# Chapter 5
# The Mausoleum of Santa Costanza in Rome: A Survey of the Light Phenomena Through the Centuries

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**Abstract** The Mausoleum of Santa Costanza is a perfect example of early Christian architecture during the late Roman Empire, when the Christian cult had just been liberalized. Located in Rome on the Via Nomentana, this circular building belongs to a monumental complex linked to the worship of the tomb of the martyr Saint Agnes, over which two basilicas were built. The oldest of the two, dated to the fourth century, was a horseshoe-shaped basilica that eventually fell into ruins. Being too large to be refurbished, in the seventh century it was replaced by the current much smaller Basilica of Sant'Agnese fuori le Mura.

According to tradition, the Mausoleum was built by Constantina for herself; the daughter of the famous Emperor Constantine I. Apparently, it also hosted the remains of her sister Helena, who died in AD 360, 6 years after Constantina. The Mausoleum does not show evident astronomical alignments but the disposition of the windows in the drum, associated with other significant features of the structure, created visible light phenomena during certain days of the year that were linked to the Saint's feast or holy days.

The identification of these occurrences in the monumental complex and their variations throughout the centuries are the main focus of this study, which is based on the fundamental work by Rasch and Arbeiter (*Das Mausoleum der Constantina in Rom*. Philipp Von Zabern, Mainz Am Rhein, 2007) where reliable plans and architectonic reconstructions are provided. The measures of the orientations were performed on satellite images and on graphic plans, assuming the average value and considering the related standard deviation as uncertainty.

## Introduction

Several recent studies have revealed the importance of studying the orientation of ancient Roman monuments that show the existence of intentional light effects in Roman architecture, as for the Basilica Neopitagorica di Porta Maggiore in Rome

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G. Magli et al. (eds.), *Archaeoastronomy in the Roman World*, Historical & Cultural Astronomy, https://doi.org/10.1007/978-3-319-97007-3_5

**Fig. 5.1** A satellite view of the area of Sant'Agnese fuori le Mura in Rome (after Bing Maps)

(Labianca et al. 2008); the Mausoleo degli Equinozi along Via Appia in Rome (De Franceschini 2012); the Roccabruna and the Accademia in the Villa Adriana (De Franceschini and Veneziano 2013); the Pantheon (De Franceschini 2014; Hannah and Magli 2011); and the Mausoleo di Adriano in Rome (De Franceschini and Veneziano 2015).

For the Mausoleo di Santa Costanza in Rome the light phenomena inside the monument have never been investigated. Our intent is to verify the existence of relationships between the main orientations of the buildings and the illumination of the interiors.

The Mausoleum is located on Via Nomentana, about two miles outside the Aurelian Wall, in the archaeological complex of Sant'Agnese fuori le Mura. Different constructions make up the complex: the catacombs of Sant'Agnese, dated between the second and the fourth centuries AD; the sacellum ad corpus, a votive chapel built over St. Agnes' burial in the first half of the fourth century AD; the horseshoe-shaped cemeterial basilica associated with St. Agnes, and the Mausoleum itself, the last two built in the middle of the fourth century AD by Constantina or Costantia, the eldest daughter of the Roman Emperor Constantine I the Great (Fig. 5.1).

According to traditional literature (Frutaz 1960; Johnson 2009; Krautheimer 1937; Rasch and Arbeiter 2007), the Mausoleum was built in the second quarter of the fourth century, probably between AD 337 and 350, when Constantina was residing in Rome between her two marriages. As reported by the contemporary historian Ammianus (Amm. Marc. XIV, 11, 6; XXI, 1, 5), Constantina died in AD

354 in Bithynia, Asia Minor, and was buried in the mausoleum. Later, the remains of her sister Helena, who died in AD 360, also were buried in it.

More recent excavations have uncovered the foundations of a triconch building under the area originally occupied by the vestibule of the Mausoleum (Stanley 1994). This fact led some authors to postpone the construction of the Mausoleum to the second half of the fourth century AD (Ringbom 2003) or even the late fourth or early fifth century AD (Stanley 1994).

The Mausoleum was connected to the cemeterial basilica through a narthex mid-way along the North side and was originally surrounded by a circular portico of which only the perimeter wall still exists. Originally the only source of light were the drum windows that today are partially occluded in the lower part, given that the small windows of the ambulatory are commonly considered as later additions (Johnson 2009; Rasch and Arbeiter 2007). Soon after the construction, possibly in the late fourth century AD, a rectangular tower (*lucernario*) was added to the drum on the South West side, blocking one of the drum windows (Johnson 2009; Prandi 1942–1943).

