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A SEMI-ACCURATE STAR MAP: AN ANALYSIS OF THE ATHENS ZODIAC CIRCLE

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Abstract

Within the collection of the National Archaeological Museum in Athens is a small marble plaque from ancient Egypt engraved with a circular depiction of the night sky and the signs of the zodiac (inventory number: NAM ΑΙΓ 109). Very little work has been undertaken to analyse this artefact, and very little has been published about it. It has been suggested that the Athens 'Zodiac Circle' is a copy of a much larger representation of the night sky, such as the Dendera Zodiac which is now in the Louvre in Paris. However, a careful and critical comparison of these two relief carvings demonstrates that the one in Athens cannot be a copy of the Dendera Zodiac. Furthermore, an analysis of aspects such as the orientation of the constellations, their azimuth and altitude angles, and their angular size, as they are depicted on the Athens Zodiac circle, shows that one half of the engraving is more accurately rendered than the other. Further analysis shows that this is due to the Athens Zodiac Circle being a representation of the midnight sky on one of the most important days of the ancient Egyptian year – the beginning of the Summer Solstice.

Keywords: Zodiac, Athens, Astronomy, Solstice, Dendera

1. Introduction

The National Archaeological Museum in Athens, Greece contains many wonderous artefacts. One of the more curious items on display can be found as part of the collection of Egyptian antiquities in Room 40 in the north-east corner of the ground floor. Within a display of artefacts labelled as relating to The Roman Period in Egypt 30 BC – AD 395, can be found a 'marble plaque with the zodiac circle' (inventory number: NAM ΑΙΓ 109). This item, which appears to depict a view of the constellations of the night sky, has been the subject of a very limited amount of scholarly examination (and many visitors to the museum seem to just walk past it). However, a careful examination of the relief carving displayed on the marble plaque shows that, while the depiction of the night sky is quite inaccurate in many ways, it was designed to represent the night sky at a particular time of year – the advent of the Summer Solstice.

The object is an engraved marble slab containing a carving in relief. The relief is in the form of a circle, 27 cm in diameter, with two more, concentric,

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circles set approximately 2 cm and 4 cm respectively inside the circumference of the outer circle. The top and bottom of the slab are damaged, and there is a fracture in the bottom-left corner, but the whole circle design is intact (Figure 1).

Figure 1. Ancient Zodiac Circle in the National Archaeological Museum, Athens, inv: NAM ΑΙΓ 109, [image used with the permission of the Hellenic National Archaeological Museum, Athens. Photo by C. Matthew].

An inscription, in roughly rendered hieroglyphs, runs between the two outer most circles. The inscription begins in-line with an image in the main field that is taken to represent the constellation Orion and seems to read: “The apex of the house / that divine pair of sisters / stairway of the house of the two gods.” The meaning, and even the translation, of this passage is indeterminate as, according to Zyhlarz: “the inscription suffers from a lack of meticulous carving, which seemed indispensable for Ptolemaic-era art, and can no longer be precisely grasped in its context” [1]. The middle ring contains three symbols that are not quite evenly distributed around the circumference which may be indicative of the three seasons of the ancient Egyptian year (see following). The main field of the

engraving (20.5 cm in diameter) contains what seems to be a view of the night sky, looking towards the zenith with the polar stars in the centre, the signs of the zodiac, and several other constellations. Set out between the zodiacal constellations and the middle ring are images that are taken to be deities or decans – figures representing a ten-day segment of the year. All of the engravings are quite crude in their rendering. There are characters that look like hieroglyphs, but are not, it is impossible to determine what some characters and figures are meant to be representing, and there are seemingly random strokes, lines, and squiggles scattered across the field which seem to not be representing anything in particular.

The provenance of this object is not known in any great detail. According to Museum records, it was purchased in Alexandria, Egypt by a Greek merchant sometime in the mid-nineteenth century, and was donated, along with other items, to the National Archaeological Museum in 1869 [1]. The dating of this object is similarly problematic. Klebs dates the relief to the Hellenistic Alexandrian Period of the fourth century BC. Von Büssing, on the other hand, dates it to the third or fourth centuries AD [1]. Gundel similarly dates the carving to the Roman imperial period of the third or fourth century AD [2, p. 208]. Zhylarz suggests that it may be a crude, Gnostic-era (second to third century AD), copy of an older original that may have been made with little understanding of what was being copied [1].

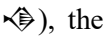
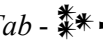
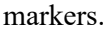
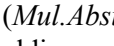
There have only been two publications to date which have referred to this artefact, both of which are in German. The first was *Dekane und Dekansternbilder* ('Decans and Decan-Constellations') by Wilhelm Gundel in 1936. This work examined the depiction of the decans and zodiacal symbols in various engravings and inscriptions from across antiquity, and contains a section on the Zodiac Circle in the Museum in Athens [1]. The examination is relatively brief, contains unreferenced material gained from discussions the author had with others about the artefact (such as on the potential date of the carving), and is mainly concerned with analysing the depiction and placement of the zodiacal signs within the main field of the engraving. The other work to touch on this topic is *Zodiakos: Tierkreisbilder im Altertum* ('Zodiakos: Zodiac Images in Antiquity') written by Hans Georg Gundel in 1992. This work, an examination of the depictions of the zodiac across ancient times, contains a brief entry for the Athens Zodiac Circle with a broader catalogue of examined engravings [2, p. 208]. The entry contains little information that is not found in the earlier work, and contains no analysis. Neither work has engaged in any sort of detailed examination of the engraving, the accuracy of the depictions of the constellations, nor attempted to assign a specific date to the carving.

