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Astrology: science or divination? The example of astro-meteorology

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Borderlines

MEDIEVAL PERCEPTIONS OF MAGIC, SCIENCE, AND THE NATURAL WORLD

Edited by
CAROLINA ESCOBAR-VARGAS
and **ANNE LAWRENCE-MATHERS**

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ASTROLOGY: SCIENCE OR DIVINATION?

THE EXAMPLE OF ASTRO-METEOROLOGY

ANNE LAWRENCE-MATHERS

MODERN UNDERSTANDING OF the nature and uses of medieval astrology is still often affected by the assumption that it was primarily focused on the casting of birth horoscopes and the making of predictions concerning the futures of individuals. This view is partially supported by the fact that medieval condemnations of astrologers and their works tend only to mention these "judicial" or "genethliacal" types of astrology. However, such condemnations were never intended to describe all of medieval astrology, and there were several forms which were accepted not simply as unproblematic but actually as socially useful. One of these was weather forecasting by astrological techniques, which came to be known as "astro-meteorology," and this chapter will focus on that as an important example of valued astrology. The question of the power of celestial bodies over earthly phenomena such as winds, rain, and storms is also one of special relevance to this volume. It raises important issues concerning both the perceived boundaries of the natural and permissible sources of knowledge. This problem, of the difficulty of precise distinction between activities which harnessed "occult" natural powers and those which involved demonic contacts, was also an ongoing concern for medieval theologians.

Lack of clarity on the term astrology itself, as well as on types of astrological practice and their levels of spiritual danger, is already found in key patristic sources on the topic. This ambiguity continued throughout the medieval period, which can make exact translations of texts into modern English problematic. St. Augustine, whose hostility to "astrology" is frequently cited, confessed to having been deeply interested in it when younger. In his very influential *On Christian Doctrine* he defined casters of birth-charts (*genethliaci*) as followers of a specific form of superstition. He acknowledged that these practitioners, called *mathematici* in Latin, were only one type of astrologer, and that they worked hard to establish the accurate positions of the planets and stars at the time of someone's birth. Their error, which was a serious one, was in making predictions which denied free will and made human beings "the slaves of Mars or Venus or all the stars." It was this, not the practical difficulties which made such horoscopes faulty, which made these practitioners so dangerous. Their beliefs and predictions are placed "in the same class as if they were leagues and covenants with devils."[1]

1 Augustine, *On Christian Doctrine*, bk. 2, chaps. 20–22. See *De doctrina Christiana*, ed. and trans. Green.

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However, even Augustine, in this same text, is clear that the movements of the stars conform to fixed patterns, set by God, which order times and seasons. Moreover, as he points out, knowledge of the course of the moon is widespread and is central to the calculation of Easter each year. Knowledge of the movements of other heavenly bodies, although much scarcer, "involves no superstition" and is impressive in some ways for granting the possibility of making "sure calculations" concerning the positions of celestial bodies in the past and the future as well as the present.[2] The danger lies in the seductive possibility of gaining "information as to our own acts and fates" which is pernicious madness.[3] It is important that the concept of "astronomy" is not invoked here as a distinct category, and neither are all forms of astrology classed together. A very similar stance is expressed in the discussion of the luminaries as "signs" in Augustine's commentary *On the Literal Meaning of Genesis*. Chapter 14.29 of this work dismisses the superstitious observation of such signs as "sheerest folly." But reading the celestial bodies as signs which: "forecast the weather" through the changing seasons; can help travellers; and enable the calculation of calendars and the precise measurement of time, is both good and useful.[4] From this evidence it can be argued that Augustine accepted that it was appropriate and useful for humans to create and apply knowledge concerning the cycles of celestial bodies and their relationship to changes in the natural world below on Earth. However, he did not attempt to produce an overview as to the exact natures and powers of the planets, or just how their influences worked.

Also important, though less often discussed by historians, are the views of St. Jerome, especially in his commentary on the biblical story of Daniel. Chapter 2, verse 2 of that book includes a list of the various practitioners of divination and magical arts in the service of King Nebuchadnezzar. This leads Jerome into brief discussions of the problems of translating from Hebrew and Greek into Latin in these cases. Once again, key terms in analysing astrology are *genethliaci* and *mathematici*, which apply to those who cast birth horoscopes.[5] These are less sinister than those whose divinations involve sacrificed animals, blood and dead bodies, but are viewed negatively. More ambiguous are the *magi*. Jerome records that the term has come to be used for malevolent enchanters, but does not entirely accept this since the word was originally applied to the Chaldean philosophers who studied the stars. Moreover, it was this study which led the experts to Bethlehem when they followed the star. Having pointed out this discrepancy, Jerome refrains from passing further judgement.[6]

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2 For the ecclesiastical "science" of computus, and the complex calculations underlying the Church calendar, see Nothaft, *Scandalous Error*.

3 Augustine, *On Christian Doctrine*, bk. 2, chap. 29.

4 Augustine, *Literal Meaning of Genesis*, trans. Hill, 208. See also Nothaft, *Scandalous Error*, chaps. 1 and 2.

5 Jerome, *Commentary on Daniel*, trans. Archer, 24.

6 Jerome, *Commentary on Daniel*, trans. Archer, 25. Medieval interpretations of the astrological expertise of the magi are helpfully discussed in Collins, "Scholastics, Stars, and Magi."

