Sphaera Mundi: The Medicis and the Armillary Sphere

Behind the Medici’s commitment to revive Classical knowledge and serve Christianity lay a driving urge to control the world of men, money and power. Their era reflects the beginning of an age of Science, the branch of the liberal arts that did not falter when it surpassed its classical origins. They collected scientific instruments that surpass the classical tradition in aesthetic grace as well as practical knowledge. One type of these instruments brought all of these strands of thought together. It reflected concepts of the divine sublimated into human knowledge, a contemporary expansion of classical principles, and graceful and iconic forms of artistic interpretation. Above all, it was a practical tool to measure and thus traverse the world. This tool was known from antiquity as the sphaera armillaria, or the armillary sphere, and the Medicis used it as a symbol of their religious faith, artistic inspiration, and power.

The armillary sphere reflects a very ancient view of the universe. In Plato’s Timaeus, (4th C. BCE) the concept of the earth as the center of a series of concentric terrestrial and celestial spheres had a mystical significance. The idea of a symmetrical, graduated ascent to celestial divinity embodied an ordered view of the cosmos. Ptolemy, the Greek philosopher (fl.127-141 AD) described in his Syntaxis (Almagest, book v. chap. i) the armillary sphere as a concrete visualization of this theory. Although it existed from
early antiquity in China, the earliest attested model in the west was created independently by the Syracusan mathematician Archimedes.¹ His armillary sphere, taken to Rome in the 2nd C. BC, mentioned by Cicero and Ovid, and lost in the sack of Rome, was considered a marvel of engineering and science.

Several factors led the Medici to use the armillary sphere as a symbol of iconic and allegorical importance. Although Ptolemy’s *Almagest* had been translated into Latin since the 11th century,² the rediscovery of the Greek manuscript of his *Geographica* galvanized interest in astronomy.³ Secondly, Cosimo “Vecchio” de Medici and his “Platonic school” emphasized this mode of viewing the universe, suggesting it was compatible with the dogma of the Catholic Church. Another factor was the conflation of all the arts and sciences into a general sense of inspiration by the “Muses.” Urania, muse of astronomy, became over time the emblematic muse of the Medicis, coming to represent a broad concept of “the Arts.” They needed to conflate the pagan arts with the Medieval traditions of Christianity. They also saw science in general and astronomy in particular, as a practical method of increasing their wealth and power. It is significant that the armillary sphere is a symbol of those who in that era sought power through colonization, trade, warfare and navigation. Examples of these include the seafaring

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¹ For a good concise history of the armillary sphere and its functions, see http://www.absoluteastronomy.com/topics/Armillary_sphere.

² *Tractatus de sphaera mundi*, written around 1240 for the students of the University of Paris by the Englishman Johannes de Sacrobosco (end XII cen.-1244 or 1256), was primarily a translation of the Almagest and arab astronomers. (see the site of the Museo di Specola di Bologna: http://www.bo.astro.it/dip/Museum/english/).

³ Albrecht Durer has a famous illustration of an armillary sphere surrounded by the twelve winds in Willibald Pirckheimer's translation of Ptolemy's *Geographicae* (ennerationis libri octo, Strassburg (Johannes Grüninger), 3 April 1525).
nation Portugal, on whose flag it still appears, Elizabeth I of England, and Lorenzo de Medici’s most terrible secret enemy of the Pazzi conspiracy, the Duke of Urbino, Federigo di Montefeltro. Thus the armillary sphere, artistic and scientific symbol of Urania, became political and religious propaganda for the Medici and others. Even after Galileo’s disproof of the terra-centric world view and discovery of the satellites of Jupiter, the “Sidera Medicea,” the armillary sphere continued to exist as a form of beauty and an icon of learning.

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5 In the Metropolitan Museum in NYC an armillary sphere is inlaid on the wooden cabinets of Federigo’s studiolo. The parallels of the power struggles with the Medici and their similar artistic choices are very interesting. See the article by Olga Raggio, “The Liberal Arts Studiolo from the Ducal Palace at Gubbio” in The Metropolitan Museum of Art Bulletin, New Series, vol. 53, (no. 4) p.3-35, (Spring, 1996).
This collection depicts armillary spheres in context with their use by the Medicis. Even more telling than the few extant examples of the actual instruments, are the depictions of the armillary spheres in paintings and sculptures commissioned and collected by the Medicis. The list progresses in a rough chronological order.

