

KIRCHERIZERS AND TRISECTORS: ATHANASIVS KIRCHER'S AUTOMATIC COMPOSITION SYSTEM IN THE SPANISH EMPIRE*

KIRCHERIZADORES Y TRISECTORES: EL SISTEMA AUTOMÁTICO DE COMPOSICIÓN DE ATHANASIVS KIRCHER EN EL IMPERIO ESPAÑOL

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Resumen

Athanasius Kircher (1602-1680) describió en *Musurgia universalis* (1650) un aparato para la composición musical automática que llamó *Arca musarithmica*, y al menos tres implementaciones físicas del *Arca* sobreviven en el Reino Unido y el resto de Europa. Aunque ya se ha establecido la influencia general de Kircher sobre la élite letrada del imperio español, Sor Juana Inés de la Cruz incluida, este artículo presenta las primeras pruebas de que en realidad algunas personas en los reinos de España intentaron usar el *Arca*. Dos misceláneas de manuscritos —una copiada en Puebla alrededor de 1695 y la otra en Madrid alrededor de 1785— incluyen versiones abreviadas del *Arca*. La fuente de la Biblioteca Palafoxiana de Puebla, sostengo, constituye una implementación parcial pero funcional del aparato —una cuarta *Arca* superviviente. A la vez esta colección abre una mirada para entender las preocupaciones de los aficionados de Kircher en Nueva España, porque contiene notas geométricas sobre la trisección del ángulo al lado de cuentas de diezmos de la catedral y escritos sobre ingeniería, alquimia, cronología, arquitectura, y otros temas que se consideraban en la época aspectos de las matemáticas. Si el *Arca* en la Puebla de 1690 fomentaba una búsqueda del saber universal, la fuente de Madrid de un siglo después, por contra, representa una tentativa relativamente tosca de dar sentido al complejo sistema

Abstract

Athanasius Kircher (1602-1680) described in *Musurgia universalis* (1650) a device for automatic music composition called the *Arca musarithmica*, and at least three physical implementations of the *Arca* survive in the UK and the rest of Europe. While Kircher's general influence on the lettered elite of the Spanish Empire, including Sor Juana Inés de la Cruz, has been well established, this article presents the first evidence that anyone in the realms of Spain actually tried to use the *Arca*. Two manuscript miscellanies —one created in Puebla around 1695 and the other in Madrid around 1785— include abridged versions of the *Arca musarithmica*. The source from Puebla's Biblioteca Palafoxiana, I argue, constitutes a partial but functional implementation of the device —a fourth surviving *Arca*. The collection also opens a window into the preoccupations of Kircher enthusiasts in New Spain: it includes geometrical notes on trisecting the angle alongside accounting records for the Church's tithe tax (*diezmos*) and writings on engineering, alchemy, ancient chronology, architecture, and other topics that were seen at the time as aspects of mathematics. But if the *Arca* in 1690s Puebla furthered a quest for universal knowledge, the Madrid source from a century later reflects an amateur's bungling effort to make sense of Kircher's complex

* This work was completed on the ancestral land of the Onöndowa'ga: (Seneca) Nation, one of the Six Nations of the Haudenosaunee (Iroquois) Confederacy. This project is based on archival research in Mexico and Spain in 2012, and for access and assistance I am grateful to the caretakers of Puebla's Biblioteca Palafoxiana and the Biblioteca José María Lafragua of the Benemérita Universidad Autónoma de Puebla; the Colección Jesús

Sánchez Garza at CENIDIM in Mexico City; and the Biblioteca Nacional de España in Madrid. Research travel was supported by grants from the United States Department of Education, the University of Chicago's Center for Latin American Studies, Columbia University's Center for European Studies, and the American Musicological Society. I am grateful to Devin Burke and the anonymous journal reviewers for their help with this project.

de Kircher y sugiere que a finales del siglo XVIII el *Arca* se consideraba más como una curiosidad.

Palabras clave

Athanasius Kircher (1602-1680), *Musurgia universalis* (1650), composición automática, historia de la teoría musical, historia de la ciencia, historia de la música, historia de las matemáticas, Puebla, Madrid, redes de influencia, circulación de libros e ideas.

1. THE VOYAGES OF KIRCHER'S ARK

The general influence of the Jesuit polymath Athanasius Kircher (1602-1680) on the intellectual culture of the Spanish Empire has been well established, with notable Kircher enthusiasts including Sor Juana Inés de la Cruz.¹ In Kircher's 1650 music treatise *Musurgia universalis* he describes a device for automatic music composition called the *Arca musarithmica*.² At least three physi-

cal implementations are known to survive, in Wolfenbüttel, Cambridge, and Florence, and there are hints that some version of this device traveled to the German lands. No one has yet shown, however, that anyone in the Spanish Empire actually used this relatively obscure part of Kircher's legacy.³

Key words

Athanasius Kircher (1602-1680), *Musurgia universalis* (1650), automatic composition, history of music theory, history of science, history of music, history of mathematics, Puebla, Madrid, networks of influence, circulation of books and ideas.

This article presents the first evidence that the *Arca musarithmica* was in fact known and used in both Spain and New Spain. Two previously unnoticed manuscript miscellanies—one from the Biblioteca Palafoxiana in Puebla, Mexico, and the other from the Biblioteca Nacional de España in Madrid—prove that some Spaniards did try to operate Kircher's system. These sources also make it possible to situate the reception of the *Arca* within the different intellectual climates of 1690s Puebla and 1780s Madrid.⁴

Like the golden record launched into space on the Voyager satellite in 1977, Kircher's *Musurgia universalis* was sent all across the Catholic world in the jubilee year 1650, even to Manila.⁵ If in those voyages the *Musurgia*

renreiter, 2006), pp. 134-143; and Margaret Murata, «Music History in the *Musurgia universalis* of Athanasius Kircher», in *The Jesuits: Cultures, Sciences, and the Arts 1540-1773*, ed. John W. O'Malley S.J. et al. (Toronto: University of Toronto Press, 1999), pp. 190-207.

³ On the physical implementations, see Bohnert, *Die arca musarithmica Athanasius Kirchers*, pp. 127-156; Claudio Annibaldi, «Froberger in Rome: From Frescobaldi's Craftsmanship to Kircher's Compositional Secrets», *Current Musicology*, 58 (1995), pp. 5-27; and Erik Boni, «L'arca musurgica di Athanasius Kircher alla Biblioteca nazionale centrale di Firenze», *Accademie & Biblioteche d'Italia*, 15/1 (2020), pp. 7-13.

⁴ Puebla, Biblioteca Palafoxiana, Manuscritos, vol. 31.765 (henceforth Palafoxiana 31.765), with no. 1213 in Jorge Garibay Álvarez and Jesús Joel Peña Espinosa, *Inventario general de manuscritos de la Biblioteca Palafoxiana* (Puebla: Secretaría de Gobierno del Estado de Puebla/Fundación Mapfre Tavera [Madrid], 2004); and Madrid, Biblioteca Nacional de España, MSS/11093, 32-31 <<http://bdh-rd.bne.es/viewer.vm?id=0000190901>> (henceforth Madrid 11093).

⁵ Jet Propulsion Laboratory, «Voyager: The Golden Record», 2022 <<https://voyager.jpl.nasa.gov/golden-record/>>; David Ir-

¹ Ignacio Osorio Romero, *La luz imaginaria: Epistolario de Atanasio Kircher con los novohispanos* (Ciudad de México: Universidad Nacional Autónoma de México, 1993); Elías Trabulse, *El círculo roto* (Ciudad de México: Fondo de Cultura Económica, 1984); Paula Findlen, «A Jesuit's Books in the New World: Athanasius Kircher and His American Readers», in *Athanasius Kircher: The Last Man Who Knew Everything*, ed. Paula Findlen (New York: Routledge, 2004), pp. 329-364; Ricardo Miranda, «“de Ángeles también el coro”: Estética y simbolismo en la misa *Ego flos campi* de Juan Gutiérrez de Padilla», in *Juan Gutiérrez de Padilla y la época Palafoxiana*, ed. Gustavo Mauleón Rodríguez (Puebla: Gobierno del Estado de Puebla, Secretaría de Cultura, 2010), pp. 131-153; and Mauricio Beuchot Puente, «Sor Juana y el hermetismo de Kircher», in *Los empeños: Ensayos en homenaje a Sor Juana Inés de la Cruz* (Ciudad de México: Universidad Nacional Autónoma de México, 1995), pp. 1-9.

² Athanasius Kircher, *Musurgia universalis, sive Ars magna consoni et dissoni in X. libros digesta*, II (Rome, 1650), pp. 1-199; Agnes Cécilie Bohnert, *Die arca musarithmica Athanasius Kirchers* (Berlin: Mensch und Buch Verlag, 2010); Carlo Mario Chierotti, «Comporre senza conoscere la musica: Athanasius Kircher e le “Musica mirifica”: un singolare esempio di scienza musicale nell'età barocca», *Nuova rivista musicale italiana*, 28/3 (1994), pp. 382-410; Carlo Mario Chierotti, «La musurgia mirifica di Athanasius Kircher: la composizione musicale alla portata di tutti nell'età barocca», *Musica/realità*, 13/37 (1992), pp. 107-127; Sebastian Klotz, «“Ars combinatoria” oder “Musik ohne Kopfzerbrechen”: Kalküle des Musikalischen von Kircher bis Kirnberger», *Musiktheorie*, 14/3 (1999), pp. 230-245; Tiziana Pangrazi, *La Musurgia universalis di Athanasius Kircher: Contenuti, fonti, terminologia* (Firenze: Leo S. Olschki, 2009), pp. 157-167; Melanie Wald, *Welt-erkenntnis aus Musik: Athanasius Kirchers «Musurgia universalis» un die Universalwissenschaft im 17. Jahrhundert* (Kassel: Bärenreiter, 2006), pp. 134-143; and Margaret Murata, «Music History in the *Musurgia universalis* of Athanasius Kircher», in *The Jesuits: Cultures, Sciences, and the Arts 1540-1773*, ed. John W. O'Malley S.J. et al. (Toronto: University of Toronto Press, 1999), pp. 190-207.

served as kind of musicological Noah's ark bearing the world's knowledge of music to the antipodes, then the *Arca musarithmica* forms the book's microcosm. In the eighth of the *Musurgia's* ten books Kircher encapsulates much of the preceding material on compositional techniques by encoding a set of musical building blocks as numeric permutations.⁶ Kircher means the *Arca* to demonstrate music's foundations in mathematical combinatorics while also providing a «new, recently discovered, method of composition», by means of which «even an untrained musician can achieve perfect composition in a short time».⁷ The *Arca musarithmica* (Figure 1) is a «box of music-numbers»; the case provides a table of tones (church keys) and a table of clefs and signatures, and inside the case there are slats, each of which holds tables of numbers and rhythmic values (*musarithms*). Given a text marked with syllable divisions and lengths, the device is supposed to be able to produce four-voice settings either in simple homophonic style or in florid counterpoint, suited to the character of the text.

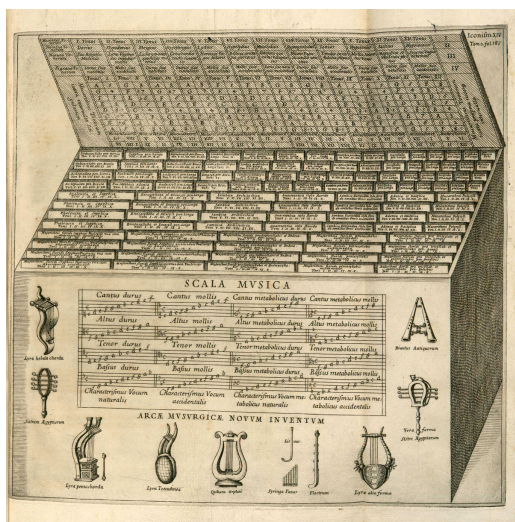


Figure 1. *Arca musarithmica*, in Kircher, *Musurgia universalis* (1650), II, facing p. 185.

ving, *Colonial Counterpoint: Music in Early Modern Manila* (Oxford: Oxford University Press, 2010), pp. 48-50; John E. Fletcher, *A Study of the Life and Works of Athanasius Kircher* (Leiden: Brill, 2011); and Joscelyn Godwin, *Athanasius Kircher's Theater of the World: The Life and Work of the Last Man to Search for Universal Knowledge* (Rochester, VT: Inner Traditions, 2009).

⁶ Kircher, *Musurgia universalis*, II, pp. 1-199.

⁷ Kircher, *Musurgia universalis*, II, p. 1.

The first question about the *Arca's* reception is whether the device actually worked as advertised. In addition to Kircher's own testimonials, the physical exemplars of the *Arca* do suggest that people tried using the system. Some researchers insist that the *Arca* is not a machine at all because it must be operated by a human and seems to require subjective judgment calls, and previous attempts to model the *Arca* in software have only been capable of producing short settings of a limited set of texts.⁸ In contrast, I have created a complete, working software implementation that is capable of setting texts of any length, in any language.⁹ The software demonstrates that it is possible with only a few adjustments to make Kircher's system fully automatic, and that it generates coherent musical output. Kircher's system combines algorithms and data structures to allow the user to transform inputs to outputs according to exactly specified rules, thus anticipating several aspects of modern computers.¹⁰ The music generated is contrapuntally correct and stylistically plausible, in a conservative ecclesiastical style of the mid seventeenth century, as any user of the web application can confirm.

The system worked, then, but did anyone in the Spanish Empire actually work the system? The manuscripts in Puebla and Madrid confirm that at least a few people did go beyond marveling at Kircher's illustrations of the device and sought to understand and use it. The context of these documents situates Kircher's reception within an intellectual context of a university-educated elite who understood music as a branch of mathematics, one that had both practical and theoretical aspects.

