

The Symbolic Use of Light in Hadrianic Architecture and the 'Kiss of the Sun'

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Abstract

In this presentation we will discuss three Roman monuments of the times of Emperor Hadrian (117-138 AD): the Villa Adriana at Tivoli near Rome, the Mausoleum of Hadrian in Rome (now Castel Sant'Angelo) and finally the Pantheon (also in Rome). In all of them we see luminous phenomena which occur only in few set days during the year; they correspond to astronomical events such as the Solstices or other important dates of the Roman calendar. As we will see, this did not happen by chance and had a precise symbolic meaning. Also, we will explain why there are no written sources about Roman oriented buildings and their illuminations, producing an ancient and rare documentation: the description of the "Kiss of the Sun".

Keywords: Archaeoastronomy, Pantheon Arc of Light, Hadrian's Villa, Mausoleum of Hadrian, Roman religion, Roman Calendar, Emperor Hadrian, Pontifex Maximus, Solstice, Roccabruna, Accademia

1. Villa Adriana

The authors of this article studied Archaeoastronomy at Villa Adriana (Hadrian's Villa¹ at Tivoli, Rome), where they discovered the astronomical orientation of the building called Accademia and of the Accademia Esplanade (De Franceschini, Veneziano, 2011, pp. 100-106). They also confirmed the astronomical orientation of the Roccabruna building², which was discovered in 1988 by the American architects Robert Mangurian and Mary-Ann Ray (Mangurian, Ray, 2008; Mangurian, Ray, 2011, XVIII–XX; De Franceschini, Veneziano, 2011, pp. 133-136). In 2006, Vittorio Castellani was dubious about an astronomical orientation, and wrote: "If [at Roccabruna] exists an astronomical connection – but we cannot be certain about it – it would seem more likely a generic connection to summer solstice, with Roccabruna looking towards the direction of the solstitial sun at few degrees of difference on the horizon at the moment of sunset. The orientation of Roccabruna (298°) differs of about 5 degrees from the azimuth of the sun at sunset of Summer Solstice" (Castellani, 2006, p. 13. Castellani, 2011, p. 44; De Franceschini, Veneziano, 2011, pp. 124-125).

¹ Video of the illuminations in the Accademia of Hadrian's Villa: http://www.youtube.com/watch?v=NuJOg_hKHUK

² Video of the illuminations in the Roccabruna of Hadrian's Villa: <http://www.youtube.com/watch?v=EKMchXfjhI4>

Later on, in 2011 he ruled out a connection with the Dies Imperii of Hadrian, August 11th (Castellani, 2011, pp. 44-45; De Franceschini, Veneziano, 2011, pp. 124-125). In 2011, De Franceschini and Veneziano published the results of their archaeoastronomical studies on the Accademia and Roccabruna in the book *Villa Adriana. Architettura Celeste. I segreti dei Solstizi* (De Franceschini, Veneziano, 2011).

1.1. The Accademia Esplanade and the Accademia building

The Accademia Esplanade (Fig. 1) is the highest and most isolated one of the Villa, a sort of Acropolis. It was accessed by means of an hidden path, which starts from the Canopus and reaches the building of Roccabruna, where a ramp was the main access going up to the Esplanade (De Franceschini, Veneziano, 2011, pp. 88-90).

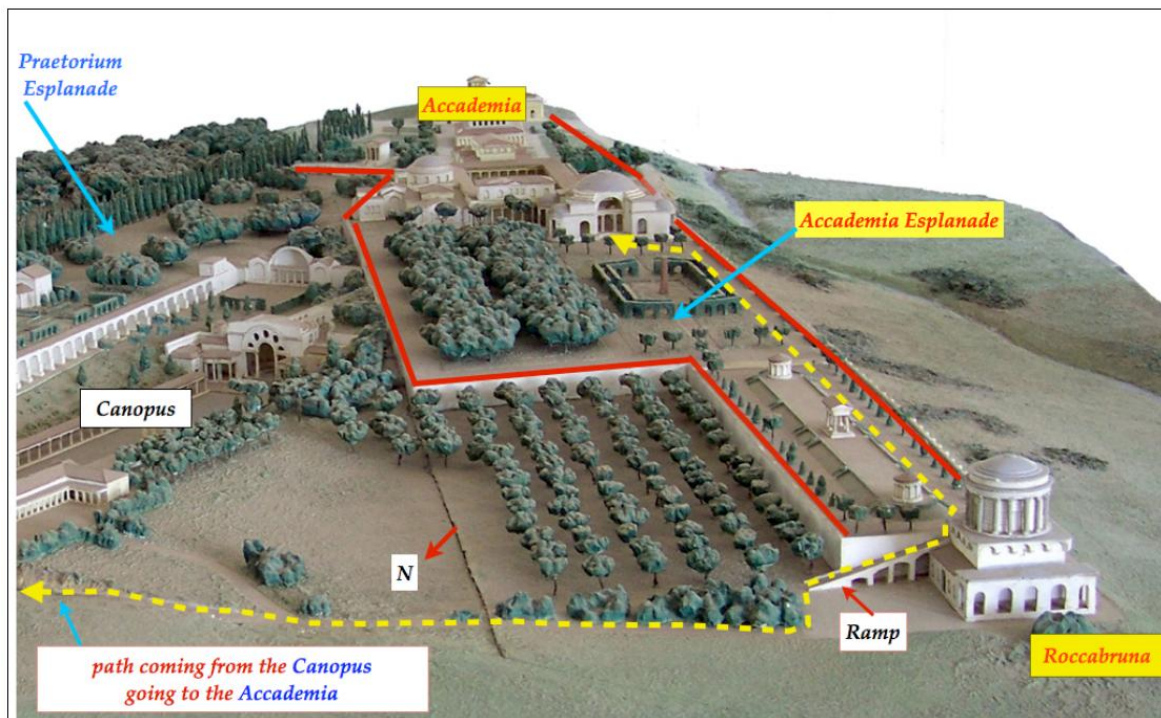


Figure 1. Plastic model of the Accademia esplanade with the path coming from the Canopus, the access ramp, and the buildings of Roccabruna and Accademia (photo M. De Franceschini).

The Esplanade and the two buildings of Accademia and Roccabruna are oriented along the solstitial axis (Fig. 2) an imaginary line connecting the rising point at dawn of the Winter Solstice and the setting point at sunset of the Summer Solstice. There is a small difference of 2° between the orientation of the two buildings (120° and 300°) and the astronomical *azimuths* of the Sun (122° Winter Solstice, 302° Summer Solstice): it was not due to a mistake, as will be explained below. Measurements at the Accademia are astronomical (De Franceschini, Veneziano, 2011, p. 179 fig. 158, table of azimuths p. 174). Our data was confirmed by calculations made with the software *Starry Night Pro Plus 6.0.3* (De Franceschini, Veneziano, 2011, pp. 197-199).

Compared to the year 125 AD, the *azimuth* of the Sun has changed only about 20': this is why the luminous phenomena are still taking place today, after almost 1900 years. At dawn of the Winter Solstice in 125 AD the *azimuth* was 122°40.6', and now is 122°19.5'; at sunset of the Summer Solstice it was 302°40', and now is 302°19.5', as calculated by Giuseppe Veneziano (De Franceschini, Veneziano, 2011, p. 174), using as said the software *Starry Night Pro Plus 6.0.3*

and also the formula of Laskar (Codebò, 2010, p. 39; De Franceschini, Veneziano, 2013a, pp. 481-482).

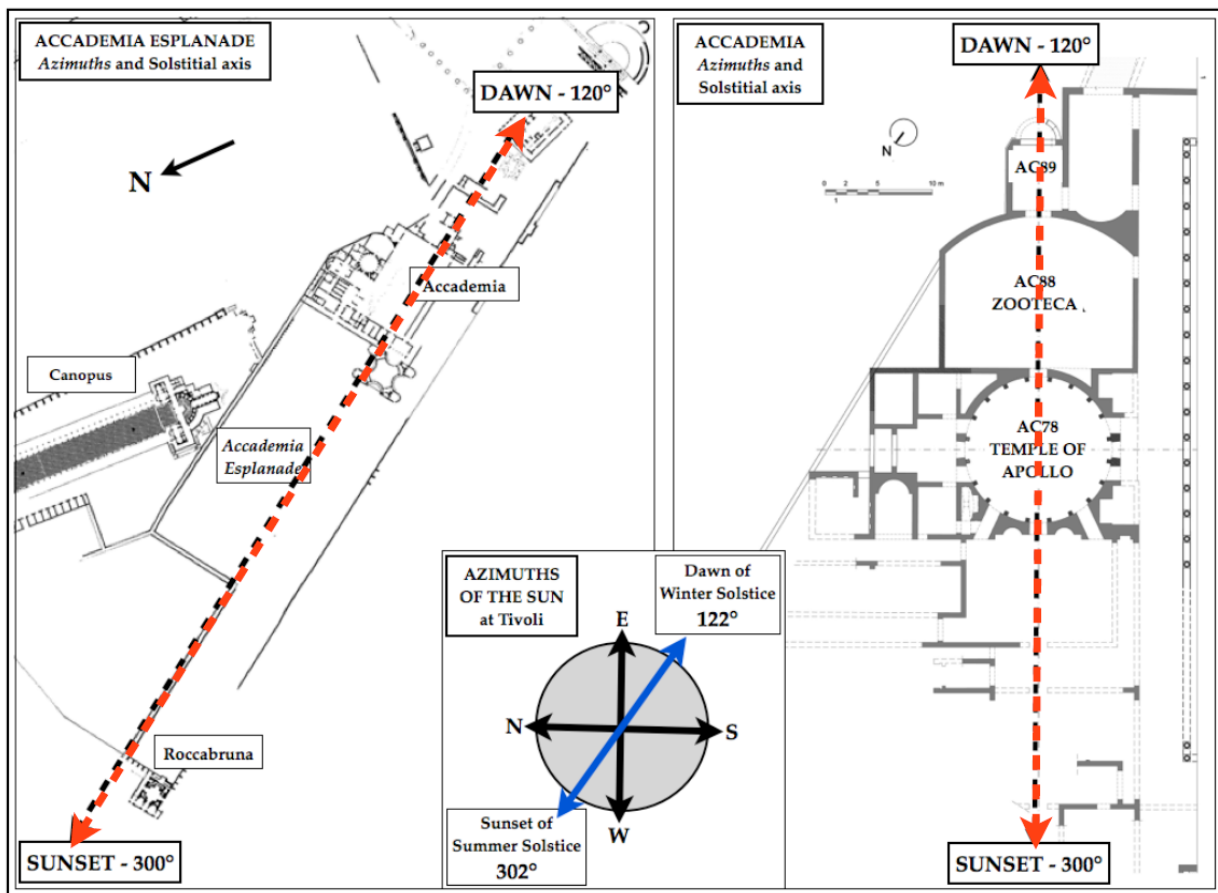


Figure 2. Left: solstitial axis of the Accademia esplanade and its buildings with their orientation. Right: plan of the Accademia with solstitial axis and azimuths. Lower center: azimuths of the sun on the winter and the summer solstices.