1) Fra Angelico and Benozzo Gozzoli *Adoration of the Magi and Christ Entombed*, between 1439 and 1443, fresco, 180 x 360 cm., Museo di San Marco, Florence.

In 1436, the Confraternity of the Compagnia delle Magi received special favor from Cosimo (Vecchio) di Medici. Therefore his special double cell at San Marco has a portrait of the adoration of Magi. The mysterious figure holding an armillary sphere in the centre of the fresco has inspired several identifications. It may be the portrait of the exiled Greek Humanist John Argyropoulos, a friend of Cosimo’s who lived in Florence until his death, that of Zarathustra, a prophet who used stars to predict the advent of the Messiah. (Scudieri 110), or even, as Frances Ames Lewis suggests, a portrait of Cosimo himself. (Richardson, 32). In any case, all the lines of the painting converge upon him at the central vanishing point.

The New Testament tale of the journey of the Magi to Christ’s birthplace, following a star, would have had special significance for Cosimo. First, the Magi bore rich gifts from foreign lands, a role which would have appealed to his mercantile interests. Secondly, they were scholars and “wise men,” who understood hidden truths of alchemy and nature (Rubin & Wright, 28). Third, they followed a star, the same type of celestial navigation employed by sailors and merchants of that era. The armillary sphere,
resting on the shoulder of the central figure, combines these three strains of Cosimo’s interest. It was not uncommon for an artist to integrate a patron’s portrait in his work, which Gozzoli also did in the fresco on the same topic in the Palazzo Medici Riccardi.


2) Sandro Botticelli, *St. Augustine in His Study* (1480). Fresco (transferred to canvas), 184 x 119 cm, between 3rd and 4th altars, church of Ognissanti, Florence.

This fresco shows the pensive saint at sunset, the moment before his vision of St. Jerome. On the opposite wall, there is a portrait of Jerome by Ghirlandaio. It was
commissioned for the Vespucci family, closely linked financial and mercantile agents of Lorenzo di Medici and other Medici. Popular myth links Giuliano de Medici as a lover to Simonetta Vespucci, Botticelli’s muse. Additionally, Amerigo Vespucci’s uncle placed him in the school of Marsilio Ficino, the Medici circle of Platonic and mathematical specialty. Later, Amerigo worked for the Medici bank, and on his third voyage, he wrote a letter to Lorenzo Pietro Francesco Di Medici describing his discovery of the Mundus Novus. It is tempting to connect Amerigo Vespucci with the armillary sphere, and concepts of travel and conquest. As a traveler, astronomer, and mathematician Vespucci would have had much occasion to make use of the armillary sphere. At the time of the painting of the Augustine fresco in his family chapel, Amerigo would have been about 30. An interesting detail of art history is a much later painting by Cecco Bravo, “Rittratti di Mathematici e Navigatori” in the Casa Buonarroti at Florence,” in which Amerigo is portrayed gazing at an armillary sphere in a fashion very similar to the pose of Augustine in Ognissanti.  

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6 Rosetti, fig. 37.
The armillary sphere at which Augustine gazes appears to be linked to the moment of his divine inspiration upon the appearance of St. Jerome, who upbraids him:

"for his ambitious and inevitably futile attempt to codify and define the infinite mysteries of heaven. Jerome explained that it was impossible for earthly man to obtain a rational comprehension of paradise through his intellect: "Immensa qua misura metieris?" While on earth we should accept our fixed limitations. (Kemp, 210).

This is an interesting topic given the climate of the times, with Savonarola in power, and the wild interest of many nations in navigation and colonization. The armillary sphere is an image of worldly and celestial imagery combined.


3) Giorgio Vasari, *The Castration of Caelus*, Florence, Palazzo Vecchio, Quartiere degli Elementi, Sala degli Elementi, oil on wood, 1555 (width: 4, 5 m circa)

This was commissioned for the “cosmographic” room of Cosimo I, who portrayed himself programmatically as master of the Cosmos in the Palazzo Vecchio. Cosimo’s “corridor” in the Palazzo Vecchio had much celestial interest. The pun on name was certainly intentional, and his interest in astronomy and navigation reflects his desire for
power over more of the great area that he mapped. In that era, astrology had as much importance as astronomy, and Cosimo was born under the sign of Saturn. Perhaps that is one reason why the court artist Vasari, who received so many commissions from the Medici, uses Hesiod’s ancient tale of the castration of Uranos by Saturn. The subject of this fresco interested the young Francesco de Medici so much that Vasari wrote a dialogue on the subject, starring the ducal prince and himself.

