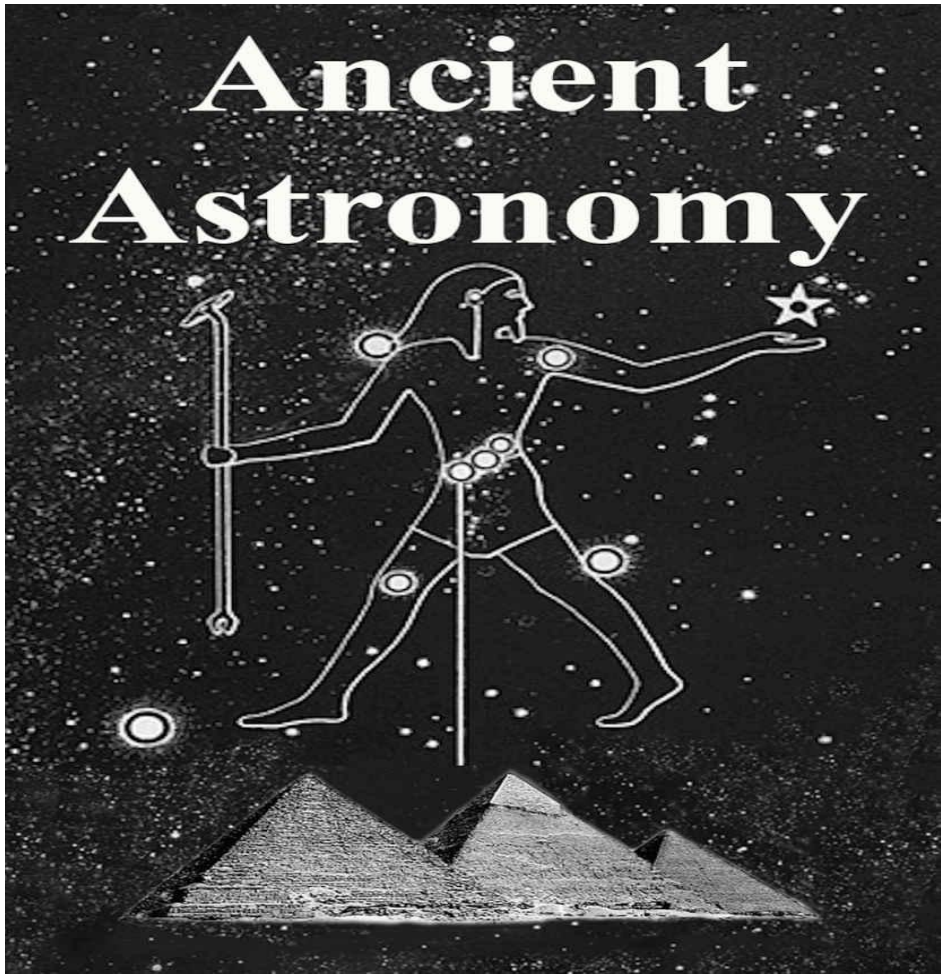
Ancient Astronomy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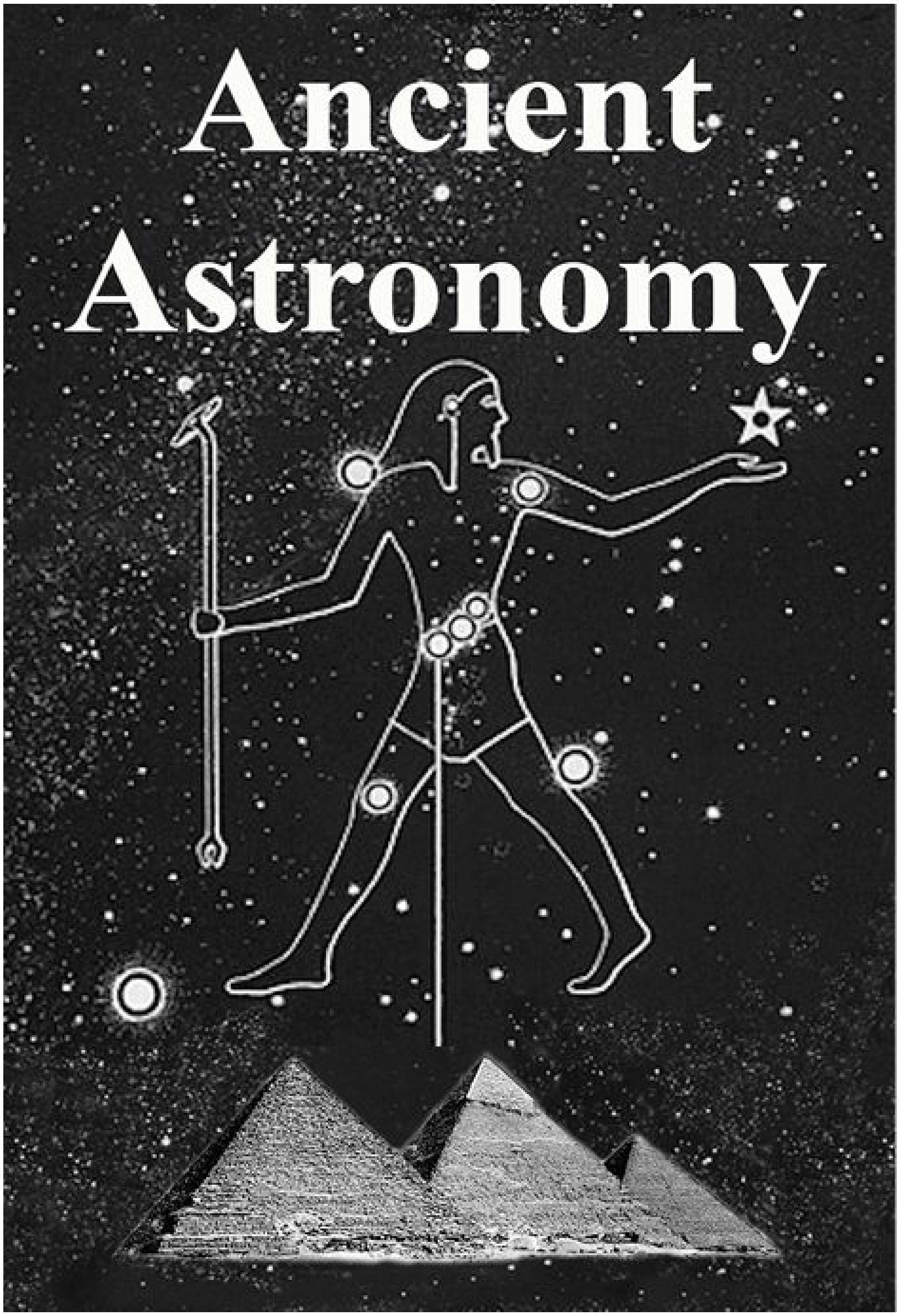
Ancient
Astronomy

Ancient Astronomy of India, Egypt, China, Maya, Inca, Aztec, Greece, Rome, Genesis, Hebrews, Christians, the Neolithic and Paleolithic

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Cosmology Science Publishers (Cambridge)

Published by: Cosmology Science Publishers, Cambridge, MA

Cosmology Science Publishers
Cosmology.com
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Prologue: Ancient Cosmologies: The Paleolithic and Neolithic Universe

Abstract
The origins of astronomy and cosmology may have a history which extends thousands and possibly tens of thousands of years into the past. Evidence of this awareness can be found in ancient caves and underground cathedrals dating from the Paleolithic, in the orientation of Neolithic monuments, and by the design of temples from ancient India and Egypt. This article briefly reviews some of this evidence.

What impresses human's soul the most is the night sky above him and the moral law inside him. --I. Kant