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A much fuller attempt to make sense of terms for experts in types of astrology, and their relationship to practitioners of other forms of superstitious and magical prediction, is provided by Isidore of Seville, in Books 3.24–71 and 8.9 of his *Etymologies*. This remained a key reference work from the seventh to the twelfth century. Unfortunately, Isidore's handling of the issue, together with its varied presentation in manuscripts, created further ambiguity. The key section of text is in Book 8 and headed *De magis*, which in some ways echoes Jerome's comment on the widening meaning of that term. However, "magi" are only explicitly discussed in the first part, with attention switching to practitioners of divination thereafter.[7] This has led leading historians of magic to conclude that, for Isidore, magic and divination were one and the same. Perhaps most influential has been Lynn Thorndike's view that "from the first Isidore identifies magic and divination" in this section.[8]

That conclusion has perhaps been over-emphasized, since elsewhere Isidore uses "magi" less pejoratively. Thorndike himself points out that Isidore states, in his discussion of the mathematical subjects of the *quadrivium*, that astrology is only superstitious in parts, with other parts being acceptable as study of the natural world.[9] This refers to Book 3.27, on the difference between astronomy and astrology, where Isidore accepts that astrological study of the movements of the planets and their positions at chosen times is licit. Astrology becomes superstitious, and the terrain of *mathematici*, when attempts are made to practise augury by the stars or to link zodiac signs to parts of the human soul, or to make predictions about chosen individuals.[10] Yet in the section *De magis* the familiar terms *genethliaci*, *mathematici*, and *horoscopi* are listed together with *astrologi* and *magi* as a subgroup of diviners. Such confusion is perhaps best explained by the fact that the tools required for the types of precise calculations needed to draw up detailed astronomical charts had ceased to be available in the Latin West and did not return until the twelfth century. Simpler substitutes were available, as discussed below, but did not conform to the late-classical descriptions. Ambiguity of learned terminology was thus a puzzle for those engaged in textual commentary but not an immediate issue for those dealing with living people and their errors.

That was certainly the case, for instance, for Bede, writing about a century later than Isidore and with reference to his works. In his textbook on the calculation of the Christian calendar, *De temporum ratione* (The Reckoning of Time), he expounds on the calculation of the positions of the sun and moon on the ecliptic and thus in relation to the zodiac. These rather basic matters are treated as presenting some difficulties for students, and there is no sense that they will be able to work out the longitudes of other planets. Even in his more wide-ranging work on natural philosophy, *De natura rerum* (On the Nature of Things), he is only able to add general information on the spheres of

7 Klingshirn, "Isidore of Seville's Taxonomy."

8 Thorndike, *A History of Magic*, 1:629.

9 Klingshirn, "Isidore of Seville's Taxonomy."

10 Isidore of Seville, *Etymologies*, trans. Barney et al., 181–83 and 99.

the planets and the time taken by each to complete a circuit around the earth.[11] The first serious change in this situation was presented in the late tenth century by the arrival of the collection of texts now known as the *Alchandrean corpus* or *Liber Alchandrei*.

This was a collection of short, primarily astrological or divinatory treatises which, like other books offering new and strange knowledge, linked much of its contents to Alexander the Great and his supposed tutor, Aristotle. Several of its treatises claimed to make it possible to offer astrological predictions—although no technical, astronomical knowledge of planetary positions was required.[12] These texts were clearly based on or translated from treatises in Arabic, and incorporated names and terms transliterated from both Arabic and Hebrew. Some Greek terminology is also apparent. The compilation, in its Latin form, was almost certainly made in Catalonia and in a Christian context. Surviving manuscripts give it varying titles, sometimes using the name *Mathematica Alhandrei summa astrologi*, which clearly transgresses the condemnations of the Church Fathers.

The texts assume that the user will be giving advice to someone seeking answers to questions concerning the outcomes of illness, marriage, or business and legal affairs. This is the traditional function of the *mathematici* and is clearly problematic. Even more so is the provision of methods of identifying key elements of a birth horoscope. The basic method is of clear Arabic origin since it uses lunar mansions, something which had not previously appeared in any Latin text. Happily for the client who did not know their date and time of birth, all that was needed was their name together with that of their mother (or sometimes the day in a lunar month most closely related to the question). These were to be written down in accordance with the instructions given, and the numerical values attributed to their component letters (in a table provided) were to be added together. The total was divided by twenty-eight and the remainder could then be applied to the numbered list of lunar mansions. Ideally the indicated mansion would be placed within the 30° of the ecliptic occupied by a zodiac sign, and the relevant sign would thus be the client's "ruling sign." A similar, though simpler, procedure was expounded for the identification of the planet ruling a client's birth horoscope.

However, the same process could be used, together with a diagram known as the *Sphere of Apuleius*, or *Sphere of Life and Death*, to deduce whether a sick person would or would not recover.[13] Augustine had not condemned medical applications of astrology; and it is also possible that priests would value guidance as to whether to give extreme unction to a sick person. Similarly, there was no ban on study of the courses and positions of the planets—Augustine had simply emphasized the practical difficulties involved in making calculations with any degree of accuracy. Therefore, the instructions concerning the movements of the planets, found in some manuscripts together with the

11 Bede, *The Reckoning of Time*, trans. Wallis, 54–63; *On the Nature of Things*, trans. Kendall and Wallis, 80–87.

12 For texts included in the collection see Juste, *Les Alchandreana primitifs*. Juste provides editions of the texts, based on a corpus of seventy-one manuscripts, together with a full commentary.

13 See chapter by Joanne Edge in this volume.

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core Alchandrean texts, were not problematic in themselves; and nor was their claim to be derived from the work of Ptolemy of Alexandria. Such information is found, for instance, in the volume which is now London, British Library, Harley MS 2506, together with texts and images taken from prestigious works of classical astronomy.[14] This manuscript was possibly produced in the abbey of Fleury ca. 1000, but the Alchandrean texts continued to be used in the twelfth century and enjoyed a revival in popularity during the Renaissance. An example of a twelfth-century copy of selected texts is found in London, Wellcome Collection, MS 21.[15] This in fact appears to be a part of a larger volume, but now contains two versions of the *Sphere* together with a treatise on the powers of the planets and an anonymous text on physiognomy.