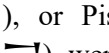
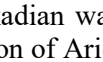
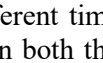
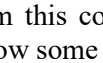
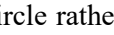
Both works do raise the concept that the Athens Zodiac Circle is a crude copy of a much more detailed original. One possibility is that the Athens Zodiac Circle is a copy of the Dendera Zodiac now housed in the Louvre in Paris. The Dendera Zodiac is a similar, albeit larger, relief carving taken from the ceiling of the portico (or *pronaos*) of a shrine dedicated to the god Osiris with the complex of the temple of Hathor in Dendera, Egypt. Construction of the shrine began in the late-Hellenistic period, but the portico was added during the reign of the Roman emperor, Tiberius, in the first century AD. The relief was removed, and

transported to Paris, in 1821 where it was displayed in a number of locations before finally being sent to the Louvre in 1922 (Figure 2) [3, p. 68-89].

Figure 2. The Dendera Zodiac [Department of Egyptian Antiquities of the Louvre Museum Paris, Room 325, photo by Shonagon, photo license: CC0 1.0 Universal Public Domain Dedication].

The main field of the Dendera Zodiac, like that of the Athens relief, depicts a scene of the night sky centred on the north pole star, the circumpolar constellations, and the signs of the zodiac. Some of the zodiacal signs are portrayed in familiar forms: A ram for Aries, a scorpion for Scorpio, a crab for Cancer, etc. Other constellations are depicted in less familiar forms: a jackal for Ursa Minor, the god Hapy (carrying two water jugs) for Aquarius, and the foreleg of an ox for Ursa Major. Rogers noted similarities between the more unfamiliar representations on the Dendera Zodiac, and those found of Seleucid-era reliefs from the Near East. This led Rogers to conclude that the Dendera Zodiac was a copy of a Mesopotamian zodiac [4]. Hoffman similarly suggested that the Dendera Zodiac displays a Babylonian star-chart with some variations influenced by Greco-Egyptian culture [5].

Early Mesopotamian, pre-scientific, astronomy seems to have been Sumerian in origin and was initially based on the identification of the heliacal rising of four key constellations which marked changes in the seasons [6, p. 15-51]. In the surviving astronomical texts from the time, the name of each constellation was preceded by the word *Mul* () – a pictograph of three stars which designated that the following name was that of a grouping, constellation, or cluster. For example, the rising of the 'Bull of Heaven' (*Mul.Gu.An.Na* - ), the modern constellation of Taurus, signified the beginning of Spring. The rising of the 'Great Lion' (*Mul.Ur.Mah* - ), modern Leo, similarly heralded the coming of Summer. Likewise, the rising of the 'Scorpion' (*Mul.Gir.Tab* - ), or Scorpio, marked the beginning of Autumn, and the 'Ibex' (*Mul.Dis.Ba.As.Pap* - ) was associated with the coming of Winter. The Ibex was later separated into two separate constellations: the 'Overseer' (*Mul.Pa.Bil.Sag* - ), which later became Sagittarius, and the 'Goat-fish' (*Mul.Suhur.Mas* - ), which became Capricorn.

Two further constellations were then inserted in between each of the four seasonal markers. The 'Great Twins of Heaven' (*Mul.Mas.Tab.Ba* - ), or Gemini, and the 'Crab' (*Mul.Al.Lul* - ), or Cancer, were inserted between the positions of the Bull and the Lion. The 'Furrow' (*Mul.Absin* -), which later became identified as a fertility goddess holding a stalk of wheat and then, later still, became the constellation Virgo, and the 'Scales' (*Mul.Zi.Ba.An.Na* - ), or Libra, were inserted between the Lion and the Scorpion. The 'Great Man of Heaven' (*Mul.Gu.La* - ), or Aquarius, was added after the 'Goat-fish' following the separations of the Ibex into two constellations. Finally, the 'Fish' (*Mul.Zib.Me* - ), or Pisces, and the 'Hired Farm Labourer' (*Mul.Lu.Hug.Ga* -), were inserted after the 'Great Man'. The 'Hired Farm Labourer' was often referred to in the contracted form of Lu in Sumerian. The equivalent of Lu in Akkadian was Immeru, or 'sheep', and the 'Labourer' morphed into the constellation of Aries [6; 7, p. 22-29; 8, p. 5-17].

2. Depictions

From these ancient astronomical accounts and records, it is possible to compare how the zodiacal constellations, and other constellations, were depicted across different time-periods of early Mesopotamian culture, and how they are depicted on both the Dendera Zodiac and the Zodiac Circle in Athens (Table 1 and Figure 3).

From this comparison, it becomes clear that there are many differences between how some of the constellations are depicted on the Athens Zodiac Circle compared to their portrayal on the Dendera Zodiac and in some eras of Mesopotamian astronomy. Virgo, for example, is depicted as a field on the Athens Zodiac Circle rather than a goddess. This is the same as in early Mesopotamian

Table 1. Comparative data for representations of constellations in early Mesopotamia, on the Dendera Zodiac, and on the Athens Zodiac Circle.

	Early Mesopotamian Astronomy	**Late Mesopotamian Astronomy**	**Dendera Zodiac**	**Athens Zodiac Circle**
Circumpolar Constellations				
Ursa Major	Foreleg of an ox	Foreleg of an ox	Foreleg of an ox	Foreleg of an ox
Ursa Minor	Wolf on a plow	Wolf on a plow	Wolf on a plow	*Indeterminate*
Draco	Bipedal hippo	Bipedal hippo	Bipedal hippo	Bipedal hippo
Zodiacal Constellations				
Scorpio	Scorpion	Scorpion	Scorpion	Scorpion
Libra	Scales	Scales	Scales	Scales
Virgo	Field	Goddess	Goddess	Field
Leo	Lion	Lion	Lion	Lion
Cancer	Crab	Crab	Crab	Crab
Gemini	Twins	Twins	Twins	Chevron (joined hands?)
Taurus	Bull	Bull	Bull	Bull
Aries	Hired man	Sheep	Sheep	Ram's head?
Pisces	Fish (tied)	Fish (tied)	Fish (tied)	Fish (not tied)
Aquarius	God with 2 jugs	God with 2 jugs	God with 2 jugs	2 circles with a cross between
Capricorn		Goatfish	Goatfish	Goat
Sagittarius		Mounted archer	Mounted archer	Archer with hind of goatfish
Some Other Constellations				
Canis Major		Sothis Cow	Apis Bull	Cow or Bull
Hydra		Flat serpent	Barge?	Undulated serpent
Bootes		Encircled man	Encircled man	Geometric shape
Lupus		Wild boar and abyss (separate)	Wolf and abyss (joined)	Wolf and abyss (separate)
Cygnus/Lyra		Standing god (Zabada) with mace	Standing god with mace	Mace? Feather?
Equus		Horse	Horse	Horse
Orion		True Shepherd of Anu	Standing god	Cartouche?
Cassiopeia	Old Man with Crook	Baboon with falcon	Baboon With falcon	Angled feather?

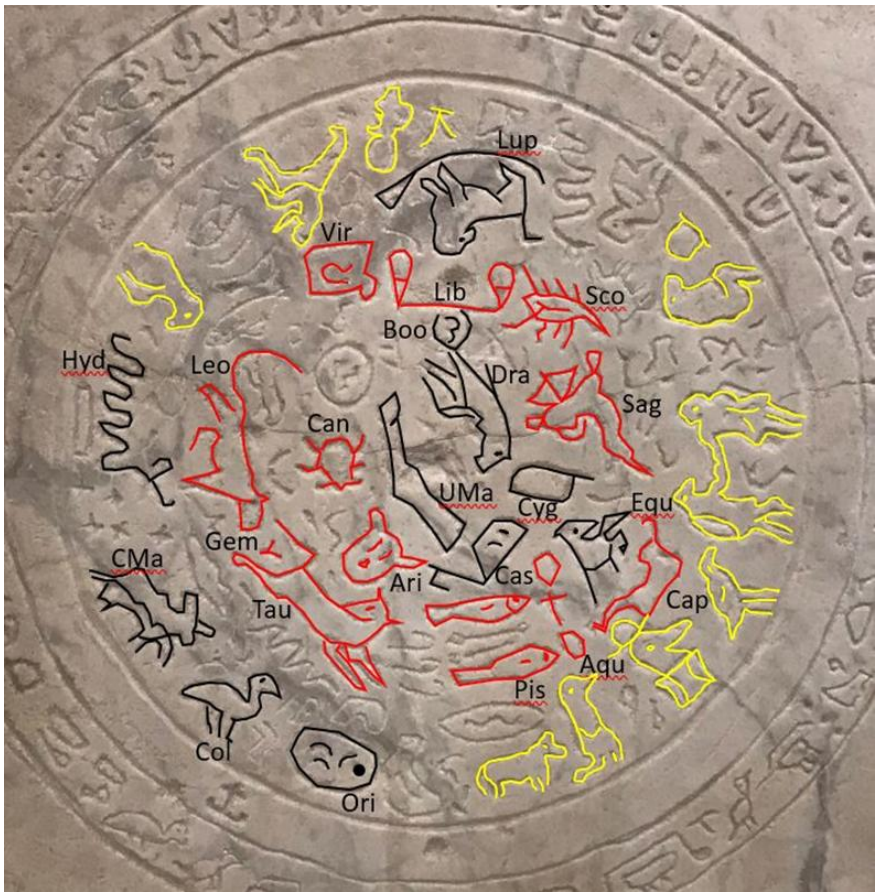


Figure 3. The Athens Zodiac Circle with zodiacal constellations (red), other constellations (black) and identified Decans (yellow).

astronomy and different from how the constellation is depicted on the Dendera Zodiac. Leo is depicted in a similar way on both the Dendera Zodiac and the Athens Zodiac Circle, with the only difference being that the lion itself is standing on a barge in the Dendera imagery, and is not in the Athens imagery. In both cases the lion is accompanied by a smaller figure – a raven on Dendera, and an indeterminate figure near the lion's tail in Athens. The crab of Cancer is depicted similarly on both the Dendera and Athens engravings and even share a similar, and incorrect positioning – with the constellation being placed inside of the zodiacal circle.

The constellation of Gemini seems to be depicted as a simple chevron on the Athens Zodiac Circle rather than as a pair of twins. However, on the Dendera Zodiac, the twins are shown holding hands. The basic chevron may be in emulation of the shape created by the two extended arms and joined hands of the divine siblings. One of the biggest differences between the Athens Zodiac Circle and all other depictions can be seen in the representation of the constellation of

Aries. On the Athens Zodiac Circle the constellation is depicted neither as the hired man from early Mesopotamian astronomy, nor is it depicted as a whole sheep/ram as in later Mesopotamian astronomy and on the Dendera Zodiac. Rather, Aries seems to be depicted on the Athens Zodiac Circle as a frontal view of the head of a sheep/ram. Gundel suggested that this image was that of a bull's head for Taurus, and the elongated, striding, animal beneath it was that of Aries [1]. However, this seems to be incorrect. The iconography for the constellation labelled as Aries by Gundel, exactly matches that for Taurus on the Dendera Zodiac (which has Aries clearly represented separately as a sheep). Aries is also positioned incorrectly on the Athens Zodiac Circle – being positioned inside the zodiacal circle similar to the crab of Cancer. This error in positioning also appears on the Dendera Zodiac.

The fish of the constellation Pisces are not tied together on the Athens Zodiac Circle as they are on the Dendera Zodiac, but the fish themselves are parallel in both instances. Another major stylistic difference can be seen in the representation of the constellation of Aquarius on the Athens Zodiac Circle where it is not anthropomorphised as on the Dendera Zodiac and in Mesopotamian astronomy, but is merely represented by two crudely cut circles connected by a cross – a style of representation otherwise unknown in Egyptian imagery [1]. In early Mesopotamian astronomy, Aquarius, known as the 'Great Man of Heaven', was depicted with arms extended and with an overflowing pot of water in each outstretched hand. The representation on the Athens Zodiac Circle may be a crude representation of this figure as seen from above.

Capricorn seems to be very crudely represented on the Athens Zodiac Circle and it is uncertain whether the iconography in meant to portray the goat-fish as per Mesopotamian astronomy and the Dendera Zodiac, or just a goat as per Greco-Hellenistic astronomy. Regardless, one noticeable difference is that, on the Athens Zodiac Circle, the head of the animal seems to be looking back along its body, whereas, on the Dendera Zodiac, the head of the goat-fish is looking forward. The other possibility is that the animal figure above that is actually the depiction of Capricorn and not Equus (see following). The crude nature of the depiction of Sagittarius also makes it difficult to decipher. Gundel interprets the image as being that of a Greco-Hellenistic centaur at full gallop with bow and arrow [1]. This would be similar to the depiction of this constellation on the Dendera Zodiac – although, the Dendera imagery has the figure wearing a crown, possessing a pair of wings, and with a small barge under its forelegs – elements that are all absent from the Athens image. The bow is also depicted differently in both images. It is also possible that the image of Sagittarius on the Athens Zodiac Circle has been incorrectly taken from an early source – possibly an oral tradition or a written version. The hind quarters of the Sagittarius figure are very similar to those of the goat-fish of Capricorn. Both Sagittarius and Capricorn had originally been combined into the constellation of the Ibex, but separated into two distinct constellations in later Mesopotamian history. Capricorn also seems to be represented as a simple goat, rather than a goat-fish, on the Athens Zodiac Circle. It is possible that the creator of the Athens Zodiac Circle knew (somewhat vaguely) of the separation of the Ibex into Capricorn and Sagittarius, but has

placed the fish-like hind section onto the incorrect constellation when the engravings were made. Scorpio is similarly portrayed on both the Dendera Zodiac and the Athens Zodiac Circle – although the tail of the scorpion is longer on in the Dendera imagery. Libra is also depicted similarly in both reliefs.

For the circumpolar constellations, both Ursa Major and Draco are depicted similarly on the Athens Zodiac Circle to the way they appear on the Dendera Zodiac – as the foreleg of an ox, and as a bipedal hippopotamus, respectively – although their renderings are a lot cruder. Bootes is depicted as an encircled figure sitting on the crossbar of the scale of Libra in the Dendera Zodiac. On the Athens Zodiac Circle, this place is occupied by a geometric shape enclosing a line which looks like the modern number three. This is most likely a very basic rendering of the same design. The remaining circumpolar constellations, Cassiopeia, Cygnus, and Equus, are all depicted very differently on the Athens Zodiac Circle compared to the Dendera Zodiac. Cassiopeia, for example, is depicted as a seated baboon with a crowned falcon on its head in the Dendera Zodiac, but is shown as an unidentifiable shape that looks like a bent feather on the Athens Zodiac Circle. Cygnus, is depicted as a standing male figure holding a mace on the Dendera Zodiac, but is shown as a feather (Gundel calls it a hatchet [1]) on the Athens relief. Finally, Equus seems to be shown as a small, quadrupedal animal, on the Dendera carving. The constellation is also shown as a quadruped on the Athens Zodiac Circle, but with much higher detail with the tail being clearly visible, and the head turned to look back over its body. Gundel takes this to be the icon for the Ibex/Capricorn [1].

Of the non-zodiacal constellations, there are a lot of differences in the representation of Hydra. In Mesopotamian astronomy, this constellation was generally seen as an outstretched serpent. This depiction then seems to have evolved into the barge that the lion of Leo is standing on in the Dendera Zodiac. However, Hydra is depicted as a two-headed, undulating, serpent on the Athens Zodiac Circle, and it is uncertain where the concept for this depiction has come from as it does not correlate with any earlier examples. Gundel sees this as a representation of the Egyptian deity, Chnuphis, portrayed as a snake, resting on a pedestal, with its head raised and wearing a crown [1]. Regardless of what the representation is meant to depict, it is interesting to note that the image for this constellation is placed towards the outer edge of the main field on the Athens Zodiac Circle whereas, in the Dendera Zodiac, this region is occupied by some of the Decans that represent parts of the year.

Following Hydra are a set of five stylised stars. Gundel interprets these stars as the constellation Orion [1]. However, this seems unlikely as it would place Orion in an incorrect part of the sky. Canis Major, Columba, and Orion are, like Hydra, also depicted in the outer area of the main field in the Athens Zodiac Circle, following the five stars. Canis major is depicted as a standing cow or bull. This iconography is most likely derived from earlier representations where the constellation is portrayed as the seated Apis Bull in the Dendera Zodiac, or as the Sothis Cow in Mesopotamian astronomy. Next comes a bird which must be a representation of the constellation of the Dove (Columba). Next, following a number of indeterminate lines and shapes, comes what appears to be a cartouche

which would represent Orion. This greatly differs from the iconography on the Dendera Zodiac where Columba is depicted as a sceptre surmounted by a crowned falcon, and Orion is represented by a standing crowned king holding a *Was Staff*. Importantly, if the cartouche does represent Orion, this would mean that the symbol in the middle ring of the Athens Zodiac Circle, which looks a bit like a modern anchor, must be indicative of the northern winter solstice which occurs in late December when Orion is overhead at midnight in the night sky. Lupus is depicted almost identically on the Athens Zodiac Circle as it is on the Dendera Zodiac – with the animal's tail erect, and with its head looking back along its body. The main difference in these two portrayals is that, in the Dendera Zodiac, the wolf rests its forepaws on an oblong shape representing the Abyss. On the Athens Zodiac Circle, on the other hand, the wolf stands above a shape similar to that of a flowering reed. If the head of the reed is representative of the Abyss, the separation of it from the wolf would make the Athens depiction closer to the separated versions found in Mesopotamian astronomy – although, even here, Mesopotamian descriptions have the Abyss shaped like an oblong, closer to the Dendera imagery.

Many of the remaining figures in the outer area of the field correlate with some of the Decans found on the Dendera Zodiac (marked in yellow in Figure 3). Starting from Orion and moving anti-clockwise, two upright Decan figures are missed on the Athens Zodiac Circle, but then both contain a small quadrupedal animal shaped like a boar, followed by a kneeling figure, and then a ram's head herm with a sun-disc crown. Eight Decans from the Dendera Zodiac are missed before coming to the image of a bird (duck?). On the Dendera Zodiac, this figure is below Aquarius, but on the Athens Zodiac Circle, it is below Capricorn. Five more Decans from the Dendera Zodiac are missed before coming to a pair of figures holding hands which are below Sagittarius in both engravings. Then another Decan is missed – although it may be the indeterminate lines on the Athens Zodiac Circle – before coming to the figure of a seated baboon. Next on the Dendera Zodiac is an animal-headed herm with a sun-disc crown. On the Athens Zodiac Circle, only the crown is shown. Next comes a bird and a snake on the Athens engraving, both of which do not appear on the Dendera Zodiac. There is an indistinguishable shape just below the hind-quarters of Lupus on the Athens Zodiac Circle, and then the next two shapes may be representative of the crowns worn by the Decans below Lupus in the Dendera Zodiac. Next comes a seated figure below Virgo which is also shown on the Dendera Zodiac, and was seen as Ninmah (a Sumerian mother-Goddess) in Mesopotamian astronomy. Following Ninmah are another set of symbols, including a fish and possibly an eye, none of which appear on the Dendera Zodiac. Next on the Athens Zodiac is what appears to be a bird-like figure which may be a poor rendering of the falcon-headed god Horus as it appears on the Dendera Zodiac. From this point on, all other Decans from Dendera are omitted and the space in the outer area of the main field of the Athens Zodiac Circle is occupied by the constellations Hydra, Columba, Canis Major, and Orion. There are several other figures and shapes on the Athens Zodiac Circle – such as the circle near the tail of Leo, the undulating line under Taurus, the hooks near the head of Taurus, the ellipse under Pisces, and

the quadruped animal below Scorpio – which do not readily correlate with any figures on the Dendera Zodiac or in Mesopotamian astronomy and the meaning of what they represent is far from clear.

As such, it can be concluded that the Athens Zodiac Circle cannot be a copy of the Dendera Zodiac. There are simply too many differences between the two relief carvings to conclude that one is a copy of the other. The only way that such a conclusion could be reached would be by accepting that the Athens Zodiac Circle was an extremely bad copy of the Dendera Zodiac. This would suggest that the Athens Zodiac Circle had been made prior to the construction of the portico in the temple at Dendera in the 1st century AD. However, does this lack of any correlation mean that the Athens Zodiac Circle is totally inaccurate? A further analysis of the iconography on the Athens relief, and a comparison to modern constellations, not only highlights some of the additional errors contained within its depiction of the night sky, but also demonstrates parts that the creator of this caving got right. Additionally, this further analysis shows that many of the errors found in the Athens Zodiac Circle can be accounted for due to the particular day that the engraving is attempting to represent, and that most of the errors found occur in a part of the Zodiac Circle that depicts a region of the night sky that would not have been visible at the time.

3. Orientation

One means of comparison is by examining the general orientation of the zodiacal constellations as they appear on the Athens Zodiac Circle, and comparing these orientations to both the Dendera Zodiac and a modern star map for the northern hemisphere. The orientation of each constellation was determined by drawing a line from the position of the North Celestial Pole through the centre of the constellation. Another line was then drawn from the centre of the constellation along the long axis of the constellation. In the case of constellations that are represented by a single figure or animal (such as Leo, Taurus, Scorpio etc.), this second line was drawn in the direction of the head – regardless of which way the head may be actually facing. In the case of Virgo, which is represented as a field on the Athens Zodiac Circle, the short axis of the field was taken. For Aries, depicted as a ram's head, on the Athens Zodiac Circle, the line running across the head was taken as the central axis. In the case of Libra, the line ran parallel to the cross-bar of the scales. In the case of both Gemini and Pisces, the line bisected the Twins and Fish respectively. In the case of Aquarius, which is represented on the Athens Zodiac Circle as two circles connected by a cross, the upright of the cross was used as the main axis (Figure 4).

Using this method, the following orientation angles were measured on the Athens Zodiac Circle, The Dendera Zodiac, and on the modern star map (Table 2).

Figure 4. Determination of the orientation angle for Leo, Gemini, and Taurus on the Athens Zodiac Circle.

As can be seen in Table 2, there is little correlation between the images on the Athens Zodiac Circle and the Dendera Zodiac. This strengthens the argument that the relief in Athens is not a copy of that from Dendera. Despite these differences, there are, however, some correlations between the images on the Athens Zodiac Circle and the actual sky. The orientation of the depictions of the constellations Capricorn, Sagittarius, Scorpio, Leo, and Gemini on the Athens Zodiac Circle, for example, all closely align with how the actual constellations appear in the sky. The differences in orientation for the depictions of the constellations Pisces, Aquarius, Virgo, and Aries can be, in part, accounted for by the different ways they are depicted on the Athens Zodiac Circle compared to how the shape of the constellation is seen in modern times. Both Libra and Cancer are depicted on the Athens Zodiac Circle in a manner similar to their modern counterparts, but their orientation is different by a considerable number of degrees. This may be true errors on the part of the design of the Athens Zodiac Circle due to the particular day of the year that the whole field of the relief is attempting to represent (see following). It is also possible that these constellations

were based on different stars in ancient times compared to how they are viewed today. The constellation of the 'Bull of Heaven' (modern Taurus), for example, which has a difference in orientation of 20° between its depiction on the Athens Zodiac Circle to the actual sky, still had the star Aldebaran and the Hyades cluster as part of its head, but was otherwise based on a different configuration of stars which only made up the animal's horns [6, p. 15-51]. This raises the possibility that the image that is taken for the constellation of Taurus on the Athens Zodiac Circle due to the similar iconography found on the Dendera Zodiac, is actually the ram of the constellation Aries, and that the image taken as the head of a ram/sheep for Aries is really the head and horns of the constellation of Taurus. The differences in orientation for these two constellations is the same, so altering the labelling of them would make no difference. Interestingly, all of the constellations that are on the Athens Zodiac Circle that differ from their modern counterparts do so by approximately 20°. It is possible that some of these constellations are, like Taurus, similarly based on a different selection of stars.

Table 2. Comparison of orientation angles of the zodiacal constellations.

	Athens Zodiac Circle	Dendera Zodiac	Modern Star Map
Pisces	90°	70°	75°
Aquarius	20°	0°	0°
Capricorn	90°	90°	90°
Sagittarius	80°	80°	85°
Scorpio	70°	50°	70°
Libra	90°	70°	150°
Virgo	60°	0°	80°
Leo	90°	90°	95°
Cancer	270°	200°	0°
Gemini	20°	0°	20°
Taurus	90°	130°	110°
Aries	90°	260°	110°

4. Angular size

The size of the depictions of each constellation, relative to the full circle of the main field of the relief carving, can also be used as a basis for comparison for the accuracy (or not) of the Athens Zodiac Circle. To determine this 'angular size', two lines were drawn emanating from the location of the North Celestial Pole, and passing across the forward and rear of the image for each constellation respectively. The angle that these two lines created could be measured (Figure 5).

Similar lines were drawn on an image of the Dendera Zodiac and on a modern star map so that these angles could also be determined. Using this method, the following angular sizes were measured on the Athens Zodiac Circle, The Dendera Zodiac, and on the modern star map (Table 3).

Figure 5. Determination of the azimuth angle for Taurus on the Athens Zodiac Circle.

Table 3. Comparison of angular sizes of the zodiacal constellations.

	Athens Zodiac Circle	Dendera Zodiac	Modern Star Map
Pisces	38°	34°	41°
Aquarius	13°	9°	38°
Capricorn	26°	25°	24°
Sagittarius	45°	25°	34°
Scorpio	28°	20°	28°
Libra	37°	28°	25°
Virgo	20°	20°	45°
Leo	50°	40°	31°
Cancer	35°	30°	11°
Gemini	5°	37°	24°
Taurus	54°	55°	34°
Aries	35°	23°	14°

The comparative data in Table 3 shows that neither the Athens Zodiac Circle, nor the Dendera Zodiac, can be considered accurate in terms of the angular sizes of the constellations depicted on their respective fields. With the exception of Capricorn and Scorpio, most of the other constellations are depicted either too small, or too large, on both reliefs. In terms of the examination of the Athens Zodiac Circle, it is interesting to note that the depictions with the smallest errors in regard to angular size, those of Pisces, Aquarius, and Capricorn, in the lower-right quadrant, are depicted too small. Some of this, for Aquarius, for example, is a result of how the image was rendered. Sagittarius and Libra, on the other hand, both in the upper-right quadrant, are both depicted too large by around 10°, and with Scorpio depicted relatively accurately between them. The remainder of the constellations are depicted either incorrectly large, or incorrectly small, by amounts in a range of ±19°-25° – in some instances due to how the constellations were depicted – as in the case of Virgo. The lower margins of error for the depictions of the constellations in the upper-right half of the Athens Zodiac Circle may be a result of what was actually visible in the night sky at the time the carving was crafted (see following).

5. Azimuth

Another means of comparing the depictions of the sky is by determining the angle around the horizon (the azimuth) that each constellation is given. This was done by drawing a line from the North Celestial Pole (NCP) up through the constellations of Bootes, Libra, and Lupus on the Athens Zodiac Circle. This line was then taken as representing a 0° azimuth. An Image of the Dendera Zodiac, and a modern star map for the Northern Hemisphere, were similarly oriented and had 0° azimuth lines drawn on them. Lines could then be drawn from the NCP through the centre of each constellation, on each image, and the angle of this central line measured clockwise from the 0° azimuth line (Figure 6).

Using this method, the following orientation angles were measured on the Athens Zodiac Circle, The Dendera Zodiac, and on the modern star map (Table 4).

As can be seen in the data in Table 4, the Dendera Zodiac seems to be a much more accurate representation of the constellations in terms of how they are positioned around the celestial sphere. The worst positioned constellation on that relief is that of Cancer, which differs from its real position by 20°. However, the remainder of the constellations are within a range of 0° – 15° of their true positions, with five constellations (Scorpio, Libra, Gemini, Taurus and Aries) lining up perfectly. The Athens Zodiac Circle, on the other hand, seems much less accurate. The worst positioned constellation on the Athens Zodiac Circle is that of the incorrectly placed Aries, which differs from its true position by 55°. However, the imagery on the Athens Zodiac Circle is relatively accurate for the placements of Sagittarius, Scorpio, Libra, and Virgo, and then again for the seemingly misplaced Cancer, and the under-drawn Gemini. This may simply be due to where in the field the images for these last two constellations have been

Figure 6. Determination of the azimuth angle for Taurus on the Athens Zodiac Circle.

Table 4. Comparison of azimuth angles of the zodiacal constellations.

	Athens Zodiac Circle	**Dendera Zodiac**	**Modern Star Map**
Pisces	165°	130°	135°
Aquarius	140°	100°	115°
Capricorn	120°	75°	85°
Sagittarius	70°	50°	65°
Scorpio	35°	25°	25°
Libra	0°	0°	0°
Virgo	330°	325°	330°
Leo	265°	285°	290°
Cancer	260°	280°	260°
Gemini	240°	240°	240°
Taurus	220°	195°	195°
Aries	220°	165°	165°

placed along the azimuth track, rather than how they have actually been carved and represented. For the other accurate constellations, the correlation between their placement on the Athens Zodiac Circle and their location in the real sky seems to be a reflection of what was actually visible in the sky of the night the carving is trying to depict (see following).

6. Altitude

Another aspect of the imagery on the Athens Zodiac Circle that can be examined is how closely (or not) the depictions of each constellation correlate to their altitude in the sky. This is a complex issue as the position of the constellations is constantly changing, and some are not even visible, at certain times of the year. However, images such as those on the Athens Zodiac Circle and the Dendera Zodiac are clearly meant to represent the position of the constellations in the whole sky at once. Similarly, the circular star map found in a modern planisphere is a representation of the whole sky, and what is visible is determined by the rotation of the map, and the blocking of what cannot be seen by the main body of the planisphere which sits over the map. Thus, if the body of the modern planisphere is removed, what remains is a map of the whole sky which is, in many ways, similar to the relief carvings on the Athens Zodiac Circle and the Dendera Zodiac. These three sources can then be compared against each other.

On the modern circular star map, the outer circumference represents the horizon. Consequently, a line drawn from the centre of the map at the point of the North Celestial Pole, extending out to the circumference, covers a 90° arc of the sky. Ninety degrees, divided by the length of the line in millimetres, gives how many degrees are covered by each millimetre. For example, if the line was 90 mm in length, then each millimetre is equal to (90° / 90 mm) 1° of arc. This will be true for any line extended from the centre-point to the circumference. If such a line was then passed through the centre of a constellation on the map, the distance from the North Celestial Pole to the centre of the constellation (in millimetres) can be converted into degrees, which are then subtracted from 90° to give the approximate altitude of the constellation in the sky.

This method of examination was chosen, as opposed to simply measuring the distance from the horizon to the centre of the constellation to determine altitude, as the horizon is not clearly delineated on both the Athens Zodiac Circle and the Dendera Zodiac. On both of these ancient carvings there are the representations on the Decans in the outer part of the main field. As such, the horizon should be just above the level of the Decans. On both the Athens Zodiac Circle, and on the Dendera Zodiac, a horizon circle was drawn so that it was situated just below the constellation of Lupus – one that is common to both reliefs. This then allowed for the method outlined above to be used to compare the ancient representations to the modern sky map (Figure 7).

Using this method, the following altitude for the depictions of the constellations on the Athens Zodiac Circle, the Dendera Zodiac, and for a modern circular star map taken from a planisphere calibrated for Alexandria in Egypt, we determined (Table 5).

Figure 7. Using radial lines, and an arbitrary horizon, to determine the altitude of constellations on the Athens Zodiac Circle.

Table 5. Comparison of the approximate altitude angles of the zodiacal constellations.

	Athens Zodiac Circle	Dendera Zodiac	Modern Star Map
Pisces	27°	34°	54°
Aquarius	31°	4°	39°
Capricorn	8°	8°	33°
Sagittarius	31°	10°	29°
Scorpio	27°	20°	25°
Libra	36°	36°	33°
Virgo	24°	36°	42°
Leo	24°	40°	54°
Cancer	50°	62°	54°
Gemini	23°	58°	54°
Taurus	45°	34°	52°
Aries	23°	30°	57°

These results reveal some interesting correlations between the three sources. Again, it is clear that the Athens Zodiac Circle cannot be a copy of the

Dendera Zodiac as there are too many differences between them. There are only five constellations - Pisces, Capricorn, Scorpio, Libra and Aries - where the comparative results for the altitude fall within a range of 10° or less. The altitudes for all of the remaining constellations differ by a much greater margin. Interestingly, the altitudes for the constellations Virgo and Gemini are much closer to the modern star map on the Dendera Zodiac than they are on the Athens Zodiac Circle. This is most likely attributable to the different way in which both of these constellations are represented on the Athens Zodiac Circle. Of particular interest is that there are a number of other constellations on the Athens Zodiac Circle which are depicted very close to their actual positions. The constellations of Aquarius, Sagittarius, Scorpio, Libra, Cancer, and Taurus at portrayed at elevations with margin of error less than 10° when compared to the modern sky map and any differences may be attributable to an incorrect placement of the artificial horizon on the Athens Zodiac Circle to make these calculations and an error of on a few millimetres in the radius of the artificial horizon circle would result in differences of several degree in the calculations.