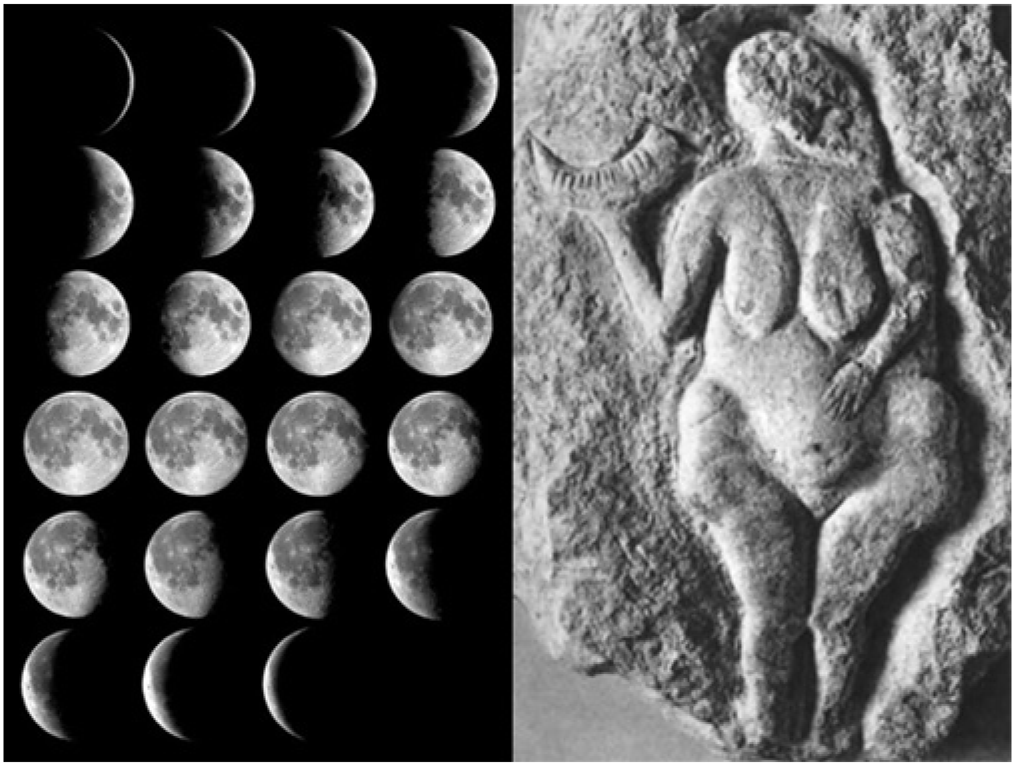
1. Introduction

Astronomy may be a very ancient science, with a history extending so far into the dim past that it origins are all but concealed. However, tantalizing clues have been left deep within the recesses of paleolithic underground cathedrals, caverns which are adorned with symbolic images of the night sky.

Unlike modern humans, where the night sky is shrouded by reflected artificial light, the stars above dominated the world view of Paleolithic humans, as the night was a tapestry of starry light, the meaning of which could only be discerned by their symbolic patterns. Our ancient ancestors, of even a few centuries ago, and certainly during the Paleolithic, lived in the "sublunary world", encapsulated into celestial spheres illuminated by patterns of light.

How the ancients may have conceived of the celestial sphere, is unknown to us, and all we may do is speculate. However, it is clear that the ancient skies were of profound significance, for the peoples of the Paleolithic reproduced the night sky in their paintings and drawings, perhaps eve as long ago as 30,000 BP (Joseph 2010). It is this symbolic "language of sky" which is of the primary interest to us here and this language was first written by prehistoric man, who adorned his underground cathedrals with stars that were filled with life. And not just stars, but constellations, and perhaps symbolic representations of the solstice and equinox (the sign of the cross, Figure 1) and an understanding that the moon (Figure 2) underwent 13 cycles during the course of a solar year (Joseph 2010) and that this was correlated with the female menstrual cycle.

Figure 1. According to Joseph (2010), the cross, painted in bold red ochre upon the entryway to the Chauvet Cave, and dated to over 30,000 years, could be interpreted as a representation of the solstice and equinox which marks the shortest and longest days of the year (December and June) and the beginning of Autumn and Spring and thus an awareness of these solar cycles during the Paleolithic.



Figures 2 and 3 (below). There are 13 new moons in a solar year, and females have 13 menstrual cycles in a year. According to Joseph (2010), the pregnant goddess, the Venus of Laussel, holds the crescent moon in her hand, and the 13 cuts in the crescent moon represent the 13 menstrual cycles and 13 lunar cycles during a solar year, thus demonstrating an awareness of this association 20,000 years ago.

The correlations between earthly events, in particular periodic changes and astral collective movements have been noted surely very early, perhaps over 30,000 years ago, and certainly before as well as during and after the Neolithic. We shall consider here a number of instances where particular toponyms are coupled with celestial objects, mainly with the most prominent of them, the stars and Sun.

2. Megaliths Most of the Paleolithic culture has been preserved in the form of cave paintings and megalithic structures. We shall first consider the issue of extant megalithic sites, with brief case study of several cases, and then analyze some of the most prominent caves and their artistic and/or magical contents.

Whatever their original purpose was, megalithic structures are for the modern archeology considered as messages from our Paleolithic ancestors, a sort of language, just as myths are for anthropologists and (pre)historians. Two phases may be discerned with regard to the technical characteristics of these constructions: (i) Stone age period and (ii) Bronze age phase. In the first undressed stones were used and it was only their mutual positions which were used to convey their purpose and meaning. With the advent of metallurgy, and production of metal tools, Neolithic man was able to shape the megaliths and construct more elaborate structures. It was a sort of historical irony that the metallic tools enable stone as a material to become dominant element of early civilizations. Metallic tools and artifacts have in the meantime vanished, due to corrosion, except under exceptional circumstances, as illustrated by Antikythera mechanism, for instance (Freeth, 2010). We shall briefly analyze a number of the characteristic cases relevant for the astronomy.

3.1. Stonehenge. This complex structure has attracted great interest from the side of astronomers, anthropologists, historians etc. And yet, with accumulation of data and even more of interpretations, our knowledge can hardly be considered advancing. The consensus as to the original (or otherwise) purpose of this imposing structure has been changed from generation to generation, at least as our historical records show. The most popular interpretations appear: (i) religious site, a prehistoric temple; (ii) astronomical observatory, of still unknown complexity. (ii) medical healing centre, something like Hypocration on Kos. But before we go on, it must be stressed that one has to distinguish between the purpose (of constructing) and usage of a ready construction. We are pretty sure today that religious ceremonies like those ascribed to Druids, had nothing to do with the primary purpose of the structure, in particular with the Aubrey's holes. Similarly, if the site was used for curing, as the name of Heel stone (which might well be written as Healstone) might suggest, it could well be a derived usage, profiting from already high reputation of the site.

For our purpose it is worth noticing that the present-day extant (and modeled) structure had undergone several phases of construction, which belonged to generations well separated in time by periods measured by centuries (Brown, 1976). The question arises: if these consecutive additions had different purpose with regards to their astronomical use, why they were fixed to the unique, present-day geographical position? What is so special with the place where Stonehenge was erected? According to our modern inference into astronomical phenomena, if there is something special about this location, it must refer to the geographical altitude. We know that at Stonehenge altitude and only at this one, sighting lines of largest southerly monthly swing of Moon and midsummer sunrise or sunset appear at right angle (Hoyle, 1977). This altitude singularity is somehow connected with the uniqueness of Stonehenge among known Neolithic sites. It raises, on the other hand, the question of completeness of our insight into the prehistory, according to the material remains. Stonehenge appears as unique among other megalith structures as the abovementioned Antikythera mechanism is an extraordinary relict of the ancient civilization and technology. Does it mean that both constructions were unique at their time or they just happened to be persevered up to our time, unlike others from their class? With single pieces of evidence it would be risky to estimate probability single item to be preserved by chance, of course.

3.2. Romania. Uniqueness of a prehistoric object leaves us with much uncertainty as regards its purpose. Otherwise, one might be able to infer from the rest of environment some features hidden from the direct inspection (contextual information). Fortunately for Stonehenge there is another prehistoric monument, at Sarmizegetusa, in southwest Romania, with similar structure.

Figure 5. Sarmizegeusa.

Figure 6. Sarmizegeusa.

There the axis of the horseshoe points towards midwinter sunrise, as compared with the same axis at Stonehenge, which points in the midsummer sunrise direction. No direct connection between Stonehenge and Sarmizegeusa constructions has been established.

3.3. India. Neolithic structures can be found all around India and Pakistan. In Figure 7 we show the megalithic stone circles at Brahmagiri from South India, dated to 900 BC (Rao, 1999; Kak 2010).

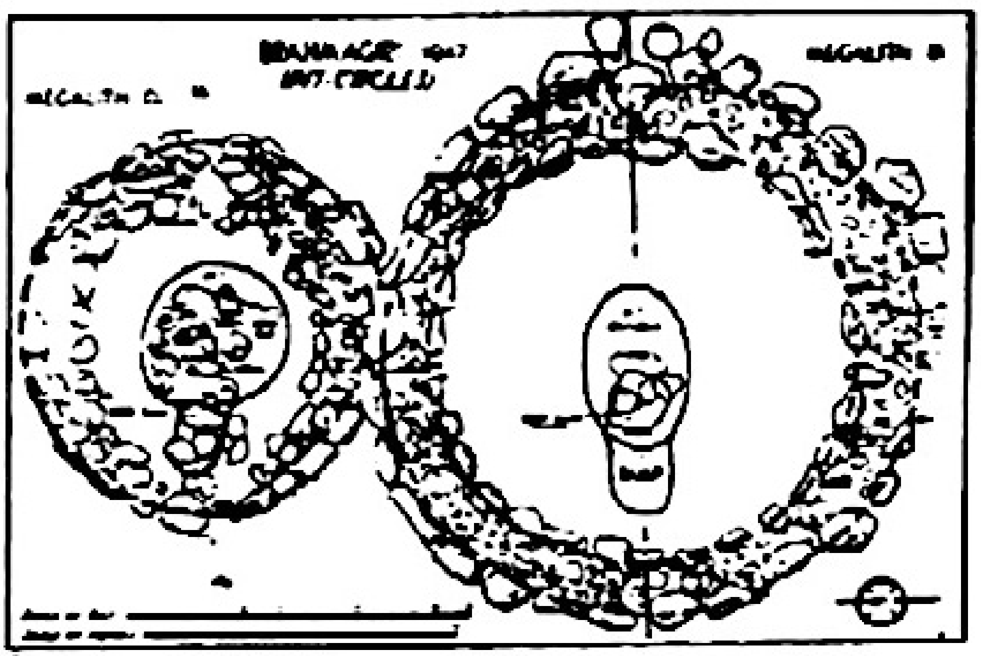


Figure 7. Megalithic stone circles at Brahmagiri (from Kak, 2010).

