Popular science as knowledge: early modern Iberian-American *repertorios de los tiempos*

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Abstract
Iberian *repertorios de los tiempos* stemmed from Medieval almanacs and calendars. During the sixteenth century significant editorial, conceptual and material changes in *repertorios* incorporated astronomy, geography, chronology and natural philosophy. From De Li's *Repertorio* (1492) to Zamorano's *Cronología* (1585), the genre evolved from simple almanacs to more complex cosmological works which circulated throughout the Iberian-American world. This article claims that *repertorios* are a form of syncretic knowledge rather than "popular science" by relying on the concept of "knowledge in transit". Elaborating on this perspective, I present how *repertorios* ended up delivering a worldview from existing materials, a fact so far unnoticed by scholarship. At the same time, *repertorios* should not be considered an exclusively Iberian phenomenon, but the full scope of their nature as a form of syncretic knowledge should include their networks with migrants, indigenous, mestizos, and *criollos* across the Atlantic. In this sense, I try to trace the paths connecting productions in the Americas with Iberian *repertorios.*

Keywords
astrology, cosmography, almanacs, lunarios, knowledge in transit

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1. Introduction

In the history of early modern accounts of the heavens and their influences on Earth, it is usual to divide the theoretical from the practical. Needless to say, historians acknowledge that the division is far from being straightforward, for it only partially maps onto the disciplinary intricacies of astronomy and astrology; neither does this division fit accurately into the practices, institutions, and self-representations of the practitioners of the period. At the same time, the boundaries between theoretical and practical are unclear, especially at the micro-level scale.[1] However, within the spectrum of astrological literature, it is possible to distinguish the almanacs, calendars, and *lunarios*, predominantly containing tables of astronomical and astrological events for a year or a rather short cycle, from treatises dealing with the principles of astrology.[2] Works of the first kind are embedded within the main types of astrological praxis: revolutions, nativities, elections, and interrogations.[3] Because of their practical orientation, these works do not present foundational aspects of astrology, and if they do, the treatment does not go beyond some short definitions. Works of the second kind deal with the principles of astrology and frequently provide extensive and detailed discussions of the connections of astrology with astronomy, optics, natural philosophy, magic, cosmography or theology. Historians of science are most familiar with this second kind of works: Ptolemy's *Tetrabiblos,* Albumasar's *De magnis conjuinctionibus,* Roger Bacon's *Astrologia* or Albertus Magnus' commentaries on Aristotle.

The practical orientation of almanacs, calendars, and *lunarios,* and their wider social circulation in the early modern societies of Europe have made of them pre-eminently, but perhaps unintentionally, forms of popular science or, in the words of Capp, "popular knowledge".[4] This genre of works is read as a vehicle of scientific ideas produced in treatises. In other words, a significant function of this literature is the "popularization" of science or the dissemination of scientific knowledge produced elsewhere.[5] Consequently,

1 The literature on this is vast. See, for example, Pedersen, "The Corpus Astronomicum and the Traditions of Mediaeval Latin Astronomy"; Pedersen, "The Origins of the 'Theorica Planetarum'"; Grant, *Planets, Stars, and Orbs*, 569-617; Grafton, *Cardano's Cosmos*, 22-70; Vernet, *Astrología y Astronomía En El Renacimiento*; Westman, *The Copernican Question*, 25-61; Lanuza-Navarro, "Astrological Literature in Seventeenth-Century Spain"; Rutkin, "Astrology"; Rutkin, *Sapientia Astrologica*, xlii-xlix; Jensen, *Astrology, Almanacs, and the Early Modern English Calendar*.

2 Zinner, *Geschichte Und Bibliographie Der Astronomischen Literatur*; Capp, *English Almanacs, 1500-1800*, 23-66; Curry, *Prophecy and Power: Astrology in Early Modern England*; Grafton, *Cardano's Cosmos*, 71-90; Casali, *Le Spie Del Cielo*; Lanuza-Navarro, "Astrología, Ciencia y Sociedad En La España de Los Asturias", 55-61.

3 Rutkin, *Sapientia Astrologica*, xxx-xxxi; 423-463.

4 Capp, *English Almanacs, 1500-1800*, 21.

5 *Ibid*., 180.

studying the almanacs, calendars, and *lunarios* has been a thread to navigate through early modern social, political, and religious problems. These studies have provided us with valuable results about the praxis of astrology and its complex and varied connections with knowledge, society, and power in several European scenarios.[6]

Still, when trying to understand the history of astrology *qua* form of knowledge and the evolution of its connections with other disciplines, there is a tendency to privilege the study of treatises over the almanacs and the ephemeral, and there are several reasons for doing so. As mentioned above, the treatises were the most visible places for these debates, and consequently, they are currently more accessible, as Jensen has recently pointed out. In fact, sometimes controversies about astrology presented in treatises started as reactions to pamphlets that are now lost or are hardly accessible to historians for their technical nature or for their invisibility in digital databases.[7] At the same time, astrological treatises were widely read, criticised and sometimes referenced by early modern astronomers, mathematicians, and natural philosophers traditionally identified with the "New Science". Therefore, historians of science have tended to establish smooth connections between the astrological treatises and the "New Science", even if some of these mathematicians, such as Galileo and Kepler, were also notoriously involved in the praxis of astrology.[8] Finally, the local scope of almanacs, calendars, and *lunarios*, that is, the fact that their validation and acceptance depended mostly on their interpretation and engagement with local circumstances and communities – such as local weather patterns, circumscribed territories, parochial religious practises, confined political settings – make of them not the first candidates when trying to account for long-scale transformations in astrology and its connections with early modern natural philosophy, mathematics, cosmography, and theology. In fact, the limited scope and practical-oriented nature of this genre of astrological works seem not to be revealing of the foundational changes that astrology, natural philosophy, mathematics and cosmography underwent in early modern Europe.

6 Just to mention a few, Thomas, *Religion and the Decline of Magic: Studies in Popular Beliefs in Sixteenth and Seventeenth Century England*; Capp, *English Almanacs, 1500-1800*; Curry, *Prophecy and Power: Astrology in Early Modern England*; Delbrugge, "Capitilizing on the Stars"; Casali, *Le Spie Del Cielo*; Lanuza-Navarro, "Astrología, Ciencia y Sociedad En La España de Los Asturias"; Chapman, "Marking Time"; Azzolini, *The Duke and the Stars*; Durán López, "De las seriedades de Urania a las zumbas de Talía"; Jensen, *Astrology, Almanacs, and the Early Modern English Calendar*.

7 Jensen, *Astrology, Almanacs, and the Early Modern English Calendar*, 5-6.

8 Lindberg, *Theories of Vision from Al-Kindi to Kepler*; Funkenstein, *Theology and the Scientific Imagination*; Westfall, *Never at Rest*; Hunter, *Robert Boyle Reconsidered*; Lattis, *Between Copernicus and Galileo*; Westman, *The Copernican Question*; Boner, "Kepler's Living Cosmology: Bridging the Celestial and Terrestrial Realms"; Heilbron, *Galileo*; Henry, *Religion, Magic, and the Origins of Science in Early Modern England*; Copenhaver, *Magic in Western Culture: From Antiquity to the Enlightenment*; Rothman, *The Pursuit of Harmony*.

In this paper, I present the evolution of a specific tradition of almanacs, calendars, and *lunarios,* the Iberian-American *repertorios* or *reportorios de los tiempos*, in a way that challenges some of the previous distinctions and calls for a re-examination of the categories under which we conceptualise this early modern production of the knowledge of the heavens. I argue that a transformation of astronomy, natural philosophy, and astrology of significant relevance for the Iberian-American world took place in a genre of writing largely ignored by historians of science. Evolving from a local tradition of almanacs, the *repertorios de los tiempos* came to encompass the traditional elements for the praxis of astrology and navigation with astronomical, natural philosophical, chronological and cosmographical elements in a way that crystallised in manuscripts and printed works from the early-sixteenth century to the mid-seventeenth century across the Iberian-American world, from Barcelona to Lima. By articulating elements from several traditions and praxes in a way that came to provide a rather consistent approach to the *machina mundi,* Iberian-American *repertorios* should be considered as knowledge rather than as "popular science", at least in two interconnected senses. In the first sense, the practical orientation of *repertorios,* rooted in their astrological origin, prevented them from discussing cosmological or astronomical novelties and then from being considered as knowledge (as opposed to forms of popularisation of knowledge originally produced elsewhere).[9] However, the articulation of diverse intellectual traditions with practical tools, of Renaissance and early modern cosmological views with the attempts to tackle the challenges posed by the emergence of global empires, resulted in *repertorios* in a coherent view of the *machina mundi* which shall be considered a form of knowledge, not a form of communication of knowledge: although the bricks from which this worldview was built came from elsewhere, the resultant construction, as I argue below, is novel and should be considered a form of syncretic knowledge with its historical and epistemological consequences. In the second, interconnected sense, the Iberian *repertorios* and the productions of their readers and respondents in the Americas should be considered knowledge in the sense of Secord's "knowledge in transit". By separating knowledge from its communication, in this case, the early almanacs from Iberian *repertorios* and these from their networks in the Americas, we introduce problematic epistemological breaks that Cooter and Pumpfrey already identified in 1994.[10] Questions such as how knowledge travels, to whom it is available, and how agreements are achieved are fundamental and constitutive of knowledge. In this sense, the knowledge-making process involves communication rather than merely being followed by it.[11]

9 "To label something unequivocally as popular science can be seen as tantamount to saying that 'it is not science' or even a kind of pseudoscience parading as a real thing". Secord, "Knowledge in Transit", 670-671. See also Cooter and Pumpfrey, "Separate Spheres and Public Places".