⁸ Chierotti, «Comporre senza conoscere la musica»; Jim Bumgardner, «Kircher's Mechanical Composer: A Software Implementation», paper presented at the 12th annual Bridges Banff Conference of the American Mathematical Society, Banff, Alberta, Canada, 26-30 July 2009 <https://jbum.com/papers/kircher_paper.pdf>; and Bohnert, *Die arca musarithmica Athanasius Kirchers*, pp. 123-126.

⁹ Andrew A. Cashner, «ARCA MUSARITHMICA. A device for automatic music composition from 1650» <<http://www.arca1650.info/>>.

¹⁰ Donald E. Knuth, *The Art of Computer Programming, Volume 1: Fundamental Algorithms* (Upper Saddle River, NJ: Addison-Wesley, 1997), pp. 1-7; Niklaus Wirth, *Algorithms + Data Structures = Programs* (Englewood Cliffs, N.J.: Prentice-Hall, 1976), pp. XII-XIII. The lack of physical implementation of an automatic mechanism does not disqualify the original *Arca* from functioning as a computational system; a human operator is also required in the two primary theoretical models for modern computer science: Turing machines and Church's lambda calculus.

2. THE ARCA AMID THE KIRCHERIZERS IN PUEBLA

Buried in an obscure manuscript collection in the Biblioteca Palafoxiana in Puebla, Mexico, there is an odd compendium of mathematical and musical speculation.¹¹ The book is one of many volumes in that library that preserve a miscellaneous pile of someone's personal papers, with sheets of different sizes, some folded over and chaotically interleaved. The notes are full of calculations of various kinds: tax accounting, chronologies of kings and popes dating from the foundation of the world, and geometric attempts to trisect the angle and square the circle. These last two puzzles are compass-and-ruler problems that are now known to be mathematically unsolvable, though people even today continue to try.¹² In the midst of all these efforts to gain arcane knowledge, someone copied out enough tables from Kircher's specifications of the *Arca musarithmica* to enable basic use.

The portions of the *Arca musarithmica* copied in the Palafoxiana manuscript are not just notes on Kircher's system; they are a functional subset of the system, constituting a usable physical implementation. The selection of tables suggests that the writer understood Kircher's system and intended to use it. Despite its name, the *Arca* can be used without the box; all a user needs is: (1) a table of clefs and signatures; (2) a table of *toni ecclesiastici* or church keys; and (3) a large array of tables containing numbers and note symbols indicating rhythms.¹³ Each table (*pinax*) holds music-numbers (*musarithmi*) for setting text in a particular meter; each is part of a division (*syntagma*) used to generate a particular style (*syntagma* 1 for simple counterpoint; *syntagma* 2 for florid). *Syntagma* 1, *pinax* 4, for example, is for simple settings of iambic verse with lines of six syllables, where the penultimate syllable is long.¹⁴ The numerals correspond to positions in the tone table (*mensa tonographica*), so that if the user has chosen tone 1, the number 1 will correspond to the

pitch D. The user then matches the pitch with the corresponding rhythm on the *pinax* table and writes it on the music paper (*palimpsest phonotacticum*) according to the table of clefs and signatures.

The Puebla writer copied out enough of the *Arca* to use it: the *mensa tonographica* and the table for the *palimpsest phonotacticum*; from *syntagma* 1, *pinax* 1, 4, 5, 6, 7, and 8; and from *syntagma* 2, *pinax* 1 and 4. The first page of copied tables (fol. 158v, see Figure 2) points to a writer who had tried to operate the system. Kircher provides two versions of each of these tables and the Puebla copyist has chosen the best version of each for practical use. Kircher includes a table of clefs and a table of *toni* on facing pages in the main text (II, pp. 50-51), but different versions appear on the *Iconismus* engraving of the *Arca* (II, facing p. 185, see Figure 1). It makes sense that the Puebla reader would copy the clef table from page 50, since it comes first in the book and is clear and useful. But as others have noted, the first tone table, opposite that clef table in the main text, is erroneous and confusing.¹⁵ Thus the Puebla copyist skips that version and uses the one from the *Arca* engraving. In programming my software implementation, I had to make the same choice. The problems with the first table only become evident when you have read through the whole book carefully and actually tried out the system.

The Puebla reader's selection of *pinax* tables also suggests a practical engagement with the ark, beyond just curiosity. Unless one were wealthy enough to own a personal copy of the *Musurgia*, the only way to use the *Arca* would be to copy out the tables. Kircher provides an overwhelming amount of data to copy, though, with eleven *pinax* tables for *syntagma* 1 and six for *syntagma* 2, along with a complex third *syntagma* of which Kircher only provides a preview. Having copied out all of this data myself, I can testify that it is time-consuming and error-prone (not least because the data already includes some errors).

A reasonable person with limited time to access the book would want to make a prudent selection of tables for practical use, perhaps by selecting only the most commonly used poetic meters. Kircher provides a paradigm text for each *pinax*: several of these are common Latin church hymns, while others are Classical poetic examples mainly found in treatises on metrics, some rather obscure. The time-pressed copyist must ask whether there will ever be a need to set verse in Sapphic meter or dodecasyllabic meter with a short penultimate (*syntagma* 1, *pinax* 10-11).

¹¹ Palafoxiana 31.765.

¹² Underwood Dudley, *The Trisectors* (Cambridge: Cambridge University Press, 1994).

¹³ On church keys, see Gregory Barnett, «Tonal Organization in Seventeenth-Century Music Theory», in *The Cambridge History of Western Music Theory*, ed. Thomas Christensen (Cambridge: Cambridge University Press, 2002), pp. 407-455; and Cristóbal L. García Gallardo and Paul Murphy, «“These Are the Tones Commonly Used”: The *Tonos de canto de órgano* in Spanish Baroque Music Theory», *Eighteenth-Century Music*, 13/1 (2016), pp. 73-93.

¹⁴ Kircher, *Musurgia universalis*, II, p. 13.

¹⁵ Bohnert, *Die arca musarithmica Athanasius Kirchers*, pp. 70-77; Chierotti, «Comporre senza conoscere la musica», pp. 393-396.

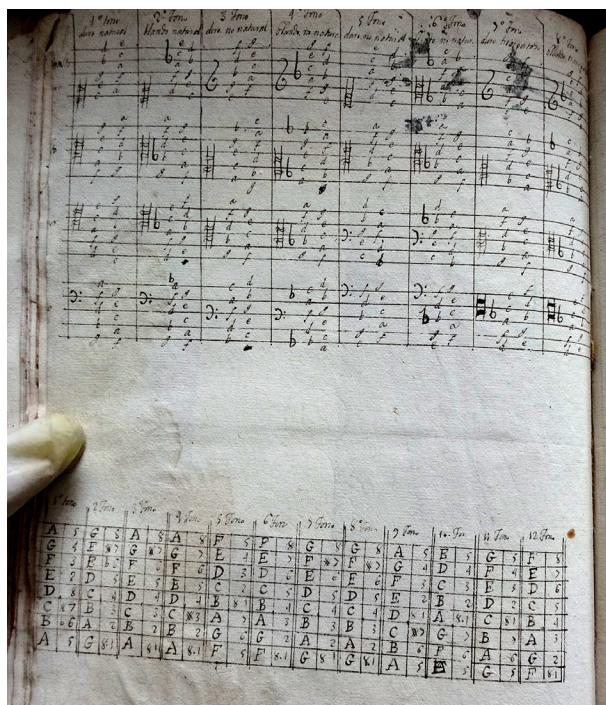


Figure 2. Top: clefs and signatures for the *Palimpsest phonotacticum*.
Bottom: *Mensa tonographica* (church keys).
Copy of tables from Kircher's *Arca musarithmica*.
Puebla, Biblioteca Palafoxiana, 31.765, fol. 158v
(see Figures 3 and 4).

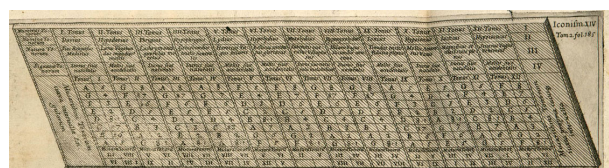


Figure 4. *Mensa tonographica* (table of church keys) for the *Arca musarithmica*, detail of Kircher, *Musurgia universalis*, II: *Iconismus XIV*, facing p. 185.

It can be no accident, then, that the Puebla reader spent the available time copying out the tables with the most practical-seeming paradigm texts in common meters (see Table 1). All but two of the tables have paradigms of common church hymns like *Veni creator Spiritus* (tables for which are copied from both simple and florid *syntagmata*). *Syntagma 1, pinax 1*, is also included, probably because this *pinax* can be used to set any text in any meter, including prose (such as psalms), as long as the user divides the text up into segments of two to six syllables.

Syntagma	Pinax	Text
1	1	(Any text, including prose)
1	4	<i>Ave maris stella</i>
1	5	<i>O ter quaterque felix Cicada</i> (Stephanus)
1	6	<i>Vexilla Regis</i> and <i>Veni creator Spiritus</i>
1	7	<i>Ave Regina Angelorum</i>
1	8	<i>Creator rerum omnium</i>
2	1	<i>Ave maris stella</i>
2	4	<i>Veni creator Spiritus</i>

Table 1. Pinax tables copied from the *Arca musarithmica*, Palafoxiana 31.7655, and their paradigm texts.



Figure 3. Table of clefs and signatures for the «Palimpsest phonotacticum» in Kircher, *Musurgia universalis*, II, p. 50.

Two other details of the copying point to a practically minded user. One is that, just like me and anyone else who has copied out these tables, the writer noted down a full *pinax* before realizing that the rhythms at the bottom are repeated from one column to the next. At first the copyist writes every symbol, but in subsequent cases, just *ditto* marks as shown in Figure 5. The second detail is that in the second *syntagma*, the copyist sometimes omits the rhythmic values for highly melismatic voices. For example, in one case (*syntagma 2, pinax 4, stropa 1, column 9*), Kircher provides twelve notes for soprano, alto, and bass voices, but includes twenty-three notes for the tenor. In several places like this the copyist stopped copying the melismatic voice partway through or omitted it. As someone who has had to debug errors resulting from my own frequent mistakes in copying out twenty-

three tiny rhythmic symbols, I can easily understand someone deciding it would be more efficient to skip this particular permutation. It is hard to believe that someone who did all the work of copying out the core of the *Arca musarithmica* would not try to use the system. Any music they produced may still be buried in another manuscript collection with a vague catalog label like this section was given («Notes on music»), or it may have been lost.

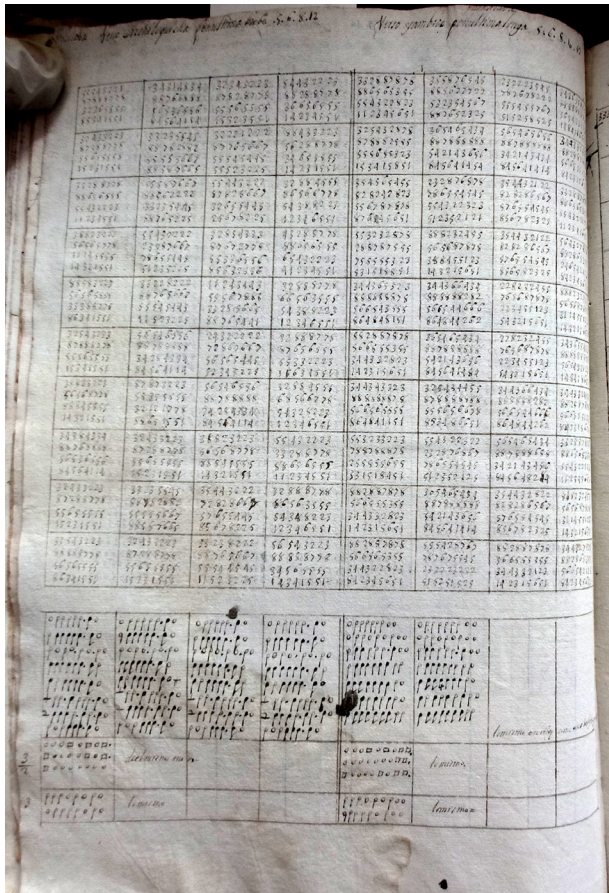


Figure 5. Copy of Kircher's table Syntagma 1, Pinax 6 and 7, for the *Arca musarithmica*. Palafoxiana 31.765, fol. 159v (see Figure 6).

Speculation about the writer aside, the simple fact should not be overlooked that these pages constitute a usable copy of the *Arca musarithmica* in Puebla. Regardless of whether these tables were ever put into a box, the Palafoxiana manuscript constitutes an additional physical implementation of Kircher's device, and the first found in the New World.

P I N A X V I.
 Iambica Archilochica octosyllaba penultima breuia.