3.4. Australia In Figure 8 we show Wurdi Youang pre-European stone circle, built by the Wathaurung people, with the major axis pointing East-West. It has been estimated that looking from three prominent waist-high stones some outlying stones indicate the setting positions of the Sun at the equinoxes and solstices (Norris and Hamacher 2009).

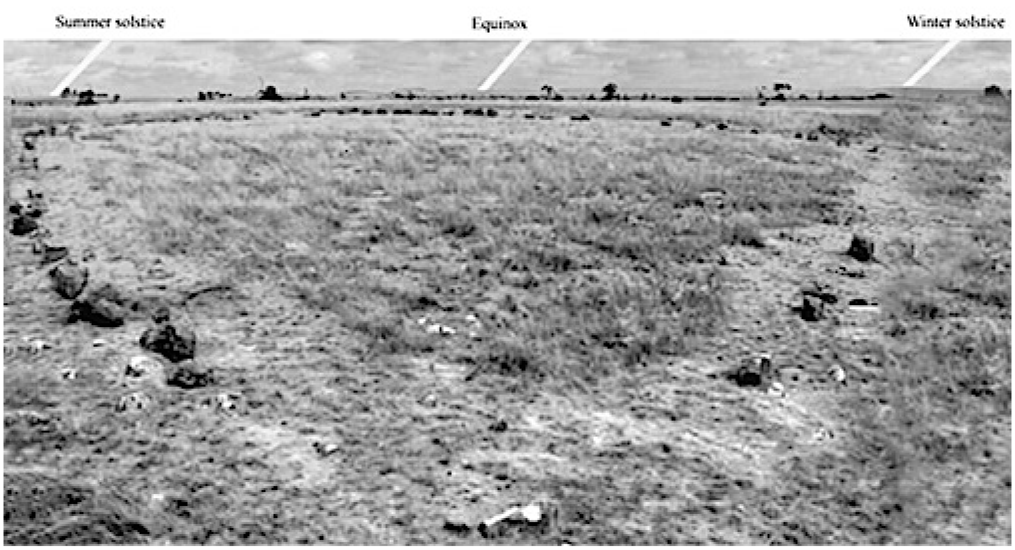


Figure 8. Wurd Youang stone circle.

3.5. Armenia At the Zorats Karer is situated a prehistoric site in Syunic Region. A stone circle, dated from the second millennium BC, see Figure 5, was probably used for the astronomical observations. The largest of the boulders weigh more than 50 tons.

3.4. Australia In Figure 8 we show Wurdi Youang pre-European stone circle, built by the Wathaurung people, with the major axis pointing East-West. It has been estimated that looking from three prominent waist-high stones some outlying stones indicate the setting positions of the Sun at the equinoxes and solstices (Norris and Hamacher 2009).

4. The Cosmology of Caves

Caves are linked with night sky for obvious reason – they appear filled with darkness. If heavenly objects are to be reproduced, caves turn out to be the best places to choose. Their role was at least twofold: (i) as the canvas for paintings and (ii) as container which can "catch the sun-beam" at particular yearly instances, like equinoxes or solstices. Usually both instances used to be combined, so that "chosen cave" was decorated with figures, which we may interpret with astronomical or other meaning.

The earliest connections of the prehistoric man with night sky date from the Upper Paleolithic. At that time, the painted walls caves flourished in several localities, including the North-West Europe. The principal caves are found at south-east of France, in Vezere and Dordogne Valleys, as well as in the Cantabria, Spain. Some of them seem to be occupied by man from -35 000 years. (- sign means before present - BP.)

But before discussing the cave paintings, let us mention an artifact dating also from the Stone Age, the -32 500 old mammoth ivory tablet found 1979 in a cave in Ach Valley in Germany. The carving of a human figure on the tablet, with legs apart, a sword between legs, and arms raised, would correspond to the stars of Orion (Rappenglueck, 2001). The proportion of the human figure would correspond to the pattern of stars of the Orion constellation, representing a part of the prehistoric Cosmos. (Orion was a hunter in Greek mythology).

4.1. Lascaux Cave: This is actually a complex of caves near the village of Montignac, in Dordogne. The wall paintings, estimated -17 000 years old (belonging to the Magdalenien period), consist mainly of realistic images of large animals, mainly horses, bulls (aurochs) and deers. It is important to notice that there are no images of reindeers, the principal source of food for contemporary hunters. Hence the images do not represent hunted animals.

Several wall paintings were related to the night sky by some prehistory researchers. In the Hall of Bulls there are four black bulls or aurochs (a species of an extinct large wild cattle). The largest one is over 5 m long. According to the Spanish researcher Luz Antequera Congregado (doctoral thesis, 1992) the set of painted dots above the shoulder of the bull depicts the Pleiades cluster and the set of dots on the bull face represents the Hyades constellation. Similar interpretations, including the correlations with the constellation of Taurus, are due to Rappenglueck and the American astronomer Frank Edge, as well as to some other researchers. Rappenglueck (1997) has also identified a star map from another painting, in the Shaft of the Dead Man. The eyes of the lying birdman, the bull and the bird represented on this image would correspond to the three stars which were prominent in the spring 17 000 years ago. These are Vega, Deneb and Altair, known as the Summer Triangle, nowadays seen in the middle of the northern summer. Another idea of Rappenglueck is that some of the animal paintings are symbolic representations of the phases of the Moon. The old lunar calendar would consist of groups of dots and squares painted alongside images of bulls, horses and antelopes, depicting the 29-day cycle of the Moon.

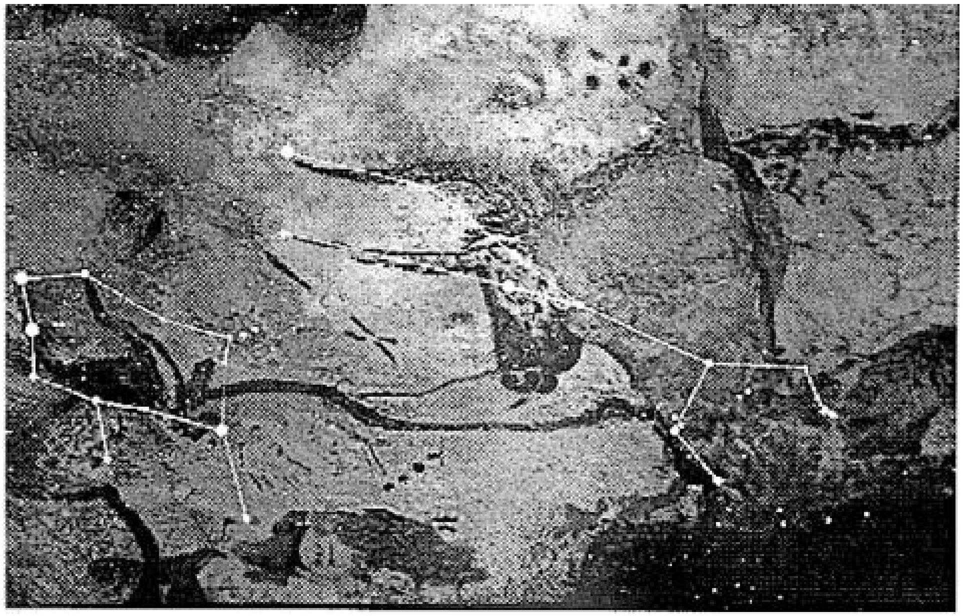


Figure 12. The prehistoric sky-map from Lascaux cave.

Lascaux paintings appear another proof that the beginning of the astronomical science dates before Babylonians (about 5000 BP). French ethno-astronomer, Chantal Jègues-Wolkiewiez noticed that the architectural structure of the Hall of Bulls makes an observer feels encapsulated, as if one watches the night sky motion from a hill. Looking at the various animals painted on the walls she claims one can recognize the zodiacal constellation of the Paleolithic sky (see Figure 10). Making use of computer programs to reconstitute the map of the Magdalenian sky Jègues-Wolkiewiez carried out orientation measurements of the sets of dots and lines represented the painted animals, comparing the archeological and the astronomical data (Jègues-Wolkiewiez, 2005). According to her one can recognize on the cave walls the stars forming the Capricorn, the Scorpio and the Taurus constellations. In the last case, the image of a bull was completed with the stars clusters Pleiades and Hyades. Jègues-Wolkiewiez. finds that the orientation of the cave was of primary importance. The plan and the section of the Lascaux cave entrance show that before the landslide blocked the access to the rotunda, at the time of summer solstice the rays of the setting sun would enter the cave and shine on the walls of the Great Hall of Bulls and on the axial diverticulum.