The Accademia was built and oriented in order to have luminous phenomena during the two Solstices (Fig. 3). At dawn of the Winter Solstice the sun enters from the door of room AC89 (Fig. 3a); at sunset of the Summer Solstice the sun enters from the opposite side, from the northwest door of the Temple of Apollo (Fig. 3b), creating a rectangle of light above that same door of room AC89 (Fig. 3c).

Today, only half of the Temple of Apollo is still standing (Fig. 4a), and a large part of the building is razed to the ground, so it is not possible to see the complete sequence of the luminous phenomena. However, we found out that there were two different phases (De Franceschini, Veneziano, 2011, pp. 102-106).

During the first phase, the sun enters from the windows of the upper level of the Temple of Apollo [AC78], creating rectangles of light on the panels of its lower level (Fig. 3d). In the second phase the sun's rays pass through the main axis of the building for its entire length, flooding it with light, as in the corridor of the Egyptian temple of Abu Simbel (Cossard, 2010, p. 169; Magli, 2005, p. 94; De Franceschini, Veneziano, 2011, p. 138 and p. 153).

The Temple of Apollo [AC78] is a circular hall of 13,40 meters in diameter; originally it was covered by a dome, whose *oculus* created other luminous phenomena as happens in the Pantheon (see below). Today they can be simulated with a 3D reconstruction (Fig. 4b), although there is no evidence to estimate the exact size of the *oculus*.



Figure 3. Illuminations in the Accademia: *a* - the sun enters in room AC89 at dawn of Winter Solstice; *b* - the sun enters from the door of the Temple of Apollo at sunset of Summer solstice; *c* - spot of light above the door of AC89 at sunset of Summer Solstice; *d* - panel of the Temple of Apollo illuminated during the first phase, on the Summer Solstice (photos by Marina De Franceschini and Giuseppe Veneziano).



Figure 4. Temple of Apollo: *a* - photo of the Temple of Apollo today (only half of it is still standing); *b* - 3D reconstruction of the dome and of a possible illumination (drawing by Brigitta Casieri).

1.2. The Roccabruna building

In 2009 the authors of this article measured and confirmed that Roccabruna was oriented along the same solstitial axis of the Accademia and its Esplanade. On the upper floor of Roccabruna once there was a circular Doric temple (few traces are visible today), accessed by means of a wide staircase (Fig. 5a-b). Its front door was oriented 120° , while the window on the other side was oriented 300° : those orientations perfectly match the ones of the Accademia building, which is located at about 350 meters south of it. All *azimuth* measurements at Roccabruna are magnetic and corrected (De Franceschini, Veneziano, 2011, p. 174 and pp. 197-199).

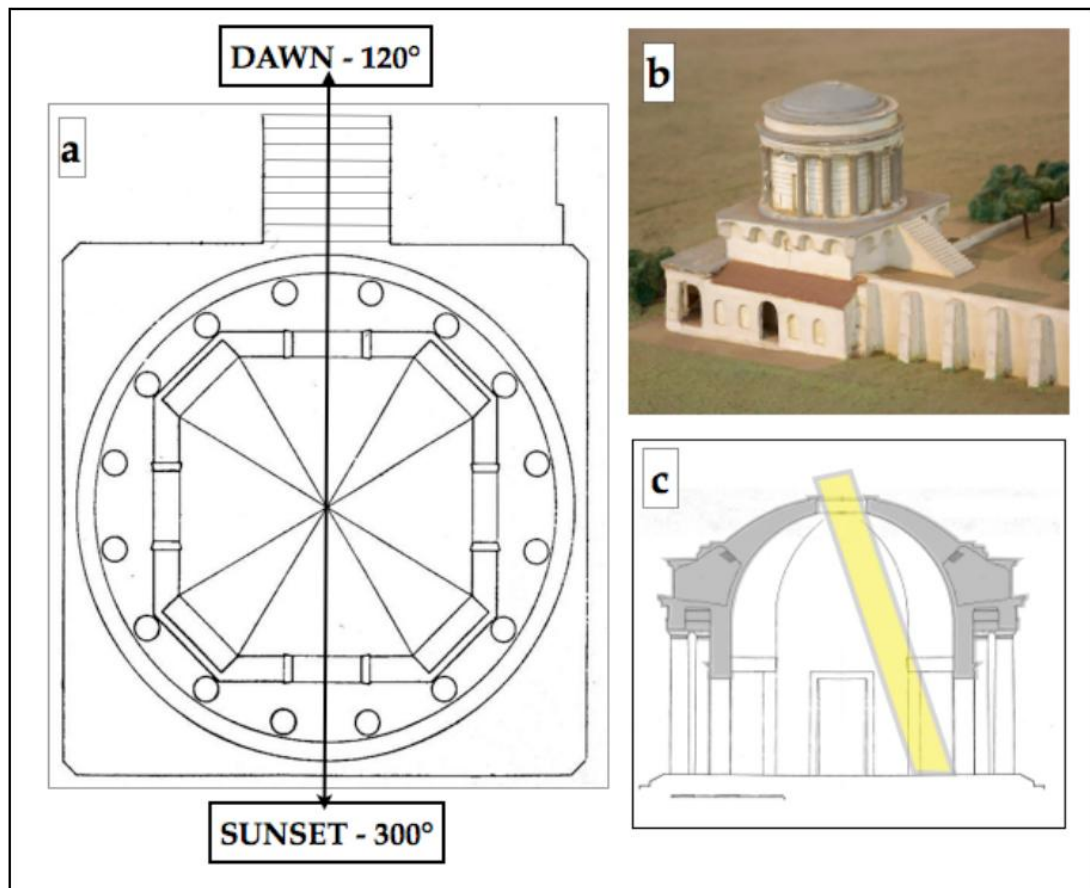


Figure 5. Temple on the upper floor of Roccabruna: *a* - plan of the temple with orientation and *azimuths*; *b* - plastic model of the temple with the stair; *c* - section of its dome with possible luminous phenomenon created by the *oculus* (from Lugli 1940).

During the two Solstices the rays of the sun passed through the temple of Roccabruna from one side to the other, flooding it with light as in the Accademia. Other light phenomena were created by the *oculus* of the dome that once covered the temple (Fig. 5c); since we know its measurements, a 3D simulation can be supported by real data (Lugli, 1940, pp. 265-267; De Franceschini, Veneziano, 2011, pp. 122-123).

The situation of the lower floor of Roccabruna is more complex (see plan Fig. 6). It has a large circular hall covered by a dome of 9 meters in diameter, inside which five conduits (A-B-C-D-E) open; their opposite ends open on the façades. Before our study, their function was not clearly understood; Castellani thought they could hold beams supporting a large armilla (Castellani, 2011).

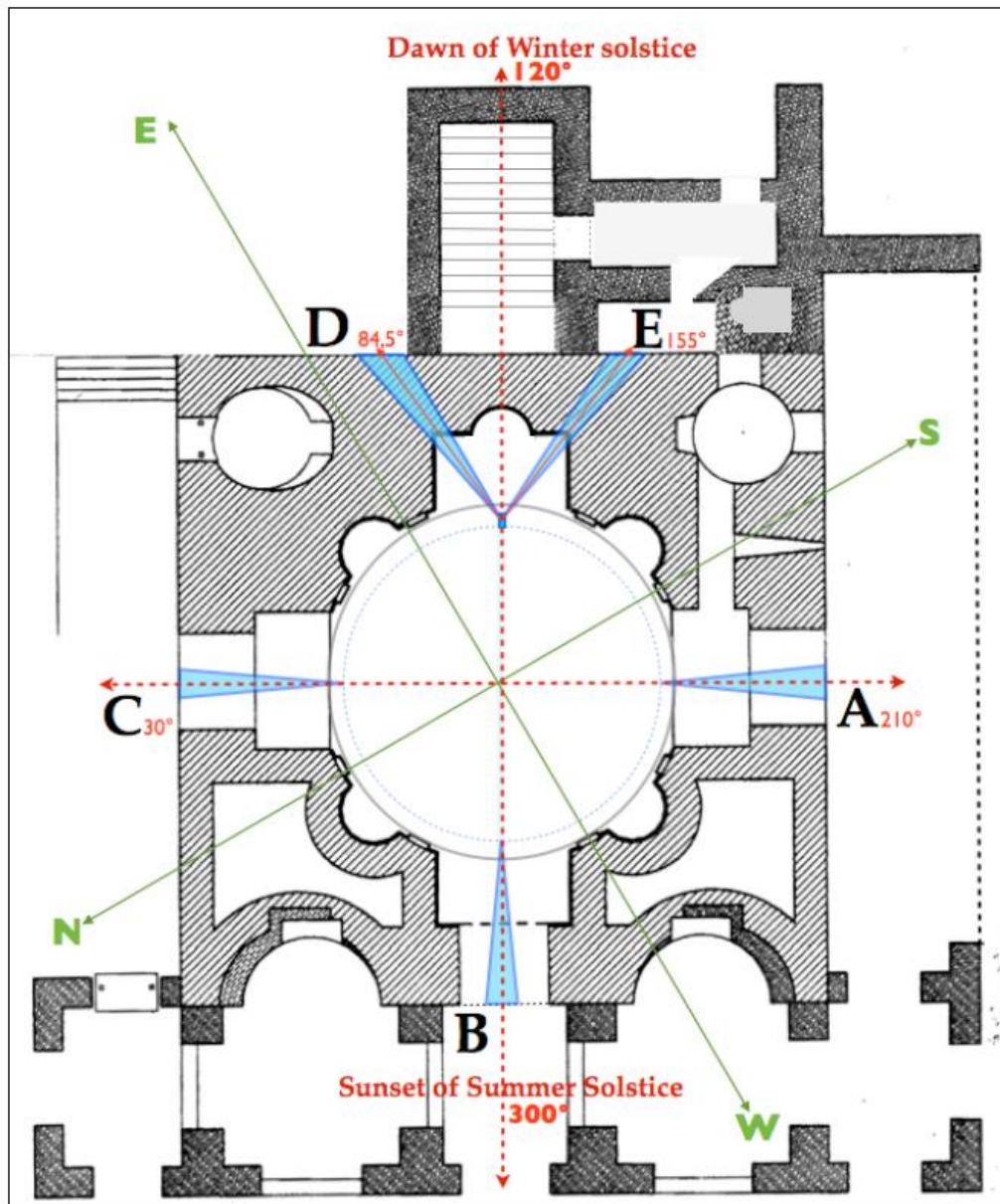


Figure 6: Plan of the lower floor of Roccabruna with orientation and *azimuths* and the five conduits A-B-C-D-E with their *azimuths* (from De Franceschini, Veneziano 2011).

