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THE ASTRONOMY OF ISIDORE OF SEVILLE: TRANSFORMING AN AREA OF KNOWLEDGE FROM LATE ANTIQUITY INTO THE EARLY CHRISTIAN MIDDLE AGES

Zongbei Huang
Department of the History of Science, Tsinghua University, Beijing 100084, China.
E-mail: huangzb22@mails.tsinghua.edu.cn

Abstract: This paper surveys the presentation of astronomical knowledge in two encyclopedic writings of Isidore of Seville, *Etymologies* and *On the Nature of Things*, as a transformative episode in the history of early medieval astronomy. In the section *De Astronomia* in *Etymologies*, Book III, Isidore provides a (re)formulation of the field of astronomy as follows: (1) he narrows and defines its scope under a Christian framework, demarcating it from astrology labelled 'superstitious' from the view of faith; and (2) he applies a characteristic etymological approach instead of mathematical calculations and geometrical models, changing the study of astronomy from an investigative enterprise into a text-based, hermeneutic learning. Sometimes this is at the expense of mathematical knowledge left available to him by earlier Latin authors. In the treatment of the seven planets in *On the Nature of Things*, Isidore more evidently imposes Christian themes on the basis of an Aristotelian–Ptolemaic cosmology, declaring the authority of scriptural assertions over 'pagan' natural philosophy on the structure of the heavens, and demonstrating the orderliness of the world as divine creation by a schema of concentric spheres. Through the works of Isidore, what took place was not simply the loss and decline of Greek and Hellenistic astronomy, but rather a conscious and methodological transformation of this area of knowledge, which was to become typical for medieval Latin encyclopedias, subsuming late Antique legacies of learning under the newly formed Christian world-picture and social realities.

Keywords: Isidore of Seville, *Etymologies* (Book III), *On the Nature of Things*, early medieval astronomy

1 INTRODUCTION

In the history of Western astronomy, the period from Late Antiquity to the Early Middle Ages is traditionally dismissed as of little significance, or more negatively, as a period of decline and degeneration. Historical accounts of either Latin medieval mathematical astronomy or cosmology tend to genuinely begin from the twelfth to the thirteenth centuries onwards (cf. Grant, 1996; Juste, et al., 2020; Mahoney, 1988), when Greco–Arabic materials were translated into Latin and re-introduced into the horizon of European thinking, reviving a once-lost Ptolemaic tradition at long last. Before that, in the Latin encyclopedic compilations, didactic handbooks, as well as literary and philosophical works and their commentaries, one could only find very meager and often faulty astronomical contents, which could at best be characterized as the poor heritage of a high science in the Classical and Hellenistic eras (cf. Pederson, 1978: 305–307).

This paper wishes to reveal a more sophisticated picture underneath such conventional historiography by examining a key figure at the beginning of the Early Middle Ages, Isidore of Seville (c.560–636, Figure 1). In his two well-known encyclopedic works, *On the Nature of Things* (*De natura rerum*, composed 612–614) and *Etymologies* (left nearly finished by 636), Isidore wrote, albeit modestly, about astronomical, cosmological, and calendrical topics,[1] which served as the basis and framework for these areas of knowledge throughout the following centuries. It was only in Carolingian times that the works of Pliny the Elder, Macrobius, Martianus Capella, and Cassiodorus were rediscovered, excerpted, and copied for their astronomical contents, providing more technical details to complement the works of Isidore (Eastwood, 2007). Nevertheless, Isidore continued to be regarded as an authority to consult in astronomy, *computus*, and natural knowledge

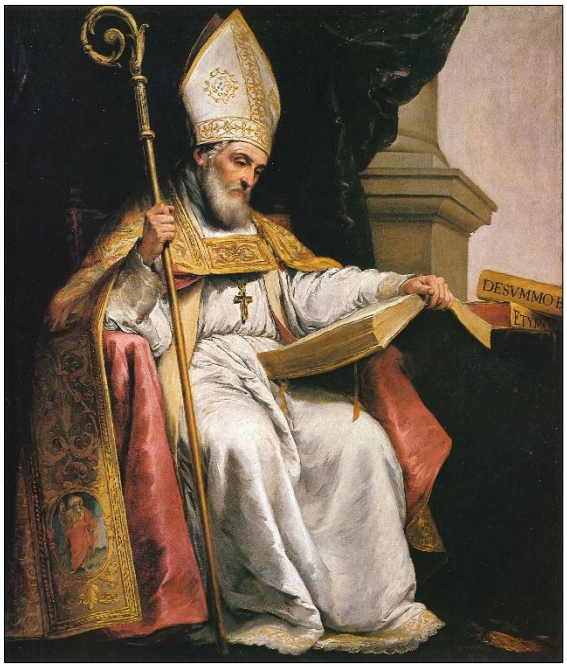

Figure 1: Portrayal of Isidore of Seville, by Spanish painter Bartolomé Esteban Murillo, seventeenth century (Wikimedia Commons, public domain).

in general, and newly produced compendia still inherited their frameworks to a large extent from Isidorian works (Obrist, 2020: 229; Wallis, 2020: 183–184; Warntjes, 2020). It is thus noteworthy to examine how Isidore introduced, defined, and laid foundations for the field of astronomy for subsequent medieval Europeans, shaping simultaneously what questions they could ask regarding the heavens and what paths they could take in finding answers. Existing literature has long noted the importance of Isidore in early medieval astronomy (Eastwood, 1993: 174–177; McCluskey, 1998: 123–127). But detailed studies are still insufficient on the astronomical and cosmological contents in his writings, with a dual view from the transitioning contexts between Late Antiquity and the Early Middle Ages, and from the line of development of early medieval astronomy (for an early analysis in French, see Fontaine, 1959: 453–589; the treatment in Ribémont, 2001: 100–107 is very brief, discussing astronomy only in the context of the order of *quadrivium*).

