

A SOCIAL HISTORY OF MEDIEVAL ASTRONOMY

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Abstract: This work is a summary of the first chapters of the book *Storia sociale dell'Astronomia (A social history of astronomy)*, currently in preparation. We analyze the main factors that played a role in suppressing or re-awakening interest in astronomical observations and events throughout the centuries. Among such elements we include: the loss of Greek-language knowledge as a vector of scientific knowledge; Christian and Islamic conceptions of astrology; religious practices connected to sky observations; the birth of universities; and the evolution of the social figure of the scientist in the West—from monks to aristocrats. In this contribution we focus attention especially on the role of the Christian and Islamic religions and on the complex relationships between Europe and Islam in the evolution of astronomy in the Middle Ages.

Keywords: *History of Astronomy, Medieval Astronomy*

The collapse of the Western Roman Empire and the loss of the Greek language

The Roman Empire culture was basically bilingual, with the Greek language being known by literate people as well as Latin. The collapse of the Western Roman Empire determined the end of this culture. In Western Europe, when the Roman schools disappeared, the Greek language was lost.

Unfortunately, most of the classic scientific literature was written in that language and typically used for science, as English is used today.

Thus the astronomical knowledge, born in Egypt and Mesopotamia, transmitted to the Greek civilization and then to the Roman Empire mainly by the Phoenician and Alexandrian Kingdoms and culminating with Ptolemy's work, also was lost.

Only a minor number of texts written in Latin (today we would call these works 'popular science')—and in particular the ones of Plinius, Macrobius and Martianus Capella—remained available (see, e.g., Le Goff, 2004). These works reported the results of ancient science but not the methods used to reach these results: this circumstance made it impossible to further develop previous knowledge.

Furthermore, with the collapse of the social organization and depopulation of the cities during the 5th century, the only schools that remained operative were those of the monasteries: and these schools were not interested in gaining further knowledge of nature, since they were based on the principle that the whole truth was written in the Bible and that the knowledge of natural phenomena was only useful to better understand the Holy Books.

The role of Christian religion

However, there are at least two reasons why the centuries following the collapse of the Western Roman Empire to the 12th century must be considered important for the development of the modern scientific thought and of modern astronomy in particular.

First, the diffusion into the whole West of the Christian religion, based on a unique God who is creator of the universe, cancelled the crowd of gods, semi-gods and spirits that the ancient world associated with natural

phenomena, smoothing the way for their subsequent scientific explanation. In the 7th Century, Isidorus, bishop of Seville, demonstrated in his work *Ethimologiarum libri XX* that all natural phenomena and human events can be described in a way independent of any mythical explanation. Furthermore, in this widely diffused work, Isidorus introduced an important distinction, ignored by classical science, between astronomy and astrology: the first studied the motion of the skies, the Sun, the Moon and planets; the second, being in contradiction with the basic Christian principle of the 'free will', had to be condemned as a superstition.



Figure 1. Christ Pantocrator (mosaic, Monreale Cathedral, c. 1190).

Second, Christian liturgy demanded the solution to a number of problems connected with time reckoning. In those days, the Julian calendar was still used as a civil calendar and there was no problem about using it also for the 'fixed feasts' like Christmas, Epiphany and the Annunciation. However, the day of the most important Christian feast, Easter, and thus all the others that derive from the date of Easter (the beginning of Lent, the Ascension and Pentecost) are not fixed but determined on the basis of rules coming from the Hebrew lunar calendar. The first Council of Nicaea (325 AD) actually stated that Easter has to be celebrated on the Sunday following the first full Moon after the spring equinox. A number of non-trivial computations, implying a deep knowledge of the Sun and Moon's apparent motions, are thus needed to determine the date of Easter ('Epact computation') in the Julian calendar, which is a solar one. This problem initiated many studies, and a final solution

came in the work by the British Benedictine monk Beda Venerabilis, *De temporum ratione*, written on 725, a masterpiece of mathematical astronomy.



Figure 2. Portrait of Beda Venerabilis from a manuscript of the 12th Century (from www.hs-augsburg.de).

A further problem for the monks was the computation of the ‘canonical hours’, i.e., the proper time to perform liturgical functions. Liturgical time has its own sacrality, which requires that it be measured through the most reliable methods: the observation of the Sun in the daytime and of the stars in the night.

Monastic astronomy as observational astronomy

Monks thus became assiduous and careful observers of the sky. Of course, they were not experts in astronomy like their contemporary Eastern astronomers. It is indeed true that writing chronicles had a quite different aim in medieval Europe in comparison with the Eastern countries. But Western chronicles cannot be defined as ‘rough’, as is too often stated by scholars of historical astronomy (i.e. the subfield of cultural astronomy devoted to the recovery of astrophysical data from pre-telescopic observation).

When monks observed a relatively ‘common phenomenon’, such as an eclipse or a comet or a meteoric shower, they were precise in their descriptions. However, when they had to deal with an ‘unusual phenomenon’—one outside of their expertise, such as a ‘new star’ (i.e. nova or supernova)—it was more difficult for them to describe it in their ‘Latin’ (as standard and conventional written language), so they did so with common words or tropes related to religious or popular beliefs that were able to suggest an explanation of the phenomenon. For the latter cases we need a much more critical effort to

interpret their descriptions (see Ghignoli and Polcaro, 2007).