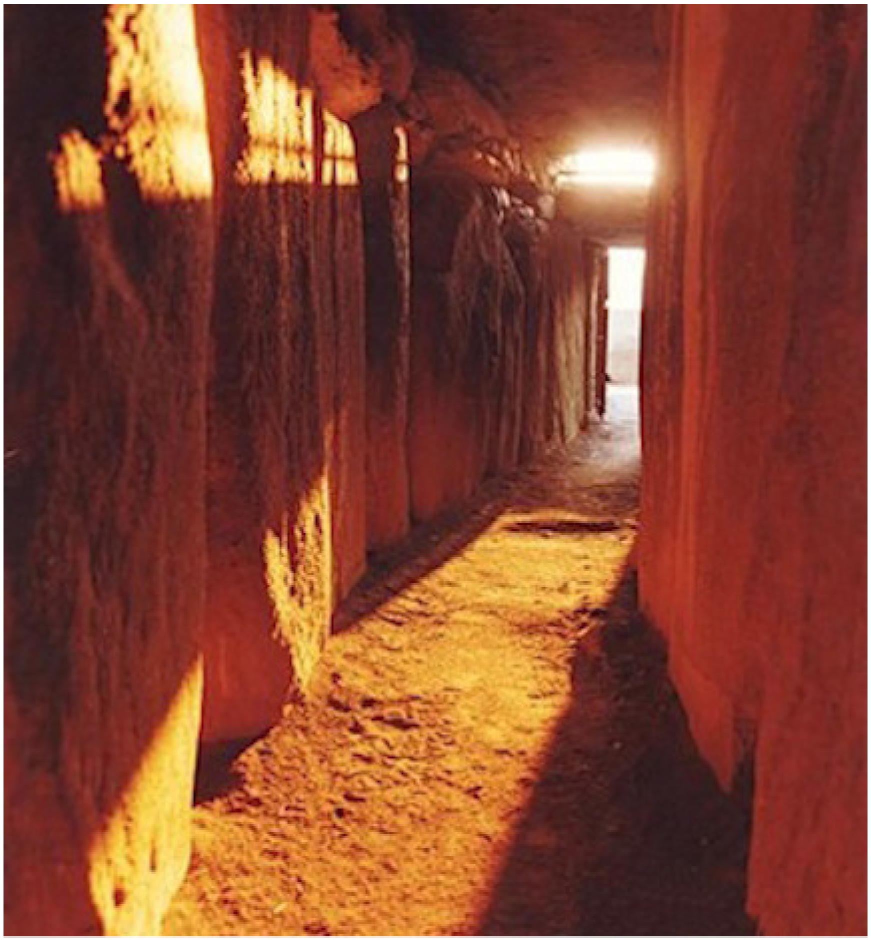
During the summer solstice 1999 Chantal Jègues-Wolkiewiez, and the Lascaux curator Jean-Michel Geneste, confirmed the above hypothesis: the setting sun illuminated completely the interior of the rotunda at the time of the creation of the images. This permitted painting under light during about one hour for several days in the beginning of the summer. Further, Jègues-Wolkiewiez verified that the similar phenomena occurred in other caves beside Lascaux. Actually, she found that the sunlight played the same role in 137 other painted caves as in Lascaux (Jègues-Wolkiewiez, 2007). These caves were aligned with the sunrise or sunset on key days of the year - solstices or equinoxes. The Paleolithic man could keep track of changing seasons by observing the sun sliding along the horizon as the months went by. This was important in connection with the migrations of the large mammal herds that they hunted. The accumulated astronomical knowledge passed from generation to generation without writing, in the "mythological" language of the Paleolithic art. Not only astronomy, but also the mythology and legends of later periods, in Sumeria, Babylonia, Mycenaean and Minoan civilizations and Egypt were most likely derived from the Paleolithic proto-types represented in Lascaux paintings (Brown, 1976).

5. Monuments

That the cave orientation choice was not accidental corroborate other extant structures. We mention here a few of the most famous in that respect.

5.1. Newgrange. This prehistoric building in Ireland, estimated to be constructed about 3000 BC (i.e. somewhat before Stonehenge), is oriented to allow the Sun beam on the winter solstice to pass along the roof elongated space (Brown, 1976).

Figures 13 (above, 14, 15 (below). Newgrange, Ireland.



5.2. Abu Simbel. This monumental rock-cut temple erected by Ramesses II appears a “modern” variant of prehistoric caves. The orientation was chosen with precision allowing the first rays of the rising Sun to illuminate the innermost halls and the sanctuary of the seated statues of the four gods twice a year (22 February and 22 October).

Figures 16 (above) 17, 18 (below). The rock-cut temple erected by Ramesses II and the illumination of the four gods

6. Concluding Remarks

To ancient man, the sky was a book to read, to copy, symbolize and translate into monuments and paintings of living celestial light. Archaeoastronomy, based on observational as anthropological research, examines the roots of our awareness of the Universe, and these roots extend deep into human history, from thousands to tens of thousands of years into the long ago.

Acknowledgements. We thank V. Panković for a number of references and useful discussions. Thanks are also due to S. Lefebvre for her kind interest and many useful references.

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1. Finding Our Place in the Cosmos: The Role of Astronomy In Ancient Cultures

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Abstract

Mircea Eliade (1992) argued that a single view of the starry celestial vault would be sufficient to awake a religious experience. This idea is as true today as in the remote past. Hence, the starry sky has often served as a source of inspiration not just for science, but metaphysics, art, and the creation of symbols of power and identity. Ancient astronomer priests found that uncovering their mysteries allowed, through the mapping of heavens, made possible the development of calendars and navigation. Consequently, astronomy developed as the best tool for determining an accurate and predictable orientation in time and space. Today, as yesterday, starry nights are able to awake our imagination and continue to inspire a desire to discover our place in the cosmos.

1. Finding Our place in the Cosmos: the Role of Cultural Astronomy

Today as in ancient times, astronomers seeking to observe the heavens have journeyed to the summits of the highest mountains, because these are the places where conditions are best suited for astronomical observation. Be it lonely mountain top, or desert, these sites are places which inspire feelings of awe and majesty; a fitting back drop to admire the wonders of the universe. Few specialists have not rested at these ancient observational outposts, under the seemingly endless tapestry of stars, and have not been amazed by their beauty and splendour, because a single view of the starry celestial vault would be sufficient to awake a religious −I would rather say spiritual− experience.

Our ancestors also selected high mountains to study the stars, ideal places from where communication between Earth and Sky was believed possible: the Axes Mundi where feelings of cosmic reality could be experienced. These stars in their endless cycle, returning again and again as they circled the heavens, provided a sense of security, inferring by similarity, rebirth and the transcendence of death. For these and other reasons ancient peoples mapped the firmament in an attempt to find the order where, only in appearance, chaos reigned.

From the mists of time emerged the fully “modern” Cro-Magnon people, Homo sapiens sapiens, with a brain larger on some occasions than modern humans, and the males standing 6 foot tall compared to the shorter Homo Sapiens Neanderthalensis with their apparent inability to produce any semblance of art (Joseph 2002). Cro-Magnon were burying their dead, and creating “Venus” figurines, some representing Earth goddess pregnant with swollen belly, one of them holding a symbol of what might be the moon in her hand (see Fig. 1). Joseph (2002) has argued that the 13 lines cut in this presumable lunar symbol may represent an understanding of the link between women and moon; a woman having nearly 13 menstrual periods and the 13 new-moon cycles in a solar year.

Figure 1. The Venus of Laussel is a 1.5 foot high figurine cut in limestone, between 25,000 to 30,000 years in age. Image courtesy of Joseph (2002).

Thus, we should not be surprised that the rock art in Lascaux (French Dordogne) depict what may be the oldest drawings of the constellations (Antequera, 1994; Rappenglueck, 1999), created more than 16,000 years ago, with the ubiquitous Pleiades −the most international asterism of the firmament (see Fig. 2)− already riding on the back of the great celestial bull (see Fig. 3).

Figure 2. The asterism of the Pleiades. Easily observable at naked-eye, this object has been recognized possibly since the Palaeolithic by every human culture on Earth from Greenland to New Zealand. Image from IAC Archive.

Figure 3. The main freeze of the bulls in the Lascaux Cave in Dordogne. There is a group of dots on the back of the great bull that has seldom and tentatively been identified with the Pleiades. The bull itself would be the earliest representation of Taurus constellation. Photograph by courtesy of M. Rappenglueck.

Figure 4. General view of the remains of Göbekli Tepe, in Turkish Mesopotamia, the oldest stone temple ever erected by human hands. Several of the big excavated circles are visible together with the huge,

decorated T-pillars which are most representative of the site. Photograph by courtesy of M. Sanz de Lara.

