

'ASTRONOMY' OR 'ASTROLOGY': A BRIEF HISTORY OF AN APPARENT CONFUSION

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Abstract: The modern usage of the words 'astronomy' and 'astrology' is traced back to distinctions that are largely ignored in recent scholarship. Three interpretations of celestial phenomena (in a geometrical, a substantialist and a prognostic form) co-existed during the Hellenistic Period. From Plato to Isidore of Seville, the semiotic contrast is evidenced, and its later developments are sketched. The concept of astronomy is found to be rather constant and distinct from changing views about astrology.

Keywords: astronomy, astrology

1 INTRODUCTION

The contemporary cultural context allows us to easily distinguish between astronomy and astrology. When needed, some discourse on physics is wedged between the two and it contrasts them, bringing support for the first but not for the second. This strategy turned out to be problematic in earlier times as an inverted situation appeared then: physics founded astrology, while astronomy was taken to be purely hypothetical (see Hübner, 1989). Language considerations point to the fact that today's astrology has appropriated the name of its founding knowledge. A statement that before modern times no clear difference was made between astronomy and astrology is perhaps trivial, but its explication is not really straightforward. Three conceptualisations of the celestial realm are found under the two names, which breed complications and confusion.

In ancient texts sometimes one (or the other) word is used for both disciplines, but no evidence appears for any inversion of the two names. This suggests that our word usage is not a convention but rather the outcome of an unstated tradition and the alleged indistinction might only be lexical. For scholars in the early Middle Ages the existence of two words implied the existence of two realia, and for all concerned the 'right' semantic co-ordination was not a problem. The person involved in celestial science was always an 'astrologer', as if the *nomos* was among the stars themselves, while their *logos* was knowledge that needed an agent. Indeed, the figure of the astronomer, with this appellation, was a late comer. In his monumental studies on the history of science, Pierre Duhem (1908) chose to promote two different kinds of practitioners of celestial science, labelling them either 'astronomes' or 'physiciens'. The traditional 'astrologer', meanwhile, was restricted to superstitious astrology. Useful as it was, this tripartite division was merely a methodological one, which relied on contemporary views and on word usage. In order to distinguish the physical from the metaphysical content, or rather positivist phenomenism from metaphysical fancy, he proposed "... saving the phenomena ..." as a slogan under which the 'astronomes' were seen to be laboring. However the expression appears to be of a rather late coinage (cf. Goldstein, 1997), just as the 'astronomer' and his whole reconstruction might seem to be somewhat arbitrarily imposed.

Since the nineteenth century, classical studies have indiscriminately asserted equivalence between 'astronomy' and 'astrology' (e.g. see Daremberg and Saglio, 1919; Lewis and Short, 1879; Smith et al., 1890; cf.

Bowen, 2007; Pines, 1964), even if lots of cases, read with regard to intention and content, just as Duhem (1908) did, disagree with this affirmation. The two words could be found to denote different disciplines and many ancient writers—at least those concerned with the distinction—used them knowingly. From Plato to Kepler, the co-existence for two millennia of a synonymic pair with similar word form would be a puzzling fact and just one occurrence of contamination seems to have been recorded. This was Marco Polo's (1928:135) use of 'astrolomie' (sic.) to denote a man who made predictions.

At the close of the Middle Ages, for rhetorical or ideological purposes, the confusion between 'astrology' and 'astronomy' might have been willful, betraying indeed a rather clear grasp of the issue. Later, historians and translators often relied on their own judgment and made incorrect substitutions, thereby obscuring further the distinction which was present in the original texts.

Anyone who was able to master the calendar at a time when almost nobody could write and few people could count up to ten was probably deemed a prodigy. Such a talent involved precise foreknowledge of the Sun's observable behaviour and how this related to seasonal happenings in nature. Different extrapolations were bound to appear. For example, Babylonian scribes left a remarkable record in which they linked the day-to-day configuration of the night sky to various earthly happenings, and it is just a small testimony to their obsession with any kind of omen. Recordings of the form, 'when x, there was the occurrence of y', were accumulated, with their content ranging from the trivial to the impossible. Exhaustion, as the degree zero of method, is not absurd in a world that is supposed to be finite, for the spirit is truly positive even if it is also totally uncritical. For cyclic phenomena, the discovery of their periods amounted to complete knowledge. Lack of causality, however, was a negative fact which practice did not reveal, so the Babylonians were able to predict celestial omens but not their apodoses, which remained as lists of precedents (Rochberg, 1998). In a similar fashion, the Greeks composed their *parapegma* (i.e. meteorological recordings for each day of the year) but, understandably, they did not achieve any success as weather forecasters. Explaining the failure lead them to accept a difference in essence between the sublunar world and the higher realm. Thus, Aristotle's decision to prescribe separate sciences for them eludes the problem by dividing it—a seemingly Cartesian gesture.