Mangurian and Ray discovered instead that conduit B was a *light conduit*: it is oriented 300° , towards the sunset of the Summer Solstice, when the rays of the Sun enter inside it (Fig. 7a), creating a blade of light on the opposite side of the dome (in front of the main entrance) above a niche where once there was a large statue (Fig. 7b) (Mangurian, Ray, 2011, pp. XVIII-XX; De Franceschini, Veneziano, 2011, pp. 134-137). The blade of light is very bright, more than one meter high, and slowly moves with an arc motion; then it becomes red, gradually fades and disappears.

The difference of 2 degrees between the orientation of Roccabruna (300°) and the *azimuth* of the Sun (302°) as we said was not a mistake: *it was done on purpose*, so that the blade of light could be visible for one hour and fifteen minutes (and still is), from 7.30 pm to 8:45 pm (all hours are in local time: UTC+ 1h + 1h summer time). If the light conduit had been oriented precisely at 302° , the blade of light would appear for few minutes only (De Franceschini, Veneziano, 2011, p. 136). This reasoning also applies to the Accademia building, where the difference is exactly the same.

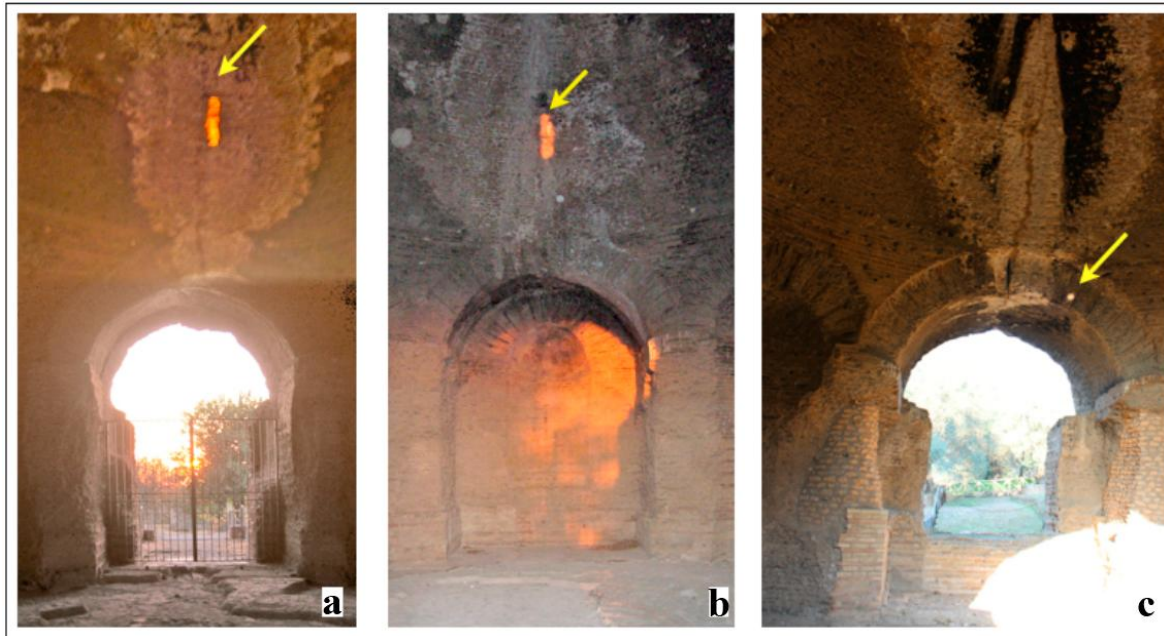


Figure 7. Roccabruna, domed hall in the lower floor: **a** - summer solstice: at sunset the sun enters from the main door from conduit B (arrow); **b** - the blade of light appears on the opposite side of the dome (arrow); **c** - winter solstice: the round spot of light created by conduit A above the arch (arrow) (photo by M. De Franceschini).

In 2009 we were not able to prove that conduit A was a light conduit such as B, since it was not possible to make day-by-day on-site observations on the spot. In 2015 we decided to find out the date when the Sun has the same *azimuth* of conduit A (210°) and the same height that it has when enters inside conduit B (18°). Calculations made by Giuseppe Veneziano (De Franceschini, Veneziano, 2016) pointed at a significant date, the Winter Solstice (December 21st): a blade of light was supposed to appear at 2:15 pm, in a somewhat lower position. On-site observations confirmed our theory, but with some differences: instead of a blade of light, a small circular spot of light appeared in a lower position, below the dome (Fig. 7c), as expected; it was visible at a later time, 2:40 pm (local time: UTC + 1), and lasted only seven minutes, probably because the conduit is not perfectly clean.

The other two conduits D and E had an *azimuth* of 84.5° and 155° , and could not be illuminated by the sun. D opens near the retaining wall, while E opens inside a room; both are on the upper level, at the two sides of the stair leading to the temple (see above plan in Fig. 6). During our on-site surveys we discovered that conduits D and E were *acoustic ducts*, because we heard the voices of the topographers who were working below, in the domed hall of the lower floor: we called them, and we were answered back (De Franceschini, Veneziano, 2011, p. 139). The conduits served to convey the sounds inside the domed hall, probably during religious ceremonies: music or oracular voices could be heard without seeing anyone, creating dramatic 'magic effects'. Something similar is mentioned by ancient sources describing the 'talking statues': hollow statues inside which a priest was hiding and talking, so that the believers thought that the god himself was speaking (Poulsen, 1945, pp. 183-184; Schmidt, 2000, pp. 98-99; Traunecker, 1992, pp. 41, 50-52; Dunand, 1991, pp. 235-246; De Franceschini, Veneziano, 2011, pp. 140-143).

The discovery of the luminous phenomena created by conduit A during the Winter Solstice confirms and supports the discoveries that we have made so far at Villa Adriana. The astronomical orientation of the two light conduits A and B is not coincidental but deliberate,

since it points to the dates of the two Solstices, as happens in the Accademia building and Esplanade. The two Solstices corresponded to the two major feasts of the Roman calendar, and have a precise symbolic meaning (De Franceschini, Veneziano, 2011, pp. 155-165). Looking at the Roman calendar, Marina De Franceschini found out that on the Summer Solstice the feast of *Fors Fortuna* was celebrated, a Mother goddess who was later identified with the Egyptian goddess Isis (Speake, 1994, p. 268; Scarpi, Rossignoli, 2002, pp. 513-514). During the Winter Solstice, the *Saturnalia* were celebrated: they were rites of passage between the old and the new year (very similar in some respects to our Christmas and New Year's Eve). At first, they were dedicated to the ancient god Saturn and later on to Dionysus, who was also identified with Osiris, the husband of Isis (Perowne, 1986, p. 44; Speake, 1994).

The iconography of the sculptures found in this area of Villa Adriana perfectly corresponds to those cults and deities: in Roccabruna the base of a candelabrum with the symbols of Isis was found (Piranesi, 1779, n. 18; Roccheggiani, 1804, pl. XXIV; Penna, 1831, pl. 132; De Franceschini, Veneziano, 2011, p. 162). In the Accademia several sculptures of dionysiac iconography were found, including a Child Dionysus (Calza, 1977, pp. 83-84 n. 96, pl. LXIII; De Franceschini, 2016, pp. 141-143), the Furietti Centaurs and Faun (Raeder, 1983, pp. 63-65 cat. I,46-47 pl. 28 and pp. 65-66, cat. I,48, pl. 29; De Franceschini, Veneziano, 2011, pp. 160-161). Several statues of Isis and Isis-Fortuna were also found at Villa Adriana, but unfortunately their exact find spot is unknown (Raeder, 1983, p. 389).

Therefore, the 'common denominator' of those cults and iconographies in the Accademia Esplanade seems to be the Egyptian goddess Isis, because she was identified with *Fors Fortuna* (celebrated on Summer Solstice) and because she was the wife of Osiris/Dionysus (celebrated on Winter Solstice). Isis was a powerful Mother goddess who governed Life and Death and ruled the planets and the Universe. Her cult was imported from Egypt and Greece; it was mysterious and therefore remained secret, and was linked to the death and resurrection of Osiris, and to the hope of afterlife; during the initiation rites, the worshipers symbolically died and were born again to a new life, after knowing the "mystery secret that is the divine principle that rules the world". Isis ruled Nature and Destiny and in the Aetiology of Cuma, speaks of her powers: "I win the Fate and the Fate obeys me" (Scarpi, Rossignoli, 2002, p. 512). The typically pagan symbolism of her cult was related to the dualism between male and female deities, between Light & Darkness and Life & Death: the same apparent death of Nature that takes place on the Winter Solstice, as opposed to its full bloom on the Summer Solstice (De Franceschini, Veneziano, 2011, p. 164).

Finally, we believe and suggest that the Accademia Esplanade with its two buildings was a sacred area and a sacred landscape: it was the Acropolis of the Villa, located on the highest level, closer to divinity. Roccabruna was probably dedicated to Isis, while the Temple of Apollo could have been dedicated to Dionysus/Osiris. On the occasion of the two Solstices – for a total of about ten days every year – there were sacrifices and ceremonies linked to the cult of Isis, as depicted in two frescoes from Herculaneum (Fig. 8), showing Isiac ceremonies or ritual sacred dances in front of a temple with a staircase, with priests and worshipers, sphinxes and palm trees (De Caro, 2003; De Franceschini, Veneziano, 2011, p. 145 fig. 130, and p. 168 fig. 148; Beaurin, 2013, p. 70 fig. 12 and p. 88 fig. 17). On the Accademia Esplanade probably there were sacred processions, going from Roccabruna to the Accademia, honoring the goddess Isis, as described by Apuleius in his *Metamorphoses*, the most significant ancient source we have about her cult (Scarpi, Rossignoli, 2002, pp. 512-513; Beaurin, 2013, pp. 41, 43, 48-68). They are similar to

those taking place in the temple of Karnak³ at Luxor in Egypt, where the long alley flanked by sphinxes was probably oriented, and the temple of Ra-Hor-Ahkty is oriented towards dawn of the Winter Solstice (Heinberg, 2001, pp. 45-46).



Figure 8. Two frescoes from Herculaneum showing Isiac ceremonies (photo by M. De Franceschini).

Archaeoastronomy thus provided a new key of interpretation for this area of Villa Adriana: the Accademia Esplanade was not an hunting ground nor the secluded residence of the Empress Sabina, as some scholars believed, although without supporting evidence (Salza Prina Ricotti, 2000, p. 280; Chiappetta, 2008, p. 182; De Franceschini, Veneziano, 2011, p. 165). It was instead an astronomically oriented and sacred landscape, where special luminous phenomena are (still) taking place: in antiquity they were linked to important feasts of the Roman calendar (De Franceschini, Veneziano, 2011, pp. 166-168).

2. The Mausoleum of Hadrian (Castel Sant'Angelo)

The Mausoleum of Hadrian, completed in 139 AD (one year after the Emperor's death), was built as a dynastic tomb; within its present Renaissance 'shell' – which transformed it into today's Castel Sant'Angelo – a large part of its original structures is still preserved (Vitti, 2014, p. 264).