10 Cooter and Pumpfrey, "Separate Spheres and Public Places".

11 Secord, "Knowledge in Transit". See also, Cooter and Pumpfrey, "Separate Spheres and Public Places"; Bensaude-Vincent, "A Historical Perspective on Science and Its 'Others'"; Topham,

From this perspective, in what follows, I argue that Iberian-American *repertorios* should not be reduced to a form of communication of knowledge produced elsewhere – the astronomical and astrological treatises. In the first part, I explain how by mid-sixteenth century, mathematicians and cosmographers in the Iberian Peninsula enlarged earlier *repertorios,* particularly Li's, by introducing substantial astronomical, cosmological, and chronological sections. The reunion of divergent astronomical and cosmological traditions, such as Sacrobosco's *Sphera* and the *Theorica planetarum,* together with astronomy-oriented chronology articulated a globalising, Catholic world-view spatially organised by mathematics (geometry and geography) and temporally embedded within the teleology of the history of redemption. Prominent Iberian mathematicians such as Jerónimo de Cháves, André do Avelar, and Rodrigo Zamorano composed *repertorios* that circulated extensively. So far, studies on these authors have overlooked these *repertorios*, considering them as minor works produced mostly for financial purposes and therefore unsuited as vehicles of any significant novelty. Next, I consider how the Iberian *repertorios* attracted attentive readers in New Spain, Peru, and, New Granada. I focus on the case of Antonio Sánchez de Cozar. Sánchez, a *mestizo* priest writing in the New Kingdom of Granada, developed an astronomical and chronological treatise, the *Tratado de Astronomía y la Reformaçion del tiempo* (c1.696), a manuscript in which the synthesis of medieval, Renaissance and early modern astronomical ideas with cosmography articulated an original theory of the cosmos. Sánchez did not stop where Iberian mathematicians did in their *repertorios*, and derived astronomical and natural philosophical information from the Bible in order to explain (visually, mechanically, and conceptually) how and why the *machina mundi* shall end after the last judgment. As part of this teleological narrative, Sánchez localises (historically and geographically) himself, the 'New World', and the natives of the Americas with the resources provided by the Iberian cosmographical *repertorios*. Although Sánchez's work seems aligned with the early modern European tradition of astronomical treatises, his *Tratado* elaborates on the *repertorios* in terms of contents, methods, conclusions and aims.

In this way, it appears that a genre of writing, overlooked for being considered adequate only for the popularisation of ideas that were innovatively formulated elsewhere, became, in the new kingdoms of the Americas, an element for the construction of local identities as part of a globalising Christian identity dominated by the narrative of the universal redemption. The construction of these identities, as in the case of Sánchez, involved the transformation of the foundations of astronomy, astrology, and natural philosophy in a treatise, not in another *repertorio,* as part of understanding the place of the 'New World' in the cosmos. Although other American *repertorios* did not further elaborate the astronomical and cosmographical consequences of this genre as Sánchez did, they mobilised math-

"Introduction"; Delbrugge, "Capitilizing on the Stars"; O'Connor, "Reflections on Popular Science in Britain".

ematical and chronological resources for explaining the place of indigenous and *mestizos* in the political and theological history of redemption portrayed in the peninsular works.

2. "Quanto tienes tanto vales, y aun tanto sabes": repertorios *between printers and mathematicians*

In the preface to the "prudent and wise reader", in the *Chronographia, o repertorio de los tiempos* (1548), Jerónimo de Chaves (1523-1574), who would be the first professor of navigation at the *Casa del Contratación* in 1552, complains about the state of liberal arts in his days. In his view, some writers, moved by greed and "corruption", abused the liberal arts and obtained illegitimate fruits. While these arts had been respected since ancient times and their fruits constituted a "common good," some of his contemporaries "pursuing their interests, and charging common people for famous names, offer to the public (with titles that benefit their income and friends) works alien and strange to their profession".[12] Because of this, they downgraded the liberal arts to "mechanical and servile practices".[13] Chaves makes clear that he has in mind the producers of the "*Repertorios* that have hitherto circulated". These *repertorios,* in the view of the young mathematician, deal with matters "frivolous and lacking any natural foundation", being "short of important and necessary things".[14] At the same time, the *Lunarios* are "incorrectly verified": the eclipses are just put at the will of the printer, without specifying "their magnitude or the time of their occurrence".[15] These and other faults, Chaves claims, have been surely noted by the prudent and wise reader.

Apart from the general accusation of degrading the liberal arts to the "mechanical and servile" – which would require a separate treatment – Chaves' condemnation of *repertorios* provides insights into at least two important characteristics that defined the manufacture and circulation of early modern Iberian *repertorios*. First, Chaves criticises the production, the producers, and the choice of topics of previous *repertorios*, emphasising the inappropriate role of printers, depicted here as "alien and strangers" to the liberal arts and, to some extent, guilty of their decline. Second, Chaves suggests that the books called *repertorios* cover, in fact, two different but related matters: the *repertorios* (containing frivolous things) and the *lunarios* (incorrectly verified and modified by printers). Interestingly, instead of rejecting *tout court* the genre of *repertorios* and their organisation, Chaves undertook a systematic reform of them that was subsequently followed by cosmographers

[12] Chaves, *Chronographia*, 4v.

[13] On this pejorative use of "mechanical" see Drake and Drabkin, *Mechanics in Sixteenth-Century Italy*; Micheli, *Le origini del concetto di macchina*; Orozco-Echeverri, "Mechanics in Renaissance Science".

[14] Chaves, *Chronographia*, 5r.

[15] *Ibidem.*

and mathematicians such as André do Avelar, Rodrigo Zamorano, Vicente de Tornamira, Ambrosio de Gante, Manoel de Figueiredo, and Bartolomé Valentín de la Hera y de la Varra during the second half of the sixteenth century.

The production of early Spanish *repertorios,* that is, of those fabricated during the first half of the sixteenth century, was in fact an enterprise mostly led by printers who saw in the enlargement of almanacs and *lunarios* the possibility of developing more competitive (and more profitable) prints in the flourishing market of the book. While Chaves criticises the nature and extent of these works, his own *repertorio* benefited from the demand already created by the editorial success of Andrés de Li's *Repertorio de los tiempos,* published for the first time in Zaragoza in 1492 and extensively reprinted, modified, and copied during the sixteenth century.[16] As Chaves correctly pointed out, Li's *Repertorio* was the union of two different texts, resulting from the editorial initiative of Pablo Hurus, an influential printer based in Zaragoza.[17] The starting point of Li's *Repertorio* was the editorial success of Bernat de Granollachs *De la nobilissima art e scientia de astrologia,* known as the *Lunario,* printed in Napoli in 1485 by Mattia Moravo in Catalan and Latin.[18]

Granollachs' *Lunario,* as it was usual in medieval and early modern European almanacs, was based on the lunar cycle – hence the name – from which it was established a 19-solar-years cycle setting the parameters for the calculations of the moveable feasts of the liturgical calendar and some matters of potential interests for astrological medicine.[19] The *Lunario* opens with a short introduction noticing that from the most noble art of astrology the master from Barcelona Bernat de Granollachs summarised the conjunctions and oppositions of the Moon between 1485 and 1550.[20] The introduction also includes some remarks on moveable and fixed feast of the liturgical calendar and some basic astronomical definitions such as time, day, and eclipse. Next, the *Lunario* incorporates the tables from 1485 to 1550, one page per year, displaying the time of all new and full moons from January to December, highlighting the dates of Easter, Ascension, Corpus Christi and other moveable feasts. Every year includes the golden number and the corresponding dominical letter (Fig. 1). According to Chabás and Rocca, the *Lunario* saw no less than 60 editions