Until very recent times, the megalithic monuments in Europe, and in particular Stonehenge, were believed to be the earliest evidence that ancient peoples of the Neolithic sought to link the heavens with Earth and to understand the cosmos. However, in the steppes of Southeast Turkey, on a barren isolated hill called Göbekli Tepe −Hill of the Navel−, a team of German and Turkish archaeologists (Schmidt, 2006) have discovered and are excavating a cluster of stone monuments erected with large pillars in the form of a T and dry-stone walls which suggest that a completely unknown hunter-gatherer society more than 11,000 years ago also sought to create monumental structures linked to the heavens. These series of sanctuaries, built presumably one after the other and even upon one another, may have been used for centuries, perhaps millennia to chart the heavens. However, for reasons which are unknown, the constructors deliberately buried the structures, creating conditions which contributed to their excellent state of preservation in spite of their great antiquity.

These monuments are mostly ellipsoidal in form. Although a favourite orientation may be established for the monument gates, there is no apparent selected pattern (see Fig. 4). However, between the group of monuments, there is one with nearly rectangular walls which were almost perfectly aligned according to the four cardinal points. These discoveries suggest that over 11,000 years ago, an ancient society had gazed into the heavens and used the sky to guide them in the appropriate ways of orientation in space and in time.

Although admittedly speculative, the profuse decoration of the T-pillars may represent yet other astronomical observations, such as the crescent and the star, so common in later cultures of the Middle East and beyond, and an earlier version of which might appear in the Venus figurine which may have been carved over 15,000 years earlier. Then there are what could be interpreted as totemic representations of animals which, if we may continue to speculate, could symbolize constellations, as Leo, Taurus or Scorpios. Certainly these constellations were recognized in the skies of other evolved cultures in the region such as the Sumerians, and their Assyrians and Babylonians heirs, thousands of years later (see Fig. 5).

However, when analyzing the date of Göbekli Tepe, we are facing a problem: their singularity. There is no other preserved monument of the same type where data can be contrasted. From my point of view, scientific research −as jurisprudence, from where the expression is original− should be guided by the premise testis unus, testis nullus. This rule confirms that a single proof of something is like a proof of nothing and we must be very cautious of risking in too adventurous conclusions. Stonehenge was a typical example of this reality. Its singularity made of it, at the beginning in the 1960s, a Neolithic calculator, a predictor of eclipses, or, in short, the oldest "observatory" known (see Ruggles, 1999, for a critical discussion on the topic). However, more recent archaeological studies carried out on site, and in other similar planimetry monuments, have forced contemporary researchers to be much more cautious about their conclusions. Now Stonehenge is interpreted as a funerary monument which includes astronomical alignments among its design, linked to possible ritual purposes associated with the cosmovision of its builders (Parker Pearson, 2008).

Figure 5. A well-preserved kudurru of King Melishipak of Babylon showing several celestial bodies and some of the earliest unmistakable representations of constellations such as the goat-fish, ancestor of Capricornus. Photograph by Juan A. Belmonte by courtesy of the Louvre Museum.

Figure 6. A beautiful snapshot of the Cueva de Menga, the largest megalithic tomb of Europe. Topographically aligned to a distant conspicuous peak −perhaps also according to the moon−, it belongs, however, to a group of monuments with undoubted astronomical

orientations. Photograph by courtesy of M.A. Checa Torres, Parque Arqueológico de los Dólmenes de Antequera.

Actually, when we look at illiterate, extinct cultures, the only way to get a certain degree of confidence in our conclusions is when we analyze multiple but similar items −either monuments or portable objects− within a same archaeological or cultural context, especially when we are able to find a pattern. In this sense, the earliest unmistakable evidence of an interest in the local landscape, including the sky, can be found throughout the megalithic monuments of the Iberian Peninsula (see Fig. 6), notably in the south-western area. In these regions, Neolithic settlers built a series of monuments with a very similar architectural structure −they almost are clones of each other. These are known as Alentejan antas, for the name of the Portuguese region where they are a majority. They have been dated in the fourth millennium B.C. Most important, they show a pattern of orientation that clearly speaks to us of a unmistakable astronomical interest, because all the studied exemplars, without exception (more than 170, Hoskin 2001), are pointing at sunrise −or moonrise in a naïve alternative interpretation (González García and Belmonte, 2010)− at a certain moment in the annual cycle. It is difficult to uniquely establish if the pattern is solar or lunar, as the only movable elements found in the antas, the "plaque idols" −small schist plates with elaborated geometrical decoration−, show patterns illustrating the interest of their builders in both the sidereal month and the seasonal cycle. Summarizing, Alentejan antas certainly show a clear, statistically significant, intention for an orientation in space −for whatever purposes possibly related to an astral eschatology. They also show an orientation to time −perhaps associated with the existence of a lunisolar calendar (Belmonte and Hoskin, 2002).

Figure 7. The large deer of Laxe dos Carballos in Campo Lameiro. The number of tips in their antlers, and the way in which they are distributed, could be a sort of astronomical count. For example, we might postulate a three-year lunisolar cycle (37 lunar months in 3 solar years) if we take into account the three isolated stripes, close to the top of the right horn. Photograph by Juan A. Belmonte.

The existence of a lunisolar calendar related to prehistoric populations of the west façade of the Iberian Peninsula has been recently confirmed by the work carried out in the rock engravings of Galicia, the north-western, Celtic origin, region of Spain. There, among beautiful representations of abstract figurative elements and animals such as deers of different sizes and typologies, our team has conducted an extensive investigative analysis. For example, a collection of large deers, with horns of exceptional proportions with too many tips, suggests that this could be a symbolic representation of astronomical counts −a sort of lunisolar calendar−, showing a fairly accurate knowledge of the movements of the Sun and the Moon (see Fig. 7). The existence of multiple representations with a similar symbology further supports this hypothesis (González García, García Quintela and Belmonte, 2008; Belmonte, García Quintela and González García, 2010). However, the lack of written texts, or any other sort of ethnographic or ethnohistoric information, prevents us from going much further in our conclusions.

Fortunately, there are cultures where we are lucky enough to have such important information. In this respect, the partnership between archaeoastronomical fieldwork along with decades of ethnographic information, collected by anthropologist Edmundo Edwards in Easter Island, has allowed us to establish, without doubt, the importance of certain asterisms in the culture of Rapa Nui ‒singularly Matariki (the Pleiades) or Tautoru (Orion's Belt, see Fig. 8). This circumstance would be reflected in the related orientation of some of Rapa Nui's major ceremonial platforms, the ahus, with their huge statues called moais. The celestial symbolism of the local art and the creation of a calendar that, both in its sacred and profane character, came determined by the visibility or invisibility of these celestial bodies at certain epochs of the year (Edwards and Belmonte, 2004). Part of these conclusions may be nuanced by the chronological difference between the last ahu constructors, in the 17th century, and their current descendants. Unfortunately, the original texts in rongorongo tablets, remain undeciphered so that we can not "speak" to the own sculptors of the moais.

Figure 8. The seven moai of Ahu A Kivi facing the sea at the helical setting of Tautoru (Orion´s Belt) as seen c. 1300 A.D. This astronomical event was one of the markers of the New Year starting in the following new

moon of the rapanui calendar. Image by J.A. Belmonte & SMM/IAC. (From Edwards and Belmonte, 2004).

Figure 9. The evocative "descent of Kukulkan" produced each equinox on one of the steps of American's most famous pyramid, El Castillo, at Chichen Itza. The monument had to be orientated accordingly. Photograph by courtesy of Jesús Galindo Trejo.

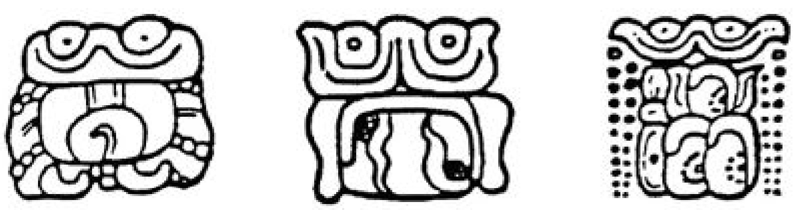

Figure 10. Three Mayan glyphs representing Star Wars. These were normally related to certain attacks upon an enemy city when Venus was at a significant position in the sky. Diagram by courtesy of I. Šprajc.

However, there are a certain number of ancient civilizations, with close ties to sky-watching practices, which fortunately left written texts that thanks to the expertise of linguists we are now able to read and understand. Two unique and illustrative cases would be the Mayan culture and the civilization of ancient Egypt. Based on recently deciphered glyphs, we now know that the Mayan civilization was obsessed by the concept of and the desire to control time. Moreover, most of this civilizations sacred buildings follow orientation patterns which are governed by their most sophisticated calendar system (see Fig. 9); and these celestial calendars promoted actions, as the so-called Star Wars (see Fig. 10), in conjunction with unique events associated with the movement of planets and stars in the heavens (Šprajc, 2001 and 2005).