The burial room, called Sale delle Urne (Hall of the Urns), is located in the center of the building, at mid-height near the top (Fig. 9, Fig. 10).

It has two large window-tunnels perfectly oriented to the east and west, as calculated on a satellite image from Google Earth Pro (De Franceschini, Veneziano, 2015, p. 8); so we thought that during the Equinoxes luminous phenomena could take place there: the sun would enter inside the Hall of the Urns at dawn and sunset. Our on-site observations, and most of all the accurate sections published by Cesare Cundari (Cundari, 2000), proved that this was not possible: the window-tunnels are sharply angled upwards, the horizon is much lower, and already in Roman times it was hidden by other buildings. Therefore, on the Equinox the sun's rays could not get inside the window-tunnels at dawn or at sunset, and in other days the *azimuth* was different (see again section in Fig. 10).

³ Video of illumination at Karnak: https://www.youtube.com/watch?v=oWHv-EZns_Q

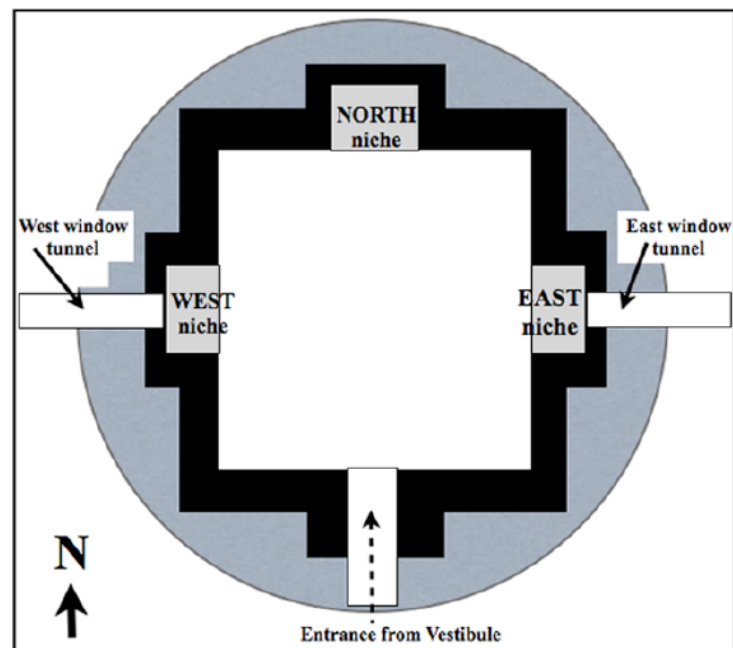


Figure 9. Plan of the Hall of the Urns inside the Mausoleum of Hadrian with the three oriented niches and two window-tunnels (Castel Sant'Angelo, Rome) (drawing by M. De Franceschini).

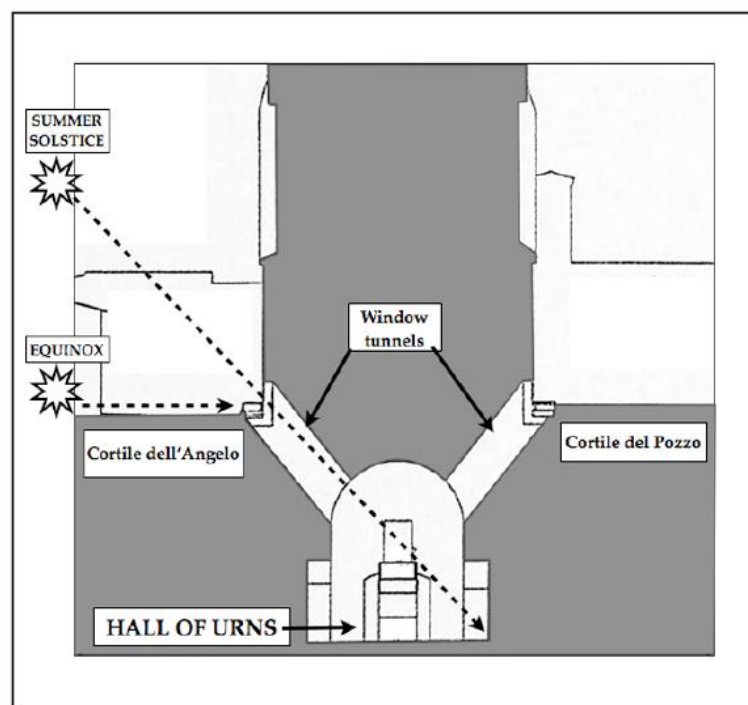


Figure 10. Section of the Hall of the Urns with the oblique window-tunnels and the height of the Sun (from Cundari 2000).

Visiting Castel Sant'Angelo in the afternoon of the Summer Solstice (June 21st, 2012), Marina De Franceschini happened to be in the right place at the right time. She noticed that in the Hall of the Urns the sun's rays entered into the west window-tunnel, creating a rectangle of light in the east niche on the opposite side, at 4:55 pm (local time: UTC+ 1h + 1h for summer time) (Fig. 11a).

Subsequent calculations made by Giuseppe Veneziano showed that the same phenomenon also occurs in the morning of the Summer Solstice at 8:53 am, when the rays coming from the east window-tunnel illuminate the west niche (Fig. 11b) (De Franceschini, Veneziano, 2015, p. 8 fig. 13).



Figure 11. Summer solstice in Castel Sant'Angelo: *a* - the east niche illuminated by the Sun entering from the west niche at 4.55 pm (summer solstice 2012); *b* - the west niche illuminated by the sun entering from the east niche in the morning at 9:00 pm (summer solstice 2014); *c* - the north niche under the footbridge (photo by M. De Franceschini).

This was confirmed by our on-site observations, during which another discovery was made: the third niche on the north side of the Hall of the Urns (Fig. 11c), now hidden by a nineteenth-century footbridge, was originally lit on those same days of the Summer Solstice, twice a day: at 10:06 am and at 4:01 pm (hours and *azimuths* in Table 1). It was the central niche, the most important one, where the sarcophagus of the Emperor was placed. A red porphyry sarcophagus was in fact found inside the Mausoleum; its lid was re-used as baptismal font and today is in the Basilica of Saint Peter's at Rome.

SUMMER SOLSTICE June 20th, 2014	Hour (Daylight saving time)	Azimuth of the Sun	Height of the Sun
Illumination of the WEST niche from east window	8.53 am	87°41'	33°28'
Illumination of the EAST niche from est window	4.55 pm	266°22'	39°55'
Illumination of the NORTH niche from east window	10.06 am	100°47'	46°48'
Illumination of the NORTH niche from west window	4.01 pm	255°45'	49°42'

Table 1. Calculations of the *azimuth* and height of the Sun and times of the illumination of the three niches, made by Giuseppe Veneziano.

From the structural point of view, the window-tunnels – which were built in Roman times – were sharply angled up (see above, Fig. 10) in order to capture the sun's rays at the Summer Solstice, when the sun reaches its maximum height in the sky. This explains the unusual position of the burial chamber, which is not subterranean – as generally happens in Mausoleums – but is set at a height of about ten meters above the level of the Tiber river (De Franceschini, Veneziano, 2015, pp. 15-16).

Although we are in a funerary context – different from the residential one of Villa Adriana – the luminous phenomena are essentially the same: they are created by window-tunnels, which are similar to the ‘light conduits’ of Roccafranca.

An earlier example is found in the so-called Mausoleum of the Equinoxes on the Appian Way in Rome (Fig. 12), a tomb of the II century BC, whose plan is very similar to the one of the Hall of the Urns. Only during the days of the Equinoxes does a ray of light enter from a window-tunnel, perfectly illuminating the center of the floor of the tomb (De Franceschini, Veneziano, 2011, pp. 194-196; De Franceschini, 2015).

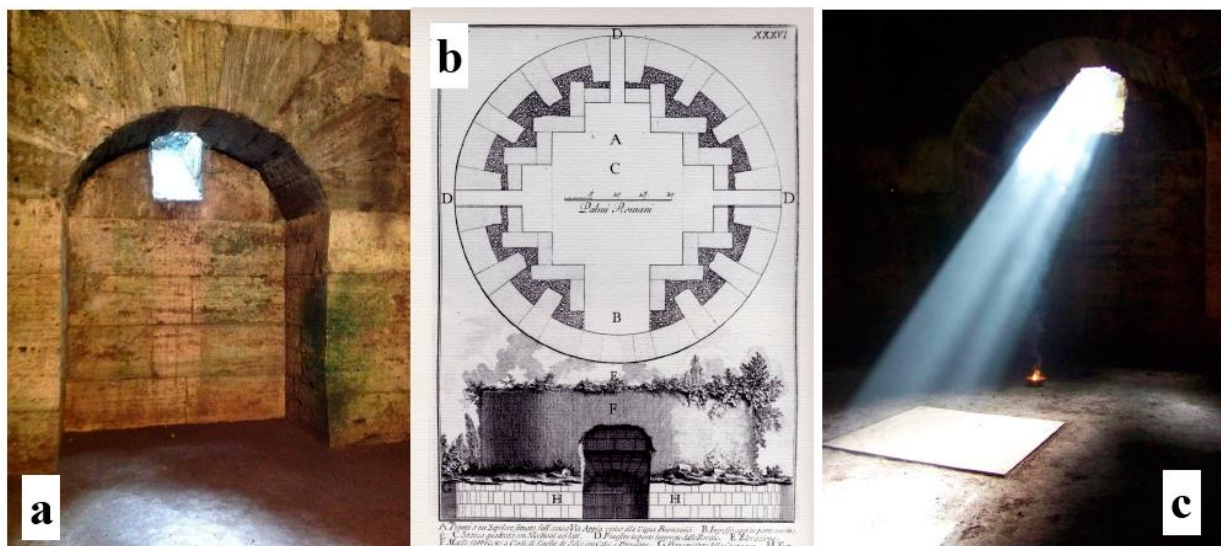


Figure 12. The Mausoleum of the Equinoxes on the Appian way at Rome, II century BC: *a* - the niche with the window tunnel from which enters the light; *b* - plan by Piranesi, similar to the Hall of the Urns in the Mausoleum of Hadrian; *c* - the ray of light appearing during the Equinox (photo by M. De Franceschini).

In the Mausoleum of Hadrian the symbolism of the decoration was not connected with the iconography of the goddess Isis, but with that of the Sun, and once again points to the duality between Life & Death and Light & Darkness. The Emperor Hadrian was deified after death and identified with the Sun: ancient sources describe a Chariot of the Sun, driven by the Emperor himself, which was on top of his Mausoleum. An imitation of the Mausoleum of Halicarnassus (one of the Seven Wonders of the world), the tomb of Mausolus which had a Chariot of the Sun on its top.