However, as a side effect this splitting produced what came to be known as astrology.

2 PLATO OR ARISTOTLE: ASTRONOMY OR ASTROLOGY

Plato's discussion of the disciplines in the *Republic* (527d-530d) includes the statement that geometry starts with planar figures, and next it proceeds to solids and their movements, which are properly the concern of astronomy (αστρονομία). The beginning of Aristotle's *Physics* neatly confronts Plato's conception: the enumeration (194a7) of 'sciences inverse of geometry' runs through optics, harmony and astrology (αστρολογία). There is no doubt about his meaning, as various translations unanimously testify, but using a different word emphasizes the difference. Plato goes on to mention how astronomy could be useful for navigation, but he then points out that we should be concerned with "... genuine astronomy." Symmetrically, Aristotle (1871: *Post. Anal.* I.13, 79a) remarks that astrology is both "... nautical and mathematical ...", and here, as elsewhere, he specifically uses the term astrology rather than astronomy. A similar distinction is also found in Xenophon's *Memorabilia* when he remarks that travelling needs a certain "... practical knowledge of astrology ...", while knowing the movements of celestial bodies that lie outside the earthly orb is "... knowledge of astronomy." (Xenophon, 1921: *Mem.* IV.7, 4-5). In Plato's works the word astronomy occurs at least twenty times, but his texts never had a role comparable to those produced by Aristotle, and it is only with the Neoplatonists, some time after Ptolemy, that his terminology achieves a wider circulation. Porphyry then wrote an *Introduction to Astronomy*, and following his mentor's usage he mentioned that Pythagoras had learned "... geometry and astronomy." (*Vita Pyth.* 11). This usage was totally eclipsed by Aristotle's teachings: Eudemos' *History of Astrology* had appeared in his lifetime and that term was adopted by all Peripatetics and the later Stoics.

The first explanation of the Sun's movement as resulting from two rolling circles was apparently proposed within the Pythagorean School, although Plato has been credited as the author of a full-blown programme. According to Simplicius, Plato proposed that the wandering of the planets was only apparent, while their true movements were just a combination of uniform circular rotations. For this step from the phenomenal to the noumenal Plato adduced arguments and restrictions appealing to perfection, divinity and other ideological bias. Eudoxus' system came as a first realisation of the proposal, an event notable enough to provide a watershed between astronomy and astrology. Aristotle took to reinterpret realistically and quasi-physically the construction that was generated theoretically—with the language itself reminding us of its origin.¹ Rather symptomatic, it was not done in the books about the heavens or physics but in the book, *Metaphysics*. Knowledge for Aristotle involved a knowledge of causes, and movement needed one. In order to build a mechanically-causal explanatory model he introduced a few more 'unrolling' spheres which allowed him to avoid unwanted transmission of movements. The centre of the system, which was originally just a geometrical point, gained the status of the most important place in the Universe. However

around that time it became known that a combination of epicycles and deferents offered the best explanation which included rotations about different points. Awareness that is equivalent to eccentric orbits may have occurred to Hipparchus or somebody else and thus Aristotle's view clashed openly with the astronomical programme. A compromise was sought by declaring that models which are not strictly geocentric are just hypothetical or fictional. The better fit to observational data was devalued and 'saving the phenomena' became the catch phrase for it. In this unfortunate category went Herakleides' semi-heliocentric model, Aristarchus' system and, much later, Copernicus' model, as presented in the Wittenberg interpretation. The physics invented by Aristotle took enough hold of reality to combat the earlier geometry and claim to be true. Actually it was only Kepler who conceived the *New Astronomy, Based upon Causes* as it was announced in the title of his book. Indeed the causes are accounted for in Newton's mechanics which reproduces easily the phenomenology of the Solar System. But even Newton refused to feign some hypothesis about the cause of gravity. The issue was solved later by introducing material fields, the same idea being already upheld by stoic thinkers who boldly asserted that 'causes are bodies'. Peripateticism and stoicism strongly favored substantial-causal explanations and geocentrism remained despite the clash with astronomical data.