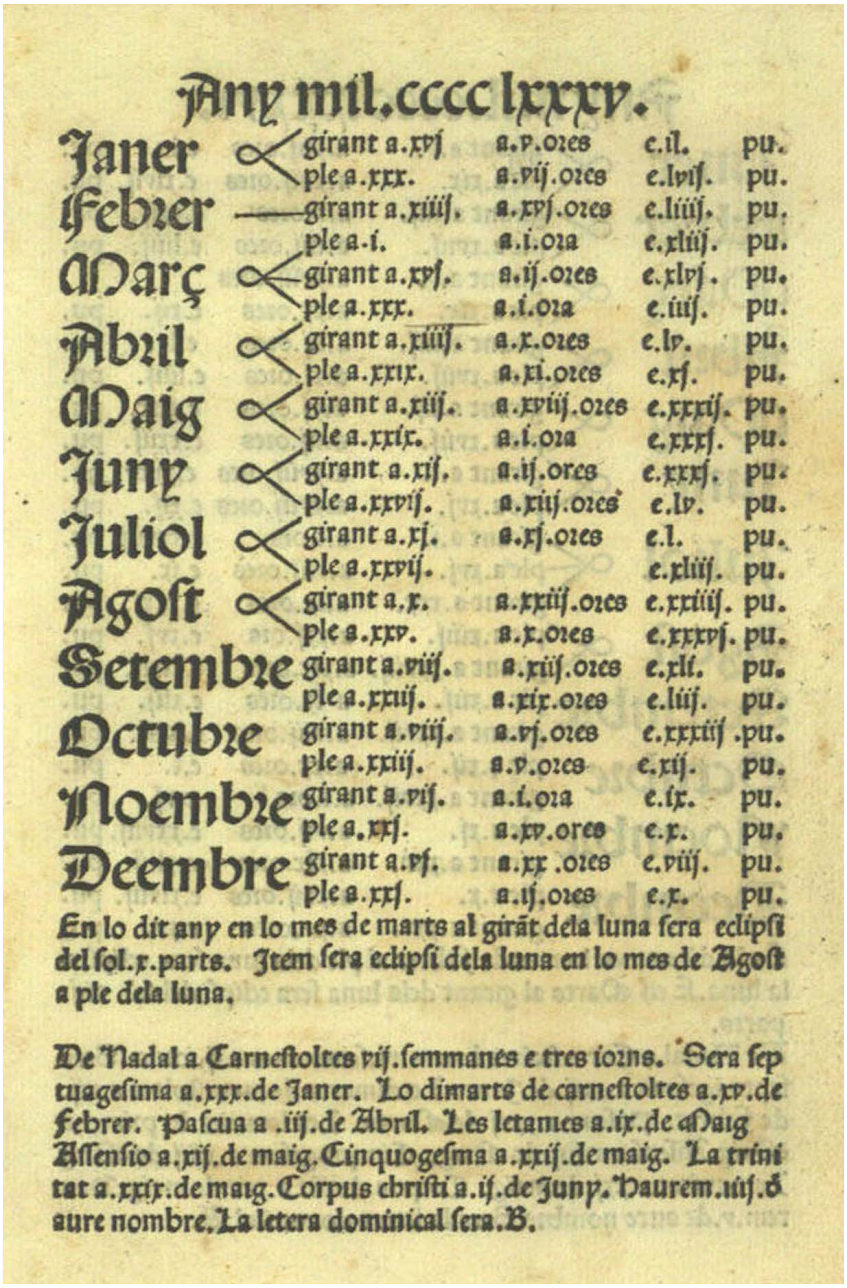
16 On De Li's *Repertorio* and the controversies about its origins see Martos, "La Editio Princeps Del Repertorio de Los Tiempos de Andrés de Li"; Chabás and Roca, "Early Printing of Astronomy"; Delbrugge, "A Critical Edition of Andrés de Li's Repertorio"; Delbrugge, "Capitilizing on the Stars"; Delbrugge, "From Lunar Charts to Li".

17 Delbrugge, "Ties That Bind (and Print)", 41-47.

18 On the controversy concerning the role of Granollachs' *Lunario* in the *Reportorios* see Chabás and Roca, "Early Printing of Astronomy"; Delbrugge, "A Critical Edition of Andrés de Li's Repertorio"; Martos, "La Editio Princeps del Repertorio de Los Tiempos de Andrés de Li".

19 Delbrugge, "Capitilizing on the Stars"; Stern and Burnett, *Time, Astronomy, and Calendars in the Jewish Tradition*; Nothaft, *Scandalous Error*; Rutkin, *Sapientia Astrologica*.

20 Granollachs, *De La Nobilissima Art e Scientia de Astrologia*, f. 1r.



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Maig	girant a.xiij.	a.xviij.ores	e.xxxij.	pu.
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Juny	girant a.xij.	a.ij.ores	e.xxxj.	pu.
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Juliol	girant a.xj.	a.xj.ores	e.l.	pu.
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Agost	girant a.x.	a.xxiij.ores	e.xxiiij.	pu.
	ple a.xxv.	a.x.ores	e.xxxvj.	pu.
Setembre	girant a.viij.	a.xiij.ores	e.xlj.	pu.
	ple a.xxiij.	a.xix.ores	e.liij.	pu.
Octubre	girant a.viij.	a.vj.ores	e.xxxiij.	pu.
	ple a.xxiij.	a.v.ores	e.xij.	pu.
Noembre	girant a.vij.	a.i.ora	e.ix.	pu.
	ple a.xxj.	a.xv.ores	e.x.	pu.
Deembre	girant a.vj.	a.xx.ores	e.viij.	pu.
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Fig. 1 – Granollachs' calculations for 1485, including remarks on moveable feasts, dominical letter and golden number. Granollachs, Lunario, f. 1v. Biblioteca de Catalunya, public domain.

in 40 years in Spain, France and Italy.[21] In 1488, the *Lunario* was translated into Spanish as *Dela muy noble arte: e sciencia de Astrologia ha seido sacado el presente sumario,* published by Juan Hurus – brother of Pablo – in Zaragoza. According to Li's Prologue to the *Repertorio,* some computational errors in Granollachs' *Lunario* but mostly because the work deals with "times, years, months, weeks, days, hours, planets, signs," he decided to provide some additions so that the reader could know "the origin of the times and why they were named in such a way".[22] The editorial collaboration between Pablo Hurus and Andrés de Li brought to light the first edition of the *Repertorio de los tiempos* in 1492, an edition in which Granollachs' *Lunario* was preceeded by Li's additions. The novelties added by Li included a Prologue explaining the importance of the work; a history of the divisions of times (day, week, month and year); a summary explanation, including illustrations, of the heavens, the astrological signs of the zodiac, and the four elements; a calendar of the year; a medical section with the traditional zodiac man; and a conclusion. As Delbrugge notes, Li's *Repetorio* was an extremely eclectic work "discussing everything from Greek and Roman gods to the proper procedures for bloodletting".[23] In this way, Li's provided mythological, astrological, astronomical, and chronological frameworks to Granollachs' *Lunario,* bringing together medieval and early modern traditions. At the same time and closely connected with the editorial intentions of the work, Li's *Repertorio* integrated a rich visual apparatus which I have analysed elsewhere,[24] summarising and rendering visible the novelties added to the *Lunario*, such as the mythological origins of the names of the months, planets, and signs, and their astrological significance for agriculture and medicine.

Compared to other European almanacs similar in format, content and style to the *Lunario*, particularly to those of English and German origins influenced by the emergence of Protestantism,[25] the editorial transformation of Granollachs' *Lunario* into Li's *Repertorio* - or rather the subsumption of the former under the latter – shows a peculiar move in this genre of astrological literature. While other European traditions of almanacs and calendars kept improving the accuracy of their tables and expanding the range of astrological elements for practical purposes such as calendrics, medicine, geography or even trade, Li's *Repertorio,* in contrast, provided to the reader of almanacs elements of history, astronomy, astrology, cosmology, natural philosophy and medicine that were usually restricted to more technical and theoretical works, such as treatises or university textbooks related to Sacrobosco's *Sphaera* and to the tradition of the *Theorica planetarum*. This does not mean,

21 Chabás and Roca, "Early Printing of Astronomy", 125.
22 Li, *Repertorio de Los Tiempos*, a ii, r-v.
23 Delbrugge, "Capitilizing on the Stars", 302.
24 Orozco-Echeverri, "Diagrams of the End of the World in a Cosmographical Manuscript Composed in the New Kingdom of Granada (c 1696)".
25 Chapman, "Marking Time"; Capp, *English Almanacs, 1500-1800*; Casali, *Le Spie Del Cielo*; Zinner, *Geschichte Und Bibliographie Der Astronomischen Literatur*.

however, that Li's *Repertorio* did not include new practical elements as a supplement to Granollachs' *Lunario*; it means, rather, that the core of Li's additions are theoretical in nature and may seem at odds with the somewhat fugacious utility of almanacs and calendars. While the introduction of the printing press made the printing of yearly almanacs cheaper, it also made possible more voluminous almanacs and calendars covering longer periods, such as Granollachs' *Lunario,* and, in this way, more useful a wider range of readers.[26] It is precisely to the readers of these more voluminous almanacs and calendars that Li's and Hurus' *Repertorio* is addressed.