The architecture is formed by a central Rotunda, surrounded by a barrel-vaulted ambulatory. The interior was richly decorated. The decoration of the ambulatory vault is preserved although actually heavily restored (see Matthiae 1967) and consists of mosaics with geometric patterns and harvest scenes. The drum was decorated with marble marquetries and the dome with mosaics representing biblical scenes; although destroyed in 1620, those decorations are known thanks to several Renaissance drawings (see Rasch and Arbeiter 2007; Ringbom 2003). Lastly, the ambulatory niches also were decorated with mosaics, which probably disappeared between the fifteenth and the seventeenth centuries. Only the decorations of the niches of the cross-axis are preserved, representing respectively the *Traditio Legis* and the *Traditi Clavium*.

An enormous porphyry sarcophagus with the remains of Constantina was preserved in the Mausoleum (Fig. 5.2). It was moved for the first time in 1467, but was brought back soon after. In 1790 it was finally moved to the Vatican Museums (Johnson 2009) and a cast replica was placed in the mausoleum, in the south-west niche of the ambulatory. Its original position is an open question. According to scholars, there were three possibilities: for Bosio et al. (1659) and Frutaz (1960) the sarcophagus was in the south-west niche; for Prandi (1942–1943) and Johnson (2009) it was under the small tower and placed over the still-existing porphyry oval mounted in the pavement; while for Jubaru (1904) it was in the centre of the mausoleum.

Today the sarcophagus is placed over a modern support and it is over 2.25 m in height (see Fig. 5.2a). Its original dimensions can be inferred from a drawing by Desgodets published for the first time in 1682 (see Desgodets 2008) in which the measurements are reported in Pied de Roy. In a recent study (not yet published) we have determined the correct conversion factor for all of the drawings made by Desgodets:

1 Pied de Roy = 0.326 m.

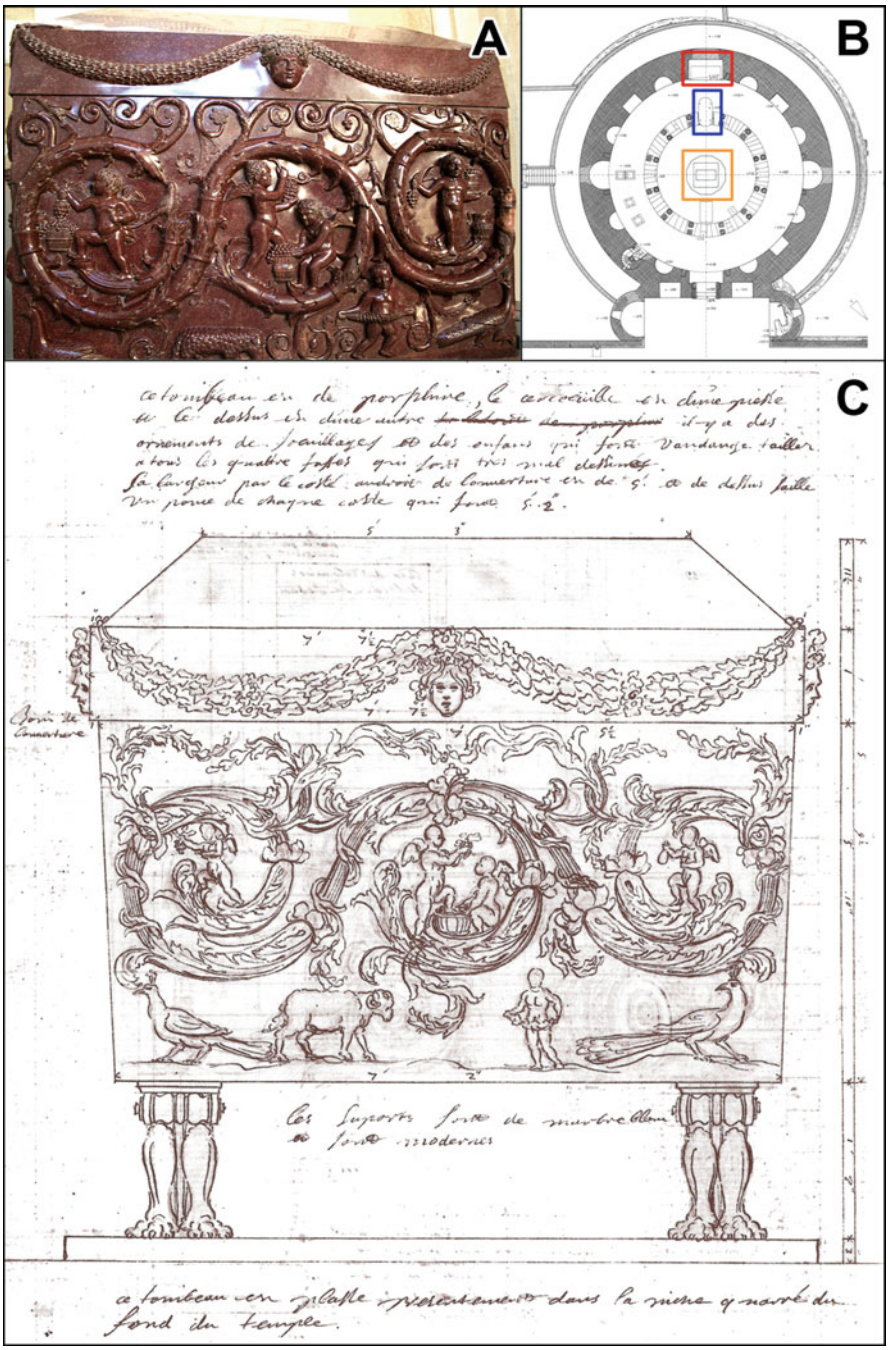


**Fig. 5.2** The sarcophagus of Constantina. (**a**) Photo (from Wikipedia). (**b**) Possible positions in the mausoleum elaborated on the plan by Rasch (see Rasch and Arbeiter 2007). (**c**) A drawing by Desgodets (2008); it is worth noting the peculiar shape of the sarcophagus cover

**Table 5.1** A chronology of events linked to the Mausoleum

| Date | Event |
|---|---|
| Second–fourth centuries AD | Catacombs. |
| AD 305 | St. Agnes' death. |
| AD 337–350<br>AD 337–350 | The Paleochristian basilica and Mausoleum was built by Constantina.<br>A sacellum ad corpus was built upon St. Agnes' tomb. |
| Late fourth century AD | Maybe, the small tower was added to the original Mausoleum, blocking the south-west window. |
| Fifth century AD | In the *Passio Latina*, Santa Costanza is described as a leper who later was cured by St. Agnes. |
| AD 625–638 | Pope Honorius I built the basilica of Sant'Agnese in place of the sacellum ad corpus. |
| AD 865 | In the *Liber Pontificalis*, the Mausoleum is mentioned as the "Aecclesia Sanctae<br>Constantiae". |
| 1256 | Pope Alexander IV consecrated the altar "beate Constantie filie Constantini". |
| 1450 | Rucellai describes only one porphyry sarcophagus in the Mausoleum. |
| 1467 | Pope Paul II moved the sarcophagus to the Piazza San Marco, but Sixtus IV brought it back to the Mausoleum. |
| Sixteenth century | Santa Costanza (with Attica and Artemia) is mentioned for the first time in Martyrologies. |
| 1538 | In a drawing by Francisco De Hollandia the sarcophagus is shown in the south-west niche. |
| 1567 | In a drawing by Peruzzi there is an oval in the centre of the Mausoleum that is compatible with the sarcophagus' dimensions. Peruzzi reports only one sarcophagus, located in the niche in front of the entrance. |
| 1606 | A porphyry sarcophagus was moved from Santa Costanza or from Santa Agnese to a chapel in San Pietro to contain the remains of the Saints Simone and Giuda. This sarcophagus is not visible anymore, because it was covered by an altar during the twentieth century. |
| 1620 | The mosaics in the dome were replaced by frescos. |
| 1791 | Pope Pius VI took the sarcophagus to its current position, in the Vatican Museums. |

This allows us to determine the original dimensions of the sarcophagus: length 2.48 m, width 1.63 m and height 1.89 m.

Through the centuries, the Mausoleum and the whole complex underwent several transformations (see Table 5.1). In AD 625–638 Pope Honorius I built the basilica of Sant'Agnese in place of the older sacellum ad corpus. During the Middle Ages the Mausoleum was transformed in the Aecclesia Sanctae Constantiae (church of Santa Costanza), mentioned for the first time in AD 865 by the *Liber Pontificalis* (Frutaz 1960; Ringbom 2003).

## Methodological Approach

As already shown in a study on the orientation of the Greek theatres (Monaco et al. 2017), the azimuth can be determined in three different ways: on-site measurements; deriving it from archaeological plans; or measuring it on satellite images. For the Mausoleum of Santa Costanza on-site measurements with a professional compass can be unreliable, because the monument is located in a dense urban area where magnetic measurements can be strongly affected by nearby structures.