A much greater advance in Latin knowledge of the science of the stars began to gather speed in the twelfth century, originating in newly-Christian-dominated regions of Iberia and carried from there by enthusiastic scholars. An impressive part of this was an impressive and fascinating Islamicate astronomical device, the astrolabe.[16] Even this very important piece of new technology did not make it possible on its own to draw up the kind of horoscope needed for full natal or judicial astrology. What it did offer was nevertheless revolutionary and provided incontrovertible evidence of the superiority of Islamicate astronomical science. For a start, an astrolabe came equipped with interchangeable plates, calibrated to represent the heavens as observed from specific locations. The appropriate plate was used together with the overlaying "star-net" or *rete*, whose pointers made it possible to locate and identify major stars.[17] The accompanying instructions advised not only on how to construct an astrolabe but also on how to use it for such practical applications as telling the time, measuring distances, and measuring heights or depths.[18] An astrolabe could also be used to measure the exact location (to fractions of a degree) of readily identifiable planets such as the sun and the moon. The instructions explain that the same procedure could also be used to establish the position of any other visible planet.[19]

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14 A digitized version of this manuscript is available on the British Library website at: www.bl.uk/manuscripts/FullDisplay.aspx?ref=Harley_MS_2506 (currently unavailable, May 10, 2024).

15 This manuscript has been digitized and can be viewed online at: https://wellcomecollection.org/works/ufns95hv (accessed May 10, 2024).

16 See Burnett, "King Ptolemy"; and McCluskey, *Astronomies and Cultures*, 179–80

17 For a helpful commentary on the parts of an astrolabe see the website of the Whipple Museum of the History of Science in Cambridge: www.whipplemuseum.cam.ac.uk/explore-whipple-collections/astronomy/medieval-astrolabe/parts-astrolabe.

18 A helpful, brief account of the development, construction, and uses of Islamicate astrolabes by Emily Winterburn is at: https://muslimheritage.com/using-an-astrolabe/ (accessed May 10, 2024). For discussion of the study of the astrolabe in medieval England see Falk, *The Light Ages*. The same author's website offers very helpful blog posts and videos on medieval astronomy and technology: www.sebfalk.com/blog.

19 An extremely useful edition and translation of the most important thirteenth-century Latin compilation on the astrolabe has been published online by Ron Thomson at: https://shareok.org/handle/11244/14221.2 (accessed May 10, 2024).

The tool which made it possible both to identify visible planets and to calculate the positions of planets not currently visible, was a set of planetary tables. These covered all seven planets, as well as the nodes of the moon (the points at which the observed path of the moon crossed the ecliptic). The latter move through the zodiac and were often treated as if they were planets. The tables were based on the work of Claudius Ptolemy, drawn up ca. 150 CE, as part of his great astronomical work, the *Mathematical Compilation* or *Almagest.* Ptolemy's tables were updated and revised by Islamicate astronomers and mathematicians, drawing upon Hindu and Persian sources as well as the work of many prominent Arabic astronomers. This meant that the tables first translated into Latin, especially those produced for use in al-Andalus, were based on much more recent observations, and on latitudes closer to locations such as Paris or London. However, they still presented many challenges to new users, and it is a tribute to their perceived value that so many scholars worked so hard to overcome these difficulties.[20] Not the least of the problems was that the differing models and assumptions underlying varying early versions of the tables could produce results at odds with one another.[21]

A particular problem was that an early Latin translation, popularized especially in England, was of the *Zīj* of al-Khwārizmī (d. ca. 850), as updated for Cordoba in the late tenth century by Maslama al-Majrīṭī (d. ca. 1007). These were the tables used by Adelard of Bath, who brought his Latin version to England.[22] The original tables had used the Persian year (of 365 days) and the era of Yazdegird III, but Maslama revised them for the Arabic lunar calendar and the Hijra era. Some tables were also recalculated for the meridian of Cordoba, although the introductory instructions in the Latin version continued to use the mysterious city of Arim as "the central place of the earth" and to explain that "the corrections for the planets and [the reckoning] of time are made with reference" to it.[23] Less likely to cause confusion were the more up to date *Toledan Tables*. These were put together in about 1080 and for the meridian of Toledo, as the name suggests. The leading astronomer on the project was al-Zarqālī, known in Latin as Azarquiel (d. ca. 1100), usually named as the author of the tables in the Latin versions. These tables drew on the earlier works, as well as providing new figures for some planets, including the sun.[24] A scholar equipped with tables like these, and with the mathematical ability to adapt them for a specific location and date, could draw up horoscopes for individual clients, for communities, or for the benefit of those ruling medieval states and kingdoms. Inevitably this would mean that it was much more

20 For full presentation and discussion see *Computational Astronomy*, ed. Chabas.

21 A helpful outline is given by Chabás and Goldstein, "Computing Planetary Positions."

22 See Burnett, ed., *Adelard of Bath*.

23 For the tables see *The Astronomical Tables of al-Khwarizmi*, ed. Neugebauer. For brief details of al-Majriti see Vernet and Samsó, "The Development of Arabic Science in Andalusia." See also Mercier, "Astronomical Tables in the Twelfth Century."

24 More than two hundred copies of the Latin versions of the Tables of Toledo are cited in *The Toledan Tables*, ed. Pedersen. This supersedes the work of Toomer, "A Survey of the Toledan Tables"; but Toomer's discussion of the variations in the tables included in the hundred manuscripts he used remains helpful.

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possible for precisely the type of astrological enquiry which the Church Fathers had condemned to be undertaken, alongside enquiries concerning "natural" phenomena such as weather. That being the case, it is hardly surprising that the great scholastic theologians of the thirteenth century showed a revived concern with the examination, definition and judgement of the varying types of astrology which were once again possible. Once again, their debates reveal much about what was perceived as "natural" in the case of astrology.