A significant role in what could be defined as ‘monastic observational astronomy’ was played by Irish monks, who transferred the traditional care for sky observation of the Celtic people into a Christian environment, and disseminated this knowledge throughout Western Europe where they established many new monasteries. St. Patrick himself is the author of astronomical books (Gaspani, 1999).

Especially with the so-called ‘Carolingian Renaissance’, the careful observation of the sky became a habit also in the ‘Schools of the Episcopates’, where laymen were admitted, too (see e.g. Lindberg, 1992). In these schools, the ‘secular’ part of the education included the ‘Seven liberal arts’, one of which was astronomy. Of course, their teaching was based on the Latin texts cited before, but it was integrated with experimental practice. Furthermore, the increased availability of economical resources allowed the ‘Schools of the Episcopates’—as incubators of the universities that were established in the following centuries—to introduce the first astronomical instruments used in Europe since the end of the Roman Empire. These were just tubes, used to isolate the star in the viewing field and to measure its alt-azimuthal coordinates; nevertheless, their use is a proof of the increasing interest in the precision of observations.

At the same time, Arabic astronomical knowledge and related observational techniques started to reach Europe. In 1050, the Benedictine Hermann of Reichenau wrote a book on the *astrolabe*, thus helping to introduce in Europe a powerful and versatile instrument allowing the precise measurement of stars’ positions and complex astronomical computations (Pouille, 1954).

The Islamic astronomy

It has been stated that Islam's interest in astronomy derived from religious needs: the prayers to be performed at fixed times and in the direction of Mecca (the *Qibla*), as well as the time of the beginning of Ramadan, determined by astronomical conditions (see, e.g., Bausani, 1977; Ruis, 2008). It has also been stated that the origin of Islamic astronomy is related to the gift, in 772 AD, of an astronomical book by some Hindi scholars to the Caliph of Baghdad al Mansur, who immediately ordered Ibn Ibrahim al Fazari to translate this book (named in Arabic *Zij al Sindhind*, i.e., Hindi astronomical tables) with the help of the same Hindi scholars. Other authors suggested that the interest of Arabic people in science and technology derived from the very nature of Islamic civilization itself: a tolerant, multi-racial and highly educated society which was ready to assimilate the best of the other peoples’ knowledge.

All these statements are at least partially true, but they are not enough to explain the role of astronomy in Islam. Most probably, the reason why astronomy became the most important science in the Islamic civilization has to be related to its origins in the Arabic nomadic people,

travelling through the sand desert of Arabia, where no geographical reference points are visible and the stars are the only reliable reference. Also the role of the Zoroastrian religion—spread in the entire area from Arabia to Central Asia in pre-Islamic times—and the Sabian religion has to be taken into account. These religions had a significant influence on the development of astronomy in Islamic world. For sure, Al-Sabi Thabit ibn Qurra al-Harrani (826-901), one of the first Islamic mathematicians, translator of Euclid's *Elements* and a renowned astronomer, was a Sabian.

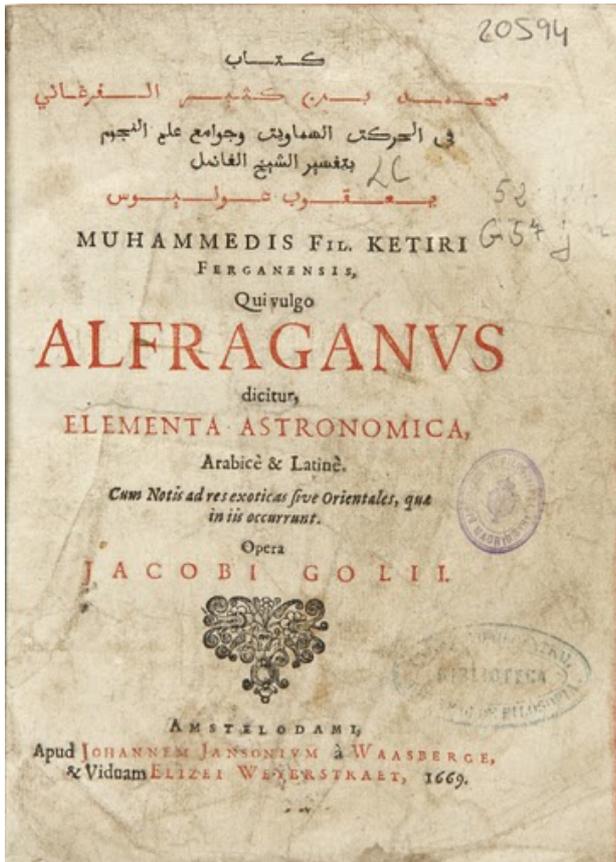


Figure 3. Dutch edition (1669) of the al-Farghani *Elements of Astronomy*, in Arabic with Latin translation.

On the other hand, the contact with these cultural heritages, as well as the preservation of the classical astronomy, also brought a stronger interconnection between astronomy and astrology than in the classical world. Actually, Islam does not accept any form of divination, including astrology, and in some cases holds the latter as ‘magic’ or even ‘idolatry’, both capital offences. However, Islamic scholars were socially highly considered and thus enjoyed a generous tolerance. Furthermore, the Abbasid caliphs were nearly obsessed with the recovery of the Greek and Roman cultures, considering them a powerful tool in the struggle (which was not only economic and military, but also cultural) with the Byzantine Empire for the control of Near East. This is why they were very inclined to make some exceptions to the doctrine in order to compete with the Byzantines on the cultural ground. It is a matter of fact that all Islamic astronomers were also (and in some cases mainly, as was Masha'allah, Baghdad, c. 800) astrologers.

It would be too long here to name all the great Islamic astronomers, from Avicenna to Ulugh Beg, and to list all the paramount developments of astronomy in the Islamic world between the 7th and 14th centuries (see, e.g., Bausani, 1977; King, 2004-2005). Here we stress just a few of these contributions to the rediscovery, and then overcoming, of Ptolemaic astronomy. The major astronomical work of Ptolemy, e.g., is known everywhere as the ‘Almagest’ (from the Arabic *al-Magisti*, an adaptation of the Greek ‘Megalè syntaxis’, i.e., ‘Great Treatise’), whose first Arabic translation was done by al Haggiag ibn Yussuf ibn Matar in the 9th century by order of the Abbasid caliph Harun al Rashid. The recovery of classical astronomy was immediately followed by the resumption of the experimental activities. For instance, the caliph al-Mamun and his team of astronomers led by the famous Ahmad ibn Muhammad ibn Kathir al-Farghani (Alfraganus) are responsible for the building of two astronomical observatories and two extraordinary astronomical exploits: the extremely precise measurement of the obliquity of the ecliptic as $23^{\circ} 33'$ in 830 AD and that of the meridian arc length in 828 AD. Worthy of special mention is the work of Nasir al-Din al-Tusi (1201-1274) and his team (including even a Chinese astronomer!) at Maragha Observatory in Persia, where a careful process of analysis and revision of the Ptolemaic model was performed. This work, often properly named the ‘Maragha Revolution’, demonstrated the incompatibility of the hypothesis of non-uniform motion and the introduction of the ‘equant’ with the Aristotelian principles that were the basis of the Ptolemaic model. Though there is no documented proof on this point, it is very probable that Copernicus’ work actually started from al-Tusi’s, given the analogy of the demonstrations used. For a deeper discussion on the influence of Maragha astronomy on Western astronomy see e.g. Saliba (2009) and Dobrzycki and Kremer (1996), who also consider the influence on Western astronomy by the later Syrian astronomer Ibn ash-Shatir.

The ‘Scientific revolution’ of the 12th Century

Islamic influence on Western astronomy (and on science as a whole) became of paramount importance during the 12th century: this fact demonstrates that, despite the Crusades, between Western Europe and Islam there was not only a clash, but an encounter too, though complex and harassed (see, e.g., Le Goff, 2004).

In this framework, the role of Emperor Frederick II (1194-1250) as a highly innovative ruler and intellectual is well known, for him being *trait d’union* between Christian and Islamic civilizations, as well as a promoter of the dawn of ‘secular science’ (see, e.g., Bressler, 2010). His masterpiece as a scholar is the book *De arte venandi cum avibus*—not only a ‘hunt handbook’ but a deep treatise on zoology, where various birds are described in detail from an experimental point of view; the author does not hesitate to criticize Aristotle himself, when his views are in contradiction with experimental evidence.

Frederick II did not leave us any text on astronomy, but his point of view on this field, fully inspired by Islamic Ptolemaic astronomy and astrology, is shown by the architectural design of his castles. For sure, Frederick II was the sponsor of Leonardo Fibonacci, the mathematician who started modern mathematics by introducing the Islamic innovations in this science (see, e.g., Sigler, 2002), and Michael Scotus, the scholar who reintroduced astrology in European astronomy. Most probably the inclination of Frederick II towards astrology was due to his admiration for Islamic culture and his opposition to Papacy.



Figure 4. Frederic II in the Manfred edition of his *De Arte Venandi cum Avibus* (Book on Falconry, 1239). Rome, Biblioteca Apostolica Vaticana, Pal. lat. 1071, fol. 1 v°. Image from Wikipedia.

However, the reintroduction of astrology must not only be considered as a cultural involution (what is of course true) but also as one of the reasons for the subsequent impetuous development of astronomy. Actually, during the Middle Ages, European astronomers were monks and clerics, performing a technical service for their communities, and only a few people dedicated their life to such a task like astronomy. When astrology was reintroduced in Europe, astronomy became a lucrative and respected profession: the number of astronomers, and thus the number of astronomical studies and results, started to increase, also supported by the need for astronomical knowledge brought by the development of long range navigation in the new economical and social framework from the 13th century onwards.

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