The best methodology to derive the orientations from archaeological plans would be that presented by Ranieri (2014), who chose the most reliable plan from among all those available. There are only two plans that appear reliable if we wish to determine the orientation of the different buildings in the complex: the one published by Rasch (Rasch and Arbeiter 2007) and the one edited by Pavolini (Magnani Cianett and Pavolini 2004) (Fig. 5.3). Neither plan indicates whether the north arrow indicates true north or magnetic north. Hence, we decided to use satellite images as well, available for free on the web (*Comune di Roma—Geoportale*, Google Earth and Bing Maps), which present a resolution appropriate to our purposes.

The orientation of each building was determined by calculating the average value, and the standard deviation was considered as the error of the measurement. The bearings were determined by measuring the angle from north to the axis of the buildings in a clock-wise direction (from north through east).

The analysis of the light phenomena for the monuments was done by carefully taking into account the restorations and the invasive changes that affected the architecture structures over time.

We used the software *Stellarium* to simulate the ancient sky and to determine the days of the year when different phenomena occurred.

## Orientations

Our measurements of the azimuth for the different buildings composing the archaeological complex are shown in Table 5.2. Five azimuth values (°) are presented:

1. $AZ._B$ measured on satellite image from Bing Maps (2017);
2. $AZ._G$ measured on satellite image from Google Earth (2016);
3. $AZ._C$ measured on ortophoto from *Comune di Roma—Geoportale*;
4. $AZ._P$ measured on the plan edited by Magnani Cianett and Pavolini (2004); and
5. $AZ._R$ measured on the plan published by Rasch and Arbeiter (2007).

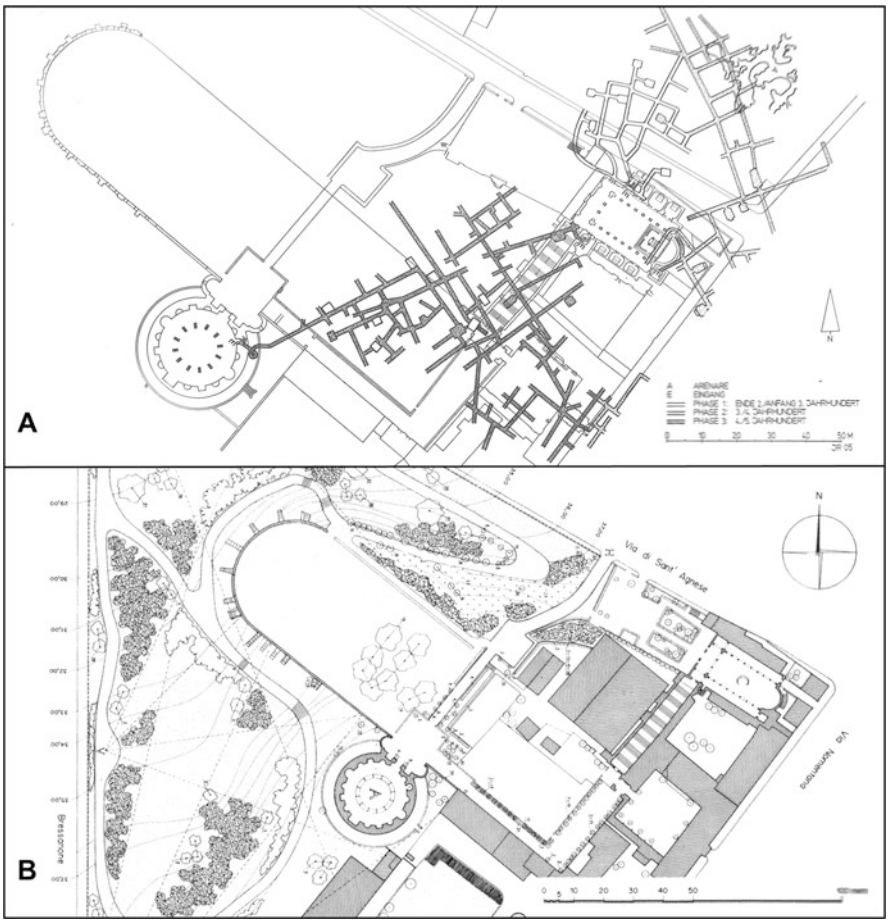


**Fig. 5.3** Plans of the archaeological complex. (**a**) After Rasch and Arbeiter (2007); (**b**) after Magnani Cianetti and Pavolini (2004)

## The Mausoleum of Constantina

Two different light phenomena were considered:

1. one connected with the main axis and related to the window in front of the entrance; and
2. one connected with the possible position of the sarcophagus and related to the drum windows.

