Archaeoastronomical Experiments Supported by Virtual Simulation Environments:
Celestial Alignments in the Antinoeion at Hadrian's Villa (Tivoli, Italy)

Bernard Frischer¹
Georg Zotti²
Zaccaria Mari³
Giuseppina Capriotti Vittozzi⁴

¹Department of Informatics, Indiana University (USA). bernard.d.frischer@gmail.com

²Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology, Vienna.

Georg.Zotti@archpro.lbg.ac.at

³Archaeology Superintendency, Lazio and Etruria meridionale. zaccaria.mari@beniculturali.it

⁴National Research Council of Italy, Institute for Ancient Mediterranean Studies. giuseppina.capriotti@cnr.it

Abstract

The archaeological site at Hadrian's Villa (Tivoli, Italy) conventionally called the Antinoeion was used as a test-bed for studying the utility of simulation environments for archaeoastronomical research. The site consists of a sanctuary with three temples facing an open plaza which may, or may not, have had an obelisk in the center. Two reconstruction models were made of the site using AutoCAD and 3D Studio Max. In one version, the obelisk was present; in the other, there was no obelisk. The models were imported into two simulation environments: Unity and Stellarium. They were then used to support observations of the sun in relationship to the built features in the sanctuary throughout the year. Several solar alignments were detected, and the dates and times in the two simulation environments coincided, thereby allowing us to replicate our own results. The most important result is the orientation of the site's main axis toward sunrise on the summer solstice. Stellarium also supported simulation of the nighttime sky. An interesting alignment was observed between the asterism Antinous and one of the temples; a second temple appears to be associated closely with Sirius. The results of the study suggest that simulation environments can facilitate archaeoastronomical research. They also suggest that the excavator was correct in identifying the site at Hadrian's Villa as an Antinoeion.

Key Words

Antinoeion, archaeoastronomy, virtual simulation environments, Hadrian's Villa, Stellarium, Unity

1. Introduction

Bernard Frischer, Indiana University

For some time it has been recognized that interactive simulation environments can be used to support heuristic and empirical searches for alignments between celestial bodies and natural or built features of the historic landscape. Earlier work in this field¹ has relied on tailoring standard game engines to the needs of archaeoastronomical research by the addition of dedicated plug-ins linked to databases populated with altazimuth data for a limited period of time and georeferenced for a specific point on earth. Recently, thanks to “3D Sceneries,” a plug-in released by G. Zotti, it has been possible to use Stellarium, Open Source planetarium software, in place of a game engine, thereby making it in principle possible to engage quickly and at low cost in virtual archaeoastronomical observations from any terrestrial position and at any moment in time.²

The present paper reports on a project in which the same terrestrial model was imported into both Unity, enhanced with a bespoke celestial plug-in, and Stellarium. The purposes of the project were, first of all, to advance understanding of the archaeological site that served as the test-bed, the so-called “Antinoeion”³ at Hadrian’s Villa, a site where previous research has suggested that astronomical alignments might well be present;⁴ second, to test whether “3D Sceneries” plug-in renders accurate results, based on the assumption that the Unity bespoke plug-in can be used as ground truth; and, finally, to weigh the relative advantages and disadvantages of Unity enhanced with a bespoke plug-in and Stellarium with its built-in “3D Sceneries” plug-in. This paper thus operates at the intersection of informatics and archaeology.

1.1. The Archaeological Data and Their Interpretation

The Antinoeion is located in the archaeological park of Hadrian’s Villa, a World Heritage Site in Tivoli, Italy.⁵ Discovered in 1998 during work on the double road leading to the Grand Vestibule,⁶ the main entrance of the villa (figure 1, n. 4), the site was excavated from 2002 to 2004 under the direction of Z. Mari, a co-author of this paper and an archaeologist employed by the Soprintendenza Archeologia del Lazio e dell’Etruria Meridionale, the department of the Italian Ministry of Culture responsible at that time for managing the archaeological park.⁷ The area uncovered was adjacent to the double road (figure 1, n. 9) and had overall dimensions of ca. 63 x 50 m (figure 1, n. 1; figure 2). The perimeter was surrounded by a wall, within which were discovered two identical temples 15 x 9 m in size: one to the northwest, the other to the southeast. They faced each other across a plaza into which were cut water channels and planters. Springing off the west side of the plaza is a large colonnaded exedra, in the middle of which was another temple. For the sake of convenience (and cognizant of the fact that the sanctuary is not oriented to the cardinal points), we refer throughout to the three shrines as Temples A, B, and C (see figure 2). For a detailed account of the site and how its architecture might be reconstructed, see section 2 below by Mari. In this section we will concentrate on the issues that were most important for the 3D reconstruction created for our project, including the

¹ Johanson and Frischer 2008; Frischer and Fillwalk 2014; Zotti 2014.

² Zotti and Neubauer 2012, Zotti 2015.

³ Hereafter written without quotation marks (i.e., Antinoeion, not “Antinoeion”). The reader should be aware that the identification of the sanctuary is disputed. Contributing to a resolution of the dispute is, indeed, a major goal of this paper.

⁴ Lanciano 2003; Castellani 2006; De Franceschini and Veneziano 2011; Frischer and Fillwalk 2012. We should also take note of the following recent study of astronomical alignments in the Hadrianic Pantheon (Rome): Hannah and Magli 2011.

⁵ <http://whc.unesco.org/en/list/907> (seen December 1, 2015).

⁶ Mari 2002-2003:145.

⁷ For reports about the excavations, see Mari 2002-2003; Mari 2003-2004. For a synthesis in English, see Mari and Sgalambro 2007.

function of the site and the question of whether or not there was an obelisk situated at the intersection of the major and minor axes.

Archaeological investigation of the site was motivated from the first to prove the theory that somewhere at Hadrian's Villa there was a sanctuary dedicated to Antinous, the emperor's lover, who died by drowning in the Nile in October, 130 AD and who was deified shortly thereafter and given cult honors in many places around the empire. The theory posited that the sanctuary at the villa might also include the new divinity's tomb or cenotaph. The first to propose the theory was Kähler, who argued that the likely spot was the Canopus (figure 1, number 2).⁸ Kähler inspired fieldwork by Hannestad, who, however, failed to find evidence supporting Kähler's theory.⁹

Grenier—like Hannestad,¹⁰ explicitly crediting Kähler's work¹¹—took the theory as his point of departure for a study proposing a hypothetical restoration of the sculptural program of the Serapeum (figure 1, number 3), into whose niches he placed 22 Egyptianizing statues found in the seventeenth and eighteenth centuries in several areas of the villa. In support of his hypothesis, Grenier relied on the report that six of the statues,¹² now in the Vatican's Gregorian Egyptian Museum, were found in 1736 by the Jesuits in excavations on land they owned which included the Canopus-Serapeum.¹³ To this core group of statues, which Grenier thought could be securely assigned to the Serapeum, he added sixteen more, some of whose find spots were not as well known, such as the two Osirantinous telamones (the so-called "Cioci") in the Vatican's Pio-Clementine Museum (figure 3).¹⁴ For two of the statues, Grenier reported the find spot as "near the Pecile" (figure 1, number 6). These are the colossal Harpocrates, now in the Capitoline Museums (figure 4),¹⁵ and the over life-size Antinous-Osiris in the Gregorian Egyptian Museum (figure 5).¹⁶

Central to Kähler's case was the Pincian Obelisk (figure 6), which at line 54 of side D¹⁷ states that it was erected near Antinous' tomb in a place whose identification depends on a disputed interpretation of the Egyptian text. To identify the place, Kähler relied on a corrected translation of Erman's edition. The latter's German version was: "Antinoos (?), welcher dort ist und welcher ruht in dieser Stätte, die im Grenzfelde der Herrin des Genusses (?)...Rom ist."¹⁸ Kähler used new photographs of the obelisk taken in 1971 to correct the text such that it could be translated: "...an der Stätte, welche liegt in der Domäne des Herrn des Glückes von Rom."¹⁹ This modification meant that the place where Antinous was buried was not necessarily in Rome (implied by Erman's "Herrin") but on a property owned by Hadrian ("Herr"). Given the fact that Hadrian's Mausoleum was not yet finished when Antinous died, Kähler thought that the likeliest such property would have been Hadrian's Tiburtine villa.²⁰ Of course, this interpretation also implied, as Kähler was well aware, that the Pincian Obelisk must have originally been erected at Hadrian's Villa, so that its modern find spot in the Circus of Valerian near the Via Labicana in Rome resulted from a secondary use probably ordered by Elagabalus.²¹ Kähler reasoned that to situate the burial at the villa, one needed to find a structure whose construction dated after Hadrian's return to central Italy following Antinous' death. When he was writing in 1975, the strongest

⁸Kähler 1975:42.

⁹Hannestad 1982.

¹⁰Hannestad 1982:45.

¹¹Grenier 1989:927.

¹²Gregorian Egyptian Museum, inventory nos. 22801, 22802, 22807, 22815, 22816, and 22817.

¹³Grenier 1989:936.

¹⁴Inventory nos. 196 and 197.

¹⁵Inventory MC 646.

¹⁶Inventory 22795.

¹⁷Ciampini 2004:185.

¹⁸Erman 1896, cited at Kähler 1975:40.

¹⁹Kähler 1975:41.

²⁰Kähler 1975:42.

²¹Kähler 1975:42.

candidate was the Canopus, where Bloch found brick stamps dating from 123 to 127 AD.²² Kähler followed Bloch in dating it to the period ca. 130-134 AD.²³

A key element of Grenier's hypothesis was the reported discovery of the statues in what we have called the "core group" on Jesuit land that included the area of the Canopus-Serapeum as well as the imprecision of his report of the find spot of the statues of Harpocrates and Antinous-Osiris. Subsequent topographical research by Salza Prina Riccotti and Mari²⁴ was able to show that the six statues were not found around the Serapeum but, according to Piranesi's 1781 plan of the villa, on the terraces of the valley through which the Canopus-Serapeum was built (figure 1, numbers 10, 11).²⁵ Salza Prina Riccotti considered the statues to have been located on these terraces, where they would have served to decorate the garden. The statues of Harpocrates and Antinous-Osiris came from the property of Liborio Michilli, which did not extend to the top of the Pecile esplanade (figure 1, number 6), as Grenier's words might be taken to imply, but only to the Cento Camerelle substructure of the Pecile, i.e., across the double road from the Antinoeion (figure 1, number 8; figure 9, area in green).²⁶

Mari's excavations of the Antinoeion turned up dating material placing it securely in the period after 134²⁷ as well as many more fragments of white and black marble Egyptianizing statues in the same marbles used for those assigned by Grenier to the Serapeum. Also found were fragments of two reliefs that must have decorated two of the three temple cellas: a scene showing Antinous approaching a seated divinity²⁸ (figure 7) and a fragment of a scene with a Hathoric capital (figure 8).²⁹ Mari was also able to reconstruct the seventeenth-eighteenth century property lines at the villa (figure 9), from which it became clear that the Jesuit land (area in yellow on figure 9) included not only the Canopus-Serapeum but also the site of the Antinoeion. He also noted that the valley continued north from the Canopus-Serapeum area toward the Antinoeion, which led him to speculate that Piranesi's report about the discovery made 45 years earlier was inaccurate and that the find spots should be moved to the north end of the valley around the Antinoeion.³⁰ His research of the sources turned up a precise indication of the find spot of ten Egyptianizing statues discovered in the mid-seventeenth century (and now lost) "in front of the Cento Camerelle," i.e., in or near the Antinoeion.³¹ The statues of Harpocrates and Antinous-Osiris were also found on Michilli land adjacent to the Antinoeion and thus, according to Mari, must have originally been erected there,³² as was the Pincian Obelisk.³³ Because of the presence of the latter and its focal position at the intersection of the major and minor axes of the sanctuary, as Mari and Sgalambro reconstructed it,³⁴ Mari insisted that the Antinoeion must have been the actual tomb (not simply the cenotaph or commemorative sanctuary) of Antinous.³⁵

Mari's work in bringing to light the Antinoeion appeared to have brought the search for Antinous' monument at the villa, initiated in 1975 by Kähler, to a successful conclusion. But in the ten year period after Mari concluded his fieldwork, skepticism about some of his conclusions was expressed, notably by Grenier. The latter's earlier work on the sculptural program of the Serapeum did not lead him to conclude that the structure was in any sense a shrine dedicated to Antinous; instead, for Grenier the structure was part of a larger

²² Bloch 1938: vol.2, p. 169; Salza Prina Riccotti 2000:263.

²³ Kähler 1975:42.

²⁴ Salza Prina Riccotti 2002-2003 and Mari 2002-2003.

²⁵ Salza Prina Riccotti 2002-2003:129 with figure 13 on p. 130.

²⁶ Raeder 1983:62-63 (Harpocrates); 114-115 (Antinous-Osiris). See Mari's plan of the properties at Mari 2002-2003:173, figure 42, and our figure 2.

²⁷ The date is clear from a brick stamp of that date reported by Salza Prina Riccotti 2002-2003:140.

²⁸ Mari 2003-2004:308 with p. 307, fig. 50; Mari and Sgalambro 2007:92 with p. 97, fig. 21.

²⁹ Mari 2003-2004:158, fig. 21.

³⁰ Mari 2003-2004:286.

³¹ Mari 2003-2004: 281; on the discovery and subsequent history of the statues see Mari 2002-2003:174.

³² Mari 2003-2004:301.

³³ Mari 2003-2004:303-305.

³⁴ Mari and Sgalambro 2007:86.

³⁵ Mari 2003-2004:308.

symbolic program in which the Canopus represented the Mediterranean and the Serapeum Egypt.³⁶ Hence he did not at first revise his earlier theory, developed with Coarelli, that the tomb of Antinous—and the Pincian Obelisk—were located on the Palatine in the Vigna Barberini.³⁷ In 2008, Grenier published a monograph on the obelisk in the course of which he responded to Mari's various reports about the Antinoeion with their thoroughgoing critique of Grenier's own publications on the Pincian Obelisk and the Egyptianizing sculpture from the villa. Grenier, who did not comment on Mari's reassignment of the statues he placed in the Serapeum to the Antinoeion, was not persuaded that the site excavated by Mari really was dedicated to Antinous, basing his doubts both on the lack of positive evidence in favor of that identification among the finds published by Mari (in particular, there is no architectural feature of the complex clinching its identification as a tomb) and also on his meticulous philological analysis of the text of the obelisk.³⁸ The key topographical passage in the latter Grenier translated as follows: "Le Bienheureux qui est dans l'Au-delà et qui repose en ce lieu consacré qui se trouve à l'intérieur des Jardins du domaine du Prince dans Rome."³⁹ He interpreted "jardins" to mean *horti*, in the Latin sense of a pleasure retreat within a city (as opposed to a *villa*, which is located outside the city), and he took "domaine du Prince dans Rome" to mean that the gardens had to be imperial *horti* at Rome. Specifically, Grenier now proposed that Antinous was buried, not on the Palatine, but in the *horti Domitiae* on a property where Hadrian was having his mausoleum constructed in the same period.⁴⁰ There is a lacuna in the inscription where the word "at" (Egyptian *m*) appears, and *m* is Grenier's conjectural supplement. Some earlier scholars had filled the lacuna with the word "of" (*n*), and Grenier reported other interpretations running counter to his, which he did not refute in detail.⁴¹

A second critique was published by Romeo.⁴² He questioned the standard reading of the word on the obelisk, which Grenier translated as "garden" (*sḥty*, standardly *sḥt*; under the received interpretation, the final *y* is evidently intended to represent the phonetic deletion of the feminine *-t* ending and its replacement by a vowel; compare Coptic *sōshe*). Because the writing lacks the ground line usually indicated in writings of *sḥt* , Romeo concluded that these three reed-leaves must be a writing of *īw*, a variant spelling of the particle *īw*. The *t* and *y* of what had been taken as part of *sḥt*, so Romeo thought, must actually go with an *n* written before the three reed-leaves to compose the relative adjective *nty* ("which"). The following writing , most often read as *dš*, "boundary" (for *t3š* with *d* archaistically substituted for *t* through false archaism; final *t* is a redundant sign) Romeo preferred to read as *dšrt*, "desert," specifically the desert on the edge of which Antinoopolis was founded. Romeo's total interpretation of the writing at this point is therefore *nty īw dšrt*, "which the desert (is...)." Because of the mention of a "desert," Romeo believed the obelisk inscription proved that Antinous was buried in Egypt, not at Rome, as Grenier had claimed, or at Hadrian's Villa, as Salza Prina Ricotti and Mari supposed. He furthermore noted that a fragmentary obelisk in the Capitoline Museums preserves the same word *Wsir* [*ntyntw*]⁴³ as we find on the Pincian Obelisk, and its find spot in Rome was nearby. This led Romeo to speculate that in the imperial period, near the Porta Maggiore, there was a religious area dedicated to oriental cults where, in the Egyptian style, a pair of obelisks was erected.

Against Romeo's theory two objections can be raised. The first is philological. Egyptologist Stephen Vinson writes⁴⁴ about Romeo's interpretation of the text that:

Problems abound with Romeo's reading of the inscription. First, while the *Wörterbuch der Ägyptischen Sprache* does record a spelling of the particle *īw* with three reed-leaf signs, this is designated as 'alt,' which means it is a spelling attested primarily, if not exclusively, in the

³⁶ Grenier 1986:975.

³⁷ Grenier and Coarelli 1986.

³⁸ Grenier 2008:40-42.

³⁹ Grenier 2008:37.

⁴⁰ Grenier 2008:44.

⁴¹ For details, see Grenier 2008:37-38.

⁴² Romeo 2007.

⁴³ That is, Osiris-Antinous.

⁴⁴ Personal communication to Bernard Frischer, December 5, 2015.

Old Kingdom. While it is always possible that the scribes of the obelisk might have stumbled upon and revived a very archaic spelling, this writing does not appear to be otherwise attested in Ptolemaic hieroglyphic inscriptions (understanding the term ‘Ptolemaic’ in this case to refer to all hieroglyphic inscriptions of the Graeco-Roman period). Typical Ptolemaic spellings are given in Dieter Kurth’s *Einführung ins Ptolemäische* II, p. 742.

Moreover, Romeo’s reading *nty* (relative adjective) prior to his claimed *lw* depends on a rather egregious garbling (or perhaps, to put it more charitably, an ingenious re-arrangement) of the hieroglyphic signs. The three reed-leaf signs that Romeo reads as *lw* occur in the middle of his *nty*—after the *n*, but before the *t* and *y*, i.e., consonants that had been read as part of *sh*. Moreover, there is also a “tongue of land” determinative included in the writing , unaccounted for by Romeo, which is also appropriate for *sh*. The hieroglyphic text printed in Romeo’s article suggests that his reading *dšrt* is based on the misreading of the final *t* of the writing as , which he evidently takes to represent *r*; but even if the sign itself had been correctly identified, is customarily read *spty* ‘two lips;’ it is not the standard writing of *r* .

The second objection is archaeological. It has been noted that the obelisk fragment in the Capitoline Museum may come, not from a second twin obelisk, but from the Pincian Obelisk itself, which has several lacunae that could be filled by the fragment.⁴⁵

Romeo did not address the issue of why the inscriptions would place the burial of Antinous in Egypt whereas the obelisks were actually erected in Rome. One possible solution to this problem was provided by Ensoli Vittozzi, who, writing some years before Romeo and in a different context, suggested that the Pincian Obelisk was a *copy* of the obelisk originally erected at Antinous’ tomb in Antinoopolis.⁴⁶ Of course, if one reckons with the possibility of a replicated obelisk preserving its original inscription even when the inscription’s topographical reference to the place of erection is no longer relevant, then the question of whether we can use topographical references on an inscribed obelisk to recover its original context in central Italy becomes moot. Concerning the possibility that there was an obelisk in the Antinoeion, we are left with the fact that the excavations brought to light a base placed at the crossing of the major and minor axes (see figure 21). So there was certainly some prominent monument displayed here. More than that cannot be asserted with any certainty.

To summarize, there is a consensus that the site excavated by Mari was religious in nature and had a strong Egyptian connection: on these two key points even his critics agree with Mari. There is no consensus about how to identify the sanctuary nor about whether there was an obelisk at the crossing of its two axes. Apart from the latter issue, the architectural reconstruction (figure 10) proposed by Mari and Sgalambro 2007 has not been critiqued in any detail and can therefore be held to be provisionally valid, at least in its broad strokes. As for the decoration of the sanctuary, there was clearly a large number of Egyptian or Egyptianizing works of art in the sanctuary, but it is not clear if the six statues now in the Gregorian Egyptian Museum came from here or, as Piranesi indicated, from the terraces of the nearby Canopus. Nor is it clear if the two Osirantinous telamones in the Pio-Clementine Museum (figure 3) stood here or elsewhere at the villa.⁴⁷ At any rate, there is no cogent reason to assign them or the six core statues to the Serapeum, as proposed by Grenier, and there is no reason to think that the Serapeum had anything to do with Antinous-Osiris or with Egypt generally. On the other hand, it is likely that Mari is right to read the documentary evidence as supporting the presence in the Antinoeion of the ten Egyptianizing statues found in the mid seventeenth century (now lost); and he is

⁴⁵ Bassignani 2011:51.

⁴⁶ Ensoli Vittozzi 1990:49.

⁴⁷ Mari 2002-2003:180 and Mari 2003-2004:301 placed them in the sanctuary’s propylon off the double road; then in Mari and Sgalambro 2007:98 they are placed into the pronaos of the west temple.

probably also correct in assigning to the site the colossal Capitoline Harpocrates and the Antinous-Osiris in the Gregorian Egyptian Museum found near the site on the Michilli property.

There is no evidence that Antinous was buried here. If there, indeed, was an obelisk on the platform at the crossing of the major and minor axes, we cannot say which of the preserved obelisks (or obelisk fragments) it was, nor even whether the hypothetical obelisk is still preserved in whole or in part.

On the basis of the archaeological evidence alone, then, one cannot be certain that the site was a cult sanctuary specifically dedicated to Antinous, although the likely presence of the colossal Antinous-Osiris statue tends in that direction. Capriotti (see below, section 3) thinks that the two reliefs from temple cellas (figures 7, 8) are consistent with identifying two of the temples with Isis and Harpocrates, and she adds in support of the latter the colossal statue of Harpocrates⁴⁸ that was found nearby. It might well have served as the cult statue in the cella decorated with the Hathoric capital relief. Furthermore, she sees in the facial features of the statue a resemblance to Antinous, in which case we should more properly speak of the statue as Antinous-Harpocrates, and this, too, weighs in favor of Mari's interpretation of the sanctuary as an Antinoeion. In this connection, we should note that the relief fragments discovered by Mari showing Antinous presented to an enthroned god (figure 7) is also consistent with an interpretation of the site as dedicated to the worship of him as a new god. A glance at the figure will show, however, just how speculative is Mari's restoration of the fragments

As noted above, a major goal of our project was to see if an interactive 3D model of the site which also included a dynamic, historically correct model of the daytime and nighttime sky, could help in any way with the identification of the sanctuary as well as of its three temples. One hypothesis was that if the sanctuary was dedicated to Egyptian gods, we might be able to discover astronomical alignments, which, as we will see, are not uncommon in Egypt. The specific alignments might constitute new evidence, independent of the archaeological controversies just recounted, that can help us assign one or more of the temples to an appropriate deity.

1.2. The 3D reconstruction model.

To pursue this goal, the first step was creation of a 3D reconstruction model of the site. To do this, we used AutoCAD and 3D Studio Max, following the indications of Mari and Sgalambro for the architecture and survey data (see figure 10). Their plan of the Antinoeion was added to the general villa map developed by architect Michael Ytterberg for his study of the villa and kindly made available for our use in The Digital Hadrian's Villa Project.⁴⁹ This map, in turn, relies on the accurate survey map by the School of Engineers, Rome published in Lanciani 1906, and by new survey data collected by Mangurian and Ray from 1985 to 1993.⁵⁰

To avoid uncertainties about the proper determination of Geographic North in the various maps consulted,⁵¹ we consulted Valerio Baiocchi, an expert on the cartography of central Italy, who confirmed the accuracy of our map; and we also determined the main axis of Temple C using the aerial photo background map service for ESRI ArcGIS 10.1, and in addition from a panorama photo created using Google Earth. Both sources agree on the following: the main axes of the three buildings were found to intersect in symmetry at the platform where Mari proposed to place the obelisk. They were found to point into azimuths of ca. 334° (Temple A), ca. 154° (Temple B) and ca. 244° (Temple C), calculated from north towards east.

⁴⁸ Capitoline Museums inv. MC646.

⁴⁹ See Ytterberg 2005 and for the map, <http://vwahl.soic.indiana.edu/villa/index.php> (seen December 23, 2015).

⁵⁰ On the accuracy of the map, see Sgalambro 2010b:172. On the later survey see Mangurian and Ray 1993.

⁵¹ The previously mentioned map of Ytterberg of Hadrian's Villa was compared against *Pianta della Villa Adriana*, Facoltà di Ingegneria, Università di Roma Tor Vergata 2006 (on which see Ianni 2006); no discrepancies were noted. Mangurian and Ray 1993:20 describe how they carefully determined geographic north by following the procedures recommended in the 1992 edition of the *Sokkia Celestial Observation Handbook and Ephemeris*. For the surrounding landscape to a distance of 5 km, we used the US Army Map Service map, Tivoli Sheet 150-I (scale 1:50,000) based on the Istituto Geografico Militare map for Tivoli (revision 1940) at a scale of 1:25,000 (available online at http://www.lib.utexas.edu/maps/ams/italy_50k/txu-pclmaps-oclc-6540719-tivoli-150-1.jpg)

Mari reviewed, critiqued, and ultimately approved the final version of our model. Since we were less certain than are Mari and Sgalambro of the presence of an obelisk in the sanctuary, we followed standard Virtual Heritage practice for handling uncertainty by creating two alternative versions—one with, the other without an obelisk.⁵² For the version with the obelisk, we used the Pincian Obelisk, but we did so *faute de mieux* and with the understanding that the dimensions of the specific obelisk that might have stood here had little, if any, impact on our study identifying possible alignments between celestial and built features. Atop the obelisk we placed a finial that resembles the scarab-like finial seen on a crater with Egyptianizing scenes said to be from the Canopus at Hadrian's Villa (figures 11, 12).⁵³ In doing so we followed Ensoli Vittozzi's suggestion that the obelisk on the crater may have illustrated the Pincian Obelisk or a similar obelisk from the Hadrianic period.⁵⁴ For the purposes of our study, the finial played no role: it was a purely decorative element of our model. We followed Mari and Sgalambro in putting the Pio-Clementine telamones in the pronaos of Temple C (figure 15), but, again, these purely decorative elements had no impact on our investigation.

1.3. Simulation environments.

We imported the 3D reconstruction model into the game engine Unity and also into the planetarium software Stellarium. The Unity application was enhanced with a plug-in created to our specifications by our partner, the IDIA Lab at Ball State University. The plug-in used NASA's Horizons System to create minute-by-minute real-time lighting solutions for the position of the sun in the sky for the year 131 AD. Stellarium was recently equipped with a plugin to load 3D models particularly for studies in archaeoastronomy⁵⁵ and was found not only to provide equivalent solar lighting solutions but also to replicate the nighttime sky. In researching this paper, Stellarium versions 0.13.3 and 0.14.0 were used.

We used two simulation environments for several reasons. First of all, the Unity and Stellarium simulations provided independent confirmation of each other's solar alignments because each uses a different method in calculating an ephemeris. Stellarium uses planetary positions from the widely used analytic VSOP87 model;⁵⁶ our Unity plug-in uses positions based on the JPL Development Ephemeris (JPL DE431).⁵⁷ Thus, in using the same archaeological data to find solar alignments calculated in two different ways, we were able to replicate our results before accepting them as valid and reporting them here.

Secondly, Stellarium simulates the sky in a more realistic way than does our Unity plug-in, since it takes into account atmospheric refraction, scattering and reddening (cf., e.g., figure 14). Finally, Stellarium, as mentioned, was able to simulate the nighttime sky making it possible to look for alignments between built features and the planets, stars, and constellations. This is potentially possible for Unity, but our bespoke plug-in would need to be augmented to include these data from NASA, something we did not think a worthwhile investment of resources once we determined that the solar data for our Unity plug-in and Stellarium closely agree.

Finally, a secondary goal of this project was to make a comparison of the relative strengths and weaknesses of the two simulation environments for archaeoastronomical applications. We will present our findings about this matter in the Conclusion.

⁵² On the need to create "alternative virtual interpretations" "since archaeology is complex and not an exact and irrefutable science," see Lopez-Menchero and Grande, "The Principles of the Seville Charter," at para. 4.4.1; Frischer, et al. 2002.

⁵³ Capitoline Museums inventory 29; see Ensoli Vittozzi 1990:47-50. On the scarab-like finial, see Capriotti's discussion below in section 3.

⁵⁴ Ensoli Vittozzi 1990:49. The crater is discussed below by Capriotti in section 3.

⁵⁵ Zotti and Neubauer 2012

⁵⁶ See <http://www.stellarium.org/wiki/index.php/Research> (seen December 1, 2015).

⁵⁷ https://en.wikipedia.org/wiki/Jet_Propulsion_Laboratory_Development_Ephemeris (seen December 1, 2015).

1.4. Methodology for Reaching the Project's Archaeological Goal

However we settle the question of the identification of the sanctuary, for the three temples in the complex previous research suggested three likely identifications: Isis, Antinous-Harpocrates, and Antinous-Osiris. The method by which we hoped to identify the sanctuary and its three temples was based on taking into account celestial data provided by our simulation environments. We took as our point of departure the fact that the sanctuary was clearly Egyptian in inspiration, décor, and cult. We therefore used as our working assumption the conclusions about astronomical orientation of Egyptian temples reached by Magli 2013 and by the Egyptian-Spanish Mission on Egyptian Archaeoastronomy (ESMEA).⁵⁸ Magli showed the importance of the concept of the “sacred landscape” in the layout and design of Egyptian monuments such as pyramids and temples. ESMEA investigated whether Egyptian temples tended to be oriented to the Nile or to relevant astronomical phenomena. That the latter might be important is suggested by the “stretching of the cord” ceremony associated with Egyptian temple foundations as early as the last king of the 2nd Dynasty (ca. 2750 BC). The earliest text discussing the rite dates to 237 BC and records “the King was looking at Meskhet(yu), the Bull’s Thigh or Foreleg, the asterism of the Plough,” when the foundations of Horus’ temple at Edfu were laid out.⁵⁹

ESMEA surveyed a remarkable 98% of existing shrines and temples in Egypt from all periods found at ca. 400 sites around the country. The research issue motivating the study was to test the validity of the commonplace idea that the orientations of most Egyptian temples were determined by the Nile. The alternative hypothesis ESMEA offered was that the orientations could be astronomically determined. The mission found that temples near the Nile were oriented to it but in such a way that astronomical orientations were also common. Both determinants of temple orientation could operate in tandem because it was possible to choose a site near the Nile that would yield the correct orientation toward the sky. Moreover, the study of temples in the desert oases showed similar patterns of orientation, leading to the conclusion that “Nile orientations were actually part of a wider general plan where both local topography and sky-watching played a significant role, simultaneously.”⁶⁰ The astronomical targets were three: the meridian (i.e., N-S) orientation; the sun on important dates of the annual cycle and/or the civil calendar; and the two brightest stars, Sirius and Canopus. Solar cults were, not surprisingly, oriented toward the sun, giving rise to phenomena such as the sunrise hierophany on the winter solstice at the temple of Sobek-Re in Qsar Qarun in El-Fayum Oasis;⁶¹ cults dedicated to goddesses such as Isis and to the brightest stars, notably to Sirius.⁶² Temples of Isis, for example, tended to be oriented toward the heliacal rising of Sirius.⁶³

ESMEA found some regional differences in temple orientation. In Upper Egypt and Lower Nubia, it found trends of orientation to sunrise on the winter solstice and to the first-magnitude stars Sirius, Canopus, and Vega.⁶⁴ The pattern was similar in Lower Egypt and Siwa Oasis.⁶⁵ In the oases of the western desert orientations to sunrise on the winter solstice were again encountered, but also important was sunrise at *Wpt Rnpt*, the first day of the first month of the flooding season.⁶⁶ One quarter of the temples had meridian orientations, which the mission interpreted as targeted at stars in the constellation *Meskhetyu* (the Plough, or

⁵⁸ See Shaltout and Belmonte 2005, Belmonte, Shaltout 2006; Shaltout, Belmonte, and Fekri 2007; Belmonte, Shaltout, and Fekri 2008.

⁵⁹ Shaltout and Belmonte 2005:273; Shaltout, Belmonte and Fekri 2007:150; and, especially, Belmonte, Molinero Polo, and Miranda 2009.

⁶⁰ Belmonte and Shaltout 2006:189.

⁶¹ Belmonte, Shaltout and Fekri 2008:188 with p. 189, fig. 7.

⁶² Information in this paragraph summarizes Belmonte, Shaltout, and Fekri 2008:206.

⁶³ Belmonte, Shaltout, and Fekri 2008:188.

⁶⁴ Shaltout and Belmonte 2005:281-283.

⁶⁵ Shaltout and Belmonte 2007:143-150 (the similarity of Upper and Lower Egypt is noted at p. 150).

⁶⁶ Belmonte and Shaltout 2006:182, table 2. *Wpt rnpt* and *pṛt spdt* (the heliacal rising of Sirius) coincided on the Egyptian calendar only once every 1460 years (the so-called “Sothic cycle”). A new cycle began in AD 139, just after Hadrian’s reign, so in the 130s AD, *wpt rnpt* and *pṛt spdt* almost coincided. On the terms “(heliacal) rising and setting” of a star, see the admirably clear exposition in Robinson 2009, especially table I (p. 357).

Big Dipper).⁶⁷ These results suggest that, although ancient Egypt reflects a widespread interest in sunrise on the solstices and the heliacal rising of Sirius, regional traditions also played a role in Egyptian temple orientations.

For Egypt as a whole, ESMEA found seven groups, or “families,” of temple orientations: (1) the equinoctial (or “eastern”) family; (2) the solstitial family (mainly oriented to the winter solstice); (3) the seasonal sun family; (4) the *Sopdet* (i.e., Sirius) family; (5); the Canopus family; (6) the meridian (or northern) family; and (7) the quarter cardinal directions family.⁶⁸

Applying these findings to the Antinoeion, in terms of function we might equate the double road (figure 1, number 9), off of which the sanctuary is located, to the Nile. It was an obvious determinant of the orientation of the complex, though one might point out that nothing required siting the sanctuary here—there was ample available land elsewhere at Hadrian’s Villa—and within the perimeter walls, the built features of the sanctuary could be positioned and oriented with some flexibility. So it makes sense to consider whether we find the same complementary terrestrial and astronomical factors dictating the orientation of the Antinoeion as ESMEA discovered in its study of Egyptian temples. Moreover, we should also take into account the fact that there are three temples within the complex, each with its own orientation. The possible astronomical orientation of each of these needs to be considered separately. The overall orientation of the sanctuary, from the point of view of the ancient visitor entering from the access road, corresponds to the minor axis running from the East Portal to Temple C. To avoid possible misinterpretation of the purely technical term “minor axis,” we will henceforth refer to this as the “axis of entry.” It was clearly the more important axis for the ancient visitor to the site.

1.5. Observations

Bernard Frischer, Indiana University, and Georg Zotti, Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology

Besides its quantitative approach, ESMEA also engaged in close readings of several sites in each region surveyed by offering case studies. These studies took into account architectural elevations, phasing of the monuments, and the effect of the natural topography on sightlines. Our approach resembled ESMEA’s case studies except that for our case study we could rely on the survey work done by the excavator, Z. Mari, and his team, and we could also take advantage of their hypothetical architectural reconstruction of the sanctuary. To do this we collaborated with Mari to produce a 3D digital reconstruction model imported into two interactive simulation environments. Thus, like ESMEA in its various case studies, we were able to take the built and natural environments into account in our analyses.

Both simulation environments supported instantaneous changes to the position of the sun in the sky based on accurate historical celestial position data that could be changed on a minute-by-minute basis. Stellarium also supported the same flexibility in viewing the night sky, and here, again, this gave us the opportunity to view the stars and constellations at various positions and times. Stellarium does not yet include specific information about heliacal risings and settings. We therefore developed a program following Schaefer’s model to estimate heliacal dates.⁶⁹ We judge the resulting margin of error to be ± 2 days.⁷⁰

ESMEA’s results gave us specific ideas about what to investigate as we considered how a drive toward creating celestial alignments at an Egyptianizing sanctuary in central Italy dedicated to a new god (albeit one clearly assimilated to Osiris and perhaps also to Harpocrates) might have influenced important elements of the

⁶⁷ Belmonte and Shaltout 2006:186.

⁶⁸ Shaltout, Belmonte, and Fikri 2007:153-156.

⁶⁹ Schaefer 1985. Depending on the magnitude (brightness) of the star, the *heliacal rising* will occur when the star is first seen rising in the east in the twilight before sunrise; the *heliacal setting* will occur when the star is last seen setting in the west shortly after sunset. Cf. Hannah 2009:15. The exact date depends on several factors, mostly on atmospheric clarity and the brightness (magnitude) of the star.

⁷⁰ See, in general, Schaefer 1985, Schaefer 1986, Schaefer 1993; Robinson 2009.

architectural and decorative design. The seven “families” of temple orientations offered an obvious point of departure. Several could immediately be eliminated as clearly not operative: (5) the Canopus family, since Canopus is not visible as far north as central Italy; and (7) the quarter cardinal directions family, since the Antinoeion is not rotated 45° with respect to the cardinal points. On the other hand, ESMEA’s case studies suggested that we also look for site-specific determinants. For example, the importance of Antinous’ Osirian aspect in the Antinoeion, as clearly revealed by the sculptural remains, might mean that, just as the Ptolemaic temple of Osiris at Taposiris Magna was oriented toward *Sah*, the stellar hypostasis of Osiris,⁷¹ so, too, the temple of Osiris-Antinous might be oriented toward his celestial hypostasis, the asterism Antinous, which Hadrian had carved out of the lower part of the constellation Aquila.⁷²

Our working hypothesis was that the discovery of such orientations would suggest identifications of the three temples in the sanctuary. However, while we made observations on the winter solstice, the date of the heliacal rising of Sirius, and the rising and setting of the constellation Antinous, we also examined the day and night sky on other days of possible significance such as the birthdays of Hadrian and Antinous, the death day of Antinous, etc. Finally, we also made empirical studies with no predetermined date and time, looking, for example, for the date at which the sun rose and set on axis with the temples.

1.5.1. Calendrical and Environmental Considerations

In reporting observations, we need to take into account the calendar. For dates that are purely Roman, such as the birthdays of Antinous and Hadrian, we can rely on the Julian calendar. In establishing when events occurred low in the sky, such as sunrise or sunset, it is necessary to take into account the natural and built environment. For example, if a building blocks a view of the natural sunrise, we call the first appearance of the sun over the blocking building “positional” sunrise with reference to the position from which the observation is made. The Antinoeion is sited lower than the building immediately to its east, the Building with Three Exedras (figure 1, number 5; figures 14, 15), and it is also several meters lower than the land that slopes westward immediately behind it (figure 1, number 7). This means that positional sunrise in the Antinoeion always occurs several minutes after the natural sunrise, and positional sunset happens several minutes before the natural sunset. Equally important is a feature in the surrounding landscape: the Colle Ripoli (peak: 522 m), located ca. 2.8 km to the east and at a quota level as much as 425 m higher than the Antinoeion. This feature turned out to affect the visibility of the sun at sunrise in the Antinoeion in June and July. Hence it was important to include it in our digital model to ensure the accuracy of our observations in those months.

1.5.2. The Sanctuary

For the ancient visitor, the orientation of the sanctuary corresponds to the axis of entry running from the East Portal (figure 2, number 7) off the access road through the center of the plaza (where Mari places an obelisk) to Temple C. From the vantage point of someone standing on the axis of entry, the sun rises (positionally) on this axis in the period on the summer solstice (June 24 in AD 134) on the Julian calendar (figure 13).⁷³ On the summer solstice and for several days before and after the sun will first be seen rising more or less on axis between the jambs of the portal. There is a major Roman holiday on the summer solstice, the festival of Fors Fortuna,⁷⁴ a goddess who was, interestingly, assimilated to Isis.⁷⁵ The summer solstice is also important in Egypt. As Magli notes,

⁷¹ See Shaltout, Belmonte, and Fekri 2007:159n30.

⁷² Dio 69.11.4 reports Hadrian’s naming of a new star after Antinous; Ptolemy, *Almagest* VII.5. Constellation XVI: Aquila (Toomer 1998:357) lists the asterism Antinous along with the stars of Aquila.

⁷³ The sunrise alignment can be seen anywhere along the axis of entry, and so if there was an obelisk erected at the mid-point of the axis, the alignment would still have been visible from the East Portal to the base of the obelisk and somewhat farther to the west from the obelisk platform. An observer standing at the entrance to the sanctuary would see the sun rising over the Building of the Three Exedras.

⁷⁴ Degraasi 1963:472-473. On the cult, see Champeaux 1982:199-247; on topographical issues, see Coarelli 2004.

⁷⁵ Cf. the altar decorated with Fors Fortuna found in 1875 in the Temple of Isis at Aquileia; Champeaux 1982:210 with n57.

“rebirth...was associated by several cultures with the winter solstice....This is not, however, the case with Early Dynastic Egypt, when the Egyptian calendar was formulated....Indeed, in the arid climate of Egypt, the natural phenomenon that allowed the ‘rebirth’ of the crops was the inundation of the Nile. This is a gradual phenomeon but usually begins at the end of June. Therefore, it is rather the summer solstice which was identified as the harbinger of the renewal....”⁷⁶ The positional setting of the sun at the opposite end of the axis will be discussed in the next section on Temple C.

1.5.3. Temple C

As noted, Temple C forms part of the axis of entry to the sanctuary; hence the solar alignments just mentioned pertain to Temple C as well. In particular, we observed that at positional sunrise in the days around the summer solstice, if there was an obelisk, its shadow fell onto the central axis of Temple C. If the doors of the temple were open, the shadow would cover the upper part of the cult statue (figure 15). If there was no obelisk, then the sunlight would have entered the cella of Temple C and illuminated the cult statue, assuming the doors were open and that either the cult statue was moved forward in the cella toward the doorway or else that the architrave was arched (figure 16) permitting the entrance of more light into the cella such as we find exemplified in the north end of the Canopus colonnade.⁷⁷

We also observed that Temple C is oriented toward the place where the newly-formed asterism of Antinous would have been visible low in the sky each day of the year. Ptolemy's *Almagest* (written after AD 132) describes Antinous as consisting of the “unformed stars near Aquila” now known as η , θ , δ , ι , κ , and λ Aquilae, an arch that spans a full 15 degrees, or one hour, in Right Ascension. This means that the setting of Antinous also takes an hour, and the series of heliacal settings of its stars spans about two weeks. The stars are of varying, and not very high, magnitudes. At such magnitudes, the algorithms are sensitive to atmospheric conditions. Since antiquity, the brightness of stars is described in a system of “magnitudes” where brighter stars bear smaller numbers (stars of first magnitude appear first, magnitude 6 are usually the dimmest naked-eye stars, visible only high in the sky). Atmospheric extinction is given based on magnitude loss k per air mass, where “air mass=1” means the light must have passed through the atmosphere in a direction perpendicular to the ground, i.e. from the zenith. Close to the horizon, this number rises quickly to about 40 so that extinction is much higher in lower altitudes. The dates for some varying atmospheric conditions are listed in table 1, and it can be estimated that the heliacal setting of Antinous’ stars occurred during the two to three week period beginning after his birthday (November 27). This means that in the days around his birthday the asterism was visible low over Temple C at nightfall (figure 17).

Finally, Sirius (Egyptian *Sopdet*) sets behind Temple C every day of the year, although a few degrees north of the axis, which makes an intended orientation towards Sirius very unlikely. The heliacal setting appears to have been in the first days of May, dates that do not appear to be culturally significant.

			$l=5.0, k=0.3$			$l=5.5, k=0.25$			$l=6.0, k=0.20$			$l=6.5, k=0.25$			$l=6.5, k=0.20$			$l=6.5, k=0.15$		
Star	mag	Hel.	Date	alt _{sun}	alt _{star}	Date	alt _{sun}	alt _{star}	Date	alt _{sun}	alt _{star}	Date	alt _{sun}	alt _{star}	Date	alt _{sun}	alt _{star}	Date	alt _{sun}	alt _{star}
Sirius	-1,46	Rise	Aug 02	-6,0	5,2	Aug 01	-5,7	4,5	July 30	-5,0	3,6	July 31	-5,7	4,5	July 30	-5,0	3,6	July 29	-4,8	3,0
Sirius	-1,46	Set	Apr 29	-6,1	5,2	May 1	-5,3	4,3	May 2	-4,9	3,8	May 1	-5,3	4,3	May 2	-4,9	3,8	May 4	-4,1	2,9
λ Aql	3,44	Set	Nov 23	-15,0	11,0	Nov 30	-14,4	7,0	Dec 4	-14,4	4,3	Dec 3	-14,4	5,0	Dec 5	-14,3	3,6	Dec 6	-14,3	2,9
δ Aql	3,36	Set	Dec 9	-14,4	9,6	Dec.13	-14,4	6,5	Dec 16	-14,5	4,0	Dec 15	-14,4	4,9	Dec 16	-14,5	4,1	Dec 18	-14,2	2,8
η Aql	3,9	Set	Dec 5	-15,6	14,1	Dec 12	-15,2	9,4	Dec 18	-14,5	5,5	Dec 18	-14,5	5,5	Dec 19	-14,4	4,8	Dec 21	-14,4	3,1
θ Aql	3,23	Set	Dec 15	-14,3	9,0	Dec 18	-14,3	6,7	Dec 21	-14,4	4,2	Dec 21	-14,4	4,2	Dec 22	-14,3	3,5	Dec 23	-14,2	2,8

⁷⁶ Magli 2013:22.

⁷⁷ Mari’s excavations found no evidence about the superstructure of any of the temples. In our model, we used the arch solution for Temple C and moved the cult statue forward toward the entrance into the cella for Temple A. Here we note that in the illustrations of this paper that derive from the Stellarium model (figures 15, 16, 17), the window behind the cult statue was cut for the convenience of the investigation in order to facilitate study of astronomical alignments on the horizon behind the temple. We do not therefore intend to imply that the cella of Temple C actually had such a window. It probably did not.

Table 1: Heliacal rising of Sirius and setting of Sirius and the stars of Antinous in Hadrian's Villa, AD 132. The exact dates (given in the Julian calendar), especially for the dim stars of the Antinous asterism, depend greatly on visible zenithal magnitude l and atmospheric extinction coefficient k . The table lists dates for several conditions from average visibility ($l=5.0$, $k=0.3$) to an excellent night ($l=6.5$, $k=0.15$). For each date, stellar and solar altitudes are also shown. Especially for dim stars ($\text{mag}>3.5$) the exact date varies significantly with atmospheric conditions.

1.5.4. Temple B

Sirius was hidden by the left half of Temple B shortly after its rise but would reappear directly over the pediment of Temple B from the point of view of someone standing at some indeterminate point along the axis between temples A and B. The exact point where one would have had to stand is dependent on the height of the pediment, something not clear from the archaeological remains; but it is, at any rate, clear that such a good observation point existed, even if we cannot specify exactly where it fell on the axial line. If we follow the lead of the Mari-Sgalambro hypothetical reconstruction, then the point will have been on the platform where an obelisk or some other object stood (figure 18). The period of visibility of Sirius from this position is approximately September 3 (morning) to February 17 (evening). Two possible objections to our interpretation should be noted here. First, such alignments generally involve the actual or positional horizon, whereas in the case of Temple B, which is not aligned to Sirius in terms of its rising on the horizon, the alignment would have to involve the peak of the pediment. Only its azimuth can be given with confidence, though. The sightline over the top of the building in our reconstruction, when seen from the central platform which may have contained the obelisk, happens to match the altitude of Sirius in that direction. Second, the view axis is not independent from the sunrise axis of Temple C on the summer solstice, so this may just be coincidental. Of course, nothing forced the architect of the Antinoeion to arrange the three temples as he did: for example, they might have been set in a line next to each other or in various other configurations. So the second reason for caution is not dispositive. As for the first reason, we should note that the Isaeum Campense had pedimental sculpture showing Isis riding a dog—a clear reference to Sirius and its constellation, Canis Major.⁷⁸ By aligning Temple B so that Sirius actually appears at the very top of the pediment, Hadrian's architect is literalizing this iconographic motif, since the Egyptians associated Sirius with Isis.⁷⁹

If, then, we accept the alignment of the pediment with Sirius as an important, intended orientation, it is interesting to investigate the calendar date when Sirius is visible here at midnight. Time in Stellarium (or most other such simulators) usually is Zone Time, which is of course not directly applicable to historical questions. The site longitude ($12^{\circ}46'$) requires delaying "midnight" by about 9 minutes compared to Central European Time (CET), so that this date would be November 20. If we account for True Solar Time (shown by sundials) instead of Mean Solar Time, we must add a correction known as the Equation of Time. This amounts to about 10 minutes for those days, which practically cancels out the longitude correction, and would have put Sirius atop the pediment at midnight of November 22 (Fig. 19). This is not Antinous' birthday (November 27), but nearly so. The deviation from true midnight on that birthday amounts to about 20 minutes and might not have been relevant. Of course, it is always possible that the alignment—which demonstrably existed—was significant even if there was an obelisk or some other obstructing object: it is safe to say that it was likely known to the designer of the sanctuary; and even if not visible directly over the pediment, Sirius would still have been visible several minutes later as it continued its daily path to the observer's right (figure 23). Thus, while we see the axial layout of the whole sanctuary governed by the solstitial alignment of the main axis, we consider it worthwhile to point out the alignment of Temple B with Sirius with a nearly perfect midnight spectacle in the days around Antinous' birthday as a possible additional intended effect.

⁷⁸ Dressel 1909:642; Coarelli 1996:109. The pediment is illustrated on a coin of Vespasian (see Dressel, table IV); it also seems to be referred to by Dio Cassius (80.10.1). The motif of Isis riding a dog is also attested in the pediment of a monument (possibly a tomb) from Cerveteri; see Lafaye 1881.

⁷⁹ On the association of Sirius with Isis see, e.g., Morentz 1973:270; Wells 1985:259, 290, 293n13; Magli 2013:47. On the alignment of temples of Isis in Egypt to Sirius see Wells 1985:290. For Isis=Sirius in works of art, see Merkelbach 1963:27.

1.5.5 Temple A

If an obelisk was present at the crossing of the axes, we observed that its shadow was projected onto the center of the temple's façade each morning from November 17 to January 25.⁸⁰ This period includes the following days with potential significance: Antinous' birthday (November 27; figure 19), the winter solstice, and Hadrian's birthday (January 24). If there was no obelisk, and if the temple's doors were opened, then on any of these days the sunlight would have entered the cella and illuminated the cult statue, at least assuming that it was positioned (whether permanently or only on a festival day) in the front part of the cella.⁸¹ As if drawing attention to this dramatic effect, the shadow of the roof of Temple B would have pointed toward the axis of symmetry of Temple A (figure 20). The association of Temple A with the birthdays of Antinous and Hadrian as well as the winter solstice could be taken to mean that the cult of Harpocrates was housed here, in which case the statue in the Capitoline Museums (figure 4) may have stood in the cella.

1.6 Summary

The main astronomical alignments occur along the axis of entry from the East Portal to Temple C. The strongest indication is a solar alignment on sunrise on the summer solstice (June 24 in the mid-130s AD), as seen at positional sunrise through the East Portal. Temple C is also aligned to the placement of the asterism Antinous low over the horizon and, for someone standing on the axis of entry, over Temple C. Moreover, the nightfall visibility (early-evening setting) of the asterism occurs around Antinous' birthday. There may also be morning solar alignments associated with Temple A on any or all of the following days: Antinous' birthday (November 27), the winter solstice, and Hadrian's birthday (January 24). Finally, Sirius is strongly associated with Temple B since it was visible each day in the period September 3 to February 17 centered over the top of the pediment as seen by someone standing on the axial line between temples A and B. Moreover, the alignment occurred around midnight on Antinous' birthday.

Thus, the Antinoeion strongly exemplifies ESMEA's astronomical ("family") alignment type 3 (solar). Also important is the site-specific alignment of Temple B to Sirius and of Temple C to the asterism Antinous, which recall the Ptolemaic temple of Osiris at Taposiris Magna, which, as noted above (section 1.5), ESMEA discovered was oriented toward *Sah*, the stellar hypostasis of Osiris.

These results may have relevance to the major controversies surrounding the Antinoeion. The key alignments were those found on the axis of entry from the East Portal to Temple C. The alignment at sunrise on the summer solstice reinforces the Egyptian association⁸² already clear from the find of many Egyptian or Egyptianizing sculptural fragments. In this connection, we may recall Champeaux's observation that despite the fact that the Roman holiday of Fors Fortuna fell on the summer solstice, it did not have solar but aquatic associations.⁸³ Here we should also recall that previous research has established that there is another important alignment at the villa on the summer solstice: at sunset on that day, the sun set on axis with the lower sanctuary of the nearby tower of Roccabruna.⁸⁴ The alignment of Temple C with the asterism of Antinous and the nightfall visibility of the asterism around the time of Antinous' birthday (November 27) also suggest that this particular shrine was dedicated to the new god. Mari may well be right to hypothesize (see below) that one of the several Antinous-Osiris statues (cf. figure 5) found in the general area prior to his excavation was erected here; and, apart from the cult statue, he also restored the two Vatican Osirintinous

⁸⁰ The times vary from 10:30 am to 11:00 am.

⁸¹ Alternatively, the light would have illuminated the cult statue if it had been erected against the back wall of the cella and over the main doorway was an arch in the manner of the Temple of Hadrian at Ephesus. Such an opening would have permitted the sunlight to penetrate to the back part of the cella. As Mari's report in section 2 makes clear, we have no evidence at all about the superstructure of the North Temple.

⁸² On the solar alignments involving Egyptian monuments on the summer solstice, see Belmonte and Shaltout 2006:182; Shaltout, Belmonte and Fekri 2007:154; Belmonte, Shaltout, and Fekri 2008:191 (figure 9), 199 (figure 14); Belmonte et al. 2009:245; Magli and Belmonte 2009:318; Magli 2013:70, 97, 188.

⁸³ Champeaux 1982:222-223.

⁸⁴ See Frischer and Fillwalk 2012, confirming the earlier work of De Franceschini and Veneziano 2011:133-146 and Mangurian and Ray 2008.

telamones in the porch of this temple. The alignment of Temple B to Sirius recalls the Egyptian association of that star with Isis and is in keeping with cases known elsewhere of alignments of Isis temples to Sirius.

2. Reconstruction of the Antinoeion at Hadrian's Villa

Zaccaria Mari, Archaeology Superintendency of Lazio and Etruria meridionale

Excavations undertaken between 2002 and 2005 brought to light at Hadrian's Villa, in front of the Cento Camerelle, along the basalt-paved road leading to the Great Vestibule, a monumental complex called the Antinoeion (figure 1) that can be interpreted as the temple-tomb of Antinous, the handsome young Bithynian boy beloved of the emperor Hadrian. He died by drowning in the Nile in 130 AD and was divinized as Osiris-Antinous. The excavations were published quickly in a series of reports⁸⁵ and numerous other synthetic accounts have followed, especially in exhibition catalogues.⁸⁶

The excavations brought to light structural elements in *opus caementicium* as well as trenches cut into the tuff rock on which the sanctuary stood, as well as numerous fragmentary finds in marble belonging to the architectural decoration⁸⁷ and to Egyptianizing sculpture. Unfortunately, the walls of the sanctuary are poorly preserved owing to repeated spoliations in the seventeenth and eighteenth centuries and to the damage inflicted by agricultural cultivation.

The axonometric hypothesis of restoration published in 2007 (figure 10) and later reproduced by other writers is a philological work that relied directly on the excavation data and also exploited precious information inferred from the discoveries of previous centuries. In this contribution we will limit ourselves to the material evidence that led us to propose this reconstruction.

The remains permit us to restore a complex comprising an open-air, rectangular area (63 x 23 m), paved with a mosaic consisting of large marble tesserae (a broad swath is preserved near the south corner), enclosed by a wall and including a wide semi-circular exedra with a colonnade (27.3 m in diameter), which opens on the side opposite the road. The thinness of the wall (90 cm) and the presence, at least on the side toward the street, of rectangular niches, which weakened its resistance, allow us to think of an enclosure about 2-3 m in height. Because of its complete destruction down to the foundations, it is not possible to have an idea of the design of the entrance off the street. In the reconstruction, it was designed in a conventional manner with a small staircase, which in any case was needed to manage the change in level from the street to the sanctuary's open area. The height of the enclosure probably coincided with that of the short side on the southeast, where the cut made in the tuff was masked by a nymphaeum wall with niches interrupted in the center by a passage that led to the higher level. The water was supplied by a lead pipe which generated jets of water falling into two basins covered with *cocciopesto*. Parallel to the exedra was an underground drain, into which two other drains in front of the temples flowed. These drains collected and directed away from the sanctuary the waste water from the fountains as well as the rain water.

The excavation of the surface of the bedrock, even if notably lowered with respect to the ancient level and battered by agricultural activity (in particular by the furrows made for planting a vineyard), revealed numerous elements useful for a reconstruction of the garden and of the buildings present in the area. Two large rectangular bases (15 x 9 m), situated in the middle, were already partly visible before the excavation. Once investigated in detail, turned out to be podia of temples whose interior structure reproduced the plan of the upper level, subdivided into a pronaos and a spacious cella. The base toward the south, created around an outcropping of appropriately shaped tuff, preserves part of its revetment in travertine blocks. In contrast, the base toward the north was completely built in masonry, but none of its ashlar revetment survives. On the basis of the faint traces preserved in Temple A, we were able to establish that the two structures faced each other. Moreover, the numerous architectural fragments in Parian marble allow us to restore an elevation with a

⁸⁵ Mari 2002-2003; Mari 2003-2004.

⁸⁶ See Mari 2010; Mari 2012.

⁸⁷ See Sgalambro 2002-2003; Sgalambro 2003-2004; Mari and Sgalambro 2007; Sgalambro 2010a.

pseudo-peripteros, almost certainly with four columns (of an uncertain order) on the façade, preceded by a central staircase inserted into a podium of travertine. We should also note the find of valuable fragments of flat bas-reliefs in an Egyptianizing style that came from the interior of the cellas (figures 7, 8).

Exactly in the middle of the two temples and on axis with the entrance off the street exceptionally important evidence came to light establishing the connection of the complex with Antinous: a 3 x 3 m square hollow, of which—because of the lowering of the surface of the tuff bedrock—only the bottom remains, contained traces of a foundation in *opus caementicium* which must have supported a base made of marble blocks (figure 21). The central siting and the ashlar base evidenced by fragments led us to hypothesize that here was erected the red granite Barberini Obelisk (height: 9.35 m). Today it stands on the Pincian Hill in Rome and is engraved with hieroglyphics relating to the new god Osirantinous and his cult (figure 6). It is our opinion that this obelisk and the telamones now in the Vatican Museum (discussed below; cf. figure 3) come from Hadrian's Villa.

Around the temples a deep ditch cut into the tuff (1.20 m deep, 1.50 m wide), interrupted only on the main axis, was filled with soil and planted with date palms, as archaeobotanical analysis confirmed (figure 22).⁸⁸ Together with the Egyptianizing sculpture, these helped to confer an exotic character on the sanctuary. Between the temples, at the sides of the obelisk, smaller and shallower ditches contained flower beds and planters. Built under the mosaic pavement in front of the nymphaeum and exedra were also two long pipes which, running like those of the nymphaeum from a cistern behind the southern corner of the complex, provided irrigation and furnished water to the basins and fountains.

On the side of the sanctuary opposite the entrance was found, as mentioned, the large semi-circular exedra, of which there are remains of two low concentric walls belonging to the foundation of the colonnade and the back wall of the porticus. Situated at a somewhat higher level and thus reachable by climbing several stairs, the exedra was preceded by two narrow and long pools, still in part revetted with marble slabs. The pavement of the open area was completely destroyed and could not be reconstructed. As a hypothesis, one can imagine that it, too, was covered by a mosaic. In contrast, the pavement of the porticus, situated at a slightly higher level, was paved with *opus sectile*, as is attested by some imprints of marble slabs. Numerous fragments of twisted columns of *giallo antico* were concentrated along the curvilinear wall further inside, and we can therefore reconstruct here a colonnade which, on the basis of the diameter of the fragments, ought to have been ca. 3 m high. Moreover, in the absence of evidence of a collapsed vault, we must conclude that the porticus (3 m wide) was covered with beams of wood or with a vault constructed of light materials.

From the center of the exedra protrude two large foundation plinths in masonry that ought to have supported not simple columns or pillars but rather the two red granite telamones in a pharaonic pose, 3.35 m high (cf. figure 3), that today are housed in the Vatican Museums but which were recorded as early as the beginning of the sixteenth century at Tivoli. They must have been transported there from Hadrian's Villa. With the architrave supported by two capitals of lotus flowers resting on the heads, the telamones were part of the porch giving access to the building, situated at a somewhat higher level, jutting out from the back of the exedra. Given the porch's prominent, central location in the sanctuary, we can recognize that it was the focus of attention of the entire complex and so must have been the entrance to the temple-tomb of Antinous (Temple C on figure 2). The walls, in this case, too, reduced to the bare foundations, presented a plan similar to that of temples A and B (with pronaos and cella). In the rear of the cella we found a statue base on which we tentatively restore one of the several statues of Antinous-Osiris found at the villa (figure 5).

The numerous marble fragments found belong either to the superstructure of the temples, built in Parian marble (blocks in *opus quadratum* of the cella, trabeation, pediment, roof), or to statues and other furnishings. The sculpture (statues of divinities, priests, and worshippers) in black, red, and white marble ought to have been set up inside the temples, in the exedra, and possibly also in the niches of the enclosure; the furnishings (altars with hieroglyphs and Egyptian symbols, vases, *labra*), all in white marble, must have embellished the open area.

⁸⁸ Giardini, et al. 2006.

3. Antinous in the Cosmic Cycle. Interpretative Elements in the Light of Egyptian Tradition

Giuseppina Capriotti Vittozzi, National Research Council of Italy, Institute for Ancient Mediterranean Studies

3.1 Introduction. The Antinoeion and Obelisk.

The figure of Antinous has been amply investigated in the light of Egyptian tradition,⁸⁹ and these analyses have well documented the efforts of the Egyptian experts engaged by Hadrian to develop a divinity who on the one hand can be inserted into the pharaonic tradition and, on the other, who represents innovations appropriate to the new context, thereby demonstrating the vitality of the tradition.⁹⁰

The obelisk of Antinous, currently re-erected on the Pincian Hill in Rome (figure 6), with its hieroglyphic inscription and the figures decorating its pyramidion, offers elements that are decisive for understanding this process and has been constantly under discussion. The debate also concerns the place where the obelisk was erected—whether at Hadrian's Villa⁹¹ or in Rome⁹²—as well as the nature of the monumental complex recently brought to light and identified by the excavators as the Antinoeion.⁹³

If the inscribed obelisk reflects pharaonic tradition, the texts were composed with a distinct impulse toward innovation and touch on themes that have Greek precedents. The monument explicitly relates itself to the birth of a new god: Antinous, drowned in the Nile, a divinity with oracular and benevolent characteristics.⁹⁴ There has also been a debate about the order in which the four sides of the obelisk should be read. The proposal of Grenier, which has revolutionized the traditional formulation, has been further modified by Liverani, who proposes that it be read counterclockwise in typically Roman fashion.⁹⁵

Because of a small lacuna in the text in line I.54 (Ciampini), perhaps the most hotly debated issue is the original location of the obelisk. The hieroglyphic text indicates that it marks the tomb of the new god, and the gap in the inscription has been interpreted by many as placing its location at “the country estate of the princeps of Rome,” i.e., Hadrian's Villa. In contrast, Grenier has proposed to supplement the missing word not as “of” but “at,” so the line would read, “the garden [i.e., *horti urbani*] of the princeps at Rome.”⁹⁶

The recent excavations in the monumental complex of Hadrian's Villa identified as the Antinoeion have brought to light a sacred area composed of a large exedra in front of which stand two temples facing each other across the plaza. In the middle of the plaza, perfectly on axis with the exedra, were found traces of a foundation which has been interpreted as the support for the Pincian obelisk.⁹⁷ It is difficult to come to a definitive conclusion given the incomplete state of the evidence both on the obelisk and at the villa, and one is torn between the cogency of the argument of the excavators and the acuity of the reflections of Grenier. Instead, we should recognize that there were several commemorative monuments or cenotaphs dedicated to Antinous in Rome and its environs,⁹⁸ one of which could well have been located at Hadrian's Villa. At any rate, the following reflections are offered as thought experiments based on two hypotheses: (1) that there was an obelisk in the center of the plaza; and (2) there was no obelisk in the center of the plaza. We then consider what consequences would follow from each hypothesis.

⁸⁹ Among others may be cited Grenier 1978; 1986; 2008; Voisin 1994 ; Meyer 1991; Grimm, Kessler, Meyer 1994; Capriotti Vittozzi, 2009a; 2012; 2013a.

⁹⁰ Capriotti Vittozzi 2013b:135-137.

⁹¹ Mari 2012, with earlier bibliography.

⁹² Grenier 2008.

⁹³ On this topic, see Mari and Sgalambro 2007 and Mari 2012, with earlier bibliography. Another interpretation is found in Grenier 2008.

⁹⁴ Capriotti Vittozzi 2013b.

⁹⁵ Liverani, in press.

⁹⁶ Grenier 2008:37, with earlier bibliography. On this interpretation of the text—admittedly possible—it is not possible to achieve certainty. See the discussion of the philological issues above, section 1.1.

⁹⁷ Mari and Sgalambro 2007, Mari 2012 with earlier bibliography, and Mari above in section 2.

⁹⁸ Capriotti Vittozzi 2013:135-137.

The impulse to undertake this experiment was given by the computer simulations described above by Frischer and Zotti. However uncertain are the various architectural and decorative elements of Mari's reconstruction, the reconstruction of the historical sky rests on the firm foundations of the two pieces of software Frischer and Zotti have used, as they explain above. Our task, then, is to interpret, from an Egyptological point of view, the interaction between the celestial and architectural features reflecting on the possible Egyptological significance of the celestial data that have emerged, some of which are possibly real while others may certainly be accidental. The relationships between the built and celestial features brought to light by the software are, however, extremely suggestive and are certainly worthy of comment, however tentative and preliminary.

3.2 Evocation of the Annual Inundation of the Nile at Hadrian's Villa?

The first alignment of interest revealed by the software concerns June 24 in the period when the Antinoeion was being planned and built (ca. 134-136 AD). On this date, assuming there was no obelisk, the first rays of the dawn sun would have entered the sanctuary through the East Portal and struck the axis of Temple C in the middle of the great exedra. The date is in itself significant given that in this period it coincided with the summer solstice, an event heralding the annual flooding ("Inundation") of the Nile.⁹⁹

The axial sunrise on June 24 observed by Frischer and Zotti in section 1.5.2 suggests the central importance of the annual flooding of the Nile to the cult celebrated in the Antinoeion.¹⁰⁰ To the Egyptians, Inundation signified an event of cosmic equilibrium which was considered an extraordinary blessing for the country and for the ruler as well. In this connection we should recall the abundance of water features in the Antinoeion which, thanks to the special hydraulic provisions, flowed into a *euripus*, parallel to the axis of the two temples and evocative, perhaps, of the Nile.¹⁰¹ Whether or not the Pincian obelisk actually came from the Antinoeion, it is useful to our analysis because it shows how Hadrian understood the new cult in relation to the annual flooding of the Nile. The analysis of the text on the obelisk's east side is particularly pertinent. Above, the scene shows Hadrian before the solar divinity, Ra-Harakhty. Although damaged, thanks to the caption it can probably be read as a scene of offering to Maat. The text which follows shows us Antinous who, as son of the solar god, intercedes on behalf of Hadrian, "beloved of Hapy," the god of the flood, so that the land prospers, the animals are fertile, and Hapy brings the flood onto the cultivated fields at the right time.¹⁰² The coincidence, on this side of the obelisk, of the presence of Ra-Harakhty, of the offering of Maat, and of the prophecy of fertility accompanied by the return of the flood at the proper time is of great interest and is perfectly compatible with the traditional ideology of Egyptian kingship. The presentation of Maat strongly connotes Egyptian kingship and has a legitimizing force:¹⁰³ Maat, as divine personification of the cosmic order and harmony, is the daughter of the solar god and guarantees the king's right to rule. The return of the beneficial flood constitutes the triumph of Maat. Even if there was no obelisk in the Antinoeion, these facts remain and are critical for understanding the orientation of the sanctuary.

Inundation may also have relevance for the siting of Temple C in the Antinoeion. In Egyptian liturgy, the rite of the union of the cult statue with the solar disk took place on relevant dates. Thus, the statues of Amon-Re and Hatshepsut were lit by the rising sun on the winter solstice at Karnak.¹⁰⁴ Also at sunrise on the winter solstice, the sun illuminated the cult statue inside the temple of Sobek-Re at Qsar Qarun.¹⁰⁵ The temple of Dendera, dating to the Ptolemaic and Roman periods, offers yet another example. At dawn on New Year's Day the

⁹⁹ Cf. Belmonte 2009:83, figure 4.2 for a graph of the average beginning date of the flooding of the Nile in the nineteenth century. It shows that the summer solstice typically marked the beginning of the process, which stretched out for four months. On the summer solstice as the "harbinger" of Inundation, see Magli 2013:22.

¹⁰⁰ Mari and Sgalambro 2007:92, "the numerous vases and basins [scil. in the Antinoeion] should be understood in relation to the importance that lustral water, symbolically assimilated to the water of the Nile, had in Egyptian funerary and cult ritual."

¹⁰¹ Mari and Sgalambro 2007.

¹⁰² Grenier 2008:27-33.

¹⁰³ Teeter 1997.

¹⁰⁴ Belmonte, Shaltout, and Fekri 2009:267.

¹⁰⁵ Belmonte, Shaltout, and Fekri 2008:189.

statue was led in a procession on a stand so that the union with the first rays of the sun could bring the image to life.¹⁰⁶

In his reconstruction of the Antinoeion (see section 2 above), Mari hypothetically restored a statue showing Antinous dressed as a pharaoh in the cella of Temple C (cf. figure 5).¹⁰⁷ As the computer simulation based on this reconstruction shows, the arrangement gives rise to an awe-inspiring effect at Hadrian's Villa quite similar to what is documented, as we have seen, in Egypt: in the simulation with an obelisk, at the first light of dawn, the sun strikes the east face of the obelisk, which casts its shadow directly on axis onto the shrine in the exedra and—if the doors are open—onto the statue inside (figure 16). Since the obelisk does not fully eclipse the sun, the sides of the statue are brilliantly illuminated, creating a dramatic play of light and shadow on the statue. Of course, if Grenier and Liverani are right in doubting that there was an obelisk in the Antinoeion, then the sunlight fell directly onto the statue at sunrise on the summer solstice (figure 15), an equally dramatic event and one also evocative of what can be paralleled at Dendera. However we settle the issue of the obelisk, then, the placement of the Antinous-Osiris statue in the west shrine by Mari has Egyptian precedent and significance.

The associations of Antinous with the Nile flood can be paralleled elsewhere. The figure of an “illuminated” Antinous appears on a mummiform lamp whose face portrays the youth and on whose body the flame rose up.¹⁰⁸ It is also useful to recall here the frequently discussed reliefs of the gate of Hadrian at Philae. Here we see, on the northern wall, the mythical cave at the first cataract from which the flood waters flow, and Isis pouring a libation onto lush vegetation dominated by the *ba* of Osiris.¹⁰⁹ Moreover, a luxuriant fluvial environment is portrayed on the southern wall, covered by an astral ceiling.¹¹⁰ In this framework, Isis expressively precedes the sign of the horizon (*akhet*), which is the site of the divine epiphany. An Osirian figure and a solar child stand on the sun disk of the *akhet*.¹¹¹ These pictures display the link between the couple Isis/Osiris, including in their astral aspect, and the flood/cosmic regeneration.¹¹²

Finally, a possible tie between Antinous and the flood is also found on the enigmatic magical stele of Geneva.¹¹³ On it we see someone who resembles Antinous standing between two crocodiles and holding in his hands three palm leaves, which in Egypt are the symbol of the New Year festival whose arrival was heralded by the summer solstice.¹¹⁴

If we ask why in adapting Egyptian religious practice to the Antinoeion at his Tiburtine villa Hadrian emphasized the summer solstice, the answer may be that the work of cultural assimilation of that date with the appropriate Roman festival had already been done long before his reign. On the Roman religious calendar, June 24 is sacred to Fors Fortuna, a goddess already interpreted by the Romans as equivalent to Isis, as is attested by the Aquileia altar from the Temple of Isis that depicts Fors Fortuna.¹¹⁵ Moreover, for both the Romans and Egyptians the summer solstice was significant because of the fertility of the earth made possible by the sun. Hence for the Romans, the summer solstice initiated the period of harvest,¹¹⁶ whereas for the Egyptians, as we have seen, it was the harbinger of the annual flooding of the Nile, without which Egypt would

¹⁰⁶ Cauville 1990:65-67. For additional bibliography, see Capriotti Vittozzi 2012.

¹⁰⁷ Mari and Sgalambro 2007.

¹⁰⁸ Gallo 1998. For a more detailed treatment along these lines, see Capriotti Vittozzi 2008.

¹⁰⁹ Junker 1913:37-41.

¹¹⁰ Ibid., pp. 41-45.

¹¹¹ On these reliefs and their possible relationship with the theological elaboration of the figure of Antinous: Capriotti Vittozzi 2009a and 2012.

¹¹² For textual references, see Junker 1913:38: “Osiris ist der Orion, Isis ist die Sirius....Osiris ist der Nil, Isis ist das Feld”.

¹¹³ Musée d'Art et d'Histoire, inv. D1328: Sternberg-El Hotabi 1999, II, figure LVI.

¹¹⁴ Capriotti Vittozzi 2012.

¹¹⁵ Cf. Champeaux 1982:210. Bricault and Versluys 2014, 32. We know an ancient identification of Isis and Fortuna in Praeneste, where the Nile mosaic was manufactured: Capriotti 2009b.

¹¹⁶ Cf. Varro, *De Re Rustica* 1.32: “In the fourth period, between the [summer] solstice and the Dog Star, most farmers harvest....” (translation by W. D. Hopper and H. B. Ash).

have been an arid desert. Just as the Nile was obviously central to the period of Inundation initiated with the summer solstice, so, too, the Roman festival of Fors Fortuna on that date had a strong connection with the Tiber River. As Ovid wrote: "Come, Quirites, celebrate with joy the goddess Fors! On Tiber's bank she has her royal foundations. Speed some of you on foot, and some in the swift boat...Ye flower-crowned skiffs, bear bands of youthful revellers, and let them quaff deep draughts of wine on the bosom of the stream" (*Fasti* 6.775-780, translated by J. G. Frazer). Indeed, this riverine connection explains why Champeaux, in her detailed monograph on Fortuna, wrote that for the Romans, the summer solstice festival paradoxically had a stronger association with water than with fire and the sun.¹¹⁷

3.3. In the Footsteps of Tradition: Abu Simbel and the Serapeum of Alexandria

In researching precedents in Egyptian tradition for the projection of the sun and/or the shadow of the obelisk onto the statue of Antinous in Temple C, we can cite at least two noteworthy cases. The first is the monumental complex of Abu Simbel, formed by two famous cliff temples dating to the reign of Ramesses II; the second is the Serapeum of Alexandria, as described by the ancient sources.

At Abu Simbel, Ramesses II (19th dynasty, 13th century BC) commissioned a temple carved out of the cliff face in which he appears between divinities such as Ra-Harakhty, Amon, and Ptah. On two days of the year, October 20 and February 20, sunlight enters into the cave to illuminate first Ramesses II and Amon, after which the rays strike the statue of Ra-Harakhty. The effect expresses the theological sense of the king's illumination and union with the divine.¹¹⁸ The other cave, of smaller size, was dedicated to Queen Nefertari. There she is represented in the role of Sirius, thanks to the intervention of Isis and Hathor. As Desroches-Noblecourt has emphasized, at Abu Simbel is expressed—and thus made visible—the connection between the king/solar divinity and the queen/Sirius, a connection beneficial to the cosmic order and reflecting the fact that in the time of Sethi I, the father of Ramesses, *wpt rnpt* and *pwt Spdt* coincided.¹¹⁹ More recent studies on the astral alignment of the temple of Abu Simbel have demonstrated that at the latitude of the temple, during the reign of Ramesses II, there was a coincidence between the New Year and the heliacal rising of Sirius.¹²⁰

The continuity and at the same time the evolution of this tradition were well expressed in a text of Rufinus (*Hist. Eccl.* 2.23) about the Serapeum of Alexandria. On an accurately calculated day, the sun's rays penetrated into the temple through a narrow window in order to strike the lips of the statue of Serapis, while the image of Helios was brought nearby in order to bring to life an encounter of the two divinities which is well attested in the iconographical sources.¹²¹ The union between these two gods of the Ptolemaic period reflects the theological tradition of the union between Osiris and Ra that is well known from the royal tombs of the New Kingdom and described by Plutarch (*De Is. et Os.* 52 and 77).

3.4. The Obelisk and the Sculpted Crater in the Capitoline Museums

We should stress that, if the obelisk really was erected in the middle of the plaza of the Antinoeion, then it will have collected the sun's light on the days indicated and will have projected its shadow both onto the façades of temples A and C.

Relevant in this connection is a large stone crater with two enigmatic reliefs from Hadrian's Villa, now in the Capitoline Museums (MC29; figure 12). Each relief is divided by an obelisk which divides the crater's two sides into two scenes. Atop the obelisk is an object with an oval form that in the past has been interpreted as a pine cone¹²² but which, according to a suggestion of Frischer, may instead be a scarab. At the moment, it is not

¹¹⁷ Champeaux 1982:211: "...il est paradoxal qu'elle n'ait été marquée que par des rites de l'eau, non par les rites du feu qui caractérisent habituellement les fêtes solaires et don't le symbolisme est si transparent."

¹¹⁸ Christophe 1970:251-255; Desroches-Noblecourt 1997:188-190.

¹¹⁹ Desroches-Noblecourt 1997:190.

¹²⁰ Shaltout and Belmonte 2005:291-293.

¹²¹ Tran Tam Tinh 1992.

¹²² Ensoli Vittozzi 1990:49, who emphasizes the funerary character of the obelisk which, however, precisely analyzed, signals the birth of a god more than the death of a mortal.

possible to definitively accept or reject this idea. All we can say is that it would be apt both because of the shape of the representation, which is consistent with a scarab, and also because of the Egyptian tradition which considered the scarab an image of the new-born sun.¹²³ Moreover, the obelisks brought to Rome offered a clear Egyptian parallel of the image of the scarab carved in relief onto the upper part of the pyramidion,¹²⁴ as we find in the noteworthy case of the Montecitorio obelisk.¹²⁵ The presence of the scarab atop the obelisk would offer another example of an innovation developed out of the tradition in a way attested by other monuments and practices of Hadrian. At the Antinoeion, on the basis of the juxtaposition, the scarab would have been able to function as an excellent pointer, superimposing at dawn its own shadow onto the divine statue. The vase, which certainly requires further investigation, appears to be a particularly expressive theological reflection of the Egyptian tradition in the circle of Hadrian.

Some additional points should be noted here. The repeated presence of two large birds, probably crowned hawks, may refer to the double kingship (cf. figure 12, side A).¹²⁶ The scene on side B depicts an enthroned bearded man, before whom a ruler is officiating, giving to the latter a staff topped by an object with two arms. This can be interpreted as the act of handing over the *k3* sign.¹²⁷ In Egypt, the royal *k3* constituted the bond between the ruler and his ancestors and thus his own royal background and legitimation.¹²⁸ It has been noted that on Domitian's obelisk, now standing in Piazza Navona, the term *k3* expresses the Latin *gens*, emphasizing the connection between the princeps and the paternal source of his power.¹²⁹

Finally, on the surfaces of the crater, the space on sides A and B is divided not only by the obelisk but also by a kind of tree with ample foliage which recurs four times. Interpreted as a sycamore,¹³⁰ it seems more likely to be a maritime pine (*pinus pinaster*). We may note that, on the basis of the palaeobotanical investigations conducted in the Antinoeion, evidence of palms and pines has been discovered.¹³¹ The significance of the palm in Egypt has already been noted: it was symbolic of fertility and of the New Year heralded by the Nile flood.¹³² The pine's significance is less clear but it has been demonstrated how, in the *Story of the Two Brothers*, which we can clearly recognize as an Osirian tale of the New Kingdom, the maritime pine has a precise role in relation to Osiris. This occurs in an episode related to the coast of Lebanon, an ambience which returns in Plutarch's myth of Osiris (*De Is. et Os.* 15).¹³³

Thus, the crater presents us with Osirian connections and allusions to kingship, its transfer and its legitimation. In this regard, the role of Antinous seems at once obvious and somewhat obscure.¹³⁴ The imagery suggests the regenerative power which is transmitted to Hadrian from Antinous, who is depicted on the pyramidion of the obelisk as a king.¹³⁵ Reflections on the kingship of Antinous, clearly made concrete by images of him in pharaonic dress, offer a clue for the interpretation of the scenes where the obelisk has an important role. Signs, probably astral—the disc or the semi-disc (crescent moon?)— are found on the crater. In one case they are found precisely to either side of the obelisk (figure 12, side A).¹³⁶ In another case (also on side A) the disc is carved behind the two birds and is connected to a sign perhaps signifying *ankh* or *nefer*.¹³⁷

¹²³ Pinch 2002:152-153.

¹²⁴ Ciampini 2004:123 (obelisk of the Pantheon), 131 (Celimontano obelisk), 137 (Dogali obelisk).

¹²⁵ Bandini 1750: tav. III; Carnevali – Cirocchi 2004:89.

¹²⁶ *Nbwy* in Erman and Grapow 1982: II 231. For additional bibliography, in particular on the reign of Ramesses II, Capriotti Vittozzi 2005:42.

¹²⁷ Ensoli Vittozzi 1990:47.

¹²⁸ Bell 195.

¹²⁹ Grenier 1987:939; Ciampini 2005:400-402.

¹³⁰ Ensoli Vittozzi 1990:47.

¹³¹ M. Giardini, et al. 2006.

¹³² Wallert 1962.

¹³³ Servajean 2011.

¹³⁴ Grenier 2008: 59-65.

¹³⁵ Winter 2007.

¹³⁶ Winter 2007.

¹³⁷ Ensoli Vittozzi 1990: 49 fig. 30.

The communication of kingship between Hadrian and Antinous would thus be apparent through the two contiguous scenes divided by the obelisk: on the left part of side B, the bearded figure—Hadrian?—wears the double crown of Egypt and offers the *k3* to a person (Antinous?) who, in the scene on the right, wears in turn the double crown and offers a bowl to a large bird. This bird recalls the ibis of Thot¹³⁸ but also brings to mind the *benu* bird, i.e., the phoenix.

The *benu* bird, generally represented as a heron and recognized as the solar bird whose myth merged with that of the phoenix described by Herodotus (2.73), was closely connected with the *ben-ben*, the raised stone; both are instantiations of the solar divinity in the Heliopolitan context.¹³⁹ The relationship between *benu*/phoenix and *ben-ben*/obelisk is well documented. The connection, too, between the scarab and the *benu* is well known.¹⁴⁰ The heron represents the Heliopolitan form of Osiris insofar as he is the *ba* (i.e., soul) of Atum, and thus is connected with the scarab.¹⁴¹ Also well-known is the connection, in the late period, between Osiris and the phoenix.¹⁴²

Both the *ben-ben* and *benu* are in close association with *wbn*, indicating the rising of the sun and solar illumination which—starting with the rising of the Nile around the summer solstice—bring life, renewal, and revitalization. The connection between the phoenix and fire is clarified by *wbn*: the fire/illumination constitute the transition of life and kingship.¹⁴³ The image of the phoenix, in the same passage of Herodotus cited above (2.73), synthesizes the mysterious passage of kingship from father to son, predecessor and successor, a passage which is renewed at the moment of death. In this context, we can also understand the bond between the *benu* and the royal Jubilee (the *Sed* festival), which had the function of renewing the kingship.¹⁴⁴ It is interesting to note that traditionally, the erection of an obelisk could be connected with the *Sed* festival.¹⁴⁵

On the other face of the crater (figure 12, side A, left), an enthroned royal figure offers the sign of life to two crowned raptors; two other small birds are on his knees; while a small cat stands on his head. In the other half of the same side of the vase (side A) we see a royal figure with a double crown handing a bird and snake to two large raptors, while a small bird stands on his knees.

The figure of the cat evokes the goddess Bastet/Sekhmet,¹⁴⁶ who is connected with royalty as daughter of the sun and nurse/protector of the ruler, and with Sirius itself.¹⁴⁷ The cult and festivals of Bastet, in the late period, in the city of Bubasti are well known thanks again to Herodotus. In the same temple context, in the Libyan period, was constructed the Jubilee room of Osorkon II.¹⁴⁸

The royal figure who, in the scene to the viewer's right, offers a bird and serpent to the two big birds also brings to mind the themes discussed above: the pharaoh can offer a bird on the occasion of the royal jubilee.¹⁴⁹ At the same time, the figure of the serpent refers to time and to eternity.¹⁵⁰

3.5. The *dies natalis* of the Solar Child

Another interesting pair of solar alignments was found through the simulation: November 27 and January 24, which are, respectively, the birthdays of Antinous and of Hadrian. Between these days the sun shines in the late morning directly onto the center of the façade of Temple A. If we restore an obelisk, following Mari and

¹³⁸ On the connections between Antinous and Thot, see Capriotti Vittozzi 2013a: 54 with bibliography.

¹³⁹ van den Broek 1972.

¹⁴⁰ van den Broek 1972: 15.

¹⁴¹ Étienne-Fart 1994:134 fig. 1, 138.

¹⁴² El-Banna 1989:121.

¹⁴³ Ciampini 1999:35.

¹⁴⁴ Ciampini 1999:35.

¹⁴⁵ Winter 1997.

¹⁴⁶ Pinch 2003, *passim*.

¹⁴⁷ Helck and Otto 1972: 111.

¹⁴⁸ Naville 1892.

¹⁴⁹ Teissier 1996:126.

¹⁵⁰ Ciampini 1999; Capriotti Vittozzi 2013a.

Sgalambro, then we see the obelisk's shadow projected right onto the center of the façade. If the obelisk had the dimensions of the Pincian Obelisk, then it is interesting to note that the simulation shows that the shadow nicely fits the height of the temple (figure 19).

Several years ago, analyzing the recent finds of relief fragments from the area of the Antinoeion, I suggested that the two temples should be identified with two aspects of Antinous: as Osiris and as the solar child. I argued in favor of this suggestion by citing Egyptian documents¹⁵¹ which at the Gate of Hadrian at Philae joined the two aspects of the solar divinity in a process of eternal renewal. The presence of Antinous as the solar youth seemed to me underscored by the recognition of his facial features on the statue of Harpocrates, now in the Capitoline Museums, from Hadrian's Villa (figure 4).¹⁵² At that time, my analysis had to be based on the few relief fragments that could be read as attesting the presence of Isis behind the throne of Osiris in the canonical pose of protecting her spouse. Other fragments, belonging to a relief depicting a Hathoric capital, I related to the cult of the solar youth (figure 8). The computer simulations seem to confirm the presence of this particular aspect: on the birthdays of Antinous and Hadrian—November 27 and January 24—the sunlight falls on Temple A, which therefore ought to be the temple of the divine, regal youth (figures 19 and 20). For Temple B, as Frischer and Zotti note above, there may have been a connection with Isis made through the alignment with Sirius, which includes an emphasized occurrence at midnight around the time of Antinous' birthday.

It is striking how transparently the ancient traditions are reworked by Hadrian and his advisors, the innovation which conceals/reveals a most ancient itinerary that is still traceable; the cosmic equilibrium expressed by kingship in which the cycle of birth-death is maintained without fracture, expressed in the figures of Osiris and the divine youth. Alongside them, the female principle Isis/Sirius plays the fundamental role of renewing life. These messages are clearly communicated in the distant temple of Philae and, undoubtedly, in the microcosm that is Hadrian's Tiburtine retreat.

3. 6 Summary

The Egyptological observations offered here in response to the new computer simulations permit us to paint a complex picture which, albeit hypothetical, is highly suggestive. It refers to complex beliefs and related rituals connected to the renewal of kingship, tightly connected to the revitalization of the cosmos in each period of Inundation, which commenced around the time of the summer solstice, and on the king's jubilee. Into this picture flowed images which in pharaonic Egypt survived for centuries enriching the Greco-Roman culture of Egypt and, ultimately, of the capital, Rome itself.

The imagery carved onto the Capitoline crater (figure 12) seems interwoven with features that we can observe at Hadrian's Villa. From them emerge some fundamental elements: the cosmic vision and thus the celestial associations; the renewal of life and of fertility; the perpetuation of kingship and the solar function through union with the sun's disc; the completely Egyptian images of the obelisk and of the phoenix, of the scarab and of the serpent. Finally, what is revealed is a reflection peculiar to the passage of kingship between Hadrian and Antinous, noteworthy for the fact that, moving from Hadrian to Antinous, it seems to return to Hadrian revitalized because of the death of the youth. The complex stratification of meanings and signifiers, ancient and yet still eloquent, shows the contribution of experts on Egyptian culture present in the court. They were able to transform traditional elements and thereby do justice to the extraordinary relationship of Hadrian and Antinous.

4. Conclusions

Bernard Frischer, Indiana University, and Georg Zotti, Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology

We stated at the outset that this paper stands at the intersection of informatics and archaeology. Our conclusions relate to both fields.

¹⁵¹ Capriotti Vittozzi 2009a.

¹⁵² Inv. n. 646.

To begin with archaeology, we conclude that the use of simulation environments such as the game engine Unity and the planetarium software Stellarium is able to advance understanding of the sanctuary excavated by Mari at Hadrian's Villa. Using the methodology of virtual astronomical observation, we found new evidence of astronomical alignments supporting Mari's controversial identification of the site as an Antinoeion. The key alignments were those found on the axis of entry from the East Portal to Temple C. The alignment at sunrise on the summer solstice (June 24 in the 130s AD) reinforces the Egyptian association of the sanctuary already clear from Mari's find of many Egyptian or Egyptianizing sculptural fragments.

A secondary archaeological goal of this paper was to see if astronomical alignments could contribute to an identification of the three temples in the sanctuary. The most compelling such identification concerns Temple C, which, in view of its orientation to the asterism Antinous, was almost certainly dedicated to Antinous in the guise of Osirantinous. Given the morning solar alignments of Temple A in the period that includes the birthdays of Antinous, Hadrian, and the winter solstice, this temple may have been dedicated to Antinous in the guise of Harpocrates-Antinous. Temple B, as we have seen, should probably be assigned to the cult of Isis.¹⁵³ Thus, the Antinoeion would exemplify the pattern observed in Egypt whereby cults of male divinities have solar connections, while goddesses have stellar associations.¹⁵⁴

A final uncertainty remains on the archaeological side, which should be mentioned here. It concerns the altitude of the nearby Colle Ripoli which determines sunrise at the summer solstice. Our digital elevation model is based on a US Army map from the 1940s, and the panorama derived from Google Earth which we made to verify these altitudes is based on Google Earth's use of SRTM. While they closely agree with each other, there is a slight mismatch in the range of arcminutes so that the perfect axial alignment of the obelisk shadow in our model seems to occur only about 4 minutes after the first ray of sunlight is cast on the obelisk. But note that the sun takes about 2 minutes to climb fully over the horizon. While this spectacle with a simulated soft shadow cast over more than 2 kilometers seems perfectly convincing, ultimately accuracy can only be reached with either a more accurate digital elevation model (LIDAR-based) or by measuring the mountain ridge from the location of the Antinoeion with an appropriate survey instrument (theodolite, total station). We can only recommend that in future archaeological investigations of sites where axial orientation might have to do with celestial objects, it should become general practice always to determine an accurate astronomical azimuth (which is usually slightly different from the deviation from the north direction in a geographical survey grid like UTM) of some well-discernible structure like a long wall, and also always invest a few minutes of work to provide an accurate record of the landscape horizon as observed from several spots on the site. Such altitude data can immediately be used as horizon line in Stellarium even if a high-quality digital elevation model is not available.

Turning now to our informatic conclusions, we begin by noting that insofar as the alignments we found are solar, they are supported by both simulations, and this is significant since the Unity solar plug-in and Stellarium use different methods for calculating the ephemerides. The solar alignments they reveal agree very closely in terms of time and space. Thus, having two simulations allowed us—at least for the solar studies—to replicate our own results. This was not possible for the alignments visible only at night with the stars and constellations because the Unity plug-in lacks the requisite astronomical information. So it will be necessary for our nighttime findings to be verified by other means.

Through this project we have become convinced of the great potential of interactive environmental simulations such as the game engine Unity and the planetarium software Stellarium for supporting archaeoastronomical research in archaeology, art history, and religious studies. The combination of accurately reconstructed built environments with the historically accurate sky is still relatively new to and underexploited in these fields. Although we found Unity and Stellarium to be indispensable tools, we did repeatedly encounter situations in which we would like to have enhanced them for the specific tasks of archaeoastronomical

¹⁵³ Cf. Belmonte, Shaltout, and Fekri 2009:278 on the tendency of temples dedicated to female divinities to be oriented toward the brightest stars in the sky, "notably Sirius."

¹⁵⁴ Belmonte, Shaltout, and Fekri 2009:278.

research. For example, it would have facilitated our ability to judge the solar alignments suggested by Unity if that program supported atmospheric refraction, or in general, a better atmospheric model.¹⁵⁵ On the other hand, Unity comes with a rich assortment of natural objects like trees, which may even move in a naturalistic way, so the Unity scene looks more natural than the static models in Stellarium.

Of course, it would have been advantageous for our Unity plug-in to include the night sky historically turned back in order to have a different calculation of ephemerides from that used by Stellarium, so that we could have attempted to replicate our own results, as we were able to do with potential solar alignments. Movement of the camera appeared at first much smoother and more precise in Unity than in Stellarium, which was never intended to function like a terrestrial game engine, but motion can be fine-tuned by zooming the field of view. The wide-angle reprojection options in Stellarium provide a larger overview, but at the cost of image resolution when one zooms in. Switching to the perspective mode avoids this loss in resolution.

It appears desirable to be able to lock the camera to a certain height and to a certain track for such applications because it is easy for an observer to be deceived about a potential alignment by moving only a small amount off the axis of alignment at average human eye level. The Stellarium plug-in can make use of a ground plane to constrain eye-height over the ground, but for axial positioning it is recommended to either provide visual aids for such axes in form of textures or even auxiliary geometry. Stellarium can print to the screen the camera's exact position in terms of real-world survey grid coordinates, if the model is accurately georeferenced to such a grid (e.g., UTM) so that findings can be more accurately reported. It is also possible to store and retrieve relevant viewpoints. Such functionalities could certainly also be added to the Unity plug-in.

So, there is much work to be done, in undertaking new fieldwork to refine the survey results on which our landscape model relied, in improving the tools available for exploring this frontier area of humanistic research, and also in using the tools we already have to pursue new interdisciplinary research about the ways in which, all over the world at different times and places, people have sometimes expressed their cultural beliefs and values by connecting the built or natural environment on earth with appropriate features in the sky.

¹⁵⁵ Others share our concern, and not only in the field of archaeoastronomy; cf., for example, <http://blogs.unity3d.com/2015/05/28/atmospheric-scattering-in-the-blacksmith/> (seen December 1, 2015).

Acknowledgements

The research reported in this article grew out of The Digital Hadrian's Villa Project, which was initiated at the University of Virginia in 2008 and which since 2013 has continued at Indiana University.

We gratefully acknowledge the contributions of the following people: Matthew R. Brennan (Virtual World Heritage Laboratory, Indiana University), who created the AutoCAD, 3D Studio Max, and Stellarium models of the Antinoeion. John Fillwalk directed his team at the IDIA Lab (Ball State University) to create the Unity model with its solar tracker plug-in as well as the first version of the Stellarium model. Architect Michael Ytterberg authored the general villa map in AutoCad used by The Digital Hadrian's Villa Project. We are very grateful to him for permission to use his map and for providing an explanation of the determination of geographic north used on the map. We thank Valerio Baiocchi for independently checking the accuracy of geographical north on our plan. We also thank Dr. Erica Bassignani for permission to use her line drawing of an Egyptian vase from Hadrian's Villa now in the Capitoline Museums (see our figure 12). Christian Leitz (University of Tübingen) answered our questions about the Egyptian calendar during the 130s AD. Stephen Vinson (Indiana University) and Antonio Loprieno (University of Basel) provided useful information about philological issues raised by the text of the Pincian Obelisk. Juan Antonio Belmonte (Institute of Astrophysics of the Canary Islands) and Robert Hannah (University of Waikato) provided invaluable constructive criticism of points we made about archaeoastronomical matters in earlier drafts. We thank the two anonymous peer-reviewers of this journal, who made many useful suggestions which helped to improve our article, and also Gabriele Guidi, who handled the editorial duties of this article for the journal. Needless to say, none of these scholars bears any responsibility for the views expressed in this paper. We thank the Vatican Museums for permission to study and to photograph the Egyptianizing sculpture from Hadrian's Villa in the Gregorian Egyptian Museum. We are very grateful to Marina Sapelli Ragni, (retired) Superintendent of the Archaeological Superintendency of Lazio, for permission granted to study and document Hadrian's Villa, including the Antinoeion. For many stimulating discussions about Hadrian's Villa we thank Paolo Liverani (University of Florence), Michael Ytterberg (BLT Architects), Marina de Franceschini (independent scholar), Adalberto Ottati (Italian Archaeological School of Athens), and F. Cairolì Giuliani (Sapienza University, Rome).

The Digital Hadrian's Villa Project has benefitted from the administrative assistance of the Department of Classics, University of Virginia, and from the School of Informatics, Indiana University. From 2008 to 2013, creation of the reconstruction model of Hadrian's Villa was made possible by a private donor, who wishes to remain anonymous, and by the National Science Foundation (grant #IIS-1018512). That phase of the project was also supported by the Zukunftscolleg of the University of Konstanz. The present article was based on new research undertaken from 2013 to 2015 which was made possible by a grant from the Andrew W. Mellon Foundation. We take this opportunity to express our deep gratitude to the Mellon Foundation as well as to our earlier supporters.

Finally, with great admiration and respect, we dedicate this article to Prince Urbano Barberini. From 2011 to 2012 he singlehandedly—and successfully—organized civic opposition to the government's irresponsible but nearly implemented plan to locate Rome's proposed vast new city garbage dump on the site of Corcolle at the very doorstep of Hadrian's Villa.

Bibliography

- Bandini, A.M. 1750. *Dell' obelisco di Cesare Augusto scavato dalle rovine del Campo Marzo* (Rome).
- Bassignani, E. 2011. "Antinoo: un caso studio di divinizzazione in età imperiale." Tesi di laurea, University of Venice.
- Bell, L. 1985. "Luxor Temple and the Cult of the Royal Ka," *JNES* 44:251-294.
- Belmonte, J. A. and M. Shaltout. 2006. "On the Orientation of Ancient Egyptian Temples: (2) New Experiments at the Oases of the Western Desert," *Journal for the History of Astronomy* 37:173-192.

- Belmonte, J. A., M. Shaltout, and M. Fekri. 2008. "On the Orientation of Ancient Egyptian Temples: (4) Epilogue in Serabit El Khadim and Overview," *Journal for the History of Astronomy* 39:181-211.
- Belmonte, J.A., M. Shaltout, and M. Fekri. 2009. "Astronomy, Landscape, and Symbolism: A Study of the Orientation of Ancient Egyptian Temples," in *In Search of Cosmic Order. Selected Essays on Egyptian Archaeoastronomy*, edited by J.A. Belmonte and M. Shaltout (Cairo) 213-283.
- Belmonte, J. A., M. A. Molinero Polo, and N. Miranda. 2009. "Unveiling Seshat: New Insights into the Stretching of the Cord Ceremony," in *In Search of Cosmic Order. Selected Essays on Egyptian Archaeoastronomy*, edited by J.A. Belmonte and M. Shaltout (Cairo) 195-212.
- Belmonte, J. A. 2010. "The Egyptian Calendar: Keeping Ma'at on Earth," in *In Search of Cosmic Order: Selected Essays on Egyptian Archaeoastronomy*, edited by J.A. Belmonte and M. Shaltout (American University in Cairo Press) 75-129.
- Bennett, C. 2003. "The Early Augustan Calendars in Rome and Egypt," *Zeitschrift für Papyrologie und Epigraphik* 142:221-240.
- Bennett, C. 2004. "The Early Augustan Calendars in Rome and Egypt: Addenda et Corrigenda," *Zeitschrift für Papyrologie und Epigraphik* 147:165-168.
- Bloch, H. 1938. *I bolli laterizi e la storia dell'edilizia romana*, 2 volumes (Rome).
- Bresciani, E. 1986. "Tra Egitto e Roma. Aspetti della cultura egiziana in rapporto col mondo romano," in *Gli scambi culturali e socio-economici fra l'Africa settentrionale e l'Europa mediterranea*, edited by L. Serra, *Atti del Congresso Internazionale di Amalfi, 5-8 dicembre 1983* (Naples) 83-98.
- Bricault, L. and M.J. Versluys. 2014. "Isis and Empires," in *Power, Politics and the Cults of Isis: Proceedings of the Vth International Conference of Isis Studies*, Boulogne-sur-Mer, October 13-15, 2011 (Leiden) 3-35.
- Capriotti Vittozzi, G. 2005. "Una statua di Ramesse II al Museo del Cairo," in *Atti del Convegno "Narrare gli eventi," Firenze 4-6 dicembre 2002*, edited by F. Pecchioli Daddi and M.C. Guidotti, *Studia Asiana* 3 (Rome) 39-48.
- Capriotti Vittozzi, G. 2008. "Una enigmatica figura nel Codice Ferrajoli 513 e una lampada da Canosa: aspetti della magia di origine egizia," in *Miscellanea Bibliothecae Apostolicae Vaticanae* 15:101-127.
- Capriotti Vittozzi, G. 2009a. "L'imperatore Adriano e la religione egizia alla luce delle recenti scoperte," in *Potere e religione nel mondo indo-mediterraneo tra Ellenismo e tarda antichità*, edited by G. Gnoli and G. Sfameni Gasparro, *Atti dell'Incontro di studio della Società Italiana di Storia delle Religioni, Roma – ISIAO 28-29 ottobre 2004* (Rome) 49-74.
- Capriotti Vittozzi, G. 2009b. "L'Egitto a Praeneste: alcune note," *Mediterranea* 6:79-97.
- Capriotti Vittozzi, G. 2012. "Horo, Osiri, Antinoo e le lampade magiche: elementi di magia egizia nel mondo romano," in *I contesti magici. Contextos mágicos*, edited by M. Piranomonte and F.M. Simón, *Atti del Convegno Internazionale a Roma dal 4 al 6 novembre 2009* (Rome) 283-287.
- Capriotti Vittozzi, G. 2013a. "Lampade e visioni. Forme oracolari di origine egizia," in *Oracoli, visioni, profezie. L'Egitto da Alessandro il grande all'Alto Medioevo*, edited by P. Buzi, *SMSR* 79.1:47-59.
- Capriotti Vittozzi, G. 2013b. *La terra del Nilo sulle sponde del Tevere, Collana di Studi di Egittologia e Civiltà Copta* 1 (Rome).
- Carnevali, G. and G. Ciocchi. 2004. *Egitto a Roma. Obelischi. Libri e stampe dal fondo antico della Biblioteca*, Mostra della Biblioteca della Camera dei Deputati, Roma – Palazzo del Seminario, 4 maggio – 4 giugno 2004 (Rome).

- Castellani, V. 2006. "Tivoli: Villa Adriana, Rocca Bruna e astronomia," *Rivista Italiana di Archeoastronomia* 5:9-18.
- Cauville, S. 1990. *Le temple de Dendera* (Cairo).
- Champeaux, J. 1982. *Fortuna. Le culte de la Fortune à Rome et dans le monde romain. I : Fortuna dans la religion archaïque*, Publications du l'École Française de Rome 64 (Rome).
- Christophe, L.A. 1970. *Abu Simbel. L'épopée d'une découverte archéologique* (Turin).
- Ciampini, E.M. 1999. "La fenice, il serpente e il tempo," *Studi e Materiali di Storia delle Religioni* 23:31-40.
- Ciampini, E.M. 2004. *Gli obelischi iscritti di Roma* (Rome).
- Ciampini, E.M. 2005. "The Pamphili Obelisk: Two Notes on Pharaonic Elements in Domitian Ideology," in *Religija i mit kao poticaj provincijalnoi plastici. Akti VIII. Međunarodnog kolokvija o problemima rimskog provincijalnog umjetničkog stvaralaštva, Religion and Myth as an Impetus for the Roman Provincial Culture*, edited by M. Sanader and A.R. Miočević, *The Proceedings of the 8th International Colloquium on Problems of Roman Provincial Art* (Zagreb) 399-402.
- Clagett, M. 1995. *Ancient Egyptian Science, Vol. II. Calendars, Clocks, and Astronomy, Memoirs of the American Philosophical Society* 244 (Philadelphia).
- Coarelli, F. 1996. "Isaeum Campense," in *Lexicon Topographicum Urbis Romae*, vol. 3 (Rome) 107-109.
- Coarelli, F. 2004. "Fortis Fortunae, Fanum, Templum (VI miglio Via Campana)," in *Lexicon Topographicum Urbis Romae Suburbium*, vol. 2 (Rome) 270-271.
- De Franceschini, M. and G. Veneziano. 2011. *Villa Adriana. Architettura celeste: I segreti dei solstizi* (Rome).
- Degrassi, A. 1963. *Fasti et elogia, Inscriptiones Italiae*, vol. 13, fasc. 2 (Rome).
- Depuydt, L. 1997. *Civil Calendar and Lunar Calendar in Ancient Egypt, OLA* 77 (Leuven).
- Derchain, P. 1991. "Un projet d'empereur," in *Ägypten im afro-orientalischen Kontext. Gedenschrift Peter Beherens*, edited by D. Mendel and U. Claudi (Cologne) 109-124.
- Desroches-Noblecourt, C. 1997. *Ramsete II figlio del sole* (Milan).
- Dressel, H. 1909. "Das Iseum Campense auf einer Münze des Vespasianus," *Sitzungsberichte der Preussischen Akademie der Wissenschaften, phil.-hist. Classe*:640-648.
- El-Banna, E. 1989. "À propos des aspects héliopolitains d'Osiris," *BIFAO* 89 :101-126.
- Étienne-Fart, M. 1994. "'De rebus quae geruntur...' dans deux inscriptions ramessides," *BIFAO* 94 :133-142.
- Ensoli Vittozzi, S. 1990. *Musei Capitolini. La Collezione Egizia* (Milan).
- Erman, A. 1896. "Obelisken römischer Zeit. II. Der Obelisk des Antinous," *Mitteilungen des deutschen archäologischen Instituts, Römische Abteilung* 11:113-121.
- Erman, A. and H. Grapow, 1982. *Wörterbuch der Ägyptischen Sprache*, II (Berlin).
- Franci, M. 2010. *Astronomia egizia* (Florence).
- Frischer, B. et al., 2002. "From CVR to CVRO. The Past, Present, and Future of Cultural Virtual Reality," by B. Frischer, F. Niccolucci, N. Ryan, J. Barcel, *Proceedings of VAST 2000*, ed. F. Niccolucci, *British Archaeological Reports* 834 (ArcheoPress, Oxford) 7-18.
- Frischer, B. and J. Fillwalk. 2012. "The Digital Hadrian's Villa Project. Using Virtual Worlds to Control Suspected Solar Alignments," *VSMM* 2012:49-55.

- Frischer, B. and J. Fillwalk. 2014. "New Digital Simulation Studies on the Obelisk, Meridian, and Ara Pacis of Augustus," *The Horologium of Augustus: Debate and Context, Journal of Roman Archaeology*, edited by L. Haselberger, *JRA Supplementary Series* Number 99:77-90.
- Galimberti, A. 2012. "Adriano e Antinoo nelle fonti storiche," in *Antinoo. Il fascino della bellezza*, edited by M. Sapelli Ragni (Milan) 15-29.
- Gallo, P. 1998. "Lucerne osiriformi d'epoca romana," *Alexandrina* 1:149-155.
- Giardini, M., G. Calderoni, V. Jolivet, Z. Mari, L. Sadori, F. Susanna, J. J. Tresseras. 2006. "Indagini archeobotaniche su alcuni materiali degli horti Luculliani (Roma) e di Villa Adriana (Tivoli)," in *The Archaeology of Crop Fields and Gardens*, edited by di J.-P. Morel, J. Tresseras Juan, J.C. Matamala, *Proceedings of the 1st Conference on Crop Fields and Gardens* (Bari 2006) 129-144.
- Grenier, J.C. 1978. *L'autel funéraire isiaque de Fabia Stratonice*, *EPRO* 71 (Leiden).
- Grenier, J.C. and F. Coarelli. 1986. "La tombe d'Antinoüs à Rome," *MEFRA* 98.1:217-253.
- Grenier, J. C. 1987. "Les inscriptions hiéroglyphiques de l'obelisque Pamphili," *MEFRA* 99:937-961.
- Grenier, J.C. 1989. "La décoration statuaire du 'Serapeum' du 'Canope' de la Villa Adriana," *MEFRA* 101:925-1019.
- Grenier, J.C. 2008. *L'Osiris Antinoos, Cahiers Égypte Nilotique et Méditerranéenne* I (Montpellier).
- Grimm, A., D. Kessler, H. Meyer. 1994. *Der Obelisk des Antinoos* (Munich).
- Hannah, R. and G. Magli. 2010. "The Role of the Sun in the Pantheon's Design and Meaning," *Numen* 58:486-513.
- Hannestad, N. 1982. "Über das Grabmal des Antinoos. Topographische und thematische Studien im Canopus Gebiet der Villa Adriana," *Analecta Romana Instituti Danici* 11:69-108.
- Helck, W. and E. Otto, editors. 1972. *Lexikon der Ägyptologie*, V (Wiesbaden).
- Ianni, A. 2006. "L'esperienza del rilievo della Villa Adriana," in *Villa Adriana: la pianta del centenario 1906-2006*, edited by B. Adembri and G. E. Cinque (Florence) 47-53.
- Johanson, C. and B. Frischer. 2008. "A Digital Model of the Inca Sanctuary of the Sun," in *Beyond Illustration: 2D and 3D Digital Technologies as Tools for Discovery in Archaeology*, edited by B. Frischer and A. Dakouri-Hild (Oxford) 106-110.
- Junker, H. 1913. *Das Götterdekret über das Abaton* (Vienna).
- Kähler, H. 1975. "Zur Herkunft des Antinousobelisken," *Acta ad Archaeologiam et Artium Historiam Pertinentia* 6:35-44.
- Lafaye, G. 1881. "Un monument romain de l'étoile d'Isis. Bas-relief inédit du Musée Kircher," *Mélanges d'archéologie et d'histoire*, 1:192-214.
- Lanciano, N. 2003. *Villa Adriana tra cielo e terra. Percorsi guidati dai testi di Marguerite Yourcenar* (Sant'Oreste).
- Liverani, P. No date. "La diffusion et la localisation du culte d'Antinoos à Rome et en Italie," in *Antinoos: la fabrication d'un dieu (Égypte, Asie mineure, Grèce, Rome, Latium)*. Séminaire, Paris 3 octobre 2009, I.N.H.A., 2 rue Vivienne, Salle Mariette. In press.
- Lopez-Menchero, V.M. and A. Grande. No date. "The Principles of the Seville Charter," published online at: <http://cipa.icomos.org/fileadmin/template/doc/PRAGUE/096.pdf> (seen November 1, 2015).

- Magli, G. and J.A. Belmonte. 2009. "Pyramids and Stars, Facts, Conjectures and Starry Tales," in *In Search of Cosmic Order. Selected Essays on Egyptian Archaeoastronomy*, edited by J.A. Belmonte and M. Shaltout (Cairo) 305-321.
- Magli, G. 2013. *Architecture, Astronomy and Sacred Landscape in Ancient Egypt* (Cambridge).
- Malaise, 1972. *Les conditions de pénétration et de diffusion des cultes égyptiens en Italie*, *EPRO* 22 (Leiden).
- Mangurian, R. and M.A. Ray. 1993. "A Modern Survey of an Ancient Roman Villa," *P.O.B.-Point of Beginning*, 18, number 6 (August-September 1993) 10-20.
- Mangurian, R. And M.A. Ray. 2008. "Re-drawing Hadrian's Villa," *Perspecta* 41, *Yale Architectural Journal*, 103-116.
- Mari, Z. 2002-2003. "L'Antinoeion di Villa Adriana: risultati della prima campagna di scavo," *RendPontAcc* 75:145-185.
- Mari, Z. 2003-2004. "L'Antinoeion di Villa Adriana: risultati della seconda campagna di scavo," *RendPontAcc* 76:263-314.
- Mari, Z. 2010. "L'Egitto a Villa Adriana: l'Antinoeion e la cosiddetta Palestra," in *Villa Adriana. Una storia mai finita. Novità e prospettive della ricerca* (exhibition catalogue), edited by M. Sapelli Ragni (Milan) 129-133.
- Mari, Z. 2012. "Antinoo a Villa Adriana," in *Antinoo. Il fascino della bellezza*, edited by M. Sapelli Ragni (Milan) 78-91.
- Mari, Z. and S. Sgalambro. 2007. "The Antinoeion of Hadrian's Villa: Interpretation and Architectural Reconstruction," *AJA* 111:83-104.
- Merkelbach, R. 1963. *Isisfeste in griechisch-römischer Zeit. Daten und Riten* (Meisenheim am Glan).
- Meyer, H. 1991. *Antinoos. Die archäologischen Denkmäler unter Einbeziehung des numismatischen und epigraphischen Materials sowie der literarischen Nachrichten* (Munich).
- Morentz, S. 1973. *Egyptian Religion*, translated by A. E. Keep (Ithaca, New York).
- O'Mara, P. 2003. "Censorinus, the Sothic Cycle, and the Calendar Year One in Ancient Egypt: The Epistemological Problem," *JNES* 62:17-26.
- Naville, E. 1892. *The Festival-Hall of Osorkon II in the Great Temple of Bubastis* (London).
- Parker, R.A. 1950. *The Calendars of Ancient Egypt* (Chicago).
- Pinch, G. 2003. *Handbook of Egyptian Mythology* (Santa Barbara, Denver, Oxford).
- Raeder, J. 1983. *Die statuarische Ausstattung der Villa Hadriana bei Tivoli* (Frankfurt am Main, Bern).
- Robinson, M. 2009. "On the Calculation of the Dates of the Rising and Setting of Stars," *Classical Philology* 104:354-375.
- Romeo, P. 2007. "Ancora sull'obelisco adrianeo del Pincio," *AANSA*:92-98.
- Salza Prina Ricotti, E. 2000. *Villa Adriana. Il sogno di un imperatore* (Rome).
- Salza Prina Ricotti, E. 2002-2003. "La ricerca della 'tomba' di Antinoo a Villa Adriana," *Atti della Pontificia Accademia Romana di Archeologia*, serie III, *Rendiconti* 75:113-144.
- Schaefer, B. 1985. "Predicting Heliacal Risings and Settings," *Sky & Telescope*, September, 1985:261-263.
- Schaefer, B. 1986. "Atmospheric Extinction Effects on Stellar Alignments," *Archaeoastronomy* 10:32-42.
- Schaefer, B. 1993. "Astronomy and the Limits of Vision," *Vistas in Astronomy* 36:311-361.

- Servajean, F. 2011. "Le conte des Deux Frères (2). La route de Phénicie," *ENIM* 4:197-232.
- Sgalambro, S. 2002-2003. "Gli elementi architettonici dell'edificio ad esedra di Villa Adriana: identificazioni e ipotesi ricostruttive," *RendPontAcc* 75:425-447.
- Sgalambro, S. 2003-2004. "L'area monumentale dell'Antinoeion a Villa adriana: osservazioni sul contesto e sulle tecniche costruttive e architettoniche," *RendPontAcc* 76:315-343.
- Sgalambro, S. 2010a. "Il contesto e l'architettura del cosiddetto Antinoeion a Villa Adriana," in *Tradition and Transformation: Egypt under Roman Rule*, edited by K. Lembke, M. Minas-Nerpel, S. Pfeiffer, *Proceedings of the International Conference* (Leiden, Boston) 385-414.
- Sgalambro, S. 2010b. "Pianta di Villa Adriana redatta dalla Scuola degli Ingegneri di Roma," in *Villa Adriana. Una storia mai finita. Novità e prospettive della ricerca*, edited by M. Sapelli Rangi (Milan) 172-173.
- Shaltout, M. and J.A. Belmonte. 2005. "On the Orientation of Ancient Egyptian Temples: (1) Upper Egypt and Lower Nubia," *Journal for the History of Astronomy* 36:273-298.
- Shaltout, M., J.A. Belmonte and M. Fekri. 2007. "On the Orientation of Ancient Egyptian Temples: (3) Key Points in Lower Egypt and Siwa Oasis," *Journal for the History of Astronomy* 38:141-160 and 413-442.
- Sternberg-El Hotabi, H. 1999. *Überlieferungsgeschichte der Horusstelen. Ein Beitrag zur Religionsgeschichte Ägyptens im 1. Jahrhundert v. Chr.* I: Textband. II: Materialsammlung, *Ägyptologische Abhandlungen* 62 (Wiesbaden).
- Teeter, E. 1997. *The Presentation of Maat. Ritual and Legitimacy in Ancient Egypt* (Chicago).
- Teissier, B. 1996. *Egyptian Iconography on Syro-Palestinian Cylinder Seals of the Middle Bronze Age* (Göttingen).
- Tolmatcheva, E.G. 2003. "A Reconsideration of the Benu-bird in Egyptian Cosmogony," in *Egyptology at the Dawn of the Twenty-first Century*, edited by Z. Hawass, *Proceedings of the Eighth International Congress of Egyptologists Cairo, 2000*, II (Cairo) 522-526.
- Toomer, G.J. 1998. *Ptolemy's Almagest, translated and annotated* (Princeton).
- Tran Tam Tinh, V. 1992. "Le baiser d'Helios," in *Alessandria e il mondo ellenistico-romano: studi in onore di Achille Adriani*, edited by N. Bonacasa and A. Di Vita, vol. II (Rome) 318-328.
- van den Broek, D.R. 1972. *The Myth of the Phoenix: According to Classical and Early Christian Traditions*, *EPRO* 24 (Leiden).
- Voisin, J.L. 1994. "Antinoös 'varius, multiplex, multiformis'," in *L'Afrique, la Gaule, la religion à l'époque romaine. Mélanges à la mémoire de Marcel Le Glay*, edited by Y. Le Bohec, *Collection Latomus* 226 (Brussels) 730-741.
- Wallert, I. 1962. *Die Palmen im alten Ägypten: eine Untersuchung ihrer praktischen, symbolischen und religiösen Bedeutung*, *MÄS* 1 (Berlin).
- Wells, R. A. 1985. "Sothis and the Satet Temple on Elephantine: A Direct Connection," *Studien zur Altägyptischen Kultur* 12:255-302.
- Winter, E. 1997. "Ägyptologisches zum Antinoos," in *Ägypten-Bilder. Akten des "Symposiums zur Ägypten-Rezeption"*, edited by E. Staehelin and B. Jaeger, *Orbis Biblicus et Orientalis* 150 (Freiburg, Göttingen) 97-102.
- Ytterberg, M. 2005. "The Perambulations of Hadrian. A Walk through Hadrian's Villa" (Dissertation in Architecture, University of Pennsylvania).

- Zotti, G and W. Neubauer 2012. "Virtual Reconstructions in a Desktop Planetarium for Demonstrations in Cultural Astronomy," in M. Ioannides, D. Fritsch, J. Leissner, R. Davies, F. Remondino, and R. Caffo, editors, *Progress in Cultural Heritage Preservation, Proceedings of the 4th International Conference EuroMed 2012, Limassol, Cyprus, Oct. 29–Nov. 3, 2012*, volume 7616 of *Lecture Notes in Computer Science* (Heidelberg) 170-180.
- Zotti, G. 2014. "Towards Serious Gaming for Archaeoastronomical Simulation," *Mediterranean Archaeology and Archaeometry* 14:271-281.
- Zotti G. 2015. "Visualization Tools and Techniques," in *Handbook for Archaeoastronomy and Ethnoastronomy*, edited by C. L. N. Ruggles, volume 1 (New York) 445-457.

FIGURES

Figure 1. Plan showing parts of Hadrian's Villa referenced in the article. North is to the left. 1. Antinoeion. 2. Canopus. 3. Serapeum. 4. Grand Vestibule. 5. Three Exedras. 6. Pecile. 7. Slope above Antinoeion. 8. Michilli property. 9. Double access road. 10. and 11. Area where six Egyptianizing statues now in Gregorian Egyptian Museum were found, according to F. Piranesi. Detail of site map of Hadrian's Villa by Matthew R. Brennan, Virtual World Heritage Laboratory, Indiana University.

Figure 2. Plan of the Antinoeion, North is to the left. (1) Exedra. (2) Temple A. (3) Temple B. (4) Base for obelisk (?). (5) Pronaos of Temple C. (6) Cella of Temple C. (7) East Portal. Map by Matthew R. Brennan, Virtual World Heritage Laboratory, Indiana University.

Figure 3. Telamones (‘‘Cioci’’) from Hadrian’s Villa in Sala a Croce Greca, Pio-Clementine Museum, Vatican Museums, inventory nos. 196, 197. Photographs: B. Frischer, with kind permission of the Vatican Museums.

Figure 4. Harpocrates, Capitoline Museums, inventory n. MC0646, illustrated in A. Penna, *Viaggio pittorico della Villa Adriana* (Rome 1836), vol. 3, table 57.¹⁵⁶

¹⁵⁶ For a photograph, see:

http://www.museicapitolini.org/collezioni/percorsi_per_sale/palazzo_nuovo/salone/statua_di_arpocrate

Figure 5. Antinous-Osiris, Vatican Gregorian Egyptian Museum, inventory n. 22795. Photograph B. Frischer with kind permission of the Vatican Museums.

Figure 6. Pincian Obelisk. Photograph B. Frischer.

Figure 7. Drawing showing fragments of Egyptianizing relief found in excavations of the Antinoeion. Courtesy of Z. Mari.

Figure 8. Relief with Hathoric capital found in excavations of the Antinoeion. Courtesy of Z. Mari

Figure 9. Plan of Hadrian's Villa with indication of eighteenth century property lines. Yellow=Jesuit property. Orange=property of Count Fede. Green=Liborio Michilli property. Courtesy of Z. Mari.

Figure 10. Drawing with axonometric view of reconstruction of the Antinoeion. Courtesy Z. Mari.

Figure 11. Screen shot of Unity simulation showing the Pincian Obelisk with a scarab finial. Credit: IDIA Lab, Ball State University.

Figure 12. Egyptianizing crater from Hadrian's Villa. Capitoline Museums (inv. 29); drawing of the two sides unwrapped.¹⁵⁷ Credit: Courtesy of Erica Bassignani.

¹⁵⁷ For a photograph, see <http://capitolini.info/scu00029/>

Figure 13 (left). Positional sunrise on the summer solstice (5:15 AM CET, June 24, 131 AD) in Unity. Note the schematic representation of the sun, which lacks atmospheric refraction. The sunrise is positional because the horizon is blocked by the Building with Three Exedras across the street from the Antinoeion. The view is shot off-axis because the trunk of the obelisk blocks the view of the sun, if we stand on axis with it. Credit: IDIA Lab, Ball State University.

Figure 14 (right). Positional sunrise on the summer solstice (5:13:43 CET, June 24, 135 AD) in Stellarium. Note that the sun is more realistic because of Stellarium's atmosphere model. The structure just to the right of the sun is the Building with Three Exedras. The Colle Ripoli is seen 2.5 km off in the distance.

Figure 15. View of Stellarium model of Temple C at sunrise on the summer solstice (June 24, 135 AD). With no obelisk in the Antinoeion, the sunlight illuminates the cult statue in the cella. Note that we have cut a window into the back wall of the cella to facilitate astronomical observation. We do not claim that such a window (for which there is no archaeological evidence) actually existed.

Figure 16. View of Stellarium model of Temple C at sunrise on June 24, 135 AD. If there was an obelisk in the Antinoeion, its shadow (red arrow) falls on the axis of the facade. Note that we have cut a window into the back wall of the cella to facilitate astronomical observation. We do not claim that such a window (for which there is no archaeological evidence) actually existed.

Figure 17. View of Stellarium model showing the stars of the Antinous asterism (red arrow) on axis behind the cella of Temple C. Date: November 27, 134 AD; time: 17:35:00 CET. Note that: (1) we have cut a window into the back wall of the cella to facilitate astronomical observation. We do not claim that such a window (for which there is no archaeological evidence) actually existed. (2) Antinous is no longer officially accepted as constellation. We show figures of Antinous and Aquila (the Eagle) from Bode's *Uranographia* (1801).

Figure 18. View in Stellarium from the platform between temples A and B looking toward Temple B at midnight of November 24, 134 AD. Atop the center of the pediment of Temple B (red arrow) is seen Sirius (yellow arrow). Note that the image has been brightened in Photoshop to enhance legibility.

Figure 19. View of Stellarium model showing that if there was an obelisk in the Antinoeion, its shadow (red arrow) was projected onto the middle of the facade of Temple A each morning in the period from November 17 to January 26. Illustrated here is the morning of November 27, 134 AD.

Figure 20. View of Stellarium model showing that if there was no obelisk in the Antinoeion, then on the morning of Antinous' birthday (November 27, 134), but also in the weeks following, sunlight enters the cella of Temple A and illuminates the cult statue (here restored as Harpocrates). The red arrow points to the shadow of the gable of Temple B, pointing toward the entrance of Temple A and thereby adding to the focus on the cult statue.

Figure 21. Antinoeion. Base of obelisk (?). Photograph: Z. Mari.

Figure 22. Antinoë. Planter cut into tuff for date palms. Photograph: Z. Mari.

Figure 23. Sirius in the Stellarium model seen from a position (red arrow) in front of the object (e.g., obelisk) on the platform at the crossing of the sanctuary's two axes. Sirius is observed just to the right of the peak of the pediment (green arrow) of Temple B at 18:33:24 CET on February 17, 134 AD.