Archaeoastronomy in the Villa Adriana at Tivoli
Foreword

On the occasion of the 10th S.I.A. Congress of Archaeoastronomy, held in Trinitapoli (Bari, Italy) on October 22nd-23rd, 2010, this booklet is presenting the first results of our study on Celestial Architecture in the Villa Adriana (near Tivoli, Rome, Italy), which will soon be published in a forthcoming book.

Sometimes discoveries are made because of a fortunate event, and so it happened in the Accademia, in the large circular hall of the Temple of Apollo.

During our survey I had to discard a series of pictures because the shades were creating dark spots on the walls, and it was difficult to see their texture.

On June 11th, 2006, I was preparing for another photo session, when I saw a spot of light in the last panel (Figure 1). At first I was annoyed, thinking that I would have to wait for half an hour for the Sun to move... but then I realized that the Sun was entering from a window on the upper floor, and it was perfectly illuminating the center of the panel on the ground floor, on the opposite site.

This could not be accidental: it was clear that the windows of the Temple of Apollo had been designed in order to create a sort of luminous ‘dance of the hours’.

This lucky episode marked the start of a research which ended up with the discovery of the archaeo-astronomical meaning of two buildings at Villa Adriana: Accademia and Roccabruna.

My first hypothesis, quite a simplistic one, was that the Temple of Apollo was oriented in such a way that at dawn the Sun would enter through a window in a room east of it, overlooking the town of Tivoli. I did not know anything about archaeoastronomy and astronomical orientations, therefore I was reasoning on geographical orientations, on the compass cardinal points; and east was not placed in the desired position.

The second hypothesis was that the Sun illuminated one after the other the wall panels on the lower floor, thus marking the hours of the day. If these panels had been twelve or twenty-four, things would have been much easier, because they could represent the hours of the day, or the seasons, the months or the signs of the Zodiac. But the panels are twenty, a number that does not match with any of these options.

Fortunately I asked the advice of Pietro Planezio, former director of the Astronomical Observatory of Genova (Italy). I showed him the plan of the Temple of Apollo, asking him to solve the problem and to find out which was the logic of the sun illumination on the walls.

The unusual number twenty of the panels puzzled him too; then he asked me to measure the angle between north and the window of the room where I thought that the Sun would rise at dawn. When I reported that it was 27° - a measure that had no particular meaning to me - he told me: “The Sun will never shine through that window. But 27° it is not an accidental measure! It means that the building is oriented towards the dawn of Winter Solstice and the sunset of Summer Solstice!”.

Thanks to him I met the scholar of archaeoastronomy Giuseppe Veneziano (of the Observatory of Genova, Italy); we worked together wonderfully and our cooperation led to the publication of this book. We deciphered and studied the archaeo-astronomical meaning of Accademia and Roccabruna, which are located on the highest artificial Esplanade of Villa Adriana. We discovered the light phenomena that are still occurring during the Solstices in the area that was the true Acropolis of the Villa.

At Roccabruna we saw and confirmed the discoveries of the American architects Robert Mangurian and Mary-Ann Ray, who already in 1988 saw the ‘special luminous effects’ that were occurring on Summer Solstice 1.

Villa Adriana has never been studied from an archaeo-astronomical point of view; our research is opening a new path for research in a completely unexplored field of studies.

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Villa Adriana - brief history

**Villa Adriana at Tivoli** (near Rome) is the most imposing and complex Roman villa that survived to our times; it was built by Emperor Hadrian starting from 117 A.D., in a place where tufa rock, pozzolana and water were abundant. It was a fashionable place, where the Roman aristocrats built their luxurious country estates since Republican times (figure 2).

**Larger than Pompeii** (80 to 120 hectares), the Villa consists of about thirty monumental and scenic buildings, with curvilinear architecture, surrounded by gardens and parks decorated by water basins, fountains and *nymphaeae*. It was sacked by the barbarian Totila in 544 A.D. and then fell into oblivion under the name of 'Tiboli vecchio' (old Tivoli). For centuries it became a convenient quarry of building material, where marbles were burned to make clay, while tufa and bricks were robbed and re-used in the houses of nearby Tivoli.