The astronomical values for the Mausoleum are reported in Table 5.3 while the periods of illumination of the possible locations of the sarcophagus in the interior are reported in Table 5.4.

**Table 5.2** Azimuth values measured for the different buildings comprising the complex

| ID | Edifice | Date AD | $AZ_B$ | | $AZ_G$ | | $AZ_C$ | | $AZ_P$ | | $AZ_R$ | | Average | | St. Dev. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | ° | ′ | ° | ′ | ° | ′ | ° | ′ | ° | ′ | ° | ′ | ° | ′ |
| 1 | Mausoleum | ~450 | 40 | 16 | 39 | 58 | 39 | 59 | 38 | 36 | 39 | 48 | **39** | **43** | 0 | 39 |
| 2 | Cem. Basilica | ~450 | 130 | 16 | 129 | 58 | 129 | 59 | 128 | 36 | 129 | 48 | **129** | **43** | 0 | 39 |
| 3 | Hon. Basilica | 638 | 304 | 30 | 303 | 46 | 305 | 52 | 302 | 08 | 303 | 49 | **304** | **0** | 1 | 24 |

KEY: *Mausoleum* Mausoleum of Constantina, *Cem. Basilica* Constantinian Cemetarial Basilica, *Hon. Basilica* Honorian Basilica, $AZ_B$ Azimuth measured on Bing Maps (2017), $AZ_G$ Azimuth measured on Google Earth (2016), $AZ_C$ Azimuth measured on *Comune di Roma—Geoportale* (2012), $AZ_P$ Azimuth measured on the plan by Magnani Cianett and Pavolini (2004), $AZ_R$ Azimuth measured on the plan by Rasch and Arbeiter (2007), *St. Dev.* Standard Deviation
The average values are shown in bold print

**Table 5.3** Azimuth, altitude, declination and the corresponding date in AD 350 of the possible heliophany occurring from the window in front of the entrance

| Event | Azimuth | Altitude | Declination | Corresponding date in AD 350 |
|---|---|---|---|---|
| Start of the heliophany | 217° 13′ | 24° 54′ | –14° 53′ | February 08 |
| End of the heliophany | 222° 08′ | 29° 20′ | –08° 54′ | February 25 |

**Table 5.4** The period of illumination of the sarcophagus depending on its position

| Position | Period of illumination |
|---|---|
| Centre | March 29–September 13 |
| Porphyry oval | May 1–October 15 |

Considering the azimuth of the main axis, the altitude and the declination (together with the position and the dimension of the window in front of the entrance) we have determined that in AD 350 the heliophany occurred between February 8th and 25th (see Fig. 5.4a).

Regarding the phenomena connected with the position of the sarcophagus in the interior, we have determined that the centre of the building was illuminated between 29 March and 13 September (see Fig. 5.4b), while the area beneath the small tower, where the porphyry oval is mounted in the pavement, was illuminated between 1 May and 15 October (see Fig. 5.4c).

## The Constantinian Basilica

The astronomical values for the Constantinian Basilica are shown in Table 5.5, and a reconstruction of it is shown in Fig. 5.5.

No evident solar alignment is suggested by this azimuth value. Due to the bad state of conservation, it is not possible to perform reliable studies of light phenomena in the Basilica.

## The Honorian Basilica

The astronomical values for the Honorian Basilica are shown in Table 5.6, and a reconstruction of it is shown in Fig. 5.6.

An alignment toward the Summer Solstice Sunset is clearly indicated by the azimuth value. Due to the numerous and important restorations made through the centuries, no further study of light phenomena was attempted.