This raises a number of points. Firstly, while an initial inspection of the positioning of the images for each constellation on the Athens Zodiac Circle would suggest that both Cancer and Aries are incorrectly placed inside the plane of the ecliptic, it is actually Leo and Aries that are in the incorrect places. Secondly, the image identified as the constellation of Equus has an altitude of approximately 27°. This is very similar to the actual elevation of the constellation of Capricorn. As previously mentioned, Gundel identified this image as Capricorn, and suggested that there were snakes below it [1, p. 191]. This may then be the correct interpretation of these two images. If the former Equus figure is taken as Capricorn, the constellation's Angular size and azimuth angle remain the same, its altitude becomes more correct, but it is orientation alters to 270° which is directly opposite both the Dendera Zodiac and the modern star map. If this is the case, then the initial identification of the figure beneath Capricorn as a goat/ram may just be due to the similar placements for the two figures on the Dendera Zodiac as they share the same altitude. Consequently, with the reattribution of Equus to Capricorn, the constellation of Aquarius, (new) Capricorn, Sagittarius, Scorpio, Libra, Cancer, and Taurus are all in their correct position of the Athens Zodiac Circle compared to a modern star map.

7. Date and time

The result of these analyses is that the Athens Zodiac Circle provides clues as to the specific date it is attempting to represent. From the analyses outlined above, a clear pattern in regards to the accuracy of the depiction of some of the constellations emerges. The representations of Capricorn, Sagittarius, Scorpio, Libra, and Virgo are some of the most accurate. Many of the images for these constellations are correctly oriented in regards to the rest of the sky, two of them (Capricorn and Scorpio) and relatively accurate in terms of their angular size, and many of this grouping have correct azimuth angles and altitudes compared to their modern counterparts. The remainder of the constellations depicted are much less

accurate in terms of their placement, their size, azimuth angle, altitude and orientation. The segment of the main field that contains these less accurate depictions of the constellations also contains images of additional constellations (which must have been known) but inserted into a field that is otherwise occupied by representative Decans. No such anomalous constellations appear in the Deacan field in the same segment as the more accurately depicted constellations. This then suggests that the Athens Zodiac Circle may have been based upon what was in the night sky when the more accurately depicted constellations were all visible. This occurred around the night of June 21st – the eve of the Northern Summer Solstice which marked the beginning of the ancient Egyptian new year, the time of festival of Min, in which the powers of the ruling pharaoh were rejuvenated, and the onset of the time of the annual flood of the river Nile [9, p. 78-83, p. 90-93].

At that time of the year, the sun sets around 8 pm in northern Egypt. A period of twilight extends to approximately 9:30 pm, and the morning twilight begins around 4:15 am. During the evening twilight, the constellation of Leo would have been low in the western sky – beginning to set just after 10 pm. During the rest of the night, Virgo, Libra, Scorpio, Sagittarius, Capricorn and Aquarius would have dominated the heavens. Pisces would have risen in the east in the early hours of the morning. It seems more than a coincidence that the most accurately depicted part of the Athens Zodiac Circle just happens to coincide with the sky as it would have been seen on the most important day of the ancient Egyptian calendar.

As if to confirm this, if a line is drawn across the face of the Athens Zodiac Circle – going from the centre of Virgo, through the point of the North Celestial Pole, and then out through the centre of Aquarius – it neatly divides the main field of the image in half. The right-hand half of this bisection contains all of the constellations that are more accurately rendered. Furthermore, if the right-hand half of the image (that containing the more accurately depicted constellations) is itself bisected, the line of bisection points directly to the symbol in the second ring of the relief. This symbol must be a reference to the Solstice, the New Year, or both (Figure 8).

Furthermore, this view of the night sky – with Virgo partially set in the west, and Aquarius partially risen in the east – is how the sky would have appeared at exactly midnight on June 21st, just as the Solstice/New Year was commencing. This seems to confirm the actual day and time that the image on the Athens Zodiac Circle was attempting to represent, and suggests that the imagery on the Athens Zodiac Circle (in the more accurate half at least) is based upon actual observations of the sky taken at this time.

The basis of the imagery being that of the night sky at midnight on the eve of the Northern Summer Solstice also accounts for many of the irregularities found in the left-hand side of the field. Constellations such as Aries, Taurus, and Orion would have only appeared during the twilight hours of the following morning, and would not have been clearly visible. Gemini, Cancer, Leo, Columba and Canis Major would have all risen after sunrise, and would not have been visible at all. However, the designer of the imagery on the Athens Zodiac Circle clearly knew that such constellations existed, and knew roughly what order they should be

placed in, and where on the map of the sky, but due to the limited viewing of these constellations, accuracy could not be maintained.

Figure 8. Bisection line of the accurate half of the Athens Zodiac Circle pointing to the symbol for the Summer Solstice.

8. Conclusion

One final question remains: what was the Athens Zodiac Circle made for? Was it art? Was it some form of temple decoration like the larger Dendera zodiac? Was it a smaller 'reference map' for some temple official to determine when the Solstice/New Year was approaching? The answers to these questions are not likely to be found except in the realms of speculation. The fact that the Athens Zodiac Circle is a representation of the night sky on the eve of the most important day of the Egyptian calendar does suggest that the imagery is significant, but who it is significant to, and who the Zodiac Circle was made for, remains unanswered. The only thing that can be said with any level of certainty is that the Athens Zodiac Circle is a semi-accurate star map of the midnight sky on the eve of the Northern Summer Solstice.

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