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IBERIAN APPROACHES TO ASTRONOMY DURING THE SIXTEENTH CENTURY

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ABSTRACT

The aim of this work is to describe different kinds of astronomical and astrological works written in the sixteenth century, with special emphasis on Portuguese and Spanish texts. This period is especially relevant in the development of astronomical culture in Portugal and Spain, since this was the age of the great overseas explorations, when astronomical navigation became of fundamental importance. The astronomical culture of that time involved ancient and new concepts, and old revisited narratives about the cosmos and its influence in many facets of the sublunary world. The present research describes the influence and transformation of the classical and medieval astronomical culture in the specific context of sixteenth century Iberian texts. There were different publics involved in the production and study of those works, such as navigators, priests, physicians, farmers, astrologers and scholars. Those different aspects of astronomical and astrological knowledge were not distinct, there was a significant overlap between them; and the educated public required some broad acquaintance with those several approaches. Some popular treatises, called *Chronographia*, or *Reportorio dos tempos*, provided astronomical and astrological information required by the general public. This overview of those sources can contribute to a better and more comprehensive understanding of the astronomical culture in that period.

KEYWORDS: Portuguese Astronomy, Spanish Astronomy, Sixteenth Century

1. INTRODUCTION

Although the study of Iberian science during the Renaissance has been overlooked by the majority of historians, its relevance is recognized nowadays (Goodman, 1992; Cañizares-Esguerra, 2004). There are several historical studies of science and, more specifically, astronomy and astrology in Portugal and Spain, during this period (Martins, 2004; Costa and Leitão, 2008; Fabiani, 1995). All over Europe, astronomy and astrology were both respected and deeply related fields, up to the beginning of the seventeenth century (Allen, 1966). Therefore, no attempt will be made here to disentangle those two fields.

The aim of this paper is neither to provide a full account of this subject nor to discuss particular works. Its purpose is calling the attention to the different publics interested in the production and study of astronomy and astrology in the Iberian Peninsula at that time.

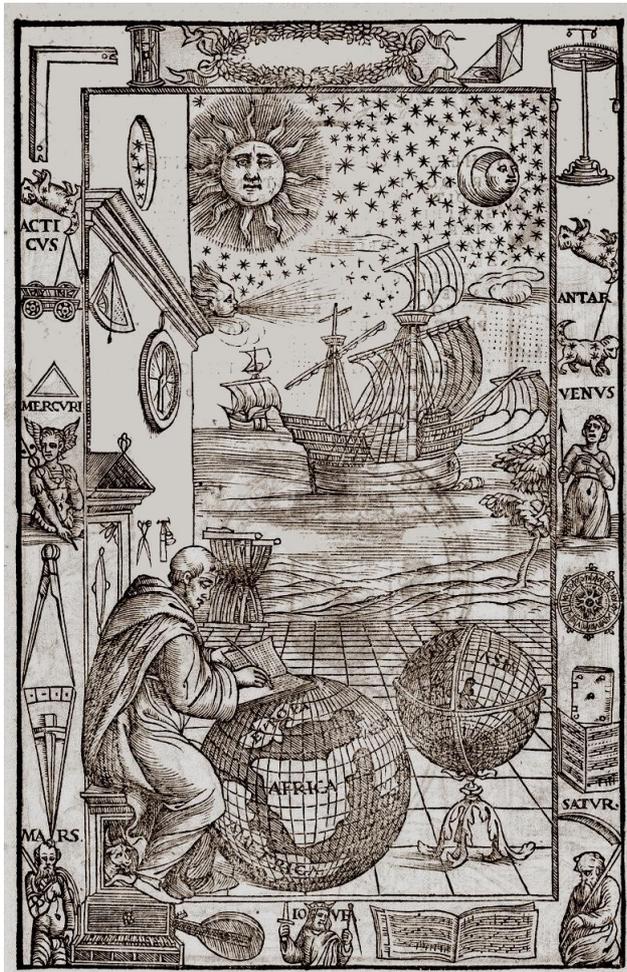


Figure 1. A representation of some of the uses of astronomy in the sixteenth century (Fra Mauro, 1537, frontispiece).