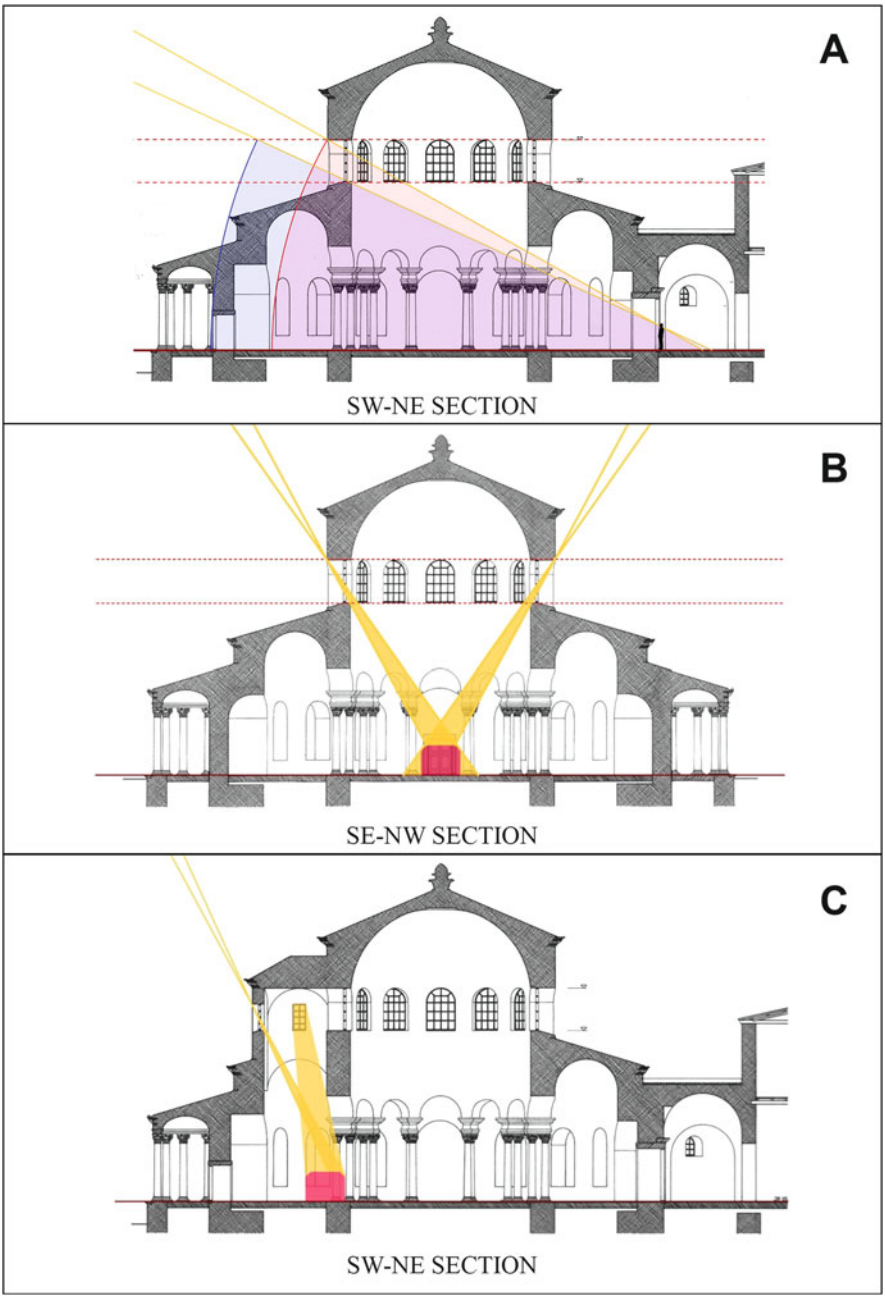


**Fig. 5.4** The mausoleum of Constantina. (**a**) Representation of the minimum and maximum altitude of the ray illuminating the entrance (see Table 5.3). (**b**) Representation of the minimum and maximum altitude of the ray illuminating the centre (see Table 5.4). (**c**) Representation of the minimum and maximum altitude of the ray illuminating the porphyry oval in its current position (see Table 5.4) (modified from Rasch and Arbeiter 2007)

**Table 5.5** Azimuth, altitude and declination of the Constantinian Basilica

| | Azimuth | Altitude | Declination |
|---|---|---|---|
| Constantinian Basilica | 129° 43′ | 10° 14′ | −20° 31′ |