Many such judgements were apparently passed on the basis of theory, without the theologian engaging directly in astrological practice. However, there were some exceptions to this rule, with one such being the scholarly bishop of Lincoln, Robert Grosseteste (ca. 1170–1253). In his early treatise *On the Liberal Arts* (ca. 1200) Grosseteste already referred with confidence to technical terminology from the "modern" study of the stars. Indeed, he here asserted that astronomical/astrological knowledge was fundamental not only to proper understanding of natural philosophy but also to successful work in areas such as farming, medical healing, and the transmutation of metals. He even states that "lower nature does not act except when celestial power moves it"[25] and goes on to explain that the moon plays a crucial role in mediating and transmitting the influences of the other planets as they pass through its sphere on the way down to Earth. The first part of this may sound surprising but is in fact in line with the views of both St. Augustine and Thomas Aquinas. In Part One of his *Summa theologica* (completed by 1269) Aquinas deals with the powers of the stars over earthly things (in Question 115) and quotes Augustine to confirm that: "Bodies of a grosser and inferior nature are ruled in a certain fashion by those of a more subtle and powerful nature."[26] Planetary influences are thus placed safely within the natural workings of the created universe.

In the same passage Grosseteste also shows understanding of technical matters, such as whether a planet is at mid-heaven, and whether it is in "aspect" with other planets (in other words whether its position in the zodiac is separated from those of other planets by a significant number of degrees). It will be clear that judgement on such questions required knowledge of specific planetary positions. Grosseteste says that a positive aspect between the waxing moon and a fortunate planet, such as Jupiter, could have very beneficial results for crops planted at that time; but an aspect with the cold, destructive force of Saturn would damage the plants, as would an aspect with the burning heat of Mars.[27] Moreover, even in his condemnation of judicial astrology, Grosseteste does not hesitate to show his technical expertise. He asserts that the claims of judicial astrologers depend upon their ability to calculate not only planetary positions and aspects but also celestial houses, ascendancies, and much more, to a level which is in fact impossible.

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25 Grosseteste, *De artibus liberalibus*, chap. 11. See *The Scientific Works of Robert Grosseteste*, vol. 1, *Knowing and Speaking*, ed. Gaspar, 88–89.

26 Thomas Aquinas, *Summa theologica*, 1a q.115. The relevant passages are available at: www.newadvent.org/summa/1115.htm (accessed May 10, 2024).

27 *De artibus liberalibus*, 88–91

This criticism was made in Grosseteste's *Hexaemeron*, or commentary on the creation, which is one of his later works; however, even here, he notes the positive comments of the Fathers concerning the planets as signs of coming weather.[28]

Grosseteste's criticisms could not have been made without knowledge of astrological textbooks, such as the widely-known *Introductorium in astronomiam* of Abu Maʿshar (written before 900 and twice translated into Latin before 1150). The use of "astronomy" in the most frequent Latin title for this work is significant for demonstrating continuing looseness in terminology, despite the increased attention being given to superstitious applications.[29] A leading figure in this critical attention was Aquinas, whose views on the powers of higher bodies were mentioned above. After a long exposition of the categories of effects and events of which the stars cannot be the cause, and which they also cannot predict, he then specifies: "On the other hand if one were to apply the observation of the stars in order to foreknow those future things that are caused by heavenly bodies, for instance, drought or rain and so forth, it will be neither an unlawful nor a superstitious divination."[30]

Grosseteste's details concerning practical problems suggest more personal study of the science of the stars than that of Aquinas. It is significant that his example is taken not from judicial astrology but from what Isidore called "natural" astrology—which was coming to be known as "mundane" or world astrology. He outlines the problems of drawing up a chart for the "revolution of the year" (in other words, the moment of the Sun's entry into the sign of Aries, closely related to the timing of the vernal equinox), something which was central to making predictions concerning the forces acting upon weather, agriculture, and human health in the relevant year. As the discussion above shows this was not viewed as divination or superstition; however, Grosseteste asserts, astronomers could not "exactly identify this revolution of the year for a given location." Islamicate astronomers had in fact found ways to deal with the problem; but personal experience informs Grosseteste's reference to "those who have laboured hard with astronomical calculations and tables." Thus, while such applications of astrology were not superstitious, practitioners were guilty of fraudulent claims.

These distinctions were very clear in theory. However, in intellectual centres such as universities there was an ever-growing body of work involving applications of the science of the stars, such that it was very difficult in practice to keep track of it all. This made it necessary to commission the critical survey and catalogue of works in the field,

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28 Grosseteste, *Hexaemeron*, eds. Dales and Gieben, especially Part Five, chaps. 7, 8 and 9. For translation of relevant passages see *Robert Grosseteste: On the Six Days of Creation*, trans. Martin, 164–68.

29 For discussion of the reception and importance of Abu Maʿshar's work see Lemay, *Abu Maʿshar and Latin Aristotelianism*. It is worth noting that Adelard of Bath had translated a shorter version, giving only the "practical instructions" in this work rather earlier, in the 1120s. See Abu Maʿshar, *The Abbreviation of the Introduction to Astrology*, ed. and trans. Burnett et al.

30 Thomas Aquinas, *Summa theologica*, 2a2ae q.95, art. 5: www.newadvent.org/summa/3095.htm#article5 (accessed May 10, 2024).

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known as the *Speculum astronomiae* and attributed to Albertus Magnus.[31] This work lists and discusses an impressive range of titles, drawing on older booklists in the process. Overall, it provides a survey of the state of knowledge concerning all branches of the science of the stars by the 1260s, together with clear statements that many necromantic works were being concealed under that heading.