Focusing on the sections concerning astronomy and cosmology in the *Etymologies* (III.24–71) and *On the Nature of Things* (9–27), this paper will analyze how Isidore, in his self-conscious didactic and systematic encyclopedic writings, dealt with the definition, scope, objects, and approaches of the study of astronomy, as well as the cosmological picture he intended to convey to his readers. While following these core texts, the analysis will also include important considerations of how Isidore made use of astronomical knowledge preserved in late Antique Latin writings, selected, recombined, and transformed them in a new manner. Section 2 of this paper provides the background to Isidore's work by briefly reviewing the materials on astronomy in late Antique Latin writings, which reflects to what extent the achievements of Hellenistic astronomy were still known and accessible to the Latin-speaking world. Isidore was not starting from a blank sheet: previous Latin authors provided him with both the sources and models of writing, forming complex textual traditions of high intertextuality. Section 3 examines Isidore's account of astronomy in *Etymologies*, Book III, showing his peculiar delineations of its scope and his etymological approach, in which the elaboration of terms and meanings replaced explanation by geometrical hypotheses as the main body of knowledge in astronomical learning. Section 4 turns to the planetary order depicted in *On the Nature of Things*, revealing that even what looks like a poor planetary theory in Isidore is not aimed at (and thus, should not be judged for) astronomical or cosmological accuracy, but is meant for demonstrating a Christianized world-picture of orderly arrangements and harmonic functioning.

2 ASTRONOMICAL AND COSMOLOGICAL KNOWLEDGE IN LATE ANTIQUE LATIN WRITINGS

In Late Antiquity, while commentaries on Ptolemy's *Almagest* and other related works were still being produced in Greek by authors like Theon and Pappus in fourth to fifth century Alexandria (Bardi, 2023; Jones, 1999), the Latin world had gradually become more and more removed from the Greek sciences and 'pagan' natural philosophies. Admittedly, one can hardly even speak of the transmission of Ptolemaic or Hellenistic astronomy in general into the Latin world during Late Antiquity or the Early Middle Ages, because there were no circulating translations, commentaries, epitomes, or compilations of any sort—or at least we have no such evidence (Eastwood, 2007: 10). Nevertheless, this situation does not imply that Latin authors had been completely ignorant of Ptolemy and his astronomical achievements, or that Latin works produced during this period had been deaf to astronomy. Works such as Hyginus' *Astronomy* (first century CE), Pliny the Elder's *Natural History* (77 CE), St. Ambrose's *Hexaemeron* (c.387 CE), Calcidius' *Commentary on Plato's Timaeus* (late fourth century CE), Macrobius's *Commentary on The Dream of Scipio* (early fifth century CE), and Martianus Capella's *The Marriage of Philology and Mercury* (c.439 CE), all touched on topics of astronomy and cosmology in varying degrees, and some of them even enjoyed fairly wide dissemination.

In contrast with what could be discerned as scientific, philosophical, and literary traditions in Greek astronomy (Evans, 1998: 17–22), Latin works involving astronomy and cosmology hardly fitted into such genre categorizations and had more complicated relationships between textual traditions as well as between individual texts. Just take a look at the list mentioned above: these works could be designated as encyclopedias, exegetical pedagogy, philosophical or literary commentaries, didactic or practical manuals, etc., with significant borrowings from one another. However, one common feature emerges from all these texts: astronomical and cosmological knowledge were scattered and embedded in non-technical treatises. There was no independent scientific tradition in Latin, no work specifically devoted to the mathematical or technical aspect of astronomy.[2] In writing about astronomy and cosmology, Platonism, Stoicism, Roman culture, or Christian creation narratives were all to be imposed on the world-picture in some way according to respective authors. Thus, 'astronomy' was not conceived as

an ongoing field of mathematical or observational investigations, but as a body of ready-made concepts, schemes and conclusions about the world. Broadly construed, Isidore belonged to this same mode of writing of astronomy as Latin authors before him.

A few early Christian authors like Boethius (c.480–524) and Cassiodorus (c.490–c.580) still exhibited some interest and knowledge in Hellenistic astronomy in their works, albeit with significant simplifications and sometimes mistaken attributions. Boethius was well versed in Greek learning and had begun an ambitious program of translating representative Greek works on the mathematical *quadrivium* into Latin (Eastwood, 2013: 310), which was unfortunately cut short by his sudden death. Preserved into the Latin Middle Ages were only his *De Arithmetica* and *De Musica*, but in a letter written by Cassiodorus to Boethius in his lifetime, the latter was praised for having produced translations of works on Euclidean geometry and Ptolemaic astronomy (*Variae*, 1.45.4, dated c.507, see Cassiodorus, 1992: 21); efforts made towards the learning of astronomy by the late fifth-century intellectual elite were thus still acknowledged (cf. McCluskey, 2012). We know more certainly that there existed a translation of the *Handy Tables* in Latin in this period, the *Preceptum Canonis Ptolomei*, dated about 534/535 CE (after Boethius' death). However, its earliest occurrence in a Latin manuscript was around the year 1000, and it probably did not find any use in medieval astronomy preceding that date (Juste, 2004: 181–182).

Under such historical and knowledge conditions, Cassiodorus composed the *Institutions of Divine and Secular Learning*, the first 'Christianized' Latin encyclopedia and important antecedent of Isidore. In Book II on secular learning, Cassiodorus followed the framework of the seven liberal arts (already canonized by Boethius) to introduce Greco–Roman learning, and mentioned Ptolemy and the *Preceptum* in this way:

> Men have written books in both languages [i.e. Greek and Latin] on the discipline of astronomy; among them Ptolemy is regarded as preeminent among the Greeks. He published two books on the subject, the one of which he called the *Lesser*, the other the *Greater Astronomy*. He also set up the canons in which the movements of the stars may be found. It seems to me not foolish to learn from these latitudes, perhaps, the length of hours, the course of the moon (to establish Easter), and how eclipses happen lest the simple should be disturbed by some confusion. (*Institutiones*, II.7.3; Cassiodorus, 1961: 155–156; translation quoted from Cassiodorus, 2004: 227).

Cassiodorus' knowledge of Ptolemaic astronomy revealed in this passage was fractured indeed: he erroneously attributed the authorship of *Little Astronomy* to Ptolemy (cf. Evans, 1998: 89–91), and knew only of the *Almagest* and the *Tables* as Ptolemy's contributions to astronomy. Judging from the way he listed these works only by name, as well as the outlines of astronomy he laid down in neighboring chapters (*Institutions* II.7.2–3), Cassiodorus probably had no further knowledge of the content of these works, only limited second-hand information on their existence and prominent place in this discipline. However, such mentions already suffice the aim of Cassiodorus' writing: it was precisely his point to list standard texts and ancient predecessors in secular learnings in history before Christianity and to salvage their values towards a re-oriented goal of understanding the divine (hence "… to learn the course of the moon …" would not be foolish).