The decoration of the Mausoleum of Hadrian included other symbols related to the sun: the bronze sculptures of peacocks (solar birds because of the spots on their tail), and the enormous pine cone now decorating the Cortile della Pigna in the Vatican Museums, which is believed to have been found there. Ritual processions linked to the Imperial cult and to the cult of the Dead took place inside the Mausoleum; they moved along the inner spiral ramp, ending inside the Hall of the Urns at the right moment, when the rectangles of light were appearing. Other similar luminous phenomena probably occurred inside the temple that once was on top of the

Mausoleum; during the Renaissance it was partially destroyed by an explosion, and incorporated into the Pope's apartment. For this reason we have no evidence for a reliable reconstruction of its windows and possible illuminations.

As for the change of the solar *azimuth*, which took place over the centuries (from the construction of the Mausoleum in the year 139 AD until today) the same reasoning we made for Villa Adriana applies. Since Rome and Tivoli have the same latitude, there has been a change of about 20' only, and this is why the light phenomena are still visible today (De Franceschini, Veneziano, 2011, p. 174; Codebò, 2010, p. 39).

3. The Pantheon

In the III century AD, Dio Cassius (Roman History, LIII, 2.7) wrote that "the Pantheon because of its vaulted roof it resembles the heavens". In 1966, De Fine Licht (De Fine Licht, 1966, p. 199) noted that "the dome in ancient times was interpreted as an imitation of heavens, so the geometrical form of the Pantheon was created as an allusion to the cosmos".

In 1976 Passuello and Dissegna made the first connection of the Pantheon with archaeoastronomy: it was a "celestial uranian symbol", and "was oriented 175°, towards the rising sun on April 1st (feast of Venus) and on September 16th, date of the *Ludi Romani*". 175° is the opposite of 355°, which is close to the actual orientation of the door of the Pantheon. The dome represented the heavens, since it "seems to rotate infinitely around the central point, that is the man standing inside this space" (Passuello, Dissegna, 1976, pp. 64-65).

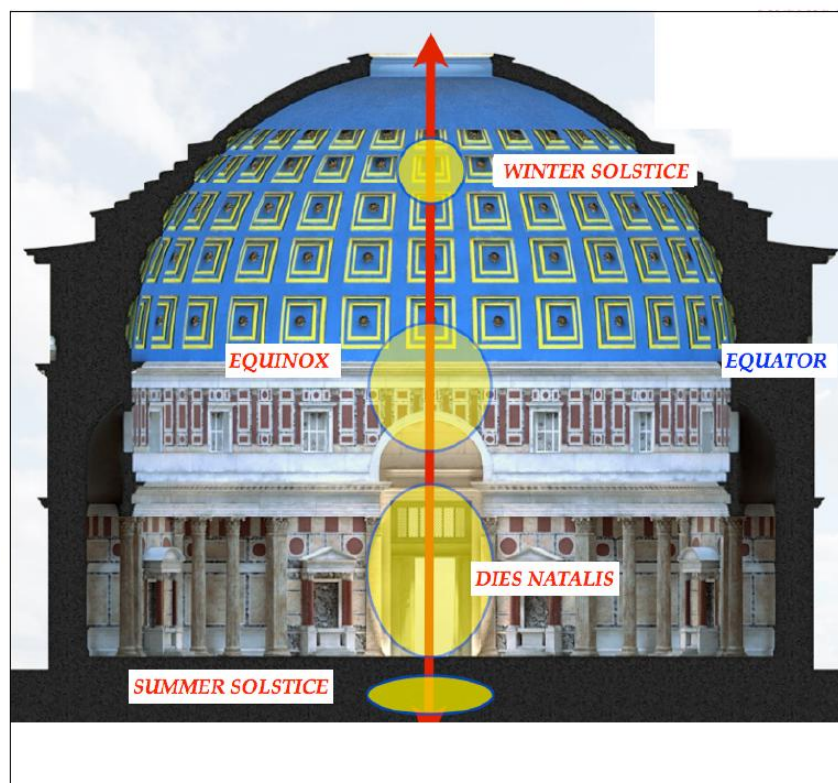


Figure 13. Inner section of the Pantheon with the spots of light: they have a different height according to the seasons.

In 1991 the Italian astronomer Aldo Tavolaro gave a new archaeoastronomical interpretation of the dome (Tavolaro, 1991, pp. 19-24): since the molding at its base is set exactly at mid-height of the building, "the dome represented the celestial vault and the molding represented the celestial equator". He was the first to notice that in the days of the Equinox (March 21st and

September 23rd) at noon (local time: UTC+ 1h) the oval spot of light created by the *oculus* illuminated the molding (Tavolaro, 1991, pp. 21-22): "the image of the sun is placed on the molding for a few moments, just as the Sun towards that date crosses the celestial equator". He also wrote that the Pantheon functioned as a seasonal sundial: "...it is equally possible to determine the dates of the year by observing the position of the light spot at the astronomical noon [...] If it is winter, the oval of light never falls below the molding, if it is summer it goes down to illuminate the floor of the temple" (Tavolaro, 1991, pp. 22-23) (see below Fig. 15).

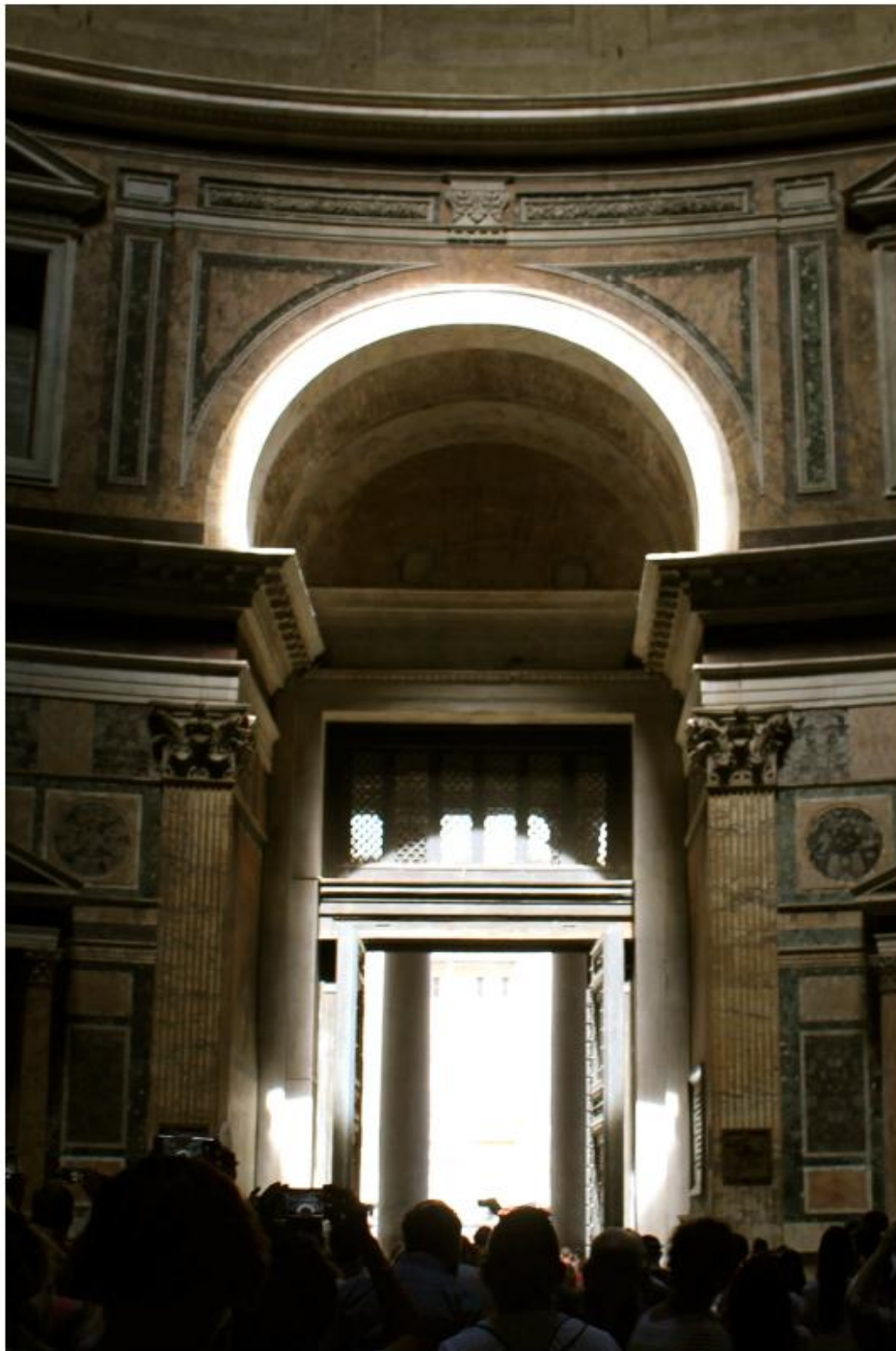


Figure 14. The Arc of Light above the door of the Pantheon, visible on April 6-7th and September 4-5 (photo by M. De Franceschini).

In 2009 and 2011 Hannah and Magli wrote that the Pantheon was as a sort of giant spherical sundial, imitating spherical sundials found at Pompeii and elsewhere (Hannah, Magli, 2011, pp.

490, 492 and p. 491 fig. 3), but pointed out that "all the astronomical analysis which follows does *not* aim to show that the Pantheon was designed to make precise measurements of the sun's cycle, but rather to substantiate the *symbolic* connection of the building with the path of the sun in the course of the year" (Hannah, Magli, 2011, p. 492). They made the same observations of Tavolaro about the height of the spot of light and the hierophanies of the Equinox, adding a new hierophany on April 21st, which was the *Dies Natalis* of the city of Rome, and measured with Starry Night Pro 6.0 and Voyager 4.5.4 (Hannah, Magli, 2009; Hannah, Magli, 2011, p. 497, and Figs 6, 7 and 9).

Every day at noon the sun comes in through the *oculus* of the dome, creating a circular spot of light, which illuminates the north side, where its monumental bronze door opens. The building is approximately oriented to the north; we measured a difference of about 3 degrees compared to true north, using a satellite image of Google Earth Pro (De Franceschini, Veneziano, 2011, pp. 78-83); Hannah and Magli report instead a difference of 5.5 degrees, calculated with a Suunto Tandem compass (Hannah, Magli, 2011, p. 490).

Depending on the date, the spot of light appears at a different height (Fig. 13 and 15) indicating the course of time and of the seasons.