Helpfully, Chapter One confirms that the Latin term *astronomia* covered two different areas of study. The first, which dealt with the structure of the cosmos and the regular movements of the heavenly bodies, corresponded to the modern definition of astronomy and was defined as "a great wisdom." Both planetary tables and astrolabes are included here. More complex is the "science of the judgements of the stars" which is subdivided into valuable and detestable parts. The former is defined as knowledge of the ways in which changes in the heavenly bodies bring about changes in material things on Earth. It is acknowledged that this was acquired from other languages, but that does not detract from its importance. Chapters Four and Five of the *Speculum astronomiae* provide a short textbook on the basics of this valuable science, including the zodiac signs, houses, planets, and technical terminology. Works by Ptolemy of Alexandria, Albumasar (Abu Maʿshar), and numerous others are commended. This leads into a summary of how to interpret the "revolutions" of the planets, all of it dependent on being able to make the sorts of calculations discussed by Grosseteste. The problem of establishing the exact time of the Sun's entry into Aries, and its correlation with the equinox, is sidestepped. What is discussed instead is the astrological "new year," defined as the planetary positions at the new or full Moon immediately preceding the Aries entry.[32]

As noted above, this was crucial for forewarning of impending events in relation to things such as floods, storms, droughts, earthquakes, disasters, crops, and animal herds. All these would affect food supply, food prices, and human health, and were thus of great economic and political significance. As Chapter Seven of the *Speculum astronomiae* states: "this information shows what God, who is glorious and sublime, will bring about in a given year, through the applications of the stars, on the rich men of some climes and on the whole of their populations, concerning the price of grain, whether there is war or peace, earthquake and floods, falling stars and terrible prodigies, and other such things." On a more detailed level, a survey is also provided as to how the movements of the planets affect the atmosphere surrounding the Earth and thus bring about changes in the weather. This is the core of what came to be known as astro-meteorology, and shows that it was always closely related to the making of judgements concerning the impacts of weather as well as forecasts of the weather itself. Detailed knowledge of the techniques involved is shown here, together with an impressive list of works on the subject, demonstrating the level of importance attributed to this field of knowledge. Terminology taken from Latin translations of Arabic texts is used, including both the lunar mansions and the concept of "gates of the moon" which determined whether and when rain would fall.

31 For discussion of the authorship and importance of this work see Giralt's chapter above. For full discussion and translation see *The* Speculum astronomiae *and Its Enigma*, trans. Zambelli.

32 *The* Speculum astronomiae *and Its Enigma*, trans. Zambelli, 208–31.

A reading list of five key works is provided, starting with the relevant parts of Ptolemy's *Quadripartitus* (Work in Four Parts) and proceeding through both direct translations of Arabic texts and what were claimed as new compositions by Latin authors.

Subsequent parts of the *Speculum astronomiae* turn to the much more problematic branches of the science of the stars, and deal not only with genethliacal and judicial astrology but also with texts instructing on the making and uses of images and talismans. These sought to draw on the powers not only of stars and planets but also of "spirits" associated with them. The proliferation of such necromantic and divinatory texts, and their adoption of misleadingly reassuring titles, were significant parts of what led to the survey and report underlying the *Speculum*.

How then were astro-meteorological forecasts—or prognostications, to use the medieval term—made? The basics were set out in Ptolemy's *Quadripartitum*. This established the various natures and powers of the planets, their inter-relationships with one another and with the climatic zones of the Earth, and then the role of such technicalities as Houses and Exaltations. These latter are important because of their perceived effect on the inter-relationships, and the degrees of power, of the planets. For instance, if two planets with differing powers are placed opposite one another in the zodiac then their effects might simply cancel one another out. However, if one planet is placed in a sign or house which enhances its power—or, obviously, which weakens it—then the outcome will be significantly affected. If a planet was "retrograde" that should also be taken into consideration, as should whether it was moving closer to another, slower-moving planet.

The idea of the "New Moon of the year," and its significance for choosing the date for which to draw up a detailed chart or horoscope in order to make a prediction, is explained in Book Two.[33] Chapter 11 of this book lists the general weather conditions associated with each sign of the zodiac, and the subdivisions of each sign, while Chapter 12 is titled "The Investigation of the Weather in Detail." Longer-term forecasts are to be made by taking the date of a new Moon and drawing up a chart for a specific location (using Ptolemy's planetary tables). Monthly, weekly and even daily forecasts can be produced by bringing increasingly technical details into the interpretation of the chart, including the risings and setting of powerful stars and their positions in relation to the Sun.

The wide-ranging, updated textbooks on the science of the stars, written in the ninth and tenth centuries by Islamicate scholars, included techniques based on Ptolemy's work—but also added new concepts and procedures. These drew on developments in both astronomical observation and mathematics, which made it possible to update Ptolemy's planetary tables and to produce a new response to the problem of the precession of the equinoxes. However, the philosopher who achieved the earliest recognition in the Latin world specifically for his expertise in weather forecasting was al-Kindi. This great,

33 Unfortunately, there is no modern, critical edition and translation of a twelfth-century, Latin version of this work. Most are based on the Greek original or a later, abridged paraphrase known as the "Proclus Paraphrase." The thirteenth-century version of William of Moerbeke, based on a Greek text, is now: *Ptolemy's Tetrabiblos in the Translation of William of Moerbeke*, eds. Vuillemin-Diem and Steel.

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ninth-century expert on both natural philosophy and the science of the stars wrote a long work *On the Revolutions of the Years of the World* which was translated first into Hebrew and then (in 1278) into Latin. However, extracts and short treatises ("Letters") on the causes and forecasting of meteorological phenomena were sought out earlier and translated into Latin under the title *De mutatione temporum* (On Weather Changes).[34] This survives in thirty manuscript copies, which is a high total for such a technical work. Part of its attraction was probably that it did not deal with weather forecasting in isolation, but set it within an overview of the forces which cause atmospheric and meteorological changes, and those which cause heat, cold, dryness, and wetness. The fundamental driving force is stated to be the physical movements of the planets, since these generate energy and, especially, heat. This basic heating process is magnified by the power of the Sun, and modified by the changing position and force of the Sun in relation to the Earth. Actual weather, and its fluctuations in any given locality, are modulated by the interactions between the Sun and other planets, and between pairs and groups of those other planets, as they also move and interact. Someone equipped with the tools and basics provided by Ptolemy should now be able to produce a forecast for any chosen date and place, without any need to call upon spirits or intelligences.

However, al-Kindi goes further than this and identifies specific planetary positions and groupings as especially significant. Practical help for the making of prognostications is given by tables, setting out planetary combinations and assigning values for the level of heat each will generate. Again, pride of place is given to the Sun. As in Ptolemy, the Moon is identified as playing the next important role in determining the weather, due to its power over the elements of both earth and water. Twelve key points in the Moon's circuit of the Earth are identified, and at each the relationship between the Moon and the Sun must be examined in detail. The significance of this is that it will make possible a forecast of coming winds, since cooler air will contract and hotter air will then expand into those zones, both causing winds of varying strengths and determining their directions. For a full weather forecast the positions of all the planets must be established, so that their groupings can be identified. The final stage is the calculation of the relative strengths of these groupings. For this, the astrometeorologist must also chart the aspects between each planet and each grouping, and apply expert judgement to interpret their overall outcomes. This will include attention to the effect on each planet of the qualities of the zodiac sign in which it is placed at the time in question.

That may sound time-consuming but in fact a full forecast needed to take still further factors into account. Of these, perhaps most important was whether a planet was moving around the zodiac in the "normal" direction or was moving in reverse (retrograde). However, the lunar mansions—which have already been mentioned—should also be considered, since these sections of the zodiac could also affect the qualities and strength of planets occupying them. Like the zodiac signs, the lunar mansions were based on stellar groupings. In this case, twenty-eight major stars or star-groups were

34 See Bos and Burnett, *Scientific Weather Forecasting*; and Burnett, "Weather Forecasting in the Arabic World."

fundamental; and their identifications and evaluations were accepted as having been made by Indian astrologers. Each mansion had a name and a set of qualities; and, at least for purposes of weather-forecasting, they were increasingly significant.[35] What was particularly useful was that they established four key times each month when the Moon's position would be especially influential in relation to the weather. This removed the need for frequent forecasts, since the forecast for each key time would hold until the next. However, some activities were so time-sensitive that daily forecasts were still required. Since the time needed for this was considerable, and the supply of astrometeorologists able to make such forecasts was limited, it follows that these were available only to the rich and powerful.

That fact, together with concerns about the practical difficulties of full-blown astrometeorology, may underlie the ongoing production of new treatises offering "improved" ways of making forecasts. Several of these, issued under the names of highly-regarded experts in the science of the stars, set out the favoured method and tips of the expert in question. One such was Guido Bonatti, who enjoyed a very successful career in Italy, working for Guido da Montefeltro (1223–1298), ruler of Urbino, amongst others. Bonatti wrote an encyclopaedic survey of astrology, which is notable for its practical approach and its lasting popularity.[36] This had six main parts, one of which was entirely devoted to the subject of astrometeorology. An edited version of Bonatti's work, with expensive illustrations, was presented to King Henry VII of England and is now in the British Library as MS Arundel 66.[37] The section on weather forecasting is here headed "On Deluges and Airs" (*De ymbribus et aeris*) and begins on folio 243v.[38] Bonatti provides both information on the wet and dry mansions of the Moon and a table of all the mansions, as well as guidance on when Saturn is likely to be powerful enough to prevent rain. This practicality is taken further in the reduction of technical details and the provision of brief guides on likely outcomes when the Moon is in specified aspects with each of the other planets. Whether the king would have made personal use of these materials is unknown; but scholars or physicians in attendance on his court would have been able to do so, and without causing anxiety about illicit divination.

However, one thirteenth-century treatise took a more radical approach. This is an anonymous text, widely believed in the medieval period to be the work of Grosseteste, entitled *De impressionibus aeris* (On Atmospheric Impressions).[39] It sets out a highly

35 For discussion see Burnett, "Weather Forecasting, Lunar Mansions and a Disputed Attribution."

36 The text was edited by Johannes Angelus and printed in Augsburg, 1491, by Erhard Ratdolt; also in Venice by Penzio, 1506; and in Basel, 1550, by Jakob Kundig. The Ratdolt edition is accessible from the website of the Bayerische Staatsbibliothek: https://bildsuche.digitale-sammlungen.de/index.html?c=viewer&bandnummer=bsb00025600; for the Basel version see http://hardenberg.jalb.de/display_page.php?elementId=5363 (both accessed May 10, 2024).

37 On this manuscript see Fronska, "The Royal Image and Diplomacy."

38 The manuscript has been digitized and can be seen here: www.bl.uk/manuscripts/FullDisplay.aspx?ref=Arundel_MS_66 (currently not available).

39 For the text see *Die philosophischen Werke des Robert Grosseteste*, ed. Baur. Extracts are given in English translation in Dales, *The Scientific Achievement of the Middle Ages*, 65–67.

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simplified method for making an astro-meteorological weather forecast and then argues that such work is a duty for good Christians since it will enable provisions to be made against coming disasters and famines. This reads like a textbook for those who have no wish to become fully trained astrologers but do accept the need to be able to make prognostications of the weather. It survives in seventeen manuscripts, so was clearly less popular than Bonatti's work, but is interesting for its demonstration of the social and practical value attributed to astrometeorology. The procedure involves the drawing of a circular diagram, comprising eight concentric circles, divided into thirty-degree segments. Each planet is then entered into the correct sign for the chosen day, using tables not provided, and the power of each in the relevant sign can be found in the text. The technical issue of aspects is much easier to handle, since the circular diagram makes them directly visible. This method effectively reduces the judgement of the interactions between planets to a matter of simple arithmetic, and makes it possible to produce a weather forecast very quickly. No interest is shown in theory, and an even more pedagogical note is struck by the "worked example" of a forecast for April 15, 1249, with an illustrative diagram. It is also noted that the forecast was correct. This leads into the forecast that July 1249 would be unusually hot and dry and that provision must be made against this, and also against the famine likely to result from the long stay of Saturn in the sign of Capricorn, which would begin in 1255 and last for five years. Both estate managers and those with a duty to provide charity for the starving would be interested in such guidance.

