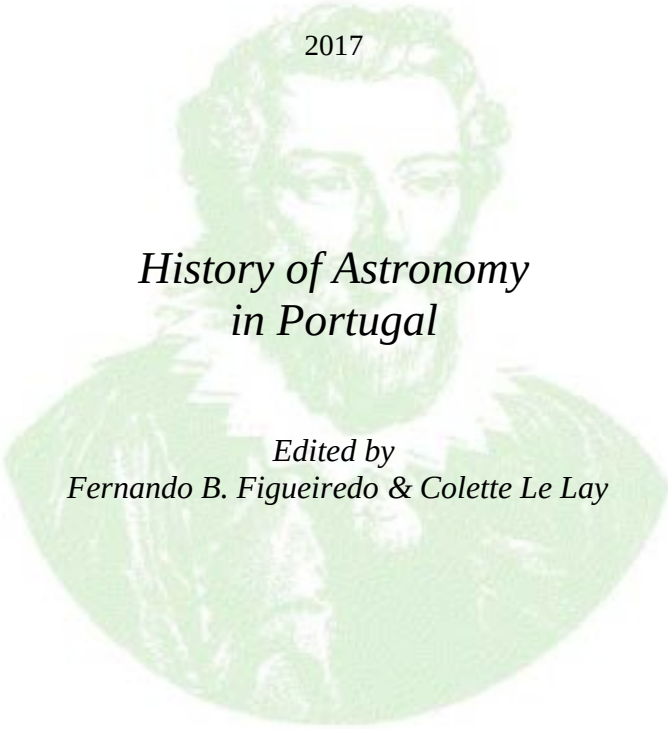
CAHIERS
FRANÇOIS VIÈTE

Série III – N° 3

2017



History of Astronomy in Portugal

Edited by
Fernando B. Figueiredo & Colette Le Lay

Centre François Viète
Épistémologie, histoire des sciences et des techniques
Université de Nantes - Université de Bretagne Occidentale

Imprimerie Centrale de l'Université de Nantes
Décembre 2017

Cahiers François Viète

La revue du *Centre François Viète*
Épistémologie, Histoire des Sciences et des Techniques
EA 1161, Université de Nantes - Université de Bretagne Occidentale
ISSN 1297-9112

cahiers-francois-viete@univ-nantes.fr
www.cfv.univ-nantes.fr

Depuis 1999, les *Cahiers François Viète* publient des articles originaux, en français ou en anglais, d'épistémologie et d'histoire des sciences et des techniques. Les *Cahiers François Viète* se sont dotés d'un comité de lecture international depuis 2016.

ISBN 978-2-86939-245-1

CONTENTS

Cahiers François Viète, série III, 3, 2017, p. 61-79

Astronomy and Diplomacy at the Court of King João V of Portugal

Luís Tirapicos*

Abstract

During the reign of King João V of Portugal (r.1707-1750), astronomy took part in a movement of cultural renewal and gave impulse to notable international exchanges, which were promoted by the absolutist monarch himself. Using the Portuguese diplomatic network and the extensive epistolary networks of their own Society, a group of Jesuit astronomers – with Neapolitan Giovanni Battista Carbone in the leading role – developed an efficient program of precise celestial observations. This program met João V's political agenda in several ways: the creation of new observatories and the publication of results in European academic journals increased the prestige of the monarchy and a novel cartography of Brazil improved the geographical knowledge of the colony.

Keywords: astronomy, diplomacy, King João V, Jesuits, Giovanni Battista Carbone, Domenico Capassi, Aula da Esfera*, observatories.*

Résumé

Pendant le règne du roi João V du Portugal (r.1707-1750), l'astronomie a participé à un mouvement de renouveau culturel et a donné lieu à des échanges internationaux, incités par le monarque absolutiste. En utilisant le réseau diplomatique portugais et grâce aux nombreux échanges épistolaires de leur société, un groupe d'astronomes jésuites, dirigé par Giovanni B. Carbone, a développé un programme d'observations célestes précises. Ce programme a rencontré l'agenda politique de João V de plusieurs façons : la création de nouveaux observatoires et la publication des résultats dans les journaux académiques ont accru le prestige de la monarchie, et une nouvelle cartographie du Brésil a amélioré la connaissance géographique de sa colonie.

Mots-clés : astronomie, diplomatie, roi João V, Jésuites, Giovanni Battista Carbone, Domenico Capassi, Aula da Esfera*, observatoires.*

* Interuniversity Center for the History of Science and Technology (CIUHCT), University of Lisbon (Portugal).

Introduction: Between the Utrecht and Madrid Treaties

In 1722, the Portuguese representative in Paris, Dom Luís da Cunha (1662-1749), wrote in one of his letters to the court: "I can assure you that there is no person who does not think that Your Royal Highness is the richest Prince in Europe and that we are the richest vassals".[1] In his communications with Lisbon, in a more surprised and worried tone, Luís da Cunha would mention that his acquaintances in Versailles believed that the streets of Lisbon were covered with gold. The Portuguese ambassador knew very well that the streets of Lisbon were not covered with the precious metal but the riches discovered in Brazilian mines in the last decade of the 17th century had a profound effect on the reign of absolutist King João V of Portugal (r.1707-1750).[2]

On the mainland, the wealth arriving from Brazil allowed the investment in various architectural projects of which the Mafra *Royal Building* (a Palace-Convent-Basilica) was the largest example: the monumental construction in Mafra employed around 50,000 workers at its peak (António F. Pimentel, 2002, p. 125-156). Simultaneously, because important mineral riches were discovered in Brazil during this period, priorities in the complex interactions and administration of the Portuguese maritime empire shifted from East Asia to the Atlantic (Safier, 2009, p. 133-183).

The continued and sustained cultural activity developed during João V's reign is generally seen as the climax of Baroque culture in Portugal (Monteiro, 2009). Focused on the figure of the king, the monarch's policy promoted the image of a protector of the arts and sciences, an image that was spread throughout Europe. As Nuno G. Monteiro argued (Monteiro, 2009, p. 350), the cultural renewal during King João V's era was perhaps more effective in the arts and in architecture than in other areas, such as the sciences – But it is also true that the need for a geographical knowledge of the vast territory of Portuguese America, the development of manufacturing activities, and even the existence of practical needs associated with mining, navigation and cartography led to the promotion of Portuguese qualified intellectuals and technicians within the court, as well as the opening to experts from other European kingdoms.