Stropha I.	Stropha II.	Stropha III.	Stropha IV.
To. V. VI. VII. XII.	To. V. VI. VII. XII.	To. V. VI. VII. XII.	To. V. VI. VII. XII.
5 5 4 3 2 2 1	3 4 3 2 4 3 3	3 3 4 3 3 3 3	5 4 4 3 2 2 3
8 7 8 8 7 7 8	8 8 7 6 8 8 8	8 7 8 2 8 7 8	8 8 2 8 8 7 8
3 2 3 6 5 5 5	5 6 3 6 5 5 6	5 5 6 5 5 5 5	3 6 6 5 6 5 5
8 5 3 4 1 5 5 1	8 4 5 6 4 1 1 4	1 5 3 3 5 5 1	1 4 3 3 4 5 5 1
3 2 4 3 3 2 2 3	3 3 2 5 5 4 5	3 2 2 1 2 2 2	3 2 2 3 2 2 2
8 7 2 8 8 7 7 8	8 8 7 2 8 8 2	8 7 7 6 5 6 6 7	5 6 2 8 8 7 8
5 5 6 5 5 5 5	5 5 5 5 6 6 7	5 5 4 5 4 4 5	3 4 6 5 5 5 5
1 5 2 3 1 5 5 1	8 8 5 8 7 6 6 5	1 5 3 3 2 2 5	1 4 3 1 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7	5 5 4 3 2 2 2	3 2 2 8 4 5 5 5
8 8 6 5 6 5 5 5	8 8 5 6 2 2 2 2	8 7 2 2 8 8 6 7 8	8 6 5 6 6 7 8
5 5 4 3 2 2 2 3	3 3 2 3 5 4 5	3 2 6 5 1 4 4 5	3 4 6 5 2 2 3
1 5 2 3 1 5 5 1	8 8 7 6 5 2 5	2 5 6 7 8 2 2 5	1 4 3 1 4 6 5 5 1
3 2 2 8 8 7 7 8	5 5 5 8 7 6 6 7		

sed among these, along with the notes on music, alchemy, and physiology. Table 2 groups the papers of Palafoxiana 31.765 by subject area and lists them in approximately the order in which they appear.

Topics	Folios	Heading	Description
Accounting			
Economics, law, cathedral administration	1-19	«Ordenanza sacada del libro capitular numero quarto que esta en el Archivo del Cauildo de esta ciudad [...]»	Copy of Puebla Cathedral ordinance of 1537 regarding tithe taxation.
Surveying	27-61	«Agrimensura y arte de medir tierras en estas indias occidentales»	Measuring land area, calculating distance.
Weights and measures (geometry)	72r, 74	«Medidas de las aguas como se practican en estos reynos computanto una bara castellana»	Calculating liquid volume?
Cathedral tithes	104-134	«Gobierno que se tiene en la Yglesia de la Puebla de los Ang ^{es} en orden del estilo y distribucion de sus rentas eclesiásticas»	Official policies for tithe accounting; calculations of tithes.
Accounting	135-144, 149-154	«Diezmos de el ano de 1695», «Comienza 1695»	Tables of tithe records for 1695.
	145-148	«Daue hecho el cuadrante de el año de 1700»	Tables of tithe records for 1700.
Accounting, computation	211-259	«Algoritmologia de las quantas de las Iglesias [...]»	Computational method for accounting.
Geometry			
Compass/ruler	20-29	«Divicion de la línea Aritmetica»	Drawings and calculations.
Navigation, surveying	30-33	«Resolución de los problemas de geometria hasta oy no resuelto, con la Ynstitucion de los grados de longitud para la Nautica»	Calculation of longitude.
Euclidian geometry	34-45	«Toda la dificultad de la Geometria consista en el aumento o disminucion de los superficies»	Excerpt of geometry treatise, including list of propositions, problems, and theorems (copied from an existing text?).
Compass/ruler	33, 46, 62-63	«Triceccion de el Angulo», «Lo que hace el quadrato de el circulo»	Trisecting the angle, squaring the circle: diagrams and calculations.
Trigonometry	70, 72v, 75-78, 80-81	«Arte para inscribir en el circulo las figuras que hasta aqui llaman irregulares»	Notes and calculations, Pythagorean theorem.
	83-102	«Triseccion de el Angulo»	More trisecting, squaring the circle.
	155-157		Notes and calculations.
Engineering			
Hydraulics, physics	64-68	«HYDROTECHNIA NOVA. Sive. Nova Machina, Artificia quo Hydrotecnica [...]»	Kircheresque Latin mini-treatise on hydraulic machines.
Architecture			
Urban planning, surveying	79, 82		Floorplan of a house.
Music			
Composition, combinatorics	158-164	«Música»	Tables from Kircher's <i>Arca musarithmica</i> .

Topics	Folios	Heading	Description
	158v		<i>Mensa tonogographica</i> ('church keys'); <i>Palimpsest phonotacticum</i> ('clefs, signatures').
	159r		<i>Syntagma</i> 1, <i>pinax</i> 4-5.
	159v		<i>Syntagma</i> 1, <i>pinax</i> 6-7.
	160r		<i>Syntagma</i> 1, <i>pinax</i> 8 (part 1) and 1.
	160v		<i>Syntagma</i> 1, <i>pinax</i> 8 (part 2).
	161r		<i>Syntagma</i> 2, <i>pinax</i> 1.
	162r		<i>Syntagma</i> 2, <i>pinax</i> 4.
Law			
Civil, canon law	165-171	«Canones», «Juris canonici», «De el Derecho civil / De el derecho canonico»	Laws and decrees.
Music	168r	Music tablature	On same page as Latin contents list of legal topics.
Chronology	173-197	«Cronología»	Year-by-year timeline tables and prose chronicles of world history from beginning, including Biblical patriarchs, kings, Near Eastern rulers, Roman emperors, popes.
Chemistry	198-203r, 204-207, 260-270	«Quimica»	Excerpts from treatise on chemistry or alchemy.
Astrology	203v	«Astrologia»	«Astrology» written three times in different hands like a cover sheet.
Science			
Universal knowledge, natural science, physiology	208-210		Foldout sheet with universal map of knowledge, including physiological, mental, and spiritual faculties, appetites, physical substances, etc.
Theology			
Doctrinal, systematic, mystical, devotional	271-341		Topics include mystical theology, the Incarnation, outline of theological categories, and <i>oración mental</i> ('mental prayer').

Table 2. Contents of Palafoxiana 31.765, part 1.

There are many pages of scratch computations and diagrams full of corrections, alongside more polished sections of fully written-out prose that seem more like fair copies intended for publication, including numbered references to figures, bibliographic citations, and print-style ornamental title pages. In their visual style and fanciful, scientific word choices, titles like «Hydrotecnia nova» (see Figure 8) and «Algoritmologia de las cuentas de las Iglesias» betray an infatuation with Kircher's publications.¹⁶

¹⁶ Kircher wrote about hydraulic machines in *Magnes sive De arte magnetica* (Roma, 1654), p. 127; a book based on Kircher by Johannes Kestler, *Physiologia Kircheriana experimentalis* (Ams-

terdam, 1680), includes a section «De Hydrotechniâ», as does the *Cursus mathematicus* of Kircher's student Gaspar Schott (Würzburg, 1661), p. 127. Since I have not found this exact title or text in other contemporary works, however, I conjecture this «Hydrotecnia nova» section is an original work inspired by Kircher. There are numerous idiosyncratic Latin spellings (like using "b" for "u" or "v") that seem to reflect a Spanish-speaker writing in imperfect Latin rather than copying out a published work.

the volume. One series has a pattern of burnt edges, for example (visible in Figure 9), and the bulk of the geometrical papers have a prominent crease going at a slight angle horizontally across the paper as though they had all as a group been folded in half and stored that way for some time (visible in Figures 2, 5, 7, and 10). The *Arca musarithmica* sections are nestled in the middle of these papers and share the horizontal crease.

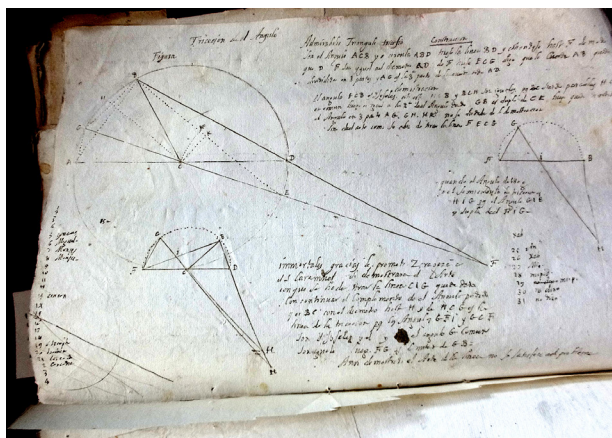


Figure 7. «Trisection of the angle», unsolvable compass-and-ruler geometry problem. Palafoxiana 31.765, fol. 33r.



Figure 8. From «Hydrotechnia nova», Latin treatise on hydraulic machines. Palafoxiana 31.765, fol. 66r.

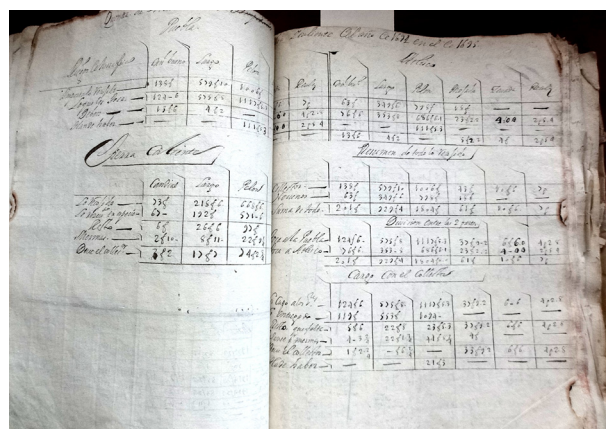


Figure 9. Accounting records of diezmos (church tithe taxes). Palafoxiana 31.765, fols. 135v-136r.

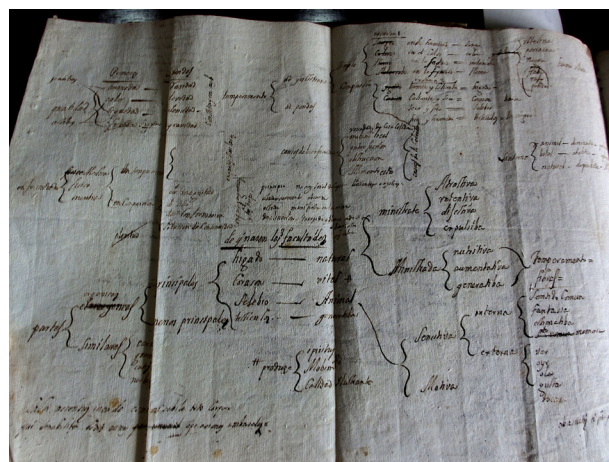


Figure 10. Map of universal knowledge. Palafoxiana 31.765, fols. 208v-209r

The recurring watermark types in the collection indicate that the sections on different topics were written on paper from the same sources within a limited time span. There are three main types of watermarks: the first resembles a U-shaped coat of arms; the second consists of a top segment with a crown over a cross flanked by two rampant griffins, over a segment with either two or three circles in a vertical column (Figure 11). This may be the crest of the city of Genoa, the source of much of New Spain's paper supply.¹⁷ The third is like the

¹⁷ Hans Lenz, *Historia del papel en México y cosas relacionadas (1525–1950)* (Ciudad de México: M. A. Porrúa, 1990).

second except there is no crown or creatures, only a cross extending up from top circle with a downward-facing crescent moon inside (Figure 12). In the latter two types, different letters are included in the circles or sometimes just below the bottom circle, probably indicating specific manufacturers and series. Grouping the contents by watermarks (see Table 3) reveals that papers with all three types are interspersed within the same original signatures, which suggests a similar date for all of them.

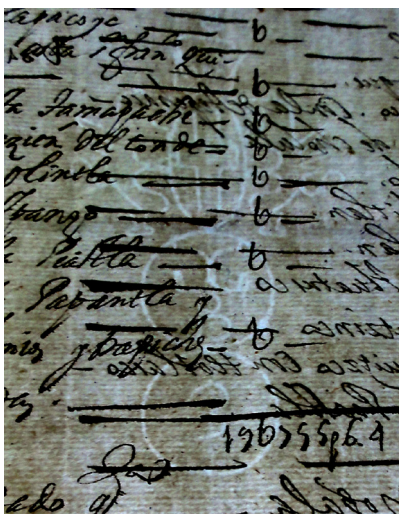


Figure 11. Cross-crown watermark type 2 (Genovese crest?) on paper with *diezmos* records dated «Comienza 1695». Palafoxiana 31.765, fol. 150.



Figure 12. Cross-crescent watermark type 3 on paper with geometry diagrams. Palafoxiana 31.765, fol. 63.

Moreover, each group contains material clearly dated within a decade of 1695. The copies from the *Arca musarithmica* are written on paper with the crown-cross-and-circles type of watermark, which is also used for portions of the geometry and chemistry material, and for the dated tithe records from 1695. The cross-crescent-and-circles watermark is also used in the same series of tithe records from 1695, as well as in the portions on chronology, the «Hydrotecnia nova», and the angle trisections.

Watermark Type	Folios	Subject
1 (crest)	1, 19, 24	Tithe accounting
1	74, 77, 93	Geometry
2 (cross-crown)	54, 109, 121, 125, 128, 131-132, 139-140, 143, 146-147, 150-153	Tithe accounting (1692-1700)
2	20, 26-28, 34-37, 40-41, 45, 47, 62, 88, 92, 102	Geometry
2	207	Chemistry
2	193	Chronology
2	165, 167	Law
2	158, 163-164, 168	Music (<i>Arca musarithmica</i>)
3 (cross-crescent)	107, 124, 136-137	Tithe accounting (1695)
3	63, 83-84, 98	Geometry
3	198, 200, 204	Chemistry
3	194, 196	Chronology
3	67-68	Engineering

Table 3. Watermarks correlated with topics in Palafoxiana 31.7655.

The tithe records dated 1695 bear a cross-crown watermark closely similar to that on the paper used for the *Arca musarithmica* tables. There are closely similar cross-crown watermarks on the paper with *Arca musarithmica* tables as with the tithe records dated 1695; see Figure 13.