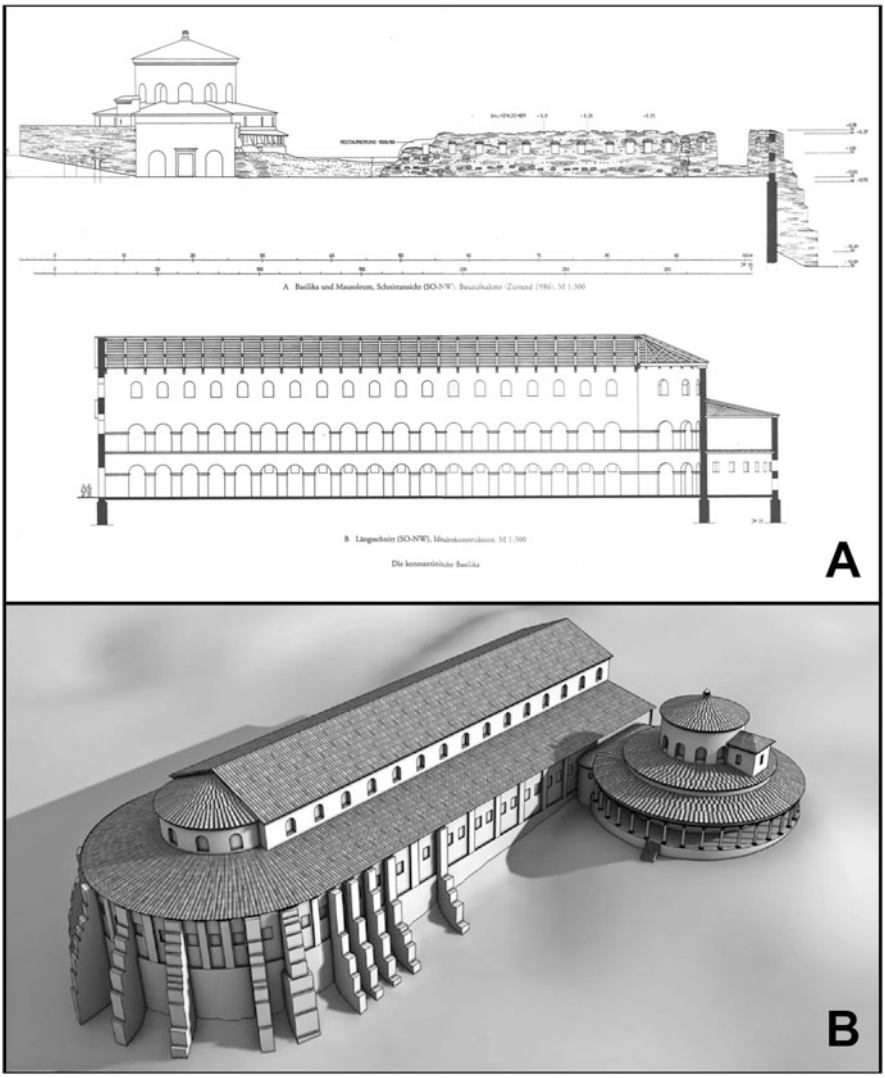


**Fig. 5.5** Reconstructions of the Constantinian Basilica of Sant'Agnese. (**a**) Drawing (after Rasch and Arbeiter 2007). (**b**) 3D reconstruction (after Bardill 2012)

**Table 5.6** Azimuth, altitude and declination of the Honorian basilica and of the Summer Solstice sunset

| | Azimuth | Altitude | Declination |
|---|---|---|---|
| Honorian Basilica | 304° 0′ | 0° 36′ | +24° 42′ |
| Summer Solstice sunset | 303° 13′ | – | +23° 39′ |

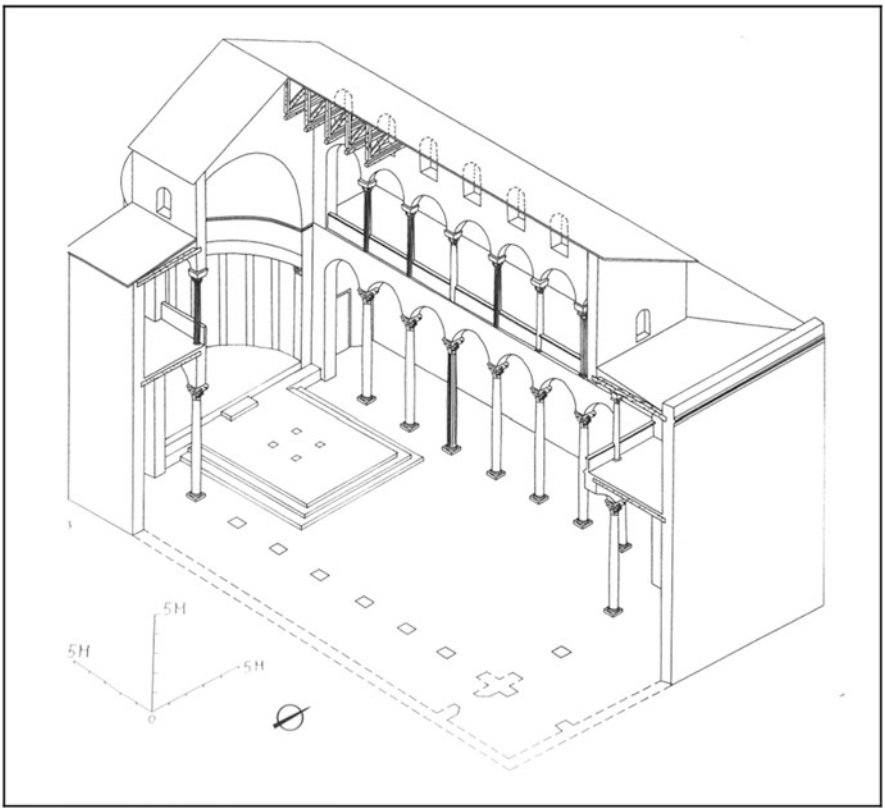


**Fig. 5.6** The Honorian Basilica (from Brandenburg 2004)

## Discussion

Two different light phenomena occurred in the Mausoleum: (1) one relating to the entrance and the window in front of it; and (2) those relating to the positions of the sarcophagus.