---

[1] Arquivos Nacionais Torre do Tombo (ANTT, Lisbon), MNE, Livro 791, p. 61 (letter dated 2 February 1722). All translations in this paper are mine. On Dom Luís da Cunha see Cluny, 1999).

[2] On King João V (1689-1750) see for instance (Silva, 2006; Reis, 2009; Monteiro, 2009).

From an economic point of view, Portugal benefited from the peace achieved with the Utrecht treaties (1713-1715) – putting an end to the War of the Spanish Succession and to expenses connected with military efforts – and from the Crown's financial relief which was provided by gold and diamonds arriving from Brazil and especially by new or increased taxes. Besides, the Methuen Treaty, signed in 1703 with England, came to benefit the export of wine although it was detrimental to Portuguese wool exports. This economic context was certainly favourable to the creation and sponsorship by the King of different cultural institutions, such as the library of the Mafra Royal Building, the University of Coimbra library, the library of the Oratorian convent-palace of Nossa Senhora das Necessidades, and the enlargement of his own library at the Palace of Ribeira, which by 1750 reached around 70000 volumes. The foundation of the Royal Academy of Portuguese History in 1720 and its renowned editorial activity in which experts had an important role – such as the printer Pierre Rochefort de Massard who had worked for the Académie royale des Sciences in Paris – demonstrate the cultural dynamism of the Johannine period.

King João V considered the French, English and Roman cultural life as his main intellectual models (Pimentel, 2002, p. 65-73, 87, 98-99). Among other things, the monarch imported his own clothes from Paris and also borrowed different etiquette rules from various European courts. Therefore, it is not surprising that King João V started to observe eclipses with court astronomers as Louis XIV had done in Paris with members of the Académie royale des Sciences when the institution was created.

In the first half of the 18th century, the tension between Portugal and Spain over their possessions in South America was still strong since the borders between the two colonial regions were not precisely set and agreed on (Cortesão, 1984, p. 349) and Portugal's territorial influence extended well beyond the limits defined by the Treaty of Tordesillas.[3] In this context, detailed knowledge of South American inland geography was a state matter and João V's officials, diplomats, cartographers and astronomers became actors in the long political process that culminated in January 1750 with the signature of the Treaty of Madrid (Ferreira, 2001). This first diplomatic agreement regarding the disputed limits recognized Spanish rule over parts of the River Plate, Sacramento Colony, and the Philippines, while Portug-

[3] On June 1494, Portugal and Spain signed in Tordesillas a treaty dividing the newly discovered lands between the two crowns along a meridian 370 leagues west of the Cape Verde islands. The lands to the east would belong to Portugal while the lands to the west to Spain.

al's territorial claims over parts of northern and western Brazil were recognized.

Before the Treaty of Madrid, the definition of precise longitude and latitude by Jesuit astronomers was the main astronomical contribution to geographical explorations and cartography in Brazil (Cortesão, 2009). The human and material resources employed in these explorations were acquired almost entirely from outer kingdoms. In this importation of astronomical knowledge, astronomers and instruments, the Portuguese diplomatic network and the Society of Jesus played a crucial role.

In 1722, following King João V's request , the general of the Society of Jesus, Michelangelo Tamburini, sent Carbone and his fellow Jesuit Domenico Capassi (1694-1736) to Portugal. The aim was to employ the two missionaries in cartographical work on the Brazilian state of Maranhão, not only because its borders were under dispute with Spain but also because an urgent need of precisely demarcated administrative divisions was felt (Almeida, 2001). Apparently, the King treasured Carbone's character and skills since, around 1724, he entered Lisbon´s court and was nominated a royal mathematician. Dauril Alden argued that Carbone became the most influential and widely respected Jesuit in the kingdom, and there is in fact plenty of evidence that important responsibilities – such as the negotiations with the papacy or the payments of Mafra's works – were entrusted to Carbone (Alden, 1996, p. 610-612).

Astronomy Teaching in the *Aula da Esfera*

During João V's era, two royal mathematical lectures – one on navigation and the other on fortification – were delivered at the Palace of Ribeira. However, the most influential royal lecture on mathematics and astronomy was held by the Jesuits at the College of Santo Antão, where Giovanni Battista Carbone lived and coordinated the astronomical observatory between ca. 1739 and 1750.

Carbone's and Capassi's observational programs further developed the investigations and studies of celestial phenomena which were carried out in the College but turning to a more "experimental" method, that is with a clear focus on geographical applications (i.e. in the determination of geographical coordinates). The long-lasting tradition of teaching cosmographical and astronomical subjects which had been developed at Santo Antão and maintained until 1759, with its emphasis on navigation, remained a kind of a parallel program that reinforced the empirical activities of the two Neapolitan astronomers.

In Santo Antão, a lecture on mathematical subjects called *Aula da Esfera* (Class on the Sphere) was established around 1590, succeeding to previous and sporadic teaching of astronomy and cosmography (Leitão, 2007, p. 44-49). The *Aula da Esfera* was a special lecture outside the Jesuit curriculum and delivered in vernacular, open not only to Jesuit students but also to members of the nobility and other lay students. The lectures were of a secondary level rather than of a high or scholarly level. Nevertheless, the *Aula* had an important social impact by helping to train, among others, future royal cosmographers (Baldini, 2004; Leitão, 2008, p. 19-23). Many physical and mathematical topics were taught, ranging from geometry, arithmetic, (rudiments of) algebra, or plane and spherical trigonometry, to their application in navigation, geography, hydrography and cartography. Optics, perspective and scenography, gnomonics, and the construction of scientific instruments or simple machines were also taught, as well as statics and hydrostatics, military architecture and engineering. Even forbidden subjects, such as astrology and chiromancy, were sometimes included by the few *Aula*'s teachers who ventured onto those dangerous grounds, although a clear distinction was maintained between 'good' and 'bad' uses (Leitão, 2006).