In 1450 the Villa was rediscovered by one of the founders of archaeology, Flavio Biondo, who showed it to the humanist Pope Pius II Piccolomini, who described it in his *Commentarii*; from then on the fame of the Villa spread all over the world. This meant the start of five centuries of ‘treasure hunting’, excavations aimed at finding statues, marbles and mosaics which still enrich the Museums and private Collections of the whole world.

Notwithstanding more than five centuries of studies, Villa Adriana - as several other famous Roman monuments - still is partly unknown in its function and meaning. Since there never were stratigraphical excavations, many information are lost forever. Only at the end of the XIX century the antiquarian and artistic approach was left aside and scholars began to study the Villa scientifically, looking at its architecture and functionality.

The Accademia Esplanade

**Villa Adriana** consists of some thirty buildings that are not located on the same level, but are scattered on a series of artificial esplanades with different heights. It is very difficult to render graphically in a plan the various levels: it is easier to look at the plastic model made by Italo Gi- smondi, which gives a clear idea of how complex was the spatial arrangement of the Villa (figure 3).

Each Esplanade or artificial Terrace was an ensemble on its own, consisting of retaining walls that surrounded it, and of the buildings that were built on top. There were few access points, which

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3 For a complete and critical bibliography of Villa Adriana see the website of the author: [www.villa-adriana.net](http://www.villa-adriana.net).
served as security checkpoints and created a system of ‘chinese boxes’: one had to follow a restrained course to go from one level to the other, and from an esplanade to another.

The lower level of the hadrianic Villa in on its north-western side, near the entrance and close to the Greek Theater, while the higher level is in the Accademia, on the opposite side of the Villa, south-west (figure 4).

Starting from the present entrance, the path climbs gradually from the Greek Theater and the Palestra to the Fede Nymphaeum and the Terrace of Tempe, and then to the Terrace of the Libraries. A modern road is now reaching the great artificial esplanade of the Pecile and the higher level of the Maritime Theater, of the Greek and Latin Libraries and of the Imperial Palace, and further on the levels of the Golden Square and of the Winter Palace. Near the Pecile was recently discovered the ancient main entrance to the complex, a paved road in the form of a ring leading to the Vestibule and then to the Large and Small Baths, which are all located on the same level, more or less the same of the Canopus.

Fig. 3 - Plastic model of Villa Adriana by Italo Gismondi, 1956, with the different levels of the esplanades (photo Marina De Franceschini)

Fig. 4 - General plan of Villa Adriana. In grey the Accademia Esplanade with the buildings of Roccabruna and Accademia (elaboration from SALZA PRINA RICOTTI 1982)
Reaching the Canopus we have in front of us a hill covered by vegetation, on top of which are the higher quarters of the Villa. Up left is the Praetorium Esplanade, overlooking the Canopus valley and the Great Baths. Above the half-dome of the Canopus is visible the small tower of a columbarium built upon the roman ruins of the Accademia. Up there is the Accademia Esplanade, the higher of the Villa, its true Acropolis, apparently inaccessible.

Even today it can be reached with a winding and hidden path, which is not easy to be found. Before the Canopus water basin, a path on the right is passing along the Museum in the Canopus Western Substructures, leading towards Roccabruna. The ramp near Roccabruna climbs up to the Accademia Esplanade and to the buildings that were located on top of it: Accademia, the so called Mimizia, and the Odeon Theater.

Fig. 5 - Plan of the Accademia with its main rooms (elaboration from WINNEFELD 1895)

Fig. 6 - Plastic model of Villa Adriana by Italo Gismondi, 1956: the Accademia with its main rooms (photo Marina De Franceschini)
The Accademia

The building of the Accademia is at the center of the Accademia Esplanade and consists of a large porch surrounding an inner garden (a ‘secret garden’) along which were arranged several other rooms. About 40% of it is still standing, the rest has collapsed; the plan of the missing parts was reconstructed by Herman Winnefeld⁴, who copied the fundamental of Giovan Battista Piranesi published in 1781⁵ (plan figure 5, plastic model figure 6, aerial view figure 7).