The debate about celestial events extends to their consideration in the sub-lunar orb: even if it was heterogeneous, the World was still a whole. Causal interaction, when viewed qualitatively, can be traced indefinitely far, and this is what the fatalistic stoics did. The difference between the effects of the Sun and Moon and those of the other planets is only in degree, not in essence, and is no reason to exclude them from consideration. Another principle was upheld to cut the endless causal interactions—the self-evident freedom of the will. The occasion for this development was the coming into fashion of Babylonian divinatory practice. The signs of the will of the gods, which they read, would be reified into astral influence by Greek thinkers.

3 THE BABYLONIAN CONNECTION

It is mainly a matter of speculation what Plato, Aristotle or Eudoxus knew about Babylonian astronomical or astrological lore, as its appropriation only became obvious after the conquest of Alexander the Great.² This is indeed the problem: why did this foreign practice come to prominence so late? Obviously, it is the conjuncture of accumulated knowledge and a flow of new information which provides a solution. This amounts to agreeing with a conclusion which, despite its numerous statements, still comes as a surprise: astrology, as we know it, was invented by the Greeks. Historical investigations lead to this view (see Neugebauer, 1968: 80; Pingree, 1968; Rochberg-Halton, 1988: 51), as does consideration of its own working and valuation (Beck, 2006).

The first attested linking of an individual's birth with astral recordings—that is, a horoscope—is in cuneiform writing, on a tablet dating from 409 BCE (Rochberg, 1998: 30), when the Greeks were already speculating on astral matters. Keeping to the contemp-

orary usage, we could ask: What kinds of celestial concerns did the Babylonians have at that time? There is an obvious contrast, but it would be totally unjust to assert that these concerns were purely astrological. Rather the reverse, for one may state that they actually discovered astronomy. It is widely accepted that Pythagorism developed into mathematical science, and obviously a similar process would have led to the appearance of astronomy in the Babylonian kingdom.³ The indebtedness to superstition, religion or myth would not be greater than the one inherited from Plato and Aristotle, who took for granted the divinity of planets. Tabulating astronomical data using ecliptic coordinates—a numerical system based on 60, with a marking for zero—are elements of a discipline which surpasses in rigor and precision most Greek endeavours. Stellar data are the main content of Babylonian horoscopes, while their interpretation is sketchy, relying on annals and tradition (see Rochberg, 1998). A transfer to Greece would mean to carry over this part which is algorithmically irreducible. The general idea, however, is easily transmissible, and the Greeks implemented it with their own means. A similar instance would be the development leading from common law to Roman law, both being practices to achieve a particular aim. Of course this inversion—astronomy being Babylonian while astrology is of Greek origin—really does not matter, except for the perspective which the participants could have had. For historical purposes one may just as well agree with Philo of Alexandria who said that the Chaldeans invented both astronomy and 'genethiology' (*De peregrinatione Abrahami* 33(178); and-see 35(194)).

So there were three main interpretations of celestial science in Ptolemy's day: a Pythagorean one, where it was viewed as geometry; a physicalist and substantial one, inspired by peripateticism; and a prognostical one which was attributed to the Chaldeans and still needed a name. It was called descriptively by referring to its alleged originators, the Chaldeans, or known as 'apotelesmatics' and, more particularly, as 'genethiology' or 'katarke'. For Latin authors, and for anybody not involved in this, the distinction between Pythagorean, peripatetic and Babylonian views would have been rather elusive. What is more, Babylonian tables allowed preparation of horoscopes and celestial prognostication without any grasp of astronomy. Any 'astronomer' could and did the same, so the common denominator of the profession was 'astrology' and correspondingly its practitioners were 'astrologers'. Before the first century CE, Latin authors did not use the term 'astronomy' (the exception perhaps being the *Astronomica* of the Manilius), as the majority of Greeks had adopted the word 'astrology'. The former term was still currently used as witnessed by the texts of Theon of Smyrna or the data collected by Diogenes Laertius. For example, Diogenes Laertius collated various sources where 'astronomy' was used at least four times and 'astrology' or 'astrologer' at least ten times. Sextus Empiricus, in writing against the learned men = doctores of his day, notes that "... Chaldeans call themselves mathematici or astrologi ..." and attacks their astrology or "... mathematical art differing from arithmetic and geometry ... [and different from] the prognostics of Eudoxus and Hipparchus, which some call astronomy." (*Adv. math.*, V: 1-2).

4 PTOLEMY'S SHUFFLE

Ptolemy has a special place in history, as for a millennium he remained the authority on astronomy, and for even longer on astrology. His achievement appears to be not so much a novelty as a reconfiguration. Instead of the dilemma describing/explaining his work brings to the front knowledge in the form of prediction – it can be only more or less exact. Describing the celestial movements is apodictic while tracing their causes or effects is just probabilistic.