Although attempts by earlier Latin authors like Boethius and Cassiodorus left only so much of a legacy on astronomy, their presentation of even this scanty material still anticipated that of Isidore, both in form and in content. In sixth-to-seventh-century Visigothic Spain where Isidore lived, against a general background of post-Roman loss of most of the original sources, there was, however, an effort initiated by Isidore and his fellow bishops to revive basic education of classical culture and literacy in fusion with Christian doctrine, to the extent that some modern scholars speak of a 'Isidorian Renaissance' and '*culture isidorienne*' (Barrett, 2020: 44–45; Fontaine, 1959: 831–888). The still-available Latin sources like Hyginus, Pliny, and Cassiodorus were to serve as Isidore's point of departure for his creative program, then, along with their intermediary, filtered depictions of the classical world of learning.

3 *DE ASTRONOMIA* IN *ETYMOLOGIES*, BOOK III: REDEFINING SCOPE AND APPROACH

Isidore dealt with astronomical, cosmological, and calendrical topics in three separate places in the *Etymologies* (hereafter *Etym*.): in Book III, Chapters 24–71 (*De Astronomia*), the third part of this book following mathematics and music, and coming after the first two books on *trivium*; in Book VI, devoted to the Scripture and ecclesiastical affairs, Chapter 17 briefly introducing the calculation of Easter and the Paschal cycle (which would develop into *computus* as a distinct medieval learning after Isidore); and finally

again in Book XIII, Chapters 1–6, reiterating on the structures of the heavens before proceeding to meteorology and terrestrial parts. For our purpose of analysis, the section of *De Astronomia* in Book III is the most relevant, being Isidore's full representation of the field of astronomy.

3.1 Introducing 'Astronomy' as a Field of Learning

From the arrangement of books and chapters, it seems obvious that Isidore placed astronomy as one of the mathematical *quadrivium* of the seven liberal arts (which he identified early in *Etym*. I.2), an institutional legacy of Roman education and already canonized by the previous Latin encyclopedic tradition. In defining what astronomy studies, Isidore also pointed to the figures (*figurae*) and relative positions (*habitudines*) of the stars, both of them proper categories in geometry:

> Astronomy [*astronomia*] is the law [*lex*, Greek *nomos*] of the stars [*astra*], which, by investigative reasoning, touches on the courses of the heavenly bodies [*sidera*], and their figures and positions of the stars [*stella*] relative to each other and to the earth. (*Etym*. III.24; Isidore, 2009: 84–85; translation modified from Isidore, 2006: 99)

However, subsequent chapters reveal that Isidore did not, in fact, follow the framework of the *quadrivium*, but rather devised on his own, as McCluskey (1998: 125) has indicated in passing in his brief treatment of Isidore. The first significant deviation appears when Isidore enunciated the distinction between *astronomia* and *astrologia*. These two terms were used mostly interchangeably to denote the study of the stars in Antiquity; or there was only the distinction of treating the same subject in the mathematical or physical way, but both were integral to the true philosophical knowledge of the heavens, as Ptolemy put it (Bardi, 2023: 7–8). Isidore was one of the first authors to articulate a clear distinction between them (cf. Hübner, 1989: 31–40), on which he wrote:

> There is some difference between astronomy and astrology. Astronomy concerns itself with the turning of the heavens, the rising, setting, and motion of the heavenly bodies, and where they get their names. But astrology is partly natural, and partly superstitious. It is the natural part, as long as it investigates the courses of the sun and the moon, or the standing-places of the [wandering] stars during certain times of the seasons. But it is the superstitious part which the astrologers [*mathematicus*] follow, when they practice augury by the stars, or when they associate the twelve signs of the zodiac one-to-one with parts of the soul or body, or when they attempt to predict the nativities and characters of people by the course of the heavenly bodies. (*Etym*. III.27; Isidore, 2009: 88–89; translation modified from Isidore, 2006: 99).

Isidore made a two-fold distinction: first between astronomy and astrology, the latter labelled potentially dangerous as it may lead to *superstitio*, the opposition of true Christian belief; and secondly between natural and superstitious astrology, the latter mostly denoting convictions of celestial influence and genethlialogy. This distinction might be more of a pragmatic admonition back in Isidore's contexts of the Visigothic Church, where the threats of Priscillianism heresy—embracing astral determinism, among other controversies—were genuinely felt and needed to be refuted (Fear, 2016: 78–79; Wallis, 2020: 191–192). But from a wider historical perspective, Isidore's demarcation and distance-keeping from astrology was to be generally retained into later medieval traditions of astronomy, ascending into a basic and commonsensical opposition.

By Isidore's (re)definition, astronomy was narrowed down to the study of the structure and parts of the heavens and the positions of the stars in its revolving movements. Such a discipline, severed from any risky pagan philosophy and superstition,[3] was fully legitimate and justifiable from a Christian point of view. The contents of such a field of astronomy can be summarized from the chapters of *De Astronomia* in *Etym*. III:

- Parts of the world and their names; position and movements of the celestial spheres; parts of the heavens, i.e. the poles, axis, four cardinal directions, five circles (the equatorial, tropical, and polar circles), zodiac circle, and milky circle (Chapters 29–46).
- The size, nature, course, effect, and path of the Sun; the size, light, phase, periods, course, and distance of the Moon; solar and lunar eclipses (Chapters 47–59).
- The light, location, course, and distance of the stars; the periods of return, antegrade and retrograde motions, and stations of the planets (Chapters 60–70).
- Explanation of the names of the stars, constellations, and planets, often serving as didactic and mnemonic ways of telling their relative positions in the sky (Chapter 71, but taking up the last one-third of the *De astronomia* section in length).

3.2 The Overarching Etymological Approach

In the unfolding of contents of astronomy that ensued, Isidore was more evident in adopting his own methodological approach consistent with the whole *Etymologies*, rather than following the Ptolemaic, *quadrivium*, *computus*, or any other astronomical tradition. This is his overarching principle of etymology: elaboration of every concept, term, and fact regarding the heavens that the reader is expected to learn is always encompassed by an analysis of the word or the name, announced right at the beginning. Explanation is done by breaking up the construction of its etymology, sometimes even going beyond Latin and invoking roots in Greek.

The definition of astronomy in the above cited passages is already an example: Isidore noted to the reader that *Astronomia* is composed of *astra* and *nomos*, which says 'law of the stars'; and he explicitly listed in the concerns of astronomy 'where the stars get their names'. The same methodology goes on in the introduction of the structure and parts of the heavens, where Isidore rewrote astronomical knowledge from earlier works in his own way; for example, about the five circles on the celestial sphere:

> There are five zones [*zona*] in the heavens ... They are called zones or circles [*circulus*] because they are produced circumferentially [*circumductio*] of the sphere. The first of these circles is called ἀρτικός, because the constellations of Arctos [i.e. the Bears] are seen enclosed within it. The second circle is called θερινὸς τροπικός, because on this circle the sun, being at its northern limit, makes summer, and does not travel beyond this circle, but rather turns back at once; whence it is called τροπικός [from Greek *tropē*, a turning]. (*Etym*. III.44; Isidore, 2009: 104–107; translation modified from Isidore, 2006: 101).

The exposition of the fundamental five circles on the celestial sphere goes back to as far as Geminus' *Introduction to the Phenomena* (V.4–5, 7–8, see Geminus, 2006: 151); Isidore here conceived of the circles primarily as zones or bands having a certain width, which is a derivation from Hyginus' *Astronomy* (I.6, see Hyginus, 2002: 8–11),[4] one of his major sources in astronomy. What is notable about Isidore's exposition is how he wrapped up astronomical phenomena and explanations into the etymology of names like 'circle', 'arctic', and 'tropic', often devised creatively on his own, and more often than not at the cost of masking over real explanations. Moreover, the style in which Isidore went on digging into each individual word assembled something more like a set of glosses on a vocabulary in literature (Eastwood, 2013: 311), rather than logically interrelated definitions and theorems in series of demonstrations, as, e.g., what Ptolemy had done in the first books of the *Almagest*.

Isidore's privileging of the etymological approach had deeper roots in his intellectual background (cf. Amsler, 1989; Elfassi, 2020: 255–264). The art of grammar, including etymology, had occupied a prominent place in Roman education, recognized especially for its pedagogical value in laying foundations for all other disciplines. In the emerging Christian traditions, grammar was still held in high esteem, for much of the learning required of a Christian was to be able to read and correctly understand one single text—the Scripture—word for word. On the basis of Clement and Origen of Alexandria, Augustine (354–430 CE) first articulated the definitive hermeneutic paradigm for biblical exegesis, and it was soon extended to the study of authoritative texts by ancient authors in other fields of learning, covering natural knowledge as well (Harrison, 1998). A prominent epistemological path, or even ontological linkage, between words (*verbum*) and the nature of things (*res*) was thus secured, formulated by Isidore as such:

> The noun [*nomen*] is so called as if it were 'denoter' [*notamen*], because by its designation it makes things known [*notus*, perfect passive participle of *noscere*] to us. Indeed, unless you know its name [*nomen*], the knowledge of a thing perishes. (*Etym*. I.7; Isidore, 2020: 31; translation modified from Isidore, 2006: 42).

Therefore, the disciplinary tradition of grammar from Roman times as well as the scriptural semiotics–hermeneutics together motivated Isidore's characteristic etymological approach, making the *Etymologies* the first Christian encyclopedia that Augustine had called for (*On Christian Doctrine*, II.39.59, see Augustine, 1958: 74; cf. Ribémont, 2001). Isidore's overarching encyclopedic program was to supply the knowledge of the inventory of nature and the system of the world (Wallis, 2020), just at the level required and comprehensible by a faithful Christian with basic education in the orders or monasteries, so that he could look up these entries and utilize them towards better understanding of lessons set down by God, both in the Bible and in the book of nature. Astronomy, the area of knowledge concerning the heavens and the stars, was subsumed under this program with no exception. It thus shifted away from a mathematical discipline connected

with observational practices, and turned to working on texts that continued to form the core of astronomical learning in the following centuries.

3.3 Leaving the Mathematics Behind: The Case on Planetary Anomalies

One of the most notable achievements of Hellenistic astronomy was the use of geometrical hypotheses—the eccentric and epicyclic circles—to account for and calculate the irregular apparent motions of the planets. Surely Isidore could not have turned a blind eye to this conspicuous kind of irregularities occurring in the sky. But his treatment on this issue most sharply brings out how natural–philosophical, sometimes even literary explanations, adapted from late Antique Latin works, replaced the technicalities of geometrical models and calculations as Isidore's choice in writing astronomical knowledge.

On the issue of planetary movements, Isidore spent five very short Chapters (*Etym*. III.66–70) introducing their anomalies and periods of return. Not surprisingly, he chose to pack up statements of these facts into exposition of terms like 'planet', 'irregular', 'retrograde', and 'stationary':

> Certain heavenly bodies, when they are hindered by the sun's rays [*radius*], become irregular [*anomala*], being either retrograde [*retrograda*] or stationary [*stationaria*], according to what the poet [i.e. Lucan] recalls when he says [*Civil War*, 10.201]:
>
> > The sun divides the seasons of time; it changes night into day, and by its powerful rays prevents the stars from proceeding, and delays their roaming courses by its ordering [*ratio*].
>
> Certain stars are therefore called planets [*planeta*], that is, 'wandering ones' [*errantes*, Greek *planētēs*], because they roam through the entire cosmos with a varying motion. It is because of their wandering that they are said to retrograde, or become irregular when they add or subtract small parts [of their course]. (*Etym*. III.66–67; Isidore, 2009: 126–129; translation modified from Isidore, 2006: 104).