On the northern side of the porch is the so called Belvedere (AC1⁶), a very airy curvilinear entrance pavilion with open colonnades, decorated by fountains. Near the Belvedere, three rooms (AC9-10-11) survived almost untouched with their barrel vaults; they are presently used as hay-lofts, on top of which was built the columbarium tower visible down below from the Canopus (figure 8).

The central porch (AC7-8) (figure 9) was double on its western side (AC6), while on the oriental one are the larger and most monumental rooms of the building, aligned along a main longitudinal perspectival axis, with a series of see-through rooms oriented from north-west to south-east. Piecing together the actual remains and the information provided by the plan of Piranesi, we can reconstruct some of these rooms (see below figure 12).

Starting from north, there is a first quadrangular court (AC41) once surrounded by a porch, after

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Fig. 7 - Aerial view of the Accademia with the visible standing structures (© Microsoft Virtual Earth)

Fig. 8 - The three rooms presently used as hay-lofts (AC9-10-11), with the tower that can be seen from the Canopus (photo Marina De Franceschini)

⁴ W INNEFELD 1895, tav. X.
⁵ PIRANESI 1781, tav. III.
⁶ The numbering of the rooms is the one used in our Accademia Project, which surveyed and studied the building since 2005.
Fig. 9 - The inner porch of the Accademia (AC7-8) in its present state (photo Marina De Franceschini)

Fig. 10 - The southern door of Court AC80 towards the Temple of Apollo, flanked by two niches (photo Marina De Franceschini)

Fig. 11 - The so-called Zooteca (AC88) with the axial door towards room AC89 (photo Marina De Franceschini)
which is a **second larger court** also with a porch (AC60) whose southern door, flanked by two semicircular niches and two oblique corridors (**figure 10**), gave access to the so called Temple of Apollo, the most imposing hall of the whole building.

Only half of the **Temple of Apollo** (AC78) is still standing, and we will describe it later. On its souther side, a door opened towards a third court surrounded by a porch, the so called ‘**Zooteca**’ (AC88) whose southern side was curved (**figure 11**), and had a central door towards the last room (AC89), which terminated the axial series of see-through rooms.

East of the Temple of Apollo was room AC79, the most luxurious of the whole building, once completely covered with marble slabs reaching up to the ceiling; on the opposite side, the vestibule AC76 connected the Temple with the central porch (**see plan figure 5**).

**Astronomical orientation and light phenomena in the Accademia**

As we will see further on, some scholars already conjectured about an astronomical meaning for **Roccabruna**; nobody ever thought about an **astronomical orientation of the Accademia, which is our significant discovery**.

As we said, the Accademia had a series of see-through rooms, aligned along a main longitudinal axis, oriented from north-west to south-east (**see plan figure 12**). This axis coincides with the ideal line joining the point where the Sun is rising at dawn during the days of Winter Solstice (at south east) and the point where the Sun sets on Summer Solstice (at north-west).

The series of ‘see through’ rooms was designed so that a man standing at the center of any of its axial doors, **during the days of Winter Solstice** can still see the light entering at dawn from the window of room AC89, then passing through the doors of the Zooteca AC88, of the Temple of Apollo AC78 and of the two courts AC60 and AC41 that were preceding it on the north-west.

On the other hand, during the says of **Summer Solstice**, an observer standing in room AC89 can see the Sun set on the opposite side, with its rays passing through the series of axial doors, in reversed order.

Fulcrum of these light phenomena is the **Temple of Apollo**, the most monumental hall of the complex (**figure 13**).

Its name - **Temple of Apollo or Tempio delle Muse et di Apolline** - was created in the XVI century by **Pirro Ligorio**, the first who studied and excavated Villa Adriana on a large scale\(^8\). The name originates from the number 10 of the niches for statues on its upper floor: nine Muses plus Apollo makes ten. The name is still in use, like the imaginative ‘**Zooteca**’, which was created by Ligorio for the nearby garden with porch.