The eclecticism of the zeitgeist is perceptible in Ptolemy's writings which comprise both platonic astronomy and peripatetic-stoic physics. Aristotelian astrology was always something like an astral twin of sublunary valid knowledge, and obviously there was no room for it in this mix. The return to a Pythagorean tradition was obvious, and the avoidance of Aristotelian terminology was marked.⁴ The dual hierarchy of Aristotle's cosmos is replaced by a fourfold scheme built on oppositions from the categories 'immaterial' and 'invisible'. Thus, theology is the science of the immaterial and invisible, mathematics is about the immaterial and visible while physics is about the material and visible. The material and invisible, which corresponds to the soul, is subsumed in physics and this imbalance reveals that the really meaningful distinction is between ideal and material.

The four books, or *Tetrabiblos*, devoted to what is today's astrology, were known as Ptolemy's *Apotelesmatics*, which is his own preferred term, explained as prognostication by means of astronomy. In the celestial realm predictions are strictly true, while anywhere else they are only probable—for meteors or individual predictions. But a continuously-distributed probability erases the opposition between sublunar and higher realms and thus invalidates the Aristotelian difference between astrology and physics. Lacking a proper content, 'astrology' can be used for the founding and explaining of astral influences, as was previously done by physics. And this is what really happened, but much later, when Aristotelian science was fully discredited. For the moment, 'astronomical prediction', or some such paraphrasing, was commonly used as it was mostly taken in the same restricted sense as 'astrologer'. An interest in star patterns when they are devoid of divinity and without reference to their effects would have been odd indeed. So the first modern-looking definition of astrology—namely, judging or predicting by the stars—appears to have been given by the more pragmatic Arabic commentators (see Pines, 1964).

5 FAST FORWARD

Since late antiquity the quadrivium has provided a context which unambiguously identifies astronomy independently of the word used. Mathematics, already in a restricted sense, included two proper subdisciplines, arithmetic and geometry and they had as counterparts music and a celestial science. Varro and Martianus Capella still called it 'astrology' but Cassiodorus only used the term 'astronomy'—even when referring to Varro's *De Astrologia*. The existence of two distinct words assured medieval authors that there were two quite different concepts involved, and generally they were able to provide an educated guess—as apparently Alcuin or Hugo of Saint Victor did⁵—and

they discussed the geometrical Pythagorean science separately from its more substantial variants. In the early ninth century Martin of Laon (1981) enumerated the disciplines from the quadrivium ending with "... astronomy to which cling astrology and medicine." The same disposition was found much later, when university education had been instituted: Aristotle was taught by the theological faculty, while astronomy and its astrological and medicinal continuation had their place in the faculty of medicine. Galileo still had to teach them there. Aristotle's texts mentioning astrology became known to Western scholars a few centuries after they learnt from the Arabs about 'judging by stars'. *Liber de Astronomie judicandi* by Roger of Hereford is an early example (ca. 1184) of an astrological treatise presented with the words that Ptolemy might have used. Improving the calendar was of prime interest to ecclesiastics, and they were aware that astronomical tables—be they Arabian or Babylonian—only offered valid data for the locations where they were computed, so any prognostication needed astronomy as its precondition.

In compiling his *Etymologies*, Isidore of Sevilla included a comment about the difference between astronomy and astrology which surely would not have been there if it had not appeared in an earlier text. It is worth noting that his definition of astronomy reproduces the words that Cicero used when writing about astrology,⁶ so Isidore, or somebody before him, knew enough to transpose this usage. Remarkably, Isidore went on and made a further distinction, dividing the topic into three parts. After separating astronomy from astrology, he added that the later was "... partly natural, partly superstitious ...", which corresponded to Aristotelian and Babylonian concepts. The religious qualification here etymologically speaks about 'standing-over' or 'supernatural', which is indeed what Chaldean science was. A 'natural astrology' would have been for a peripatetic something of a contradictio in adjecto, just like 'celestial physics', which much later was used by Kepler (1609) in the title of one of his books.⁷ Nevertheless the same text reappears elsewhere,⁸ and the *Etymologies* remained influent through the Middle Ages, transmitting an understanding achieved already at the start of Hellenism.

It seems safe to conclude that through the ages people who used the word 'astronomy' knew what they were talking about. Late Medieval and Renaissance writers sometimes stretched the term to cover most of what is astrology, but such a rhetorical strategy would not have been possible without prior knowledge of the difference.