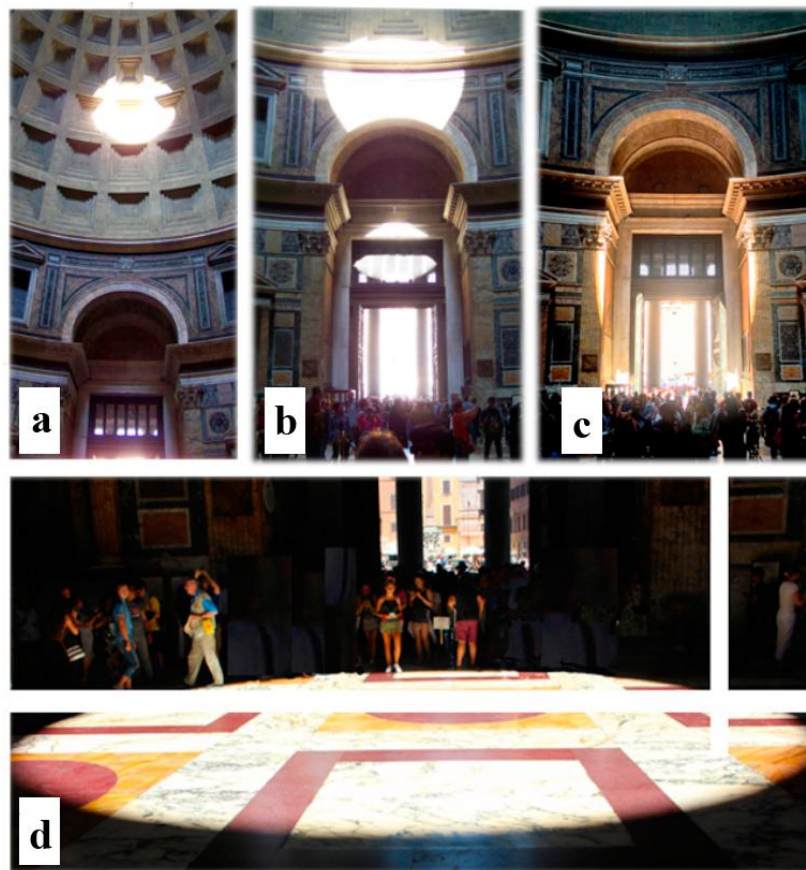


Figure 15. Illuminations in the Pantheon: *a* - During Winter the circle of light hits the dome; *b* - on the Equinox is on the molding; *c* - on April 21st *Dies Natalis* of Rome, illuminates the door; *d* - on Summer solstice a large circle of light appears on the pavement (photo by M. De Franceschini).

In wintertime, it is very close to the top of the dome (Fig. 15a).

In the days of the Equinox (March 21st, September 23rd) it hits the grate above the doorway, also illuminating the molding at the base of the dome (Fig. 15b), which is supposed to represent the Equator (Tavolaro, 1991, pp. 21-22).

On April 21st – *Dies Natalis* of the city of Rome – the spot of light completely illuminates the door from the inside (Fig. 15c).

On the Summer Solstice a large circle of light hits the floor, near its center (Tavolaro 1991, pp. 22-23; Hannah, Magli, 2009; Hannah, Magli, 2011; De Franceschini, Veneziano, 2011, pp. 78-83.) (Fig. 15d).

In 2011 Nick Glass released a video of the Pantheon for the series *The Revealer*⁴ of CNN, interviewing Giulio Magli who explained the illuminations inside the Pantheon in the dates of the Equinox and of April 21st, and said that "the emperor was deified already in life". This is not correct, because the Roman Emperor was divinized only *after his death* and after cremation, with a special decree of the Senate (Passuello, Dissegna, 1976, pp. 58-59; De Franceschini, Veneziano, 2011, p. 158). During life, at Rome, the Emperor received only divine honors or venerations (sacrifices made for his health), which were *not* offered to him in person, but to his 'Genius' or 'Numen' (Passuello, Dissegna, 1976, p. 59). The divinization of the Roman Emperors when they were still alive was allowed instead in Egypt and Asia Minor, following the centuries-old local tradition which considered divine the Pharaohs, and after them Alexander the Great and the Hellenistic rulers (Passuello, Dissegna, 1976, pp. 54-55).



Figure 16. Detail of the Arc of Light, perfectly matching the masonry arch (photo by M. De Franceschini).

In the video an Arc of Light was visible, perfectly matching the masonry arch above the entrance door (Figs 14 and 16); but in the interview Magli did not comment about it; Hannah and Magli never mentioned the Arc of Light in their publications, nor in the presentation that Hannah gave at the 2016 SIA Congress at Milan.

Marina De Franceschini saw the CNN video and was impressed by the light so perfectly matching the masonry arch (Fig. 16). She knew that it was not visible in the days of the Equinox, when the spot of light hits the molding below the dome. Therefore she went to the Pantheon on

⁴ Vide of the illumination in the Pantheon by Nick Glass, *The Revealer*, CNN: <http://edition.cnn.com/videos/world/2011/12/08/the-revealer-pantheon.cnn>

April 21st, 2012, expecting to see it: but the spot of light was in a much lower position, centering the door (Fig. 15c). Obviously the video was made assembling different shots made in different days – due to bureaucratic problems, as Nick Glass wrote.

Which was the exact date? Using an accurate section of the Pantheon⁵ of the University of Bern, Switzerland, Giuseppe Veneziano calculated that the arch above the entrance could be illuminated in order to create the luminous effect seen in the video (the Arc of Light), only when the Sun at local noon had a height in the sky of about 55°. According to solar ephemerides (Ricci 2011, pp. 19-22), this happens when the Sun has a declination δ of +7°, that is to say twice a year: from April 7th to 10th and from September 2nd to 5th. On-site observations slightly modified those dates: the Arc is visible in the days 6-7-8 of April and 4-5-6 of September; and this is due to the fact that the Pantheon is not perfectly oriented to the north.

Since there was no relationship with the *Dies Natalis* of Rome, the following question was: *Which was the symbolic meaning of the Arc?* Tavolaro and later on Hannah and Magli described the luminous phenomena occurring in the days of the Equinox, of the Summer Solstice and on April 21st: *How long do these phenomena last?*

– In Autumn and Winter, the circle of light always hits the dome above the molding (Fig. 15a) for a period of six months between the two Equinoxes (from September 23rd to March 21st), so there could be no relationship with a single feast or divinity of the Roman calendar.

– On both Equinoxes (March 21st and September 23rd) the circle of light hits the molding at the base of the dome and filters through the grate above the door⁶ (Fig. 15b). This illumination is visible twice during the year, at least from March 17th to March 24th and from September 20th to 27th, for a total of fifteen days.

– On April 21st the light hits the bronze door (Fig. 15c): this illumination is not limited to one day only: *it is visible for 15 days*, from April 15th to April 29th, when the sun has the required height of 60°⁷. Therefore, the connection with the *Dies Natalis* is not that close or exclusive. The same illumination is also visible four months later, in the (symmetrical) days around August 20th, which are not related to any particular feast of the Roman Calendar. This means that during the year the door is illuminated for a total of a month, making it unlikely that the single date of April 21st was driving its illumination.

– On Summer Solstice the sun creates a large circle of light on the floor (Fig. 15d), when the sun has an height of 71-72°. This illumination is not limited to the day of June 21st⁸: *it is visible for more than a month*, from June 5th to July 7th; once again it cannot be related to a specific date or deity.

– The Arc of Light, instead, is visible for very few days during the year, when the sun has a height of 55°: three days in Springtime (6-7-8 April), and three days at the end of Summer

⁵ The Digital Pantheon Project, Humboldt-Universität zu Berlin, Excellence Cluster 264 Topoi, Universität Bern: <http://repository.edition-topoi.org/collection/BDPP>.

⁶ On the Equinox the sun has a declination $\delta = 0^\circ$, and at Rome its height is about 48° (at the true local noon). We considered an height from 47 to 49 degrees, required to hit the molding. Source: Solar ephemerides in Ricci, 2011, pp. 26-30.

⁷ On April 21st (*Dies Natalis Romae*), at Rome the Sun has a declination of $\delta = +12^\circ$, and its height is about 60° (at the true local noon). Source: Solar ephemerides in Ricci, 2011, pp. 26-30.

⁸ On the Summer solstice, at Rome (June 21st), the Sun has a declination in the sky of $\delta = +23.5^\circ$, reaching its a maximum height of about $h = 72^\circ$ (at the true local noon). Thanks to this height, the circle of light illuminates the pavement at its innermost point. Source: Solar ephemerides in Ricci, 2011, pp. 26-30.

(September 4-5-6)⁹, for a *total of only one week during the year*. Both dates were linked to very important and significant feasts and divinities, as will be explained below.

The Arc of Light is not a casual event: is the outcome of extremely accurate calculations. In fact, the *oculus* is located at a height of about 35 meters above the masonry arch and has a diameter of 9 meters, the same width as the arch, which has the shape of an horse-shoe, so that its contours are perfectly matched by the light (Fig.s 17 and also 14 and 16). The width of the *oculus* obviously "was not fixed randomly" (Hannah, Magli, 2011, p. 494; De Franceschini, Veneziano, 2014a, p.138) and the same goes for the masonry arch.

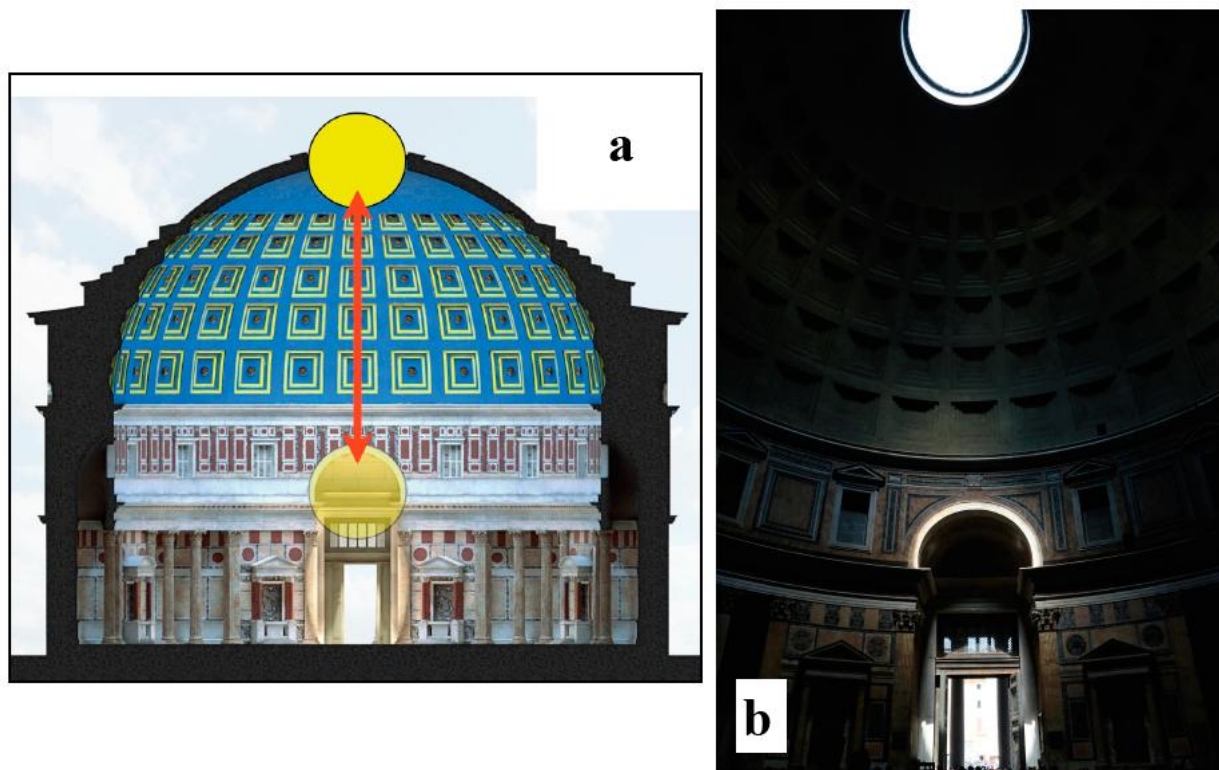


Figure 17. Pantheon: *a* - section of the Pantheon with the Arch of Light, showing that the *oculus* and the masonry arch have the same width: 9 meters; *b* - the oculus and the Arch (photo Francesco Lerteri).