From around 1620 until the expulsion of the Jesuits from Portugal in 1759, astronomy was taught in the *Aula* according to Tycho Brahe's system, as it was in all Jesuit schools and most universities during this period. The heliocentric system and the new Galilean observations were discussed but only with the aim of refuting them (Baldini, 2004, p. 19-23). Santo Antão's *Aula* was remarkable, not only for the exceptional international circulation of Jesuit experts – sometimes in transit to distant Portuguese missions – but for another reason. Actually, Giovanni Paolo Lembo (1570-1618), the most accomplished telescope maker after Galileo, taught his construction techniques in Lisbon during the period 1615-17, and his case is considered the first known historical case of telescope making in a teaching environment (Leitão, 2007, p. 50-58).

The *Aula da Esfera* also welcomed Jesuit mathematicians such as Christoph Grienberger (1564-1636) and Cristoforo Borri (1583-1632) as professors. This phenomenon was motivated, at least partly in the 17th century, by the small number of Portuguese members of the Society who were available to pursue the study of mathematics (Leitão, 2009).[4] Indeed, most Portuguese Jesuits took every opportunity to be engaged in missio-

[4] For a detailed analysis of the complex factors determining the activity of Portuguese or foreign professors of mathematics in Portuguese Jesuit Colleges, see (Baldini, 2004).

nary work. In the 18th century, the situation changed and virtually all mathematics teachers in the *Aula* were Portuguese. Many were good mathematicians – such as João Inácio Vieira (1678-1739) and Manuel de Campos (1681-1758). Luís Gonzaga (1666-1747), who taught there between 1700 and 1709, had close connections with the court and became future King João V's mathematical tutor, certainly influencing the young prince's interests and his upbringing (Leitão, 2003). The change taking place in the 18th century was a consequence of a reform introduced by the Society's general Thyrsus Gonzalez (1624-1705) and completed by his successor Michelangelo Tamburini (1648-1730). Between 1692 and 1711, the two generals introduced regular mathematics teachings, within the philosophy curriculum, in Lisbon, Coimbra and Évora Universities (Baldini, 2004).[5] Therefore, the new situation allowed Portuguese members of the Society to have access to a mathematical training and filled the need of competent technicians in several posts – as missionaries in China, as professors in the *Aula da Esfera*, and as cartographers in Brazil.[6] For instance, Diogo Soares (1684-1748) occupied the last two positions and became an accomplished cartographer in South America. Jaime Cortesão showed that the geographical coordinates which were determined by Soares in Brazil and obtained with astronomical observations were fairly accurate when compared with modern values (Cortesão, 1958).

The Practice of Astronomy during João V's Reign

The central figure in the practice of astronomy at João V's court was the Jesuit Giovanni Battista Carbone (1694-1750). Carbone was born in Oria in the kingdom of Naples, in September 1694. In 1709, he entered the Jesuit novitiate in Naples and undertook most of his studies at the Neapolitan college. The college was famous for its mathematical teaching and, as the work of Romano Gatto has shown, a distinctive tradition of astronomical practice emerged there (Gatto, 1994, p. 150-158). Since the publication of Galileo's *Sidereus Nuncius* (1610), the college had been equipped with fine telescopes and some of its best mathematicians were enthusiastic advocates of positional astronomy. In the second half of the 17th century, the college also became the most important focus in the diffusion of Cartesian analysis

[5] Coimbra was the main college in the Portuguese *Lusitania* province and Évora the only Portuguese Jesuit university.

[6] Interestingly, Gonzales reform had been motivated by the lack of Portuguese missionaries who were provided with mathematical training when the Portuguese Mission in China was challenged by the French Jesuit expedition of 1687.

in Italy, after the introduction of the teaching of François Viète's algebra in the 1620s (Gatto, 1994, p. 150-158, 283-284). It was in this stimulating environment that Carbone and Capassi studied rhetoric and philosophy as well as mathematics, since this last discipline was part of the philosophy curriculum (Almeida, 2001, p. 84).[7]

The 1720s represented an active period of astronomical observations for the two Neapolitan Jesuits in Portugal and in 1729 Giovanni Battista Carbone was elected member of the *Royal Society* of London. The same year, Capassi travelled with his fellow Jesuit Diogo Soares to South America, where, until his sudden illness and death in 1736, he produced fine and detailed maps of the territory (Almeida, 1999, 2001, p. 82-140). Those cartographic surveys covered parts of the coastline, and were improved thanks to a few inland excursions to the southern region of the Portuguese colony.

Carbone also served as rector of the Santo Antão College in the last year of his life. Carbone's influence was felt even in his office – the only administrative post he assumed within the Society. The surviving archives of the college document that a large building campaign started under Carbone's direction and with his strong support, most likely with royal patronage.[8]

To satisfy the need for astronomical training institutions regarding the intended American cartographic mission, two "observatories" were created in Lisbon by Carbone and Capassi, following King João V's orders – one at the Santo Antão College and another at the Royal Palace of Ribeira (Carvalho, 1985, p. 40-46). The precise date of foundation of these observing stations is uncertain. Apparently, the first observations started in 1723 and used no permanent structures. The word "observatory" itself – as Roger Hahn has noted – was employed ambiguously during the Enlightenment, sometimes simply referring to a place where portable instruments could be installed (Hahn 1986, p. 653-658). However, there is evidence that Carbone and Capassi performed regular astronomical observations in the 1720s at the Royal Palace, on Lisbon's waterfront, and also in Santo Antão, where ca. 1739 a *Especula*,(or permanent observatory) was finally erected over the college's church (Tirapicos, 2014).

The presence of the two Jesuits in Lisbon and the emergence of royal observatories construction projects prompted the need for larger and better instruments. In 1723, diplomatic contacts were established with the

---

[7] Carbone´s official biographer, although in a panegyric tone, argued that he was a distinguished philosophy, theology and mathematics student in Naples (Barbosa, 1751, p. 4-5).

[8] ANTT (Lisbon), Cartório dos Jesuítas, Maço 92, nº2, fl. 88.