Vasari’s array of posed nudes are twisted and contorted in a characteristic mannerist style, and the central falling armillary, which represents the celestial spheres, and suggests catastrophe, change, and universal conquest. The subject was planned as an accompaniment to the corresponding Birth of Venus in the same room. As the story goes, when Uranos was castrated by Saturn (Kronos), some of his semen fell onto the water, which grew into the goddess of love. Among neo-Platonists, it was popular to differentiate between this “Heavenly” Aphrodite Urania, patroness of Platonic love, and Aphrodite Pandemos, goddess of carnal lust. Aphrodite Urania became conflated with the astronomical muse Urania, who so often holds the armillary sphere.


Images from the Palazzo Vecchio:
http://www.digitalimages.net/Gallery/Art/Medici_1/medici_1.html
4) Girolamo della Volpaia, Armillary sphere (1564). Brass, crystal, wood, 490x775x490 mm. Museo della Storia della Scienza 2711.

This armillary sphere from the Medici collections is signed by Girolamo della Volpaia, member of one of the most famous instrument-making families of Florence. The Volpaias had many commissions from the Medici. They made objects that reflected beauty, luxury, and the classical tradition, as well as the scientific cutting edge. Their patriarch, Lorenzo was the maker of the great “Planetary Clock” of the Palazzo Vecchio, and the upkeep of this device became a family profession. Of all of the Volpaia family, Girolamo left the greatest number of armillary spheres.

The following is quoted from the museum’s description of how the device worked:

“The rings surround a large rock crystal globe representing the Earth. The user would orient the instrument in the north-south direction by means of two magnetic compasses (now missing). The polar axis would be tilted to match the altitude of the celestial pole in the place of observation. Two sights could be oriented relative to two graduated scales, one a zodiac scale, the other a calendar scale. By rotating the central part of the instrument around the polar axis, one could make the shadow of the sight aimed at the Sun overlap the second sight exactly. The resulting configuration showed the precise arrangement of the main celestial circles. By reading the degree of the celestial equator that intersected the meridian, one could thus determine the hour of observation.” (website: Museo della storia della scienza)

Website: Museo della Scienza: Multimedia Catalog


Kugel, Alexis, with the collaboration of Kœnraad van Cleempoel and Jean-Claude Sabrier. (2002). Spheres : the art of the celestial mechanic Paris : J. Kugel

Armillary spheres could be adapted to describe the terra-centric motion of the moon and other satellites. The model is set up to predict lunar eclipses. This is another fine example of Girolamo della Volpaia’s works from the Medici Collections, and another application of Ptolemaic theory from the *Almagest*. It also reflects German astronomer Georg von Peurbach’s attempt to reconcile lunar motion with the terra-centric
system. With their extensive trade interests, the Medici kept up a great transfer of knowledge from other European countries advancing in science, like Germany.


Ptolemy, Almagest. *Vat. lat. 2055 fols. 101 verso - 102 recto math17 NS.08* In Latin, Translated by George Trebizond, ca. 1481. Book VI Chapter 7, on the computation of the duration of solar and lunar eclipses.

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7See website by Hatch, R.: Summary of Ptolemaic Astronomy, and North, 269.
6) Equinoctial armillary sphere, Santa Maria Novella, façade. Ignazio Danti (born Pellegrino), (1572). Bronze, 45/50cm. diameter. Florence, Italy.
About 1567 Dominican monk, astronomer and architect Ignazio Danti was invited to Florence by Cosimo I to improve mathematical and astronomical studies. Danti may have prepared the way for Galileo and his contemporaries. He resided at the convent of Santa Maria Novella, where Cosimo had subsidized an astronomical observatory. He specialized in the study of armillary spheres and other astronomical devices, writing "Trattato del uso e della fabbrica dell'astrolabo con la giunta del planisfero del Raja" and revised and annotated an edition of "La Sfera di Messer G. Sacrobosco. His studies on the armillary sphere greatly influenced perspectival theory. Although this armillary sphere is of the simplest type, a basic “equinoctial,”at the behest of Cosimo Danti made extensive use of it in to make accurate determinations of the vernal equinox. This resolved problems with the old Julian Calendar (Bartolini, 50). In 1575, after the death of Cosimo, Francesco, the heir to the Tuscan Dukedom, told Danti he had twenty-four hours to leave Tuscany. He spent the remainder of his life as a professor in Bologna.


Danti, Egnazio (1537-1586). Trattato dell'uso et della fabbrica dell'astrolabio. Di F. Egnatio Danti ... Con l'aggiunta del planisfero del Roias. .. In Fiorenza : appresso i Giunti, 1569 (In Firenze : appresso i Giunti, 1569), [8], 194 [i.e. 192], 38, [10] p. : ill. ; 4o. Collocazione: BAP I H 294(8)

The Medici and the Sciences: The astronomical Observatory at Santa Maria Novella: http://brunelleschi.imss.fi.it/mediciscienze/imed.asp?c=70008


Stevenson, Edward Luther. (1921) Terrestrial And Celestial Globes: Their History And Construction Including A Consideration Of Their Value As Aids In The Study Of

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8 See http://brunelleschi.imss.fi.it/mediciscienze/imed.asp?c=70008


Antonio Lupicini was a skilled craftsman, mathematician, and engineer of weapons in the pay of Cosimo I. He made these “Teoriche,” (demonstrating the theory of planetary motion) for his patron Cosimo I to show the movements of the five planets as
well as those of the Sun, the Moon and the sphere of fixed stars. Cosimo died before they were finished, but the astronomer Egnazio Danti, aficionado of the armillary sphere, may have used his last bit of influence before his fall from favor and exile under Grand Duke Francesco, for them to be completed (Fiorini, 498). The San Lorenzo Library possesses the letters of Lupicini which detail his payment for supplies by Medici agents (Hain, 47). Their figural bases, depicting classical characters, are beautifully designed by a different sculptor, Valerio Cioli. The set is a rare and remarkable grouped collection, artistically and historically evocative.

Cognoscere il Cielo nel Cinquecento. (Online Catalog of special exposition in Bibliotheca Medici Laurenziana:


8) Astronomical Compendium, unknown maker, (late 16th cent.), silvered and gilt brass, closed: 86x86 mm Museo Galileo, Florence, inv. 2478.

This instrument, which belonged to Grand Duke Ferdinand I de' Medici, (it is listed in a 1595 inventory of his possessions) is a finely wrought “compendium” with markings in German, with ornaments similar to other German compendia, such as one of Ulrich Schniepp, in the Whipple museum (Whipple, 0330, 1554. Taub, 124). This device suggests Ferdinand’s ever present need to be prepared with astronomical devices that were also luxury items, showing status of Medici. It is not strictly an armillary sphere alone. Nevertheless, the presence of very simple, collapsible armilla between the first (astrolabe and a lunar calendar) and second (sundial and a magnetic compass) compartments will allow it to qualify. The device shows the armillary sphere at the height of its scientific acceptance, absorbed into standard array of tools used by a merchant, navigator, and conqueror, and in a highly practical mode, albeit continuing to reflect the typical Medici interest in luxury and classicism.

Epact: Scientific Instruments of Medieval and Renaissance Europe. Online database of medieval and Renaissance scientific instruments made before 1600 AD held at four European museums: www.mhs.ox.ac.uk/EPACT/


9) Antonio Santucci delle Pomerance, Armillary sphere (1588-1593). wood, metal, sphere diameter c. 2000 mm, height 3700 mm, width c. 2450 mm, Museo Galileo, Florence, 714.

The number of craftsmen producing armillary spheres explodes in the late 16th century. One possible explanation for the profusion of these instruments is that the Ptolemaic theorists, feeling threatened by the Copernican heliocentric system, tried to drown out the opposition by making as many beautiful, ornate, and expensive models of their view as possible. This monumental sphere by Santucci represents all this and more.
Commissioned by Ferdinand I de' Medici, it represents the idea of the “universal machine,” and the desire of the Medici prince to hold sway over it (Kemp 33). At the time of the making of the Santucci sphere, the Copernican system had made much progress in discrediting the terra-centric view of the cosmos. Santucci was undeterred, however, and with the aid of a large team of sculptors, gilders, painters, and mathematical assistants undertook the sphere as the most impressive representation of the Ptolemaic cosmos. The website of the Galileo Museum has a useful summary of its construction, and as the story is very interesting, I quote it in full:

“In early 1588, Grand Duke Ferdinand I de' Medici commissioned Antonio Santucci to build a large-scale model of the universe. Many beechwood rings of different widths and diameters were used to support the gigantic and complex structure. The rings were then painted by Antonio's brother, Enea Santucci. A gold-beater, Taddeo Curradi, supplied gold leaf for the gilt decorations. Basilio Latini, the monk of Santa Trinita, supplied milled gold for painting miniatures. A craftsman, Annibale di Francesco, executed the intaglios and the decorations, while the turner Lorenzo di Domenico produced the small spheres for the mount.

On May the 28, 1593, after five years, the work was finally completed. The parts of the sphere were assembled in the Sala delle Matematiche of the Uffizi. The blacksmith Piero Casini forged the iron axis that runs through the machine. Another blacksmith, Francesco di Filippo, supplied the iron handle that was inserted in the spring to rotate the sphere.

The planetary spheres were initially positioned by hand. Then, by turning the handle, the sphere was set in motion—providing a vivid illustration of the motions of the celestial bodies in accordance with the Aristotelian-Ptolemaic system: the heavens of the planets and fixed stars rotated around the Earth, which remained fixed at the center of the universe. Numerous rings, marked with Roman numerals, indicated the "houses of the planets." The combined coats of arms of the Medici and Lorraines, sculpted in the wooden frame, referred to the wedding of Ferdinand I de' Medici and Christine of Lorraine. The image of God, painted at the top of the sphere, watches over the world machine.”

Santucci dedicated his complex description and tract on the making of the sphere to Cardinal Ferdinand de Medici, the Dukes brother (Santucci, frontispiece). The sphere
was displayed for years in the Uffizzi, in the Sala de Matematici. Badly worn, it was
restored in 1876 by Meucci, particularly the gilded Sirens on the base. He documented
his restoration quite thoroughly (Meucci, 1876). It has been recently restored in
preparation for the re-opening of the Museo Galileo, to the extent that the moving parts
can actually move again (MG Press Release).

Pomarance” Imago Mundi, Vol. 8 pp. 99-100.

Kemp, Martin (1 July 2010). “Moving in elevated circles.” In Nature 466, 33

Meucci, F. (1876). La sfera armillare di Tolomeo. Firenze: Tipografia del
Vocabolario.

Museo Galileo, Multimedia Catalog:
http://brunelleschi.imss.fi.it/museum/esim.asp?c=500095


Santucci, Antonio. (1592) Trattato sopra la nuova inventione della sfera
armillare. Manoscritto cartaceo; 33x22,5 cm. Genova: Biblioteca Universitaria, Ms.
F.VII.6, c. 29r. Online at:
http://fermi.imss.fi.it/rd/bdv/?bdviewer/bid=000000949161&lng=it#
10) Justus Sustermans, Portrait of Cosimo II, Maria Magdalena of Austria and Ferdinando II. (1640 ca.) Oil on canvas, 158x123,5 cm. Galleria degli Uffizi, Corridoio Vasariano, Florence, inv. 1890 n. 2402.

In this posthumous portrait of Cosimo II and family, the central figure of Cosimo is dominant. The connection to our theme, like faraway satellites, is hard to see without a good eye. If you look closely, however, it is possible to see the half-hidden armillary sphere in the left hand of Ferdinando II. Cosimo II was well known for his support of the astronomer Galileo, whom he protected from the wrath of the church and sheltered at the Medici court. There, Galileo discovered the moons of Jupiter which he named "the Medici stars," after Ferdinand and his brothers. The presence of the armillary sphere in this painting subtly suggests Ferdinand’s wish for a continued association with the celestial spheres.


11) Cecco Bravo (Montelatici, Francesco called 1607-1661) Lorenzo Welcomes the Muses, Apollo and Virtue, and Ensures Peace for Italy (1635), Fresco, south wall, Sala degli Argenti, Palazzo Pitti, Museo degli Argenti, Florence.

Ferdinando II de Medici wanted to celebrate his impending wedding by hiring Giovanni da San Giovanni, the most famous fresco artist of his day, to paint the walls of
the Sala di Argenti in the Pitti Palace with the theme of Lorenzo the Magnificent, the most iconic Medici. But Giovanni died before completing the frescoes, and the commission was given to “Cecco Bravo,” (Francesco Montelatici). In his painting, Lorenzo Magnifico is portrayed as a lover of peace and a patron of all the Muses. The exemplar of these is Urania, holding an armillary sphere that serves as a focal point to draw the eye to the meeting of the two figures.


12) Coburg Vase: Turned globe with Polyhedrons (c. 1600) Ivory, gold, 28.6 cm. Museo Argenti, Florence, Inv. Bg. 1879 no. 133.

German sculptor Marcus Heiden’s fragile and intricate ivory objects were plundered as spoils of war in Coburg in 1632, and were placed in the Florentine treasure house of the Grand Dukes of Tuscany. The techniques of working on the lathe were later practiced as a hobby by Francis I de Medici.

Strictly speaking, this turned ivory object created by the in the early 17th century is not an armillary sphere, but the visual echoes to one are unmistakable. It shows the degree to which the armillary sphere had permeated the sensibility of artists in many different disciplines, all over Europe. Finally, its scientific application outmoded, it is apotheosized as a decorative motif. This transition of the armilla from emblem of
universal power to a pretty trinket makes an interesting contrast with the example above, where Urania carries one to Lorenzo. In both cases, it functions as an object of symbolic, or artistic significance, rather than one of scientific or political propaganda.


Sources and Annotated Bibliography:

Libraries:

Bibliotheca del Museo della Storia della Scienza, Florence.

This library, in the new “Museo Galileo,” was my primary research center in Florence. It gives access to many books on the Medici, on history of the sciences, and on collections in Florence. It also contains several useful manuscript reproductions, databases, and full and fast internet access. It has a peaceful environment with little traffic. Since the stacks are open, it is excellent for acquiring a wider range of information through browsing. An even greater advantage of this institution is that one can leave the library, go downstairs, and view the actual armillary spheres discussed in its catalogs.

The Dutch Institute Library, Florence.

The Dutch Institute Library was useful for its collection of books on the Medici and its catalogs of exhibitions in Florence. Since it has a large collection of English texts, it can speed up the process for Anglophones.

Bibliotheca Medici Laurenziana, Florence.

This library contains a wealth of primary sources on the Medici, including their letters, books, and business papers. It possesses many ancient scientific works that pertain to armillary spheres, and at the end of my stay in Florence, it was giving an exhibit of Lupicini’s Teoriche, which come from its collection.

The Watson Library of the Metropolitan Museum of Art, NYC.

The Watson has been the only library in New York City that has been useful for this subject. Not only does it possess books on the armillary spheres themselves, specific artists and collections, catalogs, and general art history, it also has extensive databases of
images, full text articles, and provenance. It is also located directly across from a room of Florentine Renaissance sculpture, an inspirational atmosphere. They have full scanning and copying facilities as well. The only difficulty at the Watson is that the stacks are closed, so it is necessary to know exactly what to call up.

**Books, articles, and images:**

**On armillary spheres in general: Primary Sources:**

Danti, Egnazio (1569). Trattato dell’uso et della fabbrica dell'astrolabio. Di F. Egnatio Danti ... Con l'aggiunta del planisfero del Roias. .. In Fiorenza : appresso i Giunti, 1569 (In Firenze : appresso i Giunti, 1569), [8], 194 [i.e. 192], 38, [10] p. : ill. ; 4o. Collocazione: BAP I H 294(8)

Epact: Scientific Instruments of Medieval and Renaissance Europe. Online database of medieval and Renaissance scientific instruments made before 1600 AD held at four European museums: [www.mhs.ox.ac.uk/EPACT/](http://www.mhs.ox.ac.uk/EPACT/)


The first chapter of Ignazio Danti’s *Trattato* deals with the construction of globes and spheres, and has many useful illustrations of his process. Hain’s collection of reproductions of original documents, letters, and receipts pertain to the construction of Lupicini’s Teoriche. Santucci’s manuscript in its digitized version of the original edition is fascinating document to examine, beautifully illustrated in the author’s hand, albeit
near-impossible to read. *Tractatus de sphaera mundi*, written around 1240 for the students of the University of Paris by the Englishman Johannes de Sacrobosco (end XII cen.-1244 or 1256), was primarily a translation of the Almagest and Arab astronomers. Danti’s revision of Sacrobosco’s work modernized the edition and helped him ground his own theories about globes and spheres. EPACT is an incredible website for finding broad data across four collections, as well as for basic information on the function of the spheres, and instrument makers. It is searchable by instrument type, collection, or maker, with a glossary and index.

**Armillary Spheres: Secondary Sources:**

Kugel, Alexis, with the collaboration of Kœnraad van Cleempoel and Jean-Claude Sabrier. (2002). *Spheres: the art of the celestial mechanic* Paris: J. Kugel

[http://www.absoluteastronomy.com/topics/Armillary_sphere](http://www.absoluteastronomy.com/topics/Armillary_sphere).

Stevenson, Edward Luther. (1921) *Terrestrial And Celestial Globes: Their History And Construction Including A Consideration Of Their Value As Aids In The Study Of Geography And Astronomy*. Publications of The Hispanic Society Of America No. 86 Museum London: Yale University Press.

[http://www.archive.org/stream/terrestrialceles01stevuoft/terrestrialceles01stevuoft_djvu.txt](http://www.archive.org/stream/terrestrialceles01stevuoft/terrestrialceles01stevuoft_djvu.txt)


**Armillary Spheres: Museum Collections:**


Cognoscere il Cielo nel Cinquecento. (Online Catalog of special exposition in Bibliotheca Medici Laurenziana:


Kemp, Martin (1 July 2010). “Moving in elevated circles.” In Nature 466, 33.

Museo Galileo, Multimedia Catalog:
http://brunelleschi.imss.fi.it/museum/esim.asp?c=500095

Museo Galileo “Virtual Visit” site:
http://brunelleschi.imss.fi.it/museum/esim.asp?c=402035

The Medici and the Sciences: The astronomical Observatory at Santa Maria Novella: http://brunelleschi.imss.fi.it/mediciscienze/imed.asp?c=70008


Kugel has made a beautifully illustrated, highly detailed, and well-researched book that gives an overview of spheres from different countries, one of which is the crystal armillary of Girolamo della Volpaia. For a good concise history of the armillary sphere and its functions, see Absolute Astronomy’s website. Stevenson is an outdated work, but still interesting for comprehensive overview of armilla from ancient history through the 18th century, as well as a timeline of sphere construction. His work bears a close relation to that of Fiorini, the Florentine cartographer, and Meucci, who repaired the
Santucci sphere and wrote an extensive tract about the process. Kemp’s recent article also discusses the political ramifications of the Santucci sphere for the Medici.

The collection of the Museo Galileo is very well documented. Dekker’s comprehensive catalog of the armillary spheres in the Museo Galileo is better for textual descriptions than for illustrations. Even more valuable is the beautifully designed website of the Museo Galileo, which contains comprehensive catalogs, indices, background information, and “Virtual Visits.” The press release of the Museo Galileo is a brief description of the most recent restorations performed on Santucci’s sphere prior to the reopening of the Museo Galileo. It describes conservation problems, such as woodworms, that were addressed, and the methods used to make the sphere mobile once again. The different conservators and consultants are all listed. Camerota (et al.) has recently written, not so much a catalog of this collection of instruments as an analysis of all information the collections give about them. It also discusses the different Medici’s views on the instruments in their scientific and artistic contexts.

Taub writing on the Whipple collection focuses on the English tradition of scientific instruments, showing links with very similar objects from the German, of which the astronomical compendium is an especially fine parallel. On the website of the Bibliotheca Laurenziana there is an interactive online Galley of Lupicini’s Teoriche, with much background information on the interesting story of their creation. Bartolini’s book is a well researched, recent study of the scientific application of the armillary sphere to Danti’s work on reforming the Julian Calendar, with reconstructions and primary documents.

On Ancient and Renaissance astronomy: Secondary Sources:


Plato’s *Timaeus*, (4th C. BCE) : The Perseus Project (www.perseus.org)

Ptolemy’s *Almagest*. (*Vat. lat. 2055 fols. 101 verso - 102 recto math17 NS.08*) translated into Latin by George Trebizond in 1481


North has created a good general study of ancient mathematics, astronomy and navigation, showing the place of the armillary sphere with those developing subjects. Hatch has made a website that contains an easily comprehensible section on the lunar theory in the *Almagest* that is illustrated in G. della Volpaia’s Lunary sphere. Veltman has written a fascinating article that makes the connection between Ptolemaic astronomy, armillary equinoctial readings, and linear perspective, positing that this is the reason armillary spheres are so popular in Renaissance painting. Plato’s *Timaeus*, (4th C. BCE) contained the original theory of the harmonious cosmos, the concentric celestial spheres, conceived in the 4th c. BCE. Ptolemy’s *Almagest*. translated into Latin by George Trebizond in 1481, was a reworking and reinterpretation of Ptolemy’s meaning. Book VI Chapter 7 discusses the computation of the duration of solar and lunar eclipses, as rendered in della Volpaia’s lunary.

**Medici Patronage:**


Hankins discusses the role of Platonic theory as an influence on astronomers in the time of Cosimo Vecchio. Ames-Lewis has discussed Medici patronage, and has suggested that Fra Angelico put Cosimo’s portrait in the San Marco Magi panel. Gilberts discusses patterns in Medici patronage.

**Politics, Power and Exploration:**


Wilson’s article discusses the frequent use of the armillary as a decorative motif in Elizabeth’s portraiture, and the usefulness of her association with Urania. Raggio points out Federigo di Montefeltro’s use of the armillary sphere in context with his power struggles with the Medici. The Early Americas Digital Archive contains a useful facsimile of the controversial “Medici letter” of Amerigo Vespucci.
Renaissance Artists in Florence:

Fra Angelico:

Boskovits, Miklós. (1976). Un'adorazione dei magi e gli inizi dell'Angelico
Riggisberg : Abegg-Stiftung Bern.


Richardson is a good general text on Renaissance art and artists. She cites Ames Lewis’ statement that Cosimo is the armillary holder in Fra Angelico’s Magi. Boskovitz is useful for some other examples of Fra Angelico’s work on the topic of Magi. Hood discusses all his work at San Marco, and Reifsyder has created an extremely useful discussion of the fresco cells. Each of the last two posits a different identity for the armillary holder.

Botticelli:


Kemp has written a fascinating article on logical deduction in art interpretation, and incidentally gives much valuable scholarly information on Botticelli’s Augustine in doing so. Ryan is outdated, but is inspired by the Romantic aspects of the Vespucci
chapel in Ognissanti to give much useful background information on the love affairs and relationships of the Vespucci, the Medici, and Botticelli himself. Rubin has a valuable discussion of Botticelli in his context as painter of his historical moment.

Vasari:


Davis has edited an invaluable document: a dialogue written by Vasari himself on the subject of the fresco, between himself and his young Medici patron. Apparently the young man asked so many questions about it that he felt obliged to comment in writing. Garfagnini examines Vasari’s typical subject matter and Mannerist habits. Bennett looks at the fresco in context with the celestial theme of the Palazzo Vecchio.

Sustermans:


Chiarini is an older catalog of an exhibit that looked at Sustermans in his context as a Medici portraitist. Heybrock has a useful website of the Medici portraits Sustermans painted in Florence and Heidelberg. Langedijk examines all Medici portraitists, of which Sustermans was just one. Rooney focuses on the Uffizi’s collection of Medici portraits.

**Cecco Bravo:**


Barsanti et al. is the most recent full-length study on Bravo. Calderoni has a good overview of Bravo’s works, and discusses both his paintings that contain armillary spheres. Chappell focuses on his role as a public Florentine artist, and Pagliarulo looks at his early years, when he received the Argenti commission from Ferdinand.

**Marcus Heiden:**


Aschengreen-Piacenti is a reprint of the manuscript booklet of 1640 in which the Marcus Heiden explains the creation of his elaborate ivory goblet made from 1637-39. This is followed by a description and meaning of the work with numerous biblical quotations. Although Borneff and Haag both focus on ivory vases in the Getty collection, they are useful for background information on Heiden, Coburg, and ivory turning as a German trade. Burack discusses Heiden in context with the history of ivory work in general. the Medici spoils from there. Finally, Casazza focuses specifically on the Coburg vases of the Medici, how they arrived in their collections, and what influence they had.