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7 This name was invented in the XVI century by Pirro Ligorio, who thought that in the Zooteca were kept the animals for the sacrifices occurring in the nearby Temple of Apollo.

8 LIGORIO 1550; see TEN 2005, Codice di Torino, fol. 41v. p. 64; fol. 42v. pp. 66-67; fol. 43 p. 67.
The Temple of Apollo is circular, with a diameter of 13.85 meters (about 46 roman feet\(^9\)). Its lower floor is subdivided in twenty panels (thirteen are still standing) which still have fragments of plaster with traces of fresco: white panels with a red frame were alternating with red panels framed by a white border. The small columns of the lower floor supported an architrave made of bricks, on top of which is a masonry ‘drum’ and the upper floor (see further on figure 15).

Also the upper floor was divided in twenty sectors: ten windows were alternating with ten niches. Seven windows and six niches are still standing, and in the niches there probably were statues; their ceilings still show fragments of black fresco with a white border.

As far as the roofing of the Temple of Apollo is concerned, antiquarian scholars always thought it was a dome. Francesco di Giorgio Martini, author of the most ancient sketch of the Villa that we have (about 1465), drew an umbrella-like dome\(^10\) (figure 14). The subsequent antiquarian scholars, Pirro Ligorio, Francesco Contini, Giovan Battista Piranesi, Agostino Penna e Luigi Canina agreed with his reconstruction, as did Heinz Kähler\(^11\) and also Italo Gismondi in his plastic model.

We drew a 3D reconstruction of the Temple of Apollo with a dome and central oculus (figure 15), whose dimensions were estimated following the same proportion that can be observed in the Pantheon of Rome between the diameter of the dome and that of the oculus.

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\(^9\) A roman foot is about 29.6 centimeters.


\(^11\) LIGORIO 1550; CONTINI 1668; PIRANESI 1781; PENNA 1836; CANINA 1856; KÄHLER 1950

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Fig. 13 - The Temple of Apollo in its present state: the lower floor with panels and columns and the upper floor with windows alternating with niches (photo Marina De Franceschini)
Winter Solstice

On December 19th, 2009 (Winter Solstice) the archaeoastronomer Giuseppe Veneziano photographed the light phenomena that occur at dawn: as expected, the Sun raises at the center of the window of room AC89 (see plan figure 13) and goes through the series of axial rooms. In the picture (figure 16) the Sun is seen from room AC88, the so-called Zooteca, and is visible from all the doors of the axial see-through rooms.

Summer Solstice

On June 20th, 2010 (Summer Solstice) the light phenomena were more complex than what we expected. On June 11th, 2006 - about ten days before Solstice - I had photographed just one light spot on one of the panels of the Temple of Apollo. But on June 20th, 2010, the light spots became two.

At the beginning of our observations, the Sun as expected entered through one of the windows of...
the upper floor (figure 17), illuminating the last preserved panel of the lower floor, exactly as had happened in 2006. But few minutes later appeared a second spot of light, slimmer than the previous one, which I had not seen in 2006 (figure 18).

This happens only during the days of Summer Solstice, when the sun is setting at the extreme north-western point of its course during the whole year. During the rest of the year, its rays do not reach that window. The two light spots started to move gradually from left to right, with an arched movement.

When the Sun sets there is just one light spot. The Sun enters through the north-western door of the Temple of Apollo (figure 19) and illuminates the door between the Zoooteca AC88 on the opposite side, and the axial room AC89, reaching its outer window. The direction of the light is reversed compared to what we saw on Winter Solstice (figure 20).

Unfortunately, just the north-eastern half of the Temple of Apollo is still standing, but it is likely that also during Winter Solstice there was a double spot of light on the panels; this could be verified with a 3D model or a computer simulation.

If we accept the hypothesis that the Temple of Apollo had a dome with a central oculus, we can try to calculate other light phenomena produced though this central opening in certain days of the year (figure 21).
Fig. 19 - Accademia, June 21st, 2010: the Sun shines in the door between the Temple of Apollo and court AC60 (photo Giuseppe Veneziano)

Fig. 20 - Accademia, June 21st, 2010, the rectangle of light is reaching the door between the Zooteca AC88 and room AC89 (photo Giuseppe Veneziano)

Fig. 21 - 3D reconstruction of the Temple of Apollo with hypothesis of a light phenomenon created by the oculus of the dome (drawing of Brigitta Casieri)
Roccabruna

It is located on the northern end of the Accademia Esplanade. Only the lower floor is still standing, a massive cube of masonry with three main façades preceded by a porch; the holes for the beams can be seen on the walls, and its foundations are visible on the ground. The fourth side on south-east is adjoining the retaining wall of the Accademia Esplanade (plan fig. 22, plastic model fig. 23, aerial picture fig. 24).

Near the building is a masonry ramp supported by a series of arches, leading up to the Accademia Esplanade.

The main entrance is located on the north-western side of the lower floor, and gives access to a large circular hall (RB6) with a diameter of 9.50 meters. It is covered by a dome of the same height, which means that the room was designed around an imaginary perfect sphere, as happened in the Pantheon of Rome.

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12 It has the same orientation of the doors of the series of see-through rooms in the Accademia: 302°.

13 As remarked by LUGLI 1940, p. 264. For the Pantheon see LANCASTER 2005 p. 44 fig. 36.
The circular hall (figure 25) has rectangular and semicircular alternating niches; in front of the entrance door is a niche with an **apse for a statue**. **In the dome**, above the rectangular niches, there are four small slots\(^\text{14}\) which are the starting inner point of **five conduits** that pass through the entire thickness of the masonry and come out on the four sides (figure 26).

**The first three conduits A-B-C** (plan figure 27) open at the center and on top of the three main façades of the building, facing north-west, north-east and south-west. **The other two conduits D-E** are on the south-eastern side, and open at the two sides of the staircase that once led to the temple.

From one of the rectangular niches of hall RB6 (see plan fig. 22) a corridor (RB7) led to a **circular latrine** (RB8); another symmetrical latrine is on the opposite side of the building (RB8bis), where the Jesuits built - without knowing it - a small chapel. Corridor RB9 gives access to **substructive rooms**

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\(^\text{14}\) Two of these slots, (towards north-east and south-western façades) have been closed, probably during the restorations of the Jubilee 2000; the other two are still visible. At the times of Lugli all four of them were visible and are shown in an old engraving by Penna: see PENNA 1836, tome II, tav. 106.
RB10-11, which are supporting the staircase of the upper floor once leading to the temple on top. The upper floor has been completely destroyed and presently is a wonderful panoramic terrace. Originally there was a circular temple, which was reconstructed by Lugli and Bonelli, studying the marble architectural fragments that are still visible scattered on the grass around the building (figure 28 and plan figure 33).

Fifteen out of sixteen travertine blocks which supported the bases of the columns are still in place; the 16 columns of doric order were made of white marble and had a diameter of 0.70-0.80 meters; their estimated height was about 6.5 meters (22 roman feet). The inner cell of the temple was octagonal: in its four larger sides opened the main door and three windows; the shorter sides had rectangular inner

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15 Luigi 1940, pp. 265-266.
niches (see below plan figure 33).

**Astronomical orientation ad light phenomena in Roccabruna**

During the first International Meeting “Rileggere l’Antico”, held in Rome in December 2004, Roccabruna was considered an astronomical Observatory and there was a presentation about a supposed armilla hanging inside its inner dome16.

After observing the light phenomena in the Temple of Apollo in the Accademia, I noticed that the Accademia Esplanade and Roccabruna had exactly the same orientation (see plan figure 4), therefore I started thinking about a possible orientation of Roccabruna.