King's patronage by the Secretary of State, Diogo de Mendonça Corte-Real (1658-1736), in order to purchase mathematical instruments (mainly astronomical) from the best European instrument makers (Cortesão, 2009, p. 349-351). Apart from the case of nautical instruments, the production of scientific devices in Portugal was very scarce and circumscribed, and the necessary instruments generally had to be acquired abroad (author, 2010). In August 1723, a quadrant and a semicircle were bought in Rome, and on 6th July 1724: "um óculo em um bastão com retículo e graus" and "três cavaletes para óculos" (Rodrigues, 1931-1950, tom. 4, vol. 1, p. 415-416).[9]

There were further purchase of mathematical instruments in the following years, extending Portuguese trading area to London, Paris and The Hague. A 3-feet sextant, certainly incorporating telescopic sights and made by Nicolas Bion (1655-1733), arrived from Paris as well as a 5-foot mural quadrant.[10] Quadrants and sextants of this period were typically equipped with telescopic sights (Bennett, 1987, p. 63-72). These new technical resources, along with the use of the micrometer, inaugurated an era of precise positional astronomy, which had emerged a few decades before, mainly based on the work of Jean Picard (1620-1682).

King João V's astronomers also had access to unique instruments, such as semicircles, which were very unusual devices according to Jim Bennett (Bennett, 1987, p. 76). Even if Jaime Cortesão did not make his primary source explicit, he has claimed that Carbone and Capassi preferred instruments which were made by Le Febvre over those manufactured by Bion, revealing the Jesuits' critical mind regarding instruments' accuracy and efficiency.[11] For example, the first maker supplied, at least, a 3-foot quadrant and a 2-foot azimuthal semicircle (Cortesão, 1984, vol. 2, p. 352).[12]

---

[9] Citing a manuscript from Biblioteca da Ajuda (Lisbon); "um óculo em um bastão com retículo e graus" – a telescope in a bat with reticulum and degrees; "três cavaletes para óculos" – tree tripods for telescopes.

[10] On Nicolas Bion see (Marcelin, 2004). Concerning the sextant, see (Carbone, undated [observations in 1725 and 1726]).The mural quadrant is another instruments mentioned in this pamphlet. This quadrant, mounted in a hall, marks possibly the establishment of the first astronomical observatory with fixed structures in Portugal.

[11] The preference reported by Jaime Cortesão must have been linked with technical problems found in Bion's instruments. The 3-feet sextant was damaged during its transportation to Lisbon and the required specifications were not satisfied in a refracting telescope for the observation of eclipses; both were repaired in Lisbon: ANTT (Lisbon), MNE, Liv. 14, fl. 187v (telescope), fl. 199 (sextant).

[12] Carbone, *Observationes*; ANTT (Lisbon), Cartório dos Jesuítas, Maço 78, nº46.

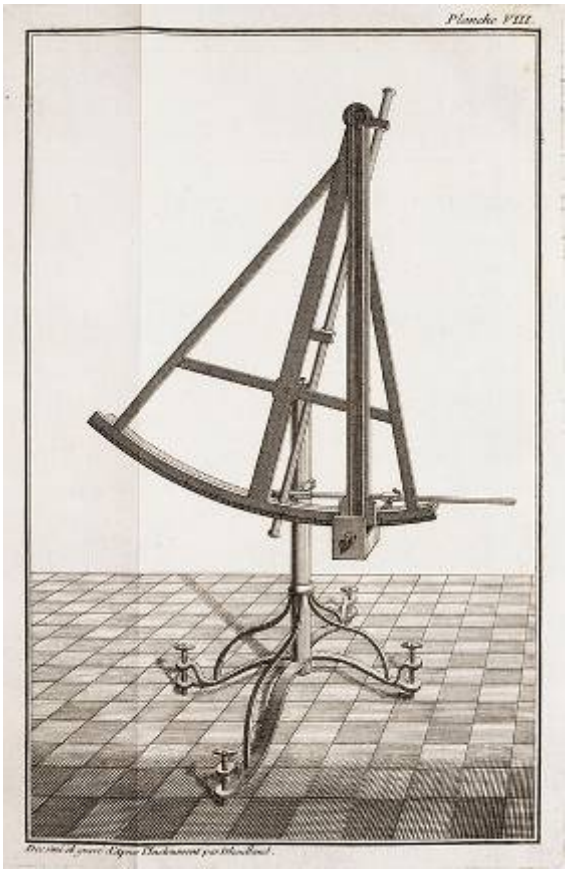


Figure 1 - A sextant, possibly similar to the one depicted in this engraving, was used by Jesuit astronomers Giovanni Battista Carbone and Domenico Capassi in Portugal in the 1720s. (Source: Cassini de Thury, M. Le Monnier, La Méridienne de l'Observatoire Royal de Paris*, 1744; courtesy of the Linda Hall Library of Science, Engineering & Technology)*

More instruments gradually arrived from London. In diplomatic correspondences, a letter dated 21th July 1724 proves that telescopes, pendulum clocks and a universal sundial have been required.[13] The pendulum clocks were commissioned from the influential clock and instrument maker

[13] Biblioteca da Academia das Ciências de Lisboa (BACL, Lisbon), Mss. 600, Série Azul (letter dated 26 December 1724).

George Graham (1673-1751).[14] Graham had begun to include the dead-beat escapement – invented by Thomas Tompion and Richard Towneley – on his clocks only a few years earlier. Therefore, the regulators available to João V's astronomers were certainly equipped with one of the latest technical innovations in time measurement. Moreover, two "big" telescopes were mentioned in another letter dated 13th August 1725. In this official letter, the Portuguese ambassador in London António Galvão de Castelo Branco reported to the Secretary of State Diogo de Mendonça Corte-Real that the two telescopes were examined by Samuel Molyneux (1689-1728)[15] before being sent to Portugal. Molyneux was the Prince of Wales's secretary, as well as fellow of the *Royal Society* of London (elected in 1712), Member of Parliament, and he also worked closely with James Bradley (1693-1762), a prominent astronomer of that time.[16] Actually, diplomats were, among other things, in charge of verifying the quality of the instruments and therefore António Galvão accompanied Samuel Molyneux several times on his visits to makers' shops.