To prove that these illuminations were visible also in Roman times we verified if the structures of the Pantheon that produce them are still the original ones. First of all, the width and shape of the *oculus* is the original one, as proved by the bronze border that still frames it (Belardi, 2006, pp. 234 and 252). The bronze door and the masonry arch above it are also the original ones. The lower floor with its large columns and the *aediculae* framed by small columns are still in their original position, although the marble wall revetment was remade. This means that the illuminations on the walls of the lower level are still the ones planned by the builder.

Instead, the illuminations of the upper or second level (immediately below the molding of the dome) are *not* the original ones: its niches and windows were in fact demolished and completely rearranged during the eighteenth century 'restorations', so what we see today is completely different (Pasquali, 1996; Pasquali, 2009, pp. 157–170; De Franceschini, Veneziano, 2011, p. 80; Marder, Wilson Jones, 2015, p. 233, 331 fig. 11.1 and pl. II).

⁹ When the Sun is illuminating the arch above the door, it has an height of about 55°, corresponding to a declination of about $\delta = +7^\circ$. According to the Astronomical Tables (Solar ephemerides in Ricci, 2011, pp. 26-30) the Sun has this declination only twice during the year: from April 7th to 10 and from September 2 to 5.

During our on-site observations of the Arc of Light, we discovered another illumination. Outside the doorway a Square of Light appears, perfectly matching the pattern of the floor: a square of pavonazetto marble enclosing a circle of gray granite (Fig. 18).



Figure 18. The Square of Light visible outside of the door in the same days of the Arc of Light, matching the pattern of the marble pavement (photo by M. De Franceschini).

Two XVII century drawings shows the original pattern of the floor, and prove that the slabs that we see today have the same position and arrangement of the original ones. The first drawing is by Desgodetz, so precise that can be superimposed to a modern plan with a minimal difference (Desgodetz, 1695); the second is of the workshop of Gian Lorenzo Bernini (Marder, Wilson Jones, 2015, pl. V).

The square containing a circle is a symbolic representation of the *Templum*, the space dedicated to the gods: according to the prescriptions of Varro (De Lingua Latina, IV, 2), the square – oriented to the cardinal points – corresponds to the Earth, while the circle represents the Heavens (Fig. 19). The square of the Pantheon floor is in fact oriented to the cardinal points.

Considering that the Arc and the Square of Light are visible only for few days during the year, Marina De Franceschini and Giuseppe Veneziano believe that they should be considered the most significant luminous phenomena (*hierophanies*) of the Pantheon. And in fact, their dates are extremely meaningful in the Roman Calendar.

– On April 6th there was a feast in honor of Diana, goddess of the Moon, symbolized by the crescent.

– The following day, April 7th, was dedicated to Apollo, the god of the Sun, symbolized by an arc.

– During those same days, from April 7th to 10th, the *Ludi Megalenses* were also celebrated: feasts and banquets in honor of the *Magna Mater*, a Mother goddess who later was identified with the goddess Cybele. The cult of Cybele was imported into Rome in order to defeat the Carthaginians, as commanded by a prophecy; Cybele also was the mother of Sabatios, the Phrygian Dionysus. Her cult was a mystery cult like the one of Isis, and it was linked to the death and resurrection of Attis (De Franceschini, Veneziano, 2014a, pp. 138-139).

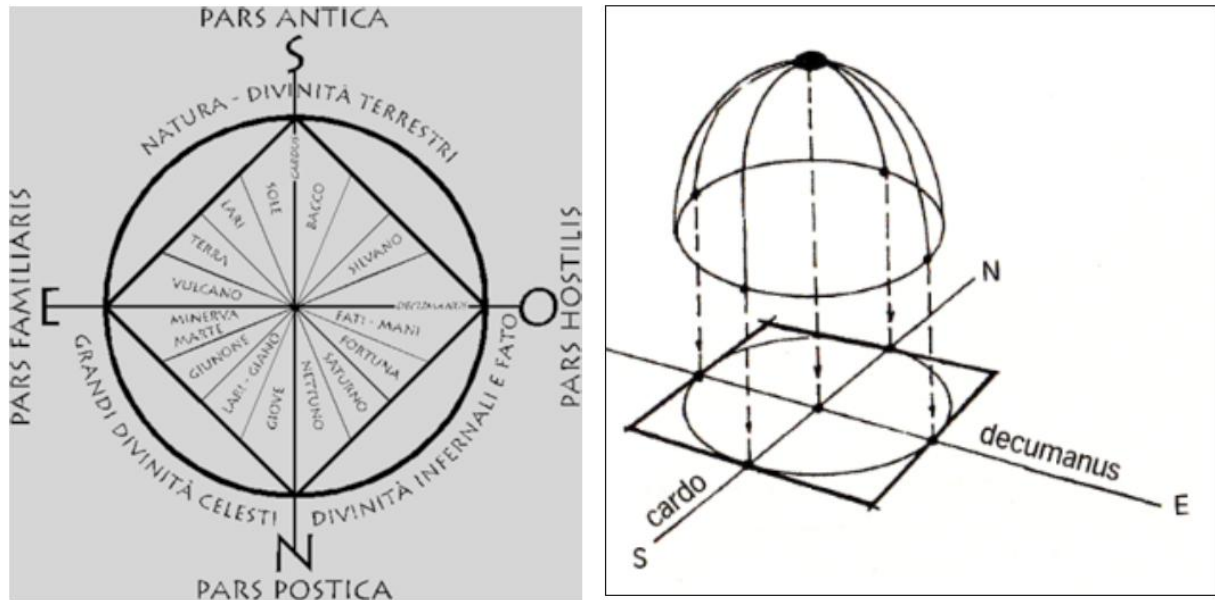


Figure 19. The *Templum*, symbolic division of space in the ancient world.

It is important to point out that a medieval text, the *Mirabilia Urbis Romae*, written in 1140 (Marder, Wilson Jones, 2015, pp. 236 and 233), proves a connection with the goddess Cybele: "Santa Maria Rotunda, which once was the temple of all gods, and most of all dedicated to Cybele, mother of all gods, was transformed by Pope Boniface IV into the church called Sancta Maria ad Martyres, dedicated to the cult of the Mother of God and to all Saints, especially to the Martyrs¹⁰". In 609 AD the Pantheon was in fact donated by the Emperor Phocas to Pope Boniface IV and transformed into the church of Santa Maria ad Martyres: this saved it from destruction.

Five months later, in the days around September 4th, the Arc and Square of Light are visible for the second time during the year. According to the Roman Calendar, from September 2nd to 5th the *Ludi Romani* were celebrated, to honor *Jupiter Optimus Maximus*, the patron god of the city of Rome (keeper of oaths, protector of justice and of good governance); he was identified with the Italic god *Diespiter*, celestial deity who manifested himself with the Sunlight during the day. The *Ludi Romani* began with a solemn procession which started from the Capitoline hill reaching the Circus Maximus, where sacrifices were made, chariot races took place and dramas were performed (De Franceschini, Veneziano, 2014a, p. 138–139).

Ancient sources mention some of the statues that once were in the Pantheon. In the 1st century AD, Pliny the Elder wrote that Agrippa decorated it with statues of Caryatids (*Naturalis Historia*, XXXVI, 38). In the 3rd century AD Dio Cassius wrote that among other ones there were the statues of Caesar, Agrippa and Augustus, and also of Mars and Venus (*Dio Cassius, Roman History*, LIII, 27; De Fine Licht, 1966, pp. 180-184; Thomas, 2017, p. 148). Scholars have been

¹⁰ Original text of the *Mirabilia Urbis Romae*: http://www.documentacatholicaomnia.eu/04z/z_1140-1143__Anonymus__Mirabilia_Urbis_Romae__LT.pdf.html

discussing for decades about the names of the gods portrayed in the Pantheon, the "temple of all gods", mainly focusing on the twelve Olympian gods. Thanks to archaeoastronomy, which provided new elements, we may suppose that in the Pantheon there were statues representing Apollo, Diana, *Jupiter Optimus Maximus* and Cybele. It is interesting to point out that "in 1545 the last remaining trace [of its statuary], supposedly a bust of Cybele, was removed from its position in the wall of the chapel left of the entrance" (Thomas, 2017, p. 146 notes 2 and 3). Together with the *Mirabilia Urbis Romae*, this information further supports our interpretation of the symbolic meaning of the illumination of April 7th linked to the goddess Cybele.

The symbolism of the Arc and Square of Light is linked to the same duality seen in the other two monuments: male and female deities, the Sun & the Moon, Light & Darkness, Life & Death, and also resurrection and hope of afterlife. We can reasonably think that inside the Pantheon sacred rites were performed, although no ancient source mentions them; on certain occasions, they would be presided over by the Emperor himself as *Pontifex Maximus*, the highest Roman religious office, as we will see below. Also, we know that Emperor Hadrian "held court [...] in the Pantheon [...] seated on a tribunal" (Cassius Dio, Roman History, LXIX, 7; De Fine Licht, 1966, p. 183).

4. Conclusions

The three buildings we have described so far have in common an astronomical orientation which was calculated to obtain special luminous phenomena during the Solstices or other important days and feasts of the Roman calendar. We have three examples all related to Emperor Hadrian (II century AD): so this did not happen by chance. The phenomena were created by letting the Sun enter inside the buildings in three different ways:

1 - with large windows, creating rectangles of light on the walls of the Temple of Apollo in the Accademia of Villa Adriana (Summer and Winter Solstice, Fig.s 3c-3d).

2 - with long window-tunnels, functioning as 'light conduits' to create rectangles, circles or blades of light in Roccabruna (Summer and Winter Solstice, Fig. 7) or in the Mausoleum of Hadrian (Summer Solstice, Fig. 11).

3 - with the *oculus* of a dome, to create circles and squares of light. Today this happens only in the Pantheon (Summer Solstice, Equinox, feasts of Diana, Apollo, Cybele and *Jupiter Optimus Maximus*, Fig. 13 to 18). Both the Temple of Apollo in the Accademia and the temple on the upper floor of Roccabruna once had a dome with an *oculus* (Fig.s 4b and 5c); therefore, it is likely that somewhat similar luminous phenomena could take place there, which can be simulated with Stellarium or Starry Night Pro and with 3D reconstructions.

Villa Adriana, the Mausoleum of Hadrian and the Pantheon had different functions, all linked to religion: a sacred area within a private villa, a tomb and a temple. Roman architecture has other examples of oriented buildings, such as the aforementioned Mausoleum of the Equinoxes on the Appian Way (II century BC). Other oriented buildings of imperial date are the *Horologium Augusti* built by the Emperor Augustus, about which a presentation was given by Bernard Frischer during the 2016 SIA Conference (Rehak, 2006; Frischer, 2017). Probably also the Mausoleum of Augustus was oriented, but unfortunately there is no evidence to reconstruct the position of its doors and windows and possible luminous phenomena. Emperor Tiberius' *Villa Jovis* at Capri was astronomically oriented, as discovered by the authors of this article (De Franceschini, Veneziano, 2013b; De Franceschini, Veneziano, 2014b). Emperor Nero's famous Golden House in Rome was oriented towards the Equinox (De Fine Licht, 1966, p. 206 fig. 209, p. 214; Voisin, 1987, p. 510; De Franceschini, Veneziano, 2011, pp. 72-77).

4.1. Ancient sources: the Kiss of the Sun

There are many astronomically oriented prehistoric monuments (such as Stonehenge, Newgrange or the Dolmens), and sun alignments towards mountain peaks or rock holes in set astronomical dates. It is not possible – of course – to produce written sources for prehistoric monuments, which prevents an historical checking of questionable or dubious discoveries such as crop circles, or phallic symbols and even "stone vaginas" that some scholars pretend to see in some rocks.

Written sources are required instead of archaeologists and archaeoastronomers who study ancient Roman buildings: in theory there should be some Greek or Latin text describing astronomically oriented buildings, but there are none. The lack of written evidence does not prove that the luminous phenomena that we have seen in so many Roman buildings are simple 'coincidences'. It is important to point out that the ancient sources that have come down to us are only a fraction of what once existed; sometimes it is difficult to understand the surviving ones, because they take for granted things that we do not know.

Since this explanation may not be good enough, and to meet the doubts of skeptics, we can produce a written source of the fourth century AD, describing a 'holy event', that is to say a sacred luminous phenomenon. It is the Ecclesiastical History¹¹ (*Historia Ecclesiastica*, XI, 2.23) partly written by Rufinus of Aquileia, who lived in Alexandria (in Egypt) between 373 and 380 AD, and described the so-called "Kiss of the Sun" which occurred in the famous Temple of Serapis of that city:

"Some parts of the temple were even designed by art and deception to evoke the astonishment and admiration of visitors. A very narrow window had been laid out on the side towards the rising sun in such a way that at dawn the Sun was brought in to salute Serapis – for the moment had been rigorously calculated – a captive sun's ray lights up through this opening, as though approaching the statue, the mouth and the lips of Serapis, so that to the eyes of the crowd, Serapis appears to be saluted by a kiss from the Sun". The words of Rufinus "a very narrow window" and "oriented towards the Sun" could be used to describe the light phenomena of Roccabruna, at Villa Adriana.

Rufinus describes another 'miracle' in the same temple: "There was yet another illusion of the same kind. As is commonly known, it is the nature of a magnetic stone to have the property of attracting and repelling iron. A craftsman had fashioned a likeness of the Sun out of very pure iron for the following purpose: a stone which had, as we have already said, the property of attracting iron, was fixed above in the ceiling plaster, and when the statue was put into its place below it, the stone attracted the iron to it by a natural force. The worshipper believed that the statue had been raised up and rested suspended in the air. But after this fake had been exposed by an unexpected fall, the ministers of the lie said: "The Sun has bid farewell to Serapis and has gone up to be with him". Many other such deceptions were constructed long ago in that place, but there is no need to go on and enumerate each one".

Rufinus was describing the temple of Serapis at Alexandria, which was oriented towards the east in order to create a luminous phenomenon (*hierophany*) at dawn on a certain day of the year. He was not at all interested in the luminous or magnetic phenomena: he simply wanted to

¹¹ English Translation of the *Historia Ecclesiastica* by Rufinus of Aquileia:
<https://web.archive.org/web/20080406071455/http://www29.homepage.villanova.edu/christopher.haas/destructioni%20of%20Serapeum.html>.

unmask the pagan cults, and in fact he explicitly speaks of "illusions and deceptions". He focused on the 'fake miracles' enacted by the priests to discredit the Egyptian cult of Isis and Serapis, which was one of the most popular ones in the Roman world, in direct competition with the Christian religion.

The luminous phenomena are mainly related to Oriental, mystery and initiation cults like those of Isis, Cybele or Mitra: very little is known about them, since their well kept secrets remained secret indeed. The mechanisms and devices which created the light phenomena were secret as well: ancient texts were not supposed to reveal how a temple had to be built to achieve them. They were something sacred: the god or the goddess were manifested by the light, and with the light they were giving a 'sacred signal' to start religious rites and ceremonies.

4.2. Symbolic meaning

The Roman Emperor, as we said, was deified after his death and was identified with the sun, following a millenary tradition dating back to the Pharaohs, who proclaimed to be the sons of Ra (the Sun-god) and then identified themselves with Osiris and his cortege (Horus, Thoth, Anubis and Isis) (Passuello, Dissegna, 1976, p. 54).

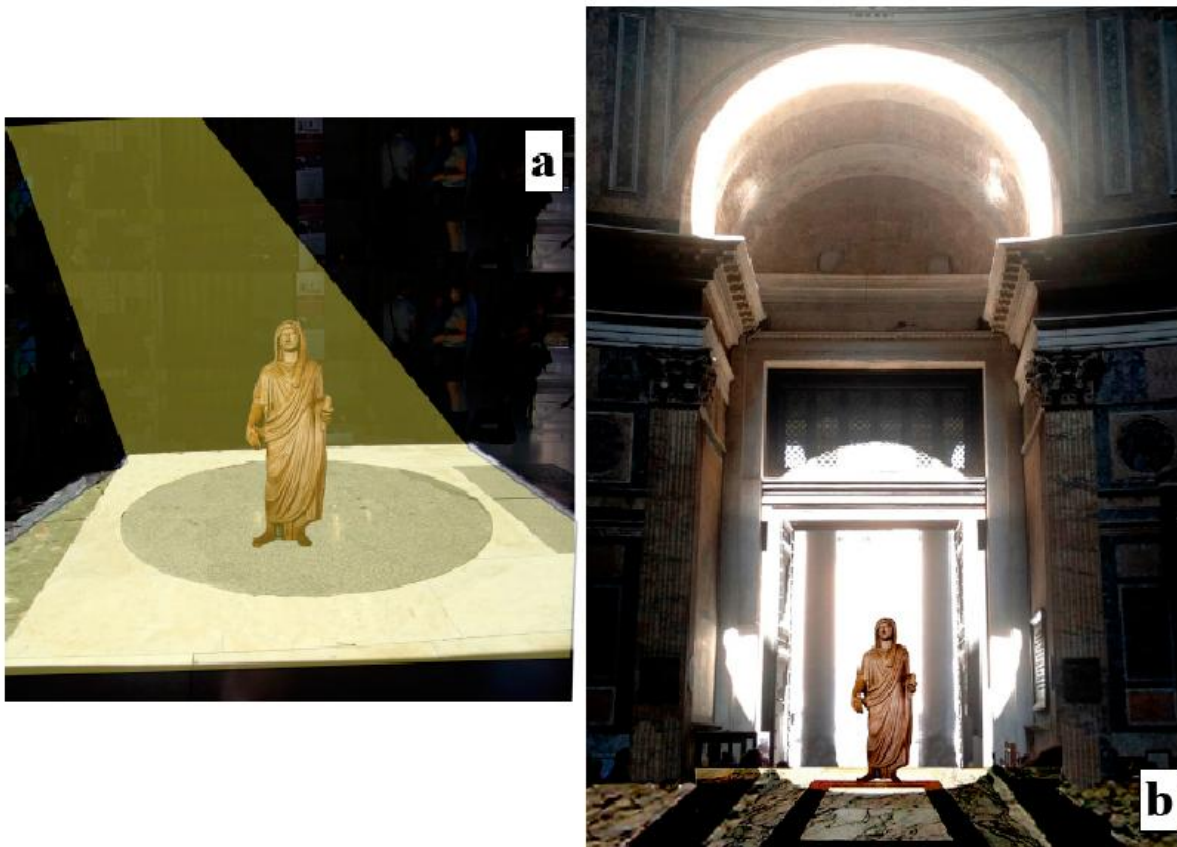


Figure 20. Emperor Hadrian *a*: Emperor Hadrian as *Pontifex Maximus* illuminated by the sun in the center of the Square of Light, symbolizing the *Templum*; *b*: Emperor Hadrian enacts a spectacular entrance in the Pantheon under the Arc of Light (photos by Marina De Franceschini).

Also the Hellenistic rulers were deified: Philip II proclaimed himself to be the thirteenth Olympic god, and set his statue together with those of the twelve Olympian gods. The oracle proclaimed that his son, Alexander the Great, was the son of a god, and this is how the ruler – or the king and therefore monarchy – became divine (Passuello, Dissegna, 1976, p. 55). During his lifetime, the Roman Emperor acted as the intermediary between God and Man; his priestly office

had a great symbolic value, because as *Pontifex Maximus* he controlled Time and therefore Power. He verified the accuracy of the Calendar thanks to the luminous phenomena (*hierophanies*) that were taking place in astronomically oriented buildings, and determined the duration of public office. Most of all, he decided the dates of religious ceremonies which must take place on the right day and at the right time, in order to be favorably accepted by the gods. The *jus divinum* carefully protected and regulated all rites: "to make a single mistake in word or act would necessitate repeating the whole rite from the very beginning" (Yerkes, 1953, p. 58).

In astronomically oriented buildings, the Emperor could boast that he was so powerful that he could command even the course of the Sun. In the Pantheon, Emperor Hadrian could enact a spectacular entrance: outside the threshold by standing at the center of the marble square which was lit by the rays of the sun as if by a powerful spotlight: the "Kiss of the Sun" (Fig. 20a). Seen from the inside, his figure would be framed by the magical and symbolic Arc of Light, another sign of divine power (Fig. 20b). According to Passuello and Dissegna, in Roman architecture structures with arches, apses and domes indicated triumph and glorification and can be hierophanic; during the Triumphal ceremony when the Emperor passed under the arch "his figure was exalted and almost deified" (Passuello, Dissegna, 1976, 59-60). In practice the same thing happened when the Emperor passed under the Arc of Light entering inside the Pantheon.

We hope that our study will be the starting point for discovering other astronomically oriented Roman buildings and their religious and symbolic meaning. Archaeoastronomy is a powerful key that opens the door to a new understanding of ancient Roman architecture.

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