Prandi (1942–1943), Rasch (Rasch and Arbeiter 2007) and Johnson (2009) suggested that the small tower or *lucernario* is an early addition in respect to the old drum of the Mausoleum: this means that between the foundation and construction of the *lucernario*, the light could directly hit the entrance each year from 8 to

25 February. These days corresponded to the *Parentalia*, a pagan feast celebrating the family dead. Once the *lucernario* was built, that window was plugged and the light phenomenon was interrupted. This kind of heliophany resembles the one occurring in the Pantheon on 21 April (the founding day of Rome): in both cases the light appears to be an integral part of the celebration of the festivity.

The Mausoleum has a peculiar feature: the maximum inclination of the sunlight passing through the windows ends at the centre of the Mausoleum: this is perfect for illuminating an object placed in that position. According to many archaeologists, the sarcophagus of Constantina was located in the large niche in front of the entrance from the early days. This niche never receives direct light, so we find it a weird location for a red sculpted porphyry sarcophagus, a material known for its reflection properties, with that particular shape of the cover.

According to tradition (see Frutaz 1960), from AD 360 to 1606 two sarcophagi were conserved inside the Mausoleum: one belonging to Constantina and the second to her sister, Helena. Probably in the beginning (see Ringbom 2003) the first one was the only one present in the monument, and the arrival of Helena's may have forced the finding of another location for it. The presence of two sarcophagi imply two different positions inside the Mausoleum, but we could not find citations about this in literature. Nonetheless, a drawing by Peruzzi (see Rasch and Arbeiter 2007) shows an oval at the centre of the Mausoleum with a size compatible with the sarcophagus dimensions. A porphyry oval is now present and mounted in the pavement under the *lucernario* (his width corresponds perfectly to the width of the sarcophagus). We have no certainty whether the ovals were two or one (the central), which was moved eventually under the *lucernario*.

However, we believe that the two positions are certain. As a matter of fact, the light phenomena still occurring in the building insist precisely on these two positions.

On 1606 a sarcophagus (probably that of Helena) was taken from the complex and moved to San Pietro to contain the remains of Simone and Giuda. Its current arrangement (behind a more recent altar) does not allow the study of it. The centre of the building was used for the current altar that we can still admire.

Later, in 1791, the porphyry sarcophagus of Constantina was permanently moved to the Vatican Museum.

Archaeoastronomical features are also present in the more recent Honorian Basilica, since its entrance is oriented toward Summer Solstice sunset. Until the seventeenth century the Basilica had the entrance at the same level of the *matroneo*, which was several meters above the pavement level. When the sunlight penetrated from the entrance, it illuminated the golden mosaic in the apse depicting Sant'Agnese and Pope Honorius.

Due to its bad state of conservation, the alignment of the Constantinian Basilica of Sant'Agnese cannot be discussed.

## Conclusions

This study adds new evidence that archeoastronomy can help in clarifying archaeological questions, as several recent publications have shown.

We have found that:

1. The entrance of the Mausoleum of Constantina was illuminated between 8 and 25 February, days corresponding to the Festival of Parentalia in honour of family ancestors.
2. The identified light phenomena endorse the theory that a sarcophagus could originally have been placed in the centre, as happened with the burial chambers of imperial mausolea. The peculiar shape and material of the sarcophagus of Constantina would allow an incredible reflection effect of the light.
3. In Late Antiquity or the Early Middle Ages, when the Mausoleum was transformed into a church, the sarcophagus was possibly moved to under the *lucernario*, which corresponds to the porphyry oval that is still mounted on the pavement.
4. Later, the sarcophagus was moved in the south-west niche, as testified by some fifteenth century drawings. In this position it could not be illuminated by natural light.
5. Like several important monuments of antiquity, the Honorian Basilica shows an alignment toward the Summer Solstice sunset.

**Acknowledgements** We would like to thank Marcello Ranieri (INAF-IAPS Roma) for review work and valuable help.

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