A reflecting telescope with appropriate size and quality for the practical use of astronomical observations was first developed by John Hadley (1682-1744) in the early 1720s. Other artisans, who gravitated around Hadley and learnt his techniques, also started to produce reflecting telescopes, but more compact and manoeuvrable compared to their refracting counterparts. Molyneux was one of those artisans and in 1725 he offered King João Va 26-inch Newtonian model of his own construction, as a diplomatic gift. This was the first reflecting telescope – or one of the first – to reach continental Europe and another innovation added to the set of instruments available to court astronomers in Lisbon (Simpson, 2009; Tirapicos, 2010, p. 25-32).[17]

---

[14] ANTT (Lisbon), Cartório dos Jesuítas, Maço 78, nº43, nº44.

[15] BACL (Lisbon), Mss. 601, Série Azul (letter dated 13 August 1725). On Samuel Molyneux see A. M. Clerke, rev. Anita McConnell (2004-2009) "Molyneux, Samuel" in *Oxford Dictionary of National Biography,* vol. 38 (Oxford: Oxford University Press), p. 559. In spite of being sometimes classified as an "amateur" in astronomy Samuel Molyneux was an accomplished astronomer and instrument maker. Molyneux's involvement in the discovery of the aberration of light is discussed in (Hirshfeld, 2001, p. 154-158).

[16] James Bradley was professor of astronomy in Oxford and the Astronomer Royal between 1742 and 1762. On Bradley see (Williams, 2004).

[17] This telescope was an offer to the king's observatory in the Palace of Ribeira (Molyneux's letter to Galvão de Castelo Branco, dated 6 September 1725, ANTT (Lisbon), Cartório dos Jesuítas, Maço 78, nº79).

As mentioned previously, larger instruments and devices that required a more permanent setup – such as the 5-foot mural quadrant – were included in the process of acquiring instruments for João V's astronomers. This shows that the Jesuits' strategy in the 1720s was not only to focus on training for the South American cartographic mission but also to generalise the use of larger observatory instruments. Such use of permanent instruments was a consequence of King João V's desire to establish observatories – following the notable examples of Paris and Greenwich – and possibly of his theatrical conception of power. Yet, the large majority of instruments used by Carbone and Capassi were in fact portable instruments. The large investment in instruments and the acquisition of quality devices also highlights the importance of accuracy to the cartographic mission in Brazil, a mission requiring the rigorous determination of longitudes and latitudes.

The Portuguese section of the Jesuits's extensive corporate network, the Portuguese Assistancy, was subdivided in provinces and sub-provinces occupying a large geographical region – continental Portugal, Brazil, the west coast of India, China, and Japan – and following the geographic organisation of the Portuguese Empire and trading routes (Harris, 1996). The circulation of letters, objects and men, within this organic and highly hierarchical structure, which was governed from Rome, helped the Jesuit network to become one of the most important international networks for the transmission of knowledge in the modern period. Analysing Jesuit correspondence, Steven Harris argued that the Society of Jesus was a sort of Republic of Letters within the Republic of Letters (Harris, 1996, p. 232). Some Jesuits were brought closer through the frequent exchanges of letters between them, and many others also became more familiar with the various [intellectual] schools of thought of the era through their exchanges with correspondents outside the Society. Besides, Harris has noted that Jesuits usually tended to trust other Jesuits rather than non-Jesuits. Therefore, it is not surprising to know that Carbone corresponded about astronomical matters with a few astronomers within the Society. Among others, he corresponded with Nicasius Grammatici (1684-1736) in Ingolstadt, Ignatio Kögler (1680-1746) and André Pereira (1689-1743) in Peking and Antoine-François Laval (1664-1728) in Toulon. Carbone used his political networks – mainly diplomatic – to communicate astronomical data to the *Royal Society* of London through his Jesuit correspondents (Carvalho, 1956). In doing so, he made a significant contribution to the prestige of the Society of Jesus but, at the same time, he shared the data obtained by other Jesuits with the larger community of astronomical practitioners.

Two documents emphasise Carbone's role as a major agent in the diffusion of astronomical knowledge and instruments in the vast Portuguese Empire, through the network of the Society of Jesus. These were found among his personal papers and consist in a list of telescopes and astronomical ephemerides that were sent to missions in boxes. The first list was sent to India but the fate of the other is not known.[18] The small telescopes listed in these documents confirm the idea that, in general, Jesuit missionaries had no access to high-quality instruments (Harris, 2005).

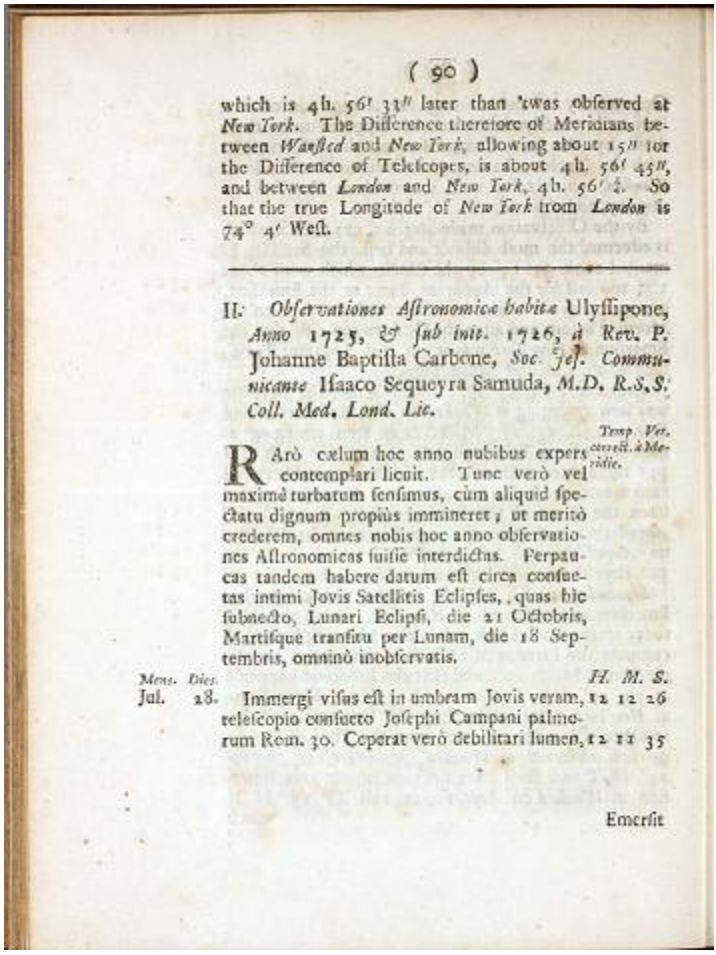
From 1730 onwards, Carbone became essentially a specialist mediator regarding bureaucratic matters and he was primarily concerned with facilitating negotiations with the papacy (Alden, 1996, p. 610). Previously, his position at court allowed for intense activity – apparently fulfilling the King's wishes – coordinating the acquisition of astronomical information and resources through Portuguese diplomatic networks. The ambassadors or special ambassadors in Rome, Paris, London, Vienna, The Hague and Brussels were asked to purchase astronomical instruments and books, following Carbone's demands. In the 1720s, a set of magnificent mathematical instruments – ordered for João V's large and encyclopaedic library – was bought under Carbone's supervision via the diplomatic network (Barchiesi, 1964; Delaforce, 2002; Tirapicos, forthcoming).