In order to appreciate the nature of Li's additions, let's consider his characterisation of the heaven of Mercury and the context in which it appears. The characterisation of the seven heavens follows the history and meaning of the divisions of times (week, months, years) and connects historical/mythographical elements with astrological/astronomical topics. This provides the historical/theoretical background of the practical information intended to be used by the readers of *repertorios.* Before explaining the nature of heavens, Li's remarks that according to ancient astrologers "planet means wandering thing (*cosa errante*)." But this does not mean that they do not follow any rule, for "as Horatio said, they follow the same rule that they had when they were created".[27] Because of this, the seven planets "correspond to the seven days of the week and in proportion to the seven climates that are seven lines or parts of the world that can be inhabited".[28] Furthermore, these planets have their strenght "in the twelve signs of the sun in the circle of the zodiac". According to the first meaning of heaven (*cielo*), Li explains that planets, stars and signs are "sculpted and impressed" (*esculpidos e impresos*) in heavens; a second meaning, in which heaven (*cielo*) is related to *celo* means "to cover up, to conceal, secret things".[29] The number of these heavens was known by a "demonstrative reason, by the number of the movements of higher bodies." Li explains that from the motion of planets it follows that heavens also move. The characteristics and meaning of these motions are detailed for every planet, headed by an illustration (Fig. 2).

Taking Mercury as an example of Li's additions, the exposition starts (1) with the most general astronomical information: that Mercury, the sixth planet, is embedded within the second heaven; that its 'circle' is consumated in 20 years and that it rules the sixth climate. This basic astronomical information is followed by (2) the mythographical meaning of the planet. Mercury means 'reasoning' and "reasoning is the way to agree between those

[26] Campos Ribeiro, "The Bounded Heavens: Defining the Limits of Astrological Practice in the Iberian Indices"; Delbrugge, "Capitilizing on the Stars"; Lanuza-Navarro, "Astrological Literature in Seventeenth-Century Spain".

[27] Li, *Repertorio de Los Tiempos*, f. b v, r.

[28] *Ibidem*.

[29] *Ibidem*.

Fig. 2 – Li's illustration of the second heaven containing Mercury. Li, *Repertorio,* f. 14. Image from the collections of the Biblioteca Nacional de España. CC BY 4.0

who sell and those who buy".[30] Therefore, the ancients called Mercury the god of trade, the god mediating between different gods: celestial and infernal. That is why Mercury comes from trade (*mercaduría*). As part of the mythographical/philological characterisation, Li explains the illustrative traditions of Mercury: the ancients "depicted it with the head of a dog by his knowledge of all things".[31] Additionally, Mercury is represented with a stick (*verga*) in his hand, which he uses to "cut the snakes and poison: because those who oppose to Mercury are divided by the reasoning of the mediators".[32] The mythographical characteristics are followed by (3) the astrological properties of the planet: Mercury is a masculine planet, of cold and dry nature. It rules over all "men of letters, accountants, painters and draftsmen: and over those who deal with subtle matters." Li explains the influence of the planet over metals, beasts, birds, trees, and plants. The astrological influences of Mercury concludes with its influence over those born under it, emphasising some medical aspects: those born under Mercury will have "a short body, and delicate head, and small and attractive eyes." Finally, the exposition concludes with (4) the geographical and meteorological aspects of Mercury: it is related to the North, its day is Wednesday, its hour the first, and its night that of Saturday.[33] The extent of Li's additions highlights that, apart from offering theoretical elements of astronomy and astrology to the reader, his interests involves providing a more comprehensive, cosmological view of the celestial elements that play a role in the life on Earth. The eighth and ninth heavens are presented in a summary way for they do not contain any planet: the former hosts the signs and its movement, according to Ptolemy, takes 36.000 years; the latter has no planets or stars but completes its movement in 24 hours in a direction contrary to those of all other heavens.[34]

The editorial success of Li's *Repertorio* has been widely noticed.[35] In a census still under construction, I have been able to identify 32 editions printed between 1492 and 1548, when Chaves' *Chronographia o repertorio de los tiempos* appeared.[36] These editions are not

30 Li, *Repertorio de los tiempos*, f. 14.

31 *Ibidem*.

32 *Ibidem*.

33 *Ibidem*.

34 Li, *Repertorio de los tiempos*, f. c v, r.

35 Chabás and Roca, "Early Printing of Astronomy"; Chabás and Goldstein, *A Survey of European Astronomical Tables in the Late Middle Ages*; Delbrugge, "A Critical Edition of Andrés de Li's Repertorio"; Delbrugge, "Capitilizing on the Stars"; Delbrugge, "From Lunar Charts to Li"; Martos, "La Editio Princeps Del Repertorio de Los Tiempos de Andrés de Li"; Albisson, "En Mala Estrella"; Carrió-Cataldi, "El tiempo, el mar, el mundo".

36 I am currently working on a census of *repertorios* deriving both from Li's *Repertorio* and from Chaves' *Chronographia*. Given the current circumstances, I have not been able to inspect many of them physically. I have relied on digital collections and on indexes of Iberian bibliography such as Navarro-Brotons et al., *Bibliographia Physico-Mathematica Hispanica (1475-1900)*; Lanuza-Navarro, "Astrología, Ciencia y Sociedad En La España de Los Asturias"; Wilkinson

just reprints or updated versions of Li's initial work, but include transformations in the methods of calculation or in mathematical techinques not always evident, such as the edition corrected by Sancho de Salaya (Zaragoza, 1536), chair of astronomy and astrology in the University of Salamanca between 1504 and 1542 and appointed in 1524 to the *Junta de Badajoz* in charge of determing whether the Maluku Islands belonged to Castille or Portugal. Although the purpose of Li's and Hurus' enterprise seemed to profit from the success of Granollachs' *Lunario*, the *Repertorio* acquired a life of its own and inaugurated a genre of writing widely influential in the Iberian-American world. Beyond the traditional genre of almanacs and calendars – to which the tradition of *repertorios* began to run in parallel – the new genre encompassed the lunar tables and the calendric information of the tradition from which it stemmed; but it now included the cosmological, natural-philosophical, astronomical, astrological, mythographical, geographical, and philological sections and remarks that appeared for the first time in Li's 1492 *Repertorio.* In this sense, Li's *Repertorio* presented the reader practical aspects within the framework of an all-comprehensive, articulated view of the cosmos that made of this genre of writing a kind of work surpassing the ephemeral and practical nature of medieval and early modern European almanacs, calendars and *lunarios*.

Celebrated Iberian mathematicians such as Jerónimo de Cháves, André do Avelar, and Rodrigo Zamorano contributed to this genre, bringing to it their background in mathematics, geography, navigation and particularly in cosmography that by the sixteenth century was thriving in the Iberian peninsula.[37] In the traditions of almanacs and calendars that flourished in the Americas during the seventeenth and eighteenth centuries, it is possible to differentiate those works belonging to the medieval and early modern traditions of almanacs and calendars (including Granollachs' *Lunario*), such as the *almanaques* and *efemérides* calculated by Carlos de Sigüenza y Góngora (1645-1700) in New Spain or those by Francisco Ruiz Lozano (1607-1677) in Perú, and those belonging to the tradition of *repertorios* such as Enrico Martínez (n.d. -1632) in New Spain, Antonio Sánchez de Cozar (*c.*1676-1696?) in New Granada, and the examples presented in the next section of this paper.[38]

and Ulloa, *Iberian Books*.

37 Sánchez, "La Institucionalización de La Cosmografía Americana"; Sánchez, "Science by Regimento: Standardising Long-Distance Control and New Spaces of Knowledge in Early Modern Portuguese Cosmography"; Portuondo, *Secret Science*; Navarro-Brotons, "Aspects of the History of Cosmography in Spain in the Last Decades of the Sixteenth Century (until 1606)"; Lanuza-Navarro, "Astrología, Ciencia y Sociedad En La España de Los Asturias"; Navarro-Brotons, "The Teaching of the Mathematical Disciplines in Sixteenth-Century Spain"; Esteban Piñeiro, "Los oficios matemáticos en la España del siglo XVI"; Vicente Maroto and Esteban Piñeiro, *Aspectos de La Ciencia*; Pardo Tomás, *Un Lugar Para La Ciencia*.