The starting point was an article by professor Vittorio Castellani, who rejected the hypothesis that the building had been oriented towards the sunset of August 11th, which was the day when Hadrian became emperor, the Dies Imperii. He wrote17:

“The direction towards which Roccabruna is oriented finds no explanation in the topography of the site, and maybe supports the hypothesis of an orientation toward the sunset on Summer solstice”. Finally he decided that this last is “perhaps the only acceptable hypothesis”18, without further developing the idea.

During the 8th Conference on Archaeoastronomy Mensura Caeli, held in Ferrara (Italy) in 2008, Giuseppina Cinque ed Elisabetta Lazzeri proposed that the conduits passing through the dome of Roccabruna were housing large beams, which supported a gigantic armilla suspended under the ceiling. There also was a very unlikely reconstruction of the center of the pavement, with an image of an armilla copied from a mosaic at Solunto (figure 29). They wrote19:

“The analysis based on such data made us rule out all hypothesis according to which the conduits were made to obtain particular and evocative illuminations inside the central hall. This idea is absolutely impossible, since the position of the two conduits on the south-eastern side forbids any kind of illumination by the Sun. ... The only possible solution is to consider the conduits as housing for beams which were sustaining some heavy ornamental object which was suspended under the center of the dome.”

**The armilla theory cannot be accepted for a series of reasons:**
- The slots inside the dome are too small to house large beams which supported an heavy object.
- The armilla was a scientific instrument, used to measure the position of planets and stars. It would be nonsense to put it inside a blind dome, which - as Castellani remarked - was the “less suitable place for astronomical observations”.
- The walls of Roccabruna are so thick that there is no need to build such complicated passing-through conduits just for supporting beams.
- Two of these conduits are opening at the two sides of the stair, this proves that the connection between the outer part of the building and the inner dome was created on purpose.

**Which was the function of these conduits, then?** For one of them, the solution was given to me by the american architects Robert Mangurian and Mary-Ann Ray, who between 1985 an 1994 surveyed the whole Villa Adriana with their Atelier Italia project. After working at the project of the Clos Pegas Winery in Napa Valley, (California, USA), which had an equinoctial alignment, they

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16 There is just an abstract of this presentation, the Proceedings have never been published.
17 CASTELLANI 2006, p. 18.
18 CASTELLANI 2006, pp. 11-13, with astronomical calculations based on an old measurement given by Maiuri in the 1930’s.
19 CINQUE-LAZZERI 2010, p. 119.
asked themselves if the radial orientation of the buildings of Villa Adriana could be due to astronomical orientations.

On June 21st, 1988, the day of Summer solstice, they went to Roccabruna at sunset, and discovered the extraordinary light phenomena which occur there\(^{20}\).

At sunset, in fact, the Sun enters through the main door illuminating the niche on the opposite side, something that happens during most of the summer days. But only in the days of the Summer Solstice the Sun penetrates also into the conduit located above that door: its rays come out from the slot inside the dome projecting a rectangular light blade on the opposite side. This blade slowly moves with an arched course, until when the Sun sets and ‘switches off’.

On June 13th, 2009, a week before the Solstice, I verified that the Sun shines through the main door, illuminating the niche on the opposite side, but there was no light blade.

On June 19th, 2009, instead, I observed the phenomenon described by Robert and Mary-Ann: the Sun penetrated in the conduit, and the light came out from the inner slot, projecting a light blade on the opposite side of the dome (figures 30 and 31). The light blade slowly moved from left to right with an arched course, on top of which it coincided with the slot where conduits D-E open inside the dome (figure 32).

The same light phenomena happened also in the temple that once existed on the upper floor of Roccabruna, which was oriented along the same axis connecting the dawn of Winter Solstice to the sunset of Summer Solstice (figure 33).

During Winter Solstice, the Sun was rising at the center of the main door of the temple, while during Summer Solstice it was setting through the window on the opposite side.

\(^{20}\) This discovery was briefly described in MANGURIAN-RAY 2008.
We also plan to study other light phenomena which were created by the central oculus of the dome that covered the temple.

Conclusions

From these discoveries and our study, it is clear that Accademia and Roccabruna have been planned with an astronomical orientation exactly as the Horologium Augusti, the Domus Aurea and the Pantheon in Rome.