Figure 13. Cross-crown watermark type 2 on paper with *Arca musarithmica* tables. Palafoxiana 31.765, fol. 158 (see Figure 11).

These same watermark types appear in the music manuscripts of the Colección Jesús Sánchez Garza, originally the music library of Puebla's Conceptionist Convento de la Santísima Trinidad (today at the Centro Nacional de Investigación, Documentación e Información Musical «Carlos Chavez», CENIDIM, in Mexico City).¹⁸ Both the cross-and-crown and crescent-moon watermark types are found in a single set of manuscript performing parts for a Marian litany composed by Mexico City chapelmaster Antonio de Salazar (c. 1650-1715) and dedicated to Isabel del Santísimo Sacramento, a sister at the Puebla convent; see Figure 14.¹⁹ The title page indicates the year 1690.

¹⁸ See Aurelio Tello *et al.*, eds., *Colección Sánchez Garza: Estudio documental y catálogo de un acervo musical novohispano* (Ciudad de México: México, Secretaría de Cultura, 2018); and Cesar D. Favila, «The Sound of Profession Ceremonies in Novohispanic Convents», *Journal of the Society for American Music*, 13/2 (2019), pp. 143-170.

¹⁹ Ciudad de México, CENIDIM, Colección Jesús Sánchez Garza CSG.262: «Letania De Nuestra Señora De Loreto. Compuesta Por El Maestro Anttonio De Salazar Maestro de Capilla De la Santa Yglecia



Figure 14. Title page of a litany for six voices composed by Antonio de Salazar in 1690 for Puebla's Conceptionist convent, Ciudad de México. CENIDIM, Colección Jesús Sánchez Garza, CSG.262. Photograph by the author, courtesy CENIDIM.

The *violón* bass part is written on paper with a watermark of the same type as that of the *Arca musarithmica* pages in the Palafoxiana manuscript; compare Figures 13 and 15. Though the letters in the central circle are different, both papers have three letters there, unlike many which have one or two. Both of these watermarks are similar to the Palafoxiana paper used for tithe records dated 1695; see Figure 11.



Figure 15. Watermark on paper of the *baxo 1º* part (see Figure 13).

Metropolitana de Mexico, dedicassele A la Madre Ysavel [Isabel] Del Santissimo Sacramento, Religiosa En el Convento De la Santissima trinidad; A Deuõion de un afecto suyo Que le estima: &al Año de 1690», According to labels in the source, the piece was originally for six voices; only the first *tiple* and continuo parts survive.

In addition to watermarks, specific references in the Palafoxiana texts point to a date after 1689. The geometry text shown in Figure 7 cites both «Zaragoza» and «Caramuel» on trisecting the angle, and in fact this passage is copied directly from a 1678 manual on Euclidean geometry by the Jesuit writer José Zaragoza.²⁰ In the section on «Agrimensura» (fol. 47), the author cites «book two» of «the Venerable» María Jesús de Ágreda as the source for the circumference of the earth. Sor María Jesús de Ágreda (1602-1665) published her *Mística ciudad de Dios* in 1670, a mystically inspired biography of Mary which at one point describes a vision of the spherical earth from above. Since this Castilian nun was beatified on December 16, 1689, the section on tithe calculations (fols. 47-54) must have been written after that date. Within the section on tithes earlier in the manuscript (fol. 19), two names appear at the top of a page of scratch arithmetic calculations: Alonso Dias and Maestro Barbero. Given the context of tithe calculations, Maestro Barbero must be Alonso Barbero Teniente, who published a guide for accountants (*contadores*) in 1694.²¹

These references also reflect the writer's connection to scientific circles in the Spanish Empire. The citation of Zaragoza reflects the writer's connection to a transatlantic circle of Spanish scientists. Referring to the Spanish polymath Juan Caramuel y Lobkowitz, Zaragoza says that he «would give undying thanks to Caramuel» if his colleague could actually publish the method he claimed to have discovered for trisecting the angle in his 1670 *Mathesis biceps*.²² In the same passage cited in the Puebla source, Zaragoza mentions a trisecting attempt by Ignacio Muñoz, a Dominican who wrote on mathematics and music; in 1668 he was a professor (*catedrático*) of mathematics at the Real Universidad de México.²³ The Puebla

manuscript's «Alonso Dias» may refer to another Dominican professor at the same school, Alonso Díaz, listed in the university's 1645 constitutions.²⁴ Scholars have already noted that the Zaragoza, Caramuel, and Muñoz also wrote on music and had close ties to Kircher.²⁵

2.2. The Circle of Kircher Enthusiasts in New Spain

In addition to dating the Palafoxiana manuscript in the last decade of the seventeenth century, these references situate the text within a known community of Spanish and New Spanish Kircher aficionados.²⁶ The New Spanish nun and poet Sor Juana Inés de la Cruz coined the term *kircherizar* ('to Kircherize') for her own tendency to follow Kircher in his attempt to gain a synoptic vision of all knowledge.²⁷ The Palafoxiana manuscript reflects the interests of a circle of speculatively-minded, educated people whom we might call *Kircherizers*.

The Palafoxiana's copy of the *Musurgia* is marked «de la librería del Coll.º del Espíritu S^o de la Puebla en 2 de Enº de 1716». This is one of two copies of the *Musurgia* that survive in Puebla; the other is in the Biblioteca Lafra-gua of the Benemérita Universidad Autónoma de Puebla (BUAP). The Palafoxiana was originally Bishop Palafox's personal library and became the library for the city's seminary for secular clergy, the Seminario Palafoxiano (still in operation), which included the Colegio de San Juan and the Colegio de San Pedro.²⁸ The Jesuit Colegio del Espíritu

²⁰ José (Ioseph) Zaragoza, *Euclides Nuevo-Antiguo. Geometria Especulativa, y Practica de los Planos, y Solidos* (Madrid, 1678).

²¹ Alonso Barbero, *Luz y claridad para contadores de partidos* (Madrid, 1694); véase Beatriz Cárceles de Gea, «La Sala de Millones y la representación del reino en el reinado de Carlos II», *Chronica Nova*, 46 (2020), p. 183 <<http://doi.org/10.30827/cnova.v0i46.6644>>.

²² Zaragoza, *Euclides Nuevo-Antiguo*, pp. 156-157: «inmortales gracias diéramos a Caramuel»; Juan Caramuel y Lobkowitz, *Mathesis biceps vetus, et nova* (Campania, 1670), p. 330.

²³ Cristina Bordas, Luis Robledo and Tess Knighton, «José Zaragoza's Box: Science and Music in Charles II's Spain», *Early Music*, 26/3 (1998), p. 408; Fortino Hipolito Vera, *Tesoro Guadalupano: Noticia de los libros, documentos, inscripciones &c. que tratan, mencionan ó aluden á la aparición y devoción de Nuestra Señora de Guadalupe* (Amecameca, México, 1889), p. 94.

²⁴ *Constituciones de la Real y Pontificia Universidad de Mexico*, 2nd ed. (Ciudad de México, 1775), p. 229.

²⁵ Bordas, Robledo and Knighton, «José Zaragoza's Box», pp. 407-408.

²⁶ Osorio Romero, *La luz imaginaria*; Trabulse, *El círculo roto*; and Findlen, «A Jesuit's Books in the New World».

²⁷ Beuchot Puente, «Sor Juana y el hermetismo de Kircher»; and Bruce Maxey, «La iconografía de *Ars magna lucis et umbrae* en *Primer sueño* de Sor Juana», *Anales de Literatura Hispanoamericana*, 49 (2020), pp. 321-334 <<https://dx.doi.org/10.5209/alhi.73134>>.

²⁸ Garibay Álvarez and Peña Espinosa, *Inventario general*; Rosario Torres Domínguez, *Colegios y colegiales palafoxianos de Puebla en el siglo XVIII* (Puebla, Mexico: Instituto de Estudios sobre la Universidad y la Educación, Universidad Nacional Autónoma de México, Benemérita Universidad Autónoma de Puebla, 2008); Alejandro G. Escobedo Rojas, «El Seminario Palafoxiano de la Puebla de los Ángeles: Su mundo jurídico en los albores del Estado mexicano», in *Los abogados y la formación del Estado mexicano*, ed. Héctor Fix Fierro, Óscar Cruz Barney, and Elisa Speckmann Guerra (Ciudad de México: Insti-

Santo evolved into today's BUAP; the former holdings of these three viceregal-era *colegios* are distributed across the Palafoxiana and Lafragua libraries.

This copy's provenance from the Jesuit college ties it directly to the story of Kircher's reception in Puebla reconstructed by Ignacio Osorio Romero, who uncovered a remarkable set of letters between Kircher and a small circle of devotees in Puebla.²⁹ Kircher's biggest fan in New Spain, and perhaps in the whole world, was the cleric Alexandro Favián (1624 - c. 1700). Favián, who was educated as a priest at the Seminario Palafoxiano and lived his whole life in Puebla, wrote in his first letter to Kircher that he discovered the Jesuit's works through the rector of the Colegio del Espíritu Santo, Francisco Ximénez. That rector was born François Guillot, and as he tells Kircher in his own surviving letters, Guillot and Kircher had become friends while at the Jesuit colleges in Lyon in 1632-1634.³⁰ In 1655, now in Puebla, Ximénez saw a copy of *Musurgia* brought by a German missionary on the way to Manila, and wrote to Kircher requesting more publications like it. On February 2, 1661, Alexandro Favián wrote to Kircher that when Ximénez had showed him the *Musurgia*, it began to fulfill a lifelong thirst for knowledge.³¹ Exalting Kircher as the «oracle of the sciences», Favián begged for more books and more information about where he could obtain one of the mechanical-musical devices like self-playing organs famously pictured in Kircher's treatise.³² The copy Ximénez showed Favián may be the same copy preserved today in the Biblioteca Palafoxiana, or that book could be a different copy that Ximénez thanked Kircher for sending in 1667.³³

tuto de Investigaciones Jurídicas, Ilustre y Nacional Colegio de Abogados de México, 2013).

²⁹ Osorio Romero, *La luz imaginaria*; Findlen, «A Jesuit's Books in the New World»; Nancy E. Márquez, ««A Most Extraordinary Man»: Alexandro Favián's Letters to Athanasius Kircher, 1661-1674» (MA thesis, Victoria University of Wellington, New Zealand, 2022).

³⁰ Osorio Romero, *La luz imaginaria*, pp. xv-xvii.

³¹ Alexandro Favián, letter to Athanasius Kircher, Feb. 2, 1661, Rome: Archive of the Pontificia Università Gregoriana (henceforth APUG), vol. 558, fols. 120r-121v and 141r; Osorio Romero, *La luz imaginaria*, pp. 7-17. Images of Kircher's correspondence are available through the Athanasius Kircher Project at Stanford University <<https://web.stanford.edu/group/kircher/>>, and all the letters transcribed by Osorio Romero have been translated and annotated in Márquez, ««A Most Extraordinary Man»».

³² Osorio Romero, *La luz imaginaria*, p. 17: «Oráculo de las ciencias».

³³ Francisco Ximénez, letter to Kircher, April 20, 1667, APUG 562, fol. 14r; see Osorio Romero, *La luz imaginaria*, p. 133.

In his next surviving letter (May 9, 1663), Favián explicitly mentions the *Arca musarithmica*; see Figure 16.³⁴ He says it was the first thing that drew his interest in the *Musurgia*, but the one he had least success in building because Kircher's diagram does not include a full explanatory key; he apparently refers to the same illustration shown in Figure 1. He asks Kircher to have an *Arca* built and sent to him in Puebla, promising to pay whatever the cost. This letter suggests that Favián had not yet actually read book eight, which does explain the diagram clearly enough, perhaps because he only had limited time to inspect the book.

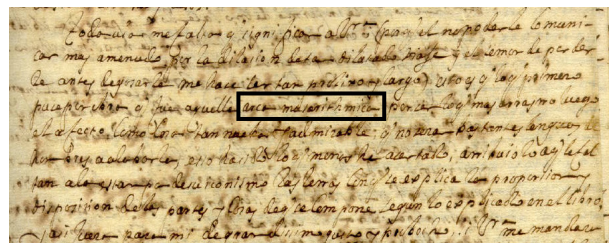


Figure 16. Letter of May 9, 1663, from Alejandro Favián to Athanasius Kircher, expressing enthusiasm and confusion about the *Arca musarithmica*. APUG 565, fol. 141r. Detail highlighting mention of the *Arca*.

Favián was known as a musician —able to play organ, lyre, theorbo, harp, and violin—, as well as a scientist, engineer, and poet, according to a 1664 recommendation letter on his behalf to Kircher from a Genovese colleague.³⁵ Favián claimed (perhaps exaggerating) to be close friends with Bishop Osorio de Escobar, and had some affiliation with the newly founded (1660) Oratorian Society in Puebla.³⁶ In that circle he could have been in direct contact with the Puebla Cathedral chapelmaster and Oratorian priest, Juan Gutiérrez de Padilla (c. 1590-1664).³⁷

³⁴ Favián, letter to Kircher, May 9, 1663, APUG 565, fols. 137r-145v; see Osorio Romero, *La luz imaginaria*, pp. 30-38.

³⁵ Francisco Maria Tassara, letter to Kircher, Jan. 18, 1664, APUG 562, fols. 130r-130v; see Osorio Romero, *La luz imaginaria*, pp. 42-43.

³⁶ Osorio Romero, *La luz imaginaria*, p. 30 (bishop) and p. 17 (Oratorians).

³⁷ Gustavo Mauleón Rodríguez, ed., *Juan Gutiérrez de Padilla y la época Palafoxiana* (Puebla: Gobierno del Estado de Puebla, Secretaría de Cultura, 2010); Rafael Castañeda García, «Ilustración y educación: La Congregación del Oratorio de San Felipe Neri en Nueva España (siglo xviii)», *Historia crítica*, 59 (2016), pp. 145-165.

Favián's correspondence quickly begins to read like a diary of obsession, in which Favián appears far more interested in parlaying his relationship with Kircher into public recognition—eventually trying unsuccessfully to be named bishop—than in querying Kircher about his scientific ideas.³⁸ Favián did manage to impress Kircher enough that the Jesuit dedicated a small book on magnetism to him in 1667.³⁹ In response, Favián promised Kircher he was writing his own treatise, a book called *Tautología extática universal* which he claimed would fill five or six volumes. According to the title page he sent Kircher in 1667 (see Figure 17), the book would cover every conceivable topic of learning: dialectics, cosmometrics, hagiography, physiology, philosophy, geography, hydrography, *topothesia* ('landscape description'), chemistry, the subterranean world, astronomy, arithmetic, optics, *machinica* ('machines/engineering?'), *musi-armónica* ('music'), and mysticism.⁴⁰ No other trace survives of this grand opus, however, and Osorio's skepticism that it was ever written seems to be well founded.⁴¹

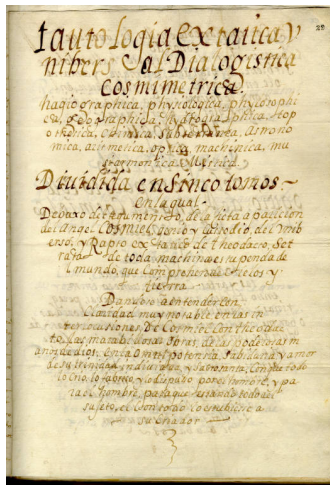


Figure 17. One of two copies of the title page of *Tautología extática universal* that Favián sent to Kircher in 1667. APUG 559, fol. 29r.

³⁸ Márquez, «‘A Most Extraordinary Man’», argues that this was part of a common strategy of Novohispanic *criollos* to advance their social standing through a system of petitions and favors.

³⁹ Athanasius Kircher, *Magneticum naturae regnum sive disceptatio physiologica de triplici in Natura rerum MAGNETE, iuxta triplicem eiusdem Naturae gradum digesto* (Roma, 1667).

⁴⁰ Osorio Romero, *La luz imaginaria*, p. 149.

⁴¹ Osorio Romero, *La luz imaginaria*, p. xxix.

The topics included in the collection bear a striking resemblance to those Favián lists as the subject of his *Tautología*, because both works reflect a conception of music as a subdiscipline of mathematics. Favián's handwriting (see Figure 16) does not seem to match with the hand used throughout most of the Palafoxiana manuscript, however. Favián's death date is still unknown, but his correspondence with Kircher and other known activity peters out after 1674, when Kircher urged Favián to accept his lot in life and let go of his aspirations for episcopal status.⁴² It seems implausible that a New Spaniard born in 1624 would be managing cathedral accounts in 1700. There may of course be items in this pile of notes that go back much earlier, or which may have been added later, but the dated title records from 1692-1700 are interleaved with most of the other material and share the same creases and wear marks, as noted above. More likely, Favián and the author of the Palafoxiana notes on geometry, astrology, and hydraulics were probably members of the same circle of Puebla *Kircherizers*.

That said, one piece of evidence in the manuscript could tie it directly to Favián, but at present this can only be a speculation. The architectural floor plan on folios 79 and 80—originally one folded sheet with more trigonometry diagrams inserted between—bears an identifiable address (see Figure 18). It appears to be the building still standing at the corner of Calle 6 Sur and 3 Oriente; see Figure 19.

Favián says that his family home was immediately next to the Colegio del Espíritu Santo. That is why he went there daily for mass, which is how he met Ximénez and was introduced to Kircher's *Musurgia*. In a study of Favián's letters Nancy Márquez estimates that «the location of Favián's family home would have been on a side street a block or two from the central square in Puebla».⁴³ This description perfectly describes the property at Calle 6 Sur y 3 Oriente. Diagonally across the street from this building is the Edificio Carolino, built in 1670 for the Jesuit Colegio del Espíritu Santo, today BUAP. It is a two-block walk from the Jesuit *templo* and three blocks from the cathedral and former Seminario Palafoxiano. Whether the writer owned or lived at this property, or was in some other way associated with it, the location so near to both of Puebla's main institutions of higher learning further situates the author in the heart of the colonial city's circles of learning and power.

⁴² Kircher, 1674 letter to Favián, APUG 566, fols. 232-233r, in Osorio Romero, *La luz imaginaria*, pp. 171-176. Neither Osorio Romero nor Findlen supply a death date; Márquez estimates 1700.

⁴³ Márquez, «‘A Most Extraordinary Man’», p. 68.

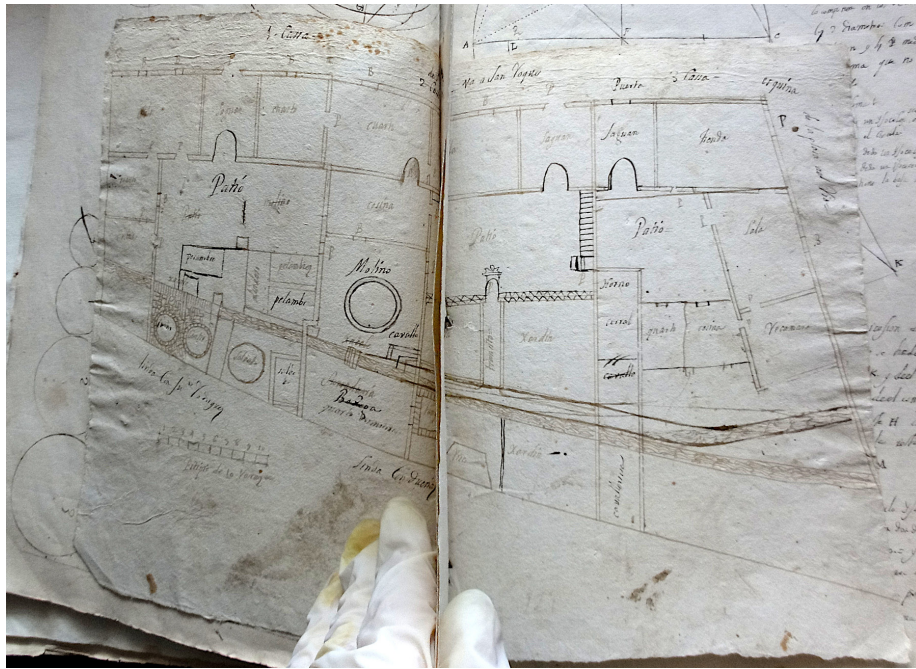


Figure 18. Architectural floor plan with trigonometry diagrams inserted between pages. Palafoxiana 31.765, fols. 79v, 82r (see Figure 19).

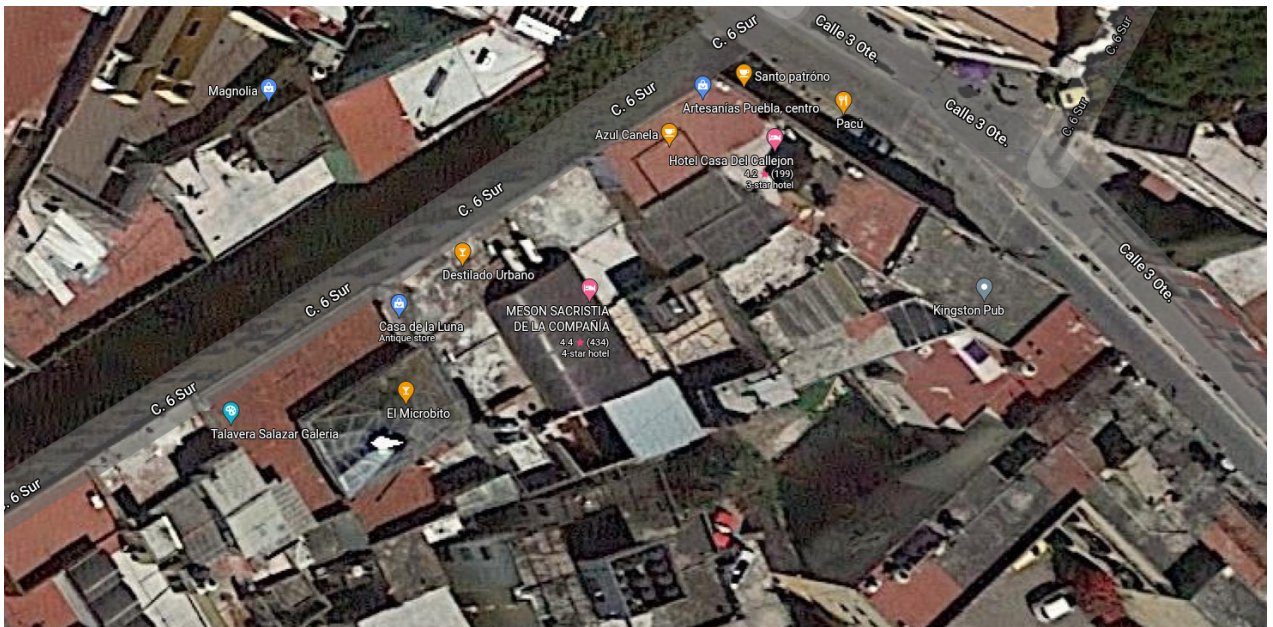


Figure 19. Satellite aerial view of Puebla, Calle 6 Sur y 3 Oriente. At top right: the Benemérita Universidad Autónoma de Puebla's Edificio Carolino. Image courtesy of Google Maps.

2.3. Tithe Accounting and the Connection to the Cathedral

The large portion of the manuscript related to *diezmos* ('tithes') makes it possible to situate its author more closely within New Spanish society, making connections between the worlds of the university and the cathedral. The tradition of *diezmos* in Iberia extended back to the sixth century CE, originally requiring farmers to pay ten percent of their produce, originally to their feudal lords and later to the Church.⁴⁴ In 1501 Pope Alexander VI decreed that all the *diezmos* of the Indies would go to the Spanish monarchy, and eventually the system in New Spain divided the tithe income among the Crown, the Church, and the local secular government.⁴⁵ The tithe records of Puebla Cathedral (founded 1526) date back to 1539, earlier than most other institutions in America, and provide insights into economic output in Puebla through the eighteenth century.⁴⁶ Bishop Juan de Palafox y Mendoza established the primary regulations for collecting, counting, and distributing tithes at Puebla Cathedral in 1645, with further regulations instituted by Bishop Fernández de Santa Cruz in 1689.⁴⁷ The tithe administration was to be overseen by two *contadores* and two *oficiales* with salaries of 300 and 400 pesos respectively, appointed by the cathedral chapter.⁴⁸ A *contador* needed knowledge of agriculture and different types of grains, how to measure them, and how to relate to *labradores* ('farm owners').⁴⁹ They kept their own records and receipts and

made a report to the cathedral chapter; some kept detailed records while others just reported summaries.

Based on these facts we can make a confident conjecture that the writer of these portions of the manuscript, if not the whole document, worked as a *contador* raising tithes for diocese of Puebla. The Palafoxiana manuscript could contribute directly to the study of *diezmos* and by extension to economic production in Puebla, because it includes records from 1692-1700, which fills in a gap in Medina Rubio's data between 1694 and 1709.

2.4. Connection to the Seminary and University: Music as Mathematics

What relationship was there between trigonometry, tithes, and automatic music composition? The one thing almost every topic in the manuscript has in common is calculation. Tithe accounting certainly depended on arithmetical calculation, as demonstrated in the scratch calculations throughout the collection, but it also required calculating areas and volumes, and land surveying. Trigonometry and other aspects of geometry were required for these calculations, and surveying additionally drew on astrology, since longitude measurements and other geographical data were computed relative to the stars in a discipline known as *cosmografía*.⁵⁰

The Palafoxiana manuscript reflects an author amid a community that saw all these areas as related applications of mathematics, whose interests extended beyond the practical into the theoretical and speculative aspects of these domains as well. The author was not content to be able to calculate sums for the 1695 tithe collection; a proper system of «algorithmology of church accounting» must be worked out and fully documented. The author needed to solve immediate problems like determining the size of a cattle yard, but this repeatedly led back to the more abstract and intractable puzzles of squaring the circle and trisecting the angle. What connects all of these areas to music is that

⁴⁴ Aristides Medina Rubio, *La Iglesia y la producción agrícola en Puebla, 1540-1795* (Ciudad de México: El Colegio de México, 1983).

⁴⁵ Medina Rubio, *La iglesia y la producción agrícola en Puebla, 1540-1795*, p. 34.

⁴⁶ Leticia Pérez Puente, «Dos períodos de conflicto en torno a la administración del diezmo en el arzobispado de México: 1653-1663 y 1664-1680», *Estudios de historia Novohispana*, 25 (2001), pp. 15-57.

⁴⁷ Medina Rubio, *La Iglesia y la producción agrícola en Puebla, 1540-1795*, pp. 92-96.

⁴⁸ On the structure of the Puebla Cathedral chapter, see Jesús Joel Peña Espinosa, «El Cabildo eclesiástico de la Diócesis Tlaxcala-Puebla, sus años de formación, 1526-1548», *Antropología*, 78 (2005), pp. 12-22; for the lists of *contadores* in the Mexico City Cathedral chapter, see José Gabino Castillo Flores, «La catedral de México y su cabildo eclesiástico 1530-1612» (Ph.D. dissertation, El Colegio de Michoacán, 2013).

⁴⁹ Medina Rubio, *La Iglesia y la producción agrícola en Puebla, 1540-1795*, pp. 100-101.

⁵⁰ Trabulse, *El círculo roto*, p. 30; Claudia Brosseder, «Astrology in Seventeenth-Century Peru», *Studies in History and Philosophy of Biological and Biomedical Sciences*, 41 (2010), pp. 146-157; Tayra M. C. Lanuza Navarro, «From Intense Teaching to Neglect: The Decline of Astrology at the University of Valencia and the Role of the Spanish *Novatores*», *Early Science and Medicine*, 22 (2017), pp. 410-437; and Tayra M. C. Lanuza Navarro, «Adapting Traditional Ideas for a New Reality: Cosmographers and Physicians Updating Astrology to Encompass the New World», *Early Science and Medicine*, 21 (2016), pp. 156-181.

they were all the professional concerns of university lecturers in mathematics. Elías Trabulse illuminates the life of one New Spanish mathematician with these interests, Fray Diego Rodríguez (c. 1596-1668), who became *catedrático* in astrology and mathematics at the Real y Pontificia Universidad de México.⁵¹ Trabulse lists this Mercedarian friar's topics of study as astronomy, trigonometry, geometry, algebra, cosmography including calculation of longitude, architecture, and urban planning. They also included speculative music theory. The friar's surviving manuscripts, Trabulse argues, were meant to form part of a projected work concerning the whole of mathematics as then understood.⁵² These manuscripts may have been preserved because Bishop Palafox had mandated that professors have their lectures bound and archived annually, though this did not take wide effect until 1671.⁵³

We have already seen that Kircher's devotee Alejandro Favián wanted to write a treatise about most of these same topics, including music; this was in line with mathematical literature of the time, which often encompassed a vast array of topics—anything that could be considered in terms of number. Our Palafoxiana author was aware of Caramuel's work, and indeed that Cistercian scholar's 1670 *Mathesis Biceps Vetus, et Nova* includes topics such as arithmetic, algebra, general geometry, cosmography, hydrography, navigation, hydraulics, logarithms, combinatorics, trigonometry, military architecture, metallurgy, meteorology, and once again, music.⁵⁴ The frontispiece brings all these topics together with geometry at the center; the compass and ruler feature prominently on the left (see Figure 20). A 1709 compendium by the Valencian Oratorian Dr. Thomas Vicente Tosca brings together «all the sciences that deal with quantity», including the same topics as Caramuel along with civil architecture, optics, astrology, and a section on music heavily citing Kircher.⁵⁵ Puebla's Biblioteca Lafragua preserves a 1690 edition of the *World of Mathematics* by Claude-François Millet Dechales, in which the chapter on music precedes a chapter on, of all things, bomb-making.⁵⁶ Millet corresponded with the Mexico City mathematics pro-

fessor Diego Rodríguez, who studied such topics while also working as a *contador*.⁵⁷



Figure 20. The many facets of seventeenth-century mathematics.

Detail of the frontispiece to Caramuel, *Mathesis biceps* (1670).

The documented provenance of the Palafoxiana manuscript confirms the book's context within seminary and university circles in Puebla, and point towards possible authors. A notation inside the front cover of the manuscript tells us that «this little work was donated to the main library of this seminary by the interim rector, D. José Antonio Ximénez, at the time *catedrático de prima*», dated February 15, 1828 and signed by a librarian whose full name is illegible.⁵⁸ José Antonio Ximénez de las Cuevas (1776-1829) is known in Puebla today primarily for founding the Academia de Bellas Artes in 1813; he was in fact rector of the Seminario Palafoxiano at that time, and donated the book just a year before his death on March 25, 1829.⁵⁹ The position he held as *catedrático de prima* referred to the time of day when he lectured, as professors were required to read their lectures at fixed hours on certain days.⁶⁰ His areas of instruction were originally philosophy

⁵¹ Trabulse, *El círculo roto*, pp. 2-30.

⁵² Trabulse, *El círculo roto*, p. 30.

⁵³ Trabulse, *El círculo roto*, p. 44.

⁵⁴ Caramuel y Lobkowitz, *Mathesis biceps*.

⁵⁵ Thomas Vicente Tosca, *Compendio mathematico, en que se contienen todas las materias mas principales de las Ciencias, que tratan de la Cantidad*, 2nd printing, 1707 imprimatur (Madrid, 1727).

⁵⁶ Claude-François Millet Dechales, *Cursus seu Mundus mathematicus* (Lyon, 1674).

⁵⁷ Márquez, «“A Most Extraordinary Man”», pp. 25-26.

⁵⁸ The inside front cover of Palafoxiana 31.765 reads as follows: «Donó esta obrita a la Biblioteca mayor de este Seminario el S. Rector Ynterino D. José Antonio Ximenez su actual Catedrático de Prima. Puebla y Febº 15 de 1828, Jose Acaria Candra [...] [illegible]. Biblio [bibliotecario]».

⁵⁹ Escobedo Rojas, «El Seminario Palafoxiano de la Puebla de los Ángeles», p. 93; and Antonio García Cubas, «Jiménez de las Cuevas», en *Diccionario geográfico, histórico y biográfico de los Estados Unidos Mexicanos*, Ciudad de México, 1889, p. 817.

⁶⁰ Torres Domínguez, *Colegios y colegiales palafoxianos de Puebla en el siglo XVIII*, pp. 74-75.

and theology, and later he became a *catedrático de artes*.⁶¹ *Arts* in this context seems to have meant something like the opposite of its use today: it included all the topics that were not rhetoric on the one hand or philosophy and theology on the other (rather like a modern STEAM curriculum of science, technology, engineering, arts, and mathematics). Ximénez, like our conjectured author, read his lectures in the same building that is now the Biblioteca Palafoxiana, across the street from Puebla Cathedral. It is plausible that Ximénez would have kept a collection of the bound volumes of university lecture and research notes from prior professors at his institution or others in Puebla.

Further research may be able to uncover the names of arts professors in Puebla between 1690 and 1700. A 1651 register of students and teachers at the Seminario Palafoxiano lists its professors «de artes» as Licenciado Pedro de Esqueda and Licenciado Miguel de Segovia with his substitute Licenciado Alonso Fernández Salcedo.⁶² A 1658 sermon publication by Miguel de Segovia survives today in the Biblioteca Lafragua.⁶³ Another seminary professor can be identified from a 1701 publication in the same archive, in which José Gómez de la Parra describes himself as «catedrático de prima» of theology at the Colegios de San Pedro y San Pablo in Puebla.⁶⁴

⁶¹ García Cubas, «Jiménez de las Cuevas», p. 817.

⁶² Ernesto de la Torre Villar, «Seminario Palafoxiano de Puebla: Nóminas de maestros y alumnos (1651 y 1770)», *Anuario de la historia de la iglesia*, 15 (2006), p. 247.

⁶³ Biblioteca Lafragua, sign. 34821/02-41040102: *Al Illmo y Rvmo. Sr. D. Alonso Cvevas Davalos, Obispo de la Santa Yglesia Cathedral de Oaxaca, del Consejo de su Magestad. (E de a. del Obispo). / Escrivialo y le dedica el Doctor D. Miguel de Segovia, Cathedratico que fue de Rethorica y Prima de Artes en los Colegios reales de S. Pedro y S. Pablo en la Ciudad de Puebla de los Angeles, y Rector de ellos: y agora canonigo de la Santa Yglesia de Oaxaca* (Ciudad de México, 1658).

⁶⁴ Biblioteca Lafragua sign. 27496/06-41040403: José Gómez de la Parra, *Grano de trigo fecundo de virtudes en la vida, fecundissimo por la succession en la muerte, la Catholica Magestad del Rey nuestro Señor don Carlos Segundo, que Dios aya: Assumpto panegyrico funeral que predicò a las funebres exequias, que en su magnifica Iglesia Cathedral celebrò el Ilustrissimo Señor Venerable Cavildo Sede Vacante, à expensas de la Nobilissima Imperial Ciudad de la Puebla de los Angeles de la Nueva-España, el dia nueve de mayo de 1701 años / Y consagra a la Suprema, Augusta, Real, Soberana Protecció de Nuestro Catholico Monarcha Don Felipe Quinto, Rey de España, Emperador de las Indias, el doctor Joseph Gomez de la Parra, Canonigo magistral de dicha Santa Iglesia Cathedral; habiendolo sido antes de la Santa Iglesia Cathedral de Valladolid Obispado de Michoacan; fue Co-*

Without knowing exactly who this person was, however, or even if there was only one author, we can confidently assert that the manuscript reflects the interests, preoccupations, and recreations of the men in the most learned circles of elite Novohispanic society (and some women, remembering Sor Juana). The subject matter of the manuscript reflects the wide range of seventeenth-century mathematics, as well as the interests of a *contador* with connections to the cathedral chapter. This was someone who probably spoke with Favián, read Sor Juana's poetry, and heard Salazar's music in person. He was a *Kircherizer* who saw all knowledge as connected through hidden correspondences rooted in the mystery of number, and saw Kircher's *Arca musarithmica* as Kircher intended it — a demonstration of the mathematical order underlying music.

Not only did this broad category of mathematics include music, but Kircher's readers in Puebla understood both within a conceptual tradition going back to Ramon Llull. The preceding volume in the Palafoxiana catalog (MS 31.764), another manuscript collection, includes a lengthy portion of notes on Llull's *Ars combinatoria*.⁶⁵ As others have noted, Kircher's quest for universal knowledge was rooted in Llull's intellectual practice of seeking to find the «combinatoric» relationships between all the elements of creation, and Kircher's own *Ars magna sciendi* extended Llull's concepts into an even broader range.⁶⁶ Kircher and his devotees sought to know the world by tracing chains of relationships between everything in the world, moving along these chains from the known to the unknown and back again. Llull models ways of encoding these relationships in mnemonic devices such as alphabetic acrostics. Kircher's *Arca musarithmica* is itself a mnemonic device, an attempt to abbreviate and encapsulate musical knowledge in one box. When Sor Juana called herself a *Kircherizer* she probably had in mind not just an interest in Kircher, but an intellectual discipline of thinking about the world after Kircher's model, the attempt to make sense of the world by taking imaginative leaps along hidden trajectories of similarity.

legial y Rector en el Insigne Colegio, ya Mayor, de nuestra Señora de Todos Santos de la Ciudad de Mexico, actual Catedrático de Prima de Theologia, y Regente de los Estudios en los Reales Colegios de S. Pedro y S. Juan de esta ciudad, de donde es originario, Examinador Synodal de este Obispado (Puebla, 1701).

⁶⁵ Garibay Álvarez and Peña Espinosa, *Inventario general*, no. 1212.

⁶⁶ Osorio Romero, *La luz imaginaria*, pp. xlii-xlix; and Beuchot Puente, «Sor Juana y el hermetismo de Kircher»; and Bohnert, *Die arca musarithmica Athanasius Kirchers*, pp. 31-64.

3. THE *ARCA* AS A CURIOSITY IN ENLIGHTENMENT MADRID

An ocean apart and a century later, Kircher's *Arca* turns up in another manuscript miscellany, preserved in the Biblioteca Nacional in Madrid; see Figure 21.⁶⁷ Intermingled with writing about Spanish politics and economics—including letters dated 1785—there is a manuscript booklet, *Modo de componer la música los ignorantes de ella* [Method of composition (for) those who know nothing about it]. The text is a Spanish digest of Kircher's *Musurgia*, book eight, including an abbreviated *pinax* table and a demonstration of how to use it to set the hymn *Veni creator Spiritus*.⁶⁸ The collection also includes a copy of a decree by Bishop Juan de Palafox y Mendoza, which looks more like a seventeenth-century document than the rest of the collection, while the handwriting in the music booklet strongly resembles the clearly eighteenth-century portions. If the *Arca musarithmica*, like the rest of Kircher's work, represents a last attempt to hold together the old system of traditional learning with aspects of the new empirical science on the threshold of the Scientific Revolution, how was the *Arca* received in the next century in the new intellectual climate of the Enlightenment?

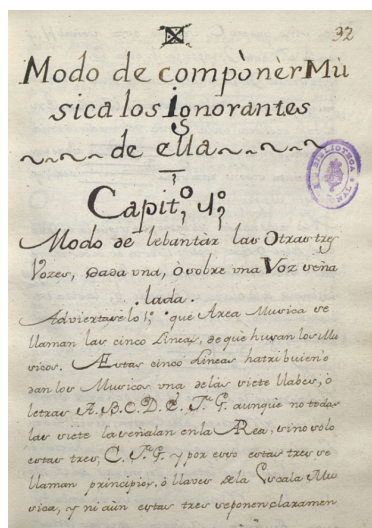


Figure 21. *Modo de componer musica los ignorantes de ella* [Method of composition (for) those who know nothing about it]. Madrid, Biblioteca Nacional de España, Ms. 11093, fol. 32r.

⁶⁷ Madrid, Biblioteca Nacional de España, Ms. 11093 (henceforth Madrid 11093).

⁶⁸ Cf. Kircher, *Musurgia universalis*, II: pp. 54-59.

The book presents a practically oriented guide to automatic composition according to «Padre Kirkèr», in two sections. The digest is based on both Kircher's original text and on Gaspar Schott's 1668 explanation and simplification of it.⁶⁹ The first section presents an extremely simplified version of Kircher's «Abacus musurgicus», from the appendix of *Musurgia*, book eight.⁷⁰ In this system the user is able to construct four-voice simple counterpoint above a bass line. By aligning a series of rods like Napier's bones according to the bass notes, one can identify the other licit harmonies above the bass and find possible upper voices.

The second section of Madrid 11093 is entitled «Modo de componer música con solos los números sonorous» [Method of composing music with only sounding numbers], and presents an abbreviated version of the *Arca musarithmica* system. The writer shows how one uses tables of numbers and rhythmic values, correlated to another table of church keys, to create four-voice settings of a text according to its meter and character, using the example *Veni creator Spiritus*; see Figure 22.

Evidence within the text and tables indicates that this Madrid treatise is actually based on both Kircher's original system in book eight of the *Musurgia* and on Gaspar Schott's revision and simplification of the system in his own 1668 *Organum mathematicum*, book nine. Within another example of the all-encompassing mathematics compendium, Schott also presents first the *abacus* approach (p. 814) and then the system using *musarithm* tables, with the example of *Veni creator Spiritus*.⁷¹ This contrasts with Kircher's own presentation, in which the *abacus* method appears after the *musarithm* method, in the appendix to book eight.⁷² The Madrid text's abridged table of *musarithms* (Figure 23) was copied from Schott (Gaspar Escoto) rather than from Kircher, as the author acknowledges (fol. 36r). Kircher's table for this hymn (see Figure 6) begins «5 5 4 3 2 2 1»—and so does the Palafoxiana copy of this table (see Figure 5)—but the Madrid text begins with «5 5 5 4 3 2 2 3», a corrected version that comes from Schott.⁷³ The Madrid writer omits the rhythmic portion of the table, perhaps because in Schott it appears on a separate page.

⁶⁹ Gaspar Schott, *Organum mathematicum libri IX explicatum* (Nuremberg, 1668); this is the system Jim Bumgardner, «Kircher's Mechanical Composer», implemented in the Perl programming language.

⁷⁰ Kircher, *Musurgia universalis*, pp. 190-192.

⁷¹ Schott, *Organum mathematicum*, pp. 814 and 829-838.

⁷² Kircher, *Musurgia universalis*, II, pp. 190-192.

⁷³ Schott, *Organum mathematicum*, p. 832.

	V	A	L	G	P	F	A	A	S	M	M	S
F	8	7	6	5	4	3	2	1	7	6	5	4
F	8	7	6	5	4	3	2	1	7	6	5	4
L	7	6	5	4	3	2	1	8	7	6	5	4
D	6	5	4	3	2	1	8	7	6	5	4	3
C	5	4	3	2	1	8	7	6	5	4	3	2
B	4	3	2	1	8	7	6	5	4	3	2	1
A	3	2	1	8	7	6	5	4	3	2	1	8
G	2	1	8	7	6	5	4	3	2	1	8	7
F	1	8	7	6	5	4	3	2	1	8	7	6

Figure 24. *Modo de componer*.

Table of church keys drawn from Kircher. Madrid 11093, fol. 37v (see Figure 4).

Mistakes in the text further support the idea that the Madrid writer did not understand Kircher's system, or that the person did not even have a very strong grasp of music. The writer begins by explaining clefs and signatures, but demonstrates the «bemo» signature (that is, *cantus mollis*) by showing an F3 clef and a flat symbol in the bottom space, which would be a C (fol. 32r). In both Kircher and Schott, the bass line over which music is to be composed with the abacus method (fol. 34r) is supposed to be F-B \flat -G-D-B \flat -C-F, in *cantus mollis*. Our writer omits the flat signature, so that the bass line begins with a tritone leap, something any trained musician would recognize immediately as an error. There are two probable reasons for this error, in addition to the author's clear lack of understanding about flat signatures: for one, both Kircher and Schott label the notes underneath with letter names but no accidentals; and second, in Schott's version there is a graphical illustration of the note names on the staff lines in between the signature and the notes. It seems most likely that the Madrid writer copied this from Schott and did not see the flat signature. In another error, in the demonstration of the abacus method showing how to align the rods to match the bass line, the rods are misaligned. Schott copies Kircher's diagram exactly, but the Madrid writer gets the second column in the wrong place (fol. 34r).⁷⁵

⁷⁵ See Kircher, *Musurgia universalis*, II, p. 191; and Schott, *Organum mathematicum*, p. 816.

With these errors, a faulty tone table, and no rhythm permutations, it would not be possible for anyone to create music using only the information in the Madrid booklet. If the errors were fixed, the text could serve as a rough guide to Schott's version of the system for the reader who did not know Latin; but unfortunately the writer would have needed to know more about music to get it right.

3.1. A Relic of the Old Science in an Aristocratic Library

The other items in this Madrid collection, apart from the Palafox decree, are connected to the Spanish political and economic situation toward the end of the Bourbon dynasty. The first work is a moral condemnation of «Ambition, the mother of all vices», which argues that this sin was behind the rise and fall of all previous worldly empires, and warns that the Spanish monarchy will be next if it does not rein in its ambition. Immediately after the *Modo de componer música* treatise there is a two-page note with a list of *dramatis personae* for a performance called *Musica del gran theatro del Mundo*:

- La prima parte di Soprano... Il Re di Francia.
- Il Baso... L'Imperatore.
- Il Ritornelo... Don Philipo.
- La Batuta musicale... Il Re di Prusia.
- La Cadenza... La Regina d'Unghia.
- Le passi Regolati... Li Inglesi, et Olandesi.
- Sospiri, e Mezzi Sospiri... La Regina di Spagna.
- Mutazione per ascendere... Il Re Sardo.
- Mutazione per diszendere... Il Duca di Modena.
- Maestro di Capella, che regula la musica... la Justicia di Dio.
- Alza, e tira li nautizi... Il Papa.
- Saranno l'orquesta... L'Ungari.
- Spectatori... Li Veneciani.
- Sonatori della Musica... tuti gl' Electori.
- Orchesta... Lo stato del Papa.

The spelling indicates a Spanish writer imitating the libretto of an Italian opera (*baso* for *basso*, *li* for *gli*, *justicia* for *giustizia*). The cast of characters and their titles suggest that this is a mock playbill intended as satire. The names are all connected to the end of the War of the Austrian Succession (1740-1748), in which France, Prussia, Spain, and Sardinia (among others) challenged the succession of Maria Theresa of Hapsburg, Queen of Hungary, to the Austrian crown, who was supported by the English and the Dutch. «Don Philipo» («Il Ritornelo») must be Philip V of Spain, who abdicated the throne in

1724 and then returned to reign again seven months later after his son Louis I died.

The other items in the collection are two letters, one from the Count of Carrión de Calatrava to the Ministers of Finance and State, answering accusations made against him by Don Francisco Cabarrús (dated Madrid, March 13, 1785), and a letter from Cabarrús to the Count of Carrión (dated Madrid, April 25, 1785).⁷⁶ These are documents of a public conflict between the two noblemen over the directorship of the Bank of San Carlos, Spain's first national bank, which had been founded in 1782 with Cabarrús as director.⁷⁷

Whoever wrote the *Modo de componer música* had access to works by both Kircher and Schott, and the little treatise ended up piled together with works of Palafox and writings pertaining to Spanish politics of the mid-to-late eighteenth century. There is little connecting the musical booklet to the other items in the treatise except the word *música* in the satirical playbill and perhaps the connection with accounting in the bank controversy, but that is a stretch. Otherwise, it seems to be a random oddment bound only to keep from losing it, in one of many such volumes labeled «Varios papeles».

This book comes from the former collection of the Duke of Osuna. The dukes of Osuna, including Don Pedro de Alcántara Téllez-Girón y Pacheco (1755-1807), were strong patrons of music and the arts, and their library—the first public library in Spain—formed the core of what would become the Biblioteca Nacional.⁷⁸ As of 1823 an inventory registered nearly the complete works of Kircher in the duke's library (listed here in chronological order):

1. *Ars magna lucis et ombrae* (Rome, 1646)
2. *Musurgia universalis* (Rome, 1650)
3. *Obeliscus Pamphilius* (Rome, 1650)

⁷⁶ See the catalog of the Biblioteca Nacional in Madrid: <<http://catalogo.bne.es/uhtbin/cgiirsi/?ps=VaV13luyXC/BNMADRID/179640923/123>>.

⁷⁷ Rafael Moreno Fernández, «El Banco de San Carlos: La quiebra del principio de prudencia tras la salida en 1790 de Cabarrús y su equipo directivo», *De Computis: Revista Española de Historia de la Contabilidad*, 1 (2013), pp. 63-64.

⁷⁸ Juan Pablo Fernández-Cortés, *La música en las Casas de Osuna y Benavente (1733-1882). Un estudio sobre el mecenazgo musical de la alta nobleza española* (Madrid: Sociedad Española de Musicología, 2007); and Francisco J. Gutiérrez Núñez, «El IX duque de Osuna: Político, militar y mecenas (1755-1807)», in *Milicia y sociedad ilustrada en España y América (1750-1800): Tomo 1* (Sevilla: Cátedra «General Castaños», 2002), pp. 103-120.

4. *Itinerarium extaticum* (Rome, 1656)
5. *Ad Alexandrum 7 obelisci aegyptiaci interpretatio* (Rome, 1666)
6. *China illustrata* (Amsterdam, 1667)
7. *China monumentis illustrata* (Amsterdam, 1667)
8. *Ars magna sciendi* (Amsterdam, 1669)
9. *Iter staticum celesta, et terrestre* (Würzburg, 1671)
10. *Principis Cristiani Archetyp. politic* (Amsterdam, 1672)
11. *Phonurgia nova* (Kempten, 1673)
12. *Arca Noe* (Amsterdam, 1675)
13. *Turris Babel* (Amsterdam, 1679)⁷⁹

It also contained ten works by Gaspar Schott, including the *Organum mathematicum*, and ten works by Juan de Palafox y Mendoza.⁸⁰

The text suggests an author who aspired to a practical orientation, but had not actually put Kircher or Schott's system into practice. The source does not indicate any interest in the more speculative or conceptual elements of the system; other than saying that there are infinite possible permutations, there is no mention of combinatorics or mathematics. We may speculate that for this author the *Arca musarithmica* was primarily a curiosity of the past, prized more as a minor engineering marvel than for its intended significance as a manifestation of a whole worldview. Even in the age of Enlightenment Kircher remained an imposing presence, but the secrets of his musical ark, along with so many other aspects of his pre-Enlightenment worldview, were slipping out of reach.

4. A DIFFERENT RECEPTION THAN KIRCHER ENVISIONED

Kircher's work, then and now, has attracted lovers of the arcane, people willing to brave his difficult Latin and his invented quasi-Greek neologisms, modern trisectors for whom his bizarre illustrations still pique curiosity.⁸¹ But this was not the reception Kircher said he wanted for his *Arca musarithmica*. He did not intend it for the speculations of trisectors and antiquarians, but to serve

⁷⁹ *Inventario y tasación de la biblioteca del duque de Osuna realizada en el año de 1823*, Archivo Histórico de la Nobleza, OSUNA, C. 3445, D. 16, p. 92 <<http://pares.mcu.es/ParesBusquedas20/catalogo/show/6411090?nm>>.

⁸⁰ *Inventario y tasación de la biblioteca del duque de Osuna realizada en el año de 1823*, p. 161 (Schott), p. 129 (Palafox).

⁸¹ Godwin, *Athanasius Kircher's Theater of the World*.

the practical needs of his fellow Jesuit priests, especially those in missions outside Europe. Thus, he included a section on how to use the ark to set texts in other languages, and though he was limited to the European and ancient languages he knew, he was confident the work could also be adapted to American indigenous languages. While technically this is possible—as my software implementation demonstrates—a major impediment to practical use arises from the need to find non-Latin texts that fit one of Kircher's Classical metrical schemes. It would be more practical for a missionary who wanted to use the *Arca* to write a new vernacular text in one of Kircher's meters, and this would be in keeping with Jesuit missionary translation practices.⁸²

It is hard to imagine, though, that a priest struggling in tropical heat to communicate in an indigenous language would find the leisure to sit down and work out a polyphonic composition using Kircher's cumbersome manual system. With his faith that the musical patterns themselves were universal and would not require translation, Kircher manifests an ambivalence toward cultural accommodation that was typical of the Jesuits of Kircher's era. Some members of the society tried to adapt to local cultures, while others tried to convert cultural elites by impressing them with the superiority of European art.⁸³ Kircher seems to be promoting both goals. The new evidence of the *Arca*'s reception, however, suggests that the invention found its audience not among missionaries but among learned, scientifically inclined, churchmen and gentlemen-amateurs. These archival sources demonstrate clearly that Kircher's ark did make its way to Iberia and Mexico, where it served some as a tool for pursuing universal knowledge and others as a curiosity.

⁸² Paolo Castagna, «The Use of Music by the Jesuits in the Conversion of the Indigenous Peoples of Brazil», in John O'Malley *et al.*, *The Jesuits: Cultures, sciences, and the arts, 1540-1773* (Toronto: University of Toronto Press, 1999), pp. 641-658.

⁸³ See, for instance, Gauvin A. Bailey, *Art on the Jesuit Missions in Asia and Latin America, 1542-1773* (Toronto: University of Toronto Press, 1999); Duarte de Sande, *Japanese Travellers in Sixteenth-Century Europe: A Dialogue concerning the Mission of the Japanese Ambassadors to the Roman Curia (1590)*, ed. Derek Massarella, translated by J. F. Moran, annotated translation of *De missione legatorum Japonensium* (Macao, 1590) with introduction (London: The Hakluyt Society, Ashgate, 2012); and Ines G. Županov, *Missionary Tropics: The Catholic Frontier in India* (Ann Arbor, MI: University of Michigan Press, 2005).

WORKS CITED

- Annibaldi, Claudio. «Froberger in Rome: From Frescobaldi's Craftsmanship to Kircher's Compositional Secrets». *Current Musicology*, 58 (1995), pp. 5-27, 131.
- Bailey, Gauvin A. *Art on the Jesuit Missions in Asia and Latin America, 1542-1773*. Toronto: University of Toronto Press, 1999.
- Barbero, Alonso. *Luz y claridad para contadores de partidos*. Madrid: Francisco Sanz, 1694.
- Barnett, Gregory. «Tonal Organization in Seventeenth-Century Music Theory». In *The Cambridge History of Western Music Theory*, edited by Thomas Christensen. Cambridge: Cambridge University Press, 2002, pp. 407-455.
- Beuchot Puente, Mauricio. «Sor Juana y el hermetismo de Kircher». In *Los empeños: Ensayos en homenaje a Sor Juana Inés de la Cruz*, director Sergio Fernández. Ciudad de México: Universidad Nacional Autónoma de México, 1995, pp. 1-9.
- Bohnert, Agnes Cäcilie. *Die arca musarithmica Athanasius Kirchers*. Berlin: Mensch und Buch Verlag, 2010.
- Boni, Erik. «L'arca musurgica di Athanasius Kircher alla Biblioteca nazionale centrale di Firenze». *Accademie & Biblioteche d'Italia*, 15/1 (2020), pp. 7-13.
- Bordas, Cristina, Luis Robledo, and Tess Knighton. «José Zaragoza's Box: Science and Music in Charles II's Spain». *Early Music*, 26/3 (1998), pp. 391-413.
- Brosseder, Claudia. «Astrology in Seventeenth-Century Peru». *Studies in History and Philosophy of Biological and Biomedical Sciences*, 41 (2010), pp. 146-157.
- Bumgardner, Jim. «Kircher's Mechanical Composer: A Software Implementation». Paper presented at the 12th annual Bridges Banff Conference, of the American Mathematical Society, Banff, Alberta, Canada, 26-30 July 2009. <https://jbum.com/papers/kircher_paper.pdf>.
- Caramuel Lobkowitz, Juan. *Mathesis biceps vetus, et nova*. Campania, 1670.
- Cárceles de Gea, Beatriz. «La Sala de Millones y la representación del reino en el reinado de Carlos II». *Chronica Nova*, 46 (2020), pp. 177-212. DOI: <<http://doi.org/10.30827/cnova.v0i46.6644>>.
- Castagna, Paolo. «The Use of Music by the Jesuits in the Conversion of the Indigenous Peoples of Brazil». In *The Jesuits. Cultures, sciences, and arts, 1540-1773*, edited by John W. O'Malley, S. J., Gauvin Alexander Bailey, Steven J. Harris, and Frank Kennedy. S. J. Toronto: University of Toronto Press, 1999, pp. 641-658.

- Castañeda García, Rafael. «Ilustración y educación: La Congregación del Oratorio de San Felipe Neri en Nueva España (siglo XVIII)». *Historia crítica*, 59 (2016), pp. 145-165.
- Castillo Flores, José Gabino. «La catedral de México y su cabildo eclesiástico 1530-1612». Ph.D. dissertation, El Colegio de Michoacán, México, 2013.
- Chierotti, Carlo Mario. «Comporre senza conoscere la musica: Athanasius Kircher e le “Musica mirifica”: un singolare esempio di scienza musicale nell’età barocca». *Nuova rivista musicale italiana*, 28/3 (1994), p. 382-410.
- _____. «La musurgia mirifica di Athanasius Kircher: la composizione musicale alla portata di tutti nell’età barocca». *Musica/realità*, 13/37 (1992), pp. 107-127.
- _____. *Constituciones de la Real y Pontificia Universidad de México*, 2nd edition. Ciudad de México, 1775.
- Dudley, Underwood. *The Trisectors*. Cambridge: Cambridge University Press, 1994.
- Escobedo Rojas, Alejandro G. «El Seminario Palafoxiano de la Puebla de los Ángeles: Su mundo jurídico en los albores del Estado mexicano». In *Los abogados y la formación del Estado mexicano*, edited by Héctor Fix Fierro, Óscar Cruz Barney, and Elisa Speckmann Guerra. Ciudad de México: Instituto de Investigaciones Jurídicas, Ilustre y Nacional Colegio de Abogados de México, 2013, pp. 83-107.
- Favila, Cesar D. «The Sound of Profession Ceremonies in Novohispanic Convents». *Journal of the Society for American Music*, 13/2 (2019), pp. 143-170.
- Fernández-Cortés, Juan Pablo. *La música en las Casas de Osuna y Benavente (1733-1882). Un estudio sobre el mecenazgo musical de la alta nobleza española*. Madrid: Sociedad Española de Musicología, 2007.
- Findlen, Paula. «A Jesuit’s Books in the New World: Athanasius Kircher and His American Readers». In *Athanasius Kircher: The Last Man Who Knew Everything*, edited by Paula Findlen. New York: Routledge, 2004, pp. 329-364.
- Fletcher, John E. *A Study of the Life and Works of Athanasius Kircher*. Leiden: Brill, 2011.
- García Cubas, Antonio. «Jiménez de las Cuevas». En *Diccionario geográfico, histórico y biográfico de los Estados Unidos Mexicanos*. Ciudad de México, 1889, p. 817.
- García Gallardo, Cristóbal L. and Paul Murphy. «“These Are the Tones Commonly Used”: The *Tonos de canto de órgano* in Spanish Baroque Music Theory». *Eighteenth-Century Music*, 13/1 (2016), pp. 73-93.
- Garibay Álvarez, Jorge and Jesús Joel Peña Espinosa. *Inventario general de manuscritos de la Biblioteca Palafoxiana*. Puebla: Secretaría de Gobierno del Estado de Puebla; and Madrid: Fundación Mapfre Tavera, 2004.
- Godwin, Joscelyn. *Athanasius Kircher’s Theater of the World: The Life and Work of the Last Man to Search for Universal Knowledge*. Rochester, VT: Inner Traditions, 2009.
- Gutiérrez Núñez, Francisco J. «El IX duque de Osuna: Político, militar y mecenas (1755-1807)». In *Milicia y sociedad ilustrada en España y América (1750-1800): Tomo I*. Sevilla: Cátedra «General Castaños», 2002, pp. 103-120.
- Hipólito Vera, Fortino. *Tesoro Guadalupano: Noticia de los libros, documentos, inscripciones &c. que tratan, mencionan ó aluden á la aparición y devoción de Nuestra Señora de Guadalupe*. Amecameca, México, 1889.
- Irving, David. *Colonial Counterpoint: Music in Early Modern Manila*. Oxford: Oxford University Press, 2010.
- Jet Propulsion Laboratory, California Institute of Technology. «Voyager: The Golden Record», 2022. <<https://voyager.jpl.nasa.gov/golden-record/>>.
- Kircher, Athanasius. *Musurgia universalis, sive Ars magna consoni et dissoni in x. libros digesta*. Rome, 1650.
- _____. *Magneticum naturae regnum sive disceptatio physiologica de triplici in Natura rerum MAGNETE, iuxta triplicem eiusdem Naturae gradum digesto*. Rome, 1667.
- Klotz, Sebastian. «“Ars combinatoria” oder “Musik ohne Kopferbrechen”: Kalküle des Musikalischen von Kircher bis Kirnberger». *Musiktheorie*, 14/3 (1999), pp. 230-245.
- Knuth, Donald E. *The Art of Computer Programming. Volume 1: Fundamental Algorithms*. Upper Saddle River, NJ: Addison-Wesley, 1997.
- Lanuzza Navarro, Tayra M. C. «Adapting Traditional Ideas for a New Reality: Cosmographers and Physicians Updating Astrology to Encompass the New World». *Early Science and Medicine*, 21 (2016), pp. 156-181.
- _____. «From Intense Teaching to Neglect: The Decline of Astrology at the University of Valencia and the Role of the Spanish *Novatores*». *Early Science and Medicine*, 22 (2017), pp. 410-437.
- Lenz, Hans. *Historia del papel en México y cosas relacionadas (1525-1950)*. Ciudad de México: M. A. Porrúa, 1990.

- Márquez, Nancy E. «“A Most Extraordinary Man”: Alexandro Favián's Letters to Athanasius Kircher, 1661-1674». MA thesis, Victoria University of Wellington, New Zealand, 2022.
- Mauleón Rodríguez, Gustavo, ed. *Juan Gutiérrez de Padilla y la época Palafoxiana*. Puebla: Gobierno del Estado de Puebla, Secretaría de Cultura, 2010.
- Maxey, Bruce. «La iconografía de *Ars magna lucis et umbrae* en *Primero sueño* de Sor Juana». *Anales de Literatura Hispanoamericana*, 49 (2020), pp. 321-334. DOI: <<https://dx.doi.org/10.5209/alhi.73134>>.
- Medina Rubio, Aristides. *La Iglesia y la producción agrícola en Puebla, 1540-1795*. Ciudad de México: El Colegio de México, 1983.
- Millet Dechales, Claude-François. *Cursus seu Mundus mathematicus*. Lyon, 1674.
- Miranda, Ricardo. «“de Angeles también el coro”: Estética y simbolismo en la misa *Ego flos campi* de Juan Gutiérrez de Padilla», in *Juan Gutiérrez de Padilla y la época Palafoxiana*, editado por Gustavo Mauleón Rodríguez. Puebla: Gobierno del Estado de Puebla, Secretaría de Cultura, 2010, pp. 131-153.
- Moreno Fernández, Rafael. «El Banco de San Carlos: La quiebra del principio de prudencia tras la salida en 1790 de Cabarrús y su equipo directivo». *De Computis: Revista Española de Historia de la Contabilidad*, 1 (2013), pp. 51-80.
- Murata, Margaret. «Music History in the *Musurgia universalis* of Athanasius Kircher». In *The Jesuits. Cultures, sciences, and arts. 1540-1773*, edited by John W. O'Malley, S. J., Gauvin Alexander Bailey, Steven J. Harris, and Frank Kennedy, S. J. Toronto: University of Toronto Press, 1999, pp. 190-207.
- O'Malley, John W., S. J., Gauvin Alexander Bailey, Steven J. Harris, and T. Frank Kennedy S.J., eds. *The Jesuits: Cultures, Sciences, and the Arts 1540-1773*. Toronto: University of Toronto Press, 1999.
- Osorio Romero, Ignacio. *La luz imaginaria: Epistolario de Atanasio Kircher con los novohispanos*. Ciudad de México: Universidad Nacional Autónoma de México, 1993.
- Pangrazi, Tiziana. *La Musurgia universalis di Athanasius Kircher: Contenuti, fonti, terminologia*. Firenze: Leo S. Olschki, 2009.
- Peña Espinosa, Jesús Joel. «El Cabildo eclesiástico de la Diócesis Tlaxcala-Puebla, sus años de formación, 1526-1548». *Antropología*, 78 (2005), pp. 12-22.
- Pérez Puente, Leticia. «Dos periodos de conflicto en torno a la administración del diezmo en el arzobispado de Méxicio: 1653-1663 y 1664-1680». *Estudios de historia Novohispana*, 25 (2001), pp. 15-57.
- Sande, Duarte de. *Japanese Travellers in Sixteenth-Century Europe: A Dialogue concerning the Mission of the Japanese Ambassadors to the Roman Curia (1590)*, edited by Derek Massarella, translated by J. F. Moran. Annotated translation of *De missione legatorum Iaponensium* (Macao, 1590) with introduction. London: The Hakluyt Society and Ashgate, 2012.
- Schott, Gaspar. *Organum mathematicum libris IX explicatum*. Nuremberg, 1668.
- Tello, Aurelio, Nelson Hurtado, Omar Morales Abril, and Bárbara Pérez Ruiz, eds. *Colección Sánchez Garza: Estudio documental y catálogo de un acervo musical novohispano*. Ciudad de México: México, Secretaría de Cultura, 2018.
- Torre Villar, Ernesto de la. «Seminario Palafoxiano de Puebla: Nóminas de maestros y alumnos (1651 y 1770)». *Anuario de la historia de la Iglesia*, 15 (2006), pp. 237-258.
- Torres Domínguez, Rosario. *Colegios y colegiales palafoxianos de Puebla en el siglo XVIII*. Puebla: Instituto de Estudios sobre la Universidad y la Educación, Universidad Nacional Autónoma de México, Benemérita Universidad Autónoma de Puebla, 2008.
- Tosca, Thomas Vicente. *Compendio mathematico, en que se contienen todas las materias mas principales de las Ciencias, que tratan de la Cantidad*, 2nd printing, 1707 imprimatur. Madrid, 1727.
- Trabulse, Elías. *El círculo roto*. Ciudad de México: Fondo de Cultura Económica, 1984.
- Wald, Melanie. *Welterkenntnis aus Musik: Athanasius Kirchers «Musurgia universalis» und die Universalwissenschaft im 17. Jahrhundert*. Kassel: Bärenreiter, 2006.
- Wirth, Niklaus. *Algorithms + Data Structures = Programs*. Englewood Cliffs, N.J.: Prentice-Hall, 1976.
- Zaragoza, José [Ioseph]. *Euclides Nuevo-Antiguo. Geometría especulativa, y práctica de los planos, y sólidos*. Madrid, 1678.
- Županov, Ines G. *Missionary Tropics: The Catholic Frontier in India*. Ann Arbor, MI: University of Michigan Press, 2005.

Recibido: 27.02.2022
Aceptado: 15.06.2022

