibility that Grosseteste's need to support himself through teaching and ecclesiastical duties forced him to stretch out his theological training over a number of years.

A final complication regarding Grosseteste's appointment as chancellor comes from Sutton's statement that Grosseteste was teaching at Oxford at the time of the appointment. If he had received his theological degree in Paris during the *suspendium*, he could have been teaching theology at Oxford only for a span of a few months at the most. Of course, he might also have been teaching in the arts prior to the *suspendium*, and we have no reason to state unequivocally that he had not been doing so. This could account for his selection by the masters as their choice for chancellor, but this seems problematic since he could have been in the theology faculty for only a brief time. While it may not have been a necessity to choose the chancellor from among the masters in theology, it seems likely that the leader chosen by the body of masters would have been selected from among the better-established members of the theology faculty, as the preeminent faculty at a university, leaving Grosseteste an unlikely choice in 1214.

So what picture of Grosseteste's life emerges from these considerations? By around 1190, he was calling himself a *magister*. It seems most likely that this simply referred to his having taught, perhaps at nothing grander than a small provincial school. For the next three and a half decades, he sought patronage within ecclesiastical households, apparently achieving some minor success, for his name occasionally appears on charters and in relationship to legal cases. He probably continued to teach and to study during this time, likely at Hereford and perhaps at Oxford. The source of his theological training is still in

question; he could have received it in Paris, and if so probably between 1209 and 1214. If this is the case, his association with Oxford predates 1209, for the *suspendium clericorum* would have compelled him to travel at that time only if he had then been at Oxford. This scenario, however, requires that he had ample patronage to conduct his studies, for which we have no positive evidence. It could be that his association with Oxford was merely as a teacher in the arts, beginning either before 1209 or after 1214, and that he picked up a theological education—or at least finally completed it—as late as the 1220s. A turning point was reached in 1225 when he finally received a benefice near Oxford. His association with the university becomes clear after that point.

I am unconvinced that we can, as yet, have a clear picture of Grosseteste's activity before 1225, and, in fact, we do not know much detail before he became bishop. Certainly he must have been teaching in the arts, at Oxford or elsewhere, well before 1225, and probably by 1190. As we shall see in the next section, and in later chapters, this lack of detail in his biography will make it difficult to establish with certainty the chronology of his scientific writings.

What of the ten years from 1225 to 1235, the time when he is clearly associated with Oxford and before his appointment as bishop? For the first five years, he was an active theological master, delivering sermons and lectures[38] and composing various works on scientific and theological topics. McEvoy believes that he was actively teaching in both theology and the arts during this period.[39] Southern states that "[b]y 1230 he was certainly

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[38]Southern identifies an important manuscript, Durham Cathedral MS A iii 12, for establishing Grosseteste's preaching and theological lecturing activities in the years before 1230; see his *Robert Grosseteste*, pp. 72–73.

[39]James McEvoy, "The Chronology of Robert Grosseteste's Writings on Nature and Natural Philosophy," *Speculum* 58 (1983): 614–655; see especially p. 631.

the most distinguished master of the schools in Oxford."[40]

A significant change in Grosseteste's life took place in 1229 or 1230 when he was asked to be the lecturer to the Franciscans. The Franciscans had arrived at Oxford in 1224, and had begun to hear lectures by secular masters at the university, walking "daily to the schools of theology, however distant, barefoot, in bitter cold and deep mud."[41] In 1229, however, they built their own school, and shortly thereafter invited Grosseteste to be their lecturer, which post he accepted and held until his appointment as bishop in 1235.
A. G. Little believed that Grosseteste's lectures to the Friars encompassed three main topics: the study of the Bible, the study of languages (especially Greek), and mathematics and the physical sciences.[42] Stewart Easton has pointed out that the evidence for Grosseteste lecturing both on languages and on mathematics and the physical sciences is slim.[43] Regarding mathematics and sciences, he points out that the evidence comes from Roger Bacon, who links Grosseteste and Adam Marsh, who was a member of that Franciscan school and a pupil and friend of Grosseteste. To assume that Grosseteste thus lectured on natural philosophy to the Franciscans, Easton argues, is to make too great a leap. But Bacon's claim is consonant with what we know of the interests of both Grosseteste and at least some of the friars—Marsh, for example—who were in Oxford at the time. McEvoy believes that Grosseteste was lecturing on natural philosophy in the secular schools of

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[40]Southern, *Robert Grosseteste*, p. 72.

[41]A. G. Little, "The Franciscan School at Oxford in the Thirteenth Century," *Archivum Franciscanum Historicum* 19 (1926): 803–874; p. 805, quoting Eccleston.

[42]Little, "The Franciscan School," pp. 808–810.

[43]Stewart C. Easton, "The Lectures of Robert Grosseteste to the Franciscans, 1229–35," Appendix A of *Roger Bacon and His Search for a Universal Science*, 206–209, New York: Russel & Russel: 1952 and 1971.

Oxford between 1225 and 1229. Adam Marsh, a pupil and lifelong friend of Grosseteste, was clearly interested in natural philosophy. Thus there was a demonstrable interest in the fields of mathematics and science in the years following Grosseteste's tenure there, and it seems unimaginable that the friars would not have taken advantage of his expertise while it was available.

It is only for the final five to ten years before his appointment to the bishopric of Lincoln that we begin to get a clear picture of Grosseteste's life. At this point, he is probably in his mid- to late-fifties, having devoted his energies to producing scholarly works, teaching in the arts at various schools in the southwest of England, and engaging in the duties of ecclesiastical office. Let us turn now especially to the first of these activities to examine the texts that he composed over this long, productive period of his life.

2.3. Grosseteste's Intellectual Development, Especially Regarding His Scientific Works

In the foregoing sections, we have concentrated on Grosseteste's life and whereabouts, but have largely neglected his vast number of written works that still survive. In this section, we shall rectify this situation. In important ways, his professional activities and his scholarly pursuits cannot be separated. It is impossible to compartmentalize the different aspects of his life. As the reader will discover, however, we must have some notion of his activities in order to place his work in its proper context, and indeed to discover the chronology of his texts. Assumptions about his progress in his own education and teaching will affect our conclusions about when he wrote his various treatises.

It is difficult to summarize Grosseteste's textual output briefly. His bibliographer, S. Harrison Thomson, classified his works using the following categories: translations from the Greek, biblical and philosophical commentaries, philosophical and scientific works, pastoral and devotional works, Anglo-Norman works, and a brief miscellaneous category. This demonstrates the broad range of his interests. We shall concentrate on examining his

scientific and natural philosophical texts,[44] but will also discuss his other writings in order to present a more accurate picture of his life's work. Regarding his astronomical and computistical textbooks, the *De spera* and the *Compotus correctorius*, I shall have much to say in the following two chapters, and so they will be mentioned only briefly here.

Thomson classified Grosseteste's works by subject matter. Because his work was a bibliography of manuscripts and early printed works, his emphasis regarding dates centered on the dates of the manuscripts, not the works themselves. Though he does discuss the date of composition of a few of the texts, he was not trying to establish a chronology of Grosseteste's writings. This required a research project in its own right, to which Thomson's bibliography would certainly prove essential.

Thomson's ground-breaking manuscript research led to various attempts to date Grosseteste's works. One of the most significant works spurring on the project of arranging Grosseteste's scientific and philosophical works chronologically did not itself focus on the chronology *per se*. In his *Robert Grosseteste and the Origins of Experimental Science, 1100–1700*, A. C. Crombie asserted that Grosseteste completed his commentary on Aristotle's *Posterior Analytics* around 1217–1220, before his other scientific texts. He based this on Trivet's assertion that it was written "while a master in the arts,"[45] and that it

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[44]The most important works on the chronology of Grosseteste's scientific writings are S. Harrison Thomson, *The Writings of Robert Grosseteste*; Richard C. Dales, "Robert Grosseteste's Scientific Works," *Isis* 52 (1961): 381–402; McEvoy, "The Chronology of Robert Grosseteste's Writings," which is largely reproduced in Appendix B of McEvoy, *The Philosophy of Robert Grosseteste*, pp. 505–519; and chapter six of Southern, *Robert Grosseteste*, pp. 111–140. Latin editions of most of the scientific works are contained in Ludwig Baur, ed., *Die philosophischen Werke des Robert Grossteste, Bischofs von Lincoln. Beiträge zur Geschichte der Philosophie des Mittelalters*, Band 9. Münster: Aschendorffsche Verlagsbuchhandlung, 1912.

[45]Qui, cum esset magister in artibus, super librum Posteriorum compendiose scriptsit. Crombie, *Robert Grosseteste*, p. 46, n. 1, citing Callus, "The Oxford Career of Robert Grosseteste," who quotes Trivet. According to contemporary assumptions about Grosseteste's career, this would place it before 1209. But as we have seen in the preceding section, Grosseteste was probably lecturing in the arts, even if not at Oxford, as early as 1200, and that he might have still been a master in the arts for some years after teaching

contains zoological information from Michael Scot's translation of *De animalibus*, which was translated no earlier than 1217. The dating of this work was vital to Crombie's larger project, namely, to establish that Grosseteste was the seminal figure in the adoption of a new method of science that relied heavily on observation and experimentation.[46] As evidence for this thesis, Crombie demonstrated the ways in which Grosseteste's scientific works relied upon the methods that he espoused in the commentary on the *Posterior Analytics*.

Richard Dales responded to Crombie's work with an article in which he both questioned the assumption that the commentary on the *Posterior Analytics* was one of Grosseteste's earlier works, and sought to establish relationships among the scientific works themselves.[47] This latter methodological technique would prove invaluable for later attempts to create a chronology of Grosseteste's works.

Dales did not try to establish a complete chronology of Grosseteste's scientific works, but discussed only a select few among which he could establish relationships in terms of subject matter.[48] He also made two assumptions: that Grosseteste's "career as a scientist" extended from 1220 to 1235, and that a few works could be dated with "relative certainty," namely, *De generatione stellarum* to about 1220, and *De lineis, angulis et figuris* and *De natura locorum* to about 1231. Dales then divided Grosseteste's career into

resumed at Oxford in 1214.

[46]Crombie's grand thesis, which places the origins of experimental science in the thirteenth century, has been convincingly challenged. See, for example, Bruce Eastwood, "Grosseteste's 'Quantitative' Law of Refraction: A Chapter in the History of Non-Experimental Science." *Journal of the History of Ideas* 28 (1967): 403–414, and "Mediaeval Empiricism: The Case of Grosseteste's Optics." *Speculum* 43 (1968): 306–321. A new attempt to establish the vital role that the medieval period played in the later development of modern science can be found in Edward Grant, *The Foundations of Modern Science in the Middle Ages*, Cambridge: Cambridge University Press, 1996.

[47]Dales, "Robert Grosseteste's Scientific Works."

[48]He explicitly stated that he would not attempt to date the *De spera* or other astronomical (and presumably computistical) works. Dales, "Robert Grosseteste's Scientific Works," p. 381, n. 2.

early, middle and late periods. Two works belong to the early period. He characterized them as less sophisticated than later works. *De generatione stellarum*, Dales notes, is "loose in structure and…indefinite in purpose,"[49] covering various topics regarding the composition and appearance of stars. It presents arguments from Aristotle that there are degrees of transparency, which Dales notes will be taken for granted in some of Grosseteste's later works. The *De generatione sonorum* discusses the generation of sound only briefly before it departs into the main topic of the treatise: phonetics, the creation of sounds by the mouth to produce words. The discussion of sound is similar to treatments he gives elsewhere, including in the *Posterior Analytics*. Dales is convinced, however, that the treatment in *De generatione sonorum* predates the developed commentary on the *Posterior Analytics* because the former is more complete and systematic, presumably allowing him merely to summarize the topic in the later commentary

Dales's middle period for Grosseteste's interest in scientific matters stretched from about 1223 to about 1230. He characterized the works of this period as more methodologically precise, and as relying less heavily on mathematics and the subordination of sciences than works from his later period. They also share a common theme of the effects of heavenly bodies on terrestrial ones. In terms of their methodological approaches, Dales's analysis was heavily influenced by Crombie's treatment, seen especially in Dales's discussion of the extent to which Grosseteste used methods of experimental verification and falsification, clearly a concern arising from Crombie's analysis of these categories. This 'experimental' approach is probably better described as an 'experiential' approach, because Grosseteste's 'experiments' do not contain the precision or control that the term 'experiment' implies in modern English. Instead, Grosseteste uses common experiences to demonstrate his points. For example, in the *De impressionibus elementorum*, which Dales

[49]Dales, "Robert Grosseteste's Scientific Works," p. 383.

placed in this period, the observation that it is colder high in the mountains than in valleys is used to prove that it is the rays of the sun, rather than the body of the sun, that cause heat. Each treatise from this period also shares the common feature that Grosseteste debunks older theories—i. e., engages in falsification, again a theme from Crombie—regarding their respective subject matter before presenting his own theory.

Dales placed three works into the middle period: *De impressionibus elementorum*, *De accessione et recessione maris*, and *De cometis et causis ipsarum*. The first shows how the celestial bodies, mainly the sun, affect the terrestrial elements, especially how heat from the celestial region affects precipitation in its various forms. Dales dates this work early because it lacks understanding of some of the optical principles that Grosseteste will utilize in later works. In *De accessione et recessione maris*, Grosseteste discusses the tides. He makes use of al-Bitruji's theory of the tides, showing his use of Arabic authors. Again his optical assumptions allow Dales to place it between *De impressionibus elementorum* and the optical works of the late period. Finally, in *De cometis et causis ipsarum*, Grosseteste discusses comets—their origin, place and nature—and ends with a brief astrological discussion, "the way in which planets affect men and earthly things and permit some men to 'sense complete what is yet inchoate.'"[50] Finally, Dales argued that the commentary on the *Posterior Analytics* belongs to the end of this period, after the aforementioned works, but before the works of the next period.

Dales's final period ranged from 1231 to 1235, a period when Grosseteste was completely involved with teaching the Franciscans. This period Dales characterized by an emphasis on mathematics and optics.[51] *De lineis, angulis et figuris*, an early work of

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[50]Dales's description; see "Robert Grosseteste's Scientific Works," p. 394.

[51]This certainly is consonant with Roger Bacon's appreciation of Grosseteste's emphasis on mathematics. If Grosseteste's use of mathematics in his scientific works reaches its fullest potential with

Dales's late period, "stresses the importance of mathematics in understanding the world of nature,"[52] but in large part this is the mathematics of geometry, not the arithmetic that characterizes later scientific methodology. That is, much of his discussion, say of heat in mountains and valleys, remains qualitative, though geometry is used to characterize the relationship of places. Three other works belong to this period: *De colore*, *De calore solis* and *De iride*. They cover the topics of, respectively, color in light, the heat generated by the sun and the rainbow. The first and last may be closely related, the latter assuming the former.

Dales's important work laid the foundation upon which James McEvoy expanded the discussion of Grosseteste's scientific works in his 1983 article.[53] He included a number of works Dales had not included, but treated the works not strictly chronologically, but also topically. Not only did he disagree with some aspects of Dales's chronology, though at the same time preserving much of it, he discussed a broader range of Grosseteste's interests.

McEvoy broadened the chronological treatment of Grosseteste's works, and placed two of them in his earliest period of activity, before 1209 when the Oxford masters dispersed. The first of these is *De artibus liberalibus*, a treatise in which Grosseteste discusses the seven liberal arts. The work must be among Grosseteste's earliest, for it lacks any awareness of Aristotle or Arabic science. Regarding astronomy, it repeats the typical Augustinian assertions of astronomy's usefulness to medicine and agriculture, and links it closely with astrology. We shall discuss this treatise again in the next chapter. The *De generatione sonorum*, a treatise discussed by Dales, has close affinities to the *De artibus liberalibus*, leading McEvoy to argue that it belongs to the same general period, but

the Franciscans, it would come as no surprise that Bacon would appreciate this aspect of Grosseteste's work.

[52]Dales's description; see "Robert Grosseteste's Scientific Works," p. 394.

[53]McEvoy, "The Chronology."

probably postdates the *De artibus liberalibus*.

After discussing these early works, McEvoy turned to Grosseteste's astronomical works. Of special interest here is the manuscript Oxford MS Bodl., Savile 21, a manuscript with a number of treatises copied in Grosseteste's own hand.[54] Among these are mathematical treatises by Jordanus and Gerbert, astronomical works by Thebit, astronomical tables, and a treatise on eclipses. The manuscript has been dated to 1215–1216, but the reasons for doing so are suspect.[55] Thomson notes that these dates coincide with the period following the Oxford dispersion. Had Grosseteste gone to Paris for a theological degree and returned to Oxford as a theological master, it would be curious that his interest would have been so focussed on complex mathematical and astronomical subjects immediately after his return.

While I will leave discussion of Grosseteste's *De spera* and his computistical works for later chapters, it is worth noting McEvoy's comments regarding two other astronomical works. Grosseteste wrote an astrological treatise, which may have been intended for teaching, entitled *De impressionibus aeris*, also known as *De prognosticatione*. In the treatise, Grosseteste calculates what the weather will be on 15 April 1249.[56] Grosseteste cites only Ptolemy and Theodosius, but no Arabic authors.[57] Some

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[54]The manuscript is described fully in Thomson, *Writings*, pp. 30–33.

[55]The date seems to come from a horoscope in the manuscript, but there is no reason that the horoscope needs to be for a date contemporary with the creation of the text. I shall discuss this manuscript in more detail in the following chapters.

[56]As McEvoy points out, there is no reason to date the treatise to that year, though others have done so; see McEvoy, "Chronology," p. 621. Of course, since the point of the treatise, and of astrology, is to predict the future, there is no reason that the 1249 date in the text implies proximity to that date for its composition.

[57]Though he does refer to Arabic years, and hence to the tables derived from Arabic sources. See the fourth chapter of this dissertation for more details.

references to the tides show that he had not yet developed the theory found in *De accessione et recessione maris*, both of which suggest an early date. McEvoy suggested 1215–1220 as a *terminus ante quem*, but I am not convinced that its composition need be so late. Given that he does not make use of Arabic astronomical resources, at least some of which he had by 1215, and given his stance on astrology demonstrated in the *De artibus liberalibus*, the work could be quite early, perhaps even dating to his period of association with Hereford, where astrology was an active interest among other scholars. I shall discuss the contents of this work in more detail in the next chapter.

The final astronomical work covered by McEvoy is the *De generatione stellarum*, already mentioned above, in which Grosseteste discusses the composition of stars, including discussion of alchemical theories. It is of note that Grosseteste uses Aristotelian ideas in this work, yet seems to lack the deep understanding of Aristotle that he will later develop. He also cites at least one Arabic author in this work, Abu Ma-shar. Both these facts suggest a slightly later date for the treatise, though it is unclear how late it need be. Both Aristotle and Abu Ma-shar were known among Hereford scholars, and so Grosseteste could have found resources there, again suggesting the plausibility of a very early date.

The next section of McEvoy's article dealt with the treatises of Grosseteste on the sublunary world, and largely overlapped Dales's middle and late periods. For the most part, McEvoy agreed with Dales's dates, give or take one to two years, thus reinforcing the picture that Grosseteste developed a more sophisticated understanding of Aristotle and a more developed sense of the importance of mathematics over the period stretching from the early 1220s to the mid-1230s. To that same period belong Grosseteste's other Aristotelian works, including his important commentaries on the *Posterior Analytics* and the *Physica*.

The commentary on the *Posterior Analytics*, McEvoy notes, predates Grosseteste's

study of the Greek language.[58] It does demonstrate, however, wide-ranging reading in Aristotelian works, including the *Physica*, *Metaphysica*, and the *Meterologica*, and it shows overlaps with various of his optical treatises, as Dales had already shown. But McEvoy also discussed portions of the commentary that do not focus on natural philosophy or scientific methodology. He noted that the psychological theories of the work show influences of a theological nature.[59] McEvoy dated the commentary to 1228–1230, which is consonant with the idea that Grosseteste developed a stronger interest in theology during this later period, rather than during the period of the *suspendium clericorum*. This also allows us to account for Trivet's assertion, mentioned earlier, that the commentary was written while Grosseteste was teaching in the arts. If, during the mid-1220s, Grosseteste was studying theology and teaching the arts at Oxford, he could accurately be described as a master in the arts while at the same time he would have had occasion to increase his knowledge of Aristotle, develop a commentary on a work vital to the teaching of logic, and at the same time be developing more concerted theological interests.

McEvoy also assigned Grosseteste's significant treatise *De luce* to this period. With this work, in the tradition of the 'metaphysics of light,' Grosseteste offered a cosmology based on the propagation of light.[60] Also a theological work, it places the origins of all

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[58]McEvoy, "Chronology," p. 637.

[59]McEvoy, "Chronology," p. 641.

[60]McEvoy summarizes the *De luce* more fully in *The Philosophy of Robert Grosseteste*, pp. 151ff. He describes the text as "one of the few scientific cosmologies, and perhaps the only scientific cosmogony, written between the *Timaeus* and early modern time," p. 151. See also his description in *Robert Grosseteste*, pp. 88ff. A translation and brief introduction is contained in *On Light*, translated by Clare C. Riedl, Milwaukee: Marquette University Press, 1942. For further analysis of Grosseteste's project in *De luce*, see Andreas Speer, "Physics or Metaphysics? Some Remarks on Theory of Science and Light in Robert Grosseteste," in *Aristotle in Britain in the Middle Ages*, edited by Jon Marendon, 73–90, Turnhout, Belgium: Brepols, 1996.

created things with God's creation of a single point of light from which all else issued. Clearly at this point Grosseteste was dealing with theological ideas at the same time as he was writing major scientific works, showing that his interests defy any neat division between science and theology. In fact, his later optical works must have been motivated by his desire to understand better the implications of his metaphysics of light, and thus cannot be considered purely 'scientific' works in the modern sense as they offer an additional goal beyond understanding the physical world: they also lead one to a better understanding of God's activity in creation.

Around the same time, Grosseteste began, but never fully finished, another commentary on a major Aristotelian work, the *Physica*. It was apparently written over the course of a number of years, and perhaps never reached the final form at which Grosseteste was ultimately aiming.[61] In any event, he probably began it around 1228, and left off around 1232. During this same period, McEvoy noted, Grosseteste was producing smaller treatises, which made use of his study of the *Physica*. McEvoy discussed four treatises: *De finitate motus et temporibus*, refuting the doctrine of the eternity of the world, *De differentiis localibus*, on the problem of defining place, and *De motu supercaelestium* and *De motu corporali et luce*, both on problems of motion.

I have included below a table allowing the reader to compare Dales's and McEvoy's chronologies.

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[61]Dales believes it is a 'rough draft' of an organized work, while Callus believes it to be less-organized, more a series of glosses. See Dales, "Robert Grosseteste's *Commentarius in octo libros physicorum Aristotelis*," *Medievalia et Humanistica* 11 (1957): 10–33, especially pp. 13–15. For the Latin text of the commentary, see Robert Grosseteste, *Commentarius in VIII Libros Physicorum Aristotelis*, edited by Richard C. Dales, Boulder: University of Colorado Press, 1963.

TABLE 1

ROBERT GROSSETESTE'S SCIENTIFIC WRITINGS, C. 1209–1235,

ACCORDING TO DALES'S AND MCEVOY'S CHRONOLOGIES[62]

Dates	Dales's Chronology	Dates	McEvoy's Chronology
		1209 or earlier	*De artibus liberalibus* *De generatione sonorum*
		1215–1220	*De impressionibus aeris*
		1217/20 –1225	*De generatione stellarum*
1220	*De generatione stellarum*		
1221–1222	*De generatione sonorum*		
		1222–1224	*De cometis et causis ipsarum* (a. k. a. *De cometis*)
1224	*De impressionibus elementorum*		
		before 1225	*De impressionibus elementorum*
		1225–1228	*De luce*
1226–1228	*De accessione et recessione maris*	1226–1228	*De accessione et recessione maris* (a. k. a. *De fluxu et refluxu maris*)
1226–1230	*De cometis et causis ipsarum*		
1227–1229	Commentary on the *Posterior Analytics*		
		1228–1230	Commentary on the *Posterior Analytics*
1228–1232	Commentary on the *Physics*	1228–1232	Commentary on the *Physics*
		1230	*De differentiis localibus* *De motu supercaelestium* *De motu corporali et luce*

[62]Dales's chronology is found in "Robert Grosseteste's Scientific Works," p. 402. McEvoy's chronology is found in "Chronology," p. 655. The table above does not include McEvoy's dates for the *De spera* and computistical works, as they will be the subject of later analysis.

TABLE 1 (contd.)

Dates	Dales's Chronology	Dates	McEvoy's Chronology
		1230–1233	*De lineis, angulis et figuris* *De natura locorum* *De iride* *De colore* *De calore solis* *De operationibus solis*
1231	*De lineis, angulis et figuris* *De natura locorum*		
1232–1235	*De colore* *De calore solis* *De iride*		
		1235	*De finitate motus et temporibus*

Richard Southern, too, has written on the question of dating Grosseteste's scientific works. His strongest objection to McEvoy's chronology, which he nonetheless respects, is that it places nearly all of the scientific works into a period that is too compressed, namely from 1220–1235.[63] Southern's main objection to this is that, in his version of Grosseteste's biography, that period was more fully devoted to Grosseteste's theological training. For example, Southern suggests that the *De cometis*, lacking certain Aristotelian discussions of comets, could belong to the late 1190s, when a comet was reported in chronicles from regions near Hereford.[64] Southern also wants to date the commentary on the *Posterior Analytics* earlier, to sometime before 1225.

[63] Southern, *Robert Grosseteste*, p. 122.

[64] Southern, *Robert Grosseteste*, p. 126.

Southern's basis for moving the dates of some of these works is his belief that, from 1225 to 1230, Grosseteste was engaged in writing a commentary on the *Psalms*.[65] This commentary, he believes, demonstrates not only Grosseteste's progression to greater theological acuity, but also his engagement with theological teaching—and thus a corresponding neglect of scientific concerns—during these years. The commentary on *Psalms*, Southern posits, shows a marked evolution in theological thought, from incomplete comments focussing on natural objects mentioned in the *Psalms* (thereby showing Grosseteste's continued interest in secular studies) to fully integrated commentary covering the complete verses, demonstrating increasing comprehension of Greek through his use of Greek authors. He also places in these years two theological-philosophical treatises, *De veritate* and *De libero arbitrio*,[66] which he believes demonstrate a move from secular to theological studies.

Southern's thesis, however, suffers from too sharp a dichotomy between science and theology. His basic assumption that, once he moved on to study theology, Grosseteste's scientific interests fell by the wayside is untenable. While this may be evident in the commentary on the Psalms, I see no reason to assume that it is valid for his work in general. Many of his scientific works show theological interests, which is not surprising for a scholar who had long been involved with ecclesiastical business. Grosseteste's biography clearly shows a multi-dimensional mind, through his pursuit of both scientific study and an ecclesiastical career. So while I believe Southern is correct regarding Grosseteste's theological training—that it took place at Oxford after the *suspendium clericorum*—I am also convinced that Grosseteste continued to work on scientific topics during and after the

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65Southern, *Robert Grosseteste*, pp. 112ff.

66McEvoy presents summaries of *De veritate* in *The Philosophy of Robert Grosseteste*, pp. 320ff, and of *De libero arbitrio* in *Robert Grosseteste*, pp. 110ff.

period when he received his theological education.

So far we have focussed mainly on Grosseteste's scientific and natural philosophical writings, but he also produced a large number of theological works. In addition to the commentary on the Psalms, he wrote a full commentary on the letter to the Galatians and a commentary on the majority of the letter to the Romans. Scraps of comments on other Pauline works also survive. No comments or lectures on the gospels remain, which is a curious omission for such a prominent and active theological master; either he never had occasion to prepare lectures on them, or they simply have not survived or been identified. He also wrote treatises on the Old Testament, including *De cessatione legalium,* on a prophecy of Christ's passion, and *De decem mandatis*, on the Ten Commandments. His most impressive work of biblical scholarship is his *Hexameron*, a thorough commentary on the creation narrative.[67]

Grosseteste also produced, in addition to strictly biblical works, other theological and pastoral works. Thomson lists thirty-two works in the pastoral and devotional category of Grosseteste's writings.[68] Some of them have already been mentioned, such as *De cessatione legalium* and *De decem mandatis*. Examining the whole list, we can see that Grosseteste wrote on a number of issues, from confession and the Eucharist to pastoral care. The popularity of one of his theological works, the *Templum Domini* or *Templum Dei*, also known as *De articulis fidei*, is demonstrated by the fact that it is extant in over forty manuscripts.

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[67]For the last item, see *Hexaëmeron*, in *Auctores Britannici Medii Aevi* VI, Latin text edition by Richard C. Dales and Servus Gieben, Oxford: Oxford University Press, 1982. A translation by C. F. J. Martin has been published as *Robert Grosseteste: On the Six Days of Creation*, in *Auctores Britannici Medii Aevi* VI (2), Oxford: Oxford University Press, 1996. The biblical works are also summarized in McEvoy, *Robert Grosseteste*, pp. 96ff.

[68]Thomson, *Writings*, pp. x-xi.

Grosseteste's theological and pastoral writings were heavily informed by his reading of the Church Fathers. He even worked out a system of unique symbols, in essence a topical concordance, allowing him the means to index the works he read. He created a symbol for each topic he wanted to index, sorted them into different categories, and then created a list of the symbols, each with references to passages dealing with the topic. The passages come from both Church Fathers and secular authors. This *Concordantia patrum*, as Thomson labelled it,[69] demonstrates Grosseteste's wide reading of numerous authors, including Ambrose, Augustine, Basil, Bede, Boethius, Cicero, Gregory, Jerome, John Chrysostom, Psuedo-Dionysius, Seneca, and many more.[70] To get a sense of the amount of labor Grosseteste put into this project, consider the following numbers: he selected 197 subjects (and their corresponding symbols, which are inventions of Grosseteste, not a system already in place) with over 6,000 references. Augustine tops the list with approximately 3,000 references, while the next most abundant references are to Gregory with 1,257, Jerome with 488, and Seneca with 333.

Despite the fact that Grosseteste was reading Latin translations of Greek scientific works, it was apparently his interest in theology, and particularly in understanding the Scripture, that prompted him to engage in yet another major scholarly project: learning Greek.[71] This would have been a difficult task in his day, as he did not have the apparatus commonly used to learn a language, such as grammars and dictionaries, readily available to

[69] For more on the *Concordantia patrum*, see S. Harrison Thomson, "Grosseteste's Topical Concordance of the Bible and the Fathers," *Speculum* 9 (1934): 139–144, and "Grosseteste's Concordantial Signs," *Medievalia et Humanistica* 9 (1955): 39–53.

[70] Southern includes a list of authors, including the number of references to each, in *Robert Grosseteste*, p. 195.

[71] See McEvoy, *Robert Grosseteste*, pp. 113ff.

him. The most probable source of such aids was John of Basingstoke, who had seen service with the Church in Athens, and himself knew Greek. Grosseteste, soon after becoming a bishop, appointed this same John to the archdeaconry of Leicester, suggesting that he was acquainted with John before that time. Grosseteste's episcopal household included Nicholas Graecus, who doubtless assisted him in his Greek translations, which continued into his episcopacy. Grosseteste did somewhere find written aids for his translation work, employing the *Suda Lexicon* and the *Etymologicum Gudianum*,[72] and perhaps a bilingual dictionary created by John of Basingstoke.

The precise date when Grosseteste first began his translating activity is not known. It has been placed during his period with the Franciscans, while McEvoy suggests it could have been earlier due to the prodigious amount of work he subsequently performed. In any event, he did produce a large number of translations. He translated the *Testament of the Twelve Patriarchs*, five works of John Damascene, the full corpus of Psuedo-Dionysius—which includes *On the Celestial Hierarchy, On the Ecclesiastical Hierarchy*, *On the Divine Names*, and *On Mystical Theology*—and commentaries on each of those four works, the letters of St. Ignatius, and the *Nichomachean Ethics*, also with a commentary. These works alone could be the production of a lifetime, but merely account for one of the many avenues of scholarship that Grosseteste pursued.

Grosseteste also produced a handful of works in the vernacular, Anglo-Norman tongue.[73] These include a *Confession*, discussing the seven deadly sins, a *Rule*, outlining the proper forms of conduct for his household, a couple of short prayers, and a long poem with the modern title *Chasteau d'Amour*, which is an allegorical salvation history. The dating of

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[72]McEvoy describes these works in *Robert Grosseteste*, pp. 115–116.

[73]See McEvoy, *Robert Grosseteste*, pp. 146ff.

these works has not received a great deal of attention.

The preceding section has not covered every written work of Grosseteste's life, and it has perhaps over-represented the scientific works because of the focus of this dissertation. I have also not attempted to establish dates for all of the works, but have presented the arguments of previous authors so that the reader may understand the major issue surrounding the dating of the works, namely, the impact of our lack of a secure biography for Grosseteste's early life. My own conclusions regarding the dating of Grosseteste's works is that previous attempts to establish a chronology have relied too heavily on strict delimitations of Grosseteste's interests and career: that he handled exclusively secular topics until he switched to theological ones, that he produced the vast majority of his works after the *suspendium clericorum* and his supposed education in Paris, that his interest in Aristotle must have arisen after about 1220, and so forth. Theories of his biography and the chronology of his writing will necessarily influence each other, and questions still remain for any of the proposed biographies.

My inclination is to push his interests in scientific matters to an earlier date, beginning in the last one or two decades of the twelfth century. The Savile manuscript in which Grosseteste copied mathematical and astronomical texts, some of them Latin translations of Arabic authors, even if it does date from 1215, need not imply that his use of mathematics and Arab science must postdate that time. The significance of this text and the implications of its date will become apparent in the next two chapters. Of greater controversy are the questions of when he received his theological education and when he began seriously to study Aristotle. I believe that the two periods in fact overlap, and both take place at Oxford after 1214 and the resumption of teaching there. His theological training, I contend, need not have occurred in the strict two to three year pattern that university education eventually took. Rather, Grosseteste, an active scholar and teacher of the arts, possessing some duties in an ecclesiastical household, may have gradually achieved

his theological training over the course of many years, eventually attaining a mastership, after which he could lecture and write authoritatively in theology. At the same time, however, his interests in science, and especially in Aristotle, did not wane, and he continued to produce works on scientific matters that overlapped with his theological interests. Eventually, his accomplishments earned him benefices and a secure livelihood, while circumstances later brought him into the Franciscan circle at Oxford. His theological work led him to pursue a study of the Greek language relatively late in life, which in turn led him to produce a number of translations, some of them during his time as bishop of Lincoln.

The reader by now has a feeling for the broad range of Grosseteste's interest and scholarly production, but also for the insecure state of scholarship regarding the chronology of his writings. We are on much more secure foundations when it comes to the final period of his life, his episcopacy, for which our documentation is more complete.

2.4. Grosseteste's Later Life as a Bishop

Grosseteste's career as a teacher ended in 1235 when he was elected to the bishopric of Lincoln. By Matthew Paris's account, Grosseteste was a compromise candidate, though he was elected unanimously.[74] When the former bishop, Hugh of Wells, died, there was controversy over who should be elected, though Matthew does not explain the source of it. Even though Grosseteste was tightly connected to the Franciscans—indeed, Matthew wrote that "it was being said that he was bound to the Franciscans"[75]—the canons agreed to elect Grosseteste. Matthew also does not explain why Grosseteste was considered an acceptable candidate. Certainly his reputation as a theologian and preacher

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[74]See Matthew Paris's account of Grosseteste's election in MvEvoy, *The Philosophy of Robert Grosseteste*, p. 11; and McEvoy, *Robert Grosseteste*, pp. 29–30.

[75]See MvEvoy, *The Philosophy of Robert Grosseteste*, p. 11; and McEvoy, *Robert Grosseteste*, p. 30, quoting from Matthew Paris's *Historia anglorum*.

must have helped. But he was an odd choice in another way, namely, that in 1231 he had resigned nearly all his benefices, including his archdeaconry, due to illness, retaining only a prebend in Lincoln Cathedral. For the last few years before his election, he had been exclusively an academic among the mendicants, an unlikely choice to lead one of the largest dioceses in England. On the one hand, this demonstrated his commitment to the offices: unable to fulfill his duties, he resigned the offices so that others could carry them out. On the other hand, his abandonment of offices and his withdrawal into the Franciscan community at Oxford might have signalled to some an apparent retreat from ecclesiastical aspirations.

It may be that the canons expected to gain a bishop who would not present problems, which is often why a compromise candidate is chosen. Indeed, he may have initially seemed to be a bishop who would not upset matters. Apparently the monks of Canterbury became upset over the issue of Grosseteste's place of consecration, desiring that he be consecrated at Canterbury. According to Southern, this episode was part of a long-standing power struggle between the monks and the archbishop. The monks claimed they wanted to maintain Canterbury as the traditional site where consecrations should take place, while the archbishop argued from the inconvenience of travelling to Canterbury when any cathedral was a legal place for a consecration.[76] In a letter filled with biblical passages,[77] Grosseteste wrote to Archbishop Edmund, his old colleague and friend from Oxford who would be performing the consecration, and willingly submitted to the monks' desire in an effort to maintain harmony.[78] This episode may have reassured the canons that their

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[76]See Southern, *Robert Grosseteste*, pp. 250ff.

[77]*Epistolae*, Letter XII, pp. 54–56.

[78]As it turned out, Edmund decided that the consecration would take place in Reading, a place between Lincoln and Canterbury; Southern, *Robert Grosseteste*, p. 252. See McEvoy, *Robert*

compromise candidate was indeed a good choice: an educated theologian, with pastoral concerns, who would not make waves. If this is indeed what they expected, they were soon disappointed.

Grosseteste's tenure as the bishop of Lincoln was not one characterized by compromise. Indeed, it might better be described as one of recurring conflict. He was no meek ecclesiastic, ready to follow the dictates of his flock, but rather an active leader, filled with the desire to meet the pastoral demands that he thought the office required. McEvoy writes that, "[t]he central motif of his episcopate was the personal responsibility of the bishop for the pastoral care of every soul in his diocese."[79] On numerous occasions, this would lead to conflict with all levels of ecclesiastical and secular officials, from monks and barons in England to the papacy itself.

Above all else, Grosseteste was an extremely active bishop. As noted in the previous section, his scholarship was not abandoned when he took office; for example, his ability to maintain scholars within his household aided his study of Greek. He preached frequently, as attested by his surviving sermons. He conducted regular visitations throughout his diocese, which must have been quite time-consuming, given its size. And he actively corresponded with a number of individuals on a variety of topics.[80] His wide range of activity, as well as his confidence in his own theological positions, inevitably brought him into conflict on a number of issues.

Within only a few weeks of his consecration, Grosseteste became embroiled in a

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Grosseteste, p. 33 for a slightly different version of the disagreement between the archbishop and the monks.

79McEvoy, *Robert Grosseteste*, p. 30.

80*Epistolae* reproduces 131 letters; see Luard's preface, pp. xcvi-xcviii on their manuscript sources. Luard also includes a table of contents, with a short description of the contents of each letter, as well as its date where available, on pp. xcix-cxxxi. See also Thomson, *Writings*, pp. 192–213 for more on Grosseteste's letters.

dispute over bastardy.[81] In thirteenth-century England, only children born in wedlock could be legitimate heirs. In 1234, the issue had come under review in England as a result of a new canon law code promulgated by Pope Gregory IX, in which it was asserted that children born out of wedlock (but not as a result of adultery) should be considered legitimate if their parents subsequently married. The king, barons, and bishops had agreed in 1234 that only the issue of legitimacy was at stake, and that the rule on succession would remain the same, namely, that children born out of wedlock would not be in a position to inherit their parents' estates. In other words, English secular and ecclesiastical officials had agreed to maintain the status quo. The means by which the status quo would be maintained, however, was the ecclesiastical court, which had to agree to this interpretation of legitimacy and succession.

Grosseteste, as it turned out, would not submit to the agreement. In a lengthy letter to William of Raleigh,[82] Grosseteste challenged the traditional English position as, in the words of Richard Southern,

> being contrary to divine law, contrary to nature and natural law, contrary to reason, as well as being contrary to canon law, to old English custom, and the theory of the relations between secular and spiritual authority.[83]

The letter is extremely detailed and closely argued, demonstrating Grosseteste's commitment to deep theological consideration of issues of import, as well as his willingness to spend the time to grapple with complex issues. Raleigh did not take Grosseteste's letter very seriously, but the bishops did, and they switched their position to support Grosseteste. The barons, however, sidestepped the issue to avoid ecclesiastical entanglement, thereby nullifying Grosseteste's efforts to change what he considered to be a violation of divinely

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[81]See Southern, *Robert Grosseteste*, pp. 252ff.

[82]*Epistolae*, Letter XXIII, pp. 76–94.

[83]Southern, Southern, *Robert Grosseteste*, pp. 254–255.

established relationships. While he had not tried to placate the barons, as he had done in the case of the monks of Canterbury, the end result was much the same. His rejection of his proposal left him in a position of making no lasting change.

Grosseteste's episcopacy was also famous—or perhaps infamous, at least to some of his charges—for his visitations. Almost immediately upon taking office, Grosseteste set out to visit all parts of his diocese, especially the religious houses and the archdeaconries. Of the former there were dozens, of the latter eight, which together included nearly two thousand parishes.[84] On these visitations, Grosseteste brought with him a sizeable number of assistants, many of them from the mendicant orders, to help him preach and hear confessions. He also used this time "enquiring into things which needed correction or reform."[85] The results of the final activity were often instructions to archdeacons for the imposition of proper Christian behavior among parishioners,[86] as well as the dismissal of numerous heads of religious houses.[87]

Many complaints were made regarding his visitations, from outcries on the local level that what he was doing was unprecedented to official appeals to the papal court regarding many of his decisions. More of Grosseteste's time was taken up with his own counter-appeals, most of which were upheld. Again we can see that conflict was the order of the day, but that in these cases his positions were upheld, at least on the official level. Apart

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84On the size of the diocese, see Southern, *Robert Grosseteste*, pp. 235–236. He also notes that Grosseteste's diocese made up about one-fifth of the population of England, p. 237.

85Quoted by Southern, *Robert Grosseteste*, pp. 258.

86For example, see *Epistolae*, Letter XXII, pp. 72–76, in which he forbids a number of activities which he found practiced in his diocese.

87On the dismissal of heads of religious houses, see Southern, *Robert Grosseteste*, p. 260, especially n. 26.

from the appointment and dismissal of ecclesiastical officials, however, it is difficult, if not impossible, to determine if his disciplinary directives were followed on the local level. Nonetheless, the records left to us demonstrate his heartfelt concern for the souls within his diocese.

Grosseteste was not afraid to try to impose his will on secular officials, at least where their functions overlapped with his ecclesiastical purview. Especially troubling to him were persons who held religious benefices while engaged in secular government.[88] Working through the papal court to receive license to deal with such matters, Grosseteste did his best to expunge his diocese of such persons. One example was Robert Passelewe, who administered a portion of the royal forest, and on whom the king wished to have an ecclesiastical benefice bestowed. Grosseteste stood firm to block his appointment to ecclesiastical office, which, as bishop, he was certainly able to do. Apparently the matter was resolved amicably, and Grosseteste maintained a positive relationship with the king. Regarding the appointment, he had been supported by the papal court, because it was clear that the bishop had command over the ecclesiastical appointments made by secular officials in his diocese. The issue of appointments within the diocese of Lincoln, however, did not cease with those of the king. Grosseteste later had difficulties with an appointment made by the pope, but we shall leave that episode for a little later.

Grosseteste did not forget Oxford when he became bishop. In fact, he could not have, given that the legatine ordinance of 1214 placed the University of Oxford under the authority of the bishop of Lincoln. Grosseteste, however, found occasion to offer unsolicited advice to the theological masters of Oxford through a letter written in 1245 or

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[88]Southern, *Robert Grosseteste*, pp. 265ff.

1246.[89] It seems that the masters at Oxford had begun to copy a practice of Paris masters by delivering ordinary lectures on Peter Lombard's *Sentences*. The real controversy was over the issue of the type of lectures in which the *Sentences* was covered. The older practice, with which Grosseteste was no doubt intimately familiar, was for ordinary lectures, delivered in the morning, to be reserved for the exegesis of scripture. Richard Fishacre, a prominent master at Oxford, proposed dividing morning lectures between scripture and the *Sentences*, as two separate dimensions of theological training. In his letter, Grosseteste exhorted the masters to restrict their ordinary lectures to the Bible, and thereby to exclude the *Sentences* from such a prominent place in the curriculum. It is significant that he did not command the masters to do so, as he might have done as their bishop, but instead only strongly recommended the practice. Ultimately the masters did not accept the recommendation of Grosseteste, and ordinary lectures on the *Sentences* became commonplace at Oxford, just as they had at Paris. In this, the masters were supported by a papal letter sent to Grosseteste soon after he sent his own letter, in which Grosseteste is commanded not to interfere with the practice of delivering ordinary lectures on the *Sentences*.

Grosseteste's early years as a bishop made it clear that he felt a strong pastoral responsibility for his flock, and his personal activity in visiting all parts of his diocese and his directives for correcting improper behavior reinforce this. His main responsibility, in Grosseteste's own eyes, was to his geographical region of influence, that is, his diocese. But he did recognize the role the pope played in the hierarchy, as the ultimate support in this world to reinforce Grosseteste's decisions in his own diocese. For that reason, Grosseteste set out for the papal court shortly before the Council of Lyons was called.

Grosseteste had departed from England for the curia in November of 1244, two months before the pope had convened the Council with a papal bull in January 1245. Two

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[89]See McEvoy, *Robert Grosseteste*, pp. 160ff.

issues had probably compelled Grosseteste to make the trip.[90] First, he had experienced recurring problems with the canons of Lincoln over his rights during periods of visitation. After a great deal of correspondence with the curia to handle appeals and counter-appeals, none resolved to Grosseteste's satisfaction, he had apparently decided it was time to take a personal hand in the proceedings. In August of 1245, after the conclusion of the Council, he received a decision in his favor.[91] The second issue occasioning his trip was an effort to canonize Edmund of Abingdon, the Archbishop of Canterbury, whom Grosseteste had known so well as a colleague both at Oxford and in the episcopacy.[92] After lengthy efforts by English representatives, they achieved their goal. On 11 January 1247, a papal bull canonized Edmund, making 16 November his feast day.

Grosseteste did not return to England until after the August decision regarding the canons of Lincoln. The sessions of the Council took place in June and July, while he was still there, but we have no clear record of Grosseteste's activity during those sessions.[93] It is difficult to imagine that he did not participate, or at least attend, but apparently he played no major role. Given the overwhelming emphasis of the Council on the international situation of the Church, in which Grosseteste was not a player—the Islamic threat to the Holy Lands, schism with the Greek Church, barbarians in the east, and the problems with Emperor Frederick II—his lack of recorded activity is no great surprise. One of the other issues of

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90See McEvoy, *Robert Grosseteste*, pp. 33ff.

91McEvoy, *Robert Grosseteste*, p. 40.

92McEvoy points out that, although Grosseteste and Edmund had sometimes disagreed in official matters, their friendship had always persisted. Both the friendship and respect that is apparent in Grosseteste's letters to Edmund must have contributed to his desire to see Edmund canonized. McEvoy, *Robert Grosseteste*, p. 34.

93His name and seal is applied to a document from the Council, the *Transsumpta of Lyons*. McEvoy, *Robert Grosseteste*, p. 39.

the Council, however, was the reform of the Church. Because he so strongly displayed an emphasis on pastoral care and responsibility, he must have been interested in sessions devoted to this topic. The emphasis at the Council, however, was on securing the financial status of the Church in a changing economy (so that it could thereby remain in a position to provide pastoral care), not on the curbing of abuses, with which Grosseteste's interest is amply demonstrated in his letters.

He also demonstrated a commitment to pastoral care with his second visit to the papal court five years later, in 1250. Grosseteste composed and presented to the pope and three cardinals a document in which he outlined the difficulties he had encountered in trying to carry out his duties. The upshot of the argument was that the Church hierarchy, including the pope and curia, were the source of the most troubling obstacles to his responsibilities.[94] Though some have seen in Grosseteste's document the seeds of a proto-reformation,[95] Joseph Goering has performed a diplomatic analysis of the relevant set of texts, which include the document just mentioned, and has reached a quite different conclusion from those who see Grosseteste as attempting any sort of overthrow of or break with the papacy.[96] Though Grosseteste's initial document was often subsequently referred to as a 'sermon,' it was in fact a diplomatic instrument addressed to the pope and curia. He was not preaching against the papacy, but was in fact appealing to it, asking the individuals within the papal court to engage in a systematic self-correction of abuses. By working within the

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[94]See Southern, *Robert Grosseteste*, pp. 276ff.

[95]See McEvoy's summary of later examples of the appropriation of Grosseteste for antipapal purposes, in *Robert Grosseteste*, pp. 62–75.

[96]Joseph Goering, "Robert Grosseteste at the Papal Curia," in *A Distinct Voice: Medieval Studies in Honor of Leonard E. Boyle, O. P.*, edited by Jaqueline Brown and William P. Stoneman, 253–276, Notre Dame, Indiana: University of Notre Dame Press, 1997.

hierarchy, Grosseteste wanted to improve the situation of ecclesiastical officials like himself who were genuinely concerned with the care of souls. By addressing himself to the papal court, he recognized the Church hierarchy as a viable means by which to care for souls within the Church, but also as an instrument that needed repair.

The documents are official texts sent to the court in the fashion of a legal case, and outline Grosseteste's concerns with abuses, including the appointment of unqualified persons to ecclesiastical offices, often the result of simony or nepotism, and the appointment of nonresident priests. The main thrust of the argument is that the Church, at the local level, is unable to provide adequately for the parishioners who need its aid because the hierarchy is not providing the proper persons to fulfill ecclesiastical offices. He provided a number of examples from his own experience in England, and especially in his dealings with the new archbishop of Canterbury, to support his arguments. In the end, Grosseteste called on the papacy to correct these abuses, for it was in the hierarchy of the Church that Grosseteste saw the potential cure for its ills.

Oddly enough, as both Goering and Southern note, these documents present arguments that are academic in nature. Rather than conforming to the precedents of canon law, which is the context in which they are offered, they appeal to the authorities of scripture, the Church Fathers, and Aristotle. For those who wish to see Grosseteste as denouncing and haranguing the curia, it is difficult to see why these arguments would even have been listened to. Goering's analysis, however, solves this problem: the arguments were seen as just that—arguments—and not simply as criticisms. This may explain why Grosseteste in fact achieved great success in prodding the pope to action, especially in restricting the activities of the archbishop of Canterbury.

One final, dramatic episode in Grosseteste's tenure as bishop occurred in the year

of his death, 1253.[97] The pope appointed his nephew to a benefice within Grosseteste's diocese without first consulting him. Incensed, Grosseteste wrote a letter to the pope, boldly rejecting the candidate and criticizing the pope for overstepping his prerogatives.[98] In a papal letter, argued by some to be a response to Grosseteste's criticism, the pope admitted that mistakes had been made regarding the appointment of benefices outside of Italy by the pope, and directed local ecclesiastical officials to retain control over appointments of their benefices now and in the future.

In October of 1253, during the night between the eighth and ninth, Grosseteste died. His episcopacy was one in which there had been rampant conflict—with his parishioners, the monks in his diocese, the nobility of England, and even the papacy itself. But for Grosseteste, the conflicts had never been about self-serving power. He had always, because of both his confidence in his own theological positions and an unwillingness to relent to the pressures brought to bear on him, stood up for the rights he perceived as due the office of bishop. At the same time, I am sure, he felt a solemn responsibility in that office: that the care of souls within his diocese was a burden for which he must accept responsibility. His amazing level of activity, even at his advanced age, must surely have been spurred on by his own recognition that his office called him to unceasing efforts on behalf of his flock.

He did not achieve success in all he attempted to do, as witnessed by his continual efforts within ecclesiastical courts to shape the episcopal office into the form he wanted it to take. He must have been aware of the herculean nature of the task he had set for himself: to

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97McEvoy, *Robert Grosseteste*, p. 47–50

98The letter, known as Letter 128 from Luard's numbering, has been edited and translated in F. A. C. Mantello, "'Optima Epistola': A Critical Edition and Translation of Letter 128 of Bishop Robert Grosseteste," in *A Distinct Voice: Medieval Studies in Honor of Leonard E. Boyle, O. P.*, edited by Jaqueline Brown and William P. Stoneman, 277–301, Notre Dame, Indiana: University of Notre Dame Press, 1997.

provide adequate pastoral care to all within his diocese. Yet at the same time, he continued to do that for which he had been trained as an academic: to question and analyze issues of theological import, whether they concern the divine law in relationship to bastardy and secular successions, or abuses within the hierarchy. His pursuit of the study of Greek texts in the fields of theology and ethics probably served both of these pursuits, allowing him both to improve his understanding of relationships between humans and God, and to discern how best to serve the needs of the souls in his care. Despite his occasional set-backs, his confidence in his own abilities never seems to have left him. Even shortly before his death, probably when he was more than eighty years old, he was still willing to oppose the pope, and his resolve won the day.

Grosseteste lived a long life, and accomplished much, though probably in the face of a number of personal travails. In conclusion to the chapter, I have produced a table that summarizes the most significant aspects of his life. The table consists of two types of entries. The first are those events for which we have more or less precise dates, and that allow us to sketch at least a skeleton framework for Grosseteste's life. The other entries are events or periods for which we have little information, and about which we are forced to conjecture. The table hopefully will convey both the breadth of Grosseteste's activities and the large number of gaps that remain in his biography.

TABLE 2

CHRONOLOGY OF GROSSETESTE'S LIFE,
INCLUDING PRECISELY AND IMPRECISELY DATED EVENTS

Dates	Precisely Dated Events	Imprecisely dated events, or conjectured activity
1160–1175		Birth in county of Suffolk (1168-1170 is current consensus) to Anglo-Norman family
1186 (or earlier)–1194		Teaching in some capacity, probably a provincial master in England, perhaps in Lincoln, and serving in household of Bishop of Lincoln
1186–1192	Signs charter while in household of Hugh, Bishop of Lincoln	
1194–1195	Gerald of Wales writes letter of recommendation for Grosseteste	
1194–1198		In the employ of William de Vere, Bishop of Hereford, perhaps involved in teaching
1198–1219		Activity and whereabouts unknown, but perhaps employed in teaching and ecclesiastical functions, and likely in region of Hereford
before 1209		Perhaps teaching at Oxford, but no direct evidence for this
1209-1214	*Suspendium clericorum* at Oxford	Spent at least some of this period in France, but no evidence for the traditional assumption that he received a theological education at Paris
after 1214		Serves as chancellor of Oxford, but date very uncertain, perhaps as late as 1230
1213–1216	Involved as an official in a land dispute in Worcester	
1214–1219		Probably teaching at Oxford, producing original scientific works, perhaps beginning theological education; continues with ecclesiastical work

TABLE 2 (contd.)

Dates	Precisely Dated Events	Imprecisely dated events, or conjectured activity
1215–1216		Copies scientific and mathematical treatises into manuscript (Bodleian MS Savile 21), but might have occurred much earlier than this
Oct. 1219	Hugh Foliot becomes Bishop of Hereford	
1219–1225		Grosseteste involved with Hugh's household in some manner, but also actively teaching at Oxford; may still be receiving theological training at this stage
after Oct. 1219	Witnesses a charter for Hugh Foliot	
before Aug. 1220	Involved in a court case in Shropshire	
1225–1235		Becomes more involved with study of Aristotelian works, continues to lecture on scientific and natural philosophical topics, composes treatises on both scientific and theological topics, and becomes one of the preeminent theologians of Oxford
1225	Granted rectory of Abbotsley, his first benefice	Has been ordained a deacon by this date
1229	Becomes archdeacon of Leicester	Has been ordained a priest by this date
1229/1230 –1235	Teaching the Franciscans, probably in both scientific and theological subjects	Continues to compose both scientific and theological works
1230		Has probably by this time begun his efforts to learn Greek
1231	Resigns all benefices except a prebend	
1235	Ordained as bishop; immediately involved in disputes over place of ordination and English legal practice regarding bastardy	

TABLE 2 (contd.)

Dates	Precisely Dated Events	Imprecisely dated events, or conjectured activity
1235–1250	Actively visiting parishes in his diocese, encouraging pastoral responsibility in ecclesiastical officials under his control	
1244–1245	Visits papal court over dispute with canons of Lincoln, and attends Council of Lyons	
1245–1246	Sends letter to masters at Oxford exhorting them to reserve ordinary lectures for the Bible, and not to deliver ordinary lectures on Lombard's *Sentences*	
1250	Second appearance at papal court, asking hierarchy to engage in self-correction of abuses	
1253	Grosseteste rejects papal candidate for a benefice in England	
1253	Dies, 8 or 9 October	

CHAPTER 3

GROSSETESTE, ASTRONOMY, AND THE *DE SPERA*

In this chapter we shall examine Grosseteste's astronomical textbook the *De spera*. The first section will be devoted to providing a context for the work by examining some of Grosseteste's other writings in which he discussed the astronomical and astrological sciences. This discussion will provide exposition on the content of some of Grosseteste's astrological works, which have received relatively little attention to date, even though they provide evidence for Grosseteste's intellectual interest in astrology. A discussion of these texts will also provide background when we try to date the *De spera*. In the second section, we shall examine the text itself. This section will provide the first complete exposition in English of the work, which has never been translated. This exposition serves both to convey Grosseteste's text, and to offer an example of medieval astronomical instruction at the beginning of the thirteenth century. The final section contains an analysis of the *De spera*, addressing the questions of when Grosseteste wrote the work, the audience for which he intended it, the goals he tried to meet with it, and its relationship to Sacrobosco's work of the same name.

3.1. Grosseteste's Astronomical Interests

As indicated in the previous chapter, Grosseteste's early biography is known only incompletely, and hence we must make certain conjectures regarding his activities and whereabouts. One means by which we can create a picture of his life is to try to fit the few known facts together into a coherent and plausible pattern. A key to this approach is to

examine the contents of his works. The validity of this approach, as well as its limitations, were shown in the previous chapter. The contents of Grosseteste's various works could be dated in relation to each other, and then placed into a scheme that also accounted for the few basic facts we have regarding his early life. Unfortunately, as the works of McEvoy and Southern have shown, widely different biographies can be constructed in this manner.

The same limitations will also affect the present work, but we shall see that an examination of Grosseteste's astronomical works will allow us to fit the works into the biographical scheme suggested in the second chapter. Just as Dales stated, the astronomical works and their interrelationships present particular complications to our ability to date them.[1] On the other hand, because of these complications, assuming we can sort them out, the astronomical works provide us with a set of texts that can further illuminate our understanding of Grosseteste's early life.

The first text we shall consider is the *De artibus liberalibus*, a relatively short work.[2] In it, Grosseteste expounds on the liberal arts as the means to correct human error, and it is thus an apologetic work for the study of the liberal arts. The largest portion of the work is devoted to the formation of sounds by the human voice, which falls under the heading of rhetoric, but all of the liberal arts make at least a brief appearance. The final section of the work is devoted to astronomy and its nature as a practical aid to human knowledge.[3] The usefulness of astronomy, indeed of all the arts, is underscored by his reference to them as *ministeria*. Astronomy is particularly useful in three ways: in the

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[1]Dales, "Robert Grosseteste's Scientific Works," p. 381, n. 2.

[2]It is contained in *Werke*, pp. 1–7

[3]The section on astronomy is found in *Werke*, p. 5, l. 21-p. 7, l. 4, about one-fifth of the whole work.

growing of plants, the transmutation of metals, and the curing of human ailments.

All of these aspects of astronomy's usefulness fall under the category of what we today would label astrology. Regarding the growth of plants, for instance, Grosseteste writes that planting when the moon is in a favorable position leads to the movement of the vital heat of the plants, which causes the plants to produce a plentiful harvest. If, however, the planting is done under the aspect of Saturn, growth will be impeded by Saturn's cold. If planted under the influence of Mars, growth is somewhat inhibited, and the harvest will be only moderate.

The transmutation of metals, an aspect of what we would call alchemy, is the second field in which astronomy provides a useful benefit. "In preparing a stone by which metals will be transmuted, the hour of election is most important."[4] That is, to prepare stones that will cause metals to change into other metals, one must prepare the stones to receive the proper celestial virtue. All metals can be transmuted into gold by changing the imperfect to the perfect. The virtue of the sun, for example, moves the *fumus sulfures mundus* in a metal, mixing it with the *argentum vivum*; after this is decocted, one will get gold. If the moon's cold affects the sun's heat, however, one will get silver rather than gold. If the heat of the sun is affected by the cold of Saturn, on the other hand, one will get lead. The heat and wetness of Jupiter, in combination with the sun's heat, will produce tin or pewter.[5] The heat and dryness of Mars, together with the sun, produce iron. Mercury is able to produce silver.

Astronomy is, lastly, helpful in the care of the human body, as knowing the proper hours for administering medicines is vital in order to cure disease. "For medicines

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[4]In preparatione vero lapidis, quo metallorum fit transmutatio, non minus necessaria est horarum electio. *De artibus liberalibus*, *Werke*, p. 6, ll. 1–2.

[5]The described situation produces *stagnum*. The common usage of this term is standing water, lake, swamp, etc., but *Latham* gives tin or pewter as a possible translation.

themselves do not cure, but nature is aided by medicine."[6] Thus the influence of the celestial bodies must be taken into account when medicines are administered, so that the proper effect can be produced. Though this section on the use of astronomy for the purposes of healing is short, it does remind one of Gerald of Wales's recommendation of Grosseteste on the basis of his knowledge "in providing cures to restore and preserve…health."[7] Because Grosseteste did not enjoy a reputation in the art of medicine in his later years, the presence of medical knowledge in this treatise reinforces the early date posited for it in the previous chapter.

In this treatise, Grosseteste does not distinguish between astronomy and astrology. There is no indication that he is even aware of a theoretical distinction between two branches of the study of the heavenly bodies, a distinction at least as old as Isidore of Seville.[8] A common formulation is that astronomy is the study of the motions of the heavenly bodies, whereas astrology is the study of the effects of those bodies on the terrestrial realm.[9] On the one hand, the *De artibus liberalibus* is not meant to be a complete description of the liberal arts, and Grosseteste's focus in the section on astronomy is about the practical benefits it conveys. The technicalities of astronomy would be out of place given the character of this brief work. On the other hand, without a knowledge of the motions of the heavenly bodies,

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6…nec sanat medicina, sed natura per medicinam adjuta. *De artibus liberalibus*, *Werke*, p. 6, l. 34.

7Southern, *Robert Grosseteste*, p. 65.

8Tester has pointed out that Isidore distinguished between the two words *astronomia* and *astrologia*; see his *A History of Western Astrology*, Wolfeboro, NH: The Boydell Press, 1987, pp. 124–125. Tester argues that the distinction was significant in the medieval world; nonetheless, two different components of the science could be recognized.

9The terms used to indicate this distinction were not always consistent. Different authors used *astronomia* or *astrologia* for either branch of knowledge.

the benefits that Grosseteste lists could not be taken advantage of, as it would be impossible to utilize the knowledge for the growing of plants, transmuting of metals, or curing of disease. Surely the study of the motions of the heavenly bodies must be implicit, but Grosseteste fails to mention it explicitly. Given the quantitative manipulation necessary to perform the astrological feats he lists, however, it is curious that he does not provide the reader with at least some sense of this aspect of astronomy.

Who composed the audience for this work? Perhaps this can best be answered if we consider its date of composition. Scholars agree that the work is from an early stage in his career, because it shows no signs of the Aristotelian science he would learn later. And while the comments on astrology are consistent with the advanced Arabic works available in England at the time, the *De artibus liberalibus* demonstrates neither the knowledge of technical astrology nor the quantitative approach to astronomy that he exhibits in other works. Thus it is entirely possible that this work came from very early in his career, perhaps during the time when he was only a provincial master. Considering the contents of the work, this is an attractive hypothesis, because we can posit that he wrote it in part to promote his own teaching. In outlining the benefits of the liberal arts, he may have been, in addition to praising the arts, advertising his own approach to teaching, hoping to attract students or an employer. In this case, the work could potentially come from a period as early as the 1180s.

We can see in Grosseteste's work that he developed a strong interest in astronomical science as the years passed. A second work, called alternatively *De impressionibus aeris* (often shortened to *De aeris*) or *De prognosticatione*, shows a well-developed understanding of astrological science, which he undoubtedly had picked up from Arabic works translated into Latin, or from Latin introductions to Arabic astrology. One obvious source of this would be from the household of Hereford, where a tradition of scholarship in the astronomical and astrological sciences dates back to at least the 1170s with Roger of Hereford. Again, the problem of Grosseteste's biography looms, as we

cannot know for sure his relationship to Hereford. In the mid-1190s, he was in the employ of William de Vere, Bishop of Hereford, but in what capacity we do not know for certain. In examining Grosseteste's early biography, we are forced to try to fit a few facts into an overall pattern. The confluence of circumstance—his employment at Hereford, his possible residence in and around Hereford perhaps as late as the 1210s, the tradition of astronomical sciences at Hereford, and a demonstrated interest and ability in technical astronomy and astrology—makes it at least plausible that Grosseteste went to Hereford around 1194 and learned a great deal of the technical and quantitative aspects of the sciences while there, leading us to date this text to his period spent at Hereford. This also suggests that his interest in Arabic science predates the period of the 1210s, as some scholars have argued; we shall deal with this at greater length below, after discussing the astrological text.

What are the contents of *De impressionibus aeris*?[10] It is a basic introduction to various astrological terms and concepts used for the prediction of weather. It begins,

> To foreknow the diverse dispositions of the airs in the future according to the diverse motions of the superior [bodies], it is necessary to examine the powers of the signs, the natures of the planets, and the qualities of the four quarters described in the daily revolution.[11]

The signs referred to are those of the zodiac, and they are each distinguished by (*distinguuntur*) the four Aristotelian elements and possess the corresponding qualities: Aries, Leo and Sagittarius, being of a fiery nature, are hot and dry (*sunt igneae naturae, calida et sicca*); Taurus, Virgo and Capricorn are earthy, cold and dry; Gemini, Libra and Aquarius are airy, hot and wet; and Cancer, Scorpio and Pisces are watery, cold and wet.[12]

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[10]The work is contained in *Werke*, pp. 41–51.

[11]Ad praecognoscendam diversam dispositionem aëris futuram propter diversitatem motuum superiorum, necesse est, potestates signorum, naturas planetarum, qualitates quoque quartarum circuli descripti per revolutionem diurnam perscrutari. *Werke*, p. 42, ll. 1–4.

[12]*Werke*, p. 42, ll. 5–9.

The planets, too, have their natures, both Aristotelian and astrological. Saturn is extremely cold, which also makes it dry; it has an inimical nature. Jupiter is hot and wet to equal degrees, and is of an amicable nature. Mars is as hot as it is dry, and of a choleric nature, and is thus somewhat contrary to life (*quodammodo vitae contrarius*). The sun is moderately hot and dry, or can be said to have all the qualities equally.[13] Venus is somewhat hot and very wet, Mercury is cold and dry. The moon is somewhat cold and very wet, and it is said to be the source (*fons*) of wetness, as the sun is the source of heat.

Based upon which signs they occupy, the planets are assigned strengths (*fortitudines*), also called powers (*potestates*), characters (*dignitates*) or testimonies (*testimonia*). These powers are calculated by considering a number of different categories. These include: the house (*domus*), exaltation (*exaltatio*), triplicity (*triplicitas*), terminus (*terminus*), facies (*facies*),[14] and aspect (*aspectus*) of the planet. Each of these terms denotes a different quanitity of strength[15] of influence: a planet in its house is said to have five strengths, in exaltation it has four, in triplicity three, in terminus two, and in facie one. Thus a planet in its house has five times the strength of a planet in facie, and so on for the rest.[16] That is, the house has five times the influence of the facie, the exaltation is four times

[13]…vel ut verius dicam, inter omnes qualitates summe aequalis. *Werke*, p. 42, l. 17.

[14]I have chosen to use the terms terminus and facies in my English exposition, because there is no corresponding English words that would convey those terms effectively. The terms are technical, astrological terms, and do not have a clear meaning other than their use as defined in the text. The English meaning of terminus, a boundary, is not equivalent to the way the term is used here, just as other terms, such as house or exaltation, take on a technical meaning in the astrological text.

[15]Grosseteste here uses the term *fortitudines*, which I have translated as strengths. In the example at the end of the work, he calls them *testimonia*. The terms appear to be synonymous.

[16]Et dicitur domus habere quinque fortitudines, exaltatio quattor, triplicitas tres, terminus duas, facies unam. Unde domus habet in se quinque fortitudines quinque facierum, et sic de ceteris. *Werke*, p. 42, ll. 28–31.

as strong as the facie, and so on. These ideas might strike the reader as a bit unclear at this point, but they will become more clear in the example Grosseteste gives at the end of the text.

Grosseteste next presents a series of metaphors for the various powers. The house is like (*comparatur*) a man's dominion in his own home. An exaltation is like a man's glory in kingship. A triplicity is as a man's honor among his aides (*auxiliatores*). A terminus is as a man among his own people (*inter cognatos et genus*). A planet in its facie is as a man in his office (*in magisterio suo*), in other words, in his official capacity. A good aspect is like an army that attends a rightful ruler, whereas a bad aspect is like an opposing army.[17] By themselves, these metaphors are not particularly illuminating, and may suggest that the text was intended to be taught, so that the metaphors could be explained during a lecture.

The exaltations[18] of the planets are as follows: the sun is exalted in Aries, the moon in Taurus, Saturn in Libra, Jupiter in Cancer, Mars in Capricorn, Venus in Pisces, and Mercury in Virgo. Thus the sun, writes Grosseteste, is exalted in Aries "through its virtue" (*per suam virtutem*), while in Libra it is decending, because that is the opposite sign. The others are affected in like manner.

The house of each planet is the sign in which it was placed at the creation of the world. The house of the sun is Leo, of the moon Cancer, of Mercury Virgo, of Venus Libra, of Mars Aries, of Jupiter Sagittarius, and of Saturn Capricorn. In addition, five planets have powers in five other signs, which has occurred "by chance" (*accidentales*). These are

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[17]Aspectus vero bonus est sicut exercitus validus regem concomitans; aspectus vero malus est sicut exercitus contrarius. *Werke*, p. 42, ll. 35–37.

[18]Grosseteste discusses exaltation first, despite the fact that exaltation comes after the house in the list of relative strengths.

called “their chance little houses” (*accidentalia eorum domicilia*), and are as follows: Saturn in Aquarius, Jupiter in Pisces, Mars in Scorpio, Venus in Taurus, and Mercury in Gemini.[19]

The triplicities of the planets are the signs that share the natures of the sign in which the planets was placed at creation, in other words, that share the same nature as the planet’s house. The triplicities of the sun, for example, are Sagittarius and Aries, which are hot and dry like Leo, the sun’s house. The triplicities of the moon are Scorpio and Pisces, which are cold and wet like Cancer, and so on for the others.[20]

There are multiple opinions regarding the termini, Grosseteste tells his reader. The most famous, he says, is the Egyptian scheme, in which Jupiter has the first six degrees of Aries, Venus the next six, and so on according to Table 3.[21] Grosseteste does not explain the table further, but we can note a few salient points about it. Each row corresponds to a zodiacal sign. The thirty degrees of each sign (12 signs, 360° in a circle), are divided up into various numbers of degrees, and the planets, with the exception of the sun and moon, are assigned to the various termini in no apparent pattern. Thus, for example, if Saturn happens to be in the first six degrees of Libra, it will be said to be in a terminus. Why the sun and moon do not have termini, Grosseteste does not explain. Quite a bit of information is not stated explicitly in the text; even the simple fact that each sign has thirty degrees is neither stated nor explained. Again, this leads us to believe the text was likely meant to be presented as a classroom lecture to students already acquainted with the basics of astronomy, and not

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[19]Grosseteste does not elaborate on why these planets have these particular “little houses,” nor does he explain why the sun and moon do not have them.

[20]Though Grosseteste does not point this out, the triplicities are four signs apart, or one-third of the way around the zodiac, hence the name.

[21]*Werke*, p. 43.

TABLE 3

THE TERMINI OF THE PLANETS

Aries	Jupiter	6	Venus	6	Mercury	8	Mars	5	Saturn	5
Taurus	Venus	8	Mercury	6	Jupiter	8	Saturn	5	Mars	3
Gemini	Mercury	6	Jupiter	6	Venus	5	Mars	7	Saturn	6
Cancer	Mars	7	Venus	6	Mercury	6	Jupiter	7	Saturn	4
Leo	Jupiter	6	Venus	5	Saturn	7	Mercury	6	Mars	6
Virgo	Mercury	7	Venus	10	Jupiter	4	Mars	7	Saturn	2
Libra	Saturn	6	Mercury	8	Jupiter	7	Venus	7	Mars	2
Scorpio	Mars	7	Venus	4	Mercury	8	Jupiter	5	Saturn	6
Sagittarius	Jupiter	12	Venus	5	Mercury	4	Saturn	5	Mars	4
Capricorn	Mercury	7	Jupiter	7	Venus	8	Saturn	4	Mars	4
Aquarius	Mercury	7	Venus	6	Jupiter	7	Mars	5	Saturn	5
Pisces	Venus	12	Jupiter	4	Mercury	3	Mars	9	Saturn	2

as a text meant to introduce students to the science.

The facies, Grosseteste writes, are found in the following manner. Each sign is divided into three equal parts, each of which is ten degrees, which, he informs us, is why the facies are also called decans. The facies begin with the first degree of Aries, and the first ten degrees belong to Mars. Following this, up to the twentieth degree, is the facie of the sun, which is inside (*succedit*) Mars in the order of the circles, also called spheres. The third facie, from the twentieth degree to the end of Aries, belongs to Venus. Continuing in like manner, one can create the table found in Table 4, below.[22] Note that an exception occurs at the end of Pisces, for Mars has two facies in a row: the last ten degrees of Pisces and the first ten degrees of Aries. We can also determine the order of the planetary spheres that

[22] *Werke*, p. 44.

Grosseteste is assuming: Saturn at the outermost sphere, Jupiter inside it, followed by Mars, the sun, Venus, Mercury, and the moon. This is yet another feature that Grosseteste does not explain explicitly, assuming the reader will already know it, or will have a teacher available.

TABLE 4

THE FACIES OF THE PLANETS

Aries	Mars	10	Sun	10	Venus	10
Taurus	Mercury	10	Moon	10	Saturn	10
Gemini	Jupiter	10	Mars	10	Sun	10
Cancer	Venus	10	Mercury	10	Moon	10
Leo	Saturn	10	Jupiter	10	Mars	10
Virgo	Sun	10	Venus	10	Mercury	10
Libra	Moon	10	Saturn	10	Jupiter	10
Scorpio	Mars	10	Sun	10	Venus	10
Sagittarius	Mercury	10	Moon	10	Saturn	10
Capricorn	Jupiter	10	Mars	10	Sun	10
Aquarius	Venus	10	Mercury	10	Moon	10
Pisces	Saturn	10	Jupiter	10	Mars	10

The planets receive their testimonies based upon their positions in relation to the zodiacal signs.[23] The testimonies are either strengthened or weakened through its ‘aspect.’ The testimony of a planet is strengthened when the planet is in a good (*bonus*) aspect, but is weakened by a bad (*malus*) aspect. There are five aspects: opposition, quartile, trine, sextile, and conjunction. The aspect of opposition occurs when a planet is in a given sign and

[23]Haec sunt testimonia, quae planeta accipiunt a signis. *Werke*, p. 44, l. 10. Previously, Grosseteste had referred to the *fortitudines*, rather than the *testimonia*, that the planets receives.

another planet is in the sign directly opposite. This is said to be a very bad (*pessimus*) aspect, and it is especially bad if the planets have contrary natures, as the signs do, such as Venus in Aries and Saturn in Libra—just as the signs have contrary natures, so do the planets.[24] The aspect of trine occurs when two planets are in similar kinds of signs, which are apart from one another by one-third of the sky. This is a good aspect, because the qualities of the signs are not contrary. If the planets are similar, such as Jupiter and Venus, nothing in this aspect is contrary. The quartile aspect occurs when two planets are three signs apart, such as when the sun is in Aries and Saturn in Cancer. It is called quartile, because the planets are one-quarter of the zodiac apart. This aspect is somewhat bad (*mediocriter malus*) and hinders like one lying in wait (*impeditivus sicut insidiator*). The sextile aspect occurs when planets are two signs apart, or one-sixth of the zodiac, and is somewhat good because the signs are alike in one property. Conjunction occurs when the planets are in the same sign. This aspect is called by astrologers the strongest (*fortissimum*), but, Grosseteste writes, we find (*nos autem invenimus*) that opposition and trine[25] are stronger (*fortiorem*).

There are other strengthenings and weakenings that the planet receives as it moves on its small circle, also called its epicycle.[26] These occur during rising (*ortus*), setting

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[24]Recall that Venus is hot and wet, whereas Saturn is cold and dry. Aries has a fiery nature, hot and dry, while Libra has an airy nature, hot and wet.

[25]Baur does not give the term for trine (*trinus*) used earlier in the text, but instead uses *tertium*. I have not checked this against the manuscripts, but *trinus* makes more sense than *tertium*.

[26]Note here that the text seems to imply that the cosmos is accurately described by the Ptolemaic system. Grosseteste probably assumed, when writing this text, that the epicycles were physically real, rather than mathematical devices. But it is not, in fact, absolutely necessary that he consider the epicycles to be real objects in the universe, as the astrological aspects of rising, setting, etc. could merely be words used to describe different aspects of a mathematically descriptive system. Such an interpretation, however, is not suggested by Grosseteste's words in the text. It seems most likely that he assumes the reality of the epicyclic universe of Ptolemy. This is potentially an issue when dating the work, as Grosseteste does

(*occasus*), progression (*progressio*), station (*statio*), and retrogradation (*retrogradatio*). A planet is rising when it comes out from under the sun and can be seen from the earth, unimpeded by the brightness of the sun. Setting is likewise, but when it disappears. Progression is when it can be seen moving across the sky. Retrogradation is when it moves from east to west faster than the sky. Station is when it stays still all day.

The influence of a planet is weakened while in the inferior part of its deferent, and strengthened in the superior part of its deferent. Grosseteste spends a long time discussing the geometry of eccentric circles and epicycle-deferent systems, citing both Ptolemy and Theodosius during his proofs. Ultimately, the purpose of this discourse is to get to the examples of the sun and moon, which behave differently depending upon their geometric configuration. The sun's speed through the zodiacal signs changes during the course of the year, while the moon has a greater or lesser effect on the tides depending upon its configuration. Both of these examples provide for Grosseteste a demonstration that the geometry of the Ptolemaic system affects the influence that the planets exert upon the terrestrial realm. The rest of the planets, too, he writes, have similar effects. Given the amount of time he spends demonstrating this point, about a third of the treatise, it seems likely that this was a somewhat controversial claim.

Next Grosseteste tells his reader—or more accurately, if this text represents a lecture for students, his listeners—that in order to understand without labor and tedium all that has been said heretofore he will now "draw for you a diagram with eight circles."[27] The figure, however, does not appear in the manuscripts, clearly suggesting that the work was originally presented orally, and that Grosseteste must have had some way to draw figures for his listener to see. He goes on to describe the figure in some detail. The first (outer) circle is

demonstrate a concern over whether the physical cosmos is Ptolemaic or Aristotelian (homocentric) in other works.

27Ut ergo omnia praedicta sine labore et taedio possis comprendere, describam tibi figuram octo circulorum. *Werke*, p. 49, l. 8.

that of the zodiacal signs, the second is that of Saturn, and so on in order through the orbs.[28] He then divides the circles into twelve equal parts, corresponding to the twelve signs. In each circle he puts the testimonies of the planets under the sign in which each is found; in other words, a planet in its house receives five testimonies, if in exaltation four, in triplicity three, in termini two, and in facie one. He does not elaborate on how this is done, nor does the example given next provide clear evidence for the appearance this diagram would take.

If we want to predict the disposition of the airs, i. e., predict the weather, at a certain time, we must find through tables the place of each of the planets at that time. By noting the testimonies of the signs and planets, we can make a judgement. Grosseteste then provides an example. We can find the locations of the planets at the end of 646 complete Arab years, that is, on the fifteenth day of the fourth month of the year 1249, or the seventeenth kalends of May of that year.[29] Examining tables,[30] we find that the sun is in the twenty-second degree of Aries, the moon in the twenty-first degree of the same sign, Saturn is in the tenth degree of Scorpio, Jupiter in the first degree of Aquarius, Mars is in the twenty-eighth degree of Aquarius, Venus is in the seventeenth degree of Taurus, and Mercury is in the fourteenth degree of Taurus.

We proceed thus: the sun is temperate in nature, moderately hot and dry, in the twenty-second degree of Aries, in other words, in its exaltation, where it has four testimonies, and in trine, where it has three testimonies, for a total of seven. It is not impeded

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28The order was presumably that assumed in the table of facies, though Grosseteste does not state that explicitly in this part of the text.

29For an explanation of how days and years are converted from Arabic to Christian form, see the explanation of the fifth chapter of Grosseteste's *Compotus correctorius* in the next chapter of this dissertation. Regarding the conversion of days of the month to kalends (and nones and ides), see the explanation of the second chapter of the *Compotus correctorius*.

30Grosseteste does not elaborate on which tables to use, nor are they present in the text.

by any contrary planets. Therefore, bearing in mind what has already been said, the weather will be disposed to its nature. Venus, hot and wet, in the seventeenth degree of Taurus is in its house, and so has five testimonies. But Mercury, by its nature cold and dry, in the fourteenth degree of Taurus, has two testimonies (because it is in a terminus, as we can see from the table of termini, though Grosseteste does not explicitly state this). Thus taking two testimonies from Venus, because Mercury has an opposite nature, leaves it with only three. Cold and wet Saturn in the tenth degree of Scorpio is in opposition with Venus in retrograde holding back its testimonies, and thus Venus is unable to bear fruit,[31] in other words, has no effect. Its testimonies have been effectively cancelled out. Because it is exalted in its deferent and near apogee, one would have expected a favorable judgment from Venus, but its significance is weakened by the opposing planets. Jupiter, hot and wet, in the first degree of Aquarius, is free from testimonies; in its rising and processing, "it is like a boy in whom one has hope,"[32] and thus it is favorable to the sun. Mars is very hot and dry, and also lacks testimonies in the twenty-eighth degree of Aquarius. It is rising and processing, and in sextile with the sun, and therefore slightly aids the heat and dryness of the sun. The cold and wet moon in the twenty-first degree of Aries lacks testimonies, and is near the apogee in its deferent, and thus its coldness and wetness proceeds.[33] Therefore, the testimonies of the sun remain unshaken. Thus one will find it to be moderately hot and dry at that time.

As stated previously, Grosseteste does not provide clear instructions on how one constructs the diagram that he described before proceeding to the example of the

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[31]…et sic testes Veneris non permittit fructificare. *Werke*, p. 50, l. 3.

[32]…sic quasi puer, de quo speratur. *Werke*, p. 50, ll. 8–9.

[33]The text is unclear here; Baur is uncertain of the verb. *Werke*, p. 50, ll. 15–16.

seventeenth kalends of May of 1249. He does not, for example, say how the position of a planet in its sign is to be written, or indeed how the names of the planets or the number of testimonies are to be recorded. With an awareness of how little we know regarding the actual appearance of these diagrams, I have created an example containing the information given in Grosseteste's example. The reader is reminded that the diagram in Figure 1 is a

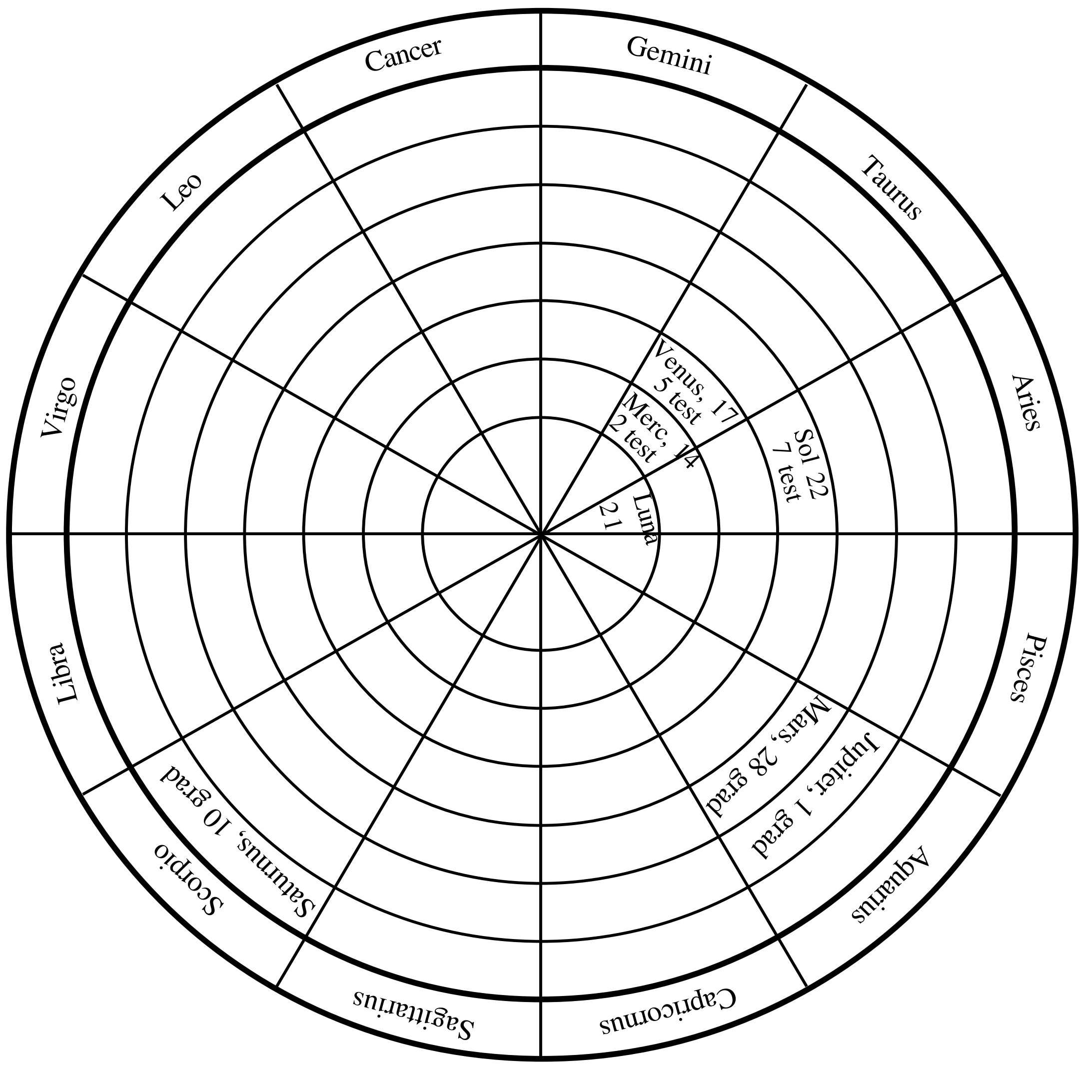

Figure 1. Astrological Figure for Weather Prediction

reconstruction of the information given, but may not accurately show the diagram as Grosseteste intended it. The comparison of the testimonies and the resultant prediction, as Grosseteste gave it in the text, is never clearly stated to be part of the diagram. Presumably the person who drew up the chart would do this for himself.

The example, Grosseteste continues, presents the general form by which one proceeds in all judgements. When one wants to know when it will be most hot, consider when the hot planets will have the most testimonies with concurrent trines. For example, in the month of July in 1249, the sun will be in Leo, its house, and Mars will be in the first decan of Aries, and thus in both its house and facie. Therefore, in that time, it will be exceptionally hot and dry. Saturn will be in Scorpio, without testimonies, but in quartile aspect with the sun, and will thus slightly moderate the heat of the sun.

When one wants to know when it will be most cold, consider when the cold planets will have testimonies, plus the other considerations. For example, in the year 1255, Saturn will be in its house, namely in Capricorn for five consecutive years, and then it will linger in Aquarius. Five winters will be affected by its nature, and the heat and summers will be impeded by its aspect of opposition with the sun, and this will in turn impede the maturation of crops. The autumns will be ruinously cold and flowers will wither. One will fear for the harvest and most of the wine and crops, unless Mars or Jupiter can counteract it. Their effects can minimize what has been predicted, because they will be far from the zenith capitis.[34] But when one wants to know when there will be abundance, consider when the wet planets have many testimonies, and the rich lands will produce especially well when the wet planets are in favorable aspects to the wet signs.

Thus ends Grosseteste's lecture on weather prediction. Coincidentally, he has

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[34]The zenith capitis is the point directly over a person's head; it is found by drawing a line from the center of the earth through the head and up into the heavens. This term is defined in the second chapter of *De spera*; see below.

returned to the topic of food production that he had mentioned in the *De artibus liberalibus*. But there are fewer generalities here than in the prior work. He has given explicit instructions on how to compute the astrological influences, which makes his awareness of the technicialities of Greek and Arabic science evident. Both of these aspects of the work suggest, the latter decisively, that the work is later than the *De artibus liberalibus*, but it is still difficult to date it precisely. McEvoy dates it to 1215–1220,[35] while Dales dates it some time before 1209.[36] McEvoy's dates are not implausible, but I believe they are more constrictive than the evidence supports. McEvoy's main argument for not dating it later is from Grosseteste's apparent lack of awareness of any of the problems between the Ptolemaic system of epicycles and the Aristotelian model of homocentric spheres, of which he will be aware in later works. On the other hand the figure of eight circles he describes in the text suggests the basic homocentric model, while simultaneously assuming the epicyclic system for the calculation of influences. It may be that the natural philosophical discussion regarding the appropriateness of the competing models is simply out of place in this kind of practical lecture. McEvoy also notes, however, that the astrological influences of the planets, as given in the *De aeris*, are incompatible with Aristotle's quintessence; their characteristics are of the four terrestrial elements.[37]

Dales's date of prior to 1209 is founded on an assumption that the lecture was given while Grosseteste was a regent in the arts at Oxford. Two problems beset this position.

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[35]McEvoy, "The Chronology," p. 621–622.

[36]Richard C. Dales, "Robert Grosseteste's Views on Astrology," *Mediaeval Studies* 29 (1967): 357–363; see especially pp. 357–358.

[37]McEvoy, *The Philosophy of Robert Grosseteste*, p. 165. But see also McEvoy's description of Grosseteste's approach to the problems of the quintessence in other writings; McEvoy, *The Philosophy of Robert Grosseteste*, p. 181ff.

First, Grosseteste may have been teaching in the arts as late as the 1220s, and, as McEvoy has suggested, may have been teaching theology and the arts simultaneously at that time. Dales was using the common assumption that Grosseteste earned a theological degree in Paris during the *suspendium clericorum*, and returned to Oxford as a theological master. If we do not accept that Grosseteste taught solely in theology after 1214, then there is no reason to assume it had to be taught at Oxford before 1209. The second problem with Dales's position, however, is that there is no reason to assume that it had to be taught at Oxford. If Grosseteste was teaching in Hereford, say, between 1190 and 1215, the text could date from any time during that period. The Arabic astrological science at the heart of the treatise, though not cited by Grosseteste as being Arabic,[38] could have been available to him in Latin translation through the resources at Hereford.

Dales also discussed some of Grosseteste's other works regarding their compatibility with the doctrines of celestial influence found in the *De aeris*.[39] In his *De luce*, Grosseteste reinforced the doctrine of celestial influence by arguing for the importance of light in transmitting influences. In *De cometis*, he states that comets are brought about by the influence of celestial bodies, one of the planets or fixed stars, again reinforcing the principle that the celestial bodies affect terrestrial ones. Both of these works date from the mid- to late-1220s, so the astrological principles of *De aeris* can still be found in works at this late date of Grosseteste's academic career. Even in the early 1230s, Grosseteste was still thinking about these issues. In his *De lineis, angulis, et figuris*, he modified his ideas about the lunar influence on the tides, arguing for influence based on strict geometrical grounds, rather than its astrological aspects. Specifically, he argued that the influence of the

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[38]Though he does hint at its source when he discusses astronomical tables and the need to convert dates between Arabic and Christian forms.

[39]Dales, "Robert Grosseteste's Views on Astrology," pp. 358ff.

moon was stronger when it was closer, and its influence was strongest at the perpendicular, weakening as the angle of incidence of its light fell away from the perpendicular. As Dales stated, this departed from the "strict letter of astrological teaching."[40] On the other hand, the doctrine presented in *De lineis* still assumes the principle of celestial influence; in this singular case, however, Grosseteste was convinced that a different method of calculating the effects of celestial influence was called for, perhaps based on observations that the traditional astrological account did not describe the situation accurately.[41]

We are thus left with a wide disparity of possible dates, again because of our lack of knowledge of Grosseteste's early life. It is plausible that the text could have originated as early as the 1190s or as late as the 1220s, and been used in a variety of locations around Hereford and Oxford. It is more likely that the text dates from the period before Grosseteste's careful study of Aristotle, but this positively rules out only the late 1220s at best.

Two other pieces of textual evidence are relevant to the context of Grosseteste's astronomical textbook. The first is a manuscript, already mentioned in the previous chapter, in which Grosseteste copied certain mathematical and astronomical texts. This manuscript,

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[40]Dales, "Robert Grosseteste's Views on Astrology," p. 359. But this theory was also present in the *De aeris*, specifically, where Grosseteste states that the relationship of the planets to the zentih capitis will be relevant to determining their effects. In that text, however, the issue is not specifically regarding the moon and the tides.

[41]That Grosseteste questioned the astrological scheme of the tides is evident from a quotation from his *De fluxu et refluxu maris*, in which he said regarding the problem of why the moon has an influence on the tides when it is hidden by the earth, "Astronomers answer this by saying that opposite quarters of the sky have similar effects, but whether this is true remains to be proven and is in need of further investigation," as quoted in Dales, "Robert Grosseteste's Views on Astrology," p. 359. Because he wrote the *De fluxu* some five years before the *De lineis*, it could be that, in the intervening period, Grosseteste actually did engage in some observational activity to convince himself that a new explanation for the tides was needed, finding the geometrical system he presented in *De lineis* (which would also have been compatible with the principles of the propogation of influence through light of the *De luce*) to describe more accurately the behavior of the tides.

Oxford MS Bodl., Savile 21, is typically dated from 1215–1216, or shortly after the return of the masters to Oxford.[42] Large portions of the manuscript are in Grosseteste's hand. The works he copied included two texts by Jordanus, an algorismus and a work on fractions; three works by Thebit, one on proportions and two astronomical works; various astronomical tables, including tables for the conversion of dates; a work on calculating the times of eclipses; two horoscopic diagrams; and a few miscellaneous paragraphs that are partially illegible, but some of which seem to be about astrological and geometrical issues.

The significance of this manuscript in relation to the *De spera* will be considered below, and in the next chapter in relation to the *Compotus correctorius*, but it is worth making a few comments here. If we accept Southern's contention, as indicated in the previous chapter, that Grosseteste did not go to Paris to study during the *suspendium clericorum*, the date of this manuscript may be less significant than it has been made out to be. That is, the fact that he copied these texts soon after the masters returned to Oxford may be simply coincidental. In addition, the dating itself might not be as certain as Thomson suggests. Though Thomson is not explicit, his dates seem to come from the date of the horoscopes, 1216. There is nothing, however, that would have prevented Grosseteste from drawing up such a horoscope some years before that time. In the *De impressionibus aeris*, for example, the astrological prediction is for at least twenty, and perhaps as much as fifty or more, years in the future. Southern has pointed out that the horoscopic diagrams emphasize the conjunctions of Mars and Saturn and of Saturn and Jupiter in the year 1216, the same conjunctions that, in 1186, had been the cause for dire predictions due to their maleficent influences.[43] Even Thomson admits that, in England, Grosseteste would have had access to

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[42]The relevant portions of the manuscript are described in Thomson, *Writings*, pp. 30–33.

[43]Southern, *Robert Grosseteste*, p. 107.

Arabic works, perhaps even better access than he would have had in Paris.[44] So there is little to rule out the possibility that this manuscript could have been written in the years before 1215, perhaps soon after 1186 when the astrological portents had been dire, and that Grosseteste was in England when he did so.

The manuscript does reinforce Grosseteste's interests in the mathematical and astronomical sciences, including arithmetic, technical astronomy, astrological prediction, and calendrical concerns during the important years of the 1190s through the 1210s. The *De impressionibus aeris* also provides evidence for his activity as a teacher during this period. Such evidence will be important for dating both of the textbooks with which this dissertation deals, but we will postpone those discussions for the appropriate time.

Before moving on to Grosseteste's astronomical textbook, the *De spera*, let us first examine another work of significance regarding his attitudes towards astronomy and, especially, astrology. Grosseteste's major exegetical work on the first chapters of Genesis, the *Hexameron*, contains a number of elaborate discussions about astronomy and astrology.[45] This treatise was written later than the textbooks, probably completed in the first decade of his episcopacy.

The first passage about astronomy and astrology clears up an issue that arose earlier, namely, the distinction between astronomy and astrology, a distinction that Grosseteste had not made clear in his other works. This passage comes in the proemium to the work, where Grosseteste is defining and explaining a number of terms before the text

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[44]Thomson, *Writings*, p. 33.

[45]All further citations of Grosseteste's *Hexameron* will be to the translation by Martin, hereafter, simply *Hexameron*. Citations will include the part, chapter and section of the work, as well as the page numbers from the translation.

proper begins.[46] Grosseteste distinguishes between astronomy as “the science of the movements of the heavenly bodies” and astrology as “the science of divination.” In fact, Grosseteste is discussing a passage from St. Jerome in which Jerome fails to distinguish between astronomy and astrology. The issue, then, becomes what to do about astrology. Jerome takes the undifferentiated science to be a beneficial one, but astrology, as divination, Grosseteste writes, is a superstition, and hence detrimental to humans. Grosseteste argues that there is a benefit to astrology if understood in the proper way.

> [I]f the benefit of a thing arises in the use that is made of it, then perhaps he [Jerome] calls it “of benefit” because there is a valuable science that derives from the part of it that makes judgements on changes in inferior elements from the movement of higher things. When it makes judgements about future voluntary acts it is not valuable nor even a science: it is a deceit of the demons.[47]

In other words, astrological predictions on changes made to the ‘inferior elements’ are perfectly valid; it is only predicitions that attempt to violate human free will that are disallowed. Thus all the previous examples of the usefulness of astrology that Grosseteste had provided still stand—prediction of the weather and thus the growth of plants, the transmutations of metals, and the affect on medicines—as valid uses of the science of astrology. Other proponents of astrology, Grosseteste implies, fall into error when they suggest that astrology can predict more than the behavior of the elements. He assumes that base, physical effects take place, but will allow no more than that.

Thus Grosseteste demonstrates his willingness to criticize those who try to give the science of astrology too much power. He also criticizes those natural philosophers and astronomers who think they have knowledge of the celestial spheres.[48] Though Grosseteste

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[46] *Hexameron*, Proemium, 117, p. 38.

[47] *Hexameron*, Proemium, 117, p. 38.

[48] *Hexameron*, Part 3, Chapter VIII, pp. 108–109.

himself had elsewhere considered questions of this nature, in the *Hexameron* he states that

> no-one can say anything with certainty about the numbers of the heavens, or about their movements, or their movers or their natures, even though worldly philosophers pride themsleves vainly on knowing about such things. The reasonings that they weave on these matters are more fragile than cobwebs.[49]

Astrology, too, arises in this context. He suggests that astrological predictions may in principle be beyond human ability to make for there could exist invisible heavenly bodies influencing generation and growth. For example, he writes, some philosophers believe the Milky Way to be made up of stars too tiny to distinguish, so how can their influence be measured by humans?[50]

The most extensive discussion of astronomy and astrology comes in Part Five of the *Hexameron*,[51] in which Grosseteste comments upon the creation of the great luminaries—the sun and moon—as well as the lesser luminaries. This section begins with a discussion of the firmament and the place of the sun and moon within it, and their time of creation in relation to the firmament. This is not so much a matter of astronomical science as it is of biblical exegesis. This is readily apparent when he offers various theories for the substance of the luminaries—quintessence, some mixture of the four elements, or of the light of creation—but fails to pronounce on what he believes to be the actual situation, because "what they were made of is not clear from the text of Scripture."[52] A variety of theories of their composition also exists among the patristic authors, Grosseteste informs his reader, so no answer lies there either. He also briefly discusses the ways in which the

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[49]*Hexameron*, Part 3, Chapter VIII, Section 3, p. 109.

[50]*Hexameron*, Part 3, Chapter VIII, Section 3, p. 109.

[51]*Hexameron*, pp. 159–186.

[52]*Hexameron*, Part 5, Chapter IV, p. 161.

luminaries are useful for dividing up time, one of their purposes mentioned explicitly in the biblical text.

The most interesting portions of this text, however, come when Grosseteste discusses the text which says "let them be for signs."[53] Here he uses Augustine's work "To Januarius" to describe four ways in which the luminaries can rightly function as signs. First, they can indicate the weather, as when the color of the evening or morning sky can foretell when there will be a storm. While these could potentially be *just* signs, that is, mere indications rather than causes of weather, Grosseteste suggests that the luminaries indeed have a causal effect.

> From the positions of the luminaries, and from their rising and setting, and from the visible impressions that they cause on things above us, we can draw definite signs of the qualities of the air, of winds and of rains, of hailstorms, of snowfalls and thunderstorms, of storm and of calm.[54]

The positions, risings, and settings are all consistent with astrological principles, and the theme of weather prediction in his writings is one with which we are already familiar. Second, the luminaries can act as signs for travelling, in other words, as navigational aids, and they can be used as timekeepers. Third, they also are "signs of the likenesses of spiritual things,"[55] providing valuable lessons to us when considered in respect to their use in scripture. Fourth and finally, they will act as signs of the ends times, according to some prophecies.

With the additional backing of St. Basil, Grosseteste is content to allow the luminaries to act as signs in this way—ordinarily, we might label it—in terms of astrological weather prediction, navigation, and time-keeping, and extraordinarily as signs of spiritual

[53]Gen. 1:14.

[54]*Hexameron*, Part 5, Chapter VII, pp. 164–165.

[55]*Hexameron*, Part 5, Chapter VII, p. 165.

things or of the end times. But more than that we cannot take from the luminaries. He writes,

> These signs, then, may licitly be considered, for they have the solidity of truth. Other signs are full of emptiness and falsehood, those signs that the mathematicians [astrologers] claim to be set in the stars, and it is irreligious to consider them. Even if it were not irreligious, it would be fruitless and vain.[56]

Grosseteste has thus voiced two objections to a different kind of astrology, namely, judicial astrology, that goes beyond the strictures he set out for it. It is objectionable because it is irreligious to inquire into it, and because it is impossible to accomplish.

He then deals with these objections in the reverse order. He grants, first of all, that we might "suppose that the constellations have some effect and some meaning for works of free will, and for what are called chance events, and for human customs."[57] Yet even if we grant this, we shall find out that it would be impossible for the astrologer to fulfill the requirements of his own art. Two major hurdles confront the would-be astrologer: the wide variety of astronomical information that must be gathered to cast a horoscope (the positions of heavenly bodies, their aspects, houses, etc.), and the necessary precision by which such information must be known. The latter, he says, is simply impossible to attain, which "is particularly clear to those who know the movements of the stars and know more clearly just what the astronomers are able to do with their instruments."[58] Because of this lack of precision, Grosseteste says, astrologers are unable to know the difference between two different events that occur close by each other, such as children born at the same time or identical questions posed to an astrologer at different locations in the same city. Those

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[56]*Hexameron*, Part 5, Chapter VIII, p. 166. The square brackets are present in Martin's translation.

[57]*Hexameron*, Part 5, Chapter IX, section 1, p. 166.

[58]*Hexameron*, Part 5, Chapter IX, section 1, p. 167.

things happening at slightly different times demand a different astrological prediction, while those occurring in different places have a different astrological configuration.[59] In either case, the astrologer does not have the ability, Grosseteste insists, to be able to predict the different cases.

There is, however, an objection to Grosseteste's position that he does not address. In the examples he gave, he always assumed that the two different instances of astrological prediction ought to result in different configurations. That is, if two children are born at the same time, but necessarily at different places, the astrologer must be able to account for their different personalities, characteristics, etc. Grosseteste assumes that the two children *will* have different lives. The obvious answer from an astrological point of view is that there is no reason to assume that they must have different destinies, but Grosseteste never considers this. It seems as if his objections do not fully tackle the problem from the astrologer's position.

Yet his objections do not cease with the hypothetical examples just adduced. He also points out that astronomers are unable to fix even a precise time for the turning of the year. They do not "know, in reality, the places of the planets in a given moment. This is clear to those who have worked hard on astronomical calculations and tables," a description which certainly fits Grosseteste himself.[60] In addition, he writes, we know that in at least one case, such precision would have been necessary to predict the difference between twins. Jacob

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[59]Grosseteste is here referring to the practices of judicial astrology, in which the location of the astrologer or event is significant. In the astrological form of weather prediction that Grosseteste discussed in the *De impressionibus aeris*, the positions of the planets were in relation to the zodiacal signs, which are identical for all people. In judicial astrology, the horoscopes are based on locations upon the earth, and thus two horoscopes created at the same time but in different places will be different.

[60]*Hexameron*, Part 5, Chapter IX, section 2, p. 167. Regarding the length of the year, Grosseteste had already discussed the problem in the first chapter of his *Compotus correctorius*. See the discussion in the next chapter of this dissertation.

and Esau, though born so close together, were of different character, not to mention physical characteristics, namely, the amount of hair on their bodies.[61] For a fuller critique of astrology, Grosseteste cites Augustine's *City of God*.

Grosseteste is not content, though, to rest his critique on this feature of astrology, that it is unable to fulfill its own theoretical demands, as damaging as it might be. Rather, he attacks the very notion that humans are susceptible to astrological influences in the way that astrologers claim.

> Nor is it true, though we granted it for the sake of argument, that the stars have power over free will, or over the characters and voluntary acts of men. Free will, in the order of natural things, is subject to nothing except God; rather it is put in authority over all bodily creatures. … Those who attribute to the stars a power over free will, then, are subjecting the nature of the rational soul and the dignity of the human creation to bodily nature.[62]

Thus the astrological practitioner upsets the proper relationship of will and body. The rational mind, which ought to act in such a way as to control the body, is instead subjected to the passions of the body as enflamed by the influence of the stars. But this would place the rational mind, the image of God in humans, under the influence of naturally inferior substance.

Having stated this position, Grosseteste next deals with potential objections to this position. Some might argue that the stars are rational beings, too, and thus can influence human will. These arguments are empty, he writes, for if they were alive, they would more likely fall under human influence, rather than vice versa.[63] Moreover, no power of a created being could be more powerful than the grace of God, and because the will acts with the aid

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[61] *Hexameron*, Part 5, Chapter IX, section 2, p. 168.

[62] *Hexameron*, Part 5, Chapter X, section 1, p. 168.

[63] *Hexameron*, Part 5, Chapter X, section 2, pp. 168–169. He cites Deuteronomy 4:19, in which the heavenly bodies are said to be at the service of humans, and Joshua's commanding of the sun.

of grace, no influence from the stars can overcome the will.

In addition, he acknowledges the potential objection that the stars might influence the material body, and thereby the soul. Grosseteste gives slightly more weight to this objection, as he explicitly acknowledges that the stars do exert some influence on the human body. The body, he states, "does receive many passions and impressions from the stars, but it also receives movements and impressions from the actions of its own soul."[64] And the soul's power, he continues, is many times greater than the influence of the heavenly bodies.

> So however much Saturn or Mars may move the body—the one by restricting the blood, the other by inflaming it, to produce sadness or anger in the soul—well-ordered reason is more powerful…. [T]here will be little or no restriction or inflammation of the blood or in the bodily spirits as a result of the action of Saturn or Mars, or at least such effects will be diminished. For true meekness of soul is more powerful in cooling and calming the blood and spirits than is the power of Mars in disturbing them; and true joy is more powerful in expanding the blood and spirits than is Saturn in restricting them.[65]

The soul, then, can overcome any of the effects of the stars.

Grosseteste also produces a few more brief arguments against astrology. He says, without elaboration, that "against the dispositions that are impressed by the stars, medical study and practice can prevail."[66] He cites Basil against the claim that the signs under which a person is born make him or her have similar characteristics as the symbols of those signs, such as curly hair for those born under the Ram of Aries, a relationship that he says is quite backwards, as it elevates the earthly thing above the celestial.[67] And finally, he

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[64] *Hexameron*, Part 5, Chapter X, section 4, p. 169.

[65] *Hexameron*, Part 5, Chapter X, section 4, pp. 169–170.

[66] *Hexameron*, Part 5, Chapter X, section 6, p. 170. This is a curious example, given his own insistence in other texts that astrological influences affect the efficacy of medicines. It would seem that the argument against the astrological influence on the human will is based upon the astrological influence on material objects.

[67] *Hexameron*, Part 5, Chapter X, section 7, pp. 170–171.

argues that, if the stars lead individuals to do evil, the stars themselves would be evil. But nothing of God's creation is inherently evil, and thus astrology must be absurd.[68] He ends his discussion of judicial astrology with a warning of its impious nature—indeed, its origins with the devil—and the danger to the astrologer himself in practicing it, as well to those who consult the astrologer.[69]

I believe Grosseteste placed his strongest argument against the very possibility of judicial astrology first, namely, the argument of the superiority of the will over astrological influences. The arguments that follow take the relationship of the soul and body for granted, namely, that any influence on the body cannot overcome the image of God placed in humanity at creation. Thus the argument that Grosseteste believed thoroughly undermined astrological theory was a theological one, and it was clearly the product of one who had received a theological education. As a practiced teacher of astronomy and as a compotist, he was in a position to evaluate, and reject, the viability of the project based on contemporary practices and tools. As a theologian, a position that he attained later in life, he was also able to mount serious theological objections.

His discussion of the passages in Genesis, however, is not over once he has dealt with the problems of astrology, for he must still deal with the purposes for which the great luminaries were placed in the sky. It is here that we can see reasons why the study of astronomy, one of the disciplines of the arts, remains necessary even when astrology has been rejected. He also manages to inject a bit of astronomical lore into his discussion of the biblical text.

Immediately following the passage in which the luminaries are said to be signs, they

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[68]*Hexameron*, Part 5, Chapter X, section 8, p. 171.

[69]*Hexameron*, Part 5, Chapter XI, pp. 171–173.

are also said to be for the seasons, which Grosseteste interprets more generally as times. Time, Grosseteste tells us, can refer simply to the passage of time, but, quoting Augustine, time "come[s] to be through the stars: not only the extent of duration, but the interweaving of affections in this heaven."[70] In other words, by establishing the luminaries, God provided the means by which time was marked out.

The seasons, for example, are known by the motion of the sun through the zodiac. Spring occurs from the vernal equinox, at the start of Aries, to the summer solstice, the start of Cancer. Summer follows, from the solstice to the autumnal equinox at the start of Libra, then autumn, up to the winter solstice at the start of Capricorn, and finally winter between the solstice and the vernal equinox again. These boundaries for the seasons are "with regard to the world without qualification,"[71] that is, are absolute. But the seasons are also sometimes marked out in regards to their nature. Spring is temperate, and the period when plants begin to grow and animals breed. Summer is hot and dry, and is the period when seeds and fruits ripen. Autumn is cool, and is the time for plants to be harvested. Winter is cold and wet, "and is more fit for keeping holiday than for working."[72] Thus this description of the seasons implies that the extent of the seasons will vary depending upon one's location on the earth, and is not absolute in the way that the astronomical measurements are.

Grosseteste must also explain why *all* the luminaries are set down for the sake of seasons, as the text reads, for it seems that the sun is solely reponsible for them. But, he

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70*Hexameron*, Part 5, Chapter XII, section 2, p. 174; Martin provides a citation for the quotation as Augustine, *De genesi ad litteram*, II, 14.

71*Hexameron*, Part 5, Chapter XII, section 3, p. 174.

72*Hexameron*, Part 5, Chapter XII, section 4, p. 174.

points out, the other luminaries can provide the same information, if one knows how to follow their movements. They all move regularly, and thus are all sufficient for measuring the passage of time. This is particularly obvious, he states, when one considers the marking of hours, rather than seasons, for which the other luminaries in the sky are necessary, especially at night when the sun is not visible.

The luminaries are also useful for marking out days, the biblical text says. The "artificial day," as Grosseteste labels it, is the day in which the sun is visible, but the "natural day" is that corresponding to a full revolution of the sun around the earth.[73] The other luminaries can again be used to ascertain the natural day, just as they could be used to mark out the seasons, though perhaps it is more difficult to do in the case of days.

Likewise, they can be used to show the year. Here Grosseteste demonstrates his own astronomical and computistical knowledge by pointing out the various kinds of years: the normal year, in which the sun completes its revolution around the zodiac, and the lunar year, which is equivalent to "twelve equal lunations: that is, all the complete lunations that take place in the solar year."[74] There are also the years of the stars. This passage is confusing, for he claims that the star's year is the time it takes for the star to complete a "revolution to its exact crossing of the zodiac,"[75] while the great year is the time it takes for the stars to return to the same relative places in the heavens that they occupied at creation. The Latin text clearly states 'star' (*annus cuiusque stelle*, *omnium siderum revolucio*), yet this makes no sense, for the stars do not move in relation to the zodiac, nor do their relative

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[73] *Hexameron*, Part 5, Chapter XIII, section 1, p. 175.

[74] *Hexameron*, Part 5, Chapter XIII, section 2, p. 176. For an explanation and discussion of lunations, see the exposition of the fourth chapter of Grosseteste's *Compotus correctorius* in the next chapter of this dissertation.

[75] *Hexameron*, Part 5, Chapter XIII, section 2, p. 176.

positions change. He must be referring to the planets, rather than the stars.[76]

Grosseteste also spends some time expounding the text by discussing whether the label of 'great' luminary is correctly applied to the moon. He points out that Ptolemy tells us that the moon is smaller in size even than the earth, and indeed smaller than some of the prominent stars. It appears larger only because of its nearness, and hence the 'great' must refer to its effect of illuminating the earth. It is interesting to note the disciplinary dynamic here. Astronomy, one of the liberal arts, is sufficiently well established to require Grosseteste to account for it in a theological context, commenting on the sacred page. The astronomy is not dismissed, but is instead accepted, and he is forced to create an explanation for the biblical wording.

He devotes a brief chapter to the consideration of a particular translation of a biblical passage. In the Septuagint, he tells us, the text reads, "The greater light for the beginning of day, the lesser light for the beginning of night."[77] This would suggest, he writes, that at the time of creation, the moon was full, and thus marked out one complete night, dividing the time equally with the sun. But this, he states, is contrary to another opinion, which says that the moon must have been created at the beginning of its cycle, its first day, rather than its fourteenth (the latter is when the full moon occurs). Grosseteste dismisses both of these arguments. The age of the moon during the month, whether it be in its first or fourteenth day, is in relation to our own vision; thus "the age of the moon [is] not reckoned according

[76]I cannot explain with certainty from where the error arises. Dales's and Gieben's critical edition does not offer alternative readings. The term 'planet' (*planete*) has its origin from the Greek word for "wandering star." Although Grosseteste does not allude to such an etymology here, Cicero, in *De natura deorum*, II. XX.51, refers to the five "stars" that are improperly called "wandering;" this could be the source of Grosseteste's terminology.

[77]Quoted in *Hexameron*, Part 5, Chapter XVII, p. 178.

to its own reality, but from its first showing of light to us."[78] In addition, half the moon is always illuminated, except during an eclipse, even if we cannot see the whole illuminated portion. In the end, based on these bits of astronomical information, he takes a position he attributes to Augustine, neither accepting nor rejecting either argument. In this case, astronomical knowledge has functioned to demonstrate that various theological positions are not sufficiently proven.

Grosseteste also provides a number of moral, we might say allegorical, interpretations of the luminaries. For example, the gospel shines like the sun, the historical books and prophets like the moon are illuminated by the gospel, and the moral books "offer a splendour like that of the individual stars in the individual moral precepts."[79] This is fully in keeping with the medieval method of finding multiple meanings within the same biblical passage, but also shows that astronomical imagery was considered useful in explaining the biblical text.

The natural properties of the sun fulfill the functions that God set for them in their creation. In chapter XXI, Grosseteste lists many of the traits of the sun: its illumination of the whole universe, its position in the middle of the planetary spheres[80] by which it guides the other planets, its constancy of motion along the ecliptic, its regulation of sleep patterns, and so forth.[81] The moon, too, is described: its pattern of illumination of the earth and by

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[78]*Hexameron*, Part 5, Chapter XVII, p. 178.

[79]*Hexameron*, Part 5, Chapter XIX, section 3, p. 180. He offers a number of alternate allegories in this chapter as well.

[80]That is, the sphere of the sun occupies the center position among the seven planets that circle the earth: Saturn, Jupiter, and Mars are above its sphere, whereas Venus, Mercury and the moon are below it. Its guiding force arises from this central position.

[81]*Hexameron*, Part 5, Chapter XIX, pp. 181–183.

the sun, its phases, its effect on the waters of the earth, and so on.[82] And so are the stars: they revolve daily, they are of varied appearances and of varied natures, they appear larger at the horizon than at the zenith, etc. These chapters seem to contribute little to the commentary on the biblical text, except that they more fully describe the luminaries of the biblical passages. Much of the detail is astronomical and astrological in nature, thereby showing once again that the science of astronomy contributes usefully to the theological goal of understanding the biblical text.

After the preceding section, we are now in a better situation to approach a reading of Grosseteste's astronomical textbook, the *De spera*. We have seen in this discussion of his other works that his astronomical interests varied during his career. Early on, he emphasized the astrological benefits provided by the study of astronomy. Later in life, he was concerned to create theological arguments against judicial astrology, though he never gave up the principle that astrological influences could affect terrestrial matter.[83] In the same text in which he made these arguments, however, he also utilized the science of astronomy on behalf of theology, so we certainly cannot say that he disparaged the study of astronomy by the time he was the Bishop of Lincoln. Let us now move on to our discussion of the textbook.

3.2. Exposition of the *De spera*

The *De spera* introduces its reader to many of the basic concepts of medieval astronomy. Overshadowed by the later popularity of Sacrobosco's work of the same name, Grosseteste's work has received less attention by modern authors. Yet the work is extant in

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[82]*Hexameron*, Part 5, Chapter XX, pp. 183–184.

[83]Dales has also made this point in "Robert Grosseteste's Views on Astrology."

a number of copies, thirty-eight according to Thomson.[84] In this section, I will provide a detailed exposition of Grosseteste's text, which will also be the first detailed introduction to the work in English. I shall save analysis of the text for the following section, so that the exposition is not burdened with extra material. I have, however, inserted occassional digressions from Grosseteste's text in order to explain certain concepts and terms to the modern reader; I have explicitly stated when I do so.

3.2.1. Chapter One of *De spera*

The *De spera* begins with a straightforward statement of the purpose of the text.[85]

> Our purpose in this treatise is to describe the shape of the world machine, the center, [place,] and shape of its constituent bodies, the motions of the higher bodies, and the shape of their orbits.[86]

Because the shape of this world machine is a sphere, Grosseteste states, we must know what a sphere is. A sphere is the figure that is formed when a semicircle is rotated about its diameter until it returns to its starting place.[87] Grosseteste then refers to the first figure that appears in the text, which contains information relevant not just to this example, but to

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[84]*Writings*, p. 116. This is more extant copies than any other of Grosseteste's scientific texts.

[85]The *De spera* is contained in *Werke*, pp.10–32. The text is based on three printed versions and eleven manuscript versions; see *Werke*, p. 10, for a list. Subsequent citations will take the form: *De spera*, page number(s), line number(s).

[86]Intentio nostra in hoc tractatu est describere figuram machinae mundanae et centrum [et situm] et figuras corporum eam constituentium et motus corporum superiorum et figuras circulorum suorum. *De spera*, p. 11, ll. 1–4. The square brackets are in Baur.

[87]Est autem sphaera transitus semicirculi diametro eius fixa, quosque ad locum suum, unde incepit, redeat. *De spera*, p. 11, ll. 6–8. This definition is taken from Euclid, *Elements*, Book XI, definition 14.

subsequent material as well. The figure is reproduced below.[88] The semicircle, Grosseteste explains, is the figure ABC, with diameter AB. If the body is rotated around this fixed diameter, he notes, then clearly all lines drawn from O, its center, to any point on the figure will be the same length, which is precisely what we call a sphere. "The whole world machine is such a body,"[89] he writes, though he waits until later in the text to explain how we know that this is the case.

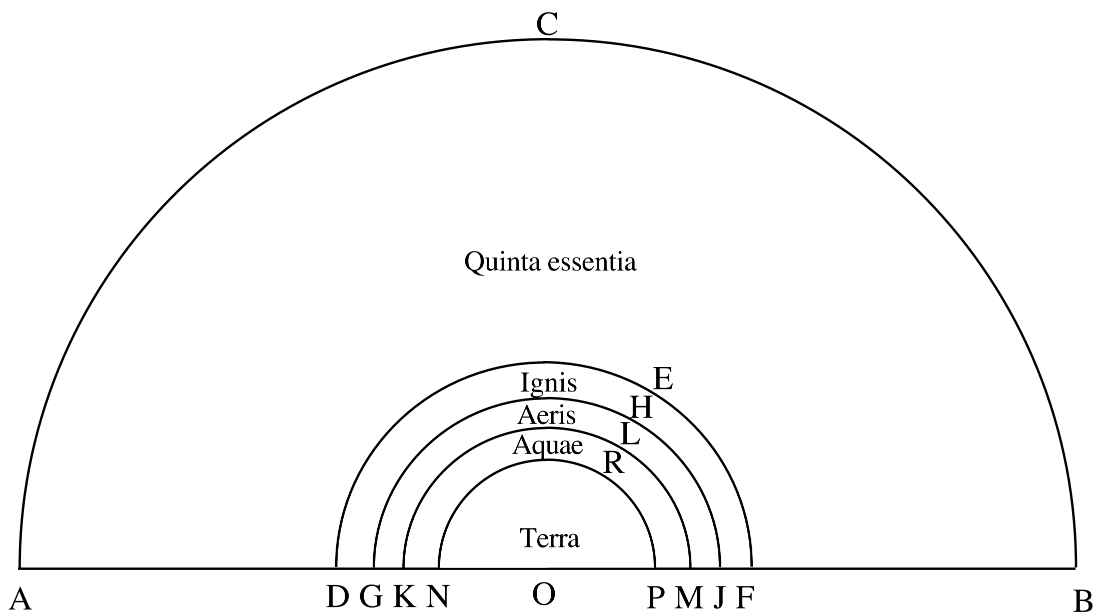

Figure 2. Elemental Spheres

[88]This figure reproduces in part the figure from *De spera*, p. 11. In manuscript versions, this figure does not always have the full amount of information reproduced in Baur. In fact, some manuscripts are missing the diagram altogether, although there is usually a space left for it, where it could have reproduced at a later time. The diagram I have produced contains the information presented in the text, but leaves out the fuller amount of information that appears in Baur and in some manuscript versions of the text. The diagram I have produced is not modelled on a particular manuscript version.

[89]Tale autem corpus est tota mundi machina. *De spera*, p. 11, ll. 12–13.

Let us next imagine a semicircle DEF, the center of which is O. If this figure is revolved about the diameter AB, another body will be formed, the inner and outer surfaces of which are spheres. This body, contained between the spheres formed by ABC and DEF, is formed of a single kind of body, "which the philosophers call the quintessence, or aether, or the heavenly substance."[90] Unlike the elements, he continues, this body has the property of circular motion. The seven planets[91] and the fixed stars are contained within it.[92]

In similar fashion, another semicircle can be drawn around center O, inside DEF, which he labels GHJ. Again, a figure of which the inner and outer surfaces are spheres will result. The outer surface is contiguous with the quintessense, whereas the inner surface contains the other elements; within the body will be the element of fire. Between GHJ and another semicircle KLM, a third figure will be present, containing the element of air. Yet another similar figure will be formed by including the semicircle NRP; between KLM and NRP, an additional figure will contain the element of water. Finally, NRP[93] encloses a spherical shape, containing the element of earth there. However, in order for animals to live upon the earth, water recedes into the concavities of the earth, and surfaces of dry land thus

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90…quod quintam essentiam nominant philosophi, sive aethera, sive corpus coeli, *De spera*, p. 11, ll. 21–22.

91In medieval astronomy, the moon, the sun, and the five visible planets—Mercury, Venus, Mars, Jupiter, and Saturn—were all understood as being the same kind of object, labelled *planetae*, planets.

92The figure in Baur, and some figures in manuscripts, contain the seven planets and their spheres in the place of the quintessence. I have left them out of my diagram because, first, the text does not state precisely how they are found within the area between ABC and DEF, and, second, some manuscripts do not contain this information in the diagram.

93Baur states that this semicircle is NRQ, apparently a typo. *De spera*, p. 12, l. 13.

appeared and water and earth were separated.[94] Thus water and earth are both contained within the sphere of the earth.

"That all the aforementioned bodies are spherical," Grosseteste writes, "is demonstrated by both natural reason and astronomical observation."[95] By natural reason, Grosseteste means Aristotelian physics. The sphere is the only shape that is alike in all its parts, and hence the cosmos and its parts must take on the shape of a sphere.[96] In addition, because heavy bodies—earth and water—move towards the center, they naturally take a spherical shape surrounding the center, and the light elements, moving away from the center, likewise form spherical shapes above them. Grosseteste then explicitly mentions Aristotle—*philosophus*, "The Philosopher"— who states that the quintessence takes on a spherical shape because of its motion. Motion in the celestial realm is naturally circular, not in straight lines, for if that body moved in a straight line, it would leave an empty space behind, which is an impossibility.

We can also see that both the earth and the heavens are round.[97] If the earth were flat, one would be able to see all the heavens at once. It is known, however, that if one looks

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[94]…aqua in concavitates terrae recessit et apparuit superficies terrae arida et separata. *De spera*, p. 12, ll. 16–17. This passage is evocative of the creation narrative in Genesis, especially Genesis 1:9.

[95]Quod autem omnia praedicta corpora sphaerica sunt et rationibus naturalibus et experimentis astronomicis ostenditur. *De spera*, p. 12, ll. 19–21.

[96]Quia namque a natura rei est forma et unumquodque praedictorum corporum naturalium naturae unius est, cuius scilicet quaelibet pars participat cum toto in nomine et diffinitione, necessefuit, ut unumquodque haberet uniformem figuram, cuius quaelibet pars esset toti consimilis. Talis autem nulla est praeter sphaericam. *De spera*, p. 12, ll. 21–26.

[97]Experimento etiam scitur, quod terra est rotunda, *De spera*, p. 13, l. 1. Quod autem coelum sit sphaericum, patet per apparentiam nobis in visu. *De spera*, p. 13., ll. 18–19. Note that Grosseteste uses the term *experimento* for the manner in which we see that the earth is round. See the previous chapter of this dissertation for more detail on the way in which Grosseteste uses the term *experimentum* as 'observation' rather than 'experiment.'

to the north pole (of the celestial sphere) from the city of Arim, one sees the north pole at the "edge of his vision."[98] If one moves towards the north, the pole becomes elevated, and one can see things in the sky below it. And, as Grosseteste succintly states, this could not happen unless the earth were round.[99] Grosseteste knows full well that this example shows only that the earth is round from north to south, and so he also explains how one knows it is round from east to west: because the beginning of daytime or nighttime comes at earlier times in the east and later times in the west. In addition, lunar eclipses show that the earth is round from east to west. If an eclipse is seen in the evening in Arim, those to the east see it during the night, whereas those to the west do not see it all. If an eclipse falls in the night in Arim, it occurs in the evening for those to the west, and in the morning for those to the east.

The heavens can be shown to be spherical in different ways. First, we can see that there is a single star in the sky that does not move, and about which all the other stars move, in small circles if they are close to this star, in larger circles if they are farther away. In addition, the magnitudes of all stars do not change over the course of the night, Grosseteste claims, and so their distance from us must be fixed, and only a sphere will produce such a phenomenon.

Grosseteste next introduces some astronomical terminology. The quintessence, we know, rotates around a fixed diameter; although he does not state it in so many words, Grosseteste implies that this corresponds to what we see in the motion of the stars. The

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[98]Sed notum est experimento, quod, qui sunt in terra in die super Arim civitatem vident polum septentrionalem et ipse est terminator visus eorum. *De spera*, p. 13, ll. 4–6. Neugebauer notes that Arin (note the different spelling) "is assumed to be located at the midpoint of the hemisphere which extends from the Ocean in the West to the Ocean in the East and from pole to pole," *The Astronomical Tables of al-Khwarizmi, Historisk-filosofiske Skrifter udgivet af Det Kongelige Danske Videnskabernes Selskab*, Bind 4, nr. 2 (1962): 1–247; the quotation is on p. 11. The latter requirement places it in a position consistent with what Grosseteste states in the text above.

[99]Hoc autem non posset accidere, nisi terra esset rotunda. *De spera*, p. 13, ll. 8–9.

fixed diameter about which it rotates is an *axis* in Latin, or a *magual* in Hebrew. The ends of this fixed diameter are called 'poles' (*poli*). The end of the axis that is visible to us is called the 'arctic'[100] in Greek, or the *ursa* in Latin. The opposite pole is the 'antarctic' because it is on the opposite end of the axis from the arctic. The heavens, and with them all the stars and the planets, rotate around these two poles with regular and uniform motion in a day and a night. The efficient cause of this motion is the World Soul.[101]

Next we must imagine a great circle[102] passing through the two poles, and another circle which intersects the first at the poles, and is at right angles to it.[103] These two circles are called 'colures' (*coluri*), and Grosseteste provides an etymology for the word based on the words *colon* and *uros*, as the shape, he says, reminds us of a cow's tail. Next we envision a circle on the perimeter of the sphere that is set at some distance from each pole. It crosses the aforementioned colures at right angles. This circle is called the 'equinoctial' (*aequinoctialis*),[104] because when the sun is at the point of intersection with one of the

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[100]Grosseteste provides a Latinized version of the word: *arcticus*. *De spera*, p. 13, l. 29.

[101]Super hos duos polos ut diximus, circumvolvitur coelum cum omnibus stellis et planetis, qui sunt in eo motu aequali et uniformi per diem et noctem semel, cuius motus causa efficiens est anima mundi. *De spera*, p. 13, ll. 32–35.

[102]Grosseteste refers to these as *magni circuli*, which I translate as 'great circles.' This refers not merely to a large circle, but in fact refers to what is technically known as a great circle, or a circle made from the revolution of a radius of the sphere, which cuts the sphere into two equal hemispheres.

[103]I have translated *orthogonaliter* as "at right angles," as I expect that term will be more generally recognizable than "orthogonal."

[104]Grosseteste does not label it as such, but this is also the celestial equator, for this is the only circle that will cut both colures at right angles. He also does not here note that, though the celestial equator cuts both colures, the sun will be on the celestial equator only when it intersects one of, but not the other, colure; this is where the equinoxes occur, the days on which night and day are equal. The colure that intersects the equinoxes is called the equinoctial colure, though, again, Grosseteste does not use this term; I include it merely for the benefit of modern readers.

colures, the circle it describes in the firmament causes day and night to be equal in all parts of the earth.

From the equinoctial circle, one passes twenty-four degrees, or twenty-three degrees and thirty-three minutes,[105] along one of the colures[106] towards the arctic pole. On the opposite side, one takes the same number of degrees towards the antarctic pole. Then a great circle is drawn through these two points. This circle crosses the equinoctial circle at two points, the points where the other colure (the equinoctial colure) intersects the equinoctial circle. This newest circle is called the ecliptic (*linea ecliptica*) or the *cingulus signorum* (roughly, the band of signs; the meaning of this will be made clear in a moment). If one draws two circles equidistant from the ecliptic, removed from it by six degrees, and thereby enclosing a total of twelve degrees of latitude between them, this band is called the 'zodiac.' Again Grosseteste notes an etymology for this term, in this case citing the term *zoas*, meaning animal, because the various parts of the zodiac are known by the names of animals.

The zodiac is divided into twelve parts (*pars*), and each is named by its sign (*signorum*). Each sign has thirty degrees, and the whole circle has 360 degrees; each degree has sixty minutes. One begins naming the signs at the point where the zodiac crosses the equinoctial circle moving, against the motion of the firmament, [107] towards the north.[108] Grosseteste then provides the name of each part of the zodiac: The first part is called Aries,

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105Grosseteste does not explain why he gives two alternative values.

106This colure is known in modern nomenclature as the solstitial colure. This name refers to the fact that, as we shall see below, this colure crosses the ecliptic at the solstices.

107In other words, though Grosseteste does not state this here, from west to east, because the rotating firmament moves east to west.

108Again, in modern nomenclature, one begins naming the signs at the vernal equinox, where the sun, travelling along the ecliptic, which is the center of the zodiac, is moving towards its northernmost point.

the second Taurus, the third Gemini, the fourth Cancer, the fifth Leo, the sixth Virgo, the seventh Libra, the eighth Scorpio, the ninth Sagittarius, the tenth Capricorn, the eleventh Aquarius, the twelfth Pisces.[109]

The beginning of Cancer, the fourth part, is the point on the ecliptic that is closest to the north pole. The motion of this point, as the firmament rotates, describes a circle equidistant from the equinoctial, and is therefore said to be parallel to it. That circle is called the summer tropic (*tropicus aestivalis*),[110] Grosseteste notes, because the sun draws near to it in the summer, before it begins to move again towards the south. Likewise, the point at the beginning of Capricorn, the tenth sign, revolving around with the firmament, will describe a circle equidistant from the equinoctial circle by the same amount as the prior circle, but on the other side. This circle is known as the winter tropic (*tropicus hiemalis*), because the sun reaches this point in winter before it begins moving back towards the north.

Next we must imagine a line that penetrates the center of the circle of the signs at right angles; this will be the axis of the zodiac. The poles of this line will be on the colure (the solstitial colure) that passes through the tropics at Cancer and Capricorn. The poles of the zodiac are declined from the poles of the world[111] by the same amount as the tropics are from the equinoctial circle.[112] The circumrotation of the poles of the zodiac describe two

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[109]The order of these signs can be seen in Figure 1 above.

[110]This circle may be better known to modern readers as the tropic of Cancer, which name comes from the zodiacal sign that follows the point described above.

[111]In other words, the arctic and antarctic poles.

[112]In other words, twenty-four degrees, or twenty-three degrees and thrity-three minutes.

circles equidistant from the equinoctial by the same amount.[113] The circle closer to the arctic pole is called the arctic or northern parallel (*parallelus arcticus sive septentrionalis*), whereas the other is called the antarctic or southern parallel (*parallelus antarcticus sive australis*). Grosseteste states that these five parallels (he does not name them, but they are the equinoctial circle, the two tropics, and the arctic and antarctic parallels) are the parallels that Virgil refers to when he says that the sky has five zones that mark out the regions of the earth.[114]

Grosseteste does not here include any diagrams for the reader's convenience. Due to the number of terms and geometrical relationships he has given, however, I have decided to construct diagrams for the convenience of the reader. The diagrams in Figures 3 and 4 can be used as reference, but the reader must understand that they are not a part of Grosseteste's text.

Grosseteste next tells his reader to imagine a circle directly beneath the zodiacal circle, at no place declined from the zodiac.[115] The sun moves along this circle in such a way that the center of the body of the sun is upon the circumference of the circle. It has a

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113That is, each is equidistant by the same amount from the equinoctial. Grosseteste does not perform the calculation, but they are equidistant from the equinoctial by ninety degrees minus the inclination of the ecliptic. Thus they are equidistant from the equinoctial by sixty-six degrees, or by sixty-six degrees and twenty-seven minutes.

114Baur identifies the source as Virgil's *Georgics*, 1, 233, but also notes a similarity to Ovid's *Metamorphoses* 1, 45–51. It is curious to note that the five parallels do not mark out the boundaries to zones, for then we would be left with six zones. Thus they must mark some sort of general region; the parallels are perhaps at the center of the zones.

115Imaginemur iterum circulum sub cingulo signorum recte dispositum nusquam a cingulo signorum declinantem. *De spera*, p. 15, ll. 20–21. I find the meaning of this sentence rather obtuse. I suspect that he means for the reader to imagine a circle inside of the region of the quintessence that could be projected onto the ecliptic circle, which is the center of the zodiac. He is just about to tell the reader about the motion of the sun, and the sun is understood to be within the region of the quintessence, and not on the firmament itself, which is the location of the ecliptic circle.

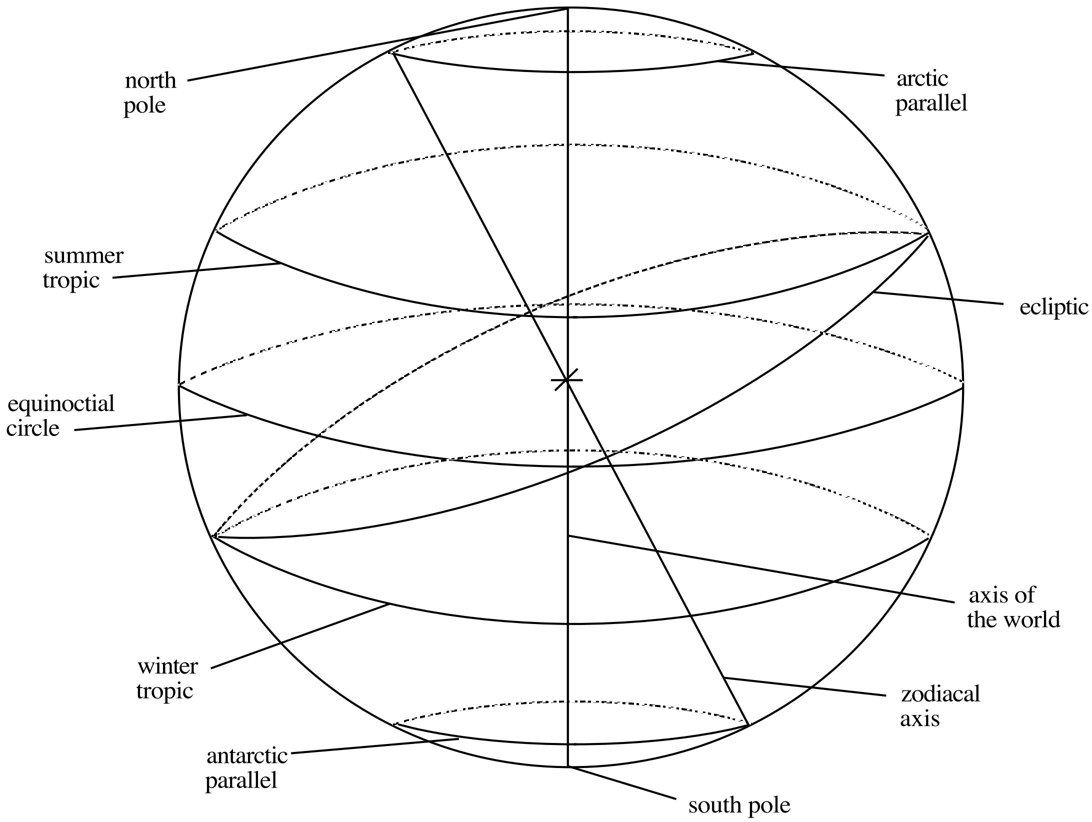

Figure 3. Circles, Parallels, and Ecliptic

proper motion along that circle against the motion of the firmament. It moves along the entire length of the circle in 365 and one-quarter days.[116] By the motion of the firmament, the sun is moved from east to west, but it also moves from west to east according to its own motion. Were the sun's own motion removed, notes Grosseteste, its revolution from east to west would describe a parallel equidistant to the equinoctial, or would move along the equinoctial itself if it were located at the beginning of Aries or Libra. But because the sun

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[116]…quod in 365 diebus et quarta diei fere percurrit circulum illum. *De spera*, p. 15, ll. 24–25. The true length of the year, which will be a point of contention in his *Compotus correctorius*, as described in the next chapter of this dissertation, is given simply as 365 and one-quarter days, without any suggestion that it might be different.

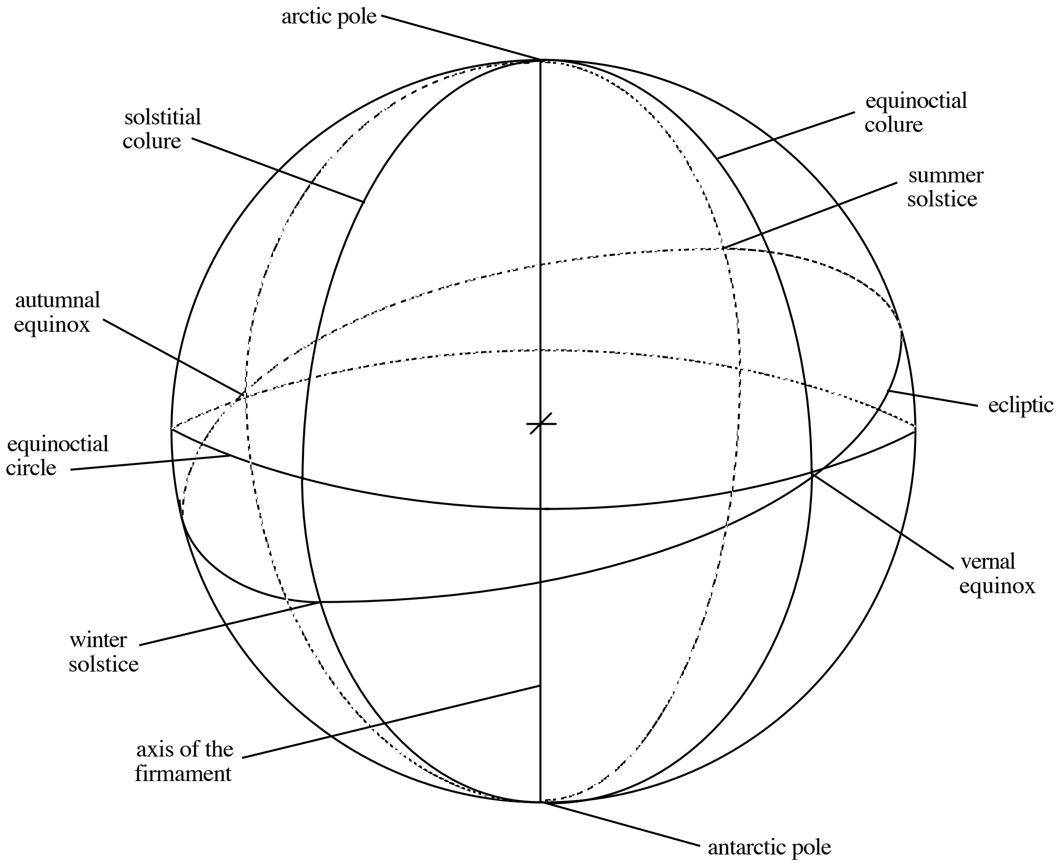

Figure 4. Colures, Equinoxes, and Solstices

does move of its own power at the same time as the firmament moves it, it moves away from the point at which its daily motion began. Thus, from the circumrotation of the firmament, the sun describes one circle[117] each day, and though the circle is not quite parallel, it is "insensibly different" from a parallel, and can be rightly called a parallel.[118] Therefore, he

117Unde circumrotatione firmamenti sphaeram unam quotidie describit. *De spera*, p. 15, l. 33. The text actually says that the sun describes one "sphere" each day. I have changed this to circle to preserve what I believe is the sense of the text. A sphere, as Grosseteste defined it earlier in the text, is not described by the sun. In addition, he will note immediately below that the motion of the sun can be called a "parallel," a word that properly belongs to a circle on a sphere.

118Quae sphaera quasi parallelus est et propter insensibilem differentiam parallelum nominamus quandoque. *De spera*, p. 16, ll. 1–2.

continues, it is clear that, regardless of the number of rotations of the firmament,[119] when the sun moves from the beginning of Cancer to the beginning of Capricorn, it covers all the parallels. And when it returns from Capricorn to Cancer, it moves through all those parallels again.

Grosseteste ends this chapter with a description of the horizon. The horizon is a circle that divides the half of the heavens that can be seen from the half that cannot. Thus, he says, the horizon is translated as the "boundary of vision" (*finitor visus*). The radius of vision is a straight line touching the earth. If this line is extended all the way to the firmament, and rotated about the point on the earth from which it originated, it will divide the sky into two equal parts, because the magnitude of the earth is insensible with respect to the heavens.[120] The circle of the horizon is thus described by the radius of vision. Therefore, there are as many horizons as there are places on the earth.

3.2.2. Chapter Two of *De spera*

Grosseteste does not use the term 'latitude,' but his second chapter is devoted to the topic of how changes in latitude affect the appearance of the sun as exhibited through the shadows it casts and moreover through the varying lengths of day and night experienced in different parts of the earth. He begins the chapter by noting that it is easy to see in which places on the earth equal days and nights occur. First, he states, we need to define the 'zenith capitis.' The zenith capitis is the farthest end of a straight line drawn from the center

119Grosseteste may use the construction "regardless of the number of rotations," because the lengths of the seasons are not equal.

120…cum magnitudo terrae sit insensibilis respectu coeli. *De spera*, p. 17, ll. 14–15.

of the earth, through the head of a person and all the way to the firmament.[121] In all places where this zenith capitis falls on the equinioctial circle,[122] the horizon passes through both poles of the world, because there is a quarter circle from the zenith capitis to the horizon (as there is from the equinoctial circle to the poles, though he does not repeat this here).

In such a place, the poles are immobile, and are always at the edge of vision; in other words, the poles fall upon the horizon. If one takes any point on the heavens, the revolution of the firmament will carry it in a circle around the poles. This circle, or parallel,[123] will necessarily be orthogonal to the horizon of the person whose zenith capitis falls upon the equinoctial. In addition, precisely half of that parallel will be above the horizon, and precisely half of it will be below the horizon. Because the motion of the firmament is constant, it will take the same amount of time for any point in the heavens to move through a whole parallel. In addition, it will move through half the sky in the same amount of time that it takes to move through the other half. When we consider the sun as being the point, we understand that it will be above the horizon for half its daily motion, which will correspond to daytime, and will be below the horizon for the other half of its daily motion, which will correspond to nighttime. This will occur no matter which parallel the sun occupies. Thus each day is equal to its night; and for every day, day and night are equal.[124]

121Voco autem zenith capitis extremitatem lineae rectae ductae a centro terrae per caput hominis usque ad firmamentum. *De spera*, p. 16, ll. 25–26.

122In other words, on those places that we would call the earth's equator.

123These circles are called parallels because they are parallel to the equinoctial circle. Thus each one of them is orthogonal to the horizon of a person whose zenith capitis is on the equinoctial circle.

124Manifestum est, quod omnis dies aequalis est suae nocti, et quilibet dies cuilibet diei et cuilibet nocti. *De spera*, p. 17, ll. 9–10. This passage can be a bit confusing because the term for day, *dies*, is used to denote both daytime, when the sun is visible above the horizon, as well as the twenty-four hour period of the revolution of the firmament, which is properly called a 'day.' In other words, Grosseteste is telling his

Moreover, Grosseteste continues, when one occupies a place directly beneath the equinoctial circle, the sun passes through the zenith capitis twice each year, namely, when the sun is at the beginning of Aries and at the beginning of Libra. At those two times, the sun follows the equinoctial circle. Before it reaches the meridian, a shadow will fall due west; after it reaches the meridian, a shadow points due east; and when the sun is at the meridian, an erect object will have no shadow at all. This happens because the shadow always falls opposite the source of light.[125] When the sun is in the northern signs,[126] the sun rises to the north and east. During its daily ascent, it stays to the north; when it reaches the meridian, that is, the line between the zenith capitis and the north, it casts a shadow due south. When the sun is in the southern signs, it rises between the east and the south, ascends and descends to the south, and the shadow at the meridian falls due north.

If one's zenith capitis falls between the equinoctial circle and the summer tropic, these appearances occur similarly. The sun yearly passes twice through the zenith capitis, at which time the sun in the meridian casts no shadows. The problem of the shadows, however, is a bit more complicated, though Grosseteste does not warn his reader. Allow me to diverge from the text, in order to make clear what Grosseteste says next. When one's zenith capitis falls between the equinoctial circle and the summer tropic, the parallel on which that zenith capitis falls is also found between the equinoctial circle and the tropic. This parallel is, by definition, parallel to both the equinoctial circle and the summer tropic, which means that it cuts the ecliptic into unequal parts.[127] Thus the sun can be found to the north of this parallel

reader that, at the earth's equator, each day and each night are equal throughout the year.

[125]Illud patet per hoc, quod umbra semper fertur in oppositum lucidi. *De spera*, p. 17, ll. 17–18.

[126]That is, when the sun is on the half of the ecliptic circle that falls to the north of the equinoctial; in other words, the sun is within one of the six zodiacal signs that fall to the north of the equinoctial circle.

[127]The equinoctial circle is the only parallel that cuts the ecliptic into equal halves. Both are great circles, and hence cut each other in half. No other great circle can be parallel to the equinoctial circle. Any

for less than half the year, and south of that parallel for the greater half of the year. I have illustrated this in Figure 5, which is not a part of the manuscripts. Say a person's zenith capitis falls on the parallel ABC. When the sun is at points A or B, where the parallel intersects the ecliptic circle, the sun at the meridian will be directly overhead, as stated above. The portion of the ecliptic to the north of A and B is smaller than the portion to the south of A and B.

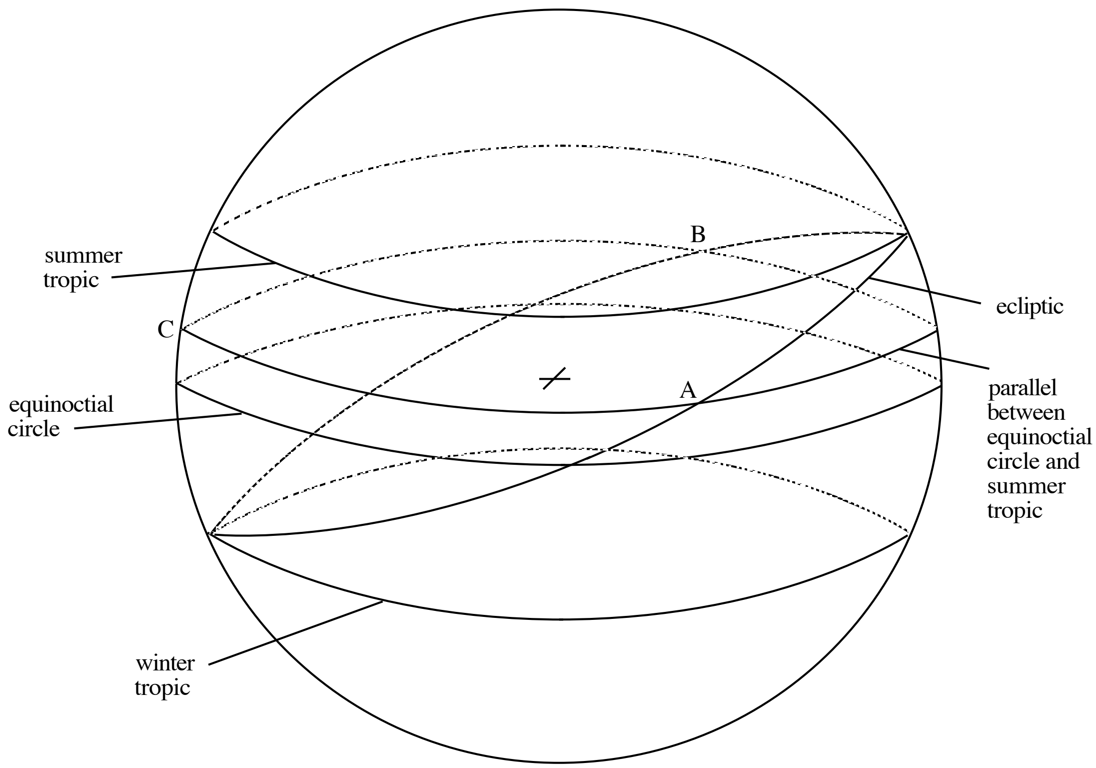

Figure 5. Parallel between the Equinoctial Circle and Summer Tropic

Let us now return to the text. When the sun is in the signs between the summer tropic and the parallel, the sun rises to the north, and the meridional shadow falls to the south. When the sun is between the winter tropic and the parallel, the contrary happens (in

circle that is parallel to the equinoctial is referred to as a 'parallel,' and is not a great circle.

other words, the sun rises to the south of east and the meridional shadow points to the north, though Grosseteste does not state this). Finally, Grosseteste also notes that, for those who are directly underneath the beginning of Cancer (in other words, those whose zenith capitis falls upon the parallel that interesects the northernmost point of the ecliptic), the sun passes through their zenith capitis once per year.

In all places[128] between the northern circle (*septentrionalis circulus*, which he has previously called the northern or arctic parallel) and the equinoctial circle, the day is longer than the night when the sun is in the northern signs, and vice versa when the sun is in the southern signs. This is so, he explains, because in those places, the north pole is elevated above the horizon by some amount, and its zenith capitis is distant from the equinoctial by the same amount. The horizon, which is a great circle, cuts across the equinoctial. All the parallels to the north of the equinoctial are cut such that the greater half falls above the horizon, and the smaller part below.

The preceding explanation is complex, and so I have again chosen to interrupt the exposition of the text to explain for the modern reader. The explanation refers to Figure 6 below, a diagram that is not a part of the manuscripts. The circle ABC denotes the horizon for someone whose zenith capitis falls on the equinoctial circle. All the parallels are cut in half by this horizon; for example, the parallel EGHF is cut at E and F, and so both arcs of the parallel from E to F (i.e., followed in either direction) are equal. If one's zenith capitis moves to the north, equivalent to changing one's latitude to the north, the horizon begins to tilt, represented by circle ABD; it remains, however, a great circle, and so it continues to intersect the equinoctial at A and B. Because of its tilt, however, it intersects the parallel EGHF at G and H. Because the arc EF is equal to half the parallel, the arc HFEG must be greater than half the parallel; this is the portion that appears above the horizon, while the

[128] By which he means all places in which the zenith capitis falls.

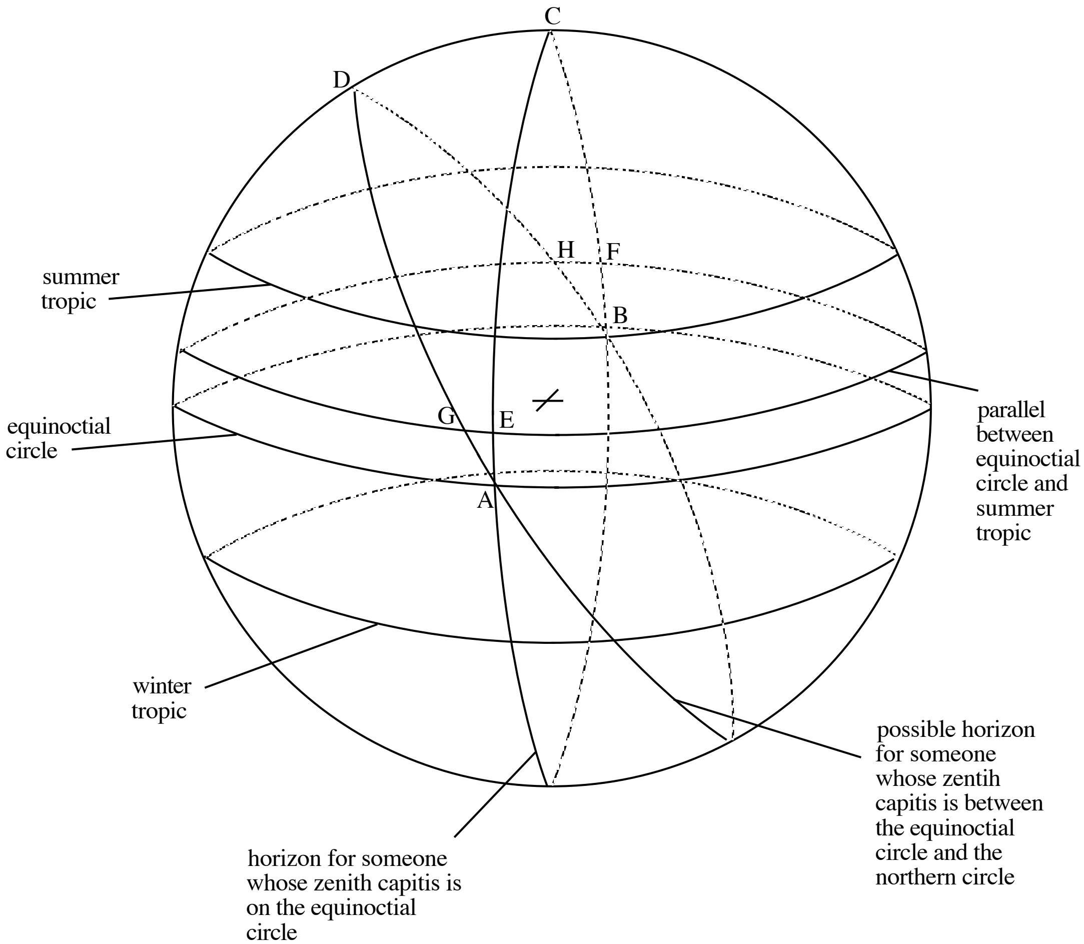

Figure 6. Horizon and Parallel

smaller portion is below the horizon.

Let us now return to the text. Because each revolution of the firmament is equal, and during each revolution the sun follows one parallel, then each day in which the sun is in the northern signs and the zenith capitis of the observer is north of the equinoctial circle, the day will be longer than the night, because that part of the parallel above the horizon is larger than that part below. Referring to the diagram above, the sun rises at H, travels through F and E and sets at G; because the arc HFEG of the parallel is more than half of the parallel, the day—the period when the sun is above the horizon—is longer than the night—the period

when the sun is below the horizon.

As the sun moves towards the beginning of Cancer,[129] that is, the northernmost point on the ecliptic, the days get longer, because the portion of the parallel above the horizon likewise gets larger. The opposite occurs when the sun is in the southern signs. In addition, the greater the distance of the zenith capitis from the equinoctial, the longer the days will be, because this will cause the horizon to be declined even further, and thus the parallels will likewise be inclined a greater amount to the horizon. In other words, though Grosseteste does not say this, the parallels will be cut into more unequal parts when the horizon becomes more and more inclined.

All of this that happens between the equinoctial and northern circles when the sun is in the northern signs, also happens in the corresponding places between the equinoctial and southern circles when the sun is in the southern signs. What happens to us (i.e., in the northern parts of the earth) when the sun is in the southern signs likewise happens to those in the southern parts when the sun is in the northern signs. One need merely imagine the south pole being elevated above the horizon and the north receding below the horizon.

In all places between the equinoctial and northern circles, each revolution is divided into day and night. However, if one is directly beneath the northern circle, then one revolution will be completely daylight, namely, when the sun is at the beginning of Cancer. This happens because, when one is under the northern circle, the zenith capitis aligns with the pole of the zodiac. When this is the case, the horizon and the zodiac are identical.[130] In that case, the whole summer tropic is above the horizon and the whole winter tropic is below

129…sol accedit ad caput cancri, *De spera*, p. 18, ll. 20–21.

130Grosseteste here uses the term zodiac to refer to the ecliptic, not the band of the zodiac, which stetches above and below the ecliptic.

the horizon.[131] Each parallel between these tropics cuts the horizon, and so each day has both daylight and nighttime. But when the sun is at the beginning of Cancer, the sun is visible during the whole revolution, because it is at the edge of vision, at the horizon. When the sun is at the beginning of Capricorn, however, the whole parallel is below the horizon, and the sun is not visible for one whole revolution.

In all places where the declination of the horizon is less than the declination of the zodiac,[132] of which there as many parallels as there are between the tropic and the equinoctial,[133] then some of the parallels on which the sun moves are completely above the horizon, while some are completely below the horizon. When the sun is on one of the visible parallels (*parallelos apparentes*), in other words, one of the parallels that is completely above the horizon, then there is daylight throughout the whole revolution of the firmament. When the sun is on one of the opposite parallels below the horizon, it is night throughout the revolution. As the zenith draws closer to the pole of the world, there are many parallels together that are either visible or hidden, whence daylight lasts for many revolutions, and nighttime occurs for the same number of revolutions.[134] If one is directly beneath the pole, the horizon is the same as the equinoctial circle. One half of the heavens is always visible and the other half is always invisible. For one half of the year, namely when

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131By way of illustration, examine Figure 3. The summer tropic touches the ecliptic at a single point, which is the summer solstice. Thus the pole of the zodiac and the pole of the horizon are the same, and the parallel of the sun at the summer solstice is completely above the horizon.

132Grosseteste again uses the term zodiac for the ecliptic.

133In other words, at whatever latitude the summer tropic falls, there is that much latitude above the northern, or arctic, circle.

134Unde plures revolutiones sunt dies unus et totidem nox una. *De spera*, p. 19, ll. 34–35.

the sun is in the northern signs, there is daylight, while the other half is night. “Whence the whole year is one day and one night.”[135]

3.2.3. Chapter Three of *De spera*

Grosseteste’s third chapter concerns the risings and settings of signs or parts of the zodiac. He begins the chapter by putting the problem in the abstract: how the risings and settings of signs are different between a right sphere and an oblique sphere.[136] This requires some explanation for the modern reader, although Grosseteste does not provide it. The oblique sphere refers to one in which the axis is not the one about which the sphere rotates, and which thus determines the rising and setting of signs. Consider the sphere on which the zodiac[137] is present.[138] The daily rotation of that sphere is about the axis of the world, which is the same as the axis of the equinoctial circle; the pole of the zodiac is inclined to that pole. Hence the zodiac is said to be on an oblique sphere, while the equinoctial is said to be on a right sphere.[139]

135Unde totus annus est unus dies cum una nocte. *De spera*, p. 20, ll. 2–3.

136…quid accidat de ortu et occasu signorum tam in sphaera recta, quam in obliqua. *De spera*, p. 20, ll. 4–6. On a previous occassion I had translated *sphaera* as circle, and it might seem appropriate again here. In this case, however, it is better to retain the term “sphere.” This will become clear as the text proceeds.

137It is clear from the context of this chapter that Grosseteste is here using the term zodiac to refer to the ecliptic circle, which is in the center of the band of the zodiac. I will retain this usage in my exposition.

138See, for example, Figure 3 above. The axis of the zodiac is inclined to the axis of the world.

139It is not obvious here whether Grosseteste is referring to these spheres cosmologically, but in other portions of the text he does appear to do so. That is, if we take an uppermost sphere to cause the daily motion, and a nested sphere to contain the stars, and thereby also the zodiac, then the spheres themselves are inclined with respect to each other. It is possible that the spheres could refer merely to those circles, in which case the analysis would still be valid; that is, the circle of the zodiac is oblique with respect to the right circle of the equinoctial. That Grosseteste assumes the reality of the spheres, however, is more

Grosseteste points out first that the equinoctial circle always rises uniformly (*uniformiter*), that is, equal parts rise in equal times. This occurs because the daily rotation of the heavens is uniform, and because the angle that the equinoctial makes with any given horizon never changes throughout this daily motion. The zodiac, on the other hand, will not meet these criteria and will rise unevenly; to give a measure of how much the zodiac rises, Grosseteste defines the ascencion of some part of the zodiac as the arc of the equinoctial that rises with that part of the zodiac.[140] Parts of the zodiac that have equal ascensions rise in equal times, while those that rise in unequal times have unequal ascensions. Equal parts of (i. e., distances along) the zodiac, however, do not necessarily have equal ascensions because they can rise at different angles; if it rises straight, it takes longer to rise, and when it rises obliquely, it takes less time to rise.

This is clear, Grosseteste writes, both by observation and imagination. In fact, however, he never discusses explicitly what observation would show.[141] In any event, he deals only with how imagination would demonstrate that this phenomenon is true. Imagine, he tells the reader, drawing great circles through the poles of the world that cut the zodiac into twelve equal parts.[142] These circles will also cut the equinoctial circle into twelve parts,

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consistent with the text as a whole.

140Arcus vero de aequinoctiali circulo, qui ascendit cum aliqua parte zodiaci, dicitur ascensio eiusdem partis. *De spera*, p. 20, ll. 10–12.

141Perhaps he takes this to be self-evident, but it is significant to realize that he has rejected observation as his chosen means of explanation. Imagination, which we will see in this case is essentially equivalent to geometric abstraction, is used instead.

142It may not be immediately obvious to the reader that great circles would necessarily cut both poles of the world and cut the zodiac into equal parts. Recall that a great circle divides a sphere into two equal halves. For any two points that are not the ends of a sphere's diameter, a unique great circle connects those points. The great circle will also, by definition, pass through the points at the opposite ends of the diameters from those two points. In the case of a pole of the world, a great circle will necessarily cut through the other pole; in the case of any point on the zodiac, it will cut through the opposite point, thus cutting the zodiac in half.

but these parts will be unequal. Where the zodiac is cut at a more acute angle, the corresponding portion of the equinoctial will be smaller, whereas when the zodiac is cut at a less acute angle, the corresponding portion of the equinoctial will be larger.[143]

Grosseteste next lists a number of phenomena that occur as a result of this geometrical arrangement of the circles. Any half of the zodiac will rise in an equal time as its corresponding half of the equinoctial. Each quarter of the zodiac between a tropic point and the equinoctial will rise with a quarter of the equinoctial circle. Every zodiacal sign has an ascension equal to that of its opposite sign. He also notes that, because the rising of one sign is equal to the setting of its opposite, the rising and setting of each sign in a right sphere is equal. A tropic point, in a right sphere, rises straight, whereas the equinoctial in such a sphere rises most obliquely. Therefore, when some sign neighboring a tropic point is in a right sphere, it rises more slowly and has a greater ascension; when it neighbors an equinoctial point, it rises more quickly and has a lesser ascension. Each of the two signs bordering the tropic point has an equal ascension, as do the signs neighboring the equinoctial point.

In an oblique sphere, all halves of the zodiac beginning in some point of a northern

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143…et pars in aequinoctiali, quae respondet parti zodiaci resectae ad angulos magis acutos, minor est parte aequinoctialis respondente parti zodiaci resectae ad angulos minus acutos. *De spera*, p. 20, ll. 23–26. This may be difficult for the reader to envision. Consider Figure 6 above. By way of exaggeration, consider the horizon pictured in that diagram. Like the zodiac, it is a great circle, but it is more greatly inclined, and hence the effects of its inclination will be increased. Now consider great circles cutting the horizon into twelve equal parts. From the northernmost tip of the horizon to an equinox point is one-quarter of the circle, and hence will be cut into three equal parts. It should be clear that the circles that do so will not cut the equinoctial circle into equal parts. The thirty-degree section of the horizon from the equinox point towards the northernmost point is more greatly inclined to the equinoctial, which will lead to the circle cutting the horizon at a more acute angle, and will thus correspond to a smaller portion of the equinoctial. Now substitute the zodiac for the horizon; the difference will not be so great, but will occur in the same manner.

sign have a greater ascension than its opposite half.[144] On a summer day, one half of the zodiac rises with the arc of the equinoctial. Consider the parallel on which the sun travels: more than half of it is above the oblique horizon. Grosseteste labels this portion of the parallel the *arcus existentus*. The other part of that parallel is less than half of the parallel; but the rising of that portion corresponds to the rising of the southern half of the zodiac. Half of the zodiac, half of the equinoctial, and the arcus existentus rise in the same time. The halves that begin at points equidistant from the tropic point have equal ascensions.[145] The signs that begin in the northern signs have greater ascensions than their opposite signs, and this difference is greatest at the tropic, in other words, between Cancer and Capricorn. The combined ascension of two signs and their opposites in an oblique sphere is equal to their combined ascension in a right sphere,[146] and the thirty degrees of the oppostie sign are added to the ascension, that is two equinoctial hours, because an equinoctial hour is the time of ascension of fifteen degrees of the equinoctial circle.[147] Finally, Grosseteste notes that when the zenith falls on the circle made by the pole of the zodiac,[148] the six signs from the beginning of Cancer to the beginning of Capricorn rise. When the pole of the zodiac is the zenith capitis, the horizon and the zodiac are the same, and thus are cut equally.

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[144]Although he does not state it explicitly, Grosseteste must here refer to the perspective of someone in the northern hemisphere.

[145]This is not surprising, as the sun is on the same parallel in each case.

[146]Ascensiones autem quorumlibet duorum signorum sibi oppositorum coniunctae in qualibet sphaera obliqua aequantur ascensionibus eorumdem in sphaera recta coniunctis. *De spera*, p. 21, ll. 26–29.

[147]By definition, there are twenty-four equinoctial hours in a single rotation of the heavens, and so 360 degrees divided by 24 hours leaves 15 degrees per hour.

[148]In other words, the parallel on which the zodiacal pole falls.

3.2.4. Chapter Four of *De spera*

The topic of chapter four is the inequality of natural days. The inequality results from the geometry of the cosmos, specifically, the unequal rising and setting times of the zodiac, as discussed in the previous chapter, but also from the sun's eccentricity. Imagine a line, Grosseteste writes, drawn from eighteenth degree of Gemini, through the center of the earth, and on to the opposite degree of Sagitarrius. From the center of the earth, move along that line two and a half degrees from the diameter of the sun's circle towards Gemini.[149] Place there a point, which will be the center of a circle of some (*eandem*) quantity. That quantity will be the semidiameter of the sun's circle; it exists below the ecliptic, and is not declined from it.[150] The circle of the sun (*circulus solis*) is that circle on the circumference of which the body of the sun (*corpus solis*) is moved.[151] The center of the body of the sun always moves along this path, and its proper motion is from west to east with uniform and equal motion. The point on the circle that is on the line drawn from Gemini through the earth and on to Sagittarius, and that is nearer Gemini, is the point on the path of the sun that is closest to the firmament and the farthest from the earth. The opposite point, closer to Sagittarius, is farthest from the firmament and the closest to the earth. The former point, that

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[149]Et a centro terrae computentur in eadem linea duo gradus et dimidus de diametro circuli solis versus geminos, *De spera*, p. 22, ll. 9–10. It is not entirely clear what the "two and a half degrees from the diameter of the circle of the sun" means. Grosseteste does not explain the term. The line from the earth towards Gemini will only in the next sentence be revealed to be along the diameter of the sun's orbit, but it seems most likely that the distance refers to the amount of the eccentricity of the sun's orbit. Referring to this quantity in terms of degrees (*gradus*), however, is unusual.

[150]Erit igitur ille circulus recte dispositus sub ecliptica nusquam ab ea declinans. *De spera*, p. 22, ll. 13–15. Grosseteste had written just before this that the sun existed on the surface of the band of the signs (*in superficie cinguli signorum*). The ecliptic, then, must be understood to be the circle on the heavenly sphere, whereas the sun's path is not the ecliptic itself, but is directly between the ecliptic and the center of the earth.

[151]We might refer to the circle of the sun as the path of its orbit.

of maximum distance from the earth, is called the *aux* or the “farther distance” (*longitudo longior*). The opposite point is called the “opposite *aux*” (*oppositio augis*) or the “nearer distance” (*longitudo propior*).[152] The circle of the sun is also called the eccentric of the sun because the center of that circle is removed from the center of the earth. For this reason, it is also called the “circle removed from the cusp” (*circulus egressae cuspidis*), because its cusp (*cuspis*), or its center, Grosseteste tells us, is removed from the center of the earth. The sun, as it is moved uniformly on this circle, is moved uniformly through the heavens.

Therefore, Grosseteste continues, the uniform motion of the sun is one cause of the inequality of natural days. The sun has its own proper motion along its path from west to east, as was just mentioned. Because this motion is along a circular path inclined to the rotation of the firmament, which was the subject of the previous chapter, the ascension of the sun is slightly different from day to day. During one given revolution, then, the motion of the sun will be some amount more or less than that during the next revolution, thus leading to unequal natural days.[153] Because the more obliquely rising parts of the zodiac have smaller ascensions than equal parts that rise straight, if the sun moves uniformly in the heavens, another cause of the inequality of natural days is evident, namely, that the ascensions will be greater or smaller from one revolution to the next. If both of these causes act in tandem, that is, if the motion of the sun adds to the day and the ascenion is more

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[152]Baur includes a diagram illustrating these points and the location of the center of the circle of the sun; see *De spera*, p. 23. Many manuscripts do not include such a diagram, nor is there reference in the text to it.

[153]Cum enim dies naturalis sit una revolutio firmamenti et insuper ascensio eius quam describet sol in caelo interim motu suo proprio et durante una revolutione plus aut minus describit sol quam sequenti revolutione, manifestum est, quod quantum est de ista causa, erunt dies naturales inaequales. *De spera*, p. 22, l. 33–p. 23, l. 2. It is only at this point that the reader is told, albeit implicitly, that the “natural day” refers to the motion of the sun as opposed to the rotation of the firmament.

oblique than the succeeding day,[154] both causes contribute to making the natural day longer, and such days are called 'larger days' (*dies maiores*). When the two causes make the natural day shorter, these days are called 'smaller days' (*dies minores*). And when the two causes act against another, that is, "when one cause adds as much as the other takes away,"[155] the days are called 'middle days' (*dies mediocres*).

This geometry leads not only to unequal natural days, but also to causing certain portions of the earth to be inhabitable or uninhabitable. When the sun is at the opposite *aux*, it is closer to the earth by five degrees than when it is at the *aux*.[156] Thus, when the sun is in the southern signs (of which Sagittarius is one, though Grosseteste does not remind the reader of this), it is significantly closer to the earth. Thus the cause of the heat is duplicated in the southern region of the earth during that region's summer: the sun is close, and it is more directly overhead. When the sun is in the northern signs, it moves away from the earth and away from the southern zenith, thereby leading to a double cause of cold. But when the sun rises towards our (i.e., the northern) region, it is also moving away from the earth. And when it recedes from our zenith, it moves closer to the earth. Thus the northern region is temperate.

The northern region of the earth, Grosseteste writes, is divided into seven climes (*climata*). He defines a clime as a space on the earth through which a sun-dial (*horologium*)

154Grosseteste phrases this as "the next parts rise straight in the zodiac" (*partes sequentes rectius oriuntur in zodiaco*), *De spera*, p. 23, l. 9. I have used what seems to me to be a less cumbersome construction.

155Quando vero tantum addit una causa, quantum reliqua diminuit, *De spera*, p. 23, ll. 14–15.

156Grosseteste does not explain why it is closer by five degrees, but it is because the center of the eccentric circle is offset from the center of the earth two and a half degrees. The difference in distance between the two points is thus double this amount, but it is still not clear what he means by degrees (*gradus*) in this context.

is sensibly changed.[157] In other words, during a summer day in one clime, the sun-dial casts a smaller shadow in the region to the south.[158] When a sensible difference is noticed, that space is called a clime (*clima*), and the observed difference in the sun-dial is not seen at the beginning and end of this space.[159]

Grosseteste ends this chapter with a description of the earth, what we might think of as geography, to further explain the concept of the climes. Imagine, he states, a great circle going around the body of the earth under each pole, and another great circle going around the body of the earth under the equinoctial circle. According to the location of these two circles, two seas go around the whole earth. That which circles the earth under the poles is called *amphitrites*, and the other (under the equinoctial) is called *oceanus*. Those two seas divide the earth into four parts, of which one is inhabited.[160] The region in the eastern corner made by the two seas of the inhabitable quarter is called simply the East (*oriens*), while the other is called the West (*occidens*). If one considers a space between the *oceanus*, which is the space described above (i.e., in reference to the change in the sun-dial), and a

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157Et dicitur clima tantum spatium terrae, per quod sensibiliter variatur horologium. *De spera*, p. 24, ll. 9–10.

158Idem namque dies aestivus aliquantas est in una regione et sensibiliter est minor in regione propinquiore austro. *De spera*, p. 24, ll. 10–12. Grosseteste does not actually state that the shadow gets smaller, but refers to the sun-dial (*horologium*) getting smaller. Clearly the term horologium cannot refer to the device itself.

159Spatium igitur tantum, per quantum incipit sic idem dies sensibiliter variari, dicitur clima. Nec est idem horologium in principio et fine huius spatii observatum. *De spera*, p. 24, ll. 12–14. This is a curious definition. Grosseteste seems to understand the geomtery of the cosmos well enough to understand that the shadow cast by the sun would vary regularly as one moves upon the earth. As the climes border each other, the shadow on either side of a boundary would not be sensibly different, and certainly would be more alike than those at the beginning and end of a single clime.

160Grosseteste does not explain why only one region is inhabited. The southern parts, he has already argued, are uninhabitable due to the place of the sun in the cosmos. Why the other northern region would be uninhabited he does not explain.

line that is drawn on the surface of the earth equidistant from (i.e., parallel to) the *oceanus* and ending in the *amphitrites*, that space is a clime. Do this again to the north of that line, drawing another line between the *amphitrites* and equidistant from the first line, and the intervening space is the second clime. Then one proceeds similarly for the rest of the climes.[161]

3.2.5. Chapter Five of *De spera*

Grosseteste proceeds to discuss what it means that the stars are fixed. They have the movement of rotation from east to west that is shared by all celestial bodies. That they are called fixed, he writes, seems to suggest that they do not have any other motion. In fact, however, they are not called fixed because they have no proper motion of their own, but because their arrangement in relationship to each other does not change. Specifically, a figure or image made by some of them always remains; for example, if three stars make a triangle, they always retain that configuration.[162] The name fixed is applied because such figures are fixed. Ptolemy, Grosseteste tells his reader, in the book the *Almagest* states that all the fixed stars and all the planteary *auges* move around the poles of the zodiac at the rate of one degree of a circle every 100 years.[163] They move in relationship to the firmament. As a result of this motion, the *aux* of the sun will move from the northern region into the

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161Et ad eius similitudinem significantur sequentia climata. *De spera*, p. 25, l. 11. Baur includes a diagram on p. 24, but again this diagram is not always present in manuscripts, and the text does not refer to it.

162Sed sciendum est, quod non dicuntur stellae fixae, quia non habent motum proprium, sed quoniam figura et imago, quam constituunt aliquot ex his, quae dicuntur stellae fixae, semper retinetur ab eis, verbi gratia si tres stellae triangulum faciunt, semper retinent eandem figuram. *De spera*, p. 25, ll. 14–20.

163This is equivalent to what we label precession, though Grosseteste does not provide a description of the phenomenon that Ptolemy describes.

southern region, and will thereby change which portions of the earth are inhabitable, based upon the explanation given in the previous chapter: that the sun's eccentricity leaves the region between the ecliptic and the southern parallel uninhabitable.[164]

Thebit, who, Grosseteste writes, worked upon the texts of Ptolemy, found through "particular observations" (*per certa experimenta*) that the motion of the stars proceeds in the following manner.[165] Keeping in mind that the stars move, we imagine in the sky the zodiac of twelve unchanging (*constantem*) signs. These signs are divided into four parts through the two equinoctial and solstitial points; Aries and Libra begin at the equinoctial points, and Cancer and Capricorn begin at the solstitial points. This is called the fixed zodiac (*zodiacus fixus*), and the twelve 'signs' are merely spaces in the firmament.[166] Below the firmament is the sphere of fixed stars, and in that sphere we have another zodiac, which is composed of the stars. This zodiac Grosseteste labels the zodiac of the animals (*zodiacus a zoas*) because it is composed of animals, or more precisely the images of animals, made by the stars of which it is composed.

Next, at the *caput*, or beginning, of Aries, we imagine the center of a small circle of

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164…fieretque regio habitata inhabitabilis; quod patet per rationem superius dictam, qua ostenditur per solis excentricitatem, quod regio inter eclipticam et parallelum australem est inhabitabilis. *De spera*, p. 25, ll. 28–31. There are two items of note here. First, Grosseteste has more fully explained which regions are contemporarily uninhabitable. Second, there is no comment on the fact that portions of the earth which are habitable will become unihabitable; perhaps this is because much of the inhabitable world is above the northern parallel (i.e., the northern tropic) and hence will not be effected.

165This is not the same as precession, though Grosseteste has not made it particularly clear to the reader that the phenomenon he is about to discuss, as taken from Thebit, is something different from he what he just attributed to Ptolemy. This phenomenon is usually called the trepidation of the equinoxes, though again Grosseteste does not use this term. It is not clear if Grosseteste understands that the two theories describe different phenomena, or if he is presenting them as alternative possibilities.

166Eruntque 12 signa 12 spatia solum firmamentum. *De spera*, p. 26, ll. 4–5. In other words, we understand these signs to be the spaces in relationship to the equinoctial and solstitial points, which will not correspond to the stars or constellations after the fixed stars have moved.

eight degrees and thirty-seven minutes.[167] At the *caput* of Libra, we imagine a similar circle. The *caput* of Aries and Libra of the imaginal zodiac[168] are carried upon the circumferences of these two small circles, moving upon them. When in the northern parts, the caput of Aries is carried with the motion of the firmament, while the motion of the *caput* of Libra is against it; in the southern parts this is reversed.[169] The motion on these circles is one degree and two minutes every twelve years.

When the *caput* of the mobile Aries[170] is in the nineteenth minute of the fifth degree of the fixed Aries,[171] then the *caput* of the mobile Libra is in the same place within the fixed Libra. And when the *caput* of the mobile Aries is in the forty-second minute of the twenty-sixth degree of the fixed Pisces, the *caput* of the mobile Libra is in the same place in the fixed Virgo. As these motions occur, the *caput* of the imaginal Cancer and Capricorn cling

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167In this case, as will be seen below, the measurment of eight degrees and thirty-seven minutes seems to refer to the 360 degrees of the larger zodiac. That is, the radius of the circle extends the distance as four degrees, and eighteen and a half minutes of the zodiac; Grosseteste cannot give an absolute measure of length without knowing the distance to the firmament. This is probably what occurred when he was discussing the eccentricity of the sun, but in that case it was not clear what the basis for the measurement was meant to be. Baur includes a diagram on p. 26, but this is not consistently found in the manuscripts, is not described in the text, and moreover contains terms and information not found in the text.

168…caput arietis et librae zodiaci imaginum, *De spera*, p. 26, l. The term 'imaginal zodiac' is my choice for the translation of this phrase; I have used this term because of his previous explanation that this zodiac is based on the images seen in the stars. Grosseteste uses this term in place of his previous label of 'zodaic of the animals,' and will later use the term 'mobile zodiac.'

169The motions with and against the firmament are the natural result of motion around the circles; Grosseteste is merely telling us at what points the motion happens to be with the firmament and when it has the opposite motion.

170Grosseteste uses the term *caput arietis mobilis*. He has switched between various terms for the imaginal or mobile zodiac without warning.

171Because the radius of the small circle that carries the *caput* is half of eight degrees and thirty-seven minutes.

to the ecliptic, processing or regressing within it.[172] The *caput* of the mobile Aries, on the other hand, as it moves away from its fullest extent in Pisces also moves away from the ecliptic; the *caput* of the mobile Libra does the same in its part. The *caput* of the mobile Aries returns to the ecliptic only when it reaches the aforementioned minute in the fifth degree of the fixed Aries.[173] These concepts are somewhat difficult to visualize, so I have included the diagram in Figure 7 to aid the reader in following the preceding explanation. My diagram has some similarities to that in Baur, but does not occur in any manuscripts.

The *caput* of the mobile Cancer is moved on the ecliptic into the same place in Gemini when the *caput* of the mobile Aries is in the aforementioned place in Pisces. As the *caput* of the mobile Aries moves towards the aforementioned minute in the fifth degree of the fixed Aries on the circumference of the aforementioned circle, the *caput* of the mobile Cancer always progresses through the ecliptic until it comes to the nineteenth minute of the fifth degree of the fixed Cancer, at the same time as the *caput* of the mobile Aries reaches the same place in the fixed Aries. As the *caput* of the mobile Aries moves back towards Pisces, again on the circumference of the small circle, the *caput* of the mobile Cancer moves back along the ecliptic in the same manner. And this motion is actually the motion of the whole sphere of the fixed stars and the *auges* of the planets.

Grosseteste now moves on to discuss the moon. The course (*cursus*) of the moon is below the ecliptic, but not directly below it like the sun. Rather, the circle of the moon (*lunae*

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[172]Caput vero cancri et capricorni imaginum adhaerent in ecliptica, progrediendo et regrediendo in ea. *De spera*, p. 27, ll. 8–9.

[173]Recall that *caput* of the mobile Aries and Libra move on the circumferences of small circles centered upon the respective *caput* of the fixed zodiac. The circumference of these small circles crosses the fixed zodiac, i.e., the ecliptic, at only two points, namely, when they are at their full distance away from the fixed *caput* as seen from earth (i.e., in the fifth degree of the fixed Aries/Libra or the twenty-sixth degree of Pisces/Virgo). Only at those points, then, is the *caput* of the mobile zodiac on the ecliptic.

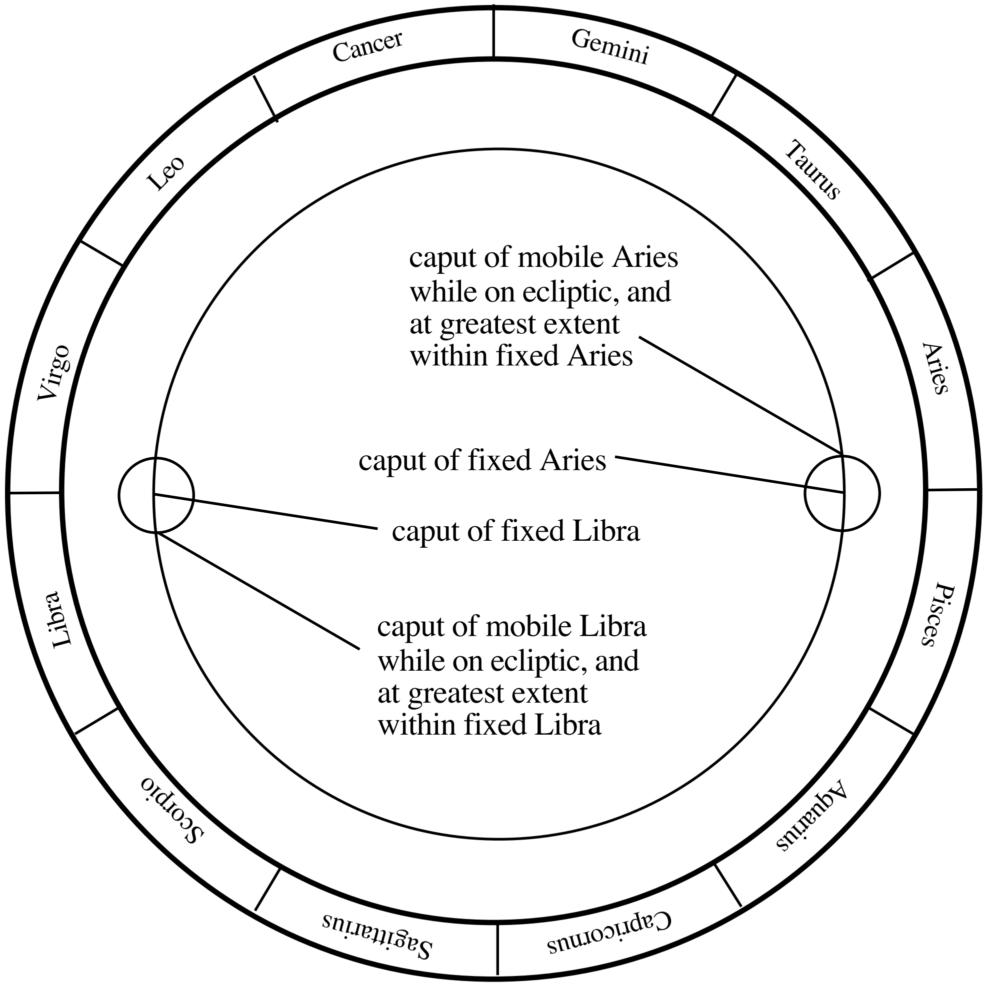

Figure 7. Fixed and Mobile Zodiacs

circulus) crosses the ecliptic at two opposite points, and is inclined to it by five degrees. The circle of the moon is eccentric, as is the circle of the sun. On the circumference of the eccentric is the center of a small circle (*circulus brevis*), which is tilted from the eccentric.[174] The center of the body of the moon is always on the circumference of the

[174]In other words, the moon has an epicycle-deferent system, in which the deferent is eccentric and the epicycle is at an angle to the deferent. Grosseteste will use the term epicycle later in the text to refer to the small circle, but conistently uses eccentric rather than deferent for the larger circle. He also states that the circles are "on one surface" (*Sunt…in superficie una*), though the meaning of this is unclear. Obviously they do not occupy the same plane, as the epicycle is tilted with respect to the eccentric. It also seems

small circle. The eccentric revolves from east to west with a continual and uniform motion. In addition, the center of the eccentric circle moves on the circumference of a (third) circle, which is centered upon the earth's center. The center of the eccentric moves along the circumference of this (third) circle. The center of the small circle (i.e., the epicycle) moves in the opposite direction, west to east.

If a line is drawn from the center of the earth through the center of the small circle (i.e., the epicycle) and on to the firmament, the end of the line is moved with an equal motion, and this motion is called the mean motion of the moon in the heavens (*motus lunae medius in caelo*). Whenever this mean motion of the moon brings the point at the end of the aforementioned line into coincidence with the mean motion of the sun,[175] the center of the epicycle (Grosseteste does use this term here, rather than 'small circle') is in the *aux* of the eccentric of the moon.[176] Immediately thereafter, the *aux* of the eccentric and the center of the epicycle move away from one another, and the mean motion of the sun is left between them, equally distant from each. This must be the case, he writes, for when the mean motion of the sun and moon are in opposition,[177] the center of the epicycle is again at the *aux* of the

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unlikely that he is referring to the cosmic orbs, because in the first chapter, when discussing the spheres of the elements, he referred to the 'surafces' between the spaces as spheres, and did not call the intervening spaces 'surfaces,' but rather labeled them 'figures.'

175Note that Grosseteste has not defined the mean motion of the sun in the text. He uses the term in such a way that it must refer to a point in the firmament defined by the mean motion, just as he had done for the mean motion of the moon.

176Recall that aux is the point of the circle farthest from the earth. Because the center of the eccentric moves, so too does the aux. By stating that the center of the epicycle is at the aux when the mean motions of the sun and moon coincide, Grosseteste has partially defined the way in which the eccentric moves; that is, the coincidence of the motions is not the result of some definition of the motions, but acts to delineate the motions themselves.

177…cum medius motus lunae opponitur medio motui solis, *De spera*, p. 28, ll. 10–11. That is, when the points defined by the mean motion lie on a line that interesects with the center of the earth, but are on opposite sides of the earth. In the previous case, he had been discussing conjunction, when they similarly lie on a line with the center of the earth, but are on the same side of the earth.

eccentric. Thus they separate and again come together when the mean motions come together. Thus, the center of the epicycle traverses the eccentric twice in one month.[178] The motion of the epicycle is faster than the motion of the eccentric by the same amount as the mean motion of the sun.[179] But in another way, the mean motion of the moon and the center of the eccentric are not always equally different from the mean motion of the sun. Because the moon moves on the circumference of the epicycle, and so in the superior part of its epicycle it moves with the firmament from east to west, while in the inferior part it moves from west to east.

The eccentric of the moon, as mentioned above, Grosseteste writes, cuts the ecliptic in two opposite points. The point at which the moon moves from south of the ecliptic to the north is called the *caput draconis* ("head of the serpent") and the opposite point is called the *cauda draconis* ("tail of the serpent"). The union of the two circles, which forms a twisted (*tortuosa*) figure, is called the *draco lunae* ("serpent of the moon"). When the moon is at or near the *caput* or *cauda draconis*, and the sun is on the opposite side of the earth, there will be a lunar eclipse. If the moon is more than twelve degrees away from either one, there will not be an eclipse. An eclipse of the moon occurs, Grosseteste states, because the moon passes through the earth's shadow, which is always cast opposite the sun. The sun is a luminous body and the earth is a shadowy body.[180] Because the rays travel in

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178This must be the case, because the center of the epicycle traverses the whole circumference of the eccentric during the time when it is in conjunction and then opposition, because it moves from the aux and then returns to it. Thus in one month, the time from conjunction to conjunction or from opposition to opposition, the center of the epicycle comes back to the aux twice.

179Estque motus epicycli velocior motu excentrici, quantum est motus medius solis. *De spera*, p. 28, ll. 15–16.

180…sol sit corpus luminosum et terra corpus umbrosum, *De spera*, p. 29, ll. 11–12. By 'shadowy,' Grosseteste apparently means that it does not produce light.

straight lines, and because the sun is larger than the earth, the sun necessarily projects a pyradimal shadow; this shadow, Grosseteste states, ends at the point directly opposite the sun on the ecliptic. Because the sun is always under the ecliptic, the cone of the shadow of the earth is always under the ecliptic, too.

The body of the moon is also shadowy, and does not produce any light, except from the sun. The part that faces the sun is always illuminated, whereas the opposite side is in shadow. When the sun and moon are in conjunction, the side that faces the earth is completely in shadow. As the moon gradually moves away from the sun, parts of it become illuminated because the rays of the sun strike different parts of it. As the sun recedes more from the sun, more of the part facing the earth is illuminated. When the moon is in opposition to the sun, the whole half facing the earth is illuminated. "And then it is called *panselenos*, the full moon, for it is full of light."[181] Then as it gradually moves back towards the sun, and so the light on the side facing the earth gradually decreases. When the full moon exists on either node or near them,[182] then it is under or near the ecliptic, and it must pass through the earth's shadow, and will lack light either upon the whole moon or some part of it.[183] But if, at the full moon, it is far removed from either node, then it is also removed from the ecliptic, and since the shadow (of the earth) falls under the ecliptic, the body of the moon is not touched by the shadow, but passes by it and does not lack any light.

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[181]Et tunc dicitur panselenos quasi plena lumine. *De spera*, p. 30, ll. 4–5.

[182]Luna igitur plena existente in altero nodorum vel prope, *De spera*, p. 30, ll. 7–8. These passages are the only places where Grosseteste uses the term 'node,' which refers to the *caput* and *cauda draconis*.

[183]…ut transeat per umbram terrae et patiatur defectum luminis aut in toto aut secundum partem. *De spera*, p. 30. ll. 9–10.

The lack of light can vary because of the differences in the aspect of the moon (*diversitatem aspectus lunae*). The diverse aspect of the moon is the arc of a great circle crossing over the zentih capitis that passes between the true place (*verum locum*) of the moon and the place it appears to be (*locum in visu apparentem*). The true place of the moon is the end of the line leading from the center of the earth through the center of the body of the moon and on to the firmament.[184] Because the earth has a sensible magnitude compared to the circle of the moon, the straight line, leading from the eye of one who both sees the moon and is not under the moon, through the center of the body of the moon and on to the firmament, ends in a place that is different from the aforementioned line. The place where the line from the eye through the moon ends is called the apparent place of the moon (*locus lunae apparens*).

The arc between these two places is called the diverse aspect of the moon. That name, the diverse aspect of the moon, is divided (*divisa est*) between the diverse aspect of the moon in longitude and the diverse aspect of the moon in latitude. Neither of those is the same as the diverse aspect referred to in the first instance. We can imagine, Grosseteste writes, the two diverse aspects of the moon thus. A circle is imagined passing through the true place of the moon, equidistant from (i.e., parallel to) the ecliptic if the true place is not on the ecliptic; if it is on the ecliptic, then we use that circle. Similarly, another circle, equidistant from the first, passes through the apparent place of the moon. Next, through the pole of the orb of the signs,[185] pass two great circles, one of which passes through the true

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[184]It is worth noting here that Grosseteste refers to the end of the line being in the firmament so that the reader understands the "true place" of the moon to refer not to the actual physical loaction, but to the projection of that place on the firmament.

[185]…per polos orbis signorum, *De spera*, p. 30, l. 36. This refers to the sphere, or orb, of the stars to which Grosseteste alluded earlier in the chapter when he discussed the mobile and fixed zodiacs. This is his first use of the term 'orb.'

place of the moon and another through the apparent place of the moon. The four circles intersect and thus make a quadrangle out of the four arcs that exist between the sections.

The arc of the circle equidistant from the ecliptic that passes through the apparent place of the moon is the diverse aspect of the moon in longitude. The arc of the circles cutting though the poles of the orb of the signs that pass through the two circles equidistant from the ecplitic is called the diverse aspect of the moon in latitude.[186] The first diversity, of which we spoke before, is the diagonal of these, which can be taken from the quadrangle. When it is the case that both circles equidistant from the ecliptic are in the same place, the diverse aspect in latitude is nothing. When the two remaining circles are in the same place, the diverse aspect in longitude is nothing.

This shows that, although the sun and moon are in conjunction at the point of either the *caput* or *cauda draconis* or near the *caput* or *cauda draconis*, when the moon in the southern parts, there will not be an eclipse of the sun in the north, because the apparent place of the moon is in the part to the south of the ecliptic. There will be an eclipse of the sun when the apparent place of the moon is in the same place as the sun, or when the distance between them is less than the two semidiameters (i.e., radii) of them, namely the sun and moon. When the sun and moon are in conjunction, and the moon is in the north, there will be an eclipse in the northern regions. Not in all cases, but only when the apparent place of the moon is on the ecliptic, or near to it by a distance less than the two semidiameters of the sun and moon.

3.3. Analysis of the *De spera*

A number of questions regarding this text can be considered, now that we have examined its content. The first is when the work was written. Baur dates the text to the

[186]The arc of either circle that cuts through the poles can be used; the arcs will be equal because the circles they cut through are both parallel to the ecplitic and thus to each other.

period 1215–1230,[187] but bases this largely on a comparison with Sacrobosco's text of the same name; we shall discuss the relationship between those texts at greater length at the end of this section. McEvoy dates it to only a few years after 1215, because its contents do not reveal a great deal of familiarity with Aristotle, and because later works show disagreement with what had been asserted in the *De spera*.[188] But McEvoy also relies on the dating of Oxford MS Bodl., Savile 21, specifically that Grosseteste made use of the works by Thebit contained in that manuscipt for the composition of the *De spera*. But as we have seen, the date of this manuscript is questionable, and it could, in fact, date from up to twenty years earlier. So other means to date the text must be used.

What can we learn from the text itself regarding its dates of composition? Some Aristotelian material is present in the text. The geocentric picture of the cosmos is consistent with, but not unique to, Aristotelian physics. The arrangement of the elements, with the celestial region occupied by the quintessence, and the terrestrial region corresponding to the typical arrangement of the other four elements, is also consistent with Aristotelian natural philosophy. The quintessence, and especially its characteristic of moving in circles, implicitly provides the material cause of the motion of the celestial bodies, and Grosseteste explictly identifies an efficient cause for its motion.[189] None of these aspects, however, would have required the in-depth study of Aristotelian natural philosophy that Grosseteste engaged in only after the early 1220s. Grosseteste cites Aristotle only once in the text, and has only a brief reference to one of his philosophical claims, which hardly implies a close

[187]Baur, *Werke*, p. 64.

[188]McEvoy, "The Chronology," pp. 617–618.

[189]The efficient cause that he names, however, is the World Soul. McEvoy has pointed out that this is not an Aristotelian notion; see his "The Chronology," p. 617.

study of Aristotelian texts. In fact, Grosseteste seems little aware of the tensions between the homocentric, spherical system of Aristotle's *Physica* and *De caelo* and Ptolemy's *Almagest*.[190] While Grosseteste could theoretically be ignoring the problem in an effort to present the basic science of astronomy, he does not refrain from mentioning the issue in another text, his *Compotus correctorius*, with which we shall deal in the next chapter. With that precedent, it is difficult to assert that the *De spera* could date from later than the early 1220s, because after that time, issues of natural philosophy would certainly have been important to Grosseteste.

Another potential issue by which to decide when the text was written is the presence of astrological material in the text. As discussed in the first section of this chapter, Grosseteste maintained throughout his life the astrological belief that celestial bodies did indeed affect terrestrial bodies, as evidenced, for example, through their effects on the weather. Even in his *Hexameron*, a product of his time in the episcopacy, and hence after 1235, he does not deny that there are real affects of an astrological nature; in the *Hexameron*, he merely denies that the astrological influences affect the human will in a significant way. And yet astrological material is distinctly missing from the *De spera*. It would appear, at the very least, that Grosseteste is aware of the distinction between astronomy and astrology as he stated it in his later *Hexameron*. In the *De spera*, he restricts his attention to issues of the motions of the heavenly bodies. Moreover, he neglects to address many of the problems that would face someone interested in using his astrological materials, for example, the *De aeris*. He provides no instruction for using astronomical tables, neither reading them nor constructing them. He also does not discuss the motions of the planets other than the sun and the moon. Certainly a reader of this text would not leave it

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[190]There remains the issue of what he means when he says that the moon's circle and epicycle are on the same surface. But this problem is not solved by positing knowledge of Aristotelian natural philosophy.

with any strong ability to deal with the astrological sciences with which Grosseteste deals in other works.

At the same time, however, there is a great deal of information in this text that would be of interest to a person wanting to gain knowledge in the astrological sciences. Some of the terms that appeared in the *De aeris* are defined in the *De spera*, such as zenith capitis. In addition, certain information assumed in the *De aeris* is explained more fully in the *De spera*, such as why each zodiacal sign has thirty degrees. Yet the text of the *De spera* does not explicitly offer much in the way of the astrological sciences. And, in fact, much of it is not directly applicable to astrology. The definition of the various circles in the heavens, for example, or the climes of the earth are not important for astrology. While some of this information might be necessary, or at least helpful, to one who studies astrology, preparation for that task does not appear to be the goal of the *De spera*. Exactly what the goals of the work were, we shall discuss later; at this point, however, we can assert that the lack of overt astrological material in the text does little to aid us in dating it. Because Grosseteste's belief in certain kinds of astrology never waned throughout his life, the lack of such material in the *De spera* is not helpful to dating it.

Another piece of information that is relevant is Oxford MS Bodl., Savile 21, mentioned in the first section of this chapter. Again, the evidence is not compelling as regards the *De spera*. The material in Grosseteste's hand, for example, includes astronomical tables, among which are tables on converting dates, a work on calculating the times of eclipses, and horoscopic diagrams. All but the last are clearly relevant not to the topic of the *De spera*, but to his work on compotus, as we will see in the next chapter. And the horoscopic tables are, of course, not helpful based on what has just been argued about the lack of astrology in the *De spera*. The Savile manuscript does, however, include works of Thebit, which are relevant to the topics of the *De spera*, and in fact, as we have seen, Grosseteste uses Thebit's theory of the mobile zodiac in that text. But as we saw in the

previous discussion of the Savile manuscript, the dating of it is problematic, and there is reason to suggest that it could be significantly earlier than the accepted date of 1215–1216.

Thus many of the potential means to date the text have proved inconclusive. It will therefore behoove us to change the tack of our analysis, and ask a different question, which may in turn allow us to argue plausibly for a range of possible dates. Specifically, it will be helpful to ask for what purpose the text was written. On the one hand, this seems fairly obvious: it conveys many of the basic principles of contemporary astronomy. But, in fact, Grosseteste must have made a number of decisions on what to include in this text. By analyzing what the text does and does not include, we can gain a better sense of what the text was intended to do.

First of all, it is worthwhile to note that the text appears to take the form of a work for use in the classroom. The frequent use of the first person, both in the singular and the plural, suggests the text could have arisen from a lecture. The use of diagrams for the purposes of illustrating certain aspects of the text also provides evidence of its instructional nature.[191] Also relevant is that, in many instances, the text provides an analysis of why certain phenomena arise, rather than merely stating that they do. For example, Grosseteste's discussion of the sphericity of the earth, as well as his discussion of the unequal risings and setting of the zodiac, both offer explanations for the phenomena, the former in terms of observational evidence, the latter in terms of geometrical abstraction. The text is thus meant not merely as a practical aid to convey certain points of fact, but is meant to instruct students, and to convince them through argumentation.

The text does not present the fully developed astronomy that was available to

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[191]Though many of the diagrams I have included in my exposition are not a part of the text, we know, for example, that at least the first diagram from the exposition, Figure 2 above, was meant to be present with the text, for the text itself refers to it.

Grosseteste, and in which we have evidence that he was interested.[192] The astronomy of the *De spera* could be called Ptolemaic in the sense of being in general agreement with the contents of Ptolemy's *Almagest*. For example, it does use Ptolemaic concepts, such as eccentric and epicyclic systems for planetary motion (though only for the sun and moon, since the other planets are neglected). But the *De spera* lacks much of the material in the much longer and much more complex *Almagest*. Not only does the smaller work lack much of the content of the larger, the *De spera* makes no attempt to preserve the quantitative aspect of the *Almagest*, nor does it preserve the deductive/geometric method of it.[193] This is clearly a text for beginners, not a full introduction to astronomy. A group for which such a text would be a natural fit were students engaged in higher education, such as at a university.

As already mentioned, the text is self-evidently not a primer for the astrological sciences. The material does not focus merely on ideas necessary for studying astrology. Moreover, it leaves out many items that would be necessary for a practicing astrologer, such as astronomical tables and any mention of how the planets other than the sun and moon move. And as McEvoy has pointed out, the characteristics of the plantary and zodiacal influences of astrology are in tension with the assertion of the quintessence as the material of the celestial region.[194]

192We know, for example from Oxford MS Bodl., Savile 21, that he copied technical treatises. Other of his texts, such as the *De aeris* or the *Compotus correctorius*, demonstrate a higher degree of sophistication than the *De spera*.

193This leads to an additional problem: whether Grosseteste knew Ptolemy's *Almagest* in translation, or whether his source of information was some previous compilation in Latin, prehaps a condensation of the *Almagest*. It is impossible at this time to say for sure, but we can say that the *De spera* bears very little similarity to the *Almagest* itself. Whether this is because Grosseteste consciously condensed the extremely technical *Almagest*, or because he drew upon another source must remain on open question.

194McEvoy, *The Philosophy of Robert Grosseteste*, p. 165.

In relation to astrology, though, we should also consider the earliest text of Grosseteste that we have discussed, his *De artibus liberalibus*. This text defended the study of the liberal arts based upon their practical utility. Recall that, for astronomy, he particularly listed the benefits that it brought in the growing of plants, the transmutation of metals, and the curing of human ailments. Only the first of these was addressed, and even then implicitly, in the more technical work, the *De aeris*, but there it was clear that the practical benefit required a relatively advanced knowledge of astrological influences and at least the ability to read astronomical tables. Such benefits as listed in the *De artibus liberalibus*, therefore, would not be garnered from working through the *De spera*.

Would there be, then, any practical benefits to reading the *De spera*? They are not immediately obvious. For example, one would, after working through the text, know quite a lot about how the sun would behave differently if one travelled to diverse parts of the earth. But the practical benefit of this seems relatively minimal. Knowledge of some of the technical terms of astronomy—zenith capitis, for example—would be garnered, but again, the immediate practicality of such knowledge is not clear.

Again I think it will be beneficial to consider another of Grosseteste's texts, in this case, his *Hexameron*. The benefit of astronomical knowledge demonstrated in that text is that it aids in exegesis of the Bible. Certain passages are more fully understood when one considers the implicit astronomical knowledge behind them. For example, one understands why the luminaries are signs for the seasons, either in terms of when seasons begin "astronomically," when the sun reaches certain places in the sky, or when they begin in regards to their nature, in terms of the effects of the eccentricity of the sun's orbit and the inclination of the ecliptic.[195] The distinction between the two ways in which to understand

[195]Grosseteste is not this specific in the *Hexameron*, where he notes merely that the seasons are known by when periods of, for example, heat or cold, or wetness or dryness, result. But in the *De spera*, an explanation for these events is given, at least partially, by the sun's movements in the heavens.

the seasons is from the *Hexameron*, and is not present in the *De spera*, but the *De spera* provides explanations for each of them. The behavior of the moon is another example. Only by understanding the changing appearance of the moon, i. e., its phases, can one fully understand the biblical passage regarding the moon being "for the beginning of night."

The *Hexameron* probably dates from after 1235, and the *De spera* from the early 1220s at the latest, so I do not wish to argue that the *De spera* was written merely for the purpose of fulfilling the functions with which it shows similarity in the *Hexameron*, namely, the exegesis of Scripture. I will, however, argue that the text is meant, at least in part, to aid students in understanding the created world, with an emphasis on the "created." I have already cited the work of Andrew Cunningham regarding the historiographical approach of understanding natural philosophy in the middle ages as fundamentally a religious task.[196] Cunningham's approach, in my opinion, helps us to understand Grosseteste's *De spera*.

The text does not reflect what many histories of astronomy claim about medieval astronomy.[197] It does not demonstrate a great deal of astronomical sophistication, but is instead a condensation of much more technical texts that had been surfacing over the previous decades. If we were to understand this whiggishly, as a step towards modern astronomy, then such texts would have to be regarded as a step backwards. The astronomy of the *De spera* has been put into basic form for the benefit of students who did not need to understand the technical achievements of Greek and Arabic astronomical science, but could benefit from a greater appreciation of God's handiwork in the world. An appreciation of many of the basic phenomena of the cosmos could be garnered through a study of this text. That it could also serve as the basis for more complex sciences, such as astrology or

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196 See his two part essay "Science and Religion in the Thirteenth Century Revisited: The Making of St. Francis the Proto-Ecologist."

197 See the preface to this dissertation.

compotus, was an additonal benefit, but not the primary one. I freely admit that my interpretation of the text is not self-evidently true merely because of the contents of the text. There is a tantalizing hint in this direction, namely, the similarity between what Grosseteste says about the water and earth being separated and the passage in Genesis 1:9, but this is hardly sufficient proof for my position. But I do think that my interpretation is consistent both with the contents of the work and, perhaps more importantly, with what we know of Grosseteste's biography.

The text itself, as has been shown, cannot be intended to teach astronomy only for the benefit of astrology; there is a great deal of material that would be superfluous to that purpose. Nor is the text intended solely for practical benefit of a mundane sort, such as the Augustinian uses to which Grosseteste refers in the *Hexameron*, such as telling the seasons or as aids to navigation. Again, there would be too much extraneous material if he had such mundane intentions, nor are those particular problems dealt with in their full sophistication. But the text does more fully explicate the created world. Recall the goals of the text that Grosseteste stated at its outset: "to describe the shape of the world machine, the center, [place,] and shape of its constituent bodies, the motions of the higher bodies, and the shape of their orbits."[198] He also discussed various other topics, such as the risings and settings of the zodiac and the causes of eclipses. All these function to provide students with a better understanding of how the physical world around them behaves.

This alone does not require that a theological undertone be present in the work. It could be the case that Grosseteste is merely satisfying a purely intellectual curiosity about the world, quite apart from understanding the world from a fundamentally theological position, as I have suggested that he in fact has done. But at this point, it will be helpful to

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[198]…describere figuram machinae mundanae et centrum [et situm] et figuras corporum eam constituentium et motus corporum superiorum et figuras circulorum suorum. *De spera*, p. 11, ll. 1–4. The square brackets are in Baur.

discuss both the date and purpose of the composition of the text in relation to Grosseteste's theological background. I have argued that the text was intended for classroom use. We know that Grosseteste was involved in teaching for much of his life. While in his early years he may have been merely a provincial master, and hence may have been teaching young students for whom astronomical sciences might not have been appropriate, at least by the time he was at Hereford he was demonstrably interested in astronomy. At the same time, he was finding employment in the households of various ecclesiastical officials. He pursued ecclesiastical offices for himself in the 1220s, at the same time as he was engaged in teaching, both in the arts and in theology. And we know that he took his ecclesiastical offices seriously, both because he resigned those offices when he was unable to fulfill their obligations, and because of his later behavior as a bishop.

Theological interests were a part of Grosseteste's life not merely after 1215, the date when some scholars believe he earned his degree in Paris (and certainly not only in the 1220s when Southern believes he was pursuing his theological education in England). His theological interests, I have argued, date from well before this, perhaps even to the 1180s and certainly by the 1190s. There is virtually no part of his life, except for the very earliest years of which we know so little, in which he was not oriented in some way towards the Church. And those years are too early for the *De spera*. Any dates after the mid-1190s and before the late 1220s, however, are plausible for the composition of the *De spera*. By this time, he had access to astronomcial and astrological texts via his connections at Hereford, he had not yet begun an intensive study of Aristotle, and he was teaching the arts throughout this period. And these dates clearly overlap with the period in which Grosseteste has a demonstrable presence in ecclesiastical households. Hence, I argue, it is consistent with Grosseteste's biography to assert that the *De spera* accomplished a fundamentally theological goal of elaborating the created world.

Consideration of one further area of analysis is called for before we leave the topic

of the *De spera*, and that is its relationship to Sacrobosco's text of the same name.[199] While this analysis will not, in the end, help us to date the text more precisely, the similarities between the texts deserve attention.[200] I do not think that this analysis will conflict with my interpretation of the *De spera*, but also will not particularly aid that interpretation.

Perhaps the most obvious difference between the texts is that Grosseteste's *De spera* is only about half as long as Sacrobosco's *Sphere*. There are a number of similarities between the two, and it is even possible that one was derived from the other. The general topics that the two cover are very similar, though they are covered in a different order. They use many of the same terms, such as parallels, colures, equinoctial circle, the *caput* and *cauda draconis*, the machine of the world, quintessence, and so forth, though there are technical terms unique to Grosseteste.[201] They define the same circles of the heavens, such as the parallels and colures. Their explanations of the sphericity of the earth, the risings and settings of the zodiac, the inequalities of days, and the eccentricity of the sun are all quite similar. They also cover the same ground regarding the different appearances of the path of the sun from different places of the earth as the sun moves through its yearly course.

For the most part, however, Sacrobosco provides greater detail and argument in the *Sphere*. In his description of the climes, for example, Sacrobosco states measurements of the border of each clime in terms of the elevation of the north pole, and also provides the

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199The text and translation of Sacrobosco's text is found in Lynn Thorndike, *The* Sphere *of Sacrobosco and Its Commentators*, Chicago: University of Chicago Press, 1949 (hereafter, *The* Sphere). To avoid confusion with Grosseteste's text, I will hereafter refer to Sacrobosco's text as the *Sphere*, in keeping with Thorndike's usage in his introduction to the text. For more information on Sacrobosco, see Olaf Pedersen, "In Quest of Sacrobosco," *Journal for the History of Astronomy* 16 (1985): 175–221.

200Thorndike also discussed this topic in *The* Sphere, pp. 10–14.

201For more details, see *The* Sphere, pp. 12–13.

length of the longest day at those places.[202] His account of the earth's immobility and its sphericity, both in terms of land and water, is treated in more detail, though it does share some of the same arguments as Grosseteste's; Sacrobosco also provides a quantitative figure for the size of the earth.[203] Sacrobosco cites additional scientific authorities: Grosseteste had used Euclid's defintion of a sphere, as did Sacrobosco, but only Sacrobosco cites him by name, and moreover includes a reference to Theodosius's work on spheres.[204] Sacrobosco also cites Alfraganus repeatedly. Sacrobosco makes use of a greater number of literary sources; Grosseteste cited Virgil and Ovid once each, but Sacrobosco has multiple quotations from each author, as well as from Lucan's *Pharsalia*. Sacrobosco also provides a brief mnemonic verse for remembering the opposite zodiacal signs.[205]

Sacrobosco also discusses some material that is not present in Grosseteste. The planets, for example, are discussed explicitly. He states that they exist in their own spheres in the heavens and have different periods, and that they travel upon equants, eccentrics and epicycles, leading to certain characteristics in their movements,[206] though he does not provide quantitative details for the latter systems. Sacrobosco also makes use of more explicitly Christian doctrines in at least two places, referring to God's creative act in disposing the four elements and a brief discussion of the miraculous nature of the solar

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[202] *The* Sphere, pp. 139–140.

[203] *The* Sphere, pp. 121–123.

[204] *The* Sphere, p. 118.

[205] *The* Sphere, p. 131. Grosseteste will make use of such mnemonic devices in his *Compotus correctorius*, as we will see in the next chapter, but does not use them in the *De spera*.

[206] *The* Sphere, pp. 119–120 and 141, respectively.

eclipse at Christ's passion.[207] Grosseteste, however, also includes some material that Sacrobosco does not. He defines the horizon somewhat differently (relying upon the viewer's radius of vision), states the direction of the sun's eccentricity (upon the line from the eighteenth degree of Gemini), provides explanation of Thebit's theory of the mobile and fixed zodiacs, describes the moon's eccentric-epicycle system in more detail, names the oceans that circle the world, and discusses eclipses at greater length. And they do have some disagreements; Sacrobosco, for example, states that at the summer tropic, the night will last an instant as the sun dips below the horizon, whereas Grosseteste states that the sun will appear for the whole rotation of the firmament. Grosseteste also argues that the sun's motions makes certain portions of the earth unihabitable; this argument requires knowing where the sun's *aux* is located, and so was not an argument available to Sacrobosco.

Because of the great similarity between the two works, even down to the level of phrasing in some places, the question of priority has naturally arisen. Baur believed Grosseteste's *De spera* was the earlier, while Thorndike argued that Grosseteste was derived from Sacrobosco. A third alternative, which neither seems to have considered, is that both are indebted to a missing third source. I find it difficult to believe that Grosseteste adapted his work from Sacrobosco, for a number of reasons. First, the extra information found in the *Sphere* would have been helpful to what I have identified as the goal of the *De spera*: elaboration of the created world. Specifically, the material on the planets more fully describes the cosmos, and would be a helpful addition to the *De spera*. Even though information on the movements of planets might be useful to those who wish to misuse astrology in the ways Grosseteste enumerates in his later *Hexameron*, we know that Grosseteste favored certain kinds of astrology throughout his life, and thus there would be

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[207]*The* Sphere, pp. 119 and 142, respectively. The eclipse at the passion was miraculous because a solar eclipse can occur only at the new moon, while the passion occurred near the full moon.

no reason from that quarter to leave out such information. Second, there is no reason why Grosseteste would have rejected the theologically relevant statements from the *Sphere*, and, if I have correctly identified the theological goal of the *De spera*, it would be surprising that he would leave those out. Third, Grosseteste was not averse to citing literary authorities, and therefore it would be curious that he would leave out the wealth of quotations from Sacrobosco, though it is conceivable that there was some measure by which he might have rejected them. And fourth, it does not seem characteristic of Grosseteste that he would abandon relevant material that was available to him; he was a very thorough scholar.

That Sacrobosco might have taken Grosseteste's text and elaborated upon it is plausible. An elaboration on the placement of the climes, for example, or the emendation of the text with extra literary quotations and scientific citations would be reasonable ways for Sacrobosco to expand the text for his own audience. To accept such an relationship between the texts, however, would require an explanation, for example, of why Sacrobosco would have chosen to drop the details on the sun's eccentricity, the moon's system and on eclipses. Such an explanation, however, is beyond the scope of the present work, but presents enough problems that any assertions about the relationship between the two texts must remain tentative. Their origin from a third, common source for each must remain a possibility. In any event, because Sacrobosco's work cannot be dated precisely, we cannot thereby date *De spera* with more accuracy.

In conclusion, it is my argument that the *De spera* could be a work dating from as early as the 1190s when Grosseteste's activities are largely conjectural. He was probably teaching by then, and had access to astronomical material while at Hereford. If it does date from such an early period, then its intended audience might have been for students at a place other than Oxford, though it is also possible that he was indeed teaching at Oxford by this time. Nothing in my analysis rules out the possibility that the text dates from a later period, for example, during the 1215–1220s period that Baur favors. If it does date from that

period, then the text was almost certainly intended for students at Oxford. If the text dates from an earlier period and was written before teaching at Oxford, it seems likely that Grosseteste would have "recycled" it for use when he did lecture at Oxford. We shall deal with this issue at greater length in the final chapter of this dissertation.

CHAPTER 4

THE *COMPOTUS CORRECTORIUS*

The corpus of computistical works traditionally attributed to Robert Grosseteste include the *Kalendarium*, the *Compotus I*, the *Compotus correctorius*, and the *Compotus minor*. The authenticity of three of these works has been challenged, and only the *Compotus correctorius* remains secure from such challenges. I shall begin this chapter with a brief introduction to the genre of compotus.[1] The second section surveys the arguments for dating the computistical works of Grosseteste and the challenges to Grosseteste's authorship of the *Kalendarium* and two of the computi. This section will also explain why I have chosen to focus on only one of these works, as the only work that can be confidently asserted to be a genuine work of Grosseteste. The bulk of the chapter is an exposition of that work, the *Compotus correctorius*. The work has not been translated, and so this portion of the chapter will provide an English-language introduction to it. While the genre of compotus is relatively well-known in some circles, the content of compotus has not acheived general recognition among historians of science or the middle ages. So an important task of this chapter will be to make the contents of this medieval instructional text available to historians who do not have a technical background. I conclude with an analysis of the work, arguing against other authors that the intended audience of the work was twofold: those

[1]Grosseteste regularly uses the term 'compotus.' Other medieval writers, as well as some modern scholars, prefer to use the term 'computus.' Because my analysis centers on Grosseteste's work, it is easier to maintain the same terms, and thus I have chosen to use the variant form compotus, except when quoting other authors or when using the term 'computus' will prevent confusion.

seeking basic instruction in compotus, and those interested in more complex aspects of the science of compotus, as well as calendar reform.

4.1. The Genre of Compotus

The compotus had existed long before Grosseteste's contribution to the field. From the second to eleventh centuries, "calendrical reckoning or computus was the context for continuing and extensive studies in the mathematical sciences of early Christian schools during the so-called Dark Ages."[2] In the monastic schools, Stevens writes, "it was *Grammatica*, *Computistica*, and *Cantica*: language, reckoning, and singing"[3] that made up the curriculum. In fact, compotus may have been the first uniquely Christian science, combining mathematical and astronomical theory from pagan sources to serve Christian ends. Stevens has argued that the computistical work in the Insular schools amounted to "concerted and significant scientific labours."[4] Compotus, he argues, was the means by which much scientific information was passed on during the early medieval period, and thus served a larger purpose than just solving calendrical problems.[5]

The essential task of the compoti was to confront a basic problem of the Christian

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[2]Wesley M. Stevens, "Cycles of Time: Calendrical and Astronomical Reckonings in Early Science," in *Time and Process: The Study of Time VII*, edited by J. T. Fraser and L. Rowell, 27–51, Madison: International Universities Press, 1993, reprinted in *Cycles of Time and Scientific Learning in Medieval Europe*, London: Variorum Reprints, 1995. The quotation is from the abstract, p. 27.

[3]Stevens, "Cycles of Time…," p. 43.

[4]Wesley M. Stevens, "Scientific Instruction in Early Insular Schools," in *Insular Latin Studies*, edited by Michael Herren, 83–111. Toronto: Pontifical Institute of Mediaeval Studies, 1981; the quotation is from p. 83.

[5]Note, however, that Faith Wallis questions whether the term 'science' is accurate; see Faith Wallis, ed., *Bede: The Reckoning of Time*, Liverpool: Liverpool University Press, 1999, p. xviii. She points out that the compotus can be seen simply as the application of other sciences to solve a particular problem.

Church, namely, the reconciliation of the solar calendar received from Roman administrative sources with the Jewish lunar calendar used from the early Christian era to calculate certain important feast days, most notably that of Easter.[6] The problem arises from the fact that the length of the solar year is not an integral multiple of the length of the lunar month. Thus the only way to reconcile the two is to adopt a cycle of some number of years in which the two correlate more closely. The reconciliation is necessary because those who assign (and celebrate) the moveable feasts operate with reference to the solar year, but the time of the celebration of the feasts must be calculated based on the lunar month. Various cycles were used in the Latin, Christian West, including 8-, 11-, 19-, 76-, 84-, 95-, and 112-year cycles.[7]

The earliest computistical works are tables and letters in which ecclesiastical officials tried to sort out the calendrical problems facing the Church. One of the earliest solutions to the problem of getting all Christians to celebrate Easter on the same date was the creation of Easter tables, which simply listed the proper date for each year, thereby bypassing the need to teach the science underlying the calculations. A few treatises of a theoretical nature were written before the eighth century, including works by Cassiodorus, Isidore, and Maximus Confessor,[8] but a turning point was reached in 725 A.D. with Bede's *De temporum*

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[6]For an extended discussion of the mathematical problems and the early history of the Christian calendar, see the section entitled "Development of the Latin Ecclesiastical Calendar" of the introduction to *Bedae, Opera de temporibus*, edited by Charles W. Jones, 3–122, Cambridge, Mass: The Medieval Academy of America, 1943; Olaf Pedersen, "The Ecclesiastical Calendar and the Life of the Church," in *Gregorian Reform of the Calendar*, edited by G. V. Coyne, et. al., 17–74, Vatican: Specola Vaticana, 1983; and the section entitled "A Brief History of the Christian Calendar before Bede" in the introduction to Faith Wallis, *Bede: The Reckoning of Time*, xxxiv-lxiii.

[7]For a comparison of the errors involved with various cycles, see Kenneth Harrison, "Episodes in the History of Easter Cycles in Ireland," in *Ireland in Medieval Europe*, edited by Dorothy Whitelock, et. al., 307–319, Cambridge: Cambridge University Press, 1982. See especially his table on p. 308.

[8]See the introduction to *Opera hactenus inedita Rogeri Baconi*, Fasc. VI, edited by Robert Steele, vii-xxvii, Oxford: Clarendon Press, 1926; the reference is to pp. xiii-xiv.

ratione.[9] Robert Steele claims that this work is the "foundation of all future treatises on the subject,"[10] though between the period of Bede's work and Grosseteste's life, Alcuin, Rabanus Maurus, and Helpericus, in the late eighth through early tenth centuries, all wrote on computistical topics.[11]

By the eleventh century, contemporary scholars were noticing errors in the calendar.[12] But despite the concern that was voiced by various authors of the period, only a handful of modern scholars have paid attention to the computistical works of the eleventh and twelfth centuries. Yet they have amassed a body of evidence that demonstrates that compotus was indeed an important contemporary concern. In the eleventh century, Gerland composed a *Compotus*, while in the twelfth century, Roger of Hereford and a certain "Constabularius" both composed original computistical texts.[13] The twelfth century, discussed in the first chapter as a time of renaissance, certainly saw advances in the science

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9The Latin edition is contained in Jones, *Bedae, Opera de temporum ratione*, and an English translation can be found in Wallis, *Bede: The Reckoning of Time*.

10Steele, *Opera*, p. xiv. The occasion which prompted Bede's composition of this text, as well as an earlier, shorter text, *De temporibus*, was the Synod of Whitby held in the kingdom of Northumbria in 664 A.D. It was at this synod that two methods of calculating Easter, as well as other ecclesiastical matters, were debated. King Oswiu eventually decided to adopt the Roman practice for setting the date of Easter, and Bede's computistical works were in large measure written to reinforce the correctness of this method. See Bede's *Ecclesiastical History*, book 3, chapter 25, for his account of the Synod.

11Steele, *Opera*, p. xv-xvi.

12Steele, *Opera*, pp. xix. Steele notes that most notably the predicted age of the moon was obviously defective, and that attempts to find a solution to the problem do not arise until the middle of the twelfth century, and made use of Jewish sources.

13Jennifer Moreton, "Roger of Hereford and Calendar Reform in Eleventh- and Twelfth-Century England," *Isis* 86 (1995): 562–586, especially p. 562. The article deals with attempts at calendar reform, and stresses that modern scholarship has not given compotus sufficient study to fully understand its place in the eleventh to thirteenth centuries. Moreton points out that none the three texts cited above has ever been printed.

of compotus.

> One of the clearest indications of intellectual revival in the early twelfth century is the large number of manuscripts of that period or shortly before which deal with the elements of arithmetical and astronomical reckoning.[14]

Yet it was only late in the twelfth century that the newly translated Arabic materials began to impact Latin computistical works, and indeed became vital to the enterprise. Roger of Hereford criticized compotists who were ignorant of Arabic astronomy.[15] And whereas Sacrobosco might have been the first to use the new material, his contemporary Grosseteste made better use of the Arabic material available at the time.[16] It is clear that Grosseteste did have in England material in Latin to draw upon, both Arabic astronomical works in translation[17] and original computistical works composed in Latin. By the latter half of the thirteenth century, computistical works, especially Sacrobosco's, were becoming a part of a standard *Corpus astronomicum*, a group of texts that could be associated with astronomical instruction in the schools.[18]

The thirteenth century was an important period in the history of compotus. During this century, a number of original computistical treatises were composed that drew upon earlier Latin material and newly translated Arabic works. In addition to the works of Grosseteste and those attributed to him, Alexander de Villa Dei, Sacrobosco, Roger Bacon,

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[14]Charles Homer Haskins, *Studies in the History of Mediaeval Science*, Cambridge: Harvard University Press, 1927, p. 83.

[15]Haskins, *Studies*, p. 87.

[16]According to Steele, *Opera*, pp. xx-xxi. Note that the dates of composition are very close. Without engaging in difficult arguments of priority, it is still safe to say that they were composed around the same time.

[17]As discussed in an earlier chapter.

[18]See Olaf Pedersen, "The *Corpus astronomicum*," pp. 73ff.

and Campanus of Novara all wrote significant treatises. Eventually, the compotus became ensconced as a topic of university study, prescribed for undergraduates as part of their study of astronomy.

4.2. Attribution and Dating of Grosseteste's Computistical Works

Before analyzing Grosseteste's major computistical work, I shall first discuss the controversy that has arisen over which computistical works are genuinely attributable to Grosseteste. The history of the debates over which works belong to Grosseteste, as well as their dates and order of composition, is a relatively complicated one. Because the stories have changed radically, I recount them here in some detail, so that those who pursue the issue in the secondary literature will understand why there are so many conflicting statements regarding Grosseteste's computistical works. I also will show, by the end of the discussion, that I have chosen to concentrate my own attention on only one of those works, the *Compotus correctorius*, because it is the only computistical text among those attributed to Grosseteste that is certainly his.

S. Harrison Thomson set forth the initial framework of Grosseteste's alleged computistical works. Thomson stated that Grosseteste had written four works, which Thomson labelled *Compotus I*, the *Kalendarium*, the *Compotus correctorius*, and the *Compotus minor*. He believed that the earliest work, the *Compotus I*, could be found only in a single document, Oxford MS Bodl. 679.[19] Thomson relied on an early ascription to Grosseteste contained in that manuscript to assign this as the first of Grosseteste's computistical works. He also argued that it predated the others computistical works because they were written in order to correct this one. Based on an examination of Oxford MS

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[19]*Writings*, pp. 94–95.

Bodl., Savile 21,[20] Thomson attributed Grosseteste's interest in Arabic mathematics and astronomy to the period of 1215–1220. As mentioned earlier, however, this dating relies is suspect, and Southern's hesitation to accept this date for the Savile manuscript leaves this date as uncertain at best. But, based on that old assumption, Thomson dated this work to the period 1215–1220.

Thomson believed that, soon after writing the *Compotus I*, Grosseteste wrote the *Kalendarium*,[21] in part, at least, to correct the earlier work. The *Kalendarium* is a set of tables, a twelve-month calendar, with a set of instructions for its use. The text of the instructions varies,[22] as do the precise contents of the tables. One significant part of the tables was the use of the 'natural,' as opposed to the 'vulgar,' compotus to compute the golden numbers over the course of four nineteen-year cycles.[23] In addition, the tables listed various pieces of information for each month, including the number of days in the month, the length of its lunation, the regular and lunar regular of the month, the ferial letter, a scheme of the kalends, nones and ides of the month, the religious festivals of the month, other pieces of astronomical and calendrical information (such as the movement of the sun into a new zodiacal house and the boundaries of the moveable feasts), and the number of days of the year that have passed.[24] Moreton has shown that the tables of the *Kalendarium*

20*Writings*, p. 30ff. This manuscript has been discussed in prior chapters of this dissertation.

21*Writings*, pp. 106–107. The *Kalendarium* is printed and discussed in Arvid Lindhagen, "Die Neumondtafel des Robertus Lincolniensis," *Arkiv för Matematik, Astronomi och Fysik*, Band 11, No. 2, 1916.

22Lindhagen gives the texts of three different manuscripts; see "Die Neumondtafel," pp. 15–19.

23This problem is dealt with fully in Moreton, "Roger of Hereford and Calendar Reform."

24These terms will be explained below, in the section expositing Grosseteste's *Compotus correctorius*. Note that the information contained in manuscript copies of the tables varies.

are integral to Roger of Hereford's *Computus*, and thus must predate Grosseteste. While she acknowledges that Grosseteste could have composed the instructions for using the tables, it is by no means certain that he did so; the text varies, and his reputation certainly could have attracted undeserved ascriptions.[25] Indeed, much of the content of the tables is consistent with Grosseteste's *Compotus correctorius*, as can be seen in the next section, and his association with Hereford makes it possible that he was intimately familiar with Roger's tables. But the information is basic computistical fare, and so there is no particular reason to assume that Grosseteste must have disseminated the tables. In any event, the instructions for using them vary enough that an original version is not readily constructed. So even if we were to accept Thomson's attribution of this text to Grosseteste, we do not have access to the original version of the text.

Next in Thomson's scheme of dating came the *Compotus correctorius*.[26] He noted that this work was written specifically to correct the *Kalendarium*, probably based on the line in the text of the *Compotus correctorius* that it was "written for the correction of *our* calendar."[27] In attempting to date the work, Thomson noted that Steele, the editor of a modern transcription of the *Compotus correctorius*, suggested that it was probably written around the same time as Sacrobosco's *Compotus*, or circa 1232. Thomson argued, however, that because of the frequency with which Grosseteste refers to Arabic authors and because of his earlier argument for Grosseteste's interest in Arabic mathematics and astronomy in

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[25]Moreton, "Roger of Hereford and Calendar Reform," pp. 580–581.

[26]*Writings*, pp. 95–96.

[27]…factus ad correctionem communis kalendarii nostri, *Comp. corr.*, p. 212, ll. 3–4; I have added the italics above to emphasize that Thomson probably was basing his argument on Grosseteste's use of "*our* calendar" to refer to a work he himself had written. If this is the case, Thomson apparently neglected the fact that the adjective *communis* would have implied a shared or communal calendar.

1215, there is no reason to date the work so late. Thomson preferred a date after the other two computistical works were written but before 1229; he based this, however, on an alleged lack of scientific writings by Grosseteste between 1229 and 1240, the period when the older tradition of biography assumed Grosseteste was completely engaged in theological scholarship.

Finally, Thomson argued, Grosseteste wrote a fourth computistical work, the *Compotus minor*.[28] This work exists in a single manuscript, Dublin MS Trinity, 441 (D. 4. 27), but Thomson was confident that its ascription to Grosseteste was accurate. Significantly, Thomson added, the work is internally dated to 1244,[29] which would imply that Grosseteste composed this work in the midst of his episcopacy. In addition, Thomson noted that it reproduces much of the *Compotus correctorius*, perhaps meaning to imply that it was written as an abbreviation of the longer *Compotus correctorius*.

Later scholars have questioned Thomson's dating scheme. James McEvoy, as we have seen, made a new effort to date Grosseteste's scientific works,[30] citing two reasons for doing so. First, no chronology was generally accepted, and two notable attempts, those of Thomson and Crombie, were heavily influenced by significant assumptions that he stated "have not always been convincing."[31] Second, the amount of scholarly work that had been done on Grosseteste in recent years afforded him a greater amount of evidence with which to frame a new chronology. He used both external evidence, such as the determination of

[28]*Writings*, p. 97.

[29]Thomson quotes a passage from f. 107[b], *sed nativitate Domini elapsi sunt 1200 anni et eo scilicet 44 amplius, in quo numero sunt decies centum and decies 20*; 1200 years and 44 more have elapsed since the birth of the Lord, in which number there are ten hundreds and ten twenties.

[30]James McEvoy, "The Chronology."

[31]McEvoy, "The Chronology," p. 614.

1230 is the earliest date for any work that refers to Averroës,[32] and internal evidence, such as development of Grosseteste's thought about particular issues.

McEvoy dealt with the computistical works under the heading of astronomy and its applications.[33] Following Thomson's lead, he treated the *Compotus I*, the *Kalendarium*, and the *Compotus correctorius* as a sort of trilogy, each subsequent work written to correct the previous. He argued that each individual work is difficult to date precisely, but that we can safely assume the order of their composition, with the *Compotus correctorius* coming last. It is this final work that McEvoy felt was the most susceptible to dating.

Using internal evidence, McEvoy placed the composition of the *Compotus correctorius* between 1225 and 1230. He put forth a number of arguments restricting it to this six-year period. First, Grosseteste, in the *Compotus correctorius*, stated that the sun was created on the first day of creation, a view which he later rejected—after a study of the patristic writers—in his *Hexameron*, composed after 1235. In addition, McEvoy pointed out that certain passages anticipate Grosseteste's metaphysics of light, and thus it probably does not belong to his earliest scientific works. A third argument concerns Grosseteste's use of the creation of the world within the computistical work. The pagans, who created the calendar, had no awareness that the world was created, whereas Grosseteste consistently assumes that the calendar can be referred back to the original creation. McEvoy believed that this is an anticipation of Grosseteste's later arguments against Aristotle's assumption of the eternity of the world, arguments that were theological in nature, and thus must date after the period when Grosseteste began his natural philosophical studies, in other words, after the

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[32]McEvoy, "The Chronology," p. 615.

[33]McEvoy, "The Chronology," pp. 616ff; the computistical works are dealt with on pp. 618–20. Some of the arguments had been presented in briefer form in his *The Philosophy of Robert Grosseteste*, Oxford: Clarendon Press, 1982; see especially pp. 16 and 506–507.

mid-1220s. Finally, McEvoy noted that Grosseteste frequently exhibited a superficial understanding of Aristotle, suggesting that the *Compotus correctorius* was composed before Grosseteste's extended studies of Aristotle's *Physics*, which he left off circa 1232.

In a brief consideration of the *Computus minor*, McEvoy simply accepted Thomson's date of 1244 based on the passage quoted earlier. He suggested that this late date would complicate any chronology that assumes Grosseteste's interests to be strictly periodized.[34] Southern, only a few years later, introduced an important consideration into the dating of the works, correcting an omission by Thomson.[35] What Thomson failed to make explicit, Southern pointed out, is that the 1244 date given in Dublin MS Trinity 441 includes a marginal note. The text itself states that 1200 years have passed since the birth of the Lord, while the marginal note adds that 44 more have passed. This preserves the additional clause in the text, namely, that the amount of time is equal to ten hundreds and ten twenties. Thus Southern dated the *Compotus minor* to about the year 1205,[36] and suggested that the marginal note may imply that it was copied in 1244.

If this dating is correct, then clearly the scheme of relationships between the texts given by Thomson is incorrect. Southern responded to this problem, however, by examining the works. It was his opinion that the *Compotus I* was written first, and claimed that the

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[34]It has been shown by Jennifer Moreton, discussed below, that the *Compotus minor* is not a work of Grosseteste. Nonetheless, McEvoy's warning about periodizing Grosseteste's interests is still a valuable methodological point, even if his particular argument over the *Compotus minor* is incorrect.

[35]Southern, *Robert Grosseteste*. His discussion of the compoti of Grosseteste are on pp. 127–31. Southern uses a unique nomenclature for the works, labelling each compotus with a Roman numeral. His I corresponds to Thomson's *Compotus I*, his II to the *Compotus correctorius*, and his III to the *Compotus minor*.

[36]Based on the formula of ten hundreds and ten twenties, Southern is confident that it must fall between 1200 and 1220. Because he dates the *Compotus correctorious* to the end of that period, he places the *Compotus minor* towards the beginning.

Compotus minor was a recension of it. He argued that the first was written about 1195. He set this early date because of the elementary nature of the text, most particularly because of the sources it uses. The *Compotus I* relies mainly on outdated authors such as Gerlandus and John Beleth, and its recension, the *Compotus minor*, contains various corrections to the first.[37] Southern pointed out that, by 1200, the computistical works of Hereford were already more advanced than Grosseteste's compoti. He thus believed that his first compotus and its recension were written before Grosseteste had engaged in the study of more advanced computistical works.

The *Compotus correctorius*, Southern believes, was composed years later, and demonstrates that Grosseteste's knowledge of astronomy and compotus had advanced significantly, that "it was the work of someone swimming vigorously in the tide of modern scientific knowledge, and undertaking independent measurements and calculations."[38] His sources were no longer outdated computistical Latin authors, but were Greek and Arabic astronomers. In addition, as the quotation above implies, Southern believed Grosseteste had spent time performing original calculations and observations, thereby making this work quite different in nature from the previous two.

A few years later, Richard Dales turned to the question of the dating and order of Grosseteste's compoti,[39] explicitly noting his own deliberate omission in his earlier attempt at providing a chronology of the scientific works. He wished to respond to problems he saw

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[37]Southern admits that he has not studied the texts in sufficient detail to note all the corrections, but notes that this second version of the work is still quite elementary compared to the later *Compotus correctorius*. See *Robert Grosseteste*, pp. 128–129.

[38]Southern, *Robert Grosseteste*, p. 129.

[39]Richard C. Dales, "The Computistical Works Ascribed to Robert Grosseteste," *Isis* 80 (1989): 74–79.

with both Southern's account and Jennifer Moreton's denial of Grosseteste's authorship of all the works except the *Compotus correctorius*.[40]

Dales first dealt with the notion that the *Compotus I* and *Compotus minor* were early texts of Sacrobosco, into which he later inserted more advanced calculations to create his *De anni ratione*. Noting its similarity to many computistical works, Dales attacked the problem by trying to tease out characteristics of the *Compotus I* that suggest it is an authentic work of Grosseteste. First, he pointed to a passage in which the author notes that the dates for the solstices and equinoxes are wrong by approximately one day in 120 years, and that this problem will be treated in a subsequent work.[41] He also argued that, on stylistic grounds, the work is consistent with Grosseteste's authorship. Dales also noted the early ascription of the work, that is, before 1250, and that the ascription is merely to "master Robert Grosseteste," without reference to his bishopric. Finally, the author's promise to write a fuller work would be fulfilled by Grosseteste's *Compotus correctorius*, Grosseteste's authorship of which is not questioned. Regarding the date, Dales reiterated the arguments of Thomson regarding the Oxford MS Bodl. Savile 21, claiming that by 1215 Grosseteste was examining Arabic astronomical treatises; Dales extended the argument by claiming that the Savile manuscript shows that Grosseteste had indeed taken

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40Dales was responding to a first draft of her article which will be dealt with in detail below. Dales's article, however, was published before the final version of Moreton's article.

41Dales, "The Computistical Works," pp. 75–76. His argument is that the author of the *Compotus I* anticipated writing another, more satisfactory compotus to deal with the problems such as the one just mentioned. It is relevant that in the *Compotus correctorius*, Grossteste does not say that one day in 120 years has been lost, but discusses in the first chapter a number of possible corrections to the calendar based on different authorities' estimates of the length of the year. He also notes in the tenth chapter that the true length of the year needs to be verified, thus implying that he has not settled on a correction such as is called for in the *Compotus I*.

up some of the computistical problems he promised to address in the *Compotus I*.[42] Thus he argued that the *Compotus I* was written by Grosseteste, and that it was composed before 1215.

Dales also discussed the *Compotus minor*. Although he agreed with Southern that this work derives from the *Compotus I*, he did not believe that Grosseteste could truly be called its author. In fact, he believed that the second work was not a recension, but merely an abridgement, of the first, probably made by a scribe sometime before 1325 when the Dublin manuscript was written. The text of the Dublin manuscript, then, was not the product of Grosseteste himself, but was constructed by someone else using Grosseteste's original text. Dales was thus convinced that this particular text should not be attributed to Grosseteste.

Finally, Dales turned to the *Kalendarium*. Again he concluded that the work is probably not Grosseteste's. He wrote that the phrase "our calendar" in the *Compotus correctorius*, which Thomson assumed to refer to the *Kalendarium*, has been misunderstood, and that the phrase in fact refers only to the ecclesiastical calendar commonly in use. In addition to the fact that many of the copies of this work are unascribed, he acknowledged that Moreton has pointed out that the *Kalendarium* is identical to that used by Roger of Hereford, and thus predates Grosseteste.[43]

The most recently published work devoted to Grosseteste's computistical works is a

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[42]Dales, "The Computistical Works," p. 77. Note that Dales does not examine the contents of the Savile manuscripts in an attempt to ascertain if the works Grosseteste copied in fact addressed the problems mentioned in the *Compotus I*, but merely notes the Grosseteste was examining Arabic astronomical works by around 1215, and that this is consistent with the order of composition that he is proposing.

[43]In fact, Moreton argues that it is integral to Roger of Hereford's work, as discussed previously. See her "Before Grosseteste."

1995 article by Jennifer Moreton.[44] She dismissed the *Kalendarium* as an authentic work of Grosseteste, noting that it is contained in Roger of Hereford's *Compotus* of 1176, and indeed was integral to that work.[45] She does concede that the preface that accompanies the calendar in ascribed texts could be the work of Grosseteste.

When she came to the *Compotus I* and *Compotus minor*, Moreton introduced a significant new finding. The *Compotus I* is, in fact, found not in a unique manuscript, as had been assumed since the time of Thomson, but is found in a number of manuscripts dating from the thirteenth to fifteenth centuries.[46] Moreton referred to this common compotus as the *Compotus ecclesiasticus*.[47] Many copies of this text have been attributed to John of Sacrobosco because of the similarity of their incipits to that of the *De anni ratione*, a genuine work of Sacrobosco. The incipit of the *Compotus ecclesiasticus* is *Compotus est scientia considerans tempora distincta secundum motus solis et lune…*,[48] while the incipit

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44Jennifer Moreton, "Robert Grosseteste and the Calendar," in *Robert Grosseteste: New Perspectives on His Thought and Scholarship*, edited by James McEvoy, 77–88, *Instrumenta Patristica* 27, Turnhout, Belgium: Brepols, 1995. James McEvoy, in his recent addition to the Great Medieval Thinkers series, *Robert Grosseteste*, Oxford; Oxford University Press, 2000, cites Moreton when he states that "Of the three treatises on the calendar that have been attributed to Grosseteste, the *Computus* [sic] *correctorius* is the only one of certain authenticity," p. 78, and p. 197, n. 3.

45Moreton, "Robert Grosseteste," p. 78. She notes that the calendar covers a seventy-six-year period, rather than the typical nineteen-year period, and that Grosseteste's possible ties to Hereford during his early years are suggestive. In the *Compotus correctorius*, Grosseteste frequently utilizes a seventy-six-year period for his calculations, based on the fact that four nineten-year periods have all the possible combinations of leap years. See also her "Before Grosseteste."

46Moreton lists seven examples on p. 80.

47She noted in "John of Sacrobosco and the Calendar," *Viator* 25 (1994): 229–244, p. 237, that the title *Compotus ecclesiasticus* often appears in manuscripts with no ascription.

48This incipit is taken from British Library MS Add. 27589, f. 13r, one of Moreton's examples. The incipit of the *Compotus I* in Oxford MS Bodl. 679 is *Multiplex est annus, scilicet solaris et lunaris, quia secundum cursum….* The incipit is quite different—Thomson took this as a genuine work of Grosseteste because the work is ascribed to Grosseteste in the upper margin, even though it is in a different

of the *De anni ratione* is *Compotus est scientia considerans tempora ex solis et lune motibus….*[49] The ease with which catalogers could make this mistake is obvious.

The *Compotus ecclesiaticus*, Moreton argued, was a textbook for use in the new universities. Its material is basic, and, rather than dealing with the theory behind the computistical approach, its goal is simply to convey basic information about the calendar: the solar basis for the year and fixed feasts, the lunar basis for the movable feasts, and the collation of the two. She also asserted that the use of mnemonic verses to speed learning, the use of the techniques of *definitio* and *distinctio*, and frequent quotations from Ovid, Cicero and Boethius imply that the work was written for the arts student,[50] while the *Compotus correctorius* was clearly a more advanced work.

Regarding Grosseteste's authorship, Moreton was confident that he did not write this work. She questioned Dales's argument from style, arguing that most of the *Compotus ecclesiasticus* does not use the complex style that Dales attributes to Grosseteste. She also noted two errors in the *Compotus ecclesiasticus*, and argued that, even if written before his advanced training, these basic mistakes were not ones Grosseteste would have made.[51] It was her argument that Grosseteste was in fact aware of the *Compotus ecclesiasticus*, and, in his *Compotus correctorius*, provided at least one innovative solution to a problem found in

hand—from the incipit in the British Library manuscript. I have not verified the similarity of the text to the other works Moreton lists.

49Note that the first five words are identical, and both incipits contain the phrase *solis et lune*, so the confusion between incipits is not surprising. The differences in the text, however, mean that upon close comparison the works can easily be told apart. In viewing manuscripts held in English libraries, I also discovered that the *De anni ratione* typically has a corpus of illustrations that easily distinguish it from the *Compotus ecclesiasticus*. Moreton also discusses this in "John of Sacrobosco," pp. 236–237.

50Moreton, "Robert Grosseteste," p. 81.

51Moreton, "Robert Grosseteste," p. 82–83.

the earlier work.[52] Finally, Moreton dealt with the ascriptions in the Bodley and Dublin manuscripts, arguing that both of them are problematic; either they are late, or that it is unclear whether they are in fact ascriptions to Grosseteste or rather to Sacrobosco.[53]

In light of this recent scholarship, what conclusions can we reach about Grosseteste's authorship of the *Compotus ecclesiasticus*, and the date of the *Compotus correctorius*? Beyond Moreton's brief introduction, little attention has been paid to the *Compotus ecclesiasticus*, and so it is difficult to analyze the work. However, given that the work appears frequently without ascription to Grosseteste, and that Grosseteste's name certainly could have attracted spurious ascriptions,[54] the burden of proof rests upon those who wish to claim that the work is genuinely that of Grosseteste. Dales, the only scholar to consider the question in light of Moreton's recent work, rests his attribution to Grosseteste mainly on the fact that the *Compotus correctorius* specifically addresses problems that were raised in the *Compotus ecclesiasticus*.[55] He writes that the *Compotus correctorius*

> retains many of the mnemonic verses and some of the wording of the earlier work, but its focus is on solving the most serious problems of the computus rather than providing a handy elementary manual for provincial clergy.[56]

The problematic part of this statement relies on the assumption that, unless the work is

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[52]The problem is that of the movement of the solstices in relationship to their respective feasts (Christmas Day for the winter solstice and St. John's Day for the summer). Moreton, "Robert Grosseteste," p. 83–85.

[53]Moreton, "Robert Grosseteste," p. 85–87.

[54]Which, of course, it did frequently. See Harrison's sections on Dubious and Spurious writings in his *Writings*.

[55]He also raises other issues, such as style and early ascriptions, as discussed above, but these seem intended to buttress his argument regarding the purpose of the *Compotus correctorius*, namely, to correct the problems present in the earlier work, rather than to be strong points of evidence on their own.

[56]Dales, "The Computistical Works," pp. 77-78.

intended to make corrections to his own earlier work, Grosseteste would have intended it for provincial clergy.

It is true that the *Compotus correctorius* is not an "elementary manual," as I will discuss in greater detail below, but I do not believe that its focus is "solely on correcting the most serious problems" of the compotus. Much of the work is elementary in nature, defining terms, giving practical advice on constructing tables, demonstrating how to calculate basic calendrical problems, and so forth. The work was not intended solely as a corrective to the earlier work, but also was meant to provide many of the basics of compotus in a text that could stand on its own. Thus Dales's scheme of Grosseteste writing an early work with which he was dissatisfied, and then a later work to offer corrections, is problematic. It is equally possible, as Moreton has pointed out, that Grosseteste knew of the *Compotus ecclesiasticus* as a text in circulation in Oxford during his time there. Moreton characterizes the work as one of "unimpeachable orthodoxy," in contrast to some of the contents of Grosseteste's *Compotus correctorius*, which she believes could not have been intended as "a textbook for young students,"[57] because it dealt with topics such as the possibility that the date of Easter was being calculated incorrectly. In other words, she has given a plausible theory to connect the two works: Grosseteste knew of the *Compotus ecclesaisticus*, and indeed tried to correct some of its faults, but that he was not its author.

Dales argued that the *Compotus correctorius* was the result of Grosseteste's consultation of Arabic astronomical works in order to correct the deficiencies of his knowledge when he wrote the earlier work. In other words, Dales asserted, the *Compotus ecclesiasticus* must have been written before the period when Grosseteste is known to have

[57]Moreton, "Robert Grosseteste," p. 80 and p. 85.

studied Arabic astronomy, namely, 1215–1216.[58] However, such a date relies upon the problematic dating of the Savile manuscript and neglects the connections to Hereford that Grosseteste had before this period. Of course, the activities of the early years of Grosseteste's life are difficult to know with any certainty, but clues in the *Compotus correctorius* suggest that Grosseteste was aware of the computistical activity of Roger of Hereford, namely, issues regarding the "natural" and "vulgar" compoti and the use of the seventy-six year cycle.[59] It is more plausible that Grosseteste is not the author of the *Compotus ecclesiasticus*, that his interest in compotus dates to well before 1215, and that he gained at least some of the tools needed to work in the field from works that would have been available to him at Hereford.

According to Moreton, the *Compotus ecclesiasticus* was most likely composed in the first quater of the thirteenth century.[60] To preserve Grosseteste's authorship, according to Dales's argument, Grosseteste must have written it before 1215, at which date we can be sure Grosseteste had begun to investigate Arabic astronomy. But recall that Grosseteste was associated with Hereford as early as 1195, and was at Oxford by 1225,[61] whereas Dales dates the *Compotus correctorius* to around 1225–1230. Thus to preserve his authorship of the *Compotus ecclesiasticus*, we must assume that Grosseteste wrote this elementary work during the first twenty years after his association with Hereford, a period during which he was interested in scientific matters, and yet must not have known of the computsitical works

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58Dales, "The Computistical Works," p. 77.

59As discussed in the previous section; details are in Moreton's "Before Grosseteste."

60Moreton, "Robert Grosseteste," p. 83.

61Southern, *Robert Grosseteste*; on his period at Hereford, see pp. 65ff, and on his period at Oxford, see pp. 70ff.

written by Roger. In the course of ten to fifteen years, after embarking on a study of Arabic astronomy in order to correct the problems of his earlier work, Grosseteste could only then have discovered the computistical works of Roger and incorporated them, along with his newly acquired knowledge of Arabic astronomy, into a complex computistical work. While not impossible, this scheme seems far too complicated to preserve Grosseteste's authorship of a work that does not live up to his reputation for interest in scientific matters.

My own conclusion is that Grosseteste wrote only the *Compotus correctorius*. He may also have written the instructions of the *Kalendarium*, but that issue is beyond the scope of my work here. The *Compotus ecclesiasticus*, under which heading can be included both the *Compotus I* and the *Compotus minor*, was likely familiar to Grosseteste. Its faults may have been one of the reasons that Grosseteste wrote his work, but the *Compotus correctorius* deals with a number of issues beyond those that Dales has used of evidence of Grosseteste's authorship of the earlier work. I will present more of my arguments after an exposition of the text, so that the reader can better understand the computistical issues at stake.

4.3. Exposition of the *Compotus correctorius*

As the only computistical work securely attributed to Grosseteste, the *Compotus correctorius* is a vital text for understanding Grosseteste's goals for compotus, including the teaching of compotus, which I shall argue was one of his purposes for composing this text. In the following section, I give a detailed exposition of the contents of the work; I reserve analysis of the text for the next section, so that the exposition is not overburdened with interruptions. The goal of this section is to provide the reader with a detailed summary of the contents of the work; access to the text has not hitherto been available apart from reading the work in Latin.

The *Compotus correctorius* was one of the most popular of Grosseteste's scientific

works; Thomson lists 29 manuscript copies of the work.[62] No modern critical edition exists, but Robert Steele has produced a transcription of the work from Brit. Mus. Add. MS 27589, with variants from Brit. Mus. Harley 3734.[63] All of my references will be to Steele's printed version, unless otherwise noted.

In the manuscripts I have examined, the work is almost invariably preceded by a list of the 12 chapters. In Steele's printed version, the list appears as follows:[64]

> *Capitulum primum, de causa bisexti, et de modis magis verificandi kalendarium nostrum, et de racione inveniendi annum bissextilem.*
> [Chapter one, on the cause of the leap year and the ways in which it makes our calendar more correct, and on the reckoning for finding the leap year.]
>
> *Capitulum secundum, de divisione anni in quator tempora et in menses, et de divisione mensium in kalendas nonas et ydus.*
> [Chapter two, on the division of the year into four seasons and into months, and on the division of the months into kalends, nones, and ides.]
>
> *Capitulum tercium, de concurrentibus et ciclo illorum, et de regularibus solaribus, et horum conjunctorum utilitate.*
> [Chapter three, on concurrences and their cycle, and on the solar regulars and the usefulness of their conjunctions]
>
> *Capitulum quartum, de ostensione erroris kalendarii nostri in sumptione primatione et in positione cicli novodecimalis et cicli epactarum, et de modo summendi primaciones secundum veritatem.*
> [Chapter four, on showing the errors in our calendar for finding the primations and our position in the nineteen-year cycle and cycle of epacts, and on the method of setting the primations correctly.]

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[62] *Writings*, p. 96. Compare this number to the number of copies of Grosseteste's other scientific works that Harrison lists: *De forma prima omnium*, 17 (p. 98); *De impressionibus aeris*, 17 (pp. 103–104); *De intelligenciis* 17 (p. 105); *Kalendarium* 23 (pp. 106–107), though note the arguments above regarding its inauthenticity; *De sphera* 38 (p. 116). He lists no more than 13 manuscripts for any other scientific work.

[63] In *Opera hactenus inedita Rogeri Baconi*, Fasc. VI, *Compotus fratris Rogeri*, pp. 212–267, hereafter *Comp. corr.*; I will cite page numbers and, where appropriate, line numbers. All translations are my own unless otherwise noted. The volume also includes the *Massa compoti* of Alexander de Villa Dei and the *Computus* of Roger Bacon.

[64] The chapter list is on *Comp. corr.*, pp. 212–213.

Capitulum quintum, de modo extrahendi annos et menses Arabum ex annis Christi tam per multiplicationem et divisionem quam per tabulas.
[Chapter five, on the method of getting the Arab years and months from the Christian years, through multiplication and division as well as with tables.]

Capitulum sextum, de eo quod necesse est in compoto non diversificare quantitatem temporis lunationis vere a quantitate lunationis equalis
[Chapter six, on the necessity in compotus not to differentiate the time of the true lunation from that of the equal lunation.]

Capitulum septimum, de quantitate lunationis quam oportet ponere secundum doctrinam kalendarii nostri, et de generacione epactarum et regularium lunarium et horum utilitate.
[Chapter seven, on the quantity of the lunation that must be set according to the rules of our calendar, and on the making of epacts, lunar regulars and their usefulness]

Capitulum octavum, qualiter 76 anni equantur penitus 940 lunationibus, quas conputamus in illis annis per restaurationem quam faciunt dies bissextiles et lunationes embolismales, et quibus locis lunationes embolismales interponuntur in kalendario, et de invenienda etate lune in temporibus mensium per tabulas.
[Chapter eight, how 76 years are precisely equal to 940 lunations, which we calculate in those years by the restoration that bissextile days and lunar embolisms make, and where to insert lunar embolisms in our calendar, and on finding with tables the phase of the moon during the month.]

Capitulum nonum, de ratione collocandi aureum numerum in kalendario.
[Chapter nine, on the method for placing the golden number in the calendar.]

Capitulum decimum, de ostensione erroris nostri sumptione terminorum et locorum festorum mobilium, et de modo sumendi terminos et loca festorum mobilium secundum doctrinam kalendarii nostri.
[Chapter ten, on showing our errors in placing the ends and locations of moveable feasts, and on the manner of finding the ends and locations of moveable feasts according to the doctrine of our calendar.]

Capitulum undecimum, de ratione compositionis tabularum ad invenienda festa mobilia.
[Chapter eleven, on the rules for composing tables for finding the movable feasts.]

Capitulum duodecimum, de temporibus jejuniorum.
[Chapter twelve, on the periods of fasting.]

4.3.1. Chapter One of the *Compotus correctorius*

Let us look closer at the contents of the work. The first issue that Grosseteste broaches is a definition of the science of compotus itself. He states that "compotus is the

science of reckoning and dividing time."[65] The science of compotus entails understanding ways of marking time that come both from the movements of the celestial bodies and from regional practices.

It is clear from Grosseteste's explanation of compotus that one who studies it will have to understand the motions of the celestial bodies, yet relatively little of this is explained in the text. For example, Grosseteste explains the daily and yearly motions of the sun, and defines the zodiac in eleven lines of the printed edition,[66] and in defining the year in the next paragraph, he uses the terms 'solstice' and 'equinox' without defining them. This implies that Grosseteste is assuming that those who use this text will already have been introduced to the motions of the heavenly bodies from some other source, perhaps from Grosseteste's own treatise *De spera*,[67] or will have someone on hand who can explain the work to them, as in an educational setting.

In addition to understanding the natural occurrences that divide time, Grosseteste also states that regional practices affect the way time is kept. For example, the names of the months are taken from the heathens.[68] Thus compotus is not merely a science that relies upon knowing the way the physical world operates; it is also an historical science. Because calendars are human creations, proper use of them requires that one understand the

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[65]Compotus est scientia numerationis et divisionis temporum. *Comp. corr.*, p. 213, l. 6.

[66]*Comp. corr.*, p. 213, ll. 23–33. There is a clear affinity with the ideas in his *De spera*, including the definition of the motion in terms of the fixed and mobile zodiac. See the previous chapter of this dissertation for further explanation.

[67]Of the 29 manuscripts of the Compotus correctorius listed by Harrision, 11 also contain a copy of Grosseteste's *De spera*.

[68]*Comp. corr.*, pp. 221–222. Before relating the origins of the names, Grosseteste states that the names are received *ab ethnicis*, p. 221, l. 17.

principles used to create them.

These two kinds of knowledge required by the compotist are made evident in Grosseteste's analysis of the length of the year in his first chapter. From its title, we know that his main objective is to explain the leap year. The sun is described as "the largest body of the cosmos, of the noblest pure substance, and the most efficacious in transmutation of nature through the strength of its light."[69] It has two motions, a daily motion by virtue of a sphere that naturally rotates once a day, and a yearly motion through the fixed zodiac,[70] an imaginary circle that marks the motion of the sun. A year is defined as the time it takes the sun to move from a given point along its yearly path and return to that same point. The length of the year was given by Abrachis[71] as 365 and one-quarter days. Thus three consecutive years are 365 days long, and an extra day is inserted into the fourth year, making it a leap year. This extra day is called the "bissextile" day because it was inserted at the sixth kalends of March, and thus six, *sextus*, was written twice in the calendar.[72]

Grosseteste then includes a diagram in the text to illustrate the motion of the sun,

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69…sol sit corporum mundanorum quantitate maximum, et puritate substancie sue nobilissimum, et fortitudine luminis sui in naturarum transmutationem efficacissimum, *Comp. corr.*, p. 213, ll. 18–21.

70There is also a moveable, or imaginary zodiac; see below.

71Dales suggests that Abrachis could be a corruption of Ali ibn Abi al-Rijal, "The Computistical Works," p. 78, but Abrachis is actually Hipparchus. In this section, because it is an exposition of Grosseteste's text, I shall preserve his Latinized names for Arabic authors. Dales provides the following correspondences: Albategni is al-Battani, Arzachel is al-Zarqali, and Alpetragius is al-Bitruji.

72…et diem intersertum in quarto anno vocant diem bissextilem, quia interserunt eum sexto kalendis Marcii, et super eandem litteram in kalendario bis dicunt sexto kalendas. *Comp. corr.*, p. 214, ll. 8–10. Kalends refers to the first day of the month, sixth kalends to the sixth day (counting inclusively) prior to that. Grosseteste will define the term 'kalends' later in the work, but takes it for granted that his readers will understand it here.

and how the insertion of a day corrects the calendar.[73] A circle is enclosed by the letters AG, and point A is the winter solstice. The sun moves from A towards the point H. If a full year is 365 and one-quarter days, then at the end of 365 days, the sun will not have returned

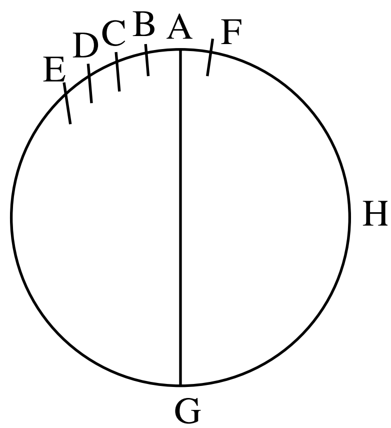

Figure 8. Illustrating the Leap Year

to point A, but will fall short by one-quarter of a day, the length BA. In the second year, it falls short by another quarter-day, the length CB; in the third and fourth years, it falls short by lengths DC and ED. In that fourth year, then, the intervals ED, DC, CB, and BA amount to one full day; adding the leap day will then bring the sun back to point A at the end of that year.

Grosseteste next notes that Ptolemy disagrees with the length of the year given by Abrachis, that in fact the year is less than 365 and one-quarter days by 1/300th of a day.[74]

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[73]Grosseteste clearly meant for a figure to be present in the text. He writes, “I place here a diagram to make these things clear” (*ad hujus rei manifestacionem pono figuram*), *Comp. corr.*, p. 214, l. 16. Indeed, either the figure itself or an empty space left for its later insertion is present in most of the manuscripts I have observed. The figure is reproduced on *Comp. corr.*, p. 214; it is present in MS Brit. Mus. Add. 27589 in the lower margin of folio 77v.

[74]See Book 3, chapter 1 of the *Almagest* for Ptolemy’s discussion of the length of the year, and for his use in that section of Hipparchus. In Toomer’s translation, see pp. 137–140.

Grosseteste again uses the preceding diagram to illustrate how this would affect the position of the sun after a year. In this case, the sun moves past the expected point by 1/300th of a day. After 300 years, instead of being at point A, the sun would in fact be at point F, one full day past point A. The result, he argues, is that removing one day every 300 years will keep the calendar correct, assuming Ptolemy's length is correct.

Grosseteste notes that Albategni assumes yet a different length for the year, namely, that it is 1/100th of a day shorter than 365 and one-quarter days, the same as Abrachis and the compotists. In this case, one day out of every hundred years should be removed. Grosseteste also argues that this value is consistent with contemporary observations, namely, that the Nativity has fallen out of place in the calendar. Grosseteste writes that Scripture states that Jesus Christ was born on the winter solstice, but that we find through observation[75] that the Lord's Birth Day[76] precedes the solstice by about as many days as the number of centuries that have passed since his birth.

Yet another means of computing the length of the year comes from Thebit. Grosseteste notes that the movable or imaginary zodiac moves in relationship to the fixed zodiac with a motion of accession and recession.[77] This means that the time it takes for the sun to move from solstice to solstice or equinox to equinox will not always be the same. To know the true length of the year, one must measure the motion of the sun against one of the fixed stars, which is not subject to this motion. Thebit finds that the length of the year is

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75…invenimus per experimentum, *Comp. corr.*, p. 215, l. 29.

76Diem Natalem Domini, *Comp. corr.*, p. 215, l. 32.

77This theory was presented in the fifth chapter of the *De spera*. See the previous chapter of this dissertation.

actually longer than 365 and one-quarter days by the amount of 23 seconds of a day.[78] This leads to the computation that one day must be added to the calendar every 156 years, but, in addition, one day must be removed every 46,800 years to bring the sun back to its correct place.[79]

Grosseteste next discusses Aristotle and Alpetrangus, noting that the latter has "recently discovered a way that explains how it is possible to save the appearances of the progressions, stations, and retrogressions of the planets, and the reflexions and inflexions, and other phenomena, through Aristotle's method, but without eccentrics and epicycles."[80] But, notes Grosseteste, even though they use principles that come from natural philosophy, they have simply assumed the same length of the year as Ptolemy, and so present nothing new regarding the length of the year.

The application of astronomical knowledge to the question of the length of the year has been made clear. But now Grosseteste moves to a discussion of the calendar as the Church uses it. It is here that we see how "regional practices" make a difference in understanding the calendar. After briefly mentioning that the calendar could be made more accurate by figuring the length of the year more accurately, Grosseteste states that the

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[78]*Comp. corr.*, p. 216, l. 14–5. Note that 'seconds' here refers 1/3600 (or 1/60^2) of a day. This is borne out by the calculation that follows, that in 156 years, the sun moves one full day less twelve seconds of a day: 23 x 156 = 3588, which is 12 less than 3600.

[79]Every 156 years, the calendar loses 12 seconds. To get a full day takes 300 times 12 seconds; thus in 46,800 (300 x 156) years, an extra day will have accumulated and must be removed from the calendar.

[80]Et Alpetrangius nuper adinvenit modum, et explanavit quomodo possible est salvare processus et stationes et retrogradationes planetarum et reflexiones et inflexiones et cetera apparencia per modum Aristotelis, et absque eccentrico et epiciclo. *Comp. corr.*, p. 217, ll. 21–24.

Church currently places the bissextile day[81] in the calendar every four years. To determine if a year is bissextile, one simply divides the number of years since the Incarnation of the Lord[82] by four. If it divides evenly, then the year is bissextile; if a remainder of one, two or three results, then the year is not bissextile. He notes that this is true when using the reckoning of the arts (*ars cognoscendi*), as opposed to that of the astronomers (*astronomi*). The reason for this difference is that the astronomers begin the year in March, and thus the bissextile day is in the previous year.[83]

Grosseteste also includes a shortcut to know the bissextile years without needing to divide,[84] as the method above requires. All years that are multiples of 100s and 1000s are bissextile. For the years inbetween, if the tens-digit is even, such as in twenty, forty, or sixty, then years ending in four or eight as well as those of the even tens will be bissextile; if the tens-digit is odd, then years ending in two or six will be bissextile.[85] He gives a brief verse to remember the scheme, “Pairs of numbers ten, follow 4, 8, two, 6,”[86] and then presents a

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81The bissextile is the extra day placed in the calendar to keep it better aligned with astronomical phenomena; in other words, to account for the fact that the length of the year is not equal to a whole number of days.

82…anni ab Incarnatione Domini, *Comp. corr.*, p. 218, l. 6; in other words, the number of the year in question, based upon the *anno domini* nomenclature introduced by Dionysius Exiguus.

83Grosseteste does not provide more detail at this point regarding the difference between the reckoning according to the arts and the astronomers. The implication is clearly that his sources use two different schemes for the beginning of the year.

84*Comp. corr.*, p. 218, ll. 20–34.

85De articulis autem omnis articulus denominatus a numero pari ut 20 et 40 et 60 et deinceps. De numeris compositis omnis numerus compositus ex articulo numeri inparis et binario vel senario ut 32 et 36. Et omnis compositus ex articulo numeri paris et quaternario vel octonario, et 24 et 28. *Comp. corr.*, p. 218, ll. 27–32.

86Dena pari numero, post 4. 8. duo 6. *Comp. corr.*, p. 218, l. 37.

detailed example of how this works with 20s and then 30s, and proceeding on to the 40s. Between the verse for mnemonic purposes and the didactic example, it is clear that Grosseteste expects his readers to prefer a memorization technique to a procedure for dividing the year. Even though the latter is simpler to describe, it requires more effort each time one tries to figure the problem.

4.3.2. Chapter Two of the *Compotus correctorius*

Quite abruptly, as is typical in the division of the chapters of this work, Grosseteste immediately moves into a new topic in the next chapter. The year, he writes, is divided into four seasons. Each has two complexions associated with it: summer is hot and dry, autumn is cold and dry, winter is cold and wet, and spring is hot and wet.[87] The seasons correspond to the position of the sun between the solstitial and equinoctial points. He again makes a distinction between two ways in which this can be understood. The astronomers (*astronomi*) say that the seasons begin immediately when the sun enters into the respective quarter of the zodiac. The physicians (*medici*), however, say that the seasons begin when the sun moves into the quarter and the complexions begin to take effect. Thus the beginning of a season, according to the physicians, comes at different times in various climates.

The year is also divided into twelve months, which correspond to the twelve signs of the zodiac. As the sun moves through the zodiacal signs, it also runs through corresponding effects based upon the four major complexions, hot, cold, dry, and wet. Each of these complexions has three different types of effects, thus giving twelve arrangements, one for each month, though he does not match them up.[88] He also states that he believes the months were created by following medical practice, not astronomical, so as with the seasons, there is

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[87]*Comp. corr.*, p. 219, ll. 9–10.

[88]*Comp. corr.*, p. 220, l. 31–p. 221, l. 4.

not a precise relationship between the movement of the sun and the months.

Grosseteste next moves on to a discussion of the names of the months and days, and how one refers to each day of the year based on the Roman system of kalends, ides, and nones. In a table, reproduced below as Table 5, he lists the names of the months, and the number of days, kalends, nones, and ides associated with each.[89] In addition to the tables, he

TABLE 5

KALENDS, NONES, AND IDES

Month	Days	Kalends	Nones	Ides
January	31	19	4	8
February	28	19	4	8
March	31	16	6	8
April	30	17	4	8
May	31	18	6	8
June	30	17	4	8
July	31	18	6	8
August	31	17	4	8
September	30	19	4	8
October	31	18	6	8
November	30	17	4	8
December	31	18	4	8

gives mnemonic verses for remembering all of this information. After providing an etymology for the name of each month and for the terms kalends, nones, and ides, he

[89]The table is on *Comp. corr.*, p. 220, and in MS Brit. Mus. Add. 27589, folio 80^r at the bottom of the second column, extending into the lower margin. I have translated the Latin words, and have not preserved the abbreviations of the manuscript. Instructions on how to use the table, as well as explanations of kalends, ides and nones follow.

explains how the system of kalends, nones and ides work. The first day of a month is called the kalends of that month. The last day of a month is the second day before the kalends of the next month, though it is normally referred to as the day before (*pridie*) the kalends of the next month; for example, the last day of January is called the day before the kalends of February. The second-to-last day of the month is the third day before the kalends of the next month; thus January 30 would be referred to as the third day before the kalends of February. This pattern repeats up to the largest kalends for a month, found in the table above. Grosseteste does not give an example, but I will provide one for clarity's sake. February has nineteen kalends. January 31 is the day before the kalends of February, January 30 is the third day before the kalends of February, January 29 is the fourth day before the kalends of February, and so on up to January 14, which is the nineteenth day before the kalends of February.

The day after the kalends of a month, in other words, the second day of the month, is referred to as the highest number of nones of that month, and each subsequent day is one less until the second nones and the nones of a month are reached. Following that is the eight ides of a month, and the numbers likewise count down to the ides of the month. Again, Grosseteste does not give an example, but I will provide one. The first day of February, as stated above, is the kalends of February. The next day is the highest nones of the month. Referring to the table above, February has four nones, so February 2 is the fourth day before the nones of February, February 3 is the third day before the nones of February, February 4 is the second day before the nones of February, and February 5 is the nones of February. Every month has eight ides, and so February 6 is the eighth day before the ides of February, February 7 is the seventh day before the ides of February, February 8 is the sixth day before the ides of February, and so on to February 13, which is the ides of February. February 14 is then the largest kalends of March; referring to the table above, we see this is

the sixteenth day before the kalends of March, and the cycle begins again. Thus are all the days of the year named.

4.3.3. Chapter Three of the *Compotus correctorius*

In the third chapter, Grosseteste discusses various cycles of time-keeping periods, as well as the cycle of concurrences. He begins with a somewhat confusing explanation of why there are 24 hours in each day. Just as the sun passes through twelve combinations of complexions and effects in a year as it moves through the zodiac, so too it passes through them each day and each night. The reason for this is unclear; hence the confusing nature of the passage. Grosseteste claims that the sun passes through all twelve during the day, and all twelve again during the night, thus leading to 24 natural divisions, and thus there are 24 hours in one day.

Regarding the number of days of the week, Grosseteste again introduces a somewhat tortuous explanation. He states that the Creator has arranged the cosmos such that the seven planets[90] give forth their virtues and forces (*virtutes et fortitudines*)[91] in each successive hour. Thus in one given day, three periods of the seven planets make up 21 hours, then the first three planets each have one hour, and the next day begins with the fourth planet. Say, then, that we begin one day with the sun; the next day will begin with the moon, as it is the fourth planet in sequence after the sun.[92] Continuing to the third day, the

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[90]Note that he does not name them here, but the order of the planets is discussed shortly hereafter.

[91]*Comp. corr.*, p. 222, ll. 32–3.

[92]To put it abstractly, the next day will always begin with the planet fourth in sequence after the planet on which the previous day began. See the next footnote for an explanation of how the sequence of planets is found.

first hour will be Mars, then Mercury, then Jupiter, then Venus, then Saturn.[93] Then, on the eighth day, the first hour returns to the Sun. Thus one week of seven days is the minimum amount of time to complete a cycle of hours and planets, which he points out is also equal to 168 hours, which is the least multiple of 7 and 24. The excellence of a period of seven days is further established because this is the time God took to create the world.[94]

Thus time is naturally divided into seven-day periods, called weeks (he notes two names for the week: *ebdomada* and *septimana*). He then discusses the relationship between the year and the week. We give each day of the week a 'ferial' letter, from A to G, in order to find cycles that allow us to determine on which day of the week each year begins, and thus also on which day of the week each month begins. In a non-bissextile year of 365 days, there are 52 weeks, plus one day. Thus if a given non-bissextile year begins with, say, letter A, the year will end with A, and the next year will begin with the subsequent letter, B. We can also calculate on which day of the week each month will begin in a non-bissextile year by remembering a cycle of 12 letters that naturally arises from the fixed length of each month. Again Grosseteste provides a verse to aid the memory:

> Altitonans dominus divina gerens bonus exstat
> Gratuito celi fert aurea dona fideli.[95]

There are twelve words, each one corresponding to a month; the first letter of each word

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[93]He states explicitly that the order of planets is from the moon to Jupiter and Saturn, with Mars in the fourth place from the moon; …*a Luna per Saturnum et Jovem est Mars quartus*, *Comp. corr*., p. 223, ll. 7–8. Using the sequence of first hours that he gives (i.e. Mercury in the fourth place after Mars, Jupiter in the fourth place after Mercury, and so on), he must order the planets in the following sequence: Moon, Mercury, Venus, Sun, Mars, Jupiter, Saturn, which agrees with his scheme in the *De aeris*. Grosseteste, however, never states that this is the sequence of the planets; he leaves the reader to figure this out from the example, or assumes that the reader has this knowledge from another source.

[94]Excellencior tamen causa et hujus cause causa est creatio mundi et ejus complecio in septenario dierum numero. *Comp. corr*., p. 223, ll. 19–20.

[95]*Comp. corr*., p. 224, ll. 4–5.

gives the day of the week which begins that month.[96] January begins with day A (Altitonans), and thus February and March begin with day D (dominus and divina), and so on through November with D (dona) and December with F (fideli).

Matters become more complicated with the introduction of bissextile years. Because a bissextile year has one extra day, the first day of the subsequent January will jump forward two letters instead of one.[97] To return to the same letter for the first day of January requires that a whole extra week be accrued over the course of years. So, for example, if we begin with the year after a bissextile year, that year will accrue one extra day, the next a second day, the next a third, the next a fourth and fifth day (since it must be bissextile), the fifth year a sixth day, and the sixth year a seventh day, thus making a whole week. As we continue in this fashion, accounting for whole weeks, we find that a cycle of 28 years is necessary to return to our starting point, a January beginning with the same letter and following a leap year. This 28-year period is called the 'solar cycle' (*ciclus solaris*),[98] and begins in March rather than January, as it must begin after the bissextile month, the reason for which, Grosseteste writes, will appear below.[99]

Each month is assigned a 'regular' according to the day of the week on which the

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96Grosseteste uses this mechanism, similar to an acrostich, in many cases throughout the work.

97*Comp. corr.*, p. 224, l. 18. It is interesting to note that Grosseteste here does not explicitly state why a bissextile year will add two days, even though in many places he works out the mathematics behind his statements. For example, on p. 223, ll. 22–25, he writes, "it is clear that a non-bissextile year has fifty-two weeks and one extra day. For if 365 is divided by seven, fifty-two will fall out by division, and one will remain after division" (…*manifestum est quod annus non bissextilis habet ebdomadas quinquaginta duas, et insuper diem unum. Si enim 365 dividantur per 7, exibunt in divisione 52, et remanebit unitas post divisionem*).

98*Comp. corr.*, p. 225, l. 23.

99Incipit autem iste ciclus non a Januario set a Martio, quia oportet ut incipiat in mense proximo sequente mensem bissextilem, cujus ratio inferius patebit. *Comp. corr.*, p. 225, ll. 24–6.

first day of the month falls. The regulars can be figured by beginning from their values given from 'the first year of the foundation of the calendar.'[100] In that year, March began on the fifth day of the week, and so its regular is five. We also know that March corresponds to the ferial letter D, and so D corresponds to the fifth place during that year. Because we know the letters for each month, given in the verse above, we can know on what day of the week each month begins. For example, April's ferial letter is G; when D is five, we know that G corresponds to one, and so April has a regular of one. May's ferial letter is B, which, in this example, corresponds to three, and so May has the regular of three.[101] We can likewise find the regulars for each month of the year, which will be used below for another calculation. Again Grosseteste gives a verse for memorizing these numbers, listing the twelve numbers that correspond to the regulars for the months March through February.[102]

The question of the history of the compotus again enters into Grosseteste's discussion. In discussing how intercalary days affect the regulars, he argues for a 'superior' method that "agrees with nature and reason,"[103] because it is based on a calendar that has a beginning in time, namely, the creation of the world by God, of which the heathens did not know.[104] Grosseteste's method is to begin the cycle of concurrences,

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100…primo anno fundationis kalendarii, *Comp. corr.*, p. 225, l. 29.

101*Comp. corr.*, p. 225, ll. 30–36.

102*Comp. corr.*, p. 226, ll. 1-9 (the verse is on lines 8–9). The regulars for March through February are 5, 1, 3, 6, 1, 4, 7, 2, 5, 7, 3, 6.

103Et modus iste conveniens est nature et rationi, *Comp. corr.*, p. 226, l. 18.

104…kalendarium sumpsimus a gentilibus qui de principio seculi nichil noverunt, *Comp. corr.*, p. 226, ll. 26–27.

defined below, on the same year as the beginning of the calendar; the heathens, he states, without a knowledge of the beginning of the world, and because they begin the year in March and assume that the first year has a bissextile day, start their cycle of concurrences in the midst of the natural and superior cycle that he advocates. He thus labels their method the 'inferior' one.

There is also another reason why Grosseteste favors his own system. To be able to figure out the day of the week on which the first day of each month falls in a given year, that is, to find the 'solar regulars' (*regulares feriales*), one can add the number of 'concurrences' to the regular of each month. The concurrences are the numbers of days by which the calendar jumps forward each year.[105] The sum of the regular of a month and the concurrence, if seven or less, corresponds to the solar regular for that month, that is, the day of the week on which the month begins; if greater than seven, subtract seven and the remaining number corresponds to the first day of the week on which the month begins. By beginning the year in the January of the first year of the calendar, the cycle of concurrences begins with one, and so by adding one to the monthly regulars, we can find the day of the week on which falls the first day of the month. The next year adds two, and so forth. By the heathen's method, though, the year begins in March. When one moves the beginning of the year to January, as is the Christian custom, this corresponds to the twelfth year of the cycle of concurrences according to Grosseteste's superior method.

Realizing that this has been complicated, Grosseteste then includes a table with the following columns:[106] (superior method) Year, Dominical Letter, (inferior method) Year,

[105]Due to the fact that the days of the week (seven) do not evenly divide the number of days in the year (365 or 366) as discussed above.

[106]The full table is produced in *Comp. corr.*, pp. 228–229. Steele uses only the term *Anni* in the first and third column, though he also notes a textual variant which labels them as 'Secundum Garlandum' and 'Secundum Dionysium,' respectively. I have introduced the nomenclature of 'superior method' and

Concurrence, and Monthly Regulars for each month from March to February.[107] The third column has numbers one through twenty-eight, corresponding to the twenty-eight year solar cycle mentioned above. The fourth column has the concurrence for that year, beginning with one and proceeding through the series of adding one in non-bissextile year or two in each bissextile year, and subtracting seven when the number is larger than seven. Then each month of each year has its solar regular, which is the sum of its standard regular (which he includes in the table under each month in a row above the first year[108]) and the concurrence, with seven subtracted if the number is larger than seven. The solar regular, recall, gives the day of the week on which the first day of the month falls. I have reproduced the table in Table 6 on the next page.[109]

The first column corresponds to what Grosseteste referred to as the superior cycle, which corrects the heathen method of constructing the calendar without knowledge of the creation of the world. He explains this more fully in a subsequent section of the text, and so I will explain this below. The second column gives the dominical letter for each year. Up to this point, Grosseteste has not introduced the concept of the dominical letter.[110] In a leap

'inferior method' to differentiate between the two cycles Grosseteste has discussed. The table in MS Brit. Mus. 27589 is on folio 84r, and simply uses *Anni* as the label for the relevant columns.

107The year must run from March to February in order for the concurrences to progress correctly. In a bissextile year, the concurrence changes at the addition of the leap day, which occurs between the first days of February and March.

108The regular can also be known from the method given previously, namely using the ferial letters given in the verse *Altitonans dominus divina*…, and calculating from the first year of creation in which March began on the fifth day of the week.

109The table is on *Comp. corr.*, pp. 228–229, and in MS Brit. Mus. Add. 27589, folio 84r. I have translated the Latin words, and have not preserved the abbreviations of the manuscript.

110It is curious that he deals with it in this fashion. Here he seems to assume that the reader will know what the dominical letter is, and yet later in the text he will explain that it corresponds in a certain way to the solar regular of March.

TABLE 6

YEARS, DOMINICAL LETTERS, CONCURRENCES, AND MONTHLY REGULARS

Year	Dom Let	Year	Con- curr.	Mr 5	Ap 1	My 3	Jun 6	Jul 1	Au 4	Se 7	Oc 2	No 5	De 7	Ja 3	Fe 6
12	gf	1	1	6	2	4	7	2	5	1	3	6	1	4	7
13	e	2	2	7	3	5	1	3	6	2	4	7	2	5	1
14	d	3	3	1	4	6	2	4	7	3	5	1	3	6	2
15	c	4	4	2	5	7	3	5	1	4	6	2	4	7	3
16	ba	5	6	4	7	2	5	7	3	6	1	4	6	2	5
17	g	6	7	5	1	3	6	1	4	7	2	5	7	3	6
18	f	7	1	6	2	4	7	2	5	1	3	6	1	4	7
19	e	8	2	7	3	5	1	3	6	2	4	7	2	5	1
20	dc	9	4	2	5	7	3	5	1	4	6	2	4	7	3
21	b	10	5	3	6	1	4	6	2	5	7	3	5	1	4
22	a	11	6	4	7	2	5	7	3	6	1	4	6	2	5
23	g	12	7	5	1	3	6	1	4	7	2	5	7	3	6
24	fe	13	2	7	3	5	1	3	6	2	4	7	2	5	1
25	d	14	3	1	4	6	2	4	7	3	5	1	3	6	2
26	c	15	4	2	5	7	3	5	1	4	6	2	4	7	3
27	b	16	5	3	6	1	4	6	2	5	7	3	5	1	4
28	ag	17	7	5	1	3	6	1	4	7	2	5	7	3	6
1	f	18	1	6	2	4	7	2	5	1	3	6	1	4	7
2	e	19	2	7	3	5	1	3	6	2	4	7	2	5	1
3	d	20	3	1	4	6	2	4	7	3	5	1	3	6	2
4	cb	21	5	3	6	1	4	6	2	5	7	3	5	1	4
5	a	22	6	4	7	2	5	7	3	6	1	4	6	2	5
6	g	23	7	5	1	3	6	1	4	7	2	5	7	3	6
7	f	24	1	6	2	4	7	2	5	1	3	6	1	4	7
8	ed	25	3	1	4	6	2	4	7	3	5	1	3	6	2
9	c	26	4	2	5	7	3	5	1	4	6	2	4	7	3
10	b	27	5	3	6	1	4	6	2	5	7	3	5	1	4
11	a	28	6	4	7	2	5	7	3	6	1	4	6	2	5

year, there are two dominical letters, one for January and February, and the other for March though December. The number written to the right in the column, which is also the prior letter in alphabetical order, is the letter for March through December, while the subesquent letter is for January and February.

Let me now digress from Grosseteste's text to present an example that explains more clearly how the table works. In the first year of the solar cycle, the inferior method year is one and the concurrence is one. To find the solar regular, the first day of each week of a month, add the concurrence, in this case one, to the regular of the month. March's regular is five, so on the first year of the cycle, March begins on the sixth day of the week (regular five plus concurrence one). April's regular is one, so its solar regular that year is two (regular one plus concurrence one) and so it begins on the second day of the week. And so on through February with regular six, and solar regular seven (regular six plus concurrence one). Note that September and December both have regulars of seven, and so adding the concurrence of one gives a sum of eight; because this is greater than seven, seven is subtracted, leaving a solar regular of one.

Moving down the table, let us examine, as a further example, inferior method year seven. Because the first year was a leap year, the concurrences of the three subsequent years each increase by one, so by the fourth year of the cycle, the concurrence is four. The fifth year, however, is a bissextile, and so its concurrence increases by two, to six. The concurrence in each of the three subsequent years will increase by one, so year six has a concurrence of seven, and year seven has a concurrence of one (subtracting seven from eight, as any concurrence greater than seven must have seven subtracted from it). The months will have the same solar regulars, that is, will begin on the same day of the week as year one because the concurrence is again one.

As a final example, take the final year of the cycle, inferior method year twenty-eight. The concurrence is six, and so the solar regulars work out as expected: the regular

plus six, minus seven when the sum is greater than seven. Moving to the next year, in other words, the first year of the inferior cycle, which is bissextile, the concurrence will jump by two, namely to eight, from which seven is subtracted to get one. This is the only place in the table in which the concurrence of one occurs on a leap year, and thus signals the beginning of a new cycle.

Let us now return to Grosseteste's text. He placed after the table instructions for using it. If one knows which year of the cycle one is in, one simply goes to the proper row and can find the dominical letter and the solar regulars for each month. If one does not know which year of the cycle one is in, one takes the current year of the incarnation and adds nine, because the first year of the incarnation was the tenth year of the cycle. Divide the sum by twenty-eight. If there is no remainder, the current year is the last year of the cycle, namely the twenty-eighth year; if there is a remainder, that is the year of the cycle.

Grosseteste also presents another method for finding the concurrence for a given year. Consider which day of the week is signified by the letter F in March. Because March's regular is five, any time the concurrence is one, the solar regular for March is six, which corresponds to the letter F. Looking at the table, we see that this occurs four times throughout the cycle, once on a bissextile year, and once on each of the first, second, and third years after a bissextile. This is also the dominical letter for that year.[111] The dominical letters thus correspond in a repeating fashion to the solar regular of March: when the concurrence is one, the solar regular of March is six and the dominical letter is F; when the concurrence is two, the solar regular of March is seven and the dominical letter is E, and so on. Once again Grosseteste gives a verse to remember the correspondences:

[111]In a bissextile year, the dominical letter of March through December is F when the concurrence is one.

Six makes A, and B has five, C four, and D
makes three, and E two, F one, and G also seven.[112]

Thus we have a correspondence between the dominical letter and the concurrence of the year. Then, because the leap years and the concurrences follow a repeating pattern, one can deduce which year it is by knowing the solar regular of March and when a leap year has occurred. By knowing the first day of March, which is its solar regular, one can find the concurrence and hence the dominical letter. Then, by memorizing yet another verse, one can match the dominical letter to the proper year in relation to the cycle of leap years. This new verse has twenty-eight words, each beginning with the dominical letter for the corresponding year;[113] after each fourth word, there is a punctuation mark to note that it corresponds to a leap year. Matching up the dominical letter and its proper place in relation to a leap year before or after it, one thereby determines which year of the cycle one is in.

Grosseteste ends this chapter with an explanation of his superior method of constructing the cycle of concurrences. This cycle is essentially the same as the inferior method, in that it uses the same twenty-eight year cycle by which concurrences and leap years repeat. However, because time began with the creation, the first bissextile year will not occur until the fourth year.[114] Looking at the table, one can see that the year that follows a leap year and in which the concurrence is one, the first year of Grosseteste's superior method, corresponds to the eighteenth year of the inferior cycle, and so the first year of the

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[112]Sex habet A, B quinque tenet, C quator, et D/ Tres habet, E que duas, F unum, G quoque septem, *Comp. corr.*, p. 230, ll. 3–4.

[113]Fert. ea dux cor amat. gens factor enim coluit. bis/ Ars genus est. de corde bono gignit. ferus ensis/ Dicta beant. aqua gens fons dat. cunctis bonus auctor, *Comp. corr.*, p. 23, ll. 26–28.

[114]Grosseteste does not make this explicit, but I belive this gets to the core of his argument. He stated earlier that the first bissextile year did not come until the fourth year of the beginning of the calendar. If time begins with the first year, than the insertion of a leap year should not come until the fourth year, because the calendar has not lost a full day until that year.

inferior cycle corresponds to the twelfth year of the superior cycle.[115] To find the year according to the superior cycle, one again refers to the years since the Incarnation. In this case, however, the first year of this cycle occurred on the ninth year of the Incarnation, and so one must either subtract eight or add twenty to the current year, and divide by twenty-eight. As before, if the remainder is zero, the current year is the twenty-eighth year of the cycle; if the remainder is greater than zero, it is equal to the year of the cycle.

4.3.4. Chapter Four of the *Compotus correctorius*

Grosseteste moves on to a very different topic in the fourth chapter. He is now concerned with cycles of the moon, and the predictions of when the 'primation' (*primationes*), or the beginning of a lunar cycle,[116] occurs. He begins by discussing the two kinds of months: the solar, which are the months to which we give names and by which we divide the year, and the lunar, which are of a length given by the amount of time the moon takes to complete an equal lunation (*equalis lunatio*), that is, to return to the same position in relation to the sun after it has moved through its path.[117] The time it takes for this to happen, according to Ptolemy and Abrachis, is 29 days, 31 minutes, 50 seconds, 8 thirds, 9 fourths, and 20 fifths of a day. It is important for the reader to note that the minutes and seconds do *not* refer to the units of time that we might expect. Rather, the 31 minutes refers

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[115]Note, however, that although Grosseteste labels his own system as 'superior,' he arranges the table about the inferior method; that is, the first row of the solar regulars corresponds to the first year of the inferior method.

[116]Grosseteste notes in *Comp. corr.*, p.237, ll. 1–8, that the primation can be defined as the conjunction of the sun and moon, as the Arabs do it, or from the first day of visbility, or the second, or third. In other words, the moment of beginning of the lunar cycle, the primation, can be taken by whatever point one desires.

[117]Equalis autem lunationis est reditus lune ad solem secundum utriusque cursum medium, *Comp. corr.*, p. 232, ll. 7–9.

to 31 minutes 'of a day.' A minute of a day is equivalent to 1/60th of a day; thus the term is used similarly to the way we typically use minutes as 1/60th of an hour. In other words, there are 60 minutes of a day in one day, and so 31 minutes is equivalent to 31/60ths of a day, or .51667 of a day, or 12.4 hours, or 12 hours and 24 minutes (in this last case, the minutes are what we expect, 1/60th of an hour). Likewise, the 50 seconds of a day are equivalent to 50/3600ths of a day. I have preserved the terms minutes and seconds because of their similarity to the Latin terms (*minuta* and *secunda*).

Arzachel, Grosseteste states, used a value similar to that of Ptolemy and Abrachis when he constructed his tables. He made a lunar year equal to twelve lunar months and, according to the tables, Grosseteste states, this was set equal to 354 days plus a fifth and a sixth of a day, or twenty-two minutes of a day. Working this out, Grosseteste finds that the time of an equal lunation for Arzachel is 29 days, 31 minutes, and 50 seconds of a day. This is equivalent, Grosseteste states, to the value of Abrachis and Ptolemy, except that the thirds, fourths, and fifths are dropped because they are so small compared to the large value.[118] By using Arzachel's value, Grosseteste finds that the least number of days that reduces to an integral number of lunations is thirty Arab years,[119] or 360 whole lunations, which is equal to 10,631 days; the reason for calculating this value is to compare the Arab and Christian calendars, as we shall see below.

Grosseteste proceeds with an example. If a conjunction of the middle of the sun and moon occurs on a given day, over the meridian of Paris, the same conjunction will occur at

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118In modern decimal values, the figure given for Arzachel's tables is approximately 29.53055556 days, while the value given by Ptolemy and Abrachis is approximately 29.53059956, giving an error of approximately .00015%. Though Grosseteste of course does not use such an analysis, his conclusion that such a small amount will make little difference in practical application is correct.

119An Arab year is Arzachel's year of 12 equal lunations; Grosseteste will use this nomenclature frequently after this point.

that meridian again when 10,631 days have passed. He then runs through the calculation, showing that a lunation of 29 days, 31 minutes, and 50 seconds of a day makes 354 days and twenty-two minutes of a day. Multiplying 354 days by thirty gives 10,620 days, and multiplying twenty-two minutes of a day by thirty gives eleven days; thus in thirty Arab years, there are precisely 10,631 days. Grosseteste goes on to explain how the Arabs work intercalary days into their calendar. Each year is made up of twelve months, alternating between twenty-nine and thirty days, for a total of 354 days. This leaves over twenty-two minutes of a day, just as the Christian year leaves one-quarter of a day out of each non-bissextile year. When the extra time adds up to a whole day, the Arabs add an intercalary day to the final month of the year, making both the eleventh and twelfth month be thirty days, and that bissextile year 355 days long.

Now because thirty Arab years have a whole number of equal lunations, 360, and a whole number of days, 10,631, this is a true cycle of lunations. That is, after thirty Arab years, the cycle of lunations will repeat itself. This reveals the error in the nineteen-year cycle that the Christian Church uses, because nineteen Christian[120] years are not equal to thirty Arab years, nor are they even multiples or fractions of each other. Again, Grosseteste explains this at some length. In nineteen years, if the first three years are not bissextile, there are 6,939 days. In nineteen years, there are 235 lunations, twelve in each year plus seven lunar embolisms.[121] Using the value of 29 days, 31 minutes, and 50 seconds of a day for a

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120Grosseteste refers to them as 'our' years. I have adopted the term 'Christian' years to differentiate it from the Arab years.

121Grosseteste is again assuming the reader has some basic knowledge of the calendar, because he does not explain what lunar embolisms are, nor why there are seven of them in the nineteen year cycle. He will discuss them at greater length in later chapters, but introduces the term here without definition. For the benefit of the reader: embolisms are extra lunar months that keep the lunar and solar calendars corollated with one another. In nineteen years, there are 228 lunar months (twelve per year), but the moon passes through its phases approximately 235 times; thus seven extra lunar months, or embolisms, are inserted over the course of nineteen years to keep the calendars more closely aligned.

lunation, 235 lunations work out to 6,939 days plus 40 minutes and 50 seconds of a day, which is more than two-thirds of a day. Thus at the end of a nineteen-year cycle of 6,939 days, the final lunation will not be complete until 40 minutes and 50 seconds of the next day have passed. If any one of the first three years in the ninteen-year cycle is bissextile, then there will be five bissextile days, for a total of 6,940 days in that cycle, which is too large by 19 minutes and 10 seconds of day, or about one-third of a day.

If instead we use the seventy-six year cycle, made up of four nineteen-year cycles, we find that there will always be the same number of days: 27,759. Three of those nineteen-year cycles will be over whole lunations by 19 minutes and 10 seconds of day each, for a total of 57 minutes and 30 seconds. The other ninteen-year cycle will be short of a whole lunation by 40 minutes and 50 seconds of a day. This still leaves 16 minutes and 40 seconds of a day too much; that is, in seventy-six years, there will be 940 whole lunations (that is, 235 times four), plus an extra 16 minutes and 40 seconds of a day. If we take four of these seventy-six year cycles, we find that after 304 years, 3,760 whole lunations will be completed, plus 1 day, 6 minutes and 40 seconds of a day. At the end of 304 years, the new moon will thus be over one day older than expected. After 4,256 years (or fourteen seventy-six year cycles), the full moon will fall on the day that a new moon is expected.

Grosseteste then deals briefly with the more precise value of a lunation given by Ptolemy, namely, with thirds, fourth, and fifths present. Computing the error accruing after 304 years, he finds the value to be fifty-eight minutes, eight seconds, four thirds, forty-six fifths, and forty fifths of a day, which is only slightly smaller than the value of one day, six minutes and forty seconds of day found with Arzahcel's value.

Grosseteste suggests that some might object, saying that the seventy-six year cycle

produces an integral number of whole lunations,[122] which would imply that Ptolemy's and Arzachel's values are incorrect. If this were true, then the tables Ptolemy and Arzachel produced should show errors in the times of eclipses. But, states Grosseteste, we do not find any appreciable errors in the observed hours of the eclipses based on their tables.[123] He then continues his analysis of the errors of the Christian calendar. The overabundance of lunations after 304 years is 1 day, 6 minutes, and 40 seconds of a day. If that number if divided into a whole lunation of 29 days, 31 minutes, and 50 seconds, the result is 26, with a remainder of 37 minutes and 55 seconds. If we multiply 304 years by 26, we get 7,904 years, which is equivalent to 97,760 whole lunations. But according to the values used by Arzachel and what Grosseteste calls "true astronomy,"[124] that time will be 37 minutes and 55 seconds short of 97,761 whole lunations, rather than a whole number of lunations.

To coordinate the two systems would take a huge expanse of time. The Arab system has a whole number of lunations in 10,631 days, or thirty Arab years. In the Christian system, the shortest cycle of whole days is the seventy-six year cycle, which contains 27,759 days.[125] To reduce one of those to the other,[126] that is, to find a common multiple, the two are multiplied together to produce 832,770 whole Arab years and 807,956 Christian years. Now the Christian calendar assumes 940 lunations are completed in seventy-six years; if

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122This is, of course, an assumption of the Christian calendar, that an integral number of lunations are present in the cycles used by the Church.

123…ipse tabule non mentiuntur nobis in aliquo sensibili de horis eclipsium, *Comp. corr.*, p. 235, l. 30.

124…veritatem astronomicam, *Comp. corr.*, p. 236, l. 2.

125Because the ninteen-year cycles can have different numbers of bissextile years, either five or four. Only when four sequential cycles are placed together will one always have the correct number of days.

126…reducit simul ad unum, *Comp. corr.*, p. 236, l. 19.

that is multiplied by 10,631 days, or thirty Arab years, the number of lunations becomes 9,993,140. But if one multiplies the 360 lunations of thrity Arab years by 27,759 days, or seventy-six Christian years, one gets 9,993,240 lunations, so 100 greater than the previous calculation.

This, Grosseteste concludes, makes it quite clear that there is an error in the Christian computation of lunations, and therefore the times of primation are incorrect. Thus the cycle of epacts[127] by which one finds the age of the moon at the beginning of a month are also in error. If one wishes to know the day of primation according to "astronomical truth,"[128] then one need only know the Arab months. The Arab month begins with the conjunction of the sun and moon; if one can convert from this date to the Christian date, one can know the age of the moon at any given time. If one chooses as primation the first visibility of the moon, one simply takes the second day of the Arab month; if primation is the second day of visibility, then use the third day of the Arab month, and so on .[129] For this reason, we need to know how Christian years can be converted to Arab years, and this will be the topic of the next chapter.

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[127]This is another example of where Grosseteste assumes his reader controls calendrical vocabulary, as the epact cycle has not been defined. As with the case of 'lunar embolism,' he will return to the topic in a later part of the work, but here it has been introduced without a definition. For the benefit of the reader: the epact cycle is concerned with the days by which the solar year is longer than a whole number of lunations (e.g., one year of 365 days is eleven days longer than the 354 days of twelve lunations). The epacts also determine when lunar embolisms are inserted into the calendar; this will be discussed fully in a later portion of the text.

[128]Possumus autem cognoscere semper diem primationis secundum veritatem astronomicam, *Comp. corr.*, p. 237, ll. 1–2.

[129]*Comp. corr.*, p. 237, ll. 1–13.

4.3.5. Chapter Five of the *Compotus correctorius*

Grosseteste gives two methods for calculating the Arab year from the Christian year. The first is a mathematical calculation. Take the current year of the Lord, and subtract 621, the number of years after Christ on which the Arab calendar began. Multiply the difference by 365, add to the sum one-fourth of the original difference (in other words, the current year of the Lord minus 621), then take away 195, and add the number of days that have passed in the current year of the Lord; this will give the number of days that have passed since the beginning of the Arab calendar.[130] Multiply this value by thirty, and divide by 10,631; this will give the number of complete Arab years that have passed. Divide the remainder by thirty, and this leaves the number of days of the current Arab year. Subtract the number of days for complete months, alternating between thirty and twenty-nine days. Whatever remains[131] gives the days of the current month.[132]

Grosseteste then notes that Arzachel made tables and wrote explanations of them that allowed one to find Arab, Persian, Greek, Spanish, Egyptian, and Christian years, each from the other.[133] Using these table, Grosseteste states, he has made tables to find the Arab year and month from the Christian. He also explictly notes at this point that this will allow

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[130]Grosseteste does not explain why this formula works. The addition of one-fourth of the years is to account for bissextile days, and the 195 days account for the first Arab year starting in the midst of the Christian year.

[131]In other words, a number less than the next month in sequence, either thirty or twenty-nine days.

[132]Grosseteste does not state explicitly that the days of the month are of the Arab month, and hence are the same as the number of days since the conjunction of the sun and moon. He also does not note what to do with the fractions that can appear during the calculation.

[133]Posuit etiam Arzachel tabulas et doctrinam tabularum ad extrahendos annos Arabum, et annos Persarum, et annos Grecorum, et annos Hisspanencium, et annos Egipciorum, et annos Domini quoslibet ex quibuslibet, *Comp. corr.*, p. 237, l. 35–p. 238, l. 2.

one to find the true primations.[134] The tables are contained in Tables 7 and 8 below.[135]

To convert from Christian years to Arab years, note the current year, month, and day. Next, from the current, unfinished year, figure out the number of thirty-day months that have passed; that is, take the number of days of the present month, add one day for each

TABLE 7

THE ARABIC MONTHS OF THE YEAR

Lunar Months	Months	Days
Almuarum	1	0
Saphar	1	29
First Rabe	2	29
Second Rabe	3	28
First Gunedi	4	28
Second Gunedi	5	27
Rageb	6	27
Saabe	7	26
Ramadan	8	26
Scarihol	9	25
Dulcada	10	24
Dulhega	11	24

[134]…per annos et menses Arabum extractos habeamus veram cognitionem primationum, *Comp. corr.*, p. 238, ll. 3–5. It is curious that he notes this before he begins the explanation of the tables, but not before he gave the mathematical formula for figuring the primation. This might imply he considered the tables to be more accurate, or he may have assumed that his reader would use the tables rather than the mathematical formulation.

[135]The tables are on *Comp. corr.*, p. 239, and in MS Brit. Mus. Add. 27589, folio 88^{v} in the second column, extending into the upper and lower margins. The tables of MS Brit. Mus. Add. 27589 do not have the labels that Steele provides in square brackets; he notes they are from a different manuscript. In MS Brit. Mus. Add. 27589, the two tables are placed next to each other. I have translated the Latin words, and have not preserved the abbreviations of the manuscript.

month of thirty-one days that have passed in that year, subtract one or two days for February (if it was bissextile or non-bissextile, respectively), and thus one will know the number of thirty day months and the remaining number of days that have passed. Then, referring to Table 7,[136] find the entry for the Christian month and day that is less than the total just found, and subtract that amount from the total; this will give an amount that is left over after a complete Arab year, and thus what is left over from the completion of a lunation.

The difference that was just calculated is then used in Table 8.[137] As with the first table, find the Christian year, month, and day that is less than the difference calculated. The first column of this line will give the number of Arab years that have passed from the year given in the first table, while the difference between the previous amount and the amount given in the table for Christian years, gives the amount of time that has passed since that Arab year was complete. This will work out to a certain number of months and days. This value is then used in the latter portion of the table, again finding the amount that is less than the previously calculated difference; on this line, one finds the completed Arab month, and subtracting the months and days given for the respective Christian year leaves one with the number of days by which the current time is within an Arab month. Thus from the current Christian year, month and day, one has found the current Arab year, month and day;[138] the

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136*Comp. corr.*, p. 239.

137*Comp. corr.*, p. 239.

138One curious feature here is that Grosseteste has given the names of the Arab months in the tables. To find the age of the moon, the names are not strictly necessary, as one could simply serially subtract thirty and twenty-nine days from the calculated number of days until a number less than the next month is reached, if the only goal were to find the age of the moon. That Grosseteste includes a means to find the Arab year, month and day, both in the table and in his instructions, reinforces the notion that he finds the cultural nature of the calendar to be significant; that is, he wants not only to reach the practical goal of finding the age of the moon, he also preserves the foreign calendrical information.

day is thus the number of days that have passed since the conjunction of the sun and moon, because that always falls on the first day of the Arab month, and therefore one knows the age of the moon. The tables end the chapter.

TABLE 8

THE EXPANSION OF ARABIC YEARS

Arab Years	AD Years	Mon.	Days	Frac- tions
600	1203	7	29	2
630	1232	9	8	1
660	1261	10	17	0
690	1290	11	27	2

Arab Years Exp.	AD Years Exp.	Mon.	Days	Frac- tions
1	0	11	24	0
2 b’	1	11	23	3
3	2	11	2	2
4	3	10	21	1
5 b’	4	10	11	0
6	5	9	29	3
7 b’	6	9	19	2
8	7	9	8	1
9	8	8	28	0
10 b’	9	8	16	3
11	10	8	5	2

Arab Years Exp.	AD Years Exp.	Mon.	Days	Frac- tions
12	11	7	29	1
13 b’	12	7	14	0
14	13	7	2	3
15	14	6	21	2
16 b’	15	6	11	1
17	16	6	0	0
18 b’	17	5	19	3
19	18	5	8	2
20	19	4	28	1
21 b’	20	4	18	0
22	21	4	5	3
23	22	4	24	2
24 b’	23	3	14	1
25	24	3	3	0
26 b’	25	2	22	3
27	26	2	11	2
28	27	2	0	1
29 b’	28	1	20	0
30	29	1	8	3

4.3.6. Chapter Six of the *Compotus correctorius*

Grosseteste, in a very brief chapter six, argues that one need not differentiate between the length of a true lunation and an equal lunation. He has previously been dealing with equal lunations, or the length of time used for a lunation in the construction of the calendar, Arzachel's value of 29 days, 31 minutes, and 50 seconds. The true lunation, however, is the length of time for the actual conjunction of the sun and moon, literally, when the moon returns to the sun after following its actual path.[139] This value, because the true sun and true moon do not move uniformly, is not equal from one true lunation to the next; sometimes it is more than the equal lunation, and sometimes less. According to the *Almagest*, he states, whenever 251 lunations are complete, 251 true lunations have also passed.[140] Grosseteste claims that any discrepancy between the true and equal lunations will disappear over time, even though from one lunation to the next the difference might be noticeable. In any event, the process of measuring that difference would take too long and be too laborious for those engaged in the art of compotus. Finding the exact time of the true lunation, he leaves for those who can find the places of all the stars from the times given in astronomical tables.[141]

139…tempus lunationis vere, id est, tempus reditus lune ad solem secundum utriusque cursum verum, *Comp. corr.*, p. 240, ll. 4–5.

140Quelibet tamen 251 lunationes equales adequantur precise quibuslibet 251 lunationes veris, sicut ostensum est in libro *Almagesti*, *Comp. corr.*, p. 240, ll. 7-9. See Book 4, chapter 2 of the *Almagest* for Ptolemy's discussion of the period of the moon. In Toomer's translation, see pp. 174–176.

141Investigatio autem deffiniti temporis cujusque lunationis vere relinquenda est illis qui loca stellarum omnium ad data tempora per tabulas astronomicas inveniunt. *Comp. corr.*, p. 240, ll. 21–24.

4.3.7. Chapter Seven of the *Compotus correctorius*

After this brief chapter, Grosseteste moves on to the seventh chapter. The topic of this chapter is the way in which lunations are dealt with in the calendar, including the number of lunations, where they should be placed, and the formation of epacts and lunar regulars. He begins by stating the premise that the calendar is false regarding the nineteen-year cycle and the cycle of epacts. Because this cycle is used by the Church, he will examine the roots of the problem.

If we assume, as did those who first set down the Christian calendar, that seventy-six years completes a whole number of equal lunations, namely 940, we would find that the length of an equal lunation is 29 days, and 31 minutes, 51 seconds, 3 thirds, 44 fourths, 47 fifths, 14 sixths, and 2 sevenths of a day.[142] This is greater than the length given by Arzachel by 1 second, 3 thirds, 49 fourths, 47 fifths, 14 sixths, and 2 sevenths of a day. The errors of using a value different from Arzachel's have already been stated in a previous chapter, he reminds the reader, but he continues on to show the error more clearly. In nineteen years, 235 lunations pass. Using the value given above, 235 lunations equates to 6,939 days, 44 minutes, 59 seconds, 59 thirds, 59 fourths, 59 fifths, 57 sixths, and 50 sevenths. He then notes that all of those minutes, seconds, thirds, and so forth, are different from forty-five minutes by only 2 sixths and 10 sevenths; this amount is so small that even over a long period no difference will be seen, and so he will use the value of 6,939 days and 45 minutes for the length of 235 lunations.

Now when nineteen years include four bissextile days, they have 6,939 days, and thus are too short by forty-five minutes. But anytime there is a nineteen-year cycle with four bissextile days, it is followed by three cycles with five bissextile days, and thus with 6,940

[142]Recall that the minutes, seconds, etc. are of a day. That is, 29 days, 31 minutes is a little more than 29.5 days.

days each. This amount is too long by fifteen minutes for each cycle, and thus over the course of seventy-six years, the lunations come out precisely equal: seventy-six years is exactly 940 lunations.[143] He then notes that this is the only possible quantity for an equal lunation if one assumes 940 lunations in seventy-six years, because dividing the numner of days in seventy-six years by 940 lunations again gives that value of 29 days, 31 minutes, 51 seconds, 3 thirds, 44 fourths, 47 fifths, 14 sixths, and 2 sevenths for an equal lunation.[144]

To place lunations into the calendar, one assumes that lunations alternate between thirty and twenty-nine days. This leaves out a small amount of time, as the length of the lunation is slightly more than 29 days and 30 minutes, but this small amount will be added back into the calendar when it begins to make a sensible difference. It will be added back by adding a day, and thus having two thirty-day lunations in a row, or by inserting a lunar embolism, the rules for which he will give below. Twelve lunations alternating between thirty and twenty-nine days account for 354 days, which falls short of a non-bissextile year by eleven days. In a given year, there are twelve lunations, and each lunation is said to belong to the month in which it ends.[145] When an extra lunation is added into a calendar, because of the extra days that each year has, it will cause two lunations to end in the same month; the additional lunation is called an embolism.

The extra days that remain at the end of the year are called the 'epact' of the next year; this increases by eleven each year, until a sufficient amount of time has accumulated to

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[143]This is no surprise, as the value he calculated for the equal lunation was based on this equality; he had not explicitly stated how he arrived at that value, but this calculation shows it to be correct based on the premise that seventy-six years have exactly 940 lunations.

[144]He has thus shown that the value can be determined in either direction, from the assumed length of the equal lunation or from the assumed number of days and lunations in seventy-six years.

[145]He gives a verse to remember this rule: "The moon is given to the month to which it is joined at its end." *Mensi luna datur cui fine suo sociatur*, *Comp. corr.*, p. 243, l. 10.

insert a lunar embolism. Because the eleven days were extra days of a lunation, eleven days is also the amount by which the age of the moon is older on a given day of the year than it was in the previous year. Grosseteste notes specifically that the age of the moon at the beginning of a month is eleven days days more than it was at the beginning of that month in the previous year.[146] Let us now go through an example that is not in Grosseteste's text to be sure this is clear. Say that in a given year, the age of the moon on the first day of June is one. The epact of the next year is eleven, and so on the first day of June in the second year, the moon will be twelve days old.

Grosseteste then defines the 'lunar regular.' The lunar regular is the age of the moon on the first day of the month on the first year of creation. Thus each month has its own unchanging, lunar regular. Now the epact cycle begins in September, and we know that the age of the moon on the first day of September on the first year of creation was five. Thus the lunar regular of September is five. From this can be found the lunar regulars of each month in the following manner. Add the lunar regular (the age of the moon on the first day of the month) to the number of days in September. Subtract from this sum the lunation of September, and the difference gives the lunar regular for the next month. Proceeding through all the months, Grosseteste finds the following regulars: October's lunar regular is 5, November's is 7, December's is 7, January's is 9, February's is 10, March's is 9, April's is 10, May's is 11, June's is 12, July's is 13, and August's is 14. Again he gives a verse to remember these values:

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[146]Et per eosdem undecim dies etiam majoratur etas lune in principio cujusque mensis sequentis anni super etatem suam in principio cujusque mensis prioris anni. Comp. *corr.*, p. 243, ll. 15–17.

Five is given to September and October, to November and December seven, three threes to January and March,
February and April have 10, add one to each of the next.[147]

He also gives another verse in which the first letter of each of the twelve words corresponds to the lunar regular of each month, from September to August.[148] Now the lunation for each month alternates between thirty and twenty-nine days. For odd months, the first, third, and so on, the lunation is thirty days; and for even months, the second, fourth, and so on, the lunation is twenty-nine days. Again he gives a verse for remembering this.[149]

Grosseteste next moves on to the issue of calculating subsequent epacts. In the second year, eleven days will again accrue, making the epact for the third year twenty-two. He also notes that bissextile years will not increase the epact by an extra day; instead, the second lunation of the year will simply be made thirty days instead of the expected twenty-nine days. Thus, while the year will have one extra day, so will the twelve lunations, and only eleven days will accrue to the epact even in bissextile years. In the third year, another eleven days accrue, giving an epact of thirty-three. However, since this number is greater than thirty, an extra lunation, an embolism, is inserted into the third year, and thirty days are taken away from the accrued days, leaving an epact of three for the fourth year. He will discuss later where the embolism will be inserted.

Grosseteste then runs serially through each year. The epact for the fifth year, after eleven days accrue in the fourth year, is fourteen. In the sixth year, it is twenty-five. During the sixth year, the extra eleven days bring the total to thirty-six, so an embolism is added in

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[147]Quinque Sep. Oc. dantur: No. De. septem, ter tria Ja. Mar./ Feb A. decem, sumant: Post unum cuilibet addas. *Comp. corr.*, p. 243, ll. 38–39.

[148]Estuat esuriit gramen gravat igne kalendas; Igne kalendarum liquet mihi nominis ordo. *Comp. corr.*, p. 244, ll. 2–3. The fifth letter of the alphabet is 'E', and so September's and October's regulars are five, and so on through 'O,' the fourteenth letter, for August.

[149]Inpar luna pare, par fiet in inpare mense. *Comp. corr.*, p. 244, l. 13.

the sixth year, and the epact for the seventh year is six. This leads to an epact for the eighth year of seventeen. Adding the eleven extra days gives an epact of twenty-eight days for the ninth year, but the pattern is here disrupted. Two days are "borrowed" from the ninth year, and a lunar embolism is added to the eighth year. Adding eleven to the epact of the ninth year gives a total of thirty-nine, but thirty of those days were used for the embolism of the eighth year, and so the epact of the tenth year is nine. In the eleventh year, the epact is twenty; eleven more days accrue during that year, giving a total of thirty-one, of which thirty are used to make an embolism in the eleventh year, leaving for the twelfth year an epact of one. In the thirteenth year, the epact is twelve, and in the fourteenth year, the epact is twenty-three. Adding the eleven days in the fourteenth year gives a toal of thrity-four, of which thirty are taken for an embolism in the fourteenth year, and the epact for the fifteenth year is four. In the sixteenth year, the epact is fifteen, and in the seventeenth year, the epact is twenty-six. During the seventeenth year, eleven days accrue, and an embolism is added, leaving an epact for the eighteenth year of seven. This leads to an epact of eighteen for the nineteenth year. In that final year of the cycle, eleven more days accrue, for a total of twenty-nine days. In that year, one day is borrowed from the lunation of July, making its lunation only twenty-nine days instead of the usual thirty.[150] Then in the nineteenth year, an embolism of thirty days is added, leaving an epact of zero for the next year, at which point the cycle repeats.

The cycle of epacts is nineteen years, as is the cycle of primations,[151] because the

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[150]Because it is an odd month, it normally has a lunation of thirty days, as we know from the rule previously given.

[151]Recall that the cycle of primations has to do with the age of the moon; the primation is defined as the beginning of the moon's month (either as a new moon, first appearance or some other chosen day—Grosseteste does not favor one in particular). Thus the epact is relevant to knowing the age of the moon at any given time.

primation can be calculated from the epacts and lunar regulars; the lunar regulars stay constant, and so the cycle of epacts will also be the cycle of primations. One difference, however, is that the cycle of primations is understood to run with the solar year, that is, beginning in January. The epact cycle, though, is begun in the September preceeding the January in which the primation cycle begins. This will be relevant when Grosseteste covers the rules for placing the embolism within the calendar.

Grosseteste next summarizes some of the information he has just covered. In nineteen years, there are seven embolismic years, that is, years to which a lunar embolism of thirty days is added, namely, the third, sixth, eighth, eleventh, fourteenth, seventeenth, and nineteenth years. The nineteen-year cycle is divided into the *ogdoad*, the first eight years, of which three are embolismic, and the *endecad*, the final eleven years, in which four are embolismic. Yet again Grosseteste gives a verse by which to remember which years are embolismic.[152] He also gives a verse for remembering the epact of each year,

> What the moon has on the eleventh kalends of April
> Shows the number of the epact for any year.[153]

In this case, however, the verse does not remind the reader of each subsequent epact. Instead, one has to remember a certain amount of information. On the first year of the cycle, by definition the moon is thirty days old on the eleventh kalends of April. In the second year, it will thus be eleven[154] on that day. If one performs the subsequent calculations,

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[152]Cristus factus homo levat omnia reddita trono. *Comp. corr.*, p. 246, l. 16. The first letter of each word corresponds to an embolismic year: the third year is represented by ‘C,’ the third letter of the alphabet, through the nineteenth year represented by ‘T.’

[153]Que tenet undenas Aprilis luna kalendas/ Epacte numerum monstrat per quemlibet annum. *Comp. corr.*, p. 246, ll. 21–22.

[154]Because eleven days accrue in the first year.

Grosseteste states, then one can find the epact for each year.[155] To do so requires that one know for which year of the nineteen-year cycle one wants to know the epact. To find this out, add one to the year of the Lord in question, and divide the sum by nineteen. If there is no remainder, that year is the nineteenth year of the cycle. If there is a remainder, that gives the year of the cycle of epacts, recalling that the year of the epacts begins in the preceding September.

Grosseteste ends the chapter by reminding the reader why this is useful information. By adding the epact and the lunar regular, one can find the age of the moon at the beginning of the month. If the sum is less than thirty, it is the age of the moon. If it is greater than thirty, subtract thirty and the difference is the age of the moon. Errors in this method can crop up because of the fact that the actual length of the lunation is twenty-nine and one half days, whereas the luantions of the calendar are always twenty-nine or thirty days. The exceptions to the rule of epacts and lunar regulars, as well as the placement of the lunar embolisms in embolismic years are the topics of the next chapter.

4.3.8. Chapter Eight of the *Compotus correctorius*

A basic assumption of the calendar, as previously stated, was that an equal lunation was more than twenty-nine and one half days by 1 minute, 51 seconds, 3 thirds, 49 fourths, 47 fifths, 14 sixths, and 2 sevenths of a day. When two subsequent lunations of thirty and twenty-nine days pass, twice that amount is left over. At the end of twelve lunations, of which six are thirty days long and six are twenty-nine days long, the extra amount is twelve times the original amount, or 22 minutes, 12 seconds, 49 thirds, 57 fourths, 26 fifths, 48

155This mnemonic device is fundamentally different than most of the other examples. In many of them, numbers are drawn directly from the verse, for example from a letter's position in the alphabet. In this case, though, the calculation must be performed from the first year to the year in question, so the device does little more than remind the reader that the relevant number for calculating epacts is eleven, the number of days that accrue each year. The verse also does not aid in remembering the exceptions to the pattern in the eighth and nineteenth years.

sixths, and 24 sevenths of a day. Grosseteste calls the lunations of alternating thirty and twenty-nine days 'common lunations.'[156] In nineteen years, there are 228 of these lunations, leaving an extra amount of 7 days, 2 minutes, 2 seconds, 33 thirds, 11 fourths, 29 fifths, 19 sixths, and 36 sevenths left over after that time. However, as stated in the previous chapter, one day was removed from the lunation of July to make the lunar embolism in that year thirty days, leaving the lunation of July to be twenty-nine days. This subtraction of a day from July and the addition of the day to the lunar embolism is called the *saltus lune*, the 'leap of the moon.'[157]

In the nineteenth year, then, we can say that there were twelve common lunations and a lunar embolism of twenty-nine days. The embolism is thus shorter than an equal lunation by 31 minutes, 51 seconds, 3 thirds, 49 fourths, 47 fifths, 14 sixths, and 2 sevenths of a day. Adding this amount to the previous amount found to be left over after 228 common lunations gives a total of 7 days, 33 minutes, 53 seconds, 37 thirds, 1 fourth, 16 fifths, 33 sixths, and 38 sevenths left over after 229 lunations (228 common lunations and an embolism of twenty-nine days).

There are also an additional six lunar embolisms in each ninteeen-year cycle. Because each of them is thirty days long, they are longer than an equal lunation by 28 minutes, 8 seconds, 56 thirds, 10 fourths, 12 fifths, 45 sixths, and 58 seveneths of a day. Six times this amount comes out to 2 days, 48 minutes, 53 seconds, 37 thirds, 1 fourth, 16 fifths, 35 sixths, and 48 sevenths. Subtracting this amount from the previous shortcoming leaves an extra 4 days, 44 minutes, 59 seconds, 59 thirds, 59 fourths, 59 fifths, 57 sixths, and 50 sevenths. This is essentially 4 days and 45 minutes because there is no sensible difference

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[156]…tale lunationes voco lunationes communes, *Comp. corr.*, p. 247, l. 32.

[157]Et hec subtractio unius diei de lunatione Julii et additio ejusdem diei lunationi embolismali vocatur 'saltus lune.' *Comp. corr.*, p. 248, ll. 5–7.

between them.[158]

The calculation so far has left out bissextile days. As stated previously, in a bissextile year, the extra day is simply added to the lunation of February; this leads to an extra day compared to common lunations. In a nineteen-year cycle with four bissextile years, four extra days are added during the 235 lunations (228 common lunations, six thirty-day lunations, and one twenty-nine day lunation), leaving an extra time of only forty-five minutes. Then, in each of the next three nineteen-year cycles, there are five bissextile years. In each of those cycles, the five extra days account not only for the 4 days and 45 minutes, but also add an extra fifteen minutes to each cycle. These three lengths of fifteen minutes cancel out precisely the extra forty-five minutes left over from the other nineteen-year cycle in the seventy-six-year cycle, and thus the 940 lunations in the calendar of the seventy-six years are exactly equal to the 940 equal lunations that occur in that time.[159]

Grosseteste then moves on to the rules for placing the lunar embolisms into the calendar. The first comes in the third year of the cycle of epacts, and is begun on the fourth nones of December and ends on the last day of December. Because the epact cycle begins in the prior September of the nineteen-year cycle, this embolism is actually within the second year of the nineteen-year cycle. The placement of this lunar embolism leads to two consecutive thirty-day lunations, namely, the embolism and the lunation of the subsequent January.[160] If the third year of the nineteen-year cycle happens to be a bissextile year, this

158…quia non differunt ab illis in aliquo sensibili. *Comp. corr.*, p. 248, l. 34.

159Again this is not surprising, given that the length of the lunation was figured from the assumption that 940 lunations are completed in precisely seventy-six years, and the calculations from this eighth chapter use the length of an equal lunation found from that assumption, namely, 29 days, 31 minutes, 51 seconds, 3 thirds, 49 fourths, 47 fifths, 14 sixths, and 2 sevenths.

160Grosseteste does not note this, but the previous lunation was of December, because it ended on the first day of December (the day before the fourth nones of December), and was thus of twenty-nine days.

will lead to four consecutive thirty-day lunations, the two just mentioned, plus the subsequent February (normally a twenty-nine day lunation, but made thirty with the bissextile day), and March lunations. In all cases, as we shall see, Grosseteste explicitly points out when thirty-day lunations follow each other, presumably because these will be exceptions to the rule of typical common lunations, which consist of subsequent thirty- and twenty-nine-day lunations.

The second lunar embolism begins on the fourth nones of September and ends on the kalends of October in the sixth year of the epact cycle, the fifth year of the nineteen-year cycle. Again, there are two consecutive lunations of thirty days, that of September and the embolism. The third embolism begins the day before the nones of March and ends on the day before the nones of April in the eighth year. Grosseteste notes explicitly that this is the eighth year of both the epact and nineteen-year cycles, as the periods from January through the beginning of September of a given year are the same in each cycle, while September through December occur in the year of the epact cycle that is one greater than that of the nineteen-year cycle. There are again two consecutive thirty-day lunations in the eighth year, namely, that of March and the embolism; if the year is bissextile, there will be four consecutive thirty-day lunations, those of January, February, March and the embolism. In that year, a set of exceptions to a normal rule occurs. A lunation is said to be of a month if it ends in that month. Given the placement of the embolism in the eighth year, however, the lunation for April, the lunation that must follow the embolism that followed the lunation of March, ends on the fifth nones of May, the lunation of May ends on the fourth nones of June, and the lunation of June ends on the kalends of July. In subsequent months, the rule is again followed, with the lunation of July ending in July, and so forth. This shifting of dates also causes another rule to be suspended, namely, the age of the moon at the beginning of the month cannot be found from the rule of adding the epact of the year to the regular of the month during the months May, June, and July. He adds a verse that will aid

the reader to remember this, though the verse serves only to remind that the rule will fail in those months, but does not give the necessary correction.[161]

The fourth embolism occurs in the eleventh year of both cycles, begins on the third nones of January, and ends on the kalends of February. In this year, both the lunations of January and the embolism are thirty days, and, if the year is bissextile, the subsequent lunations of February and March will be thirty as well. The lunation of February ends on the sixth nones of March, and the lunation of March ends on the kalends of April. The rule for finding the age of the moon from adding the epact and the monthly regular fails for March, unless it is a leap year, in which case the rule holds.[162] Grosseteste gives a verse for remembering the exception to the rule, as well as for the exception to the exception, "Unless it is bissextile, the first fails in March in the eleventh year."[163] He also explains that the rule for finding the age of the moon on the first of March will fail when the lunation for March begins before the bissextile day is added, because if the bissextile days falls within the lunation of March, a thirty-day lunation, that lunation effectively becomes too long—thirty-one days—and so the rule fails.

The fifth embolism lasts from the fourth nones of November to the kalends of December, in the fourteenth year of the epact cycle and the thirteenth year of the nineteen-year cycle. Two consecutive thirty-day lunations occur, that of November and the embolism.

161The verse is, "July fails in the eighth year with May." *Fallitur octavo cum Mayo Julius anno. Comp. corr.*, p. 250, l. 38. He notes immediately prior to the verse that the eighth year's epact is eleven and May's regular is seventeen, but that the moon is actually twenty-seven on the first of the month, not twenty-eight as would be expected from the rule.

162Grosseteste notes that the epact is twenty, the regular for March is nine, but the moon is twenty-eight on the first day of March. In a leap year, however, the moon is one day older, and the rule holds.

163Ni sit bissextus fallit Martem endeca primus. *Comp. corr.*, p. 251, l. 14.

The sixth embolism runs from the fourth nones of August to the kalends of September in the sixteenth year. The sixth embolism needs the eleven days accruing in the seventeenth year, but because it ends on the kalends of September, he writes, it is acceptable for it to use the extra days of the seventeenth year because it ends on the first day of the seventeenth year of the epact cycle. In addition, for the same reason, the seventeenth year is said to be embolismic, even though most of the lunation occurs in the sixteenth year. This embolism, and the subsequent lunation of September, both have thirty days.

The seventh and final embolism begins on the third nones of March and ends on the third nones of April in the nineteenth year of each cycle. The prior lunation of March and the embolism are thirty days each, and, in a bissextile year, the previous January and February lunations are also thirty days each. Following the embolism, the lunation of April ends on the sixth nones of May, and the lunation of May ends on the kalends of June. The rule for finding the age of the moon from the epact and the regular fails in May and August.

Grosseteste ends the chapter with a table for finding the age of the moon. In a column, he wrote the years of the epact cycle from one to nineteen. To the left, he wrote the epact for each year. To the right, he wrote columns for each month. Above the row for the first year of the cycle, he added the regular for each month. Then, at the intersection of each year and month, he wrote the age of the moon, calculated by adding the epact for that year and the regular for that month, except in the months noted previously in the text where the rule failed. In March of the eleventh year, he placed two numbers, twenty-nine with a 'b' and twenty-eight, signifying the moon will be twenty-nine on the first of March if the year is bissextile, and twenty-eight if it is not. The table is reproduced below:[164]

[164]The table is on *Comp. corr.*, p. 253, and in MS Brit. Mus. Add. 27589, folio 95^r in the second column, extending into the upper and right margins. The table reproduced here does not indicate the scribal error of MS Brit. Mus. Add. 27589 in which the epacts and years are begun one row too high in their respective columns (the row listing the regular for each month). I have translated the Latin words, and have not preserved the abbreviations of the manuscript.

TABLE 9

EPACTS AND REGULARS

Epact	Year	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
		5	5	7	7	9	10	9	10	11	12	13	14
0	1	5	5	7	7	9	10	9	10	11	12	13	14
11	2	16	16	18	18	20	21	20	21	22	23	24	25
22	3	27	27	29	29	1	2	1	2	3	4	5	6
3	4	8	8	10	10	12	13	13	13	14	15	16	17
14	5	19	19	21	21	23	24	23	24	25	26	27	28
25	6	30	30	2	2	4	5	4	5	6	7	8	9
6	7	11	11	13	13	15	16	15	16	17	18	19	20
17	8	22	22	24	24	26	27	26	27	27	29	29	1
28	9	3	3	5	5	7	8	7	8	9	10	11	12
9	10	14	14	15	16	18	19	18	19	20	21	22	23
20	11	25	25	27	27	29	30	29b28	30	31	32	33	34
1	12	6	6	8	8	10	11	10	11	12	13	14	15
12	13	17	17	19	19	21	22	21	22	23	24	25	26
23	14	28	28	30	30	2	3	2	3	4	5	6	7
4	15	9	9	11	11	13	14	13	14	15	16	17	18
15	16	20	20	22	22	24	25	24	25	26	27	28	29
26	17	1	1	3	3	5	6	5	6	7	8	9	10
7	18	12	12	14	14	16	17	16	17	18	19	20	21
18	19	23	23	25	25	27	28	27	28	29	30	1	3

4.3.9. Chapter Nine of the *Compotus correctorius*

The ninth chapter covers the rules for placing the golden number into the calendar. The cycle of primations, Grosseteste writes, repeats after nineteen years. In the first year, it is signified by one, in the second year by two, and so on. These are called, he states, the golden numbers, the name deriving from the Roman habit of writing the numbers in gold on

their calendars.[165] The usefulness of the cycle of primations is that the cycle of primations allows one to know the dates when the new moon falls in a given year. Thus the golden numbers, which correspond to the primations, will do the same.

To make this clear to the reader, let me present an example not found in Grosseteste's text. If a particular day has a golden number of one, that day will be a new moon in the first year of the cycle. If, say, a day has a golden number of seven, a new moon will occur on that day in the seventh year of the cycle. If a day does not have a golden number, then a new moon will never fall on that day.

Grosseteste notes that the first full lunation of the first year of the cycle begins on the tenth kalends of February; this year's golden number, because it is the first in the cycle, is one. Thus any year with the golden numeral of one will have a new moon on the tenth kalends of February. Once this date is fixed, all subsequent new moons can be calculated, and one can know, simply from the golden number of a year, when each new moon will fall. The usefulness of this is that the movable feasts of the Christian year, as we will see in the next chapter, are fixed based upon the lunations in a year.

The golden numbers are then placed on certain days of the calendar.[166] Grosseteste, however, does not explain this, and clearly assumes that the reader either will be familiar with the process, or will be taught the process. The means to calculate where the new moons will fall, states Grosseteste, is easily found by considering the kalends of January. In the third year, the moon is new on the kalends of January, and so the golden number on the kalends of January is three. Add to this eight, to get eleven, and eleven will be the next

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165…vocatur 'aureus numerus,' quia cum primo inveniebatur scribebatur apud Romanos aureis litteris. *Comp. corr.*, p. 254, ll. 1–2.

166This is illustrated in E. G. Richards, *Mapping Time, The Calendar and Its History*, Oxford: Oxford University Press, 1998, pp. 355–8, including Table 29.1.

golden number placed in the calendar. Add eight again to get nineteen, and nineteen will be the next number placed in the calendar. Continue to add eight and, if the next number is more than nineteen, subtract nineteen to get the next golden number to be placed in the calendar. Next he notes that anytime the number is more than eleven, the addition of eight will give a sum more than nineteen; so, rather than adding eight, eleven can be subtracted.[167] If the number placed in the calendar is eleven or less, then the next number, after the addition of eight, is placed not on the next day, but two days forward.[168] If, however, the number is greater than eleven, and thus eleven is subtracted from it to find the next golden number, the difference is placed on the next day.

Grosseteste does not provide an example, but I will again provide one for clarity's sake.[169] The kalends of January has a new moon on the third year of the cycle. Thus the golden number of three is placed next to the first of January. Adding eight to this three gives the next golden number, eleven. Because the previous number was equal to or less than eleven, the next golden number is placed two days forward, and so the golden number eleven is placed next to the third of January. Eight is added to eleven to give nineteen, and this new golden number is placed ahead two days on the fifth of January. Then eleven is subtracted to give the next golden number of eight; in this case, the new golden number is placed only one day ahead, on the sixth of January. Then the golden number sixteen is placed on the eighth of January; then the golden number five is placed on the ninth of

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167Grosseteste does not give an example, but I offer this one to clarify for the reader. Say the total happens to be fourteen; add eight, and you get twenty-two; take away nineteen and you get three. Subtracting eleven from the initial fourteen would also have given three.

168Which Grosseteste refers to as "on the third day," *die tercio*, meaning the third day including the first day where the previous number had been placed.

169The example is drawn from the table in Richards, *Mapping Time*, mentioned above.

January, and so on. Grosseteste will add some exceptions to the rules later in the chapter.

Grosseteste explains why this works in the following fashion. Eight years, without bissextile days, have 2,920 days. Any eight continuous years of the calendar, except when beginning with the ninth year of the nineteen-year cycle, have three embolismic years.[170] In eight years, the common lunations—pairs of thirty- and twenty-nine-day lunations—account for 2,832 days. Subtracting this from 2,920 days leaves eighty-eight days. The three lunar embolisms account for this time plus two extra days. Thus the new moon falls two days later, on the third day, after the eight years pass. If, however, the eight years include the last year of the nineteen-year cycle, which includes the *saltus lune*, and therefore lacks one day, only a single extra day is left after the embolisms are accounted for. So any sequence of eight years that begins on the twelfth year or later, thus corresponding to a golden number greater than eleven, includes the *saltus lune*, and thus only jumps forward by a single day.

Grosseteste then covers the exceptions to the rule. On the fourth nones of February, the golden number eleven is placed, and the golden number of nineteen immediately follows it on the third nones of February. There are only two lunar embolisms during the eight years beginning on the fourth nones of February, because the fourth embolism ends on the third nones of January in the eleventh year, and the seventh embolism does not begin until the third nones of March in the nineteenth year. Thus the ninety-nine lunations of those eight years are made up of ninety-six common lunations, two lunar embolisms, and twenty-nine (instead of the expected thirty) days. This leads to only a single extra day remaining after those eight years, and thus there is no extra day interposed between the two golden numbers of eleven and nineteen on the fourth and third nones of February.

[170]In the ninth to sixteenth years, a span of eight years, only the eleventh and fourteenth years are embolismic. Any other consecutive span of nine years has three embolismic years.

The *saltus lune* causes six exceptions to the rules by causing there to be one less day than expected. Again, the golden number of nineteen is placed on the day immediately following a day with the golden number of eleven on the fourth and third kalends of August, the sixth and fifth kalends of September, the sixth and fifth kalends of October, the eighth and seventh kalends of November, the eighth and seventh kalends of December, and the tenth and ninth kalends of January. In these places, too, a further exception is present. Normally, the golden number following nineteen would be eight, and would fall on the next day. However, in all the places just mentioned, in other words, in the months following the third kalends of August, the golden number eight falls two days beyond the nineteen, instead of the expected one day. This is because the *saltus lune* fell in the lunation of July on the nineteenth year, and thus the eight years following the nineteenth year have one more day than expected, and must fall two days ahead.

The final exception to the rule falls on the nones of April, on which the golden number of eight is placed. This should be followed two days later by the golden number sixteen, but in fact the golden number sixteen falls on the day immediately following the nones. This happens because the lunar embolism of the eighth year ends before the nones of April, thus causing the eight years following the nones of April, which should have 99 lunations, to have 96 common lunations, plus two embolisms, plus a remaining twenty-nine days, leading to a jump of only one day for the full moon eight years later.

It also happens that two golden numbers, thirteen and two, fall on the fourth nones of December. The lunar embolism of the fourteenth year of the cycle of epacts ends on the kalends of December in the thirteenth year of the nineteen-year cycle; thus only two embolisms fall in the eight years following the nones of December. From before, we would thus expect the next golden number, two, to fall on the next day. However, the eight year period after the nones of December in the thirteenth year also includes the saltus lune, thus taking away one more day, and causing the two subsequent golden numbers to fall on the

same day.

Grosseteste ends the chapter with a mnemonic device in the form of a long poem. It is twenty-two lines long, whereas most of the verses he has given for mnemonic purposes have been only one or two lines long. The poem gives the same instructions for finding the golden numbers, plus some information on the exceptions.[171]

4.3.10. Chapter Ten of the *Compotus correctorius*

The tenth chapter demonstrates that the flaws of the Christian calendar, which Grosseteste has already discussed, lead to errors in finding the correct boundaries for the movable feasts of the Christian year, but then gives the doctrine for finding those boundaries, which the Church still uses. He begins by explaining the manner of finding the boundaries of Easter, the dates on which it can be celebrated. These are based on the age of the moon at the vernal equinox. This leads to two sources of error. First, the vernal equinox is set as the twelfth kalends of April (March 21), which, Grosseteste allows, may have been the date of the equinox when the teachers of the Church first set down the rules for determining Easter.[172] In his own day, Grosseteste states, it is clear from instruments and astronomical tables that the equinox no longer falls on that day; in fact, according to the Toledan tables and the proper length of the year given there and Thebit's work on the motion of the eighth sphere, the equinox falls on the day before the ides of March (March 14).[173] Thus the first error in setting Easter lies in the fact that the true length of the

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171The verses are found on *Comp. corr.*, p 257, l. 24–p. 258, l. 5.

172…equinoctium fuit 12° kalends Aprilis in tempore priorum doctorum, *Comp. corr.*, p. 258, ll. 30–31.

173…et manifestum est tam per instrumentum consideracionis quam per tabulas astronomicas ibi non esse equinoctium in hoc tempore nostro: set secundum Tabulas Tholetanas fundatas super quantitatem anni et motum octave spere quos posuit Thebit, equinoctium vernale hoc nostro tempore est pridie idus

year is not the same as that used in the calendar, which has led to the equinox falling on an earlier day of the year.

The second error lies in the use of the incorrect length of a lunation. As mentioned before, he writes, the error in the length of a lunation leads to incorrect dates for the primation. Eventually, he adds, the full moon will fall on the date of an expected new moon (a reference to an earlier portion of the text). That this error has begun to have an effect on the predictions of the age of the moon is clear from the fact that the full moon falls not on the fourteenth day of the moon, but on the twelfth or thirteenth. We know this, he states, because lunar eclipses occur before the moon is fourteen.[174]

To correct these errors, Grosseteste writes, one would need to verify the length of the year, and then incorporate this into the calendar. If this is not done, then the vernal equinox should be figured by using instruments or astronomical tables.[175] Then, using the correct length for the lunation as discussed previously, the proper boundaries for setting Easter can be found. This is the extent of Grosseteste's suggestions on correcting the calendar; he enumerates the corrections that are needed, but has not worked out the precise corrections that ought to be put into effect.

Grosseteste moves on to a discussion on the placement of the movable feasts according to the doctrine of the Church. These rules, he states explicitly, do not incorporate any of the corrections he has just suggested "because the holy Church has not yet changed

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Martii. *Comp. corr.*, p. 258, ll. 25–27.

174 That is, before the moon is fourteen according to the Christian calendar. In other words, the moon should be full on its fourteenth day, but in fact is full on the days that the Christian calendar says it should be only twelve or thirteen days old.

175 Modus autem verificandi hunc errorem est ut verificetur anni quantitas, et verificata ponatur in kalendario, vel etiam absque verificatione quantitatis anni cognoscatur semper dies equinoctii vernalis per instrumentum considerationis vel per tabulas astronomicas verificatas. *Comp. corr.*, p. 259, ll. 11–15.

ancient doctrine."[176] First, the vernal equinox is placed on the twelfth kalends of April. According to Rabanus, Grosseteste writes, the equinox was placed there because that is where it was in the beginning of time. Grosseteste, on the other hand, believes that it was placed there because that was its position when the teachers of the Church, who did not know the true length of the year nor of the precession of the solstices and equinoxes, first put down the doctrine.

The first task is to determine the boundaries (*termini*) of Easter. Easter falls on the first Sunday after the first full moon on or after the vernal equinox. Thus the earliest day on which Easter can fall is the day after the vernal equinox, or the eleventh kalends of April, whereas the earliest full moon can fall on the vernal equinox itself. Working backwards, this means that the first appearance (*incensio*) of that lunation, also called the Paschal moon, falls as early as the ides of March. The latest possible first appearance of the Paschal moon falls on the nones of April, leading to the latest possible full moon on the fourteenth kalends of April; if this latest full moon falls on a Sunday, then Easter is on the subsequent Sunday, causing the latest day that Easter can fall to be the seventh kalends of May. One more time, Grosseteste gives a verse to remember the boundaries, though the verse requires some calculation, rather than simply giving the dates of the boundaries.[177]

Once these boundaries are found, Grosseteste continues, the boundaries and places (*termini et loca*) of the other movable feasts are easily found. The four other movable feasts are Septuagesima, Lent, Rogations, and Pentecost. The boundaries of Septuagesima precede Easter by nine whole weeks, and the Sunday of Septuagesima falls nine weeks before Easter. The boundaries and day of Lent precede Easter by six weeks, those of Rogation

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176…quia sancta ecclesia nondum mutavit antiquam doctrinam, *Comp. corr.*, p. 259, l. 18.

177Post Martis nonas ubi sit nova luna requiras/ Que postquam fuerit bis septima Pascha patebit. *Comp. corr.*, p. 260, ll. 7–8.

precede Easter by five weeks, and those of Pentecost fall seven weeks after Easter.

Grosseteste also gives another method for finding the first boundary of Septuagesima, and thereby finding the other boundaries of the other feasts in a given year. Consider the age of the moon on the day of Epiphany. Then, beginning with that number, count the subsequent days until forty is reached. That is the first boundary of Septuagesima, and Septuagesima is celebrated on the next Sunday. If the year is bissextile, and forty is reached on a Saturday, Septuagesima is not celebrated on the subsequent Sunday; instead, that Sunday is the first boundary, and Septuagesima is celebrated on the following. Grosseteste gives a four line verse to remember this rule and its exception.[178]

Grosseteste next explains a third way to locate the feasts. The beginning of the boundaries of the feasts repeat over the course of the nineteen-year cycle; thus a system using this cycle can also be used to find the feasts if one knows which year of the cycle one is in. Each year has a particular number associated with it, called the *claves*, and each feast has a day associated with it.[179] To find the boundary of the feast, start on its relevant day and count the days up to the *claves* for that year. The days are the seventh ides of January for Septuagesima, the fifth ides of March for Easter, the kalends of May for Rogations, and the third kalends of May for Pentecost.[180] The *claves* for the first year of the cycle is twenty-six; this is verified by calculating for Easter: counting 26 days from the fifth ides of March leads us to the nones of April, which is indeed, Grosseteste confirms, the boundary of Easter in the first year of the cycle. Similarly, this method is confirmed by giving the

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[178]*Comp. corr.*, p. 260, ll. 30–33.

[179]Each feast also has a letter associated with it, but this is not used in the computation he describes below.

[180]Curiously, Grosseteste does not give the day for Lent.

proper boundaries for Septuagesima, the kalends of February, and for Rogations and Pentecost.

To compute the *claves* in subsequent years, use the *claves* of the previous year. If it is greater than twenty-one, subtract eleven; if it is less than twenty-one, add nineteen.[181] The subtraction of eleven or addition of nineteen come about because of the length of a lunation , and the difference in primation for Paschal moons in subsequent years.

One exception to the rule occurs when the calculation places the beginning of the boundary of Septuagesima on a Saturday in a bissextile year. If this occurs, Septuagesima does not occur on the subsequent Sunday, the second day of Septuagesima, but on the following Sunday, the ninth day of Septuagesima. When this occurs, it will also be the case that the beginning of the boundary of Easter will fall on a Sunday. Easter will not be celebrated on that day, but rather on the subsequent Sunday, the octave day of Easter. Grosseteste ends the chapter with verses to remember the beginning dates for the feasts and the rule for calculating the *claves*.

4.3.11. Chapter Eleven of the *Compotus correctorius*

Grosseteste devotes the eleventh chapter to the composition and use of tables to find the dates of the feasts. To create a table that gives the boundaries of each feast for each year requires a cycle of 532 years, because it must account for both the nineteen-year cycle of primations and the twenty-eight-year solar cycle; the least common multiple of the two numbers is 532. To make such a table, Grosseteste notes first that, based on the limits of the boundaries discussed previously, there are thirty-five days on which Easter can fall, namely, between the eleventh kalends of April and the seventh kalends of May. He directs the reader

[181] Grosseteste has not said what to do when it turns out that the *claves* is equal to twenty-one, but it turns out that case never occurs.

to write these in order in a descending column.[182] Next to each, in a column to the left, a sequence of thirty-five marks (*notule*) is written.[183] Next to each Easter date, in columns to the right, the dates for the corresponding Septuagesima, Lent, Rogations, and Pentecost are written.

A second portion of the table is then constructed.[184] First, one writes the numbers one through twenty-eight in a column, representing the year of the solar cycle. To the left is written each year's concurrence. In a row placed one line above the numeral one of the solar cycle, one places the numbers one through nineteen, representing the nineteen-year cycle. Above this row are written the respective epacts and claves of each year. By creating twenty-eight rows, one for each year of the solar cycle, and ninteen columns, one for each year of the ninteen-year cycle, 532 small squares (*quadrati parvi*) are formed. Next to the first year of the solar cycle and below the first year of the ninteenn-year cycle, one places the mark corresponding to the date of Easter for that year. The rest of the squares in that row, corresponding to the first year of the solar cycle falling on each of the nineteen years of the nineteen-year cycle, are subsequently filled in. Likewise, the remaining rows are filled in, using the marks corrsponding to the proper Easter date for that year. To use the table, one simply finds the square corresponding to the proper year of each cycle, and finds the mark that is written there; then the dates of all of the movable feasts can be found for that year from the first part of the table.

182This can be found at *Comp. corr*., p. 266.

183In the example in Steele, he uses upper-case, Latin H-Z for the first sixteen marks (no I or U), and nineteen lower case Greek letters for the remaining. Other manuscripts use different systems; for example, some use numbers and other symbols, such as MS Brit. Mus. Harley 4350 and MS Oxford Digby 191, while one example, Oxford MS Bodl., Savile 21, uses Latin letters written in ink of a different color.

184Curiously, this table is usually placed before the list of dates, as in Steele's version, even though the instructions for its construction follow the instructions for the other table..

A few exceptions to the rules of the tables exist. In a leap year, the date for Septuagesima found in the table will be incorrect, and Septuagesima will actually begin on the day following the day written in the table, because the intercalary day is inserted in that year between the beginning of Septuagesima and Easter. Also in a bissextile year, if Easter falls after the eighth ides of April, Lenten Sunday falls one week later than the date written in the table.

Grosseteste also explicitly notes that, using the table, one can easily find the date of the next Easter by moving one column to the right and one row down; thus the dates of subsequent Easters are always found to the lower right. If one is at the last column, move down one row, and find the mark in the first column of that row. Similarly, if one reaches the last row, use the first mark in the next column. Finally, Grosseteste notes how many times each date for Easter appears in the 532-year cycle: the earliest and latest appear four times each; the second, third, second-to-last and the one before the second-to-last eight times each; the fourth, thirty-first and thirty-second twelves times; and the rest sixteen or twenty times. Those that appear four times in a single row recur sixteen times during the cycle, and those that appear five times in a single row recur twenty times.

4.3.12. Chapter Twelve of the *Compotus correctorius*

The twelfth, and very brief, chapter lists the fasting times of the year. Advent occupies the three Sundays before Christmas, and the first of those is always the one closest to the feast of Saint Andrew, which falls on the day before the kalends of December.[185] There are four fasts throughout the year: the first Wednesday after the feast of St. Luke, the first Wednesday of Lent, the Wednesday of the week of Pentecost, and the first Wednesday

185Though it can fall before or after the first Sunday of Advent, and he gives a verse to remember this. *Comp. corr.*, p. 266, ll. 7–8.

after the Exaltation of the Cross. He again gives a verse to remember these days.[186] Fasts are also celebrated on the four vigils[187] of the six apostles: Peter and Paul, Simon and Jude, Andrew, and Matthew; again he gives a verse to remember this,[188] but no dates. There are six other festivals on which vigils are celebrated with a fast, namely, the Nativity of the Lord Jesus Christ, Pentecost, the birth of John the Baptist, Saint Lawrence, the Assumption of the Holy Virgin Mary, and the Commemoration of All Saints, and a fast is celebrated on the day of St. Mark. A verse is given to remember these seven fasts.[189] He ends by noting that, in addition to these dates, fasts set down by the Church Fathers (*patriarcharum*) are permitted.

4.4. Analysis of the *Compotus correctorius*

The most important issue for understanding Grosseteste's *Compotus correctorius* is to determine the purposes for which Grosseteste composed the work. I must emphasize the plural of 'purposes,' for indeed such a long work undoubtedly served a multitude of goals. As Edith Dudley Sylla has written, "Most science in medieval universities … may have been science for undergraduates, but it was of such a nature that the concerns of undergraduates, bachelors, and masters of arts could be merged into a single work."[190]

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[186]*Comp. corr.*, p. 267, ll. 3–4. He does not give instructions for fasting, nor does he have any discussion of the dates for the non-movable feasts, assuming the reader will have this information from some other source.

[187]That is, the day before the festival.

[188]*Comp. corr.*, p. 267, ll. 9–10.

[189]*Comp. corr.*, p. 267, ll. 17–18.

[190]In her "Science for Undergraduates in Medieval Universities," in *Science and Technology in Medieval Society*, edited by Pamela O. Long, *Annals of the New York Academy of Sciences* 441 (1985): 171–186; the quotation is on p. 183. Her evidence is drawn from the fourteenth century. I shall contend that

This is only relevant, of course, if the work was indeed written within the university community, as I claim that it was. My argument, which I shall detail below, is that we can best understand the nature of this work by examining the various purposes it serves, and then showing how these purposes coincide with, or perhaps modify, our understanding of what a university education in the early thirteenth century required.

The first point to consider is the dating of the work. As discussed previously, the date of composition for the work is usually placed between Grosseteste's study of Arabic astronomy, which began at least by 1215, and before the early 1230s. The latter date is usually argued by an appeal to one or more of three main reasons: 1) his acceptance of the bishopric of Lincoln in 1235 would have prevented him from having the necessary time to compose the work, 2) his scientific work precedes this date, or 3) ideas present in the *Compotus correctorius* are superseded by ideas in other works that can be dated to a later period.

The first reason, his acceptance of the bishopric, is suggestive, but hardly decisive. The work is rather long, certainly one of Grosseteste's longest scientific works, and it is unlikely that he would have had the time to compose the work in its entirety after accepting the manifold responsibilities of a large bishopric. Yet we do know that Grosseteste always kept himself busy, and so it is not impossible that he continued the work during this period. But I shall argue below that the text is best understood as being written for a university audience. His ties to the university were certainly reduced after taking the bishopric, whereas he was fully ensconced within that community before that time.

The second reason for dating the work before the early 1230s at the latest, as part of Grosseteste's "scientific period," is more problematic. For example, Thomson states that between 1229 and 1240, Grosseteste's interests "were almost exclusively theological and

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this understanding of medieval scientific texts is also useful for understanding texts of the thirteenth century.

pastoral,"[191] To assume that Grosseteste made the same distinction between science and theology as we do today is unreasonable. In fact, the *Compotus correctorius* has clear theological and pastoral implications, as it conveys the means to celebrate properly religious festivals and includes significant theological assumptions, such as the relevance of the creation of the world to the making of the calendar. While Thomson would like to place the composition of the work before 1229, his reason for doing so is problematic.

The third reason for dating the work before the early 1230s arises from the consideration of Grosseteste's larger corpus of works. McEvoy has a number of arguments by which he attempts to place the composition of the work before 1230, and also suggests an earliest date of composition of 1225.[192] Comparing the *Compotus correctorius* to the earlier computistical treatises ascribed to Grosseteste, McEvoy claims that it shows a greater theological interest than the other works, leading him to favor a later date given that Grosseteste's own theological studies are more intense after 1225. The other computistical works, however, can no longer be taken to be genuine works of Grosseteste, and so no relative dating can be secured. In addition, McEvoy's reliance on Grosseteste's increasing interest in theological matters falls prey to the same false dichotomy of theology and science criticized above.

To date the work later solely on the grounds that Grosseteste's interests changed from scientific to theological is untenable. McEvoy, however, does not rely only upon this principle. He also argues that his dating of the work relies on the Aristotelian material present in the *Compotus correctorius*. In particular, he points to Grosseteste's insistence on the creation as a beginning for time as an anticipation of concerns over the eternity of the

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[191]Thomson, *Writings*, p. 95.

[192]McEvoy, "The Chronology," pp. 618–620.

world, an issue that arises out of Aristotelian physics, which assumes no beginning for time. In addition, McEvoy points out some confusion in the *Compotus correctorius* between the doctrines of Aristotle and Alpetragius, the differences between which Grosseteste would better understand after more study of Aristotle. Because of McEvoy's confidence in assigning Grosseteste's study of Aristotle to the late 1220s, he dates the *Compotus correctorius* to the period 1225–1230.

Such a late date for this text is also consistent with what we have seen regarding the dates of the *De spera*.[193] Clearly, as McEvoy has shown, the *Compotus correctorius* shows a greater awareness of the tension between the Aristotelian homocentric scheme of the cosmos and the work of technical astronomy. Much of the astronomical nomenclature that Grosseteste leaves undefined in the *Compotus correctorius* was dealt with in that work. But the *Compotus correctorius* is a great deal more quantitative in its treatment, perhaps reflecting greater familiarity on Grosseteste's part with the technical material. On the other hand, compotus *requires* the use of quantitative material, which the *De spera* arguably did not.

The later dates suggested by Thomson and McEvoy both use a problematic division of theology and science. Their arguments take for granted that Grosseteste's interests divided neatly along our modern categories, moving from science to theology, though McEvoy nuances his stance with other types of evidence, such as Grosseteste's study of Aristotle. In fact, McEvoy himself notes the possibility that Grosseteste might have been teaching natural philosophy and theology at the same time.[194] Is it necessary, then, to

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193See the previous chapter of this dissertation.

194McEvoy, "The Chronology," p. 631. He also writes in his *The Philosophy of Robert Grosseteste*, p. 510, that either Grosseteste broached natural philosophical questions in his theology lectures, or held lectures in both theology and natural philosophy in the same period.

assume that his interest in compotus was left behind because he was becoming more concerned with theological study? This seems unlikely, especially because certain parts of the *Compotus correctorius* are theologically oriented. The assumption of the creation of the world and the need to base the calendar on that, and the purpose of explaining the correct ecclesiastical rules for finding festivals belie any such claim. The work can better be understood as serving functions that we would label as both scientific and theological, functions of a distinctly practical goal.

Arguments that restrict the possible dates based upon this false dichotomy are thus untenable, although McEvoy's arguments from internal evidence are still quite strong, at least for dating the work relative to other aspects of Grosseteste's knowledge and study. The dates of 1225–1230 that McEvoy assigns thus suggest that the work was written within the time he was teaching at Oxford, probably teaching both theology and natural philosophy. The latter subject would have been taught in the arts, and thus to undergraduates. Does the work, then, fit a pattern of characteristics that would have been reasonable for undergraduate students? Jennifer Moreton, as already stated, does not think the work would have been appropriate for undergraduates.[195]

I offer two responses to her argument, both methodological ways to approach scientific texts used in the medieval university. The first returns to the statements of Edith Dudley Sylla, quoted above, namely, that scientific texts could serve multiple purposes, and that the topics within them could deal with issues for a range of readers, from undergradautes to bachelors to masters.[196] In discussing Aristotelian commentaries of the fourteenth century, she also writes that this genre of literature "could play the roles of both

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[195]Moreton, "Robert Grosseteste," p. 87.

[196]Sylla, "Science for Undergraduates," p. 183.

the modern textbook and the modern research paper."[197] In other words, it could serve both as a texbook and as a presentation of more complex ideas, perhaps even ideas that were unorthodox. The *Compotus correctorius*, I will argue in more detail below, could likewise serve multiple purposes, including the introduction of basic computistical ideas and skills to undergraduates, as well as the more challenging notions of calendar reform.

The second response to challenges of the appropriateness of the *Compotus correctorius* for undergraduates lies with a methodological principle established regarding universities in a much later period. Charlotte Methuen has forcefully argued that Michael Maestlin, a professor at the University of Tübingen from 1584–1631, taught different materials to students of varied ability.[198] To the less able students, he taught the standard astronomy of the day. But, she continues, "[t]o his more advanced students he taught the more controversial topics…,"[199] in this case heliocentrism. Her evidence for this claim is based on the contents of his astronomical textbook, *Epitome astronomiae*, and surviving disputations in which more complex topics and methods were used. For Grosseteste, unfortunately, we have only the former kind of evidence, namely, his text.[200]

In analyzing the *Compotus correctorius*, I shall take as a methodological principle a hybrid of these approaches. I believe the work is best understood as a texbook to introduce

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197Sylla, "Science for Undergraduates," p. 183.

198Charlotte Methuen, "Maestlin's Teaching of Copernicus: The Evidence of His University Textbook and Disputations," *Isis* 87 (1996): 230–247.

199Methuen, "Maestlin's Teaching," p. 246.

200For more on disputations in medieval universities, see Brian Lawn, *The Rise and Decline of the Scholastic 'Quaestio Disputata,' with Special Emphasis on Its Use in the Teaching of Medicine and Science*, Leiden; E. J. Brill, 1993. For Grossteste specifically, and especially on his impact on the Franciscans, see pp. 24–28. The areas in which Lawn discusses Grosseteste's influnce do not include the computistical.

basic and essential computistical concepts that students at Oxford would need to learn. In addition, the work contains material unsuited to basic instruction, and such material could be passed over in certain circumstances, perhaps reserved for study by Grosseteste's more able students or peers. My analysis shall suggest that these various purposes are accomplished in this long and complex work, and that it is in a university context that the goals for the work are best met.

Let us first note that much of the material is, to put it simply, basic computistical information. Were this a work intended for an advanced audience already familiar with the compotus, large portions of it would be redundant information. In other words, if the work were intended only to introduce complex, and perhaps unorthodox, material, then much of the basic information would be superfluous.

It is difficult to know precisely what should be counted as 'basic,' as no modern scholar has published a general study of the compotus of the twelfth and thirteenth centuries. Instead of a standard to which we might compare Grosseteste, I have chosen to use what we might call a 'classic' work, Bede's *De Temporum ratione*, or *The Reckoning of Time*. As noted previously, Steele identifies Bede's work as a turning point in computistical studies, making it, as it were, the basis for later works. Certainly the genre had changed by the thirteenth century; compotus was no longer a general repository for various scientific information, but had become more restricted to strictly calendrical problems. In addition, Grosseteste made use of material unavailable to Bede, such as Arabic astronomy. Nonetheless, we can see that much of what Grosseteste covered was also present in Bede, and thus constitutes what we might call 'basic' computistical fare.

Bede begins his work with what Faith Wallis has termed "technical preparation,"[201] which includes counting on the fingers, the small divisions of time and the

[201] Wallis, *Bede*, pp. 9–18.

use of duodecimal fractions. The first, counting on the fingers, had become part of a different genre of literature in Grosseteste's day,[202] though works on counting are often present in manuscripts containing computistical works. The latter portions of Bede's technical preparation were superseded by the time Grosseteste wrote his *Compotus correctorius*; Bede's divisions of hour, *puncti*, *minuta*, *partes* and *momenta*[203] are replaced by the hour, minute, second, third, etc. divisions that Grosseteste uses. Grosseteste does not, however, explain the divisions into sixtieth parts, nor does he give rules for the mathematics involved in manipulating them. In fact, he assumes his readers can do this for themselves, as he often makes use of this type of calculation, such as when comparing the times of lunations to various periods of years. The lack of explanation in Grosseteste's work suggests that the work was intended for readers already educated in the *algorismus*, the genre of literature on basic arithmetic.[204] This would include, though is not necessarily restricted to, students at the university.

The second division of Bede's work that Wallis makes is the explantion of the Julian calendar.[205] This section includes definitions of various calendrical notions, including day and night; the week; the Roman, Greek and English systems of months; the kalends, nones and ides system of dating; the zodiacal signs; the motions, phases and powers of the moon; eclipses; how to calculate the age of the moon; how to know the day of

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202For example, see an illustration of a twelfth-century manuscript, which shows how such counting was performed in John E. Murdoch, *Album of Science, Antiquity and the Middle Ages*, Charles Scribner's Sons: New York, 1984, p. 79.

203Wallis, *Bede*, p. 15.

204For more on the *algorismus*, see Guy Beaujouan, "The Transformation of the Quadrivium," in *Renaissance and Renewal in the Twelfth Century*, 463–487, especially pp. 467–470.

205Wallis, *Bede*, pp. 19–111.

the week at the beginning of the month; the equinoxes and solstices; the lengths of day and night; the seasons, elements and humours; and the year and placement of the leap year. It is clear from this list how the genre of compotus had changed by the time of Grosseteste. Bede's computistical work included a wide variety of astronomical and scientific information that Grosseteste never broaches. For example, though Grosseteste discusses the age of the moon frequently, he does not discuss the principles of its phases or eclipses in *Compotus correctorius*. Nonetheless, much of the information is of a similar nature. Grosseteste discusses the various divisions of the year (months, weeks, days); the system of kalends, nones and ides; calculating the age of the moon or the day of the week on which the month starts; and the leap year.

In Wallis's next division, "The Anomalies of Lunar Reckoning,"[206] Bede discusses the *saltus lune* and the reasons why the age of the moon may be slightly different than expected. Again, the topics are similar, though Grosseteste handles them in different ways, a development only to be expected in a work that was written five hundred years later. Wallis's fourth section of Bede's work is entitled "The Paschal Table."[207] Again, much of the information is similar to that found in Grosseteste, including sections on the nineteen-year cycle, lunar embolisms, the epact, the concurrences,[208] and the placement of Easter. Bede's work contains two final sections, which Wallis labels "The World Chronicle,"[209] a long chapter chronicling the years since creation and relating various biblical, Greek and

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[206]Wallis, *Bede*, pp. 113–119.

[207]Wallis, *Bede*, pp. 121–156.

[208]Which Bede calls the solar epact. See Wallis, *Bede*, p. 136ff.

[209]Wallis, *Bede*, pp. 157–237.

Roman events in a common calendar, and "Future Time and the End of Time,"[210] a section on what can be expected in the future according to Christian prophecy. These two sections have no counterpart in Grosseteste's *Compotus correctorius*.

If we use Bede as a standard, then, we can see that Grosseteste's work contains the standard fare of computistical information. Bede's work includes a great deal of material beyond what Grosseteste found relevant to include; Bede's work incorporates quite a bit of biblical exegesis and additional scientific information, for example. But there is relatively little in Grosseteste that does not have a precedent in Bede's work. Grosseteste's work is more strictly limited to calendrical matters than Bede's, but is clearly meant to teach the basics of compotus, as well as more complex ideas.

Because Bede's work predates Grosseteste's by five centuries, no straightforward comparison will allow us to establish that Grosseteste's work is meant to teach basic computistical material. Other clues, however, suggest that teaching the basics is one of the goals of the work. One example comes at the very beginning of the work: the table of contents. The table of contents is repeated in virtually all of the manuscript editions of the text. It functions as a prototypical form of an index. The title of each chapter clues the reader to the place in the text where the information they seek can be found. This is a rather primitive form of an editorial device to enhance the use of the text; in most cases, the chapter is only identified in the text by a large capital letter or a rubric when a new chapter begins—there is no consistent use of chapter numbers in the margin of each page, for example. Nonetheless, the identification of chapter topics allows the user to find information without searching through the whole text and without knowing the text intimately.

The chapters are of very unequal length. In the modern, printed edition of Steele, chapters vary in length from less than a page to over ten pages. If this text was intended for

[210] Wallis, *Bede*, pp. 239–249.

use in the classroom, the chapters do not represent lectures. In combination with the chapter headings, however, the varied length of the chapters would allow the teacher to move around to various topics, while maintaining the ability of a the reader to find relevant information more easily. The arrangement of topics in this way also accounts for the periodic instances, noted in the exposition of the text above, where Grosseteste uses a term that has not yet been defined, but will be defined later in the text. The ability to move around the text instead of treating it linearly is also consonant with the notion that certain portions of the text might be too advanced for beginning students. Moving around the text, a teacher would be able to skip over portions of the text that he found inappropriate to his audience.

The notion that the text could be used in this way, as one through which students were guided rather than one read as a straightforward, linear work, faces some difficulties of proof. In the first case, it is not clear where students obtained the work. Clearly if this scenario was indeed used, the text had to be copied nearly completely before use by the student, and could not have been presented as lectures. This is not a particularly significant issue because the text is probably too long for such a procedure, given that relatively little time would typically have been devoted to a work of compotus in an undergraduate career. In my survey of manuscripts in England, I found no evidence that the works had been written down in this way. I found no evidence of *pecia* marks, for example, and so the means by which students would have obtained the work is still an open question.[211]

One relevant issue, however, is the consistency with which tables appear in the text. Among the manuscripts that I viewed, tables almost invariably appeared. For example, a

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[211]For information on the *pecia* system, see Graham Pollard, "The *Pecia* System in the Medieval Universities," in *Medieval Scribes, Manuscripts and Libraries*, edited by M. B. Parkes and Andrew G. Watson, 145–161, London: Scolar Press, 1978. The *pecia* system was one in which students would borrow a portion of a text for copying, then return it before borrowing the next portion. Texts copied in this way typically include marks where the portions begin and end, thereby revealing when a manuscript was created in this way.

survey of seven manuscripts[212] produced the following results. The table of kalends, nones and ides from Grosseteste's second chapter appear in all seven. The table of regulars and concurrences of the third chapter appear in six of the seven;[213] only Cambridge University Library MS Pembroke 278 lacks the table. The table of chapter five for finding the Arab years and months are missing in two of the seven, the Pembroke manuscript that lacks the previous table, and the Savile manuscript. The Savile manuscript, however, does contain the Toledan Tables from which this information was taken. The table of epacts and regulars found in chapter 8 is again present in six of the manuscripts, lacking only from the Pembroke manuscript. The tables of the 532-year cycle and the boundaries of the movable festivals from the eleventh chapter is present in four of the manuscripts; the 532-year cycle alone is present in the St. John's manuscript,[214] and both are missing from the Pembroke and Harley 3735 manuscripts.

Thus we can see that the tables were an integral part of the text. With the exception of the tables to find the Arab year, directions are given in the text for the construction of

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212The manuscripts are: British Museum MSS Harley 3735 and 4350, Cambridge University Library MSS Kk. I.1, Pembroke 278 and St. John's 162/F. 25, and Oxford Bodl. MSS Digby 191 and Savile 21. The text on which Steele based his edition, British Museum MS Add. 27589, also includes all tables. I have chosen these as representatives of a cross-section of manuscript versions, but always using texts that are of the thirteenth or early fourteenth century. This survey is by no means complete, but the results are suggestive.

213In Cambridge University MS St. John's 162/F. 25, this and all subsequent tables appear after the text.

214This is particularly odd, as the 532-year cycle is relatively useless without a table to decipher what the thrity-five symbols mean. That is, the first table alone simply gives the reader a symbol for any relevant year, but that symbol alone does not convey any information without the other table. It is relevant that the tables in the St. John's manuscript appear after the text; perhaps a page has gone missing from the manuscript.

each table.[215] We know relatively little about how masters conveyed information to students in a lecture. The common picture is that the master lectured, and the students copied his words. With the *Compotus correctorius*, however, we may be forced to modify this image when it comes to the creation of the tables for the text. Either the text was copied outside of lecture, which certainly cannot be ruled out, or the tables were seen as an integral part of the text. Perhaps, then, the exercise of copying the text included following the directions for making the tables. There are variations among the tables, some of which Steele has noted in his printed version. The manuscripts surveyed above also demonstrate that the symbols used for the 532-year cycle table vary.

Where, then, does this information on the tables leave us? Any account of how the text was copied must take into account the consistency with which the tables are retained. It seems more likely that students were copying the texts from another copy, than that they were copying it during lecture, because it would have been difficult for the master to convey the table to students. On the other hand, the tables might suggest some variations in teaching procedure from the typical picture of the medieval university lecture.

This discussion, however, depends on the fact that the *Compotus correctorius* was actually used within the university for teaching the basics of compotus. That the text included instructions for creating the tables also suggests that the text was meant to teach the basics of compotus. With the exception of the tables for finding the Arab year, all of the information contained in the tables can be calculated from information in the text.[216] By

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[215]Yet even in this case, the same information, the age of the moon, can be found without the tables. Grosseteste provides a calculatory method for finding the Arab date, and thus the age of the moon, in addition to rules for using the tables. Therefore, even if the tables are missing, the information they provide can still be calculated.

[216]In addition, one would need to know one instance of which year of the Lord corresponded to which year in the nineteen-year cycle, and at least one instance of the date of Easter on a particular year. Grosseteste probably takes it for granted that such information is readily available. In addition, it is worth

including both the table and the instructions for constructing it—not just using it—Grosseteste has provided a useful means to teach the computistical information to a variety of audiences. For those who need only to use the information, the tables provide the necessary numbers. At the same time, the construction of tables can further enhance the learning experience of a student who constructs his own table. The instructions also function to ensure that the tables can be checked for accuracy, and that they can be reproduced if necessary.

Other elements of the text also suggest that it was meant to teach the basics of compotus. The frequency of mnemonic devices is consistent with a text meant for teaching. In numerous instances, a brief verse is presented explicitly to aid the memory. The verses are not necessary to the text itself, as they do not offer any new information; they simply offer an additional way to order, reatin, and access information. The nature of the mnemonic devices are consonant with the goals of teaching.

The tables, too, fulfill a function similar to that of mnemonic devices, but instead of giving the student a means to remember information, tables condense the information into a more manageable form. All of the information contained in the tables is calculable from the information in the text and a little general knowledge of the dating of years. Tables offer a shortcut to finding information, while the text still remains to explain how the information was derived.

Other features also suggest a university setting. Grosseteste begins the work by defining the subject, "Compotus is the science of numbering and dividing time."[217] This definition is refined by adding the different means by which it is divided, "through signs and differences given by the motion of celestial bodies, and also … by regional

noting that, although the tables for finding the Arabic year, month and day cannot be reconstructed from information in the text, the end result—the age of the moon—can be found using a calculation given in the text.

[217]Compotus est scientia numerationis et divisionis temporum. *Comp. corr*., p. 213, l. 6.

practices."[218] Beginning the work in this fashion defines both the science and the basis of the knowledge. This is a typical scholastic approach: to define clearly the topic the work is to cover, as well as to discuss the sources of information. In this case, other fields of knowledge will be necessary, namely, astronomy, to know the motions of the celestial bodies, and history, to know the various regional practices. This forms the relationships between the science in question and different areas of knowledge.

The detail that he offers regarding the regional practices also suggests a university setting in that he conveys a great deal of information that is not necessary to the purely practical goal of using of the calendar.[219] For example, the meaning of the names of the months taken from the pagans does not assist one in using the calendar. The inclusion of this kind of material certainly has precedent in earlier computistical works; Bede has an extended discussion of the names of the months, for example.[220] So perhaps this material is simply a holdover from the an older style of compotus. But the genre had changed in many other ways; Grosseteste's work, for example, is much more focussed on the calendar, without as much attention being given to other sciences as Bede had done.

That Grosseteste did retain information on regional practices is thus significant, and cannot simply be dismissed as a retention of older forms. Instead, I believe it is best understood to form a part of a broader educational goal that Grosseteste has for the work,

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[218]…per signationes et differentias quas dant eis motus celestium corporum, et iterum … eis cultus regionum. *Comp. corr.*, p. 213, ll. 8–10.

[219]On the other hand, some of his arguments about regional usage will be more significant to his arguments about the reform of the calendar, because he felt that calendar was founded on an incorrect basis, namely, not from the year of creation. Thus, in that case, with which I shall deal more fully below, the regional developments are a necessary part of his argument.

[220]Wallis, *Bede*, pp. 46–50, for the Roman months. Bede also discusses the Greek and English names for months on pp. 51–54.

namely, to introduce students of the compotus to the history of the material itself. Such a goal seems best understood within a setting of a broad, liberal education instead of merely practical training. Thus a university community, where knowledge is valued for its own sake, in addition to offering practical training, seems the proper setting for Grosseteste's work.

That the text was intended for use in a university setting is also suggested by some of the information that is not present in the text. In particular, Grosseteste assumes that the reader has some knowledge in two particular areas: arithmetic and astronomy. He does not teach the reader how to perform arithmetical calculations, though he does occassionally walk the reader through some of his calculations, for example, when he correlates 940 lunations with seventy-six years, or demonstrates the inequality of the length of lunations in the Christian cycle and the value given by Arzachel. In the case of astronomy, Grosseteste discusses briefly the cause of the year, i.e., the sun's motion through the zodiac, but leaves much unstated. For example, in discussing the equivalence of the week and seven days, he uses an argument based on the order of the seven planets,[221] but defends neither the fact that there are seven planets, nor their order; he is taking it for granted that the reader knows this.

Arithmetic and astronomy are, of course, both quadrivial arts, and thus formed part of the basis of education in the Middle Ages. The liberal arts were an important component of education inside the universities, especially before the broader field of philosophy became more significant over the course of the thirteenth and fourteenth centuries. The assumption of arithmetical and astronomical education on the part of his readers thus cannot, by itself, offer absolute proof that Grosseteste intended his work to be for university students. In fact, on the basis of this point alone, the work could potentially be intended for

[221]That is, the moon, Mercury, Venus, the sun, Mars, Jupiter, and Saturn. These bodies are the planets in ancient and medieval cosmology because they are the bodies that move in relationship to the fixed stars.

anyone with an education advanced enough to have included the quadrivial subjects. As discussed in the second chapter, Grosseteste may have been teaching before he came to Oxford, and his interest in astronomical matters certainly predates the period when we can be certain he was at Oxford.

This introduces an additional complication, or perhaps a modification, of what we can say concerning Grosseteste's intended audience. Because the date of compostion of the work is still impossible to pin down precisely, we must be open to the possibility that the work was written before 1225. This could mean that it was written before Grosseteste arrived at Oxford, and thus his intended audience was larger than just the students of a single university.

I have stated elsewhere that I approach the work as one written to fulfill more than one purpose. On the one hand, I have argued that much of the material is basic computistical information intended to teach students how to work with and understand the calendar. But in addition to so much of the material that is intended for basic instruction, there are also certain features of the work that go beyond the standard fare of computistical instruction, standard, that is, in comparison to the "classic" work discussed above, Bede's *Reckoning of Time*. Now to say that Bede's work represents a standard must be understood correctly. Bede's work was five centuries old at the beginning of the thirteenth century, and other computistical treastises has been written in the intervening period, as was discussed in an earlier portion of this chapter. However, no modern study has made a careful study of twelfth- and thirteenth-century computistical developments, and so comparisons are difficult to make. I am not, however, aware of any other computistical work before Grosseteste that includes the material I will discuss below, and that is also intended for basic instruction. In other words, I believe that Grosseteste's *Compotus correctorius* is the first computistical work to incorporate new methods that were available only by the beginning of the thirteenth century and that was intended for use in an educational setting. Works such as Roger of

Hereford's compotus seem to be concerned with particular issues, such as calendar reform, while works of basic instruction, such as the *Compotus ecclesiasticus*, failed to use the developments of recent generations.

Certain aspects of Grosseteste's work are different from, say, Bede's work, because of the time in which he lived, and the work that others before him had done. It is difficult, again because of the lack of scholarship, to know precisely what was new in Grossteste's treatment; I shall point out a few features of the work that make use of other work that had developed in the decades before he wrote his work. The uniqueness of his presentation, I shall argue, lies in its presentation to a university community.

What aspects of the *Compotus correctorius* distinguish it from older treatments of compotus? Perhaps the primary difference lies in its use of Arabic and Greek materials to solve problems involving errors in the calendar. Two problems in particular could be overcome, in theory at least, by using the more accurate astronomical knowledge contained in his sources: the problems of incorrect dates for solstices and equinoxes, brought about by an incorrect length for the year, and the problem of incorrect values for both the age of the moon and the date of eclipses, brought about by an incorrect value for the length of a lunation. Both problems with the Christian calendar, as Grosseteste found it, could potentially be solved by using new information, unavailable to writers of compotus in England before the twelfth century.

Let us examine the problem of the length of the year first. In his first chapter, Grosseteste discusses the various values that astronomers have used for the length of the year. It is probably significant that the only diagram Grosseteste includes in the work helps to explain the length of the year. Not only does the diagram explain the fairly basic fact of the bissextile year; it can be used to explain the minor differences between the real length of the year and that which is assumed as a reason to include an extra day every four years. He credits Abrachis with the basic value of 365 and one-quarter days for the length of the year,

noting that this is also the value the computists use; hence it is the value assumed for the calendar.[222] Ptolemy, he says, puts it at 1/300th of a day less than that, while Albategni gives a value of 1/100th of a day less than the standard computistical value. The latter value, Grosseteste claims, best accords with the errors of the solstices that have been observed.[223] His basis for this is that the Scriptures say that Christ was born on the winter solstice, but that now Christmas precedes the solstice by about as many days as centuries since his birth.[224]

Following his explanation of Albategni's length for the year, Grosseteste considers the solution he found in Thebit's works. Thebit, Grosseteste tells us, took into account the difference between the movable and fixed zodiacs to determine that the time between one solstice and the sun's return to the soltice can vary. Taking this into account, and using a fixed star as the point of comparison, Thebit calculated that the year's length is greater than 365 and one-quarter days by twenty-three seconds of a day.[225] Aristotle and Alpetrangius, Grosseteste writes, although they use a natural philosophical explanation for the movement of the sun different from that employed by the astronomers, simply use the value of the length of the year used by Ptolemy.

Thus Grosseteste has suggested three measurements for the length of the year

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222He equates the value of Abrachis and the computists at *Comp. corr.*, p. 215, l. 21.

223The error in the solstices is known *per experimentum nostri temporis*, *Comp. corr.*, p. 215, ll. 29–30. Note that *experimentum* can be accurately translated as "observation" only if taken in the general sense of experience, not in the precise sense of experimentation.

224Quia secundum scripturam, Dominus noster Jesus Christus natus fuit in solsticio hiemali; nunc precedit solsticium Diem Natalem Domini circiter tot dies quot centenarii annorum ab ejus nativitate transierunt. *Comp. corr.*, p. 215, ll. 30–32.

225This calculation was discussed in more detail in the previous section.

different from the value used by the compotists: that of Ptolemy (and Aristotle and Alpetrangius), that of Albategni, and that of Thebit. But he ends his discussion by stating that "these are the methods by which our calendar might be made more correct,"[226] and then proceeds to an explanation of the standard, computistical method of having one leap day every four years, as the Church dictates. In the end, he offers no value as the preferred one for the correction of the calendar, though his statement about Albategni's value being most closely in accord with observation is significant. In fact, though, he puts them all on an equal footing when he lumps them together at the end of the discussion. Even more importantly, he is careful to put the alternative values at arms length, so to speak, by immediately following his discussion with a presentation of the orthodox way to insert bissextile days and figure bissextile years according to the method prescribed by the Church.

By ending his discussion with the proper ecclesiastical method for handling the bissextile year, Grosseteste accomplishes two things. First, he avoids any implication of impropriety by refusing to state that one particular value is better than the standard computistical value. Because the standard value of 365 and one-quarter days is prescribed by the Church, to state that the value is wrong could be construed as unorthodox. Grosseteste is careful not to do this, and, to drive the point home, immediately follows his discussion of alternative values by presenting the method that the Church uses to handle the bissextile year. Second, Grosseteste accomplishes the task of teaching the basic computistical information to his reader. While he suggests both the need and the means to reform the calendar, he ends the chapter by presenting instructions for handling the calendar

[226]Hii igitur sunt modi quibus kalendarium nostrum posset magis verificari, set quia sancta ecclesia solius bisextilis diei interposicione adhuc contenta est, exposicionem kalendarii secundum usum ecclesie, Deo adjuvante, prosequemur, dicentes secundum usum sancte ecclesie anni quantitatem esse ex 365 diebus et quarta diei integra, que minucia cum quarto anno pervenit ad integrum diem, in eodem quarto anno, ut supradictum est, interseritur. *Comp. corr.*, p. 217, l. 34–p. 218, l. 4.

as it exists. This portion of the text is most useful for the reader who is approaching the topic for basic computistical instruction. The sections of the first chapter relevant to the potential reform of the calendar could be treated separately, if at all. On the other hand, the more advanced reader, who already knows how the bissextile year works, is presented with more complex ideas better suited to a more sophisticated audience.

In addition to the length of the year, Grosseteste also includes sections on the proper length of lunations, the time it takes for the moon to complete its phases. The age of the moon—its place within its cycle of phases—is significant for more than one reason. For one thing, knowing when a moon is new or full is essential for predicting ecplises of the sun or moon. More significantly, the moon's age at the vernal equinox is relevant to the computation of the proper date for Easter, and thus all the other movable feasts of the Church calendar. If the moon's age does not agree by observation with what the calendar predicts, then there is the distinct possibility that festivals could be celebrated on the wrong dates.

In the fourth chapter, Grosseteste introduces the Arab years found in the tables of Arzachel. These years are lunar years, made up of twelve lunar months. The months alternate between thirty and twenty-nine days, making the year 354 days long. However, because the length of a lunation is not an integral factor of 354 days, the year is actually too short, and thus an intercalary day is occasionally added to a twenty-nine day month, making that year bissextile, and thus 355 days long.

The length of a lunation is vital to Grosseteste's remaining analysis. He takes it for granted that the length used by Arzachel is correct. Ptolemy and Abrachis, he states, assume a length of 29 days and 31 minutes, 50 seconds, 8 thirds, 9 fourths, and 20 fifths of a day for a lunation. Arzachel, Grosseteste writes, drops the thirds, fourth, and fifths, and uses the

value of 29 days and 31 minutes, 50 seconds of a day.[227] In one Arab year, that is, twelve lunations, this length of the year is too short by twenty-two minutes of a day.[228] In thirty Arab years, however, this yearly error works out to eleven whole days.[229] Thus, according to the value Arzachel uses for a lunation, an integral number of whole lunations is completed precisely every thirty Arab years. At 354 days per year, plus eleven interacalary days, this works out to 10,631 days.

The Christian calendar, however, uses the nineteen-year cycle. Grosseteste shows that this cycle is not compatible with the length of a lunation used by Arzachel. I shall not run through Grosseteste's computations again,[230] but instead merely remind the reader of Grosseteste's conclusions. Every nineteen-year cycle has 235 lunations; but using Arazachel's value for a lunation, we find that 235 lunations does not work out to an integral number of days. In addition, we cannot consider simply the nineteen-year cycle, but must consider the seventy-six year cycle.[231] But even when this is done, we find that an integral number of lunations has not passed in that time. In fact, we find that seventy-six years is too long by 16 minutes and 40 seconds of a day. This error will accumulate with every seventy-

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227The error introduced by the thirds, fourths, and fifths is indeed minor, as shown in the previous section where this topic was covered.

228That is, 22/60ths of a day, or a little over 1/3 of a day.

229Each year accumulates twenty-two minutes of a day; in thirty years, this works out to 660 minutes of a day (22 x 30=660). This is equal to eleven whole days (660/60=11), which days are distirbuted throughout the thirty-year cycle as intercalary days.

230I have already done so in the previous section; the reader may refer to the exposition on Grosseteste's fourth chapter to see the computations.

231Because the bissextile year comes every fourth year, four sequential nineteen-year cycles must be considered. Two sequential nineteen-year cycles can have a different number of days, depending on whether they have four or five bissextile years, but seventy-six sequential years always have the same number of bissextile years, and thus the same number of days: 27,759.

six year cycle; Grosseteste drives this home by pointing out that, after 4,256 years have passed, we will see a full moon when we expect a new moon.

Grosseteste then deals with potential objections to his analysis. If one uses the value of a lunation given by Abrachis and Ptolemy, the error in a seventy-six year cycle is still 14 minutes, 32 seconds, 13 thirds, 46 fourths, and 40 fifths of a day. This is a bit smaller than the error that results from Arzachel's value, but is still appreciable. If one objects that Arzachel's or Ptolemy's values are incorrect, Grosseteste writes, then their tables must show errors in the time of eclipses.[232] In fact, we can observe that "these tables do not deceive us regarding the observed hours of eclipses."[233]

Therefore, to know truly the age of the moon, we cannot rely upon the Christian calendar, because it has been in error regarding the length of the lunation. To know the real age of the moon, he writes, we must instead rely upon "astronomical truth."[234] This can be found by using the Arab calendar, because they use the proper length of a lunation.[235] It is for this reason that Grosseteste spends the fifth chapter explaining how to convert the

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232Grosseteste also notes that one might object because Ptolemy, in the second chapter of the fourth book of his *Almagest*, discussed possible errors in calculating the length of the lunation. In Toomer's translation, see p. 178, for Ptolemy's remarks about Hipparchus's methods for calculating the length of the lunation. Ptolemy, following these remarks, notes that due care must be given to carefully observing the eclipses. Grosseteste's own insistence on observing astronomical phenomena may thus be due in part to his reading of Ptolemy.

233…ipse tabule non mentiuntur nobis in aliquo sensibili de horis eclipsium. *Comp. corr.*, p. 235, l. 30.

234…veritatem astronomicam, *Comp. corr.*, p. 237, l.1.

235Grosseteste does not suggest that astronomical truth is to be found through observation, as we might expect. Observation functioned in this argument only to show a lack of error in the Arabic reckoning, not to establish new information. Observation is on the side of the Arabs, and thus their values and tables should be used.

Christian date to the Arabic date, and thereby to know the true age of the moon on a given date.

Grosseteste begins the seventh chapter by again noting that the nineteen-year cycle of the Christian calendar is in error regarding the length of a lunation. However, the nineteen-year cycle is what the Church prescribes, and thus he will spend the rest of this chapter, as well as chapter eight, explaining how to coordinate the solar year and the lunar months through the use of epacts and embolisms, as thereby to know the age of the moon according to this method. The whole analysis, he states explictly, will rely upon the assumption that an integral number of lunations is precisely finished in seventy-six years.[236]

Grosseteste then spends these two long chapters presenting the basic computistical methods for dealing with lunar months within the solar year. As we have seen before, this information is of a straightforward nature, and would be most useful to the reader who requires basic instruction in the calendar. Grosseteste does not return to the subject of errors in the calendar until the tenth chapter, when he is discussing the placement of movable feasts. The errors discussed above—the incorrect length of the year and of a lunation that the Christian calendar uses—both contribute to errors in calculating the date of Easter. First, the time of the vernal equinox is set as the twelfth kalends of April.[237] But, Grosseteste writes, "it is clear, taking into account either instruments or astronomical tables,

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[236]Quia tamen sancta ecclesia ciclis illis utitur, expositionem kalendarii nostri quoad ciclos illos cum Dei adjutorio prosquemur, supponentes cum illis qui ciclos predictos primo posuerunt quod 76 anni nostri, quorum quilibet non bissextilis constat ex 365 diebus…; et hac suppositione ponita pro radice, super eam fundabimus doctrinam consequentem concordantem radici ponite. *Comp. corr.*, p. 241, ll. 5–12.

[237]That is, March 21.

that the equinox does not fall there in our time."[238] Using the Toledan tables for the length of the year and the method of Thebit discussed in his first chapter,[239] he writes, the equinox falls on the day before the ides of March.[240] This difference of seven days corresponds to what would be expected if the person who first set down the rules for finding the boundary of Easter set the twelfth kalends of April as the equinox, and an incorrect length for the year caused the movement of the winter solstice in the manner stated in the first chapter.[241]

In addition, the age of the moon shows errors as well. According to the premise that an integral number of lunations is complete in seventy-six years, the cycle of primations should maintain the age of the moon correctly. That is, if the primations of the moon occur when expected, then we should observe the moon to be full on the fourteenth day of the lunar month. Instead, Grosseteste claims, the moon is full on the thirteenth, or even the twelfth, day of the lunar month.

Thus two parameters relevant to setting the date of Easter, the date of the vernal equinox and the age of the moon at that time, both have errors. The means to correct this, Grosseteste writes, lie either in verifying the length of the year and using this value for the calendar, or by verifying the day of the vernal equinox by the use of instruments or

238…manifestum est tam per instrumentum consideracionis quam per tabulas astronomicas ibi non esse equinoctium in hoc tempore nostro. *Comp. corr.*, p. 258, ll. 25–27.

239Note again that, though Grosseteste has mentioned instruments as a possible means to find the equinox, he favors the use of tables made based upon Arabic methods.

240That is, March 14.

241Et constat quod si equinoctium fuit 12° kalendas Aprilis in tempore priorum doctorum, qui primo tradiderunt doctrina de inveniendo termino Pascha, quod in hoc tempore nostro non est equinoctium eodem die, immo necesse est nunc equinoctium precedere diem illum per rationem eandem quam diximus in capitulo primo de antecessione solsticii hiemalis. *Comp. corr.*, p. 258, ll. 30–35.

astronomical tables.[242] He immediately follows this suggestion, as we have seen is his pattern in other places, by stating explicitly that, because the Church has not adopted any new method, he will next explain how to perform the computistical calculations according to proper doctrine, which he proceeds to do for the remainder of the text.

We have seen a distinct pattern in his use of the Arabic material. He discusses Arabic and Greek astronomical works that have been available in England for only a few generations. He presents his findings from these works that suggest that the Christian calendar has errors, and that the means for correcting them lie with this new astronomical material. To establish that errors exist, he claims that observational evidence shows that certain astronomical pheneomena are not occurring when expected, and that the errors are consistent with the use in the Christian calendar of incorrect numerical values. The proper values are contained in the new materials, and thus the Christian calendar can be corrected by using them. In all cases, though, he does not stop with the suggestion merely to correct the calendar, but proceeds to cover fully the computistical methods that students of compotus would need to learn.

I thus see two distinct goals for the *Compotus correctorius*. On the one hand, Grosseteste is presenting basic computistical information consistent with a readership that is learning compotus for the first time. On the other hand, he also presents newly available material for the correction of the calendar. Clearly the audience for these two goals is unlikely to be the same person. One who is learning compotus for the first time is in no position to assess Grosseteste's material on errors in the calendar and the need for reform. On the other hand, a person sophisticated enough in computistical matters to understand the

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[242]Modus autem verificandi hunc errorem est ut verificetur anni quantitas, et verificata ponatur in kalendario, vel…cognoscatur semper dies equinoctii vernalis per instrumentum consideracionis vel tabulas astronomicas verificatas. *Comp. corr.*, p. 259, ll. 11–15.

problems and the solutions would not need to be presented the basic computistical doctrine that the Church approves. The work thus fits Sylla's description of a medieval scientific text for use in a university, cited at the beginning of this section, as a work that addresses "the concerns of undergraduates, bachelors, and masters of arts … [in] a single work."[243]

Was the *Compotus correctorius* composed while Grosseteste was at Oxford, for the express purposes of teaching compotus and proposing calendar reform? Two problems confront us when trying to answer this question. First, the dates when Grosseteste was at Oxford are not clearly established. Second, the likely dates of compostion overlap with years where we are unsure of Grosseteste's location. I think it is clear that the work was written, in part, to instruct students in the basics of the art of compotus. The work is intended, then, for an educational setting. But because of the problems with establishing precise dates, we are unable to state confidently whether the original intended setting was Oxford. As we saw in the second chapter, Grosseteste could have been teaching in the arts before he came to Oxford. Thus it is possible that the work was written for some other educational setting. The work does not contain the sophisticated Aristotelian thought that Grosseteste would develop during his study at Oxford. Thus it seems plausible, at least, that he wrote the work before embarking upon that course of study.

Clearly he must have already studied Arabic and Greek astronomical work in translation before writing the *Compotus correctorius*, but his study of Arabic material precedes the dates by which we can securely place him at Oxford. Thus, while that the work may have been written outside Oxford, the setting for which it seems to have been written was certainly an educational one. It is plausible, then, that Grosseteste was teaching sophisticated computistical, and probably astronomical, material before he arrived at Oxford. In either case, the *Compotus correctorius* would have found an audience at Oxford,

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[243]Sylla, "Science for Undergraduates," p. 183.

whenever Grosseteste arrived there and taught students in the arts.

This was an important development in the incorporation of Arabic and Greek scientific material into the Latin educational system. On the level of introductory computistical information, this is not very apparent. Students who read just the material on basic, orthodox computistical material, if indeed the text was read or taught in portions, would not have been aware of this. But on the level of calendar reform, the picture is quite different. Here the Arabic and Greek material is indispensable; the reforms that Grosseteste envisions will come directly from those materials. As often as he suggests that observation of astronomical phenomena is useful, he insists that the new scientific material already holds the solution to the problems that observation reveals or demonstrates.

The practical benefits of the new science are immediately obvious: it can be used to correct errors in the calendar, which in turn has important theological implications. In the case of astronomy taught to undergraduates, for example, the benefits of the new material are not so clear. That is, basic instruction in astronomy, such as that found in Grosseteste's *De spera*, discussed in the previous chapter, did not have an immediate "payoff;" whereas students may better understand what is occurring in the sky, the usefulness of this is not self-evident. It becomes useful, in the medieval context, when students proceeded to use the information in other contexts, such as in biblical exegesis or astrology,[244] as well as for the general purpose of understanding the created world. In the case of compotus, on the other hand, the benefits are presented in the same text. As I suggested previously, we can consider the possibility that the text could be used to teach students different things. For those students who grasp the basics of compotus, Grosseteste can then present them with problems he has identified, as well as the means to correct these problems he has found

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[244]As was seen in the previous chapter, however, the astronomy of *De spera* had little obvious connection to astrology.

through the study of the new science.

Grosseteste has thus taken the new sciences, recently translated into Latin, and incorporated them into a basic text for university teaching. The benefits of the new science could be presented to the university audience, either to sophisticated undergraduates or to his peers. Compotus at Oxford, then, whether the work was originally written for that setting or was just eventually taught there, was a means by which the new science of the Arabs and Greeks was both incorporated into the curriculum of the young universities and was demonstrated to have usefulness to the Western, Latin world.

CHAPTER 5

CONCLUDING COMMENTS

In this dissertation, I have attempted to provide the reader with expositions of two important texts of medieval astronomy and compotus, Robert Grosseteste's *De spera* and *Compotus correctorius*. In these expositions, I have combined aspects both of translation and of commentary so that the reader can best understand the topics with which Grosseteste dealt in these texts. I have also tried to place the texts within their contemporary context. Some topics, however, remain for further discussion.

What can we now say we know better regarding Grosseteste's life? As discussed in the second chapter, his early life is extremely difficult to piece together. In the attempt to create a plausible picture of his life, we must combine elements of textual production and the few external sources of information that we possess. We know that he had an early interest in astronomy, particularly in the practical benefits of astrological prediction, through his work, the *De artibus liberalibus*. Yet that text showed a lack of explicit awareness of the technicalities of astronomy.

We know that Grosseteste eventually overcame the dearth of quantitative sophistication. In his *De aeris*, he shows familiarity both with using astronomical tables and with various technical astronomical and astrological concepts. In the *Compotus correctorius*, he certainly dealt with quantitative measurements in the attempt to convey the basic elements of the science, as well as in the more difficult problem of correcting the calendar. So at some point in his life, he learned to deal with the complex, technical aspects

of the astronomical sciences, which included the consultation of Arabic texts in translation.

The problem of where he learned the Arabic science has not been solved definitively, but we do have some better ideas in light of the analysis of his life and texts in this dissertation. The period from the mid-1190s to the early 1220s is key. During this period, Grosseteste was in the Hereford and Oxford region, perhaps teaching, and certainly taking part in the duties of ecclesiastical households. This is also the period in which he is most likely to have begun his investigation of Arabic astronomy. Resources would have been available to him through Hereford, where scholars had actively pursued astrology and compotus in the generation before Grosseteste. He most likely composed his *De spera* and *De aeris* during this period, before he began a more intensive study of Aristotelian natural philosophy. The *Compotus correctorius* was also composed during this period, perhaps closer to the end of it, when he was engaged in more careful study of Aristotle. And, lastly, the provocative manuscript that contains his handwriting, Oxford MS Bodl., Savile 21, dates from before 1216, the date of a horoscope in the manuscript, but could date as early as the late 1180s based on the significance given to planetary alignments in the horoscope. And so it seems most plausible that the source of his increasing sophistication in astronomy and compotus was Hereford.

Giving more precision to the date and place of composition of the *De spera* is complicated by the fact that we do not know precisely from what textual sources he drew his material. Certainly some of it is similar to topics presented in Ptolemy's *Almagest*, but the differences in presentation—the general absence of both quantitative results and the geometric method, for example, as well as the negelct of certain central topics, such as the planetary motions—do not make it clear that his source was the *Almagest* itself.

The dynamic of the theological import behind the texts is also significant. It is not certain when Grosseteste began his university training in theology, but I favor Southern's scheme that he began this training in earnest after the masters returned to Oxford in 1214.

This date, though, does not preclude that he was interested in matters of a theological nature before that time; that his interests began earlier is reinforced by his presence within ecclesiastical households and his eventual holding of ecclesiastical offices himself. Thus the theological goals of the *De spera* and the *Compotus* do not require that they were composed only after his theological training began.

Yet I have also argued that both the *De spera* and the *Compotus* were texts intended for the instruction of students at an advanced level. After the *suspendium clericorum*, i. e., after 1214, Grosseteste is associated with the University of Oxford, either as a student or faculty member of the theological faculty, but also teaching in the arts. Before that time, it is possible that he had been teaching in Hereford, and perhaps even at Oxford before the *suspendium* began in 1209. He had been recommended to the Bishop of Hereford because of, in part, his knowledge of the liberal arts.

So based on these items, I propose the following scheme for dating these texts and modifying Grosseteste's biography. In the middle of the 1190s, he becomes a member of the household of William de Vere, Bishop of Hereford. While at Hereford, Grosseteste is able to increase his knowledge of the astronomical sciences, especially of the Arabs, from the resources there. When William dies in 1198, Grosseteste stays in the vicinity of Hereford and Oxford, probably teaching, as he had done before he entered William's household. Now, however, he does not have merely young students as a provincial master, but has become more adept in the field of astronomy. Some time over the next twenty years, he composes the *De spera*, and probably the *De aeris*. Some time before 1209, he becomes associated with Oxford, using the *De spera* and perhaps the *De aeris* to attract students interested in astronomy. His presentation of new theories of astronomy, such as Thebit's theory of the mobile and fixed zodiacs, is helpful to building his reputation. He is then able to find work there teaching in the arts, although his association with ecclesiastical households continues as well, and begins pursuing a theological degree after the masters

return in 1214. His *De spera* becomes the standard text through which at least a generation of Oxford students learn astronomy, and which helps to cement, in concert with his further work in natural philosophy and optics, his reputation among his students as a natural philosopher.

Through his familiarity with Arabic astronomy, and his continued use of Arabic tables, as evidenced by the *De aeris* and the horoscopes in the Savile manuscript, and perhaps due to material he encountered at Hereford, Grosseteste at some point discovers that the calendar has a number of errors. His anxiety over this problem is heightened as he begins his education in theology and becomes more aware of the serious repercussions of a faulty calendar. In addition, at some point, he becomes dissatisfied with the text of the *Compotus ecclesiasticus*, either through teaching it (which would account for ascriptions of the text to him) or through consulting it in an attempt to solve the problems of the calendar. Eventually he decides to construct his own textbook and produces the *Compotus correctorius*, in which he both teaches the basic elements of the art and makes suggestions on how the calendar might be corrected. This probably occurred in the mid-1220s, when he was teaching in the arts and also beginning his investigation into Aristotelian natural philosophy. In this case, the text was clearly meant to instruct students at the University of Oxford.

The scenario I have just suggested has not been proven absolutely, but very little of Grosseteste's biography can be. Rather, as stated above, we are forced to fit together his texts and the little we can know for certain from external sources. The scenario I have proposed takes into account his astronomical and computistical texts and the purposes I have identified for them. I have thus constructed a narrative that is coherent and at the same time takes advantage of the new analysis of the texts that I have provided in this dissertation.

What, then, is the relationship of these texts to the teaching of astronomy and compotus at Oxford? We saw in the first two chapters of this dissertation that Oxford had a

strong reputation in natural philosophy by the middle of the thirteenth century. We also learned that this was due in large part to Grosseteste and his continuing influences on his students, especially among the Benedictines. And finally, we discovered that the statutes of Oxford, though the earliest are from a relatively late date, probably in the fourteenth century, explicitly require astronomy and compotus among the texts that students are to learn.

These texts fit neatly into a picture of the university in which astronomy and compotus were early taught as part of the basic education of undergraduates. At the same time, however, not all undergraduates were necessarily exposed to the same material. The *De spera* was clearly an introductory text. It did not include difficult quantitative material, nor did it incorporate many of the more complex ideas of astronomy that were available to one of Grosseteste's technical ability and scholarship. The *Compotus correctorius*, I have argued, could be taught at a variety of levels, either in more basic form for the general instruction in compotus, or in its more complex form for those students who exhibited an interest or aptitude in the art.

I have not provided a full analysis of the *De aeris*. It is possible, however, that this text, too, was taught at Oxford. According to Grosseteste's later, theologically sophisticated arguments against astrology of certain kinds, the *De aeris* remains a theologically acceptable text, because it speaks only of celestial influences on passive elements, not on the human will. Because more complex astronomical techniques are necessary to understand this text, it too may have been only for select students, as were portions of the *Compotus correctorius*. The astrological component never became a part of the statutory requirements, so far as we know, so it is plausible that the *De spera* was the basic text for all students, while the *De aeris* might have been reserved for the students with a special interest in astrology and aptitude in the manipulation of astronomical tables and astrological concepts.

The *De aeris* never became a companion piece to the *De spera*, or at least evidence for this is not available in the manuscripts I have consulted, so we cannot draw too close an

analogy between the way these two texts might have been taught and the way I suggest the *Compotus correctorius* was taught. But I do not believe that the astrological sciences ever became ensconced as a part of the curriculum in the way that astronomy and compotus did. This may explain in part why Oxford never faced the condemnations of Aristotelian science in the way that Paris did, because the threatening aspects of astrology were not promoted in the same way.

What can we say about the level of astronomical and computistical teaching at Oxford? With Grosseteste's text as a basis, we can characterize what teaching was like, at least in the first half of the thirteenth century while Grosseteste's influence was still fresh among his students and the following generation. The astronomy that was taught to every student was fairly basic, explaining some of the fundamental principles of astronomy and the physical constitution of the cosmos. Perhaps more sophisticated instruction in astrology, which would have necessitated instruction in at least the use of astronomical tables, might have been available to some students, but never became a common part of the curriculum. A fairly high level of sophistication in compotus was expected of students. At the very least, competency in arithmetic and a basic level of astronomical knowledge was assumed.

This emphasis on astronomy and compotus was important to the developments in natural philosophy at Oxford in a variety of ways. First, I have suggested that Grosseteste's reputation, which acted to draw students to Oxford (it was still a fledgling university, and the reputation of the masters was likely more important than that of the institution at this stage), was based at least in part in his ability in astronomy. Having a master who could teach these arts and who possessed such a degree of technical achievement must have fostered an environment in which natural philosophy more generally could flourish. And when the master himself turned to Aristotelian natural philosophy in earnest, his students naturally followed suit.

In fact, Grosseteste's turn towards Aristotelianism probably charted the path for

future endeavors at the university. Because certain aspects of this philosophy conflicted with the Christian understanding of the world, it required careful study to determine its proper use within the Christian environment. Astronomy and compotus, which already had competent texts, could persist at a fairly low level of technical sophistication because they accomplished their purposes: revealing God's activity in creation, providing information for biblical exegesis, and teaching the basics of the Christian calendar.

In certain circles, however, a greater level of ability led some scholars to greater achievements, eventually leading to a great deal of astronomical and mathematical research at Oxford in the fourteenth century.[1] Undoubtedly Grosseteste's work in the early years of the university contributed to this eventual situation.

The astronomical and computistical textbooks of Grosseteste had a lasting effect on the curriculum of Oxford, as well as the research into natural philosophy that took place there. These texts are now available to a broader modern audience than they were previously. Grosseteste's technical ability in these arts can be more fully appreciated, as can the content of what medieval undergraduate students learned. Although in the following decades astronomers would surpass Grosseteste's acheivements, his influence was a necessary precondition for the development of those arts at Oxford.

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[1]See North, "Astronomy and Mathematics."

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