38 Tappan, "Representaciones de La Tierra"; Lanuza-Navarro, "Astrología, Ciencia y Sociedad En

Li's *Repertorio* inaugurated, then, a variant of astrological literature which embedded the practicalities of *lunarios* and calendrics within wider elements of astronomy, cosmology and natural philosophy, delivering a more comprehensive view of the cosmos and its interactions accessible to readers that typically had no formal education or access to Scholastic textbooks, medieval and early modern astronomical treatises, and medical and natural philosophical literature. A significant transformation of the genre of *repertorios,* already consolidated in the Iberian Peninsula, occurred with the publication of Jerónimo de Chaves' *Chronographia o repertorio de los tiempos, el más copioso y precisso que hasta ahora ha salido a luz* (Seville, 1548), a transformation described elsewhere as the introduction of cosmographical *repertorios*.[39] As we have seen, Chaves was critical of both the accuracy of the calculations of *lunarios* contained in the *repertorios* and of the matters (astronomical, astrological, mythological, natural philosophical and medical) acompanying them. I noticed that Li's *repertorios* already called the attention of the reader of *lunarios* to the fact that the tables of conjunctions and opposition of the Moon – the key to the liturgical and medical calendrics – were just a visible part of a *machina mundi* in which the motion of planets, stars, and signs informed the life on Earth, especially the human body represented in the zodiac man. Emphasising, even more, the importance of time in the conception and understanding of the cosmos, Chaves offered in his *Chronographia* a work in which the mathematical account of time played the central, cohesive role of the world and the humankind. His view of time was not restricted, as in the case of *lunarios,* to the determination of celestial events for astrological events of meteorological or medical significance: in the hands of the young professor of cosmography, time was now extended to embrace a (mathematical) consideration of history, a chronology ruled by astronomy, which set in order the occurrence of events on Earth.[40] In so doing, Chaves integrated into the genre of *repertorios* a prominent practice of historical chronology that goes back to Roger Bacon (1220-1290) and that would became popular in Europe through the works of Joseph Scaliger (1540-1603).[41] Consequently, Chaves' *Chronographia* is divided into four treatises: the first, which sets the framework for the remaining treatises, deals with time. In a way

La España de Los Asturias"; Lanuza Navarro, "Adapting Traditional Ideas for a New Reality"; Suárez, *Astros, Humores y Cometas: Las Obras de Juan Jerónimo Navarro, Joan de Figueroa y Francisco Ruiz Lozano (Lima, 1645-1665)*; Trabulse, *Ciencia y Tecnología En El Nuevo Mundo*, 25-37; Peraza-Rugeley, *Llámenme "El Mexicano": Los Almanaques y Otras Obras de Carlos de Sigüenza y Góngora*; Gruzinski, *Quelle heure est-il là-bas?*; Orozco-Echeverri and Molina-Betancur, "A Mestizo Cosmographer".

39 Orozco-Echeverri and Molina-Betancur, "A Mestizo Cosmographer".

40 Tappan, "Representaciones de La Tierra"; Carrió-Cataldi, "El tiempo, el mar, el mundo"; Orozco-Echeverri and Molina-Betancur, "A Mestizo Cosmographer".

41 Grafton, *Joseph Scaliger. Historical Chronology*; Smoller, *History, Prophecy, and the Stars*; Nothaft, *Dating the Passion*.

similar to previous *repertorios,* Chaves explains the divisions of time (day, week, month, year). The basic astronomical divisions of Li's *Repertorio* are now explained as part of a philosophical discussion of the nature of time that initiates with the definition of eternity, evo, and atom and concludes with the chronological explanation of the mosaic creation in which the distinction between day and night was set by god. Next, Chaves continues with a detailed historical account of the divisions of time at which Li's only hinted in the Prologue of the *Repertorio.* This historical review relies on mythological, historical, and philological analysis. But borrowing from cosmographical works, Chaves offered more techincal, astronomical divisions of time, only then to turn to astrological and chronological considerations of the ages of man, the ages of the world, the catalogue of Caesars and Roman Emperors, the catalogue of Popes, and the catalogue of Kings of Spain.[42] The first treatise concludes stating that "After this sixth age, until our time, 1584 years have passed. From the origin of the world, according to the Hebrews, 5832 years. According to the interpreters, 6777. According to the King *Don* Alfonso 8565 years, and 111 days".[43] This remark not only reveals that the intention behind the chronology is to provide a historical view of human action from the creation to the present. It also acts as context for the second treatise in which Chaves deals with "the world and its parts." In other words, by dealing with the astronomical, astrological, but notably with the chronological and historical aspects in the first part of his work, Chaves set a view of time that underpins the astronomical and cosmological expositions of the second part; the historical, astronomical, and chronological treatment of the calendar in the third part; and the medical astrology and the meteorological considerations of the fourth part.

Chaves' *Chronographia* preserves important elements of the tradition inaugurated by Li's *Repertorio.* For example, the characterisation of the heavens and their planets follows the order of topics – and to a large extent, the same words – set by Li. Chaves further elaborates on the astrological influence of those born under the sign, but even the elements of the illustrations are not too different from the woodcuts of Hurus' edition of Li. However, some other elements, notably those coming from cosmography, offered the reader of *repertorios* the novelties of the century. Chaves incorporates geographical illustrations and detailed visual representations of the elements according to the Aristotelian natural philosophy when dealing with the elements and the sublunar word. Furthermore, Chaves introduced the cross-section of the cosmos or the *figura de la máquina del mundo* that goes back to the visual tradition of Sacrobosco's *Sphaera* (Fig. 3). In this way, the textual tradition of medieval textbooks connects with the popular tradition of the almanacs represented in the *repertorios.* The connection between these traditions is more evident in the visual apparatus of the prominent mathematician and cosmographer Rodrigo Zamorano's

42 Chaves, *Chronographia*, 56r-80v.
43 *Ibid.*, 80v.

Fig. 3 – Chaves' cross-section representing the heavens following the illustrative tradition of Sacrobosco's *Sphaera*. Chaves, *Chronographia*, 112. Universidad Complutense de Madrid, public domain.

Cronología y repertorio de la razón de los tiempos (Seville, 1585). Zamorano's *Cronología* attempted to correct Chaves' calculations after the introduction of the Gregorian calendar that rendered useless all previous *repertorios.* Significantly, Zamorano incorporates cosmological and natural philosophical elements, and introduced both in the visual apparatus and in the characterisation of the heavens the highly-technical astronomical tradition of the *theorica planetarum.* Following the order set by Li, Zamorano presents the astronomical, mythological, and astrological aspects of the heavens, but as just discussed, he introduced more technical elements of cosmography. For example, in the visual representation of the heaven of Mercury, it is possible to appreciate the introduction of the layered orb that accounts for the singular motion of the planet, detailing the epycicles (Fig. 4).

The transformations of the tradition of *repertorios,* involving cosmographical, astronomical and natural philosophical elements, provided a synthesis of elements from divergent disciplines and traditions in a popular format widely accessible to readers in the Old and in the New worlds. It would be a mistake to assume that the *repertorios* were just an enlarged form of almanacs and calendars intended only for practical reasons of calendrics

Fig. 4 – Notice the layered orb coming from the illustrative tradition of the *Novae theoricae planetarum* (top-right) added to the traditional pictoric elements of *repertorios*. Zamorano, *Cronología y repertorio de la razón de los tiempos*, 62. Universidad Complutense de Madrid, public domain.

and medicine. In fact, since Li's *Repertorio,* but notably in Chaves' reform of the genre, the *repertorios de los tiempos* postulated an eclectic but all-comprehensive view of the cosmos and its history, centred around the idea of time that inexorable goes from the creation to the end of the world. In this movement from the beginning to the end, human events – under the influence of stars and depending on their location – hint at the triumph of Christianity, represented by the Spanish Monarchy, and at the redemption of humanity after the last judgment. The practical aspects providing guides for human actions concerning the moveable feasts, agriculture, navigation, and medicine acquire a different dimension in the *repertorios:* they are subsumed under the universal history of redemption, not only under the influence of the stars, as it used to be in the medieval and early modern European traditions of almanacs and calendars. In what follows, we will see how the European invention of the New World and the expansion of Christianity over the new lands constituted a central step in the astronomical chronologies and geographies presented in the *repertorios.*