As can be seen from these passages, Isidore was well aware of the anomalies in planetary motion, but he took a radically different direction in explanation from the previous mathematical astronomy: he invoked the power of the Sun's rays to give a physical, qualitative cause to explain the anomalies, attributing them to the effects of the fiery nature of the Sun (already introduced in Chapters 49 and 51 beforehand); accordingly, there were no quantitative details of the anomalies either. This kind of natural–philosophical explanation can be traced back to his source, Pliny the Elder's *Natural History*, Book II. Here, Pliny discussed at length the stations, retrograde and latitudinal motions of each planet, as well as the bounded elongation of Mercury and Venus, and repeatedly referred to the fiery force of solar rays as the cause (§§59–77, see Pliny the Elder, 1949: 208–217). More generally, the idea of influence of celestial bodies over each other, and the active, dominant force executed by the Sun through its rays, is one Pliny adopted from the Stoics (Eastwood, 2007: 140–142). It thus manifests how Roman popular cosmology and natural philosophy still left marks on Isidore through the materials he reworked and the mode of explanation he chose.

Isidore did not include anything pertaining to geometry, mathematical calculations, or quantitative data on planetary movements, not even citing the brief, qualitative mentions of the deferent-epicyclic and eccentric models still appearing in the works of Calcidius (*Commentary*, Chapters 79–86, see Calcidius, 2016: 250–267) or Capella (*The Marriage*, VIII, §§849, 873, 879, 880, see Capella, 1977: 330, 339–342). Hence, such reticence cannot simply be attributed to Isidore's ignorance of the mathematical astronomy tradition, but rather to a conscious process of selection and exclusion. In composing the *Etymologies*, Isidore often borrowed from earlier sources without naming or explicitly citing them—the passages analyzed so far all contained substantial information compiled from Cassiodorus, Hyginus, or Pliny, yet not once do these names appear in text. But in all that was said on planetary motion, Isidore was willing to indicate one source of acknowledged author: the Roman poet Lucan's *Civil War*, quoted verbatim without any adaptation. A strong influence and preference of Roman–Latin literary traditions is thus felt, even in the domain of astronomy and natural knowledge.

Yet another point of comparison can be made between Isidore's and Pliny's account on the sizes and distances of the Sun and the Moon, to serve the argument that Isidore deliberately chose *not* to include mathematical details that were available to him in Latin sources. On these matters, what Isidore said amounts to that

> The size of the Moon is said to be less than that of the Sun ... Indeed, just as the Sun is larger than the Earth, so the Earth is greater than the Moon by a certain

> quantity. (*Etym*. III.48; Isidore, 2009: 111; translation from Isidore, 2006: 102),

and that "The Moon is nearer to the Earth than the Sun is …" (*Etym*. III.57; Isidore, 2009: 119; translation from Isidore, 2006: 103). While in *Natural History* II. §§83–88, the text that Isidore knew well and relied on significantly, Pliny had recorded in length disputations among Pythagoras, Posidonius, and two Egyptian astronomers on the distances of each of the planetary spheres and the zodiac from the Earth, giving numerical calculations and values (Pliny the Elder, 1949: 226–231).

To sum up, although Isidore initially seemed to present astronomy under the framework of the *quadrivium*, the actual definition and unfolding of this area of knowledge in his writing deviates from a mathematical discipline. Astronomy was restricted to basic knowledge of the structure of the heavens and movements of the stars, conforming to the requirements of a Christian encyclopedic ideal, centered primarily on textual reading and clarification of names and meanings. With previous foundations of the Roman grammatical art and early Christian modes of exegesis, Isidore established his characteristic etymological paradigm, under which he selectively exploited earlier materials on astronomy passed down to him in Latin writings, leaving out the remnants of mathematics and technicalities, forging the seeming decline of early medieval astronomy in his wake.

4 PLANETARY ORDER AND COSMOLOGICAL PICTURE IN *ON THE NATURE OF THINGS*

Isidore's other encyclopedia, *On the Nature of Things* (hereafter *DNR*), composed before the *Etymologies*, is much shorter in length (only one book comprised of 48 chapters) and more narrowly focused on cosmology and meteorology. It is intended to provide an overview of the world in a single book. This gives us a more apparent case of Isidore's active intervention in reshaping knowledge of the heavens, for cosmology had long been a field of clashing thought traditions. In the *DNR*, biblical passages and spiritual allegorizations appeared frequently. If Christian intellectual backgrounds and forms of learning were only implied in the approach of *Etym*. III, Isidore had been more explicit and self-conscious in conveying substantial doctrines of cosmology and worldview in this earlier work. He discussed cosmological problems peculiar to Christian theology and exegesis (e.g. whether the stars have souls) and declared the precedence of biblical assertions over any pagan natural philosophy (possibly aiming at Lucretius' famous poem of the same title, cf. Fear, 2016). A short portion of the limited space for this text was still preserved for the seven planets, providing their order and periods of return. But this partial planetary theory, upon examination, differed far from any mainstream mathematical astronomy, for Isidore was aiming at a different goal than Hellenistic astronomers.

In the *DNR*, Chapters 9–27 deal with topics related to astronomy and cosmology, starting with the parts of the heavens (Chapters 9–14), the Sun and the Moon (Chapters 15–21), before proceeding to the stars (including planets) on their positions and names (Chapters 22–27). These parts generally correspond to the contents of the later *De astronomia* in *Etym.* III (for detailed cross-identification and comparisons, see the scholarly commentary by Kendall and Wallis in Isidore, 2016). Among the seven planets, the Sun and the Moon received disproportionally more attention, which may be partly due to practical considerations to account for solar and lunar eclipses, so that lay people would not turn to superstitions or read them as politically dangerous omens (Fear, 2016: 79–80; cf. Wallis, 2020: 191). Also part of the reason was that they constituted the primary (and one may say, sole) planetary problem confronted by Christian scholars in Isidore's time, since establishing the date of Easter required knowledge of the positions of the Sun and the Moon. As a result, still fewer passages were left for the other five planets, and these planets received treatment only taken together as a whole in Chapters 13, "The Seven Planets of Heaven and Their Revolutions", and 23, "The Position of the Seven Planets".

However, if one goes looking for accounts of planetary movements in Chapter 13, one would be disappointed to find it mainly consisting of exegetical discussions on the number and structure of the heavens. Isidore took the problem from Ambrose's *Hexaemeron* (II.2.5–6, see Ambrose, 1961: 49–50), stated that "… worldly philosophers have maintained that there are seven heavens …", but decided, as the Psalm 148:4 only reads "… heavens of heavens …", their specific number should not be presumptuously asserted (*DNR* 13.1, see Isidore, 2016: 135–136). This is in line with Isidore's general exegetical approach, where he tended to follow the more literal interpretations, believing there was a single, true meaning of any passage of the Scripture that ecclesial teachers should seek out, instead of trying to reconcile it with other pagan philosophies under more flexible allegories (cf. O'Loughlin, 1995; 2020: 139–143).[5] Yet, when Isidore takes on the topic again in Chapter 23, he depicts the heavens precisely with *seven* planetary spheres, and even devises a diagram along with the text

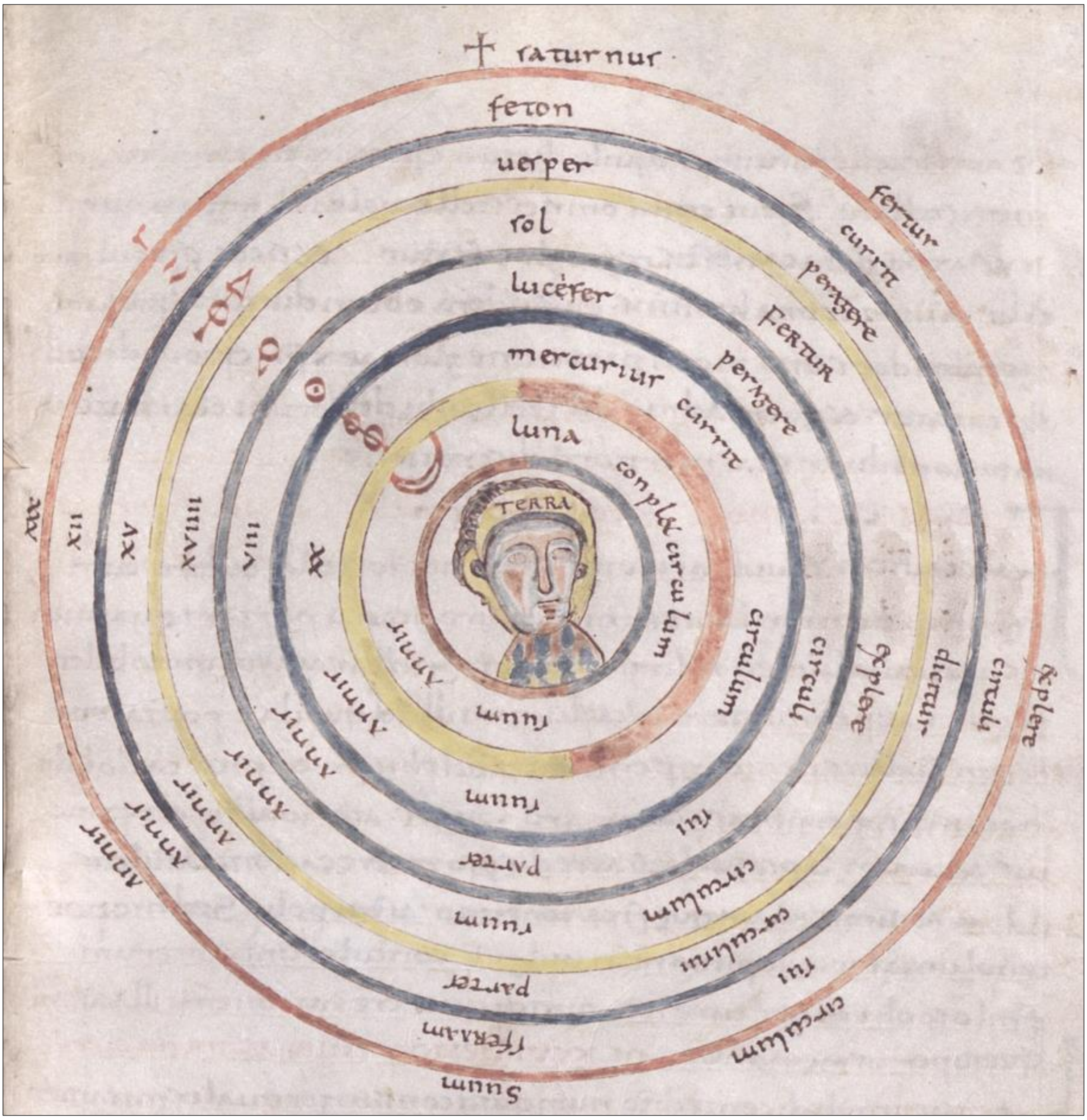

Figure 2: Isidore's cosmological diagram of concentric planetary spheres, in *DNR* Chapter 23; Munich, Bayerische Staatsbibliothek, MS Clm. 14300, f. 14r, late eighth century to early ninth century (https://www.digitale-sammlungen.de/en/view/bsb00046640?page=30,31; License CC-BY-NC-SA).

(Figure 2) to make this picture clear to the readers—a picture that does not deviate from the Aristotelian–Ptolemaic cosmos (cf. Taub, 1993), only with significant simplifications and added Christian iconologies (the human head in the Earth's sphere at the center, as well as the cross placed to the top of the outermost sphere, cf. Kühnel, 2005). This visual presentation of seven concentric planetary spheres, one of the six typical diagrams introduced in the *DNR* by Isidore himself or very early manuscripts and reoccurring in the parallel chapters in *Etym*. III, became widely influential and was regarded as authoritative for early medieval views of the Universe (Obrist, 2020: 229–233). In effect, Isidore largely popularized this refined, Christianized worldview based on Hellenistic cosmology by way of his successful encyclopedic writing.

In the diagram above we also see a clear exposition of the order of the planets, marked by names and symbols of the seven planets next to their respective spheres. It sheds some light on Isidore's deeper motivations behind this seemingly self-contradictory diagram. Cosmological order had long been a theme of ancient discussion, both in the more philosophical traditions like Plato, Aristotle, and later Cicero, and in the more astronomical traditions like Ptolemy's. In late Antique Latin writings preceding

Isidore, the most famous and available discussion was probably that by Macrobius in his *Commentary on The Dream of Scipio* (I.19), where the differing opinions on the matter by authorities in earlier times were carefully recorded, laying the basis for Isidore's discussion.[6] Entering the Christian Early Middle Ages, however, this topic began to take on more theological connotations, for the world was regarded anew as a divine creation, with rational planning and arrangements from God himself. Hence, it is this point that Isidore first sought to emphatically make in both Chapters 13 and 23:

> God did not make the heavens formless or confused, but distinct in accordance with a rational plan in a particular order. (*DNR* 13.2; Isidore, 1857: 29; translation quoted from Isidore, 2016: 136).

To strengthen the point, Isidore even went so far as to provide the only series of numerical 'data' in all his presentations of astronomical knowledge, that is, the years each planet takes to return to the same position in the sky:

> These are the years of the individual stars that are contained in the appended sphere [i.e. Figure 2 here]. After these years are completed, the stars return to the same [zodiacal] signs and the same parts of their circle [*circulus*], proceeding [again]. The Moon is said to complete its circle in 8 years; Mercury in 20 years; Lucifer [i.e. Venus] in 9 years; the Sun in 19 years; Vesper [i.e. Mars] in 15 years; Phaëton [i.e. Jupiter] in 12 years; and Saturn in 30 years. The appended figure [*figura*] shows the position of these orbs and stars. (*DNR* 23.4; Isidore, 1857: 46; translation modified from Isidore, 2016: 149).

It is immediately obvious how little Isidore got things right in this passage, judged by its astronomy. Not only did he give the name for Venus as an evening star, Vesper, mistakenly to Mars, but also among the periods of return for the seven planets, only the two—for Jupiter and Saturn—correspond to their actual sidereal periods as claimed by Isidore (returning to the same position in the zodiac). The rest of the numbers are way off the mark, not making coherent sense despite efforts by various modern commentators (see commentary and footnotes in Isidore, 2009: 126–127; 2016: 223–224; and also Eastwood, 1993: 175–176). Even if we try to align it with other astronomical cycles of these planets (e.g. the great cycles[7] or the luni-solar cycles), it is hardly supported by textual evidence, which is inexplicably randomly pieced together.[8] On the other hand, both Pliny and Hyginus gave correct periods of the planets in their works,[9] which, for some reason, Isidore did not copy, despite his heavy reliance on these two authors in respect to astronomical knowledge. He might have chosen to compile this series of numbers on his own, from sources unbeknownst to us today, or maybe this simply testifies to a lack of accurate sources in his library in sixth-century Visigothic Spain. These same numbers were given repeatedly in the text of *DNR*, in the *De Astronomia* in *Etymologies* (III.66), and also on the seven concentric spheres in the diagram accompanying these texts (see the Roman numbers labelled on the spheres in Figure 2).

Therefore, regarding this unusual presentation of planetary order and their cycles, it could be argued that accuracy in astronomical knowledge was not Isidore's main purpose. Rather, he wanted to advance the cosmological–theological point that the world was created with divine rational order. Invocation of a set of returning periods, exact in their numbers and neatly labelled in a visual schema, could deepen the reader's impression of a well-functioning, harmonic orderliness—whether these numbers were in fact accurate or not. Looking beyond the *prima facie* chaos, the rationale behind Isidore's writing was consistent throughout: either the inclusion or exclusion of certain material was in service of his larger argumentative and pedagogic program, which took advantage of whatever astronomical and cosmological knowledge the Latin traditions had handed down to him; Christian ideals were superimposed upon, while everything was creatively organised into an encyclopedic whole.

5 CONCLUDING REMARKS

In Isidore's writings on astronomy, we can see both the inheritance and transformation of astronomical knowledge from earlier traditions. Working after the literary, non-technical writings by late Antique and early Christian Latin authors, Isidore maintained the same attitudes and meager memories as Boethius and Cassiodorus towards Greek secular learning. He redirected the field of astronomy towards Christian faith, and for this purpose he cut out astrology, which he considered superstitious (even though it us-ed to be an important part of ancient astronomy). Adopting an etymological paradigm rooted in Roman grammatical education and biblical exegesis, he transformed astronomical knowledge from a mathematical discipline into nomenclatural explanations of natural things and phenomena appearing in specific canonical texts. To this end, he discarded the details of geometrical models, technical calculations, and quantitative data, despite being in possession

of such material from the writings of Pliny the Elder, Hyginus, and Capella. He largely promulgated a simplistic version of Aristotelian–Ptolemaic cosmology, but presented it primarily as a world of creation with rational, harmonious orderings by God. Behind these compilations in *Etymologies* and *On the Nature of Things*, what Isidore eventually presents is a consistent, overarching Christian world-picture. This was founded on the Latin remnants of Hellenistic and Ptolemaic astronomy, but now with spiritual meanings to be pursued above all, which may be aided through adequate (yet not excessive) learning of the secular sciences.

In the course of these workings, we notice Isidore consciously reorganizing and rewriting the Latin materials that he had access to. Rather than simply being a follower of Pliny, Augustine, or Cassiodorus, he earned himself the status as a seminal knowledge authority in the Early Middle Ages. As part of the well-educated cultural elite occupying prominent positions in the Visigothic Kingdom and the Church, Isidore stood at the far end of Greco–Roman legacies in late Antiquity. He wrote for a newly formed world of Christendom, the 'world' both in its spiritual sense—as stated above—and in its reality, in terms of the need to educate priests and the expanding group of monks in monasteries (cf. Barrett, 2020), providing written guides to liturgy, exegesis, and ecclesiastical affairs. Compared with what was happening in the Greek-speaking world around the same period, astronomical knowledge in the Early Latin Middle Ages seemed to be barren and have declined. Yet this situation did not automatically follow from some kind of carelessness towards or separation from Greek sciences of the Latin tradition (cf. Lindberg, 1978b: 52). It should be attributed instead to the active choices and creative interventions of Isidore and other Latin writers: an encyclopedist was never just a copyist. He actively transposed the bodies of knowledge from his sources into organized compilations, serving purposes conditioned by his cultural and social contexts (Ribémont, 1997), and, in Isodore's case he exerted long-lasting influence on later activities of learning in the Middle Ages. Ultimately, Latin and Greek textual traditions on astronomy from late Antiquity to the Early Middle Ages can be viewed as different responses arising from diverging epistemological landscapes in a time of transition:[10] the authors had different answers to questions such as "Why and how should one learn astronomy?", and "What things should be included in astronomy".

Nor, therefore, should we understand Isidore's writing only in the vaguely teleological terms of "… preservation of ancient secular learning …" (cf. Lindberg, 1978b: 53–54), or, when this task was done badly, criticize him for some kind of ideological suppression and monopoly. Rather, we may treat it constructively as an episode from the perspective of the history of knowledge, and dig into the presuppositions, dynamics, and practices underlying such historical forms of 'unknown' and 'ignorance', asking why certain knowledge slipped into obscurity (Verburgt, 2020). What seems like a haphazard compilation leading to the hopeless loss of Hellenistic astronomy at first glance, is in fact the outcome of a self-conscious, even programmatic effort of transformation of an area of natural knowledge. More profoundly, such transformations exemplified by Isidore were to set the course for astronomical, cosmological, and computistical inquiries in the subsequent Christian Middle Ages. After gradually accumulating momentum, these enquiries would constitute in turn motivations behind the searches and re-introductions of Ptolemaic astronomy by European scholars in the twelfth to thirteenth centuries.

6 NOTES

1. In pioneering studies, McCluskey (1998; 2011: 223) speaks of the plural 'astronomies' in early medieval Europe and gives a taxonomy of five different traditions: the Roman liberal art, *computus*, monastic timekeeping, solar horizon astronomy, and astrology. This is not to mention that cosmological themes and understandings are also in close relation, but these were not included in this taxonomy. Throughout this paper, I use 'astronomy' in a broad sense, sometimes in parallel with 'cosmology', exceeding the mathematical, Ptolemaic discipline that focused on calculating planetary movements.
2. The only exception might be Calcidius' *Commentary on Plato's Timaeus*, which includes geometrical expositions of the eccentric and the epicyclic hypotheses, although only in a qualitative way. This text did not receive attention until around the ninth century, with only a very modest and slow reception in the following centuries due to difficulties in comprehension (Eastwood, 1999).
3. But, as shown in Section 3.3 of this paper, Isidore still appealed to a kind of celestial influence (effects of solar rays) to account for retrograde motions of the planets. This is evidence that traces of popular Roman natural philosophy seeped into Isidore's writings through his sources, in this case Pliny the Elder. Such 'superstitious' remnants were criticized and more carefully

filtered out by a later medieval scholar, Bede, in his own *On the Nature of Things* (*De natura rerum*, c.703), a new encyclopedia composed with the same title as Isidore's. Bede's work may be regarded as a more thorough execution of Isidore's narrow, Christianized reformulation of 'astronomy'.

4. In Hyginus' exposition, it seems that the celestial sphere is divided into sixty parts of parallel, oblique circles, each 6° in width, based on the system of five principal circles. Fear (2016: 76–77) shows a comparison between Hyginus' and Isidore's 'zonal theory'.
5. I must thank the anonymous referee for pointing this out to me.
6. Macrobius (1990: 162–168) recounted two different views on cosmological orders as follows, disagreeing on the sequence of the inner planets: (1) the 'Egyptian' order, which gave Moon–Sun–Mercury–Venus, adopted by Plato, Aristotle, and Chrysippus, among others, and (2) the 'Chaldean' order, which gave Moon–Mercury–Venus–Sun, adopted by Cicero, Geminus, Cleomedes, Vitruvius, and Ptolemy (which became more popular after the second century BCE). Macrobius defended the Platonic order, being a Neo-Platonist himself, but Isidore followed Pliny and Hyginus in adopting the Chaldean order.
7. The great cycle, or joint return (discussed by Ptolemy in the *Almagest*, IX.3), denotes that the planet returns to the same position in the zodiac *and* with the same relation to the mean Sun, i.e. exhibiting the same patterns in anomalies (Evans, 1998: 313–315; Ptolemy, 1984: 423–424).
8. Among the remaining five planetary periods unaccounted for: (1) A 9-year period for Venus and a 15-year period for Mars may roughly fit with their great cycles. 8 years as a great cycle for Venus is attested in the *Almagest*, IX.3 (Ptolemy, 1984: 424); while 15 years may serve as a less-accurate cycle for Mars (Ptolemy's value was 79 years), since 15 years equals seven synodic cycles and eight tropical cycles of Mars (Evans, 1998: 313), and it is also the interval for Mars' perihelic oppositions (translators' footnotes in Isidore, 2009: 127). (2) An 8-year period for the Moon and 19-year period for the Sun may correspond to two important luni-solar cycles, the *octaeteris* of 8 years and Metonic cycle of 19 years, discussed by Geminus in his *Introduction to the Phenomena* (VIII. 25–57, see Geminus, 2006: 180–184). Isidore might have misunderstood their meanings, assigning one to the Moon and the other to the Sun. (3) So far, no plausible explanation can be found in the literature for the 20-year period of Mercury.
9. Hyginus' *Astronomy* (IV.14.4, see Hyginus, 2002: 142–143) gave the following periods of return: 30 days for the Moon; 1 year for Mercury, Venus, and the Sun; 2 years for Mars; 12 years for Jupiter; and 30 years for Saturn. Pliny, in *Natural History* (II.§§32–40, see Pliny the Elder, 1949: 188–193), gave more accurate values for the periods of the Moon (27⅓ days), Mercury (339 days), and Venus (348 days).
10. In a way, the transformative influence of encyclopedic writings by Macrobius, Capella, and Isidore on astronomy as an area of natural knowledge, as argued in this paper, can be juxtaposed with what Netz (1998) has argued for 'deuteronomic texts' in making a new ideal of a unique, perfect, text-like image of Mathematics in late Antiquity.

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Zongbei Huang is a PhD candidate at the Department of the History of Science at Tsinghua University in Beijing, China. After graduating from the Department of Philosophy with a Bachelor's degree at the same university, she is currently working on her PhD thesis about forms of experiential knowledge in sixteenth-century Europe.

Her broader scholarly interests include pre-modern and Renaissance encyclopedism, cultural and intellectual history of early modern Europe (fifteenth–seventeenth centuries), and historical epistemology. She has published a scholarly translation of excerpts from the natural-historical books of Isidore's *Etymologies* in Chinese, and a recent paper on the seventeenth-century Persian astrolabe in the collection of the Tsinghua University Science Museum.