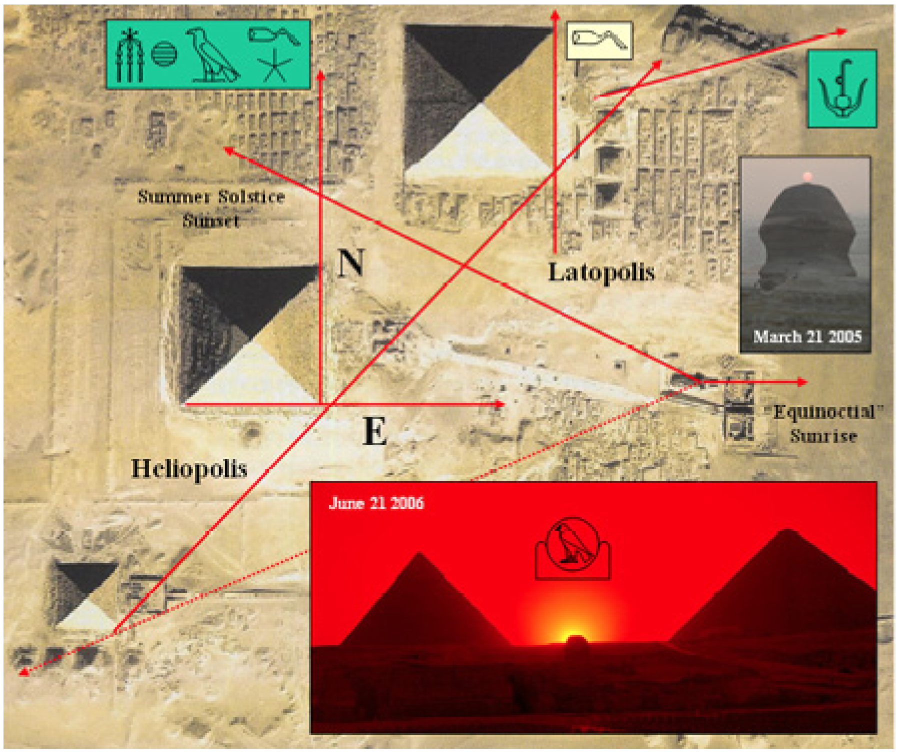

Figure 11. Schematic diagram where we show the astronomical and topographical relationships between the different monuments erected in the Giza Plateau, notably the Sphinx and the pyramids, and certain elements of the sky or nearby geography. The topographic relation with Letopolis and Heliopolis is quite suggestive. However, in this diagram, we additionally relate the original northern orientation of the pyramids, based on the observation of Meskhetyu's meridian transit, to the similar name of the province which had Letopolis as capital, the Bull's Foreleg. Astronomical connections of the Sphinx with equinox sunrise and summer solstice sunset (behind Akhet Khufu, the Horizon of Khufu) are also stressed. Finally, the alignment of Khufu's causeway to Wepet Renpet −New Year's Eve− during his reign is emphasized. Photographs by Juan A. Belmonte. (From Belmonte and Shaltout, 2009).

The culture that the author has devoted much of his time seeking to understand and to research, as reflected in his writing, and which includes several archaeoastronomical missions in the country, is the Pharaonic civilization of ancient Egypt. Thanks to the texts of the pyramids −collection of religious literature of the Old Kingdom− it is known that the ancient Egyptians had already mapped the sky, recognized constellations, asterisms and unique stars, early in the historic period. Furthermore, they saw these objects as celestial destinations of the late king in a real paradigm of stellar eschatology. One of these groups of stars was Meskhetyu, equivalent to the Plough −or Big Dipper− asterism in the constellation Ursa Major. This group of stars was circumpolar during the Old Kingdom and the ancient Egyptians recognized this nature by including it among the "imperishable" stars (the ikhemu sek of the texts) par excellence. They associated this fact to the transcendence of the afterlife, and to such an extent that the two interchangeably recognized elements in the asterism (a bull's foreleg or an adze) were intimately related to certain funerary cult ceremonies such as the "opening of the mouth", which was believed to provide immortality for the deceased. Our fieldwork in the country (Belmonte and Shaltout, 2009), particularly in the fields of pyramids, seem to confirm this fact, especially as Meskhetyu may be the principal celestial object used to align these imposing monuments. Consequently, the architectural arrangement of the pyramids could be a realization in the land of the cosmic order prevailing in the sky (see Fig. 11).

Figure 12. One of our current dreams is to find an exoplanet, or a related moon, with a huge ocean of liquid water where life could survive and evolve. This would probably be the major change in our metaphysical view of nature for generations. Image by courtesy of J. Whatmough.

We could continue ad infinitum our tour of the various forms that have been used to link astronomy and various aspects of culture in the thousands of years of human development. However, we believe that, already at this point, two basic ideas have clearly been expressed in the short essay that I would like to stress as arguable conclusions, indeed open to debate. On the one hand, that the observation of the sky has been, and remains (see Fig. 12), one of the main generators of metaphysics in human thought and, on the other hand, that astronomy has traditionally been the most powerful tool of human beings to reach a proper orientation in time and space. Therefore, our discipline is certainly one of the best guides that humanity had, since the dawn of the species, to find our correct place in the cosmos.

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2. Prehistoric Astronomers? Ancient Knowledge Created By Modern Myth

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Abstract

Elaborate bone artifacts along with spectacular cave art from the Upper Paleolithic represent outstanding achievements of modern Homo sapiens. Decorative items, abstract figurines, and cave art emerge as part of complex symbol systems (Bednarik 1997). It has been argued again and again that some of these artifacts reveal calendaric notation and as such are proof of our distant ancestors' sophisticated minds, their artistic talents and scientific knowledge. Several interdisciplinary works have attempted to identify the Paleolithic origin of certain Greek constellations. The purpose of the paper is to scrutinize and evaluate the methods and arguments of these attempts.

1. Introduction

Paleolithic people depicted the surrounding world in a variety of forms; these represent the earliest monuments of art. The significant appearance and spread of the European Paleolithic works of art can be dated to approximately 30 000 BC. and are considered one of the achievements of the Upper Paleolithic cognitive revolution. The artifacts are categorized as cave art or portable works of art. While artistic creations of this type of mobiliary art have also been brought to light in older contexts [such as Bilzingsleben, Germany; Stránská Skála, Bohemia; Leonardi, Italy], the Upper-Paleolithic era has the greatest number of them. The earliest cave paintings were created about 31 000 years ago (La grotte Chauvet-Pont-d'Arc), the youngest ones about 9000 years ago (La grotte de la Mairie). In addition to being esthetically pleasing to our modern eyes, European Paleolithic cave art has also motivated researchers to attempt to "decipher" the meaning and purpose of the artifacts themselves. Since the 1970s when Alexander Marshack's investigations first appeared in print, astronomy has also played significant role in the study of these, often several ten thousand year-old finds. Although Marshack's arguments concerning the existence of meaningful astronomical knowledge in the Paleolithic were called into question early on and then contravened ten years ago, his assumptions had a significant influence on the direction of future research and still impacts work being carried out today in scientific circles (Joseph 2011). Therefore, films, scientific books and articles frequently portray this profound interest in astronomy which has been attributed to Upper Paleolithic culture.

2. The Carved Bone Artifacts and the Calendar

Figure 1: Abri Blanchard, Dordogne, France. Archaeological Museum, Photo: author.

Figure 2: Cave of Taï, Drôme, France. After Marshack 1991.

The carved-engraved bone plates of mobiliary art were the earliest objects which attracted the attention of researchers. Alexander Marshack (1972) interpreted the various Paleolithic and Mesolithic, mostly portable, objects that bear engraved or painted series of dots or lines as accurate lunar observations. His arguments were based not only on counting the signs but on what he called "microscopic analysis". The interpretation of the markings on various artifacts as notational systems rests on the hypothesis of a slow accumulation of these marks which correlate with lunar or solar motion. Thus he concluded that these artifacts reflect nonarithmetic observational astronomical skills and lore. The most well-known depiction interpreted by him is found on the bone plate about 30 000 years old, from Abri Blanchard (Dordogne, France) which is said to represent the waxing and waning moon positions in serpentine form.

Francesco d'Errico and colleagues developed a different type of methodology (d'Errico 1989). Drawing on experimental archaeology, they compiled a database in an attempt to demonstrate whether the notches represent notational systems or not. After investigating great number of artifacts they concluded that there were some objects which might have depicted parts of a series of complex codes based on the hierarchical organization of information, and using formally differentiated marks. One of these artifacts might be the find from the cave Taï (Drôme, France) whose age is about 10 000 years.

After studying Eurasian portable art the Russian investigator B.A. Frolov also became convinced that these objects were calendars following the monthly motion of the moon and/or yearly solar path, and claimed they were used by early communities. The most well-known bone plate interpreted as a lunisolar calendar is from Ma'lta (Irkutskaya Oblast, Russia).