In Portugal and Spain, during the sixteenth century, there was a variety of interests concerning astronomical and astrological knowledge – as it usually

happens in any culture (Macedo, 1975). Different publics were involved with diverse contents and uses of astronomy. Among the several cultural aspects of Iberian astronomy in this period (Martins, 2004), we may include the astronomical prospects of:

- priests and other people concerning with religion;
- pilots, navigators and cartographers;
- physicians, surgeons and other persons concerned with health;
- farmers, hunters and fishermen;
- astrologers;
- scholars, that is, university students and teachers;
- other groups.

During the sixteenth century, astronomy was regarded as an important and practical science, useful for several purposes (Figure 1). Although there was an overlap of those different snippets of astronomy, each of them made a specific use of selected portions of astronomy and astrology, producing distinct texts.

2. PUBLICS AND INTERESTS

The religious dimensions of astronomy, at that time, included the biblical and theological view of the cosmos; the relation between the heavenly spheres and the different orders of angels and saints; the locality of God and of demons; and technical calendar problems such as ascertaining the Easter days.

The astronomical profile of pilots, navigators and cartographers embraced the study of celestial circles and corresponding terrestrial circles; the annual motion of the Sun (from a geocentric point of view) and the motion of the Moon; the influence of the Moon and the Sun on the tides; the constellations and the celestial poles; the astronomical determination of time; the study of the terrestrial zones and climes; ascertaining the main geographical directions; and determination of latitude (by the stars and the Sun) and longitude (especially by lunar eclipses).

Physicians and surgeons of that time required a knowledge of the accepted influences of the celestial bodies (especially the Moon) on health and diseases; the connection between the bodily humours and the sky; the relation between drugs and heavenly influences; the correlations between parts of the human body and the planets and constellations; the adequate astronomical settings for specific treatments (such as bleeding); the relation between celestial phenomena and epidemics; and the precise relation between the individual horoscope and health problems.

The astronomical profiles of farmers, hunters and fishermen involved the study of constellations and their associations with the seasons; the seasonal in-

fluences on animals and plants; the association between the phases of the Moon and biological phenomena; and the relation between celestial occurrences and the weather.

Although judicial astrology was banned for theological religious reasons in Spain and Portugal (Baldini, 2001), it was practiced; and the study of collective (not individual) astrological influences was permitted. Both required the detailed study of the celestial bodies, including the computation of the motion of the planets, and knowledge of their influences on sublunary events. Of course, not every astrologer was able to compute the motions of the celestial bodies, most of them used tables produced by a few experts.

The astronomical contingent of students and teachers of liberal arts at the universities and colleges embraced the study of philosophical views of the universe; the structure of the cosmos; discussions about the form and position of the Earth; a general study of the heavenly motions; the understanding of astronomical phenomena; the philosophical views of astronomy; and astronomical knowledge discussed or cited in classical literature. This general basis was also the basis of the study of Medicine, but medical students required a more detailed study of the motion of the planets and of astrology.

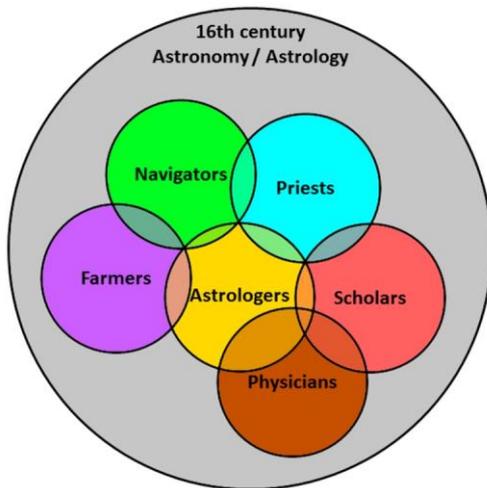


Figure 2. A schematic representation of several interest groups that were concerned with astronomy and astrology in the Iberian Peninsula, during the sixteenth century. No attempt was made to show all intersections or to provide a quantitative estimate of each approach.