Portuguese ambassadors were responsible for initiating communication with the *Royal Society* in London and the *Académie royale des Sciences* in Paris. Moreover, diplomats had to make the initial contact with leading astronomers such as Samuel Molyneux (1689-1728), Francesco Bianchini (1662-1729), Giacomo Filippo Maraldi (1665-1729) and Joseph-Nicolas de l'Isle (1688-1768). Additionally, the network was at some point used for an inquiry in the astronomical observatories. In 1724, the Secretary of State issued an official note which included a questionnaire regarding the extant observatories in the main European kingdoms – detailed plans, descriptions and drawings were requested (Carvalho, 1985, p. 42-43). The mere existence of a program concerning the construction of a modern and well-equipped observatory clearly revealed the general interest and the political support for astronomy in Portugal at that time.

As a result of Carbone´s access to and efficient involvement in these two powerful networks – and in addition to his personal correspondence – astronomical observations were published in influential scientific periodicals such as the *Philosophical Transactions,* the *Histoire de l'Académie royale des sciences avec les mémoires de mathématique et de physique,* the *Acta Eruditorum,* the *Commentarii Academiae Scientiarum Imperialis Petropolitanae* and the *Journal de*

[18] ANTT (Lisbon), Cartório dos Jesuítas, Maço 78, nº89, nº90.

Trévoux. Through these journals, Carbone and Capassi's data – made to determine Lisbon's geographical coordinates accurately – reached a wider audience of astronomers, mathematicians and geographers. Comparing simultaneous observations, their results allowed other specialists to establish the longitudes of various important cities and ports, improving navigational and geographical knowledge of the globe.



(90)

which is 4h. 56′ 33″ later than 'twas observed at *New York*. The Difference therefore of Meridians between *Wanſted* and *New York*, allowing about 15″ for the Difference of Teleſcopes, is about 4h. 56′ 45″, and between *London* and *New York*, 4h. 56′ ½. So that the true Longitude of *New York* from *London* is 74° 4′ Weſt.

II. *Obſervationes Aſtronomicæ habitæ* Ulyſſipone, *Anno* 1725, *& ſub init.* 1726, *à Rev. P.* Johanne Baptiſta Carbone, *Soc. Jeſ. Communicante* Iſaaco Sequeyra Samuda, *M.D. R.S.S. Coll. Med. Lond. Lic.*

Temp. Ver. correſp. à Meridie.

RAro cælum hoc anno nubibus expers contemplari licuit. Tunc verò vel maximè turbatum ſenſimus, cùm aliquid ſpectatu dignum propiùs immineret; ut meritò crederem, omnes nobis hoc anno obſervationes Aſtronomicas fuiſſe interdictas. Perpaucas tandem habere datum eſt circa conſuetas intimi Jovis Satellitis Eclipſes, quas hic ſubnecto, Lunari Eclipſi, die 21 Octobris, Martiſque tranſitu per Lunam, die 18 Septembris, omninò inobſervatis.

Menſ.	*Dies.*		*H.*	*M.*	*S.*
Jul.	28.	Immergi viſus eſt in umbram Jovis veram,	12	12	26
		teleſcopio conjuncto Joſephi Campani palmorum Rom. 30. Coperat verò debilitari lumen,	12	21	35

Emerſit

Figure 2 - Carbone's astronomical observations performed in Lisbon in 1725 and 1726 (*Source:* Philosophical Transactions, *vol. 34, 1726-1727, p. 90; courtesy of the Linda Hall Library of Science, Engineering & Technology)*

Carbone's involvement was also notable in a remarkable affair centred on diplomatic relations as well as in the establishment of the first solid interaction between the Hindu and Muslim astronomical traditions and the European astronomical tradition (Forbes, 1982). In 1727, in the Moghul Empire, Raja Sawai Jai Singh II of Amber (1668-1743) sent a fact-finding mission to Lisbon in order to recruit an expert astronomer (Sharma, 1995, p. 283-303). Manuel de Figueiredo – Jesuit rector of the Agra College – and Pedro da Silva – Portuguese layman born in India – took part in this scientific diplomatic mission to King João V's court. The Portuguese monarch answered the Raja's requests by sending back another diplomatic mission, thus encouraging good relations with the Moghul Empire and fostering the stability of Portuguese presence in the region. In Portugal, Pedro da Silva received training and guidance from Carbone before his return to India (Mercier, 1993). João V's royal mathematician was, almost certainly, the key adviser of the diplomatic mission organized in Lisbon. Furthermore, books and instruments were the principal gifts offered to Jai Singh. For example, one should mention La Hire's astronomical tables, a source used by Carbone for his astronomical work. The astronomical tables were one of the items offered to the Hindu ruler when the Portuguese diplomatic mission arrived in Jaipur, in July 1730.