During the Solstices there were light phenomena signaling a particular moment during the year. Winter Solstice, in fact, meant the apparent death of Nature, while Summer Solstice coincided with the ripest period of harvest and flowering.

Since the times of Augustus, buildings planned as ‘solar machines’ were part of the iconography of the imperial power, since the emperor - as Pontifex Maximus - superintended to the Calendar and therefore to the rites and ceremonies linked to the cycle of the Time and the Seasons.

As we said, this booklet is anticipating the first results of our surveys and studies at Villa Adriana.
which will be explained and fully discussed - also in their symbolic meaning - in a forthcoming book.

**Astronomic Orientation at Villa Adriana**

by Giuseppe Veneziano

After the first pictures shot by Marina De Franceschini in June 2006 in the Accademia, in the so-called Temple of Apollo, where a wall panel in the lower floor was illuminated by the light of the Sun shining through a window of the upper floor, we started our studies from the orientation given by Vittorio **Vittorio Castellani**. Thanks also to the discoveries of the American architects **Robert Mangurian and Mary-Ann Ray**, who first saw the light phenomena occurring in Roccabruna during the Summer Solstice, we understood that the Accademia Esplanade and its buildings all had an astronomical orientation.

Therefore we organized several surveys and inspections on the spot, which confirmed that during the Solstices there were very significant light phenomena.

Our coordinated surveys focused on two main buildings: **Roccabruna** (in the state property) which is at the northern end of the Accademia Esplanade, and the **Accademia** with the Temple of Apollo (in the Bulgarini private estate).

The two buildings are located ad about 350 m. one from the other, and their geographical coordinates are the following (source: Google Earth):

<table>
<thead>
<tr>
<th>Roccabruna:</th>
<th>North latitude</th>
<th>East longitude</th>
<th>Height above sea level of lower floor</th>
<th>Height above sea level of upper floor</th>
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<td>41° 56' 16,63&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>12° 46' 23,13&quot;</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>100 m circa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>110 m circa</td>
<td></td>
<td></td>
<td></td>
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<table>
<thead>
<tr>
<th>Temple of Apollo:</th>
<th>North latitude</th>
<th>Est longitude</th>
<th>Height above sea level</th>
</tr>
</thead>
<tbody>
<tr>
<td>41° 56' 12,32&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12° 46' 39,56&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>114 m circa</td>
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</tbody>
</table>

Then we estimated the ‘real’ *rising and setting points of the Sun*, as they are visible in these two buildings, during the most significant astronomical events of the year, the two Solstices.

We also estimated the present azimuth of the point where the Sun is rising and setting today, considering the latitude of the two buildings, and we obtained the following results.

During Winter Solstice, the upper part of the Sun is rising at an azimuth of 122° and is setting at an azimuth of 237°; during Summer Solstice, the Sun is rising at an azimuth of 58° and is setting at an azimuth of 302°.

According to the program **Planetario 2.0** by Piero Massimino, of the Observatory of Catania (Italy), in year 125 A.D. - the average year of the construction of Villa Adriana - the astronomical Spring Equinox was on March 22nd, Fall Equinox was on September 24th, Summer Solstice on June 23rd and Winter Solstice on December 22nd.

The true inclination of the terrestrial axis on the ecliptic, as we saw before, is not consistent: within a period of about 41,000 years it spans from 22,1° to 24,5°, and this variation is causing a different Sun declination in the sky. Using the Laskar formula, we estimated which was the Sun declination at that time, and the result is 23° 40,5'.