Since the end of the thirteenth century there has been a discussion about how much of astrology is 'licit': the Church and secular powers maintained conflicting opinions, which were further complicated by the humanists' views during the Renaissance. As a defender of astrology Pierre d'Ailly (1414) went so far as to write about "... astronomy falsely known as astrology ..." in his *Tractatus de concordantia theologie et astronomie*, while Pico della Mirandola's *Disputationes adversus astrologiam divinatricem* (1496) dealt it a nearly fatal blow.

Acknowledging the history hidden behind the term 'astrology' leads to a clearer grasp of the ambiguities

in its usage. Pleonastically-looking qualifications such as 'divinatory' or 'judicial astrology' are witnesses of the distinction from a 'physical' or 'natural astrology', an early attempted science which became sidetracked.

6 NOTES

1. It would be almost a tautology to point that astronomy is the first 'theoria' – a way of seeing. Aristotle's approach was metaphysical, as he proposed to explain what is seen: a separate realm with its own laws. Nature, or 'physis', for him consisted of generations and corruptions explained by the four elements, but above the Moon there was a fifth substance. One is tempted to describe the appropriate science, astrology—which inevitably relies on earthly logic and analogies—as literally supernatural or at least para-physical. The situation was further complicated by viewing the soul also as a substance; interestingly, renaissance alchemy was sometimes called 'astronomia inferior').
2. Plato's *Timaeus* provides grounds for some acquaintance with Babylonian astronomical lore to be acknowledged, while Aristotle's remarks remain in a naturalistic vein. According to an uncorroborated remark in Cicero (*De Div.*, ii, 42, 87), Eudoxus demanded that "... no credence should be given to the Chaldeans, who predict and mark out the life of every man according to the day of his nativity."
3. Today Babylonian mathematics is understood to be mostly arithmetic but, rather curiously, Josephus wrote in his mythical account of the *Jewish Antiquities* that Chaldeans learned from Abraham 'arithmetic and astronomy' (I.8.2 (166)), the usual pair of 'geometry and astronomy' appearing elsewhere (I.3.9 (106)).
4. For example, in the *Almagest* neither word appears; in the *Tetrabiblos* 'astronomy' is used just six times and, as Feke (2009: 153) notes, its only other appearance is in the *Harmonics* where it is defined as a mathematical science.
5. Alcuin (*Opera Omnia*, col. 947): "Astronomia lex astrorum, qua oriuntur et occident astra. Astrologia est astrorum ratio et natura et potestas, coelique conversio." ["Astronomy is the law of the stars, how the stars rise and set. Astrology is about the reason and nature and the power of the stars and sky rotation."] Hugo St Victor (*Opera Omnia*, col. 756): "... astronomia de lege astrorum nomen sumpsit, astrologia autem dicta est quasi sermo de astris disserens. Nomos enim lex et logos sermo interpretatur." ["... astronomy took the name of 'law of stars' but astrology is said to be like a discourse treating of the stars; because 'nomos' is translated as 'law' and 'logos' as 'discourse'."] (cf. Pines, 1964).
6. *Etym* 3.27: Astronomia caeli conversionem, ortus, obitus motusque siderum continet, in the enumeration of disciplines by Cicero: "Astrologia, caeli conversio, ortus, obitus motusque siderum." (*De Oratore*, ii.42). ["Astronomy comprises the rotation of the sky, the rise, setting and movement of stars / Astrology is (about) the rotation of the sky, the rise, setting and movement of stars."]
7. *Astronomia Nova Αἰτιολογητος, seu Physica Coelestis*, which was translated into English as: *New Astronomy, Based on Causes, or Celestial Physics*.
8. See in *Dubia et Spuria* of Bede (908D), where

'astronomy' and 'astrology' are named as two of the six parts pertaining to physics, and then the same text is reproduced.