3. Histories, stars and signs of the New World

In the previous section, I provided arguments to consider that *repertorios de los tiempos* constitute a form of novel, syncretic knowledge, not by announcing ideas never mentioned before, but by providing an all-encompassing view of the *machina mundi* centred around a complex, layered conception of time that borrowed from different traditions, disciplines, and praxes. Compared to other astronomical and astrological literature of the period, including treatises, *repertorios* are centred around a chronological perspective that makes of the history of the world and of the motion of planets consistent and integrative axis. Rather than mere compendia of information, *repertorios* articulated a rather coherent historical and natural philosophical view of the cosmos, underpinned by astronomy, astrology and chronology, in which events led relentlessly to the redemption of humanity. Readers of *repertorios* in the Americas were influenced by this worldview: a synthesis that constituted a key to understanding European elements that were now part of their immediate reality. In this sense, American readers of Iberian *repertorios* attempted to interpret their local histories, genealogies, territories, and traditions within the astronomical and chronological elements represented in the works of Chaves and Zamorano that widely circulated in the New World.[44] In so doing, these American writers enlarged the scope of *repertorios* by including new information and also by developing some astronomical, astrological, natural philosophical, and chronological perspectives. In this sense, indigenous and mestizos borrowed elements from the *repertorios* to understand their own place both in space and in time but also developed the genre in new directions. However, readings of *repertorios* in the New World have followed a top-down approach focusing on how and to what extent local productions replicate Iberian models. Enrico Martínez's *Repertorio de los tiempos y historia natural de nueva España* (Mexico, 1606) has set the standard against which American *repertorios* are read. Considering the European origin and education of its author, however, this *repertorio* can hardly be representative of the readings of indigenous and mestizos, although its value in understanding the European creation of the New World remains beyond doubt.[45]

In this section, I present some elements that challenge this way of reading *repertorios* by reading them as "knowledge in transit", constituting the history of the production of knowledge in the Iberian-American world, not as a form of circulation of peninsular ideas. The American *repertorios* are not imitations of their Iberian sources but contain elements introduced by indigenous and mestizos to produce their own works in which they read

[44] Torre Revello, *El Libro, La Imprenta y El Periodismo En América Durante La Dominación Española*; Rubio, "Prácticas y Actores Del Comercio de Libros En La Nueva Granada".

[45] On the controversial nature of Enrico Martínez's *Repertorio* see Gruzinski, *Quelle heure est-il là-bas?* For a recent treatment of the value of Martinez's *Repertorio* in connection with the New World see Lanuza Navarro, "Adapting Traditional Ideas for a New Reality".

their reality now inevitably including Spanish and European natural, cultural and social elements. At the same time, some indigenous and mestizos readers did not limit their engagement with *repertorios* to practical astrology but embraced their contents as elements of a universal explanation that provided the clues to interpret their locations, backgrounds, and circumstances. From this perspective, the *repertorios* mobilised astronomical, astrological, and cosmological elements for the construction of indigenous and mestizo identities. While this aspect has not been fully considered by historians of science, its importance for the construction of local identities is beginning to appear in recent scholarship in the Iberian-American world.[46]

The *reperdorio delos dienpos* written in náhuatl transcribed, translated, and analysed by López Austin in 1976 constitutes a first example of American *repertorios*.[47] The manuscript seems to date from the sixteenth century and it provides short astrological remarks on the months, from January to December, following the style of peninsular *repertorios.* Interestingly, the *repertorio* opens claiming that "many things are omitted for they lack of interest for the indigenous".[48] There are some mentions to local animals and plants but also to those coming from the Old world that were already incorporated into the Americas. The astrological remarks are limited to characterising "those born in this month shall not be tall, some of them shall be very short. They will be fond of women," reads for those born in January.[49] However, the meteorological and medical aspects receive more consideration. For example, every month explains what to do with plants and trees ("this month is very convenient to dig next to the vines" or "this month is very convenient to plant all the seeds in wet lands, even the melons, quince trees and fruit trees").[50] Concerning medical aspects, the *repertorio* náuhatl incorporates traditional elements of the Aztecs and Mesoamerican cultures, such as the *temazcal* baths and the use of obsidian. The *temazcal* was a type of steam room used for hygienical and ceremonial reasons, particularly by women after birth and by the ruling elites who had private *temazcals* in their houses.[51] In the *repertorio*, the writer recommends the *temazcals* baths in January but warns against them in

46 Cañizares-Esguerra, "New World, New Stars: Patriotic Astrology and the Invention of Indian and Creole Bodies in Colonial Spanish America, 1600-1650"; Spitler, "Nahua Intellectual Responses to the Spanish: The Incorporation of European Ideas into the Central Mexican Calendar"; Rappaport, *The Disappearing Mestizo*; Ramos and Yannakakis, *Indigenous Intellectuals. Knowledge, Power, and Colonial Culture in Mexico and the Andes*; Marroquín Arredondo and Bauer, *Translating Nature. Cross-Cultural Histories of Early Modern Science*; García-Arenal and Pereda, *De Sangre y Leche*.

47 López Austin, "Un Repertorio de Los Tiempos En Idioma Náhuatl".

48 *Ibid.*, 288.

49 *Ibid.*, 193.

50 *Ibid.*, 193, 196.

51 Walsh, *Virtuous Waters: Mineral Springs, Bathing, and Infrastructure in Mexico*, 20-21.

August ("And *temazcals* baths and gluttony are very bad").[52] While this *reportorio* does not elaborate on chronological matters and sketches some astrological remarks, it follows the *repertorios* in style and topics but direct its contents to the indigenous, incorporating local elements that predate the arrival of Spaniards.

Similarly, the *Codex mexicanus,* now in the Bibliothèque national de France, has been widely recognised as "influenced" by *repertorios* and particularly by Chaves' *Chronographia*.[53] A recent article by Lori Diel has provided sound evidence of the way in which the elements presented by Chaves were used by Nahua intellectuals, about 60 years after the fall of Tenochtitlan, to adopt calendric and chronological elements. Using the Aztec pictorial system, the manuscript contains a monthly calendar, calendar wheels, astrological medical charts, an Aztec sacred calendar, comparative numeric systems written in Aztec, Roman, and Arabic scripts, a genealogy of the Tenochca royal dynasty, Annals history of the Aztec Empire (1168-1590), alphabetic text on the Zodiac, and some Biblical visions in which characters wearing indigenous clothes found Jesus on the road to Emmaus.[54] The calendric system starts with an annotation revealing that in 1575 the Friars of Saint Augustine arrived at San Pablo. From this initial date, a wheel calendar is used to establish the dominical letter and their corresponding years (Fig. 5). But more interestingly, the *Codex mexicanus* uses chronological elements to elaborate a genealogy of Aztec kings and a chronicle of the events of the Aztec empire going up to a few years after the Spanish conquest. As Diel noted, the *Mexicanus* historical narrative "mimics the reportorios, which communicate an identity for Spain that is tied to its ancient Roman past and suggest a pagan, but illustrious, foundation for the modern Christian nation. The Codex Mexicanus fashions a corollary identity for Christian New Spain, one that is built upon its own pagan, and equally illustrious, Aztec foundation".[55] In this sense, the background against which the New Christian identity is construed is not dissolved or erased but incorporated into a providentialist view in which the Christianisation of the territory and their people is presented with the elements of the chronology of *repertorios* (Fig. 6).

But Iberian-American *repertorios* not only incorporated local plants, traditions, and kings into the framework of peninsular *repertorios*. Writers in this New World elaborated on the foundations and debated theoretical topics. This is the case of the manuscript entitled *Tratado de astronomía y la reformación del tiempo,* written between 1676 and 1696 by

[52] López Austin, "Un Repertorio de Los Tiempos En Idioma Náhuatl", 294.

[53] Diel, "The Codex Mexicanus"; López Austin, "Un Repertorio de Los Tiempos En Idioma Náhuatl"; Plas, "Une Source Européenne"; Spitler, "Nahua Intellectual Responses to the Spanish: The Incorporation of European Ideas into the Central Mexican Calendar"; Ramos and Yannakakis, *Indigenous Intellectuals. Knowledge, Power, and Colonial Culture in Mexico and the Andes*, 215.

[54] Diel, "The Codex Mexicanus", 435.

[55] *Ibid.*, 429.

Fig. 5 – Calendar wheel, *Codex Mexicanus*, 5. Bibliothèque nationale de France, public domain.