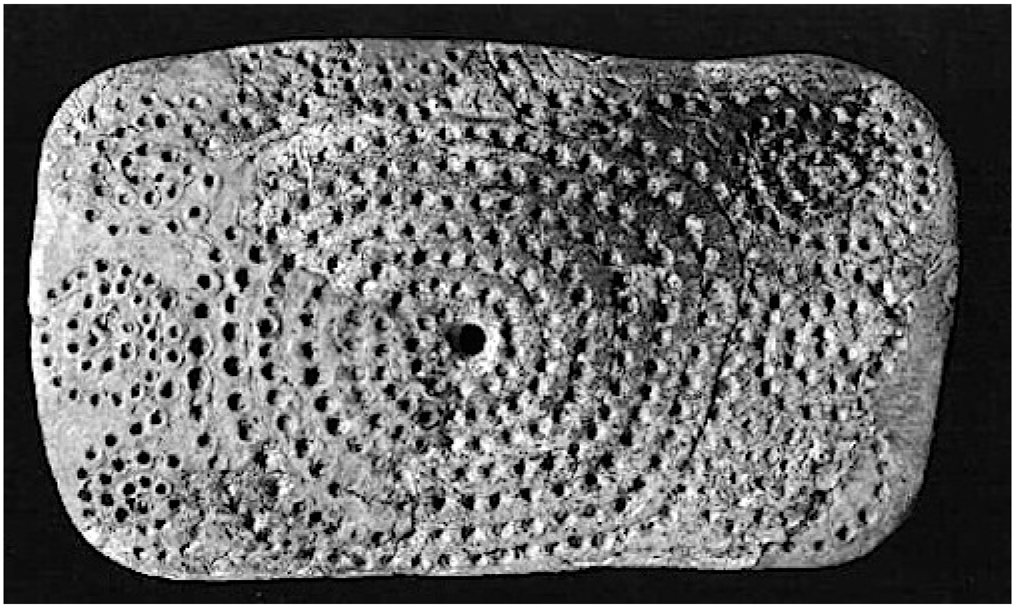
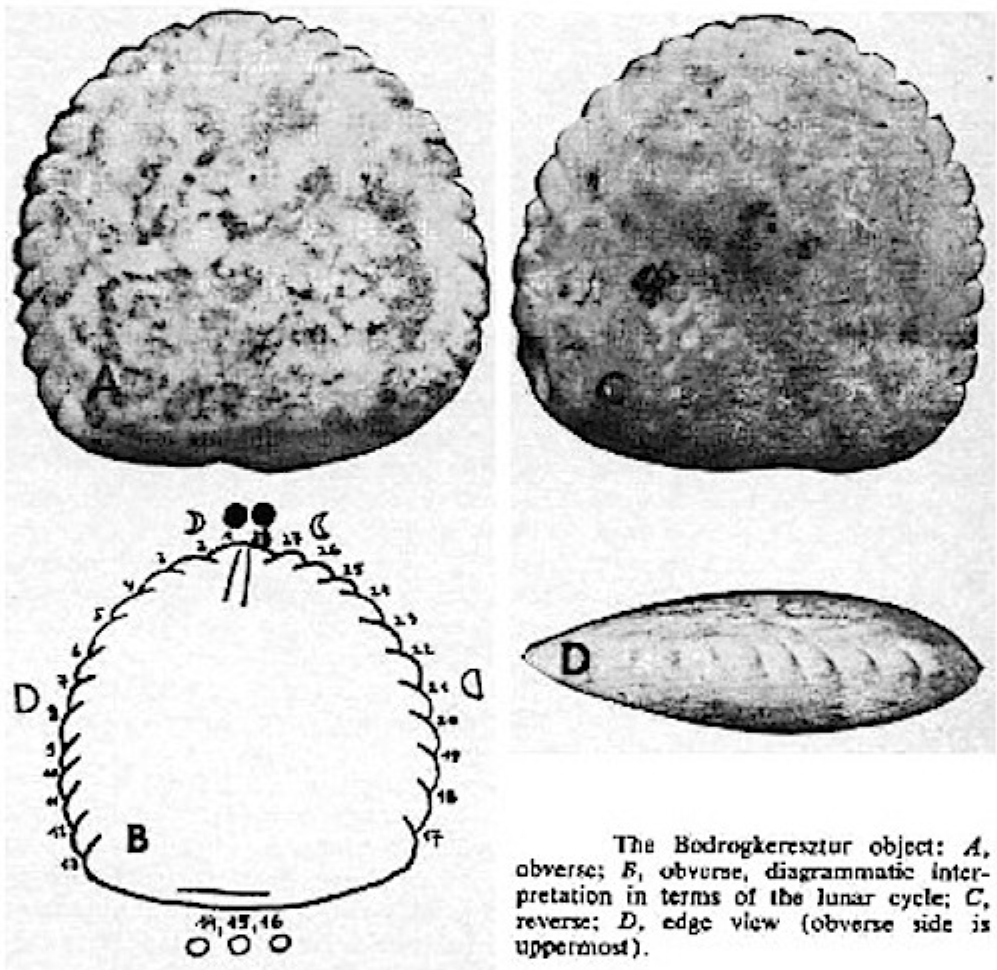


Figure 3: Mal’ta, Irkutskaya Oblast, Russia.

However, not only has the abstract decoration of small objects been interpreted as a type of calendric notation. On the large, smooth well-worn surface of a rock at Abri de Laussel (Dordogne, France), faint, fragmentary reliefs of several human characters were discovered among them that of a curved standing figure of a female holding a bison horn engraved with 13 strokes. This number is assumed to have a relation to the moon and the depiction to the notion of pregnancy (Joseph 2011). The creators were supposedly aware of the connection between the periodicity of the menstrual cycle and the moon.

Alexander Marshack’s arguments had an impression even on Hungarian researchers. László Vértes, the internationally recognized palaeontologist, published a description of a small artifact made of carved limestone, found in an excavation at Bodrogkeresztúr-Henye, Hungary, in 1963. He claimed that it represented a uterus with lunar calendric notations. The find can be (Vértes 1965) dated to the middle part of the Upper Paleolithic Period and is about 27 000 years old.



The Bodrogkeresztur object: *A*, obverse; *B*, obverse, diagrammatic interpretation in terms of the lunar cycle; *C*, reverse; *D*, edge view (obverse side is uppermost).

Figure 4: Bodrogkeresztur-Henye, NE-Hungary. After Vértes 1965.

The possible existence of a notational system is not in itself evidence for the existence and use of a calendar. According to Francesco d'Errico, Alexander Marshack's classification was based on Marshack's own intuition and in reporting his results, Marshack manipulated the number of marks and sequences in order to achieve an accumulation correlated to the motion of the sun or moon (d'Errico 1989). For calendric purposes, the notational system requires the object to have recognizable reference points, some visually distinctive marks (signaling a feast, or regularly occurring phenomena or events taking place during the year, etc.), as is the case with modern calendar sticks. Thus, a series of undifferentiated notches on a surface is not sufficient. None of these distinctive features are found on these artifacts. Moreover, since the objects themselves are quite small, the marks can hardly be differentiated by naked eye. Thus they would have been rather unsuitable for calendric purposes.

Moreover the following question must also be considered: whether there was a need for the owners to have a calendar. Previously, researchers assumed that calendars based on astronomical phenomena were used only by agricultural peoples so that they could know when to perform important activities such as sowing and harvesting. The example commonly cited is Hesiod's work titled "Works and Days", dated to the 7th century BC. It proves the significant role of the Pleiades' risings and settings in farming. A number of researchers assume that the western European megalith stone circles (3rd millennia BC) and the even older circular earthworks of Central Europe (5th millennia BC) also had a calendric function. However, this has not yet been clearly demonstrated.

Cyclical movements of celestial bodies, together with the seasons and changes in the weather could have been connected with other periodic changes of importance for hunter-gatherers, such as the timing of the migration of birds and animals, the collection of fruits, berries, etc. According to anthropological research, sky phenomena are also associated with the recurring celebration of important community events. The use of decorative body objects, the increasing emphasis on the burial of the dead, but, most importantly the high-quality, artistic animal and human representations attest to the significant cognitive development of Upper Paleolithic populations (Rossano 2010). Therefore, it could be argued that during this same period, these human cognizers who, according to archaeological research, already showed characteristic symbolic behaviors, might have operated with (simple) calendric systems.

3. Cave Paintings and the Constellations

Interest in the sky is as old as human culture. All peoples have populated the sky with mythical creatures, heroes who played an important role in the life of the community, and figured prominently in their myths and legends. Researchers interested in Paleolithic sky lore use different methodological approaches to explore this possibility. The Spanish investigator Luz Antequera Congregado applies art-history to the study of the paintings; the French researcher Chantal Jègues-Wolkiewiez uses complex anthropological methods involving astronomical measurement and constellation projection. The German archaeoastronomer Michael Rappenglück approaches the problem with interdisciplinary methodology. And their work is regularly published in scientific journals.

In their search for Paleolithic constellations, the researchers have been inspired particularly by the famous paintings of the Hall of Bulls (La Salle des Taureaux) in the Lascaux Cave (age approx. 15 000 years). Although many of the bison-(and some deer-) representations cover the ceiling, most of the interest was aroused by an especially large figure of a bull. There are six dots arranged in two rows above his shoulder and dots can also be seen on his V-form head. This notational set is generally interpreted as the visualization of the Taurus constellation in its whole shape, together with the "six dots" of the Pleiades and the "spotted" V head representing the Hyadok star cluster.