21 Castellani 2006.
Considering these new parameters we re-estimated the azimuths of the Sun; the out-coming values that we obtained are shown in the following scheme:

<table>
<thead>
<tr>
<th>Sun event</th>
<th>Azimut in 2010</th>
<th>Azimut in 125 A.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dawn on Winter Solstice</td>
<td>122° 19’ 28</td>
<td>122° 40’36</td>
</tr>
<tr>
<td>Sunset on Winter Solstice</td>
<td>237° 40,5’</td>
<td>237° 19,24’</td>
</tr>
<tr>
<td>Dawn on Summer Solstice</td>
<td>57° 40’ 31</td>
<td>58° 10’</td>
</tr>
<tr>
<td>Sunset on Summer Solstice</td>
<td>302° 19’ 28</td>
<td>301° 50’</td>
</tr>
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These values have been superimposed on an accurate plan of the Temple of Apollo (AC78) which was measured and astronomically oriented by professor Friedrich Rakob with the german architects Edmund Faller, Dirk Helfgen ed Axel Krück during their surveys between 1991 and 1993.

The azimuths of some structures of this building showed a surprising coincidence with the azimuths of the Sun. And - most of all - we noticed that during dawn of Winter Solstice the rays of the Sun are penetrating through a series of rooms aligned along a longitudinal main axis, which is passing through the geometric center of the temple of Apollo; then the light beam goes further on, passing through the north-western door of the Temple and the other rooms aligned on that side. The same phenomenon occurred during Summer Solstice, but the rays of the Sun followed a reversed opposite course, from north-west to south-east.

These two peculiar phenomena were followed (during Winter Solstice) or preceded (during Summer Solstice) by other striking ‘special light effects’, when the Sun, shining through the windows of the upper floor of the temple of Apollo illuminates the panels and the doors of the lower floor, generating a ‘magic’ that has a deep symbolic meaning. Seen from the geometric center of the Temple of Apollo, these wall panels (which were framed by small columns) have a width of about 18°: if we consider that they were reveted by a thick layer of plaster (which is still visible in situ in the lower panels) their angular width could be 15°, which corresponds to the angular distance covered by the Sun within an hour; therefor the rays of the Sun could move from one panel to the other on every hour.

Similar light phenomena were visible during the two Solstices in the building of Roccabruna. The lower floor was oriented towards the sunset of Summer Solstice and the upper floor - where just the level of the pavement is preserved - was oriented towards the dawn of Winter Solstice.

It is obvious that the present study in not final, since there is so much more to study and to understand. For example, using 3D models it will be possible to understand the light phenomena occurring the Temple of Apollo during Winter Solstice, since the part of the building which has collapsed is the one that was illuminated by the Sun in that period.

As far as Roccabruna is concerned, the present study pointed out that its lower floor is oriented towards the sunset of Summer Solstice. We have to study more thoroughly the orientation of the Temple that once was on the upper floor, oriented towards the dawn of Winter Solstice; there also were other light phenomena created by the central oculus of its dome.

This is just the beginning, because other buildings of Villa Adriana could have been astronomically oriented; to understand if this idea is true, is will be necessary a long research work, that could last for years - if not decades. This is why we decided to publish the results of this preliminary study - focused on these two buildings; we are certain that this will open a new path towards new discoveries with other studies, also for other scholars.
Bibliography

Updated and critical Bibliography on Villa Adriana can be found on the website of Marina De Franceschini: **www.villa-adriana.net**

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Title and Details</th>
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<tr>
<td>CONTINI F.</td>
<td>1668</td>
<td>Hadriani Caesaris immanem in agro Tiburtino villam, Roma 1668.</td>
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<tr>
<td>LIGORIO P.</td>
<td>1550</td>
<td>Libro o vero trattato delle Antichità XXII di Phyrro Ligorio Patrizio Napoletano et Cittadino Romano nel quale si dichiarano alcune famose Ville et particolarmente della Antica Città di Tibure et di alcuni monumenti. Archivio di Stato di Torino, a II 7 J20, foll. 30r-55.</td>
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<td>LUGLI G.</td>
<td>1940</td>
<td>&quot;La Roccabruna della Villa Adriana&quot; in Palladio 1940, pp. 257-274.</td>
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<tr>
<td>PIRANESI G.B.</td>
<td>1781</td>
<td>Pianta delle fabbriche esistenti nella Villa Adriana, Roma 1781 (pubblicata postuma dal figlio Francesco).</td>
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