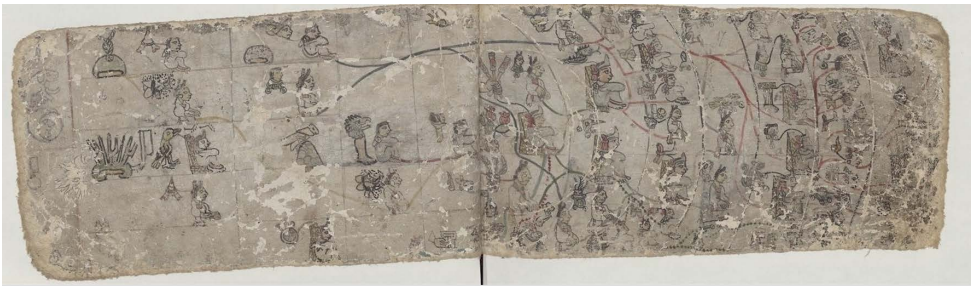

Fig. 6 – Genealogy of the Tenocha royal family, *Codex Mexicanus*, 16-17. Bibliothèque nationale de France, public domain.

Antonio Sánchez de Cozar y Guanientá, a *mestizo* priest, who claims to be a parish priest in Vélez, New Kingdom of Granada.[56] The *Tratado* touches upon topics that were present in Chaves' and Zamorano's *repertorios:* spherical astronomy and *theorica planetarum*, definitions of time, chronology, calendars, astrology; it relies on the typical (first and second

[56] Sánchez de Cozar, "Tratado".

hand) sources: Ptolemy, Macrobius, Clavius, Venegas, Cortés, Zamorano, Pérez de Moya, Copernicus, the Alphonsine and Prutenic tables, to mention a few. It is structured in three "*tratados*": the first dealing with introductory definitions of cosmography and astrology similar to the astronomical sections of *repertorios*; the second deals in some detail with the measurements of time, chronology, and *computus;* and the third with a reform to the calendar, tables of conjunctions, and the table of longitudes of the Spanish world calculated from the city of Vélez. Consequently, Sánchez's *Tratado* is structured around the elements that I presented as constitutive of the cosmographical tradition of *repertorios* introduced by Chaves' *Chronographia,* as I have shown elsewhere.[57]

Sánchez's engagement with the topics coming from Spanish *repertorios* differs from the examples so far presented. In Sánchez, the *machina mundi* relies on the astronomical and astrological elements of *repertorios* to provide a natural philosophical explanation of the two regions of the world (celestial and terrestrial) but this is done in a way that challenges central theoretical tenets of the spheres, the *theorica*, and the Spanish cosmography. The cosmos is formed by celestial spheres in constant interaction by means of pyramidal knots (*ñudos*) where planets are located, not by layered orbs of varying density which, according to the *Hypotheses* of Ptolemy and the *Theorica planetarum,* account for the changing speed observed in the motion of planets. These orbs include one "unknown to the Ancients" (*cielo incógnito*), above the Moon but below Mercury, in which comets circulate (Fig. 7). Furthermore, the motion of the celestial orbs is explained in terms of their "measured heaviness" (*peso medido*), by which all existing things – including the heavens – are directed towards "the central point of gravity". Although the *Tratado* confronts central theoretical aspects of the cosmographical traditions depicted in *repertorios,* it also follows them similarly to the *repertorio* náhuatl and the *Codex Mexicanus:* by incorporating the local perspective and elements of the author in a wider view of time (and history). In Sánchez's case, the teleological sense of history provided by the Christian conception of time represented in the Spanish cosmographical *repertorios* provides a general framework to depict the *machina mundi* as a historical device created by God at the creation that will be locked at the last judgment: when the motion of heavens ceases, the times shall end. At the same time, Sánchez's *Tratado* aims at understanding his own place, and that of the New World, in this history of redemption.

The *Tratado* put forward a reform of astronomy with natural philosophical undertones in which celestial orbs containing pyramidal knots account for the changing position and speed of the seven planets. Although this aspect seems new, Sánchez claims, it is not "if you observe with care".[58] In part, because this structure explains not only how the *machina mundi* works but how it will end, when the stars of Aries fall over the heaven of Saturn,

[57] Orozco-Echeverri and Molina-Betancur, "A Mestizo Cosmographer".
[58] Sánchez de Cozar, "Tratado", 7v.

according to St John's *Revelations*, bringing the entire system of the heavens to a standstill after the last judgment. Although Spanish astronomers and cosmographers, such as Alejo Venegas and Rodrigo Zamorano, mentioned the last judgment as part of their wider eschatology, only Sánchez's *Tratado,* as far as I am aware, develops in detail mathematical and cosmological arguments accounting for its natural effects. However, Sánchez's reform of astronomy involves not only the transformation of the shape and position of the heavens but also the discovery of another heaven, "so far unknown," in which comets circulate. After observing the "comets" of 1681 and 1682 and calculating the trajectories of these celestial bodies, Sánchez explains that there is a new heaven that was unknown to

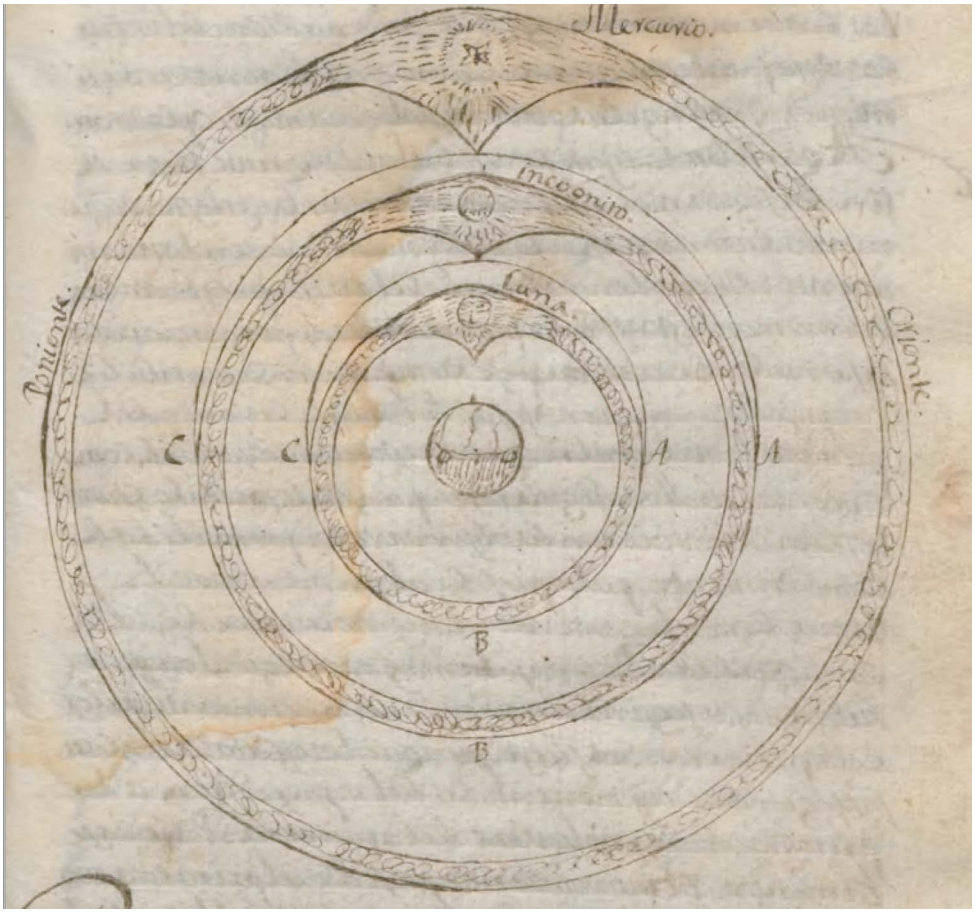

Fig. 7 – Sánchez's heavens of Mercury, the unknown heaven, the Moon and the Earth. The spheres are "free in the air", just in contact through the pyramidal knots. Sánchez, *Tratado*, f. 30v. Biblioteca Nacional de Colombia, public domain.

the ancients and to his contemporary "astrologers", and, therefore this heaven should be called "the unknown".[59] As trivial as the name may seem, the reason for the name involve an important aspect of Sánchez's view of the significance of the event in which a new heaven was discovered by a mestizo in the New World. Ancient mathematicians and modern astrologers do not ignore this heaven by lack of mathematical knowledge or observational skills. On the contrary, Sánchez relies on Ptolemy's and Alfraganus' numbers to calculate the thickness of celestial orbs. The reason is, rather, the *moment* in which this discovery should be made and its meaning, as he explains:

> This second heaven which I named "unknown" for not being hitherto known, was shown to us in such a singular wonder last year of the Lord 1681 after 5502 years from the creation, with such a terrifying and never-seen comet in the shape of the scourge of the Moorish sect of Mohamed, which in my understanding has been the last signal in which our Lord has announced virtue and reserved strength that will accompany the royal house of our Catholic King Charles II against the sectarians. And this has been more clearly revealed with the other smaller comet, which appeared the following year of 1682 in the shape of a sceptre in the sign of Aquarius. This sceptre means that Only one sceptre shall prevail over all sceptres and crowns. The announcement seems to me to favour our Christianity.[60]

Sánchez's introduction of a heaven unknown to the ancients, as well as his rearrangement of the *machina mundi,* are embedded within his interpretation of the history of Christianity as the history of redemption, which in his view includes the natives of the Americas.[61] His "discovery" of these truths unknown to the ancients but also to the modern "astrologers" has a particular meaning in Sánchez's understanding of the temporality of the world.[62] Sánchez presents his own detailed genealogy as a convergence of indigenous rulers or *caciques* and Spanish conquistadors. In a way resembling the *Codex Mexicanus,* Sánchez depicts his own indigenous ancestors, and those ruling in the "nuevo mundo"

[59] Sánchez de Cozar, f. 15r-v.