Figure 5 : Grotte de Lascaux, Hall of Bulls.

In his doctoral dissertation Michael Rappenglück (2004) claims that the cave walls reveals not only constellations but also the full worldview of the

Paleolithic shamans that inhabited it, concretely, in the paintings on the walls of the gallery named “the Shaft of the Dead Man” (Le panneau de l’homme blessé) in the depth of the cave itself. The night sky offered a particular spectacle in the middle of the midsummer night, about 14-15 000 years ago. Three close bright stars (Vega, Deneb and Altair or Rotanev) as circumpolar stars, forming a triangle revolved around the North Pole which pointed at δ Cygnus lying on the Milky Way. Rappenglück assumes that all these elements had made such a deep impression on the shaman of the Paleolithic community that he immortalized the spectacle by incorporating its coordinates in a drawing of his own body. The eyes of the figures form the Summer Triangle, the standing shaman figure serves as reference line, whilst the bird-headed ‘shaman stick’ points to the North Pole.

Figure 6: Grotte de Lascaux, Shaft of the Dead Man.

Interpreting pictorial elements as star groupings is not confined to the Lascaux cave. One of the 21 000 year-old drawings of the Tête-du-Lion cave (Ardèche, France) depicts a bison cow with 21 dots arranged in a curved line. A group of 7 dots can also be found on the animal’s body, not far from a single point. Rappenglück argues that this picture set represents the Pleiades with the bright star Aldebaran and includes a symbol of the moon cycle.

A number of well-known representations of the Pleiades are actually quite similar to the group of dots mentioned above. Since it has a rather compact shape, this is a star cluster found in many cultures, although with different names. Some peoples saw it in oblong shape such as in the representation of the Mesopotamian boundry stones (kudurru) and seals whilst others arranged the stars in a circular fashion as is the case of the famous buckskin map of the North American Skidi Pawnee Indians. Moreover, the six-dot-circular group on the Bronze Age Nebra disc is also likely to stand for the Pleiades (Pásztor 2010).

At the El Castillo cave in Spain there are human hands painted on the walls. Their age is about 13 000 years. Beside one hand a semicircle of seven points can be seen. According to Rappenglück's interpretation they represent the Northern Crown constellation (CrB) in lower culmination. The German researcher claims that the joint depiction of the hand and the dots signals how to find the position and direction of the North Pole in the sky.

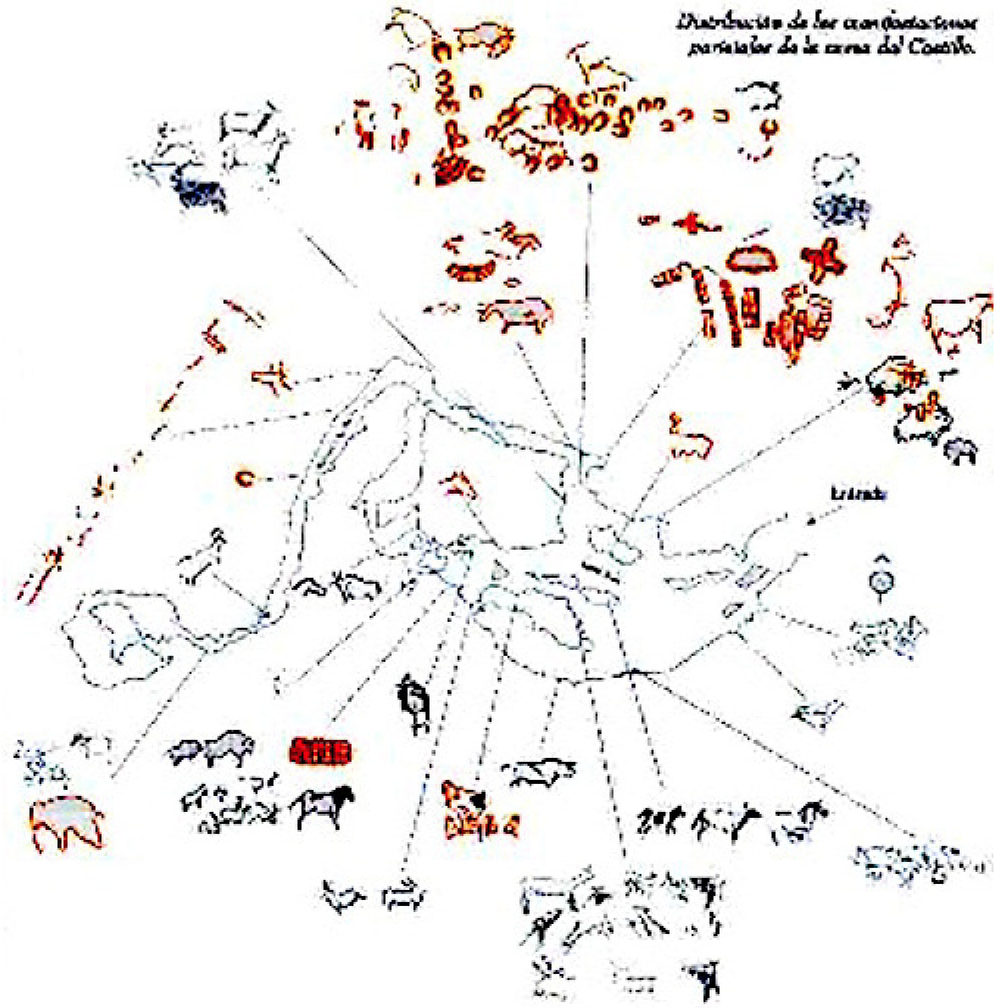


Figure 7: Cueva di El Castillo, Spain.

4. The Origin of Constellations

The investigation of the origin of star groups is one of the most discussed themes in the history of Western astronomy. Their “birth” and history can only be examined broadly as it is difficult for research on this topic to be examined with a narrow geographic focus.

The first known Greek description of the now classical constellations and among them the Pleiades was made by Eudoxus of Cnidus around 370 BC. However, his description of the stars and constellations form the basis of a great poem called Phenomena, written about 270 BC by Aratus of Soli. Parts of the description are believed to date from at least a thousand years earlier. This ancient Greek system is assumed to have developed gradually and from multiple traditions. A well-established Mesopotamian list of stellar constellations, among them the twelve zodiacal signs and four associated constellations, was taken over by the Greeks as late as around 500 BC when astrology rapidly started to spread in the Classical World (Rogers 1998). The Perseus group associated with a classical legend has been proven to be of clear Greek origin and was placed in the sky between 1250 and 480 BC. (Wilk 2000).

Some of Eudoxus' constellations have been shown to be of non-Mesopotamian and non-Greek (or pre-Greek) origin. Among these groups of star figures, there would have been enormous serpents and bears and giants that were eventually integrated into the classical sky map (Rogers 1998).

In early prehistoric Europe interest in the night sky might have been stimulated by rites related to initiation or vision quests to the Upper World. During the initiation rites the candidates might have looked at and followed the life of cultural heroes, retelling their exploits, projecting their deeds and stations onto the sky, like in Australia. Each constellation, representing heroic actions, helped the participants of the rites remember the story-line itself. So many communities, so many stories, thus 'countless' different constellations populated the celestial landscape, although there are star groups belonging to different cultures which are constituted by the same bright stars as their compact formations are easy to recognize. These include the Great Bear and Orion constellation, the Milky Way and also the Pleiades. However the latter is not viewed as an independent constellation; it is the part of the Taurus.

The strange creatures of the classical map might have played roles in pan-European Bear Ceremonialism and were projected onto the sky as the Spirit Animal Guardians of the hero, while other constellations acted as stations that marked the ritual path of the shaman and/or initiate's own vision quest to the Upper World. A research project called "Hunting the European Sky Bears" has investigated a set of folktales known as "Bear Son Tales", found in all the languages of Europe (Frank and Bengoa 2001). The results of this project suggest that these orally transmitted tales along with the related performance art, dances and animal miming still can be found as part of the cultural and linguistic repertoire of Euskal Herria, the Basque region of the Pyrenees in Europe. It proposes that the astral counterparts of the half human and half bear hero Hartzkume ("Bear Son"), who was placed where we now find Hercules, included not only the circumpolar stars of Draco, Ursa Major and Ursa Minor, but also certain southern constellations as main characters in the stories. Calculations based on the location of the zone of evasion indicate that the time period in which the early Europeans were already conscious of these celestial phenomena can roughly be estimated as between 4000 BC to 2000 BC. The star groups of Bears with Bootes as a hunter may well be much older, dating to before 10,000 BC when North America was populated by the migration across the Bering Strait as both Eurasia and North America share the primeval myth of the sky bears (Gibbon 1964).

Naturally, the constellations or rather groups of stars were used for different purposes. In addition to their use as reference points in establishing the seasons of the year and telling time at night, another reason for creating them could have been the need to take bearings on land and at sea. Consequently, members of prehistoric societies would have acquired a certain level of knowