# 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.

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

[8]Tester 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.

[9]The 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

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[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.

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

[29]For 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*.

[30]Grosseteste 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

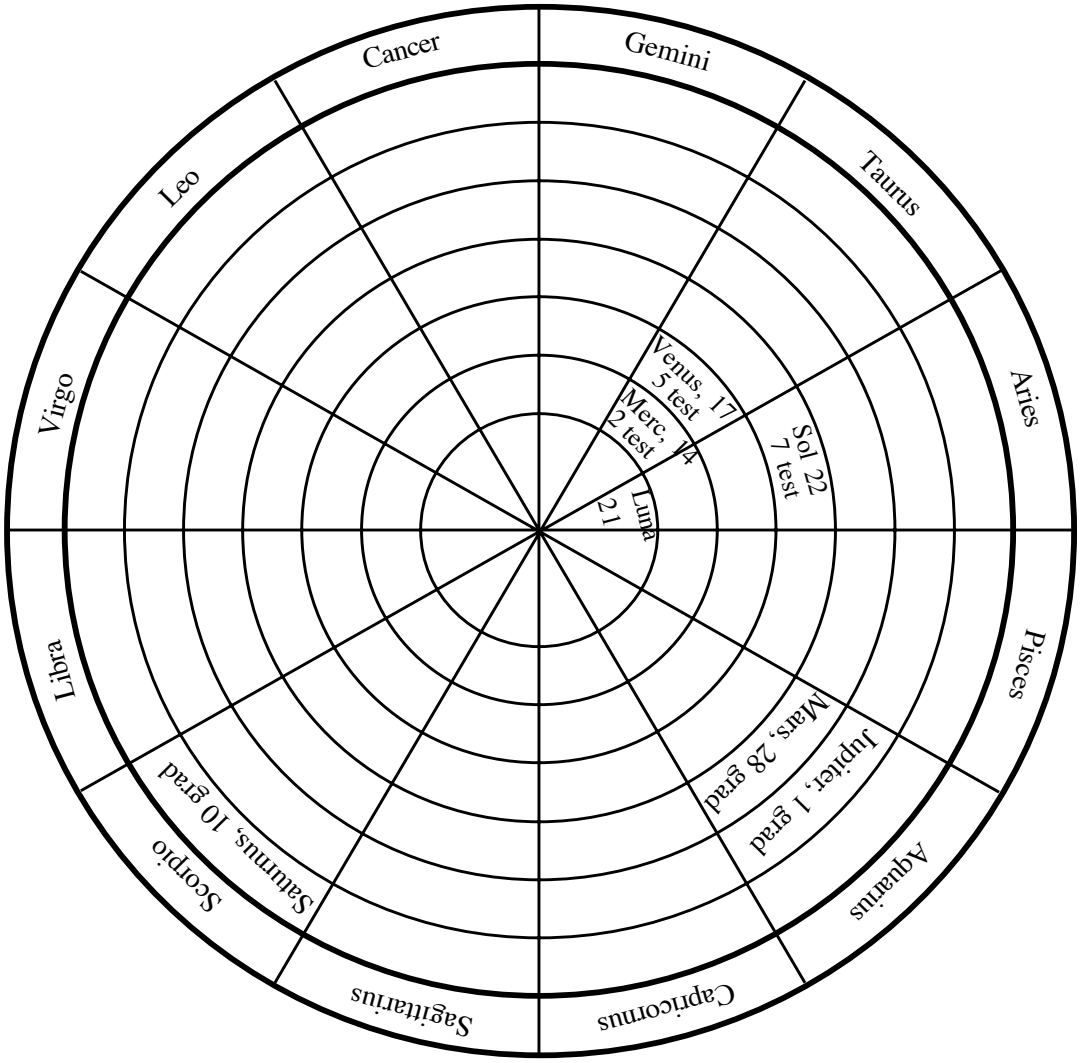


Figure 1. Astrological Figure for Weather Prediction

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

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[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

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[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.

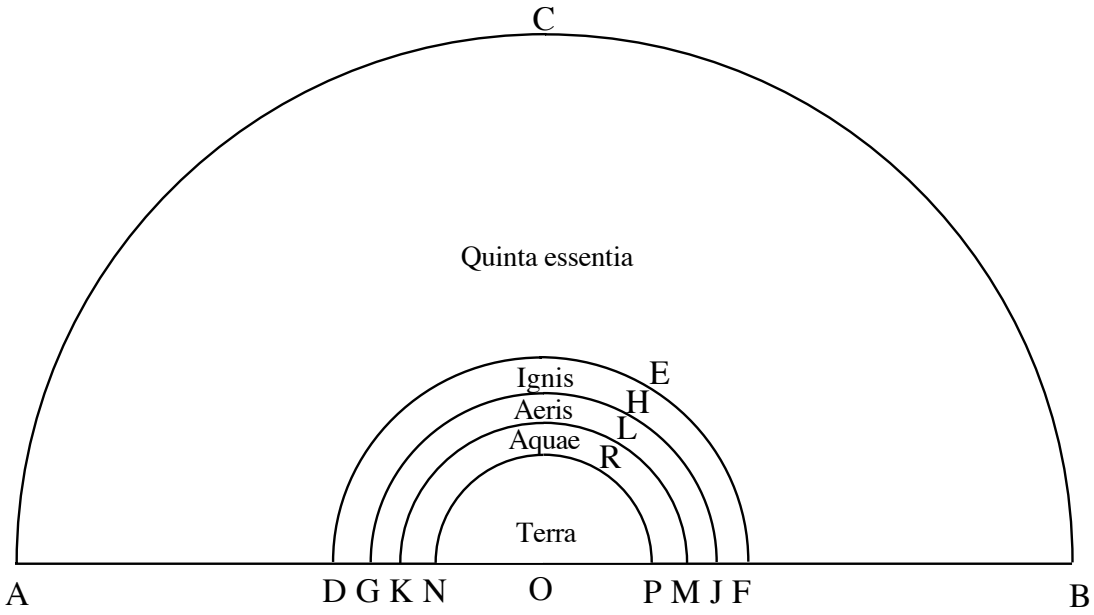


Figure 2. Elemental Spheres

[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.

[91]In 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.

[92]The 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.

[93]Baur 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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[105]Grosseteste does not explain why he gives two alternative values.

[106]This 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.

[107]In other words, though Grosseteste does not state this here, from west to east, because the rotating firmament moves east to west.

[108]Again, 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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[113]That 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.

[114]Baur 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.

[115]Imaginemur 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.

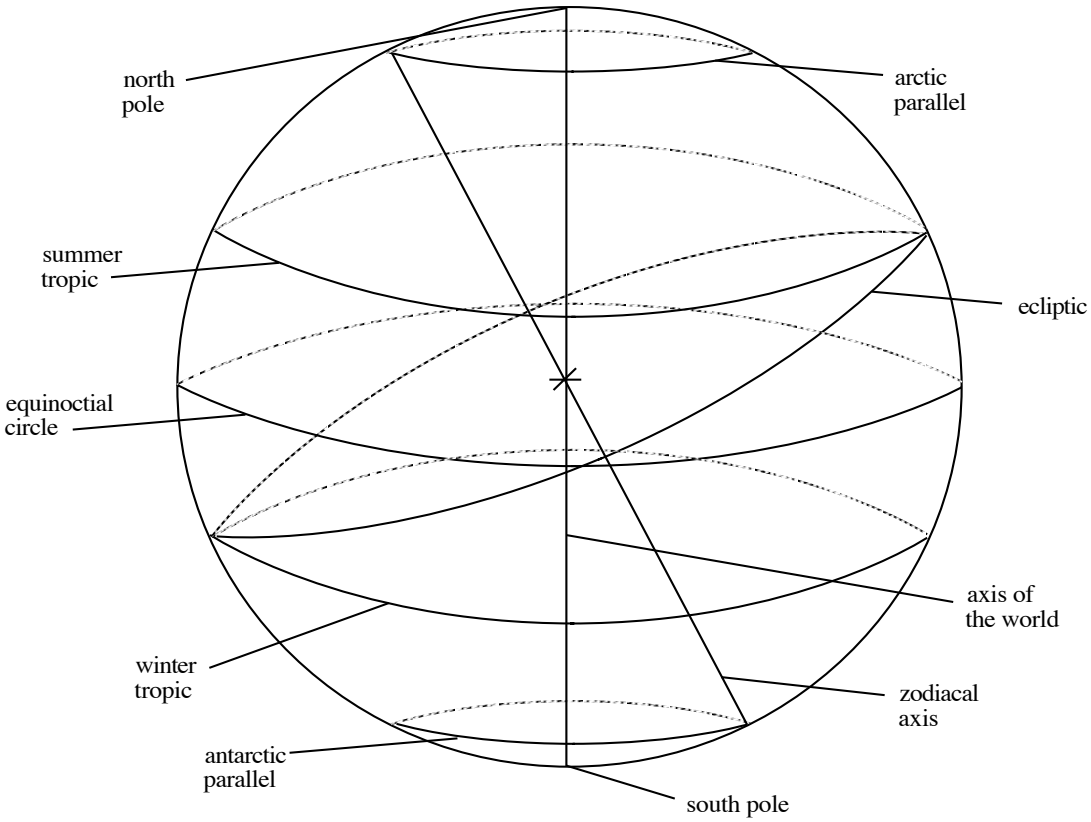


Figure 3. Circles, Parallels, and Ecliptic

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.

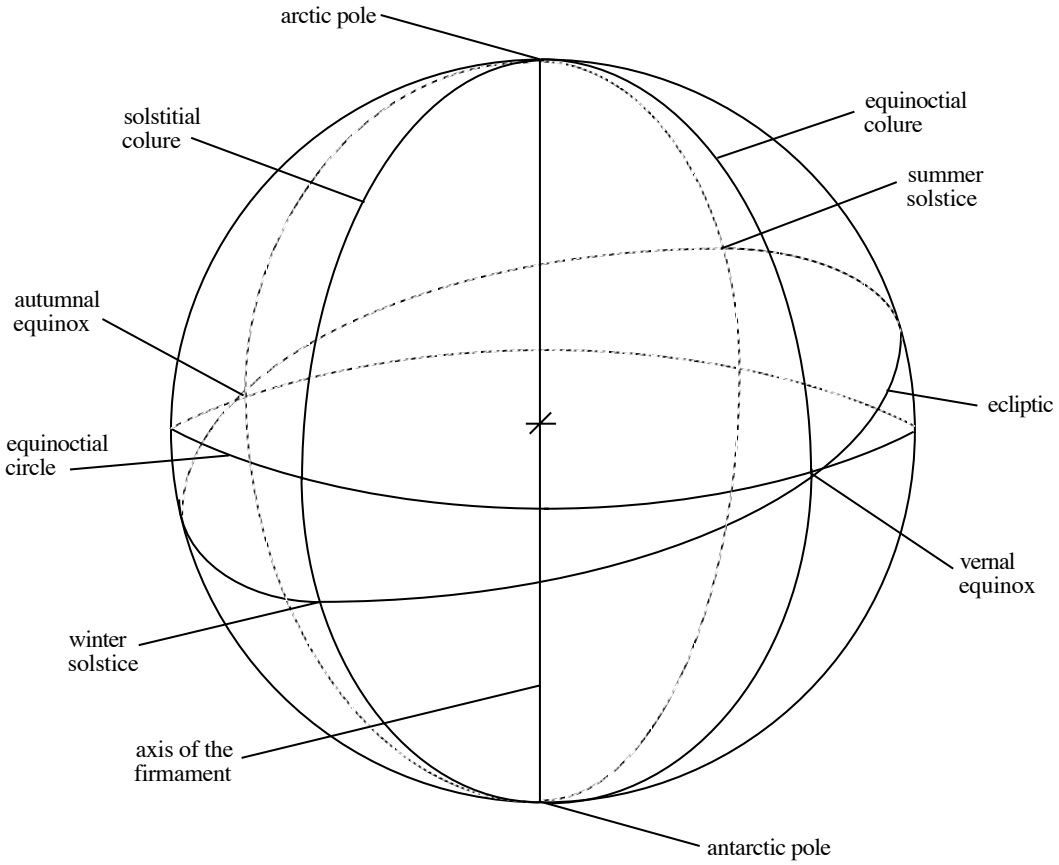


Figure 4. Colures, Equinoxes, and Solstices

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

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[117]Unde 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.

[118]Quae 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

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[119]Grosseteste 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]

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[121]Voco autem zenith capitis extremitatem lineae rectae ductae a centro terrae per caput hominis usque ad firmamentum. *De spera*, p. 16, ll. 25–26.

[122]In other words, on those places that we would call the earth's equator.

[123]These 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.

[124]Manifestum 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.

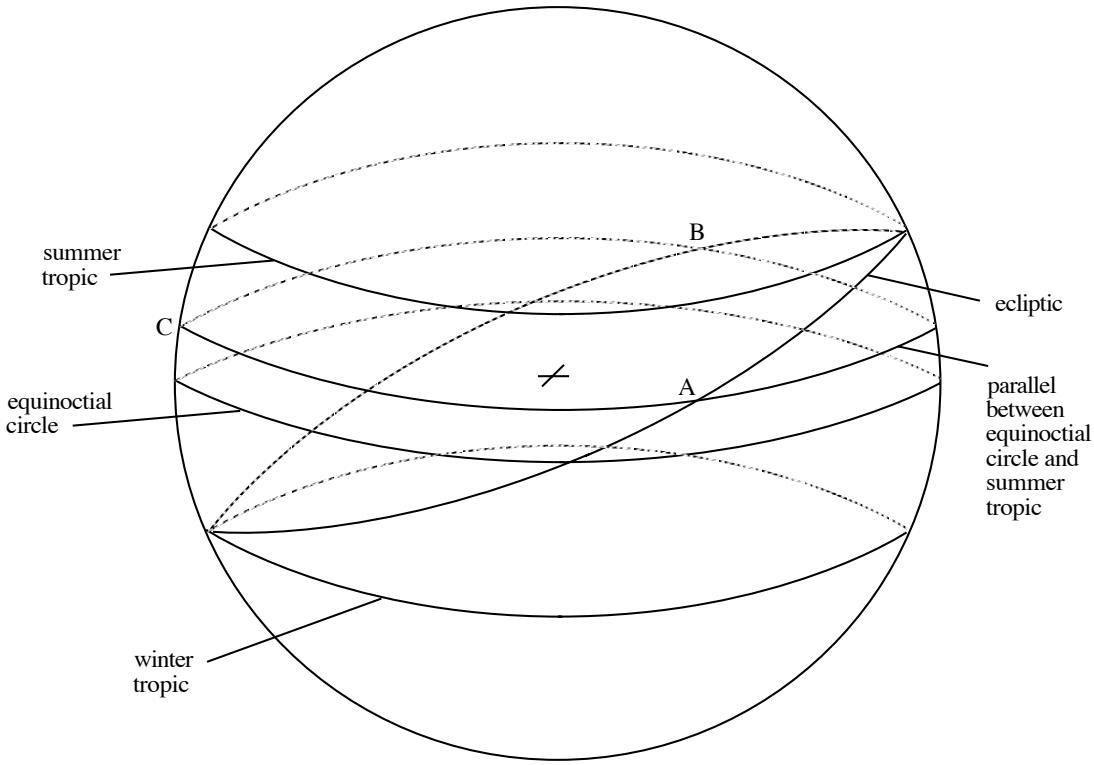


Figure 5. Parallel between the Equinoctial Circle and Summer Tropic

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.

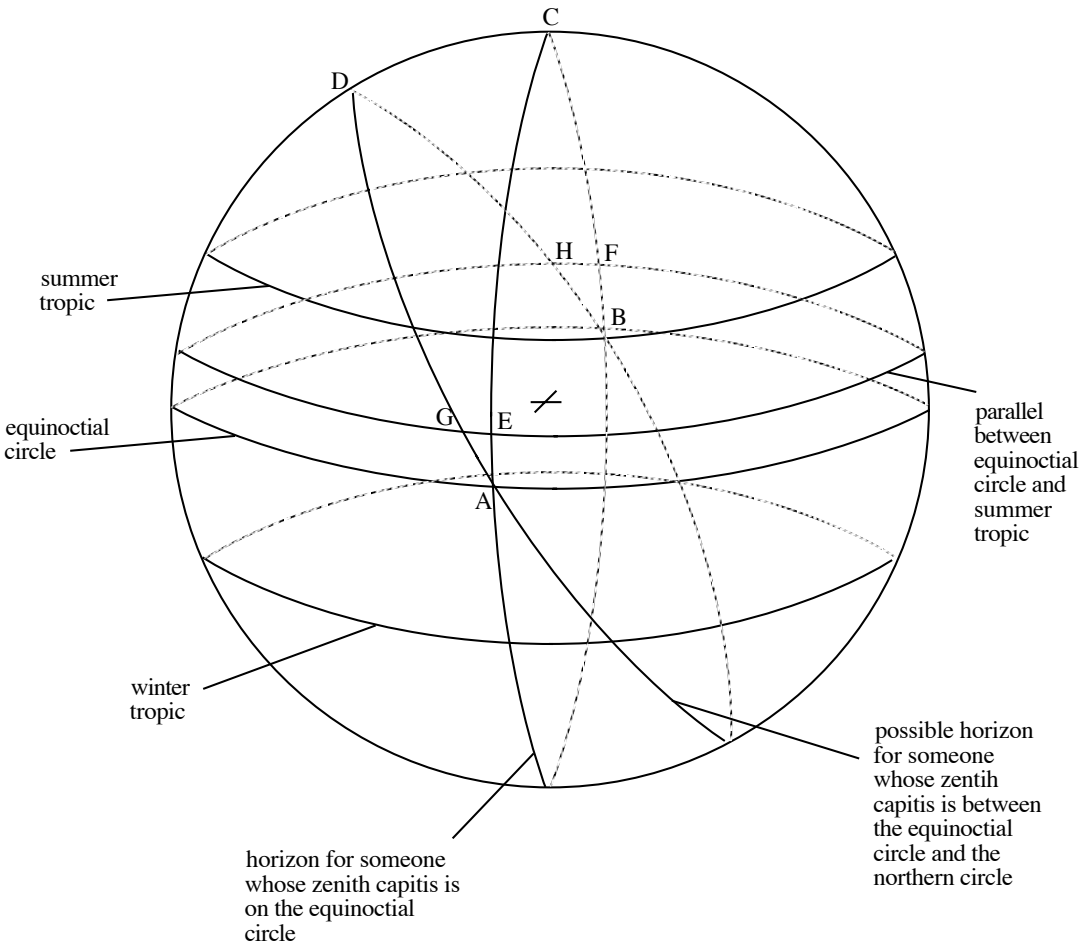


Figure 6. Horizon and Parallel

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

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[129]…sol accedit ad caput cancri, *De spera*, p. 18, ll. 20–21.

[130]Grosseteste 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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[131]By 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.

[132]Grosseteste again uses the term zodiac for the ecliptic.

[133]In other words, at whatever latitude the summer tropic falls, there is that much latitude above the northern, or arctic, circle.

[134]Unde 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]

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[135]Unde 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.

[137]It 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.

[138]See, for example, Figure 3 above. The axis of the zodiac is inclined to the axis of the world.

[139]It 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.

[140]Arcus vero de aequinoctiali circulo, qui ascendit cum aliqua parte zodiaci, dicitur ascensio eiusdem partis. *De spera*, p. 20, ll. 10–12.

[141]Perhaps 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.

[142]It 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*)

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[154]Grosseteste 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.

[155]Quando vero tantum addit una causa, quantum reliqua diminuit, *De spera*, p. 23, ll. 14–15.

[156]Grosseteste 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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[157]Et dicitur clima tantum spatium terrae, per quod sensibiliter variatur horologium. *De spera*, p. 24, ll. 9–10.

[158]Idem 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.

[159]Spatium 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.

[160]Grosseteste 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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[161]Et 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.

[162]Sed 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.

[163]This 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.

[165]This 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.

[166]Eruntque 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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[167]In 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.'

[169]The 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.

[170]Grosseteste uses the term *caput arietis mobilis*. He has switched between various terms for the imaginal or mobile zodiac without warning.

[171]Because 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.

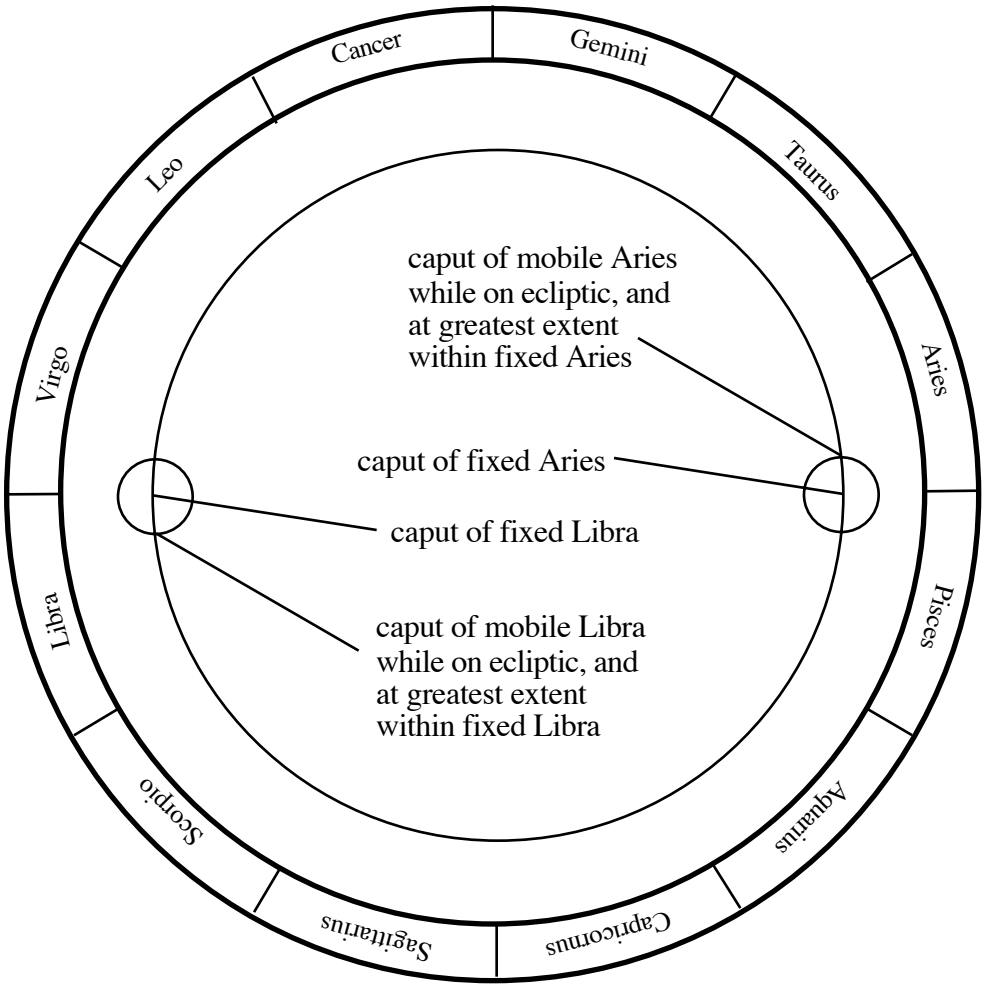


Figure 7. Fixed and Mobile Zodiacs

*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.'

[175]Note 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.

[176]Recall 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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[178]This 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.

[179]Estque 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

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[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

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[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]

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[192]We 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*.

[193]This 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.

[194]McEvoy, *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

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[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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[199]The 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.

[200]Thorndike also discussed this topic in *The* Sphere, pp. 10–14.

[201]For 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.