Conclusion

During the reign of King João V (r.1707-1750), astronomy took part in a larger movement of cultural renewal encompassing sciences and the arts (including mechanical and the fine arts) and involving exchanges with European scholar centres. The practice of astronomy in Portugal in this period was not only driven by the King's enlightened interest in experimental sciences and other technical matters but chiefly by the need of a better geographical knowledge of Portuguese America. The discovery of large deposits of Brazilian gold, the dispute with Spain over the limits of Iberian American colonies and the need to demarcate the administrative divisions of Portuguese possessions were certainly key factors for the development and patronage of astronomy. Yet a mutual relationship existed between Brazilian gold and astronomy. Astronomy was sponsored and paid by the American gold but, at the same time, astronomical methods and instruments were political and diplomatic tools used to protect Brazilian mineral riches. In other words, state-sponsored science meant that science had to serve the State. Nonetheless, this 'state service' had different meanings. For example, the cartographical surveys were organized to fill imperial needs. Besides, the spectacular and theatrical representation of power of King

João V – consisting in public observations of astronomical phenomena and the establishment of royal observatories – had a prominent place in Portugal, even if the main royal observatory ended up in the Jesuit College of Santo Antão where a cosmographical and astronomical teaching tradition was well established. Moreover, several astronomical communications were published in European scholar journals and helped to promote João V's image as a patron of the arts and sciences.

At João V's court, the Neapolitan Jesuit Giovanni Battista Carbone occupied a central role in the practice of astronomy, in its multiple meanings. As the King's assistant, Carbone had a privileged political and institutional position, at the confluence of the Portuguese diplomatic network and the Jesuit transnational network. Fulfilling the King's wishes, Carbone was an active observational astronomer, organizer of observatories, and agent in the circulation of astronomical data and instruments within the vast Portuguese Empire as well as in the main European academic circles. In the process, he had access to some of the latest innovations in astronomical instrumentation, resources allowed by João V's exceptional patronage – as seen in the examples of Graham's pendulum clocks and reflecting telescopes.

In the 1720s, both Carbone and Capassi contributed to create a corpus of astronomical data that ultimately improved the navigational and geographical description of the globe. However, that result was only achieved thanks to the Jesuits's full adherence to the King's political agenda (with its multiple facets of "state service"). A pamphlet, written by the two astronomers on the lunar eclipse of 1st November 1724 and distributed all over Europe through the Portuguese diplomatic network, shows that they communicated precise and careful timings of the phenomena through a laudatory discourse about a royal and magnanimous protector of astronomy (Carbone & Capassi, 1724).

Acknowledgements

I wish to thank the *Fundação para a Ciência e a Tecnologia* (Portugal) for granting me Ph.D. scholarship FCT/MCTES, SFRH/BD/78881/2011, and to the Linda Hall Library of Science, Engineering & Technology (Kansas City, Missouri, USA) for awarding me, in 2013, a residential fellowship during which the final writing of this paper was carried out. Thanks are also due to my supervisor, Professor Henrique Leitão, for his numerous inspirational comments and to the two anonymous referees for their perceptive suggestions.

References

ALDEN Dauril (1996), *The Making of an Enterprise. The Society of Jesus in Portugal, its Empire, and Beyond, 1540-1750*, Stanford, Stanford University Press.

ALMEIDA André Ferrand de (1999), "Os jesuítas matemáticos e os mapas da América portuguesa (1720-1748)", *Oceanos*, vol. 40, p. 79-92.

ALMEIDA André Ferrand de (2001), *A formação do espaço brasileiro e o projecto do novo Atlas da América Portuguesa*, Lisboa, Comissão Nacional para a Comemoração dos Descobrimentos Portugueses.

BALDINI Ugo (2004), "The teaching of Mathematics in the Jesuit Colleges of Portugal, from 1640 to Pombal", in Luís SARAIVA & Henrique LEITÃO (eds.), *The Practice of Mathematics in Portugal*, Coimbra, Imprensa da Universidade de Coimbra, p. 293-465.

BARBOSA Fernando A. da Costa (1751), *Elogio Funebre do Padre João Baptista Carbone, da Companhia de Jesus,* Lisboa, Oficina de Miguel Manescal da Costa.

BARCHIESI Roberto (1964), "I Bianchini a la corte di Lisbona. Spigolature dall'Archivio Bianchini della Vallicelliana", *Estudos Italianos em Portugal*, vol. 23, p. 147-159.

BENNETT Jim A. (1987), *The Divided Circle. A History of Instruments for Astronomy, Navigation, and Surveying*, Oxford, Phaidon.

CARBONE Johannes B. (undated), *Observationes astronomicae habitae Ulissypone*, Lisboa.

CARBONE Johannes B. (1726-1727), "Observationes Astronomicae habita Ulyssipone Anno 1725, & sub init. 1726", *Philosophical Transactions*, vol. 34, p. 90-101.

CARBONE Johannes B. (1727-1728), "Observationes Astronomicae a R. P. Joh. Baptista Carbone Transmissae", *Philosophical Transactions*, vol. 35, p. 471-479.

CARBONE Johannes B. & CAPASSI D. (1724), *Observatio Lunaris Eclipsis Habita Ulyssipone in Palatio Regio Die I. Novembris 1724. A' PP. Joanne Baptista Carbone, et Dominico Capasso Soc. Jesu,* Lisboa.

CARVALHO Rómulo de (1956), "Portugal nas 'Philosophical Transactions', nos Séculos XVII e XVIII", *Revista Filosófica*, vol. 15-16, p. 3-59.

CARVALHO Rómulo de (1985), *A Astronomia em Portugal no Século XVIII,* Lisboa, Instituto de Cultura e Língua Portuguesa.

CLUNY Isabel (1999), *D. Luís da Cunha e a Ideia de Diplomacia em Portugal*, Lisboa, Livros Horizonte.

CORTESÃO Jaime (1958), "A Missão dos Padres Matemáticos no Brasil", *STVDIA*, vol. 1, p. 123-150.