This analysis has strongly suggested that by the end of the thirteenth century the distinction between "mundane" astrology and judicial or genethliacal astrology was both clear and long-established. The value placed upon the benefits provided by the first is demonstrated by a compelling quantity of evidence. What had been a new science of the stars had gained a place in natural philosophical studies as well as in medicine; but its value was not purely academic, as the careers of famous figures like Guido Bonatti and Michael Scot demonstrate. Of course, the very fact that Bonatti and Scot were credited with providing secret advice to their patrons, Guido da Montefeltro and the Emperor Frederick II, meant that they were suspected of indulging in the forbidden forms of astrology as well as the "natural" ones. However, there was no condemnation of all types of astrology. Indeed, knowledge of the regular movements of the celestial bodies, with at least basic understanding of how these related to such things as seasonal patterns of weather, daylight and tides, became more widely available.

At the level of university study this was provided by textbooks such as *De sphaera mundi* (On the Sphere) by John of Sacrobosco (written ca. 1230). Moreover, something almost akin to a space race was under way by the fourteenth century, in the form of the appearance of publicly-displayed astronomical clocks. Basic clock-making had been a recognized trade, at least in Cologne, since the late twelfth century, and trade was good enough for that city to have a street of clockmakers by 1220. In 1232 the Emperor Frederick II received from the Sultan of Damascus a much more advanced, astronomical clock. This had "images" of the Sun and Moon which moved mechanically around models of their courses and thus "infallibly" indicated the hours of both day and night. Its value was estimated at the impressive figure of more than 20,000 marks, but the chronicler

sounds still more impressed by its scientific accuracy.[40] The clock designed by Richard of Wallingford for his abbey of St. Albans is impressively described in his treatise *Tractatus Horologii Astronomici* (On the Astronomical Clock, 1327) was one of the earliest recorded. This clock does not survive but at least parts of others which were completed before the end of the fourteenth century remain in Wells, Rouen, and Bad Doberan.[41] Equally impressive was the development of *equatoria* which provided schematic, working models of celestial orbits and positions. These were made up of discs bearing graduated scales, which simulated the movements of the planets.[42]

Nevertheless, the science of the stars remained a challenging field of study, as the appearance of new "teaching aids" in the fourteenth century demonstrates. A leading figure in this pursuit was John of Saxony, who was trained in Paris in the 1320s. By 1327 he had composed a new set of "canons" or instructions for using the Alfonsine Tables, which was rapidly followed by a textbook designed to introduce Latin readers to the basic concepts and procedures of mundane astrology.[43] In a later work he moved on to produce a detailed guide to the Tables, even providing worked examples for Paris in 1355. He also drew up an *Almanach scilicet temporale* (effectively a set of lists of ready-calculated planetary positions) for 1336 to 1380, for the meridian of Paris. This innovation heralded the production of more such ready-calculated tables, often combined with medical and health advice, for wealthy patrons.

The increasing integration of astrology into medical theory and practice, like its use for weather prediction, did not end hostility on the part of theologians towards judicial and genethliacal astrology. Accordingly, experts went out of their way to support mundane astrology. John of Eschenden, writing in Oxford in the 1340s, wrote a *Summa iudicialis de accidentibus mundi* (Summa on Mundane Astrology)[44] which rebutted criticisms. He and his work achieved a very positive reputation after the disaster of the Black Death, since he successfully claimed to have predicted that catastrophe as early as 1345, on the basis of eclipses and planetary conjunctions. Evidence that Eschenden's skills were valued is provided by commissions for him to draw up astro-meteorological forecasts.[45] One of these covering the years 1368 to 1374, opens with five charts for major planetary conjunctions in 1365. These conjunctions laid down the prevailing conditions

40 Part 7 (*continuatio IV*) of *Chronica regia Coloniensis*, ed. Waitz, 263 (www.dmgh.de/mgh_ss_rer_germ_18/index.htm#page/263/mode/1up, accessed May 10, 2024).

41 See Falk, *The Light Ages*; on Richard of Wallingford's achievements see North, *God's Clockmaker*.

42 For an overview see North, "The Quadrivium." For discussion of the equatorium see Falk, *The Light Ages*, chap. 7; and "Vernacular Craft and Science."

43 Translations of extracts from John's "Rules" or canons, with extracts from his "edition" of the Tables, are provided in *A Source Book in Medieval Science*, ed. Edward Grant (Cambridge, MA: Harvard University Press, 1974), 465–88.

44 John's name appears in different forms. Thorndike, who has given the fullest account of John's works in *A History of Magic*, 3:325–46, uses Eschenden. John North prefers the form Ashenden; see for instance "Astrology and the Fortunes of Churches," in his *Stars, Mind and Fate: Essays in Ancient and Mediaeval Cosmology* (London: Hambledon, 1989).

45 These are found in Oxford, Bodleian Library, MSS Ashmole 192 and 393.

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for the forecast, while two in 1369 would further affect the years from 1370. On these bases Eschenden forecasts a prolonged period of disturbed weather, with floods likely up to 1370 and droughts in the last three years.

Such forecasts were clearly immensely valuable if correct but always open to error. This may well be the driving force behind a clear trend in the fourteenth and fifteenth centuries towards improving their accuracy. Interest in checking forecasts against actual weather is demonstrated in surviving manuscripts from Oxford, Wurzburg, and (probably) Basel. The earliest example is found in Bodleian Library, MS Digby 176, where weather is recorded from January 1337 to January 1344 in *Consideraciones temperiei pro 7 annis Christi* ("Notes on Weather for 7 Years").[46] Their author, William Merle, has been identified as rector of Driby, Lincolnshire, but had repeated licences to live and study in Oxford. His notes on weather relate both to Oxford and Lincolnshire and accompany both work on natural "signs" of coming weather and study of astrometeorology. The records from Wurzburg and Basel are slightly different in approach, since they are embedded into textbooks on mundane astrology and on astro-meteorology in particular. Both seem to record past weather as evidence that astro-meteorological techniques would have been able to predict it.[47] A curious fact is that no instructions for making astro-meteorological predictions are found in treatises and collections concerning agriculture and estate management. These contain only simple guides to the positions and interactions of the Sun and Moon, together with short prognostic texts, at most. The implication of this is that full forecasts continued to be the preserve of the highly trained expert.

That conclusion is further supported by the instant popularity of the annual forecasts of weather, economic conditions, and largescale disasters (including war) when they began to be part of the duties of university-based professors of astronomy and astrology in the fifteenth century. Competition for such experts, and their predictions, is shown by the frequency with which they moved from one centre to another and the speed with which their prognostications were rushed into print. Charles V had sponsored a chair in Paris in 1379, and this was quickly followed by others. John of Gmunden, who died in 1442, was the first professor of astronomy at Vienna, and he was succeeded by Georg Peurbach, who was also employed by Ladislaus V of Hungary and the Emperor Frederick III. Experts were in place at the universities of Bologna, Padua, Louvain, Krakow, Ingolstadt, Leipzig, Wittenberg, and Salamanca (to name only those with surviving records) during the fifteenth century.

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46 For facsimiles of the weather records, with accompanying translation, see William Merle, *Merle's MS.*, ed. Symons. Brief details on Merle's career, with notes on his meteorological terminology, are given in the *Dictionary of Medieval Latin from British Sources* at: www.dmlbs.ox.ac.uk/web/william-merle-consideraciones-temperiei.html (accessed May 10, 2024).

47 The Wurzburg record is now Nuremberg, Stadtbibliothek, MS Cent V 64, part 1. It is discussed in Thorndike, *A History of Magic*, 3:143–46. The Basel manuscript is Basel, Universitätsbibliothek, MS F. III. 8. A digital facsimile is available at: www.e-codices.unifr.ch/en/list/one/ubb/F-III-0008 (accessed May 10, 2024). For discussion see Thorndike: "A Weather Record for 1399–1406" and "A Daily Weather Record from the Years 1399 to 1401." The later article is followed by a "Climatological Analysis" by Frederick, Landsberg and Lenke.

The career of Joannes Vesalius illustrates the demand for these predictions and forecasts. This Vesalius studied at Cologne and Pavia before coming to the new University of Louvain/Leuven in 1429. By 1455 he was one of the most important physicians in Brussels and was also being consulted and paid by Duke Philip the Good of Burgundy. Already in 1430 the council of Louvain commissioned from him an almanac (or set of planetary calculations) and accompanying prognostication for 1431. This was presumably successful, since others are recorded for 1439 and 1440, and he was commissioned to produce later almanacs for the duke. When Jan van Westfalen, Leuven's first printer, arrived in the 1470s he began almost immediately to publish annual prognostications of this type, thus making them more widely available. The production of such forecasts was speeded up by the growing availability of ready-calculated *Calendars* or *Almanacs* showing full sets of planetary positions, and eclipses, for periods of several years. Most celebrated of all such works was that of Johann Müller, better known as Regiomontanus, whose work was printed by Ratdolt, the publisher of many astronomical and astrological works. Indeed, Ratdolt's first publication in Venice was Regiomontanus' *Calendar*, issued in 1476, and followed in 1481 by the *Ephemerides*.[48] Both were reissued many times, and in rival editions. Publications of printed prognostications, with accompanying tables of varying complexity, spread across Europe alongside printing workshops themselves. Demand was such that they were a main source of income for printers, and became the basis of a lucrative monopoly for the Crown and the Company of Stationers in seventeenth-century England, despite ongoing literary satires.

Strikingly, support for astro-meteorology survived both the new discoveries of astronomers in the sixteenth and seventeenth centuries and the rising persecution of witches and practitioners of magic. Astro-meteorology was practised and strongly supported by Tycho Brahe (1546–1601) and Johannes Kepler (1571–1630) amongst others.[49] Moreover, sales of almanacs remained respectable until the end of the eighteenth century.[50] Astro-meteorology both gave rise to and was finally subsumed into the increasing trend of keeping weather diaries and delivering reports to the learned societies which sprang up across Europe. This was very different from the fate of horoscopic astrology and emphasises the complex yet fundamental differences between different branches of the medieval "science of the stars."

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48 A digital copy of Ratdolt's version of Regiomontanus' *Ephemerides* 1484–1506 is hosted online by the Europeana website. The work belongs to the University of Vienna. A rival edition, also produced in Venice, but in 1498, can be viewed via the Gallica website at: https://gallica.bnf.fr/view3if/ga/ark:/12148/bpt6k596433 (accessed May 10, 2024).

49 On Brahe see Adam Mosley, "Tycho Brahe and Weather Prediction," (Cambridge: Department of History and Philosophy of Science, University of Cambridge, 1999), at: www.sites.hps.cam.ac.uk/starry/tychoweather.html (accessed May 10, 2024). For Kepler's *Ephemerides* see vol. 11, pt. 1 of *Johannes Kepler Gesammelte Werke*.

50 See Kassell, "Almanacs and Prognostications"; and Capp, "The Potter Almanacs." The classic work on the subject remains Capp's *English Almanacs*. The most recent survey is that of Kusukawa, "Incunables and Sixteenth-Century Books."

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