7 REFERENCES

- Alcuin, 1863. *Alcuini Opera Omnia*. Edited by J-P. Migne. Patrologiae Cursus Completus (Volume. 101), Paris.
- Aristotle, 1871. *Aristotelis Opera*. Edited by I. Bekker. Berlin, Academia Regia Borussica.
- Beck, Roger. 2006. *A Brief History of Astrology*. London, Blackwell.
- Bede, 1904. *Venerabilis Bedae Opera Omnia*. Edited by J-P. Migne. Patrologiae Cursus Completus (Volume 90). Paris
- Bowen, Alan. 2007. The demarcation of physical theory and astronomy by Geminus and Ptolemy. *Perspectives on Science*, 15, 327-358.
- Cicero. *Opera*. In The Latin Library. See the following web site: <http://www.thelatinlibrary.com/cic.html>
- Daremberg, C., and Saglio, E., 1919. *Dictionnaire des Antiquités Grecques et Romaines*. Paris, Hachette.
- d'Ailly, Pierre, 1414. *Tractatus de Concordantia Theologie et Astronomie*. See the following web site: <http://warburg.sas.ac.uk/pdf/fah1620p.pdf>
- Diogenes Laertius, 1972. *Lives of Eminent Philosophers*. Translated by R.D. Hicks. Cambridge, Harvard University Press.
- Duhem, Pierre, 1908. *Σοζειν τα φαινόμενα Sozein ta phainomena. Essai sur la Notion de Théorie Physique de Platon à Galilée*. Paris, Hermann.
- Josephus Flavius, *The Judean Antiquities*. See the following web site: <http://pace.mcmaster.ca/york/york/showText?Text=anti>
- Feke, Jacqueline, 2009. Ptolemy in Context. Unpublished Ph.D. dissertation, Institute for the History and Philosophy of Science and Technology, University of Toronto
- Goldstein B., 1997. Saving the phenomena: the background to Ptolemy's planetary theory. *Journal for the History of Astronomy*, 28: 1-12.
- Hübner, Wolfgang, 1989. *Die Begriffe "Astrologie" und "Astronomie" in der Antike*. Stuttgart, Akademie der Wissenschaften und der Literatur.
- Hugh of St. Victor 1880, *Hugo de S. Victore Opera Omnia*. Edited by J-P. Migne. Patrologiae Cursus Completus (Volume 176). Paris.
- Isidore of Sevilla, 1911, *Isidori Hispalensis Etymologiarum sive Originum libri*, edited by W. M. Lindsay, 2 vols. Oxford, Oxford University Press
- Kepler, J., 1609. *Astronomia nova Aίτιολογητος, seu physica coelestis, tradita commentariis de motibus stellae Martis, ex observationibus G. V. Tychonis Brahe*, [Prague].
- Lewis, C., and Short, C., 1879. *A Latin Dictionary*. Oxford, Clarendon Press.
- Martin of Laon / Hibernensis, 1981. *Physica in quattuor divisines partitur id est arithmetica, musica, geometria, astronomia quibus adherent astrologia, medicina*. In Herren, M.W. (ed.). *Insular Latin Studies*. Toronto, Pontifical Institute of Mediaeval Studies. Pp. 22-64.
- Neugebauer, Otto, 1969. *The Exact Sciences in Antiquity*. New York, Dover Publications.
- Philo of Alexandria, 1830. *Philonis Judaei opera omnia*. Edited by M. Richter. Leipzig, Schwickerti.
- Pico della Mirandola, Giovanni, 1496. *Disputationes Adversus Astr-ologiam Divinatricem*. Bologna, Benedictus Hectoris.
- Pines, Shlomo, 1964. The semantic distinction between the terms astronomy and astrology according to al-Biruni. *Isis*, 55, 343-349.
- Pingree, David, 1968. Astrology. In Wiener, Philip P. ed. *The Dictionary of the History of Ideas*. New York, Charles Scribner's Sons Pp. 118-126.
- Polo, Marco, 1928. *Il Milione*. Edited by L. Benedetto. Firenze, L.S. Olschki. Edited by J. Burnet. Oxford, Oxford University Press.
- Rochberg-Halton, Francesca, 1988. Elements of the Babylonian contribution to Hellenistic astrology. *Journal of the American Oriental Society*, 108, 51-62.
- Rochberg, Francesca, 1998. Babylonian horoscopes. *Transactions of the American Philosophical Society*, New Series, Vol. 88, No.1, Pp. i-xi+1-164.
- Roger of Hereford, ca. 1184. *Astronomice Judicandi*. In Whyte, Nicholas, 1991. *Roger of Hereford's Liber de Astronomice iudicandi*, M.Phil Dissertation, Cambridge, Clare College.
- Sextus Empiricus, 1569. *Sexti Empirici Viri Longe Doctissimi Adversus Mathematicos*. Paris, G. Hervetus.
- Smith, W., Wayte, W., and Marindin, G., 1890. *A Dictionary of Greek and Roman Antiquities*. London. John Murray.
- Xenophon, 1921. *Xenophontis Opera Omnia*. Oxford, Clarendon Press.

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