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THE SEMANTIC DISTINCTION BETWEEN THE TERMS
ASTRONOMY AND ASTROLOGY ACCORDING
TO AL-BĪRŪNĪ

By S. Pines *

From the semantic point of view the terms *astronomy* and *astrology* have had a most checkered history. It is the current view based on the evidence of the texts that in the Greek usage the significations were practically indistinguishable; either of them could be applied to the two sciences in question.¹ Isidore of Seville (d. 636) is considered by some to have been the earliest author who by his differentiation between the two terms prepared the way for the modern semantic distinction.² The relevant passage of his *Etymologiae* (III, XXVII) reads as follows:³

De Differentia Astronomiae et Astrologiae. Inter Astronomiam autem et Astrologiam aliquid differt. Nam Astronomia caeli conversionem, ortus, obitus motusque siderum continet, vel qua ex causa ita vocentur. Astrologia vero partim naturalis, partim superstitiosa est. Naturalis, dum exequitur solis et lunae cursus, vel stellarum certas temporum stationes. Superstitiosa vero est illa quam mathematici sequuntur, qui in stellis auguriantur, quique etiam duodecim caeli signa per singula animae vel corporis membra disponunt, siderumque cursu nativitates hominum et mores praedicare conantur.

The definition of *astronomia* is for the greater part taken over from Cicero's *De oratore*, in which it is applied to *astrologia*.⁴ Superstitious *astrologia* as understood by Isidore pertains to astrology in the modern sense of the word. On the other hand, the some-

what vague definition of natural *astrologia* suggests that this discipline may be concerned with astronomical observation. A rather similar connotation of the term *astrologia*, differentiated from *astronomia*, is perhaps hinted at in a passage of Proclus' *Commentary on the Timaeus*,⁵ but no analogous use of the two terms occurs in other texts of this Greek Neoplatonist.

In the early Middle Ages Isidore of Seville was a frequently read and frequently quoted author. Clearly the definitions of *astrologia* and *astronomia* occurring in the *Eruditio didascalica* of Hugh of St. Victor (d. 1141) owe a good deal to the passage of Isidore quoted above and to other statements of his in the same context. There are, however, some significant differences. The definitions of Hugh read:⁶

Astronomia et astrologia in hoc differe videntur, quod astronomia de lege astrorum nomen sumpsit, astrologia autem dicta est quasi sermo de astris disserens. Nomos enim lex et logos sermo interpretatur. Ita astronomia videtur esse quae de lege astrorum et conversione caeli disserit, regiones, circulos, cursus, ortus et occasus siderum et cur unum quodque ita vocetur, investigans. Astrologia autem quae astra considerat secundum nativitatis et mortis et quorum libet aliorum eventuum observationem

⁵ See Proclus, *In Platonis Timaeum commentaria*, ed. E. Diehl, (Leipzig: Teubner, 1906), vol. III, p. 145, ll. 12 ff. This passage seems to imply that *tērēseis*, "observations," pertain to astrology rather than to astronomy. However, another work of Proclus, the *Hypotyposis astronomiarum positionum*, (ed. C. Manitius, Leipzig: Teubner, 1909, p. 2, l. 7) uses the expression *tērēseis peri astronomiam*. This is a typical instance. No uniform rule seems to apply to the occurrence of the terms *astronomia* and *astrologia* in the various works of Proclus. The verbs *astrologein* and *astronomein* are juxtaposed in the *Oracula Sibyllina*, III, verses 227-228 (ed. J. Geffcken, Leipzig: Hinrichs, 1902, p. 60); in the context, they may, and again may not, be synonymous.

⁶ See *Eruditio didascalica*, ch. XI, in J. P. Migne's *Patrologia Latina* (Paris: Garnier-Migne's, 1880), vol. 176, col. 756.

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¹ See the article "Astronomie" by Hultsch in Pauly-Wissowa, *Real-Encyclopädie der klassischen Altertumswissenschaft*, Zweiter Band (Stuttgart: J. B. Metzlersche Buchhandlung, 1896), cols. 1828-1862; A. Bouché-Leclercq, *L'Astrologie grecque* (Paris, 1899), p. 3.

² This appears to be the opinion of J. Fontaine; see his masterly study entitled *Isidore de Séville et la culture classique dans l'Espagne wisigothique* (Paris: Études augustiniennes, 1959), vol. 2, pp. 465-466.

³ I use W. M. Lindsay's edition of the *Etymologiae* (Oxford: Clarendon Press, 1911).

⁴ See Fontaine, *op. cit.*, p. 467.

quae partim naturalis est partim superstitiosa. Naturalis in complexibus corporum, quae secundum superiorum contemperantiam variantur, ut sanitas, aegritudo, tempestas, serenitas, fertilitas et sterilitas. Superstitiosa in contingentibus et in iis quae libero arbitrio subiacent; quam partem mathematici tractant.

The main divergency between Isidore and Hugh concerns natural astrology. As a result, Hugh's definitions approximate modern usage much more closely than those of his predecessor. However, this particular usage of Hugh's was not followed to any considerable extent; throughout the greater part of the Middle Ages it was the rule rather than the exception that the two terms under discussion were regarded as quasi-synonymous, *astrologia* being used to designate astronomy, or vice versa.⁷ Their semantic differentiation

⁷ See, for instance, Lynn Thorndike, *A History of Magic and Experimental Science* (8 vols., 1923-1958), vol. II (New York: Macmillan, 1929), pp. 6, 40, 81, 255 (n. 5), 256 (n. 4), 319, 559, 577, 591, 669, 673, 790, 829, 868. At the time of Peter of Abano (died before the close of 1318) the present-day distinction was beginning to be made (*ibid.*, p. 890); however there are many examples of this distinction not being observed up to the middle of the fourteenth century and even later. See, for instance, *ibid.*, vol. III (New York: Columbia University Press, 1934), pp. 333, 338, 422, 520 (n. 14). It may be noted that in Marco Polo's *Il Milione*, written in French, the words *astreonomie* and *astrolomie* signify astrology (see, for instance, ch. CXL, ed. L. Benedetto, Florence: Olschki, 1928). The book is supposed to have been dictated by Marco Polo while he was in prison in Genoa in 1298 and 1299.

At a much earlier period, William of Conches (died probably before 1159), who was apparently followed by a writer whom P. Duhem designates as pseudo-Boethius, makes a semantic distinction between *astrologia* and *astronomia* that is quite different from the one that ultimately came to be universally accepted. According to this author, astrology deals with the celestial phenomena without any reference to the question of whether these appearances conform to reality. Astronomy, on the other hand, treats of the heavens as they really are, whatever the appearances, which may, or may not, correspond to reality, (see P. Duhem, *Le Système du monde*, Paris: Librairie scientifique Hermann et cie, 1954-1956, vol. IV, pp. 215 f.; Lynn Thorndike, *op. cit.*, vol. II, pp. 55 f.) This semantic differentiation may have some connection with the distinction between astronomy and astrology hinted in the passage of Proclus' *Commentary on the Timaeus* re-

seems to have gradually started to become a normal linguistic habit only in the fourteenth century, especially in its second half. A belated example of the term *astrology* being applied to astronomy may be found at the end of the sixteenth century in the following lines in Christopher Marlowe's *Doctor Faustus*, Act II, Scene II:

Come, Mephistophilis, let us dispute again,
And reason of divine astrology.
Speak, are there many spheres above the moon?
Are all celestial bodies but one globe,
As is the substance of this centric earth?

This passage and the subsequent dialogue between Faustus and Mephistophilis are concerned exclusively with the heavenly bodies. No reference is made to any influence which the stars may have on terrestrial affairs.

If one may go by the available evidence,⁸ the Byzantine use of the two terms under discussion is analogous to that found among the medieval Latins: in most cases no semantic distinction between them can be discovered.⁹ How-

ferred to above because of its possible bearing on Isidore's definitions.

⁸ The study of Byzantine astronomy and astrology has been neglected in spite of the abundance of manuscripts; cf. O. Neugebauer, *The Exact Sciences in Antiquity* (New York: Harper, 1962), pp. 55 f.

⁹ Cf., for instance, the great *Catalogus codicum astrologorum Graecorum*, composed by F. Cumont and other scholars, vol. I (Brussels, 1898), p. 81, the extract "Ex libro Apotelesmatico Masalae (770-820? p. c. n.)," 1. 5. The text is ascribed to Mā Sh'ā'llāh, a well-known astrologer who wrote in Arabic; like many other Byzantine astrological texts, it is probably a translation (see below) (*ibid.*, vol. II, 1900, p. 183, l. 4; p. 184, l. 6; p. 188, l. 2). These references to *astronomia*—a science which is said to be concerned with the motions and positions of the heavenly bodies as well as with the knowledge of future favorable and untoward happenings—occur in a treatise *On Mathematical Art* (*Peri Mathematikēs Tekhnēs*) composed by the "philosopher" Stephanos, who probably lived in the eighth century, and who mentions that he came from Persia (*ibid.*, vol. II, p. 182, l. 2). According to this author, the rejection of *astronomia* is a sin against the Holy Ghost, that is to say, a sin which—as Christ said—cannot be forgiven.

Ibid., vol. V, pt. I (1904), p. 147, ll. 9-10: in a Greek translation of a work of the celebrated Arabic astrologer Abū Ma'shar Ja'far al-Balkhī (d. 886) the mysteries of *astronomia*

ever, a Byzantine writer of the twelfth century does make a semantic distinction which calls to mind the modern differentiation between the two terms.¹⁰ Michael Glycas, who was imprisoned in 1156 by the Emperor Manuel Comnenus and blinded shortly afterward, states in a text quoted in the *Catalogus codicum astrologorum Graecorum* that mathematical science is divided into astronomy and astrology.¹¹

Astronomy is permitted even to the saints, as it teaches the position, the motion and also the well-ordered coming-together and separation of all the heavenly (bodies). For as we have heard in an ancient story, the angel in whose charge are the stars, (namely) the manifestly divine Uriel, descended towards Seth and Henoch and taught them thereupon the revo-

are mentioned in a context which leaves no doubt as to the astrological nature of the mysteries in question (see also below). I may add that the vocabulary of the Greek versions of Arabic (and perhaps also Persian) scientific texts must have had an appreciable influence on scientific terminology, as a by no means negligible portion of the manuscripts of the Byzantine astronomical, astrological, and alchemical treatises is constituted of such translations. See Neugebauer, *op. cit.*, pp. 175 f.; ed. P. Kraus, *Jābir ibn Ḥayyān, Contribution à l'histoire des idées scientifiques dans l'Islam* (Cairo: Impr. de l'institut français d'archéologie orientale, 1942), vol. II, pp. 39 (n. 3), 265 (n. 3).

¹⁰ It may, however, be noted that a semantic distinction between *astronomy* and *astrology* seems to be assumed in the Greek text of a treatise of pseudo-Apollonius of Tyana entitled (in the *Catalogus codicum astrologorum Graecorum*, vol. VII, Brussels, 1908, p. 174) "De horis diei et noctis." In this treatise Apollonius is supposed to state that he had composed, among others, four precious books: (1) an *Astronomia*, (2) an *Astrologia*, (3) a *Skholastikē*, and (4) one dealing with signs, omens, and mysteries. This last book is the most precious of all (*ibid.*, pp. 175-176). No indication is given as to the difference between *astronomia* and *astrologia*.

Both *astronomia* and *astrologia* are mentioned, with some distinction apparently being made between them, in the title of the third chapter of *Eisagōgē kai Themelion eis tēn Astrologian*, a work attributed to Aḥmad the Persian and, in consequence, apparently supposed to have been translated into Greek from the Arabic (or the Persian); see *ibid.*, vol. II (1900), p. 6. The difference between the two sciences may, or may not, be indicated in the text of the treatise. The *Catalogus* offers no information on this point.

¹¹ *Ibid.*, vol. V, pt. I (1904), p. 140.

lutions of the seasons and the signs of the stars.

Astrology, however, i.e. prediction that derives from these (things) . . . which makes known the future, has never been permitted to the fathers, as it leads too much astray those who are rather simple-minded and forces them to direct their attention to birth and to fate.

This semantic distinction, however, seems to have been generally unknown in Glycas' time or to have been ignored. Thus Glycas' powerful opponent the Emperor Manuel Comnenus seems to be unaware of it. In a treatise written between 1147 and 1156, which refutes an attack on astrology made by Glycas,¹² Comnenus uses both words apparently with the same connotation, though *astrologia* occurs more frequently.¹³

Prima facie it might seem that the Arabic authors need not be mentioned at all in this connection, as neither of the two words under discussion was integrated into the Arabic scientific vocabulary. There was no need to borrow them, as purely Arabic terms could be substituted for them. Astronomy was called *'ilm al-hay'a*, *'ilm al-falak*, or *'ilm al-nujūm*; and astrology, insofar as it was differentiated from astronomy, could be designated by the term *ṣinā'at aḥkām al-nujūm*, meaning *ars iudi-*

¹² *Ibid.*, pp. 108-125.

¹³ On the other hand, the thirteenth-century Byzantine astronomer Theodorus Meliteniotes makes in his important work *Astronomikē Tribiblos* a distinction reminiscent of that set forth by Glycas, whose terminology and attitude may have, directly or indirectly, influenced Theodorus. According to Theodorus, *astronomia* may be defined as "the science which is concerned with the heavenly bodies, and which has as its final end the knowledge of their movements" (*ibid.*, vol. V, pt. III, 1910, p. 139). He thinks that if one abstracts from theology, *astronomia* is the most precious part of philosophy and provides the other branches of mathematics with their *raison d'être* (*ibid.*, p. 134). This praise goes hand in hand with a total rejection of astrology (*hē astrologikē*), regarded by Theodorus as a pseudo-science, which claims to predict terrestrial events from the observation of the heavenly phenomena. According to him, astrology is totally untrue. It is incompatible with piety and leads its adepts to perdition. In consequence, the divine laws seek to prevent people from practicing it (*ibid.*, pp. 136-137).

ciorum stellarum, i. e., "judicial astrology."

Nevertheless the Greek words in question were sometimes transcribed in Arabic characters and explained, this being in keeping with the habit of the translators from whom the authors of the various treatises acquired their information. Thus the *Rasā'il Ikhwān al-Ṣafā'*, an encyclopedic work composed in the tenth century, includes an epistle treating both of astronomy and astrology, the full title of which reads:¹⁴ "The third epistle of the mathematical part entitled astronomy (*astrūnūmiya*) (treating) of the science of the stars (*'ilm al-nujūm*) and the composition of the spheres." The Greek term *astronomia*, which etymologically is said to signify the science of the stars, is also mentioned in al-Kwārizmī's *Mafātih al-'ulūm*, likewise written in the tenth century.¹⁵

The two terms *astronomia* and *astrologia* figure in a passage which occurs in a recently published treatise of al-Bīrūnī (d. 1048 or a few years later), who perhaps considered astronomy and mathematics in general as the chief of his many interests. The treatise in question is entitled "Ifrād al-maqāl fi 'ilm al-zilāl" ("Discourse which Exclusively Treats of the Science of Shadows").¹⁶

¹⁴ See the Cairo edition of *Rasā'il Ikhwān al-Ṣafā'* (Al-Matba'a al-'Arabiyya, 1928), vol. I, p. 73.

¹⁵ Ed. Van Vloten (Leiden, 1895). The first of the two relevant passages (p. 210) may be translated as follows: "The science of the stars (*'ilm al-nujūm*) is called in Arabic: *al-tanjīm*, and in Greek: *Ast.r.numiyā*." The second passage (pp. 232 f.) may be translated as follows: "*As.ṭ.r.* (means) star and *nūmiyā* science. *A.s.ṭ.r.lāb* means instrument for measuring (*miqyās*) the stars. The Greek (term is *as.ṭ.r.lābūn*, *a.s.ṭ.r.* (meaning) star and *lābūn* mirror. For this reason the science of the stars is called *a.s.ṭ.r.numiyā*."

¹⁶ This is the second of four treatises of al-Bīrūnī published in a volume entitled *Rasā'il al-Bīrūnī* (Hyderabad: Osmania Oriental Pub. Bureau, 1948). The first of these treatises, "Fi istikhraj al-awtār fi'l-dā'ira," is in the main composed of excerpts from Arabic and Greek mathematicians. One of the authors quoted (pp. 7, 18, 20) is Sārīnūs al-Thibā'i (meaning a native of Thebes), who is invariably mentioned together with Archimedes. This Sārīnūs is possibly the Greek mathematician usually called Serenus of Antinoëia, after the name of

The passage reads as follows (p. 69):

In *Kitāb al-muwāzana* (*The Book of Establishing a Balance*) Ḥamza al-Isfahānī¹⁷ men-

a colony founded by Hadrian, which has been identified as Serenus' native town. Even if one makes the rather improbable supposition that this identification is incorrect, the name of the locality in question must have been very similar to Antinoëia. This being so, the transformation of Serenus into a Theban could be brought about by a few slight changes in the Arabic script. Al-Bīrūnī mentions (*ibid.*, "Fi istikhraj . . .," pp. 7 and 18) a work of Sārīnūs entitled *On Geometrical Elements* (*Fī'l-uṣūl al-handasiyya*). On Serenus see Orinsky's article in Pauly-Wissowa, *op. cit.*, 2. Reihe (1923), cols. 1677-1678. According to al-Bīrūnī, one of the excerpts he makes from Archimedes and Sārīnūs (al-Bīrūnī, *op. cit.*, "Fi istikhraj . . .," pp. 20 ff.) also occurs in (apparently anonymous) *Questions* (*Masā'il*), translated by Yūhannā ibn Yūsuf, which "might be fittingly (attributed) to Apollonius" (of Perga). An excerpt from a text of Apollonius is found on pp. 144 ff. (*ibid.*).

In "Ifrād al-maqāl . . ." (*ibid.*, "Ifrād al-maqāl . . .," p. 15) al-Bīrūnī refers to a passage in Abu'l-'Abbās al-Irānshahrī's *Masā'il al-ṭabī'a*, which discusses a personal experience of the author—namely the fact that when standing on the shore of a river he saw upon the slope of a mountain facing the sun two shadows, one above the other, cast by a man approaching this mountain from the river. Very little is known about Irānshahrī, whose works have been lost and who, as far as I know, is only referred to by two authors, al-Bīrūnī and his contemporary the Persian writer Nāṣir-i-Khosraw. A reference to him in al-Bīrūnī's "al-Qānūn al-Mas'ūdi" informs us that Irānshahrī was in Nishapur on July 28, 873; see S. Pines, *Beiträge zur islamischen Atomenlehre* (Berlin: Gräfenhainichen, Gedruckt bei A. Heine, 1936), pp. 34 f., 40, 45, 52, 56 ff.; *La Doctrine de l'intellect selon Bakr al-Mawṣilī*, Studi Orientalistici in onore di Giorgio Levi della Vida (Rome, 1956), vol. II, p. 350, n. 1 (on p. 351). The text of al-Bīrūnī dealt with by Krenkow, in the article quoted by me because of its reference to Irānshahrī in *La Doctrine de l'intellect . . .*, has been edited by M. al-Tabkhi under the title *Tahdīd nihāyat al-amākin li-taṣṭih masāfāt al-masākin* (Ankara: Doğu Şirketi Matbaası, 1962).

In "Ifrād al-maqāl . . ." al-Bīrūnī also mentions (p. 10) a work of Thābit ibn Qurra treating of the lines described by the extremities of shadows, and a text of al-Kindī. Among the numerous other quotations occurring in "Ifrād al-maqāl . . ." one finds a reference to *al-Kibrīt al-Ahmar*, a work of the mystic al-Hallaj (p. 27), to *Rasā'il Ikhwān al-Ṣafā'* (p. 40), and to Plato's *Timaeus* (p. 17). This last reference may be translated as follows (the beginning is omitted): "For in the work (entitled) the *Timaeus* he says, when mentioning

tions that astrolabe (*'s.t.r.lāb*) is an Arabized Persian word: namely *sitāra-yāb*, i. e. perceiver of the stars (*mudrik al-nujūm*). It is possible that this is its name among the Persians, derived either from the special function of (the instrument) or adapted from the Greek in the way the Persian language does adapt words. The Greek term for (the instrument) is *astrolabion*.¹⁸ *Astēr* means star, as is proven by the fact that *'ilm al-hai'a* (meaning astronomy in the modern sense of the word) is called by them (i. e. by the Greeks) *astrūnūmiyā*, and *ars iudiciorum stellarum* (*sin'at aḥkām al-nujūm*, i. e. judicial astrology) is called *astrulūjiyā*.¹⁹ (The astrolabe) is an instrument with regard to the fabrication and the use of which we have found ancient books (composed by) them (i. e. the Greeks), whereas we have found no books (composed by) people other than they though they may have had (this instrument). The men of the East (*ahl al-mashriq*; apparently the Hindus are meant²⁰) are not acquainted with the astrolabe and in its lieu are only guided by making use of shadows.

A passage follows (pp. 69–70) in which al-Birūnī refers to an unnamed author, "one of those who are partisans (*al-*

the hylē and its being one of the shadows, that the shadows constantly flow out from the bodies and that thereupon by means of a high (*'āliya*) spiritual (*rūḥāniyya*) strategem (*hila*) they become solid and thicken. And therefrom the shadow comes into being." In the last sentence the word "shadow" (*al-zill*) may seem out of place; its occurrence may be due to a scribe's error. On the other hand, a plausible explanation may be found for the sentence as it stands.

¹⁷ On Hamza al-Isfahānī (died before 970), see E. Mittwoch, *Die literarische Taetigkeit Ḥamza al-Isbahānī*, Mitteilungen des Seminars für orientalische Sprachen an der königlich Friedrich-Wilhelms-Universität zu Berlin (1909), pp. 109–168. On *Kitāb al-muwāzana*, which seems to have been a lexical work putting special emphasis to Persian etymologies of Arabic words, see pp. 135 f. and 140 f. A fragment of the work, preserved in a Cairo MS, is also published by Mittwoch (pp. 156–159).

¹⁸ Written in the printed text *'s.t.r.l.yūn*. A very slight emendation produces *'s.t.r.l.b.yūn* or, alternatively, *'s.t.r.l.būn*—transcriptions which suggest the Greek *astrolabion* rather than the equivalent Greek term *astrolabos*. The transcription *'s.t.r.lābūn* figuring in *Mafātīḥ al-'ulūm* (see above) also seems to indicate *astrolabion*.

¹⁹ Written in the printed text *as.t.r.lūkhīyā*. Only the displacement of one diacritic point is entailed by this emendation. There is, of course, no absolute certainty that al-Birūnī did not write *as.t.rulūkhīyā*, but he is more likely to have used the correct form.

²⁰ See S. Pines, "La Philosophie orientale d'Avicenne," *Archives d'histoire doctrinale et littéraire du Moyen Age*, 1952, p. 16, n. 2.

muta'aṣṣibūn) of the Hindus as against the Byzantines (*al-Rūm*) who considers that in the matters under discussion the Hindu methods are most accurate." According to al-Birūnī, "this statement resembles words (spoken) by epileptics. . . ." These references to the Hindus and to Hindu science are very much in character and would, in my opinion, definitely establish al-Birūnī's authorship of the passage if there were any reason for questioning it.²¹

²¹ The only possible reason for doubting al-Birūnī's authorship of the passage is to be found in the fact that the scribe who copied the treatise states in the colophon (al-Birūnī, *op. cit.*, "Ifrād al-maqāl . . .," p. 226): "I finished (faraghtu) *min ta'liqihī* in Mossul in Dhu'l-Ḥijja (a Moslem month) of the year 631 (after the Hijra, i. e., July or August, 1231)." The same formula is used, and the same place and date are mentioned in the colophon of "Tamhīd al-mustaqarr li-taḥqīq ma'nā al-mamarr," the third treatise published in the volume of al-Birūnī's *Rasa'il* . . . , which appeared in Hyderabad (see p. 107 of this treatise). The fourth treatise in the volume, entitled "Maqāla fi rashikāt al-Hind," has in its colophon a somewhat different formula: *faraghtu min kitābatihā*. . . . As the same place and date are mentioned here, evidently one and the same scribe copied in Mossul in the course of one month the three treatises, the colophons of which have been referred to. Now the formula *faraghtu min kitābatihā* means quite plainly "I finished writing it." In the context the formula *faraghtu min ta'liqihī* means as clearly "I finished copying it"; this is the rendering of *ta'liq* in the English translation of "Tamhīd al-mustaqarr . . ." published under the title *Al-Birūnī On Transits* (translated by M. Saffouri and A. Ifram, with a commentary by E. S. Kennedy, Beirut: American University of Beirut, 1959, p. 119). On the other hand, a frequent meaning of *ta'liq* is "comment" or "inserting a comment," and it might be argued that this is what the scribe did in the case of the two treatises in which *faraghtu min ta'liqihī* occurs. However, an examination of the works concerned shows that this supposition is not borne out in any way by the text of the two treatises; neither shows any sign of interpolations or of having been tampered with in any way. The verb *'allaqa*, of which *ta'liq* is the verbal noun, sometimes means "to copy." This signification does not figure in the dictionaries, but Dozy, *Supplément aux Dictionnaires Arabes* (Leiden/Paris, 1927), vol. II, p. 161, does mention that *'allaqa* can have the meaning "écrire, noter par le moyen de l'écriture." The meaning "to copy" can be deduced from the colophons of manuscripts; see G. Flügel, *Die Arabischen, Persischen und Türkischen Handschriften der*

Al-Bīrūnī's statement proves that examples of a semantic differentiation between the terms *astronomia* and *astrologia* approximating modern usage occurred among the Greeks not later than the first half of the eleventh century, that is to say, a hundred years before Glycas' time. In fact, however, al-Bīrūnī probably refers to a much earlier period.

He obviously did not deduce (as the text of the passage might lead one to suppose) the meaning of the word *aster* from the comparison of the three foreign terms *astronomia*, *astrologia*, and *astrolabion*, for he also gives the correct signification of the second part of the last word. He may, of course, have known a smattering of Greek or have known a Greek-speaking person. Be this as it may, it is on the whole probable that he gleaned his information as to the meaning of *astronomia* and *astrologia* from some written source: an Arabic version of a Greek text or a gloss in an original Arabic text giving the signification of these two rare Greek loan-words. As the Greek texts translated into Arabic generally date from pre-Islamic time, this would mean that the evidence seems to indicate that the semantic differentiation between *astronomy* and *astrology* which is familiar to us could be found in a Greek text or in a group of texts dating from the sixth or seventh century or perhaps even from some earlier period. This hypothesis may also account for (and be corroborated by) the partly similar distinction between the two terms found in Isidore's *Ety-mologiae*. In all probability this Latin author had no knowledge of Greek, or none to speak of.²² However, in his sources, many of which are unknown to us,²³ he may have encountered some

reference to the Greek usage set forth by al-Bīrūnī and by Glycas. At this point one may ask whether the final crystallization and universal acceptance of the present-day distinction between the terms *astronomy* and *astrology* was entirely due to the influence of Isidore and other early medieval writers and to a later autonomous terminological development in Latin Europe; or whether knowledge of some Arabic text (such as al-Bīrūnī's) or of Byzantine sources may have contributed to the final result.

In conclusion I shall quote al-Bīrūnī's personal views, set forth in his great work *Al-Qānūn al-Mas'ūdī*, on astronomy and astrology. The passage occurs at the beginning of the section dealing with astrology:²⁴

The heart of those who do not conceive the quality of pleasure except (such as is found) in the preliminaries to bodily sufferings, nor utility except (such as is found) in things of this world, scarcely incline to this art (i. e. astronomy), of which this book has exclusively treated; and this despite the fact that (astronomy) because of its great intrinsic value suffices unto itself. As (people) had no wish for astronomy, disliked it and had a distaste for it, they manifested hostility to it and towards those who (practiced) it. For this reason the ancients came to predict the (future) states of the world by means of propositions (drawn from this art), working out various methods which had the appearance of persuasiveness in order to provide knowledge (of these states) on the basis of (astronomical) influences. (Thus) they differentiated from (astronomy) the art of judicial astrology (*ṣinā'at al-ahkām*), and made (people) think that the latter was the fruit of the former, . . . knowing, as they did, that the desire of the generality of people to obtain knowledge²⁵ with a view to an increase in welfare and to the avoidance of hurt would turn away from them (i. e. the astronomers in question) the sharp point of blame and ward off from them the keen edge of calamities.

Some of the basic principles of the art of judicial astrology (*ahkām al-nujūm*) are presented in the form of (mathematical) calculations. In consequence, (astrologers) have a sufficiency of trouble with the principles they regard as being recognized (by all of them), and with respect to which there is no controversy. As this (i. e. astrology) is not based on (intellectual) necessity, differences of opinion

Kaiserlich-Königlich Bibliothek zu Wien (Vienna, 1865), vol. II, pp. 38 f., who translates 'allaqtuhā ". . . abgeschrieben." See also G. Makdisi, "Moslem Institutions of Learning in Eleventh Century Baghdad," *Bulletin of the School of Oriental and African Studies*, University of London, 1961, p. 13.

²² The alleged proofs of Isidore's knowledge of Greek are not convincing; see J. Fontaine, *op. cit.*, pp. 849 ff.

²³ See *ibid.*, pp. 750 ff.

²⁴ Al-Bīrūnī, *Al-Qānūn al-Mas'ūdī* (Hyderabad: Osmania Oriental Pub. Bureau, 1956), vol. III, p. 1354.

²⁵ Namely the knowledge of the future which astrology is supposed to procure.

are possible, and the methods used in it have multiplied in various ways.

Thus al-Bīrūnī, who was himself a practicing astrologer, regards astrology as a protective device invented by ancient astronomers with a view to escaping the persecution which threatened them because of their scientific pursuits. People refrained from giving vent to their hatred of astronomy because astrology dangled before them

the prospect of practical advantage deriving from the knowledge of the future. It is quite evident that in spite of the semblance of persuasiveness which al-Bīrūnī concedes to astrology and in spite of its use of mathematical language, he considers it in the main as a pseudo-science. As such it favors the proliferation of conflicting schools and methods; for the check provided by the recourse to strict scientific demonstration is absent.

THE GROWTH OF SCIENTIFIC PHYSIOLOGY

While it may be unwise to reply to a hostile review, it is perhaps ungenerous to reply to a friendly one (*Isis*, 1962, 53: 541–542). In doing so I both thank Dr. Wilson for his kind remarks and apologize, but I am compelled to answer him because he uses my book to support the very myths that I was hoping to expose.

In this short answer I shall confine myself to one crucial historical example which I documented fully in the book. Dr. Wilson states, "The 1783 paper of Lavoisier and Laplace, she shows, is important for the fact that the authors found it necessary to distinguish the terms used to describe the physical nature of heat before they could talk about the source of animal heat." Lavoisier and Laplace did *not* find it necessary to make these distinctions, and their views on the physical nature of heat were quite irrelevant to their experiments. What they did make clear were their definitions of certain crucial terms — distinguishing between "free" and "bound" heat and "capacities" for heat (p. 58).¹ Both they and Adair Crawford, performing similar experiments in the same period, took care to point this out: "La conservation de chaleur libre, dans le simple mélange des corps, est donc *indépendante de toute hypothèse sur la nature de la chaleur*; elle a été généralement admise

par les physiciens, et nous l'adopterons dans les recherches suivantes."²

It is equally misleading to speak of Lavoisier and Laplace "talking about the source of animal heat," for they were not studying this. In Article 4 of their famous paper (pp. 45–55) they state: "Nous nous bornerons ici à comparer les quantités de chaleur qui se dégagent dans la combustion et dans la respiration avec les altérations correspondantes de l'air pur, *sans examiner si cette chaleur vient de l'air ou des corps combustibles et des animaux qui respirent.*"³

It is essential to be absolutely clear just what Lavoisier and Laplace were doing. In a paper presented to the Academy on 5 September 1775,⁴ Lavoisier had first suggested a qualitative analogy between respiration and combustion. The 1783 experiment was intended to demonstrate that there is also a quantitative analogy. When Dr. Wilson says in his review, "The demonstration of the chemical identity of combustion and respiration in this paper removed much of the mystery from the feature of higher animals which had seemed most unique — their maintenance of a uniform temperature," he misrepresents both the purpose and the

¹ Page numbers in this article all refer to G. J. Goodfield, *The Growth of Scientific Physiology* (London: Hutchinson, 1960).

² A. L. Lavoisier and P. S. Laplace, "Mémoires sur la chaleur," *Mémoires de l'Académie des Sciences*, 1780, p. 355.

³ *Ibid.*

⁴ A. L. Lavoisier, "Mémoire sur la combustion en général," *Mémoires de l'Académie des Sciences*, 1777.