CORTESÃO Jaime (1984), *Alexandre de Gusmão e o Tratado de Madrid*, Lisboa, Livros Horizonte.

CORTESÃO Jaime (2009), *História do Brasil nos Velhos Mapas*, Lisboa, Imprensa Nacional - Casa da Moeda.

DELAFORCE Angela (2002), *Art and Patronage in Eighteenth Century Portugal*, Cambridge (UK), Cambridge University Press.

FERREIRA Mário Clemente (2001), *O Tratado de Madrid e o Brasil Meridional*, Lisboa, Comissão Nacional para as Comemorações dos Descobrimentos Portugueses.

FORBES Eric G. (1982), "The European astronomical tradition: its transmission into India, and its reception by Sawai Jai Singh II", *Indian Journal of History of Science*, vol. 17, p. 234-243.

GATTO Romano (1994), *Tra scienza e immaginazione: le matematiche presso il collegio gesuitico napoletano (1552-1670 ca.)*, Firenze, L. S. Olschki.

HAHN Roger (1986), "Les observatoires en France au XVIII[e] siècle" in René TATON (ed.), *Enseignement et diffusion des sciences en France au dix-huitième siècle*, Paris, Hermann.

HARRIS Steven J. (1996), "Confession-Building, Long-Distance Networks, and the Organization of Jesuit Science", *Early Science and Medicine*, vol. 1, p. 287-318.

HARRIS Steven J. (2005), "Jesuit Scientific Activity in the Overseas Missions, 1540-1773", *ISIS*, vol. 96, p. 71-79.

HIRSHFELD Alan W. (2001), *Parallax: The Race to Measure the Cosmos,* New York, W. H. Freeman and Company.

LEITÃO Henrique (2003), "Jesuit Mathematical Practice in Portugal, 1540-1759", in Mordechai FEINGOLD (ed.), *The New Science and Jesuit Science: Seventeenth Century Perspectives*, Dordrecht, Kluwer Academic Publishers, p. 229-247.

LEITÃO Henrique (2006), "Entering Dangerous Ground: Jesuits Teaching Astrology and Chiromancy in Lisbon" in John W. O'MALLEY, Alexander B. GAUVIN, Steven J. HARRIS & T. Franck KENNEDY (eds.), *The Jesuits II. Cultures, Sciences, and the Arts, 1540-1773*, Toronto, University of Toronto Press, p. 371-389.

LEITÃO Henrique (2007), *A Ciência na "Aula da Esfera" no Colégio de Santo Antão 1590-1759*, Lisboa, Comissariado Geral das Comemorações do V Centenário do Nascimento de S. Francisco Xavier.

LEITÃO Henrique (2008), *Sphaera Mundi: A Ciência na Aula da Esfera. Manuscritos Científicos do Colégio de Santo Antão nas Colecções da BNP*, Lisboa, Biblioteca Nacional de Portugal.

LEITÃO Henrique (2009), "A Periphery between Two Centres? Portugal in the Scientific Route from Europe to China", in Ana SIMÕES, Ana CARNEIRO & Maria Paula DIOGO (eds.), *Travels of Learning. A Geography of Science in Europe,* Dordrecht, Kluwer Academic Publishers, p. 19-47.

MARCELIN Franck (2004), *Dictionnaire des fabricants français d'instruments de mesure du XV^e^ au XIX^e^ siècle*, Aix-en-Provence, Galerie Franck Marcelin.

MERCIER Raymond (1993), "Account by Joseph Dubois of Astronomical Work Under Jai Singh Sawa'i", *Indian Journal of History of Science*, vol. 28, p. 157-166.

MONTEIRO Nuno G. (2009), "A Monarquia Barroca (1668-1750)" in Rui RAMOS (ed.), *História de Portugal*, Lisboa, A Esfera dos Livros, p. 331-356.

PIMENTEL António F. (2002), *Arquitectura e Poder. O Real Edifício de Mafra*, Lisboa, Livros Horizonte.

REIS Maria F. (2009), *D. João V: O Magnânimo*, Lisboa & Matosinhos, QuidNovi.

RODRIGUES Francisco (1931-1950), *História da Companhia de Jesus na Assistência de Portugal*, 7 volumes, Porto, Apostolado da Imprensa.

SAFIER Neil (2009), "The Confines of the Colony: Boundaries, Ethnographic Landscapes, and Imperial Cartography in Iberoamerica" in James AKERMAN (ed.), *The Imperial Map. Cartography and the Mastery of Empire*, Chicago, The University of Chicago Press, p. 133-183.

SHARMA Virendra N. (1995), *Sawai Jai Singh and His Astronomy*, Delhi, Motilal Banarsidass Publishers Private Limited.

SILVA Maria Beatriz Nizza da (2006), *D. João V*, Lisboa, Círculo de Leitores.

SIMÕES Ana, CARNEIRO Ana & DIOGO Maria Paula (1999), "Constructing Knowledge: Eighteenth Century Portugal and the new Sciences", *Archimedes*, vol. 2, p. 1-40.

SIMPSON A. D. C. (2009), "The beginnings of commercial manufacture of the reflecting telescope in London", *Journal for the History of Astronomy*, vol. 40, p. 421-466.

TIRAPICOS Luís (2010), *O Telescópio Astronómico em Portugal no Século XVIII*, Master's Thesis, Faculdade de Ciências da Universidade de Lisboa.

TIRAPICOS Luís (2014), "Instruments and Astronomical Observations at the Jesuit College of Santo Antão-o-Novo, 1722-1759", in Luís SARAIVA (ed.), *History of Astronomy in Portugal. Institutions, Theories, Practices*, Porto, Sociedade Portuguesa de Astronomia, p. 65-84.

TIRAPICOS Luís (forthcoming), "The Cabinet and Astronomical Observatory of João V", in Marta LOURENÇO (ed.), *Royal Cabinets of Physics in Portugal*, Lisboa, Caleidoscópio.

WILLIAMS Mari E. W. (2004), "Bradley, James" in *Oxford Dictionary of National Biography*, volume 7, Oxford, Oxford University Press, p. 213-219.