The general public did not require a deep or technical acquaintance with astronomy and astrology, but the broad astronomical knowledge of the time was an important part of their culture and practical life.

None of those groups was interested in the whole astronomical and astrological knowledge of that time (Figure 2). Of course, the different cultural pro-

files of astronomy had some overlap; and any specific person could be uniquely interested in a smaller or larger set of astronomical and astrological issues, not restricted by his or her professional involvement.

Our classification of interest groups does not include “astronomers”. During that period, astronomical observations were rarely made in Portugal or Spain; and theoretical (mathematical) astronomy was a subject that was not restricted to a single group. It was part of the university teaching and it was practiced mainly among astrologers and a few physicians.

3. ASTRONOMICAL PUBLICATIONS

The sources used and produced by the several cultural profiles of astronomy varied; sixteenth-century literature produced in the Iberian Peninsula reflected the astronomical concerns of several different interest groups.

There was a very strong development of astronomy and astrology in the Spanish-speaking world, since the reign of Alfonso X de Castilla, “el Sabio” (1221–1284). The Iberian Peninsula was one of the places where the classical astronomical and astrological knowledge was brought back to Europe, accompanied by its recent Islamic developments (Hasse, 2006; Procter, 1945). From that time to the sixteenth century, the study of Greek, Roman and Arabic works on the subject became gradually widespread, with the help of the recently created European universities and, later, of the invention of the printing press. Important Latin Medieval treatises were also produced, such as Johannes de Sacrobosco’s *Tractatus de Sphaera*, and the more technical works called *Theorica planetarum* by Gerard of Cremona, Campanus de Novarra and, later, by Georg von Peurbach.

Beginning in the late fifteenth century, a second wave of astronomical and astrological interest developed in the Iberian Peninsula (Chabá, 2006), stimulated by the beginning of the great oversea explorations developed by Portugal and Spain, when astronomical navigation became of fundamental importance (Bensaúde, 1912; Costa, 1934). The wealth brought back by the conquerors produced a stream of new literary, philosophical, medical and scientific developments, with the production of some relevant original production related to astronomy (Navarro-Brotóns, 1992). The poet Luís Vaz de Camões (1525–1580) wrote the epic *Os Lusíadas* (first printed in 1572), describing the Portuguese conquests. In this work we can find a profusion of astronomical allusions (Silva, 1943).

The Portuguese and Spanish navigators produced new geographic, cosmographic and cartographic works (Mosley, 2009), describing and mapping the

lands they visited and the new ship routes they followed (Cortese, 1935). The production and use of the maps required technical astronomical knowledge and the use of instruments (such as the nautical astrolabe) to find out the geographical latitude of a place. In clear nights, the latitude can be found from the position of the stars close to the celestial North Pole, in the northern hemisphere; but during the day, or after crossing the Equator, the best method is measuring the altitude of the Sun and using tables of the solar motion to establish the latitude. This method and the required tables were produced by the Spanish mathematician Abraham ben Samuel Zacuto (c.1450–c.1522), who produced in the decade of 1470 the first version of his *Almanach perpetuum* (Goldstein, 1965), in Hebrew (*ha-hibbur ha-gadol*). This work was translated into Spanish and afterwards in Latin by his disciple, Mestre José Vizinho, and published in Leiria (Zacuto, 1496). It was one of the first books published in Portugal with a movable type printing press and it became the basis of the tables used by navigators.

All over Europe, Sacrobosco's *Tractatus de Sphaera* was the main astronomical textbook, and the universities of Spain and Portugal followed the main current (Navarro-Brotons, 2006). Even in the case of Iberian works directly based on former treatises (such as Sacrobosco's *Sphaera*) we find a mixture of tradition – with plenty of quotations of ancient thinkers and natural philosophers as Aristotle, Pliny the Elder or Ptolemy, for example – and innovation – such as the new geographical knowledge that corrected and complemented the old tradition (Martins, 2004). Pedro Nunes (1502–1578), professor of the University of Coimbra, published in 1537 a Portuguese translation of Sacrobosco's *Tractatus de sphaera*, to which he added not only several comments (as was usual), but also other tracts on the motion of the Sun and the Moon, the translation of the first book of Ptolemy's geography, and two treatises on nautical maps and astronomical navigation (Nunes, 1537). Jerónimo de Chaves (1523–1574) published an erudite Spanish translation of and commentary on Sacrobosco's work, transforming the short original into a treatise of over 200 pages, with the addition of tables and practical elucidations (Chaves, 1545).

Towards the end of the century, the Jesuit priests of the “Colégio das Artes” (School of Arts) of Coimbra produced a series of treatises on Aristotle's philosophy (Casalini, 2017), including a detailed commentary of his book *De coelo* (Colégio das Artes de Coimbra, 1608), first printed in Lisbon, in 1593. This work, containing the Greek and Latin versions of the original work, with lots of additional material, attempted to update the Aristotelian cosmology, introducing much new information. The treatises pro-

duced by the *Conimbricenses* had a strong influence all over Europe.

Astrological medicine was taught in the Iberian peninsula, as in most other European countries (Navarro & Tayra, 2006); and a book by Jerónimo de Miranda (1562) highly recommends its study by physicians. The production of specific works associated to the several cultural aspects of Iberian astronomy in this period was a rare occurrence. Only a few of the astronomical/astrological works produced in this period were highly specific, such as Enrique de Cuellar's treatise on astrological medicine (Cuellar, 1543). This book was written for medicine students and physicians and it is likely that it did not come to the attention of other people. Most sixteenth-century Iberian astronomical works, however, were addressed to a wide public.

A representative work of that time is a manuscript treatise on the sphere written in the form of a dialogue between a teacher and a student, written around 1530 (Castro, 1940). It is usually attributed to Dom João de Castro, Vice-Roy of Portuguese India, although its authorship is not easily ascertained (Cardoso, 2004). It contains many elements and astronomical concepts in common with other texts of that period that were used to teach navigators or to serve as reference to an extensive public interested in themes related with astronomical subjects in that time (Cardoso and Martins, 2001). Another relevant unpublished work of that time was Duarte Pacheco Pereira's *Esmeraldo de Situ Orbis* (Pereira, 1991), a book primarily containing geographical information but also exhibiting a remarkable acquaintance with the astronomical knowledge of the period (Carvalho, 1983).

4. DISTINCTIVE IBERIAN ASTRONOMICAL WORKS

Much of the astronomical and astrological production of sixteenth-century Portuguese and Spanish authors exhibit no Iberian peculiarity and they could have been written in any other European country – such as Pedro de Espinosa's commentary on Sacrobosco's *Sphaera* (Espinosa, 1550). There were, however, two special types of publications that were distinctively Iberian: those related to cosmography and navigation; and the astronomical / astrological compilations called *Reportorio de los tiempos*.

4.1. *Cosmography and navigation*

Astronomical navigation required a basic knowledge of spherical astronomy that was uncommon among pilots of that day. In Spain, the *Casa de la Contratación* provided the necessary training of navigators (Martínez, 2010). Around 1510 two Portuguese seafaring guides were published, including

a translation of Sacrobosco's *Tractatus de sphaera* to provide the fundamental concepts required for understanding the nautical methods (Albuquerque, 1965). They were the first examples of a new genre of Iberian astronomical literature, the so-called "nautical guides", that contained a description of basic astronomical concepts; explanations of the methods for determining the latitude of a place using the Sun, the Pole Star and the Southern Cross; the method of ascertaining the time, at night, from observations of the Ursa Minor and the Southern Cross; tables of the daily declination of the Sun; and other relevant geographic and astronomical information. There were also several attempts to evaluate longitudes, during the sixteenth century (Randles, 1985). This kind of practical astronomical literature grew in Portugal and Spain from small manuals to huge detailed treatises that also described astronomical instruments and their use (González, 2006). Some of those treatises had a strong influence all over Europe, during that period (Waters, 1970). They combined traditional astronomical knowledge with new methods, tables, instruments and practical wisdom (Lisboa, 1903; Faleiro, 1535).

Pedro de Medina (1493–1567) was one of the most important Iberian cosmographers during the sixteenth century (Lamb, 1972). The title of his most famous work was *Arte de navegar* ("The art of navigation"), published for the first time in 1545, in Valladolid. This very successful book was published three times in Spanish, six times in French, once in Italian, four times in German, three times in Dutch and twice in English, during the sixteenth century – besides other editions in the next century. It's awesome if you consider that time! He also published other works, including a cosmographical treatise (Medina, 1980).

4.2. *Reportorio de los tiempos*

In addition to the nautical guides, there were other peculiar Iberian astronomical and astrological works produced during the sixteenth century. There were, for instance, many popular treatises called *Chronographia*, or *Reportorio de los tiempos*, which provided the astronomical and astrological information required by the general public and by some special groups. The oldest example of this kind of literature was Andrés de Li's *Reportorio de los tiempos*, published in Zaragoza, in 1495 (Li, 1999). This small work was published several times in Spain and in Portugal, where it was translated and improved by Valentim Fernandes (1552).

Li's book inspired other larger works with similar title and content, the most famous being Jerónimo de Chaves' *Chronographia o reportorio de los tiempos* (Chaves, 1550), republished nine times in Spain and

once in Portugal. A similar work was produced in Portugal by André do Avelar (1546–c.1625): *Reportorio dos tempos, o mais copioso que até agora sahio a luz* (Avelar, 1585; Costa, 2007). It underwent four editions (from 1585 to 1602).

The highly popular works of the genre *Reportorio de los tiempos* are a good example of the amalgamation of a variety of approaches and interests (Costa, 2007). Its chronological part included information required by priests to calculate the religious calendar and the correlation between the hours of each weekday and the planets, according to astrologers; it described the division of the day and night in natural and artificial hours; the heavenly spheres, and the astrological influence of each planet; the Zodiac is described both from the point of view of its influence on the sublunary world and regarding the details of the motion of the Sun along the ecliptic, and the duration of the days and nights. The work includes a fairly detailed description of the universe and its parts, of the heavenly circles and their terrestrial counterparts, introducing the zones and climes. The religious calendar, with the names of the catholic saints associated to each day, is combined with recommendations concerning what should be done or avoided in each lunar phase, for each month. A considerable part of the book is devoted to astrological medicine, explaining the four humours and temperaments, and the astronomical choice of treatments according to the temperament and the configuration of the heavens. Eclipses are described both as purely astronomical phenomena, providing tables of their occurrences; and as astrological causes of storms and other wars. The treatise deals with the influence of the Moon on the weather and on crops; and its final part presents information concerning navigation and tides.

The encyclopaedic character of works of this kind shows that it was not aimed at a particular public with peculiar interests – indeed, any person of that time might profit from reading some part of the book. This circumstance probably explains the wide circulation and popularity of those works.

5. FINAL COMMENTS

When studying the history of astronomy in the past, it is important to note desirable to notice that this field of knowledge was not the domain of a specific class of "astronomers"; it was a subject studied from different points of view by different publics. Instead of being a single discipline, astronomy (together with astrology, in the period studied here) can be regarded as a set of subfields, each of them contemplating specific interests.

It is impossible, of course, to present in a single paper the whole variety of Iberian astronomical

works of the sixteenth century. We hope, however, that his overview can contribute to a better and more comprehensive understanding of the astronomical culture in that period.

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- compreições. E a declinaçam do sol com seu regimento. E ho regimento da estrella do norte. Com outras muytas cousas acrecentadas de nouo, Lixboa, Germão Galharde.
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