[60] *Ibid*., ff. 24v-25r.

[61] For example, Sánchez claims that now, as subjects of the Spanish crown, inhabitants of the "nuevo mundo" are freer than when they ruled themselves: "Because that freedom and dominance lacked the light of the Gospel, while this servitude and vassalage comes with such a light: through the invincible weapons of our Catholic monarchs your predecessors in glorious memory, we were told, by the mercy of the supreme and true god, that after so many thousand years all these nations, so numerous and extended, remained in the sad darkness of God's gentility. But now we enjoy this benefit, and we have more insofar the spiritual is better than the material".Sánchez de Cozar, "Tratado", f. 4v.

[62] See Orozco-Echeverri and Molina-Betancur, "A Mestizo Cosmographer"; Orozco-Echeverri, "Diagrams of the End of the World in a Cosmographical Manuscript Composed in the New Kingdom of Granada (c 1696)"; Sánchez de Cozar, "Tratado", ff. 7r; 24r-25v; 27r-29r.

before the arrival of the Spaniards, as nobles and virtuous but lacking of "the light of the Gospel". In this sense, the domination that former *caciques* exercised over their vassals was rejected in favour of the submission to the king of Spain, for "the invincible weapons of our Catholic monarchs" derived from the "supreme and true God." Hence, the submission "of the vassals of this new world" to the true authority of God got "all these nations, so numerous and extended … [from] the sad darkness of God's gentility. But now we enjoy this benefit, and we have more insofar the spiritual is better than the material".[63]

Astronomy and astrology provide Sánchez, as it did in other American *repertorios,* a way to understand his own place in the history of salvation. This includes, as we have seen, the interpretation of comets and of their place in the cosmos as indications of the expansion and final triumph of the Catholic Church that biblical hermeneutics scholars read in the *New Testament.* But the reformation of astronomy has another important consequence: the correct calculation of the true length of the year which, for Sánchez, consists of 365 days, 5 hours and 50 minutes. By restoring the length of the year, Sánchez thinks to have unlocked the key to encompass the historical chronology of the Bible with the information of the natural world that, in his view, allows him to correct the date of the birth of Jesus, the dividing event in human history (and chronology). From correcting the mismatch between the astronomical year and the year of the civil and religious calendar, Sánchez argues in favour of a different use of the leap year not only to correct the Gregorian calendar but also to reinterpret the past based on these recalculations. Central to this correction is the clarification of the position of the Sun and the Moon during the supernatural eclipse that the Gospels reported that occurred during the Passion of Jesus – a remark that also appears in the closing section Sacrobosco's *De Sphaera*.[64] In a complex set of arguments, close to the medieval tradition of the *computus* and resembling Scaliger's scholarship, Sánchez calculates the date of the birth of Jesus on the year 3821 after the creation. The establishment of this date has chronological and calendric consequences. On the one hand, Sánchez re-writes the chronology of the historical events in a way in which the year 3821 after the creation constitutes the centre of history. In so doing, he attempts to show that Jewish chronology is mistaken for missing the last two ages:

1. From the creation to the universal deluge; 2. From the universal deluge to the call of Abraham; 3. From the call of Abraham to Moses; 4. From Moses to the captivity of Jerusalem; 5. From the captivity of Jerusalem to the coming of Jesus; 6. From the coming of Jesus to the end of the world; 7. From the end of the world to eternity. The strength of his arguments is such, he thinks, that it is enough "for the Hebrews to be removed from the mistake in which they have lived showing them the deceit of their misleading account-

63 Sánchez de Cozar, "Tratado", f. 4v.

64 For a wider perspective on the significance of this date, see Nothaft, *Dating the Passion*.

ing".[65] While the reformed astronomy explains how the heavens announce the defeat of the Muslim, it also provides arguments to persuade the Jewish of this mistake. In this sense, the calendric reform acquires significance in the history leading towards the universal redemption of mankind.

Sánchez's narrative of the triumph of Christendom incorporates the defeat of the Ottomans and the final conversion of the Jews as historical steps towards establishing a universal Catholic monarchy. By placing in history the astrological and astronomical analysis of celestial objects, knowledge acquires a political and theological dimension that is present in European astrological thinking and has some prominence in the *repertorios*.[66] In fact, underlying the defeat of Ottomans and their faith and the correction of the Jewish chronology, Sánchez understands the occurrence of celestial events as part of an astronomical chronology with religious significance that widely circulated in Spain and the Americas as part of the narrative of a universal (Catholic) monarchy.[67]

4. Conclusion

Iberian *repertorios* arrived in the New World during the consolidation of Spanish rule in the Americas in the sixteenth and seventeenth centuries. But this does not mean, as I argued, that readers in this New World were passively adapting peninsular ideas to their immediate surroundings and local traditions. On the contrary, the American engagement with the astrological, astronomical, and chronological elements of the *repertorios* shall be thought of as part of a wider dynamic of production of knowledge, not as a form of circulation in the Americas of knowledge produced in Europe. Although the European and American authors involved in the production of *repertorios* did not form a *république des lettres,* their works established a conversation spanning at least over a century and a half on the meaning of celestial bodies for understanding the nature of the heavens and their influence in human affairs, relying on a shared set of evolving theoretical and practical resources. The evidence I presented, although limited when compared to the vast amount of works involved in the Iberian-American tradition of *repertorios,* is sufficient to claim that by reading *repertorios* as popular science or as a form of circulation of knowledge, we miss constitutive and central elements of the production of knowledge in the Iberian-American world. First, the path leading from Granollachs and Li to the cosmographical *repertorios* of Chaves and Zamorano consolidates a synthetic form of novel knowledge which avoided discussions of theoretical novelties, following the nature of the astrological literature

[65] Sánchez de Cozar, "Tratado", f. 82r.

[66] Gruzinski, *Quelle heure est-il là-bas?*; Malcolm, *Useful Enemies. Islam and the Ottoman Empire in Western Political Thought, 1450-1750*.

[67] Pimentel, "The Iberian Vision"; Cañizares-Esguerra, "De La Esfera a Los Dos Planetas: Las Indias Como Planeta Alternativo Desde La Colonia a La Independencia".

at their origin. However, by incorporating different traditions and praxis, cosmographical *repertorios* became a new form of knowledge by producing a novel and complex view of the *machina mundi* and its history out of existing materials (and sometimes without changing them). In this sense, *repertorios* are not manifestations of knowledge produced elsewhere, such as astronomical or astrological treatises, but a specific form of complex knowledge. Second, the popularity of Iberian *repertorios* in the New World transformed the genre when writers from Mexico to Lima introduced their own local circumstances and engaged in discussions on the astronomical, chronological, and historical fundamentals of the genre. When these phenomena are interpreted as the circulation in the New World of knowledge discretely produced elsewhere (in Iberian *repertorios*), American writers of *repertorios* are deprived of agency, and their intellectual production is reduced to a mimicry of European manners in an exotic land whose result is not worthy of the history of science and knowledge but of a cabinet of curiosities. By reading *repertorios* as "knowledge in transit", as a complex dynamic of production of natural knowledge, it is possible to appreciate that knowledge production is not as centralised as colonial dynamics may suggest, and it is richer than a unidirectional influx of information. Furthermore, the reduced number of astronomical or astrological treatises or prints in the Americas – and in the Iberian peninsula when compared with other European places – do not evidence the absence of the production of natural knowledge. On the contrary, the production of natural knowledge took other forms, such as the *repertorios de los tiempos,* that have remained somewhat invisible to historians of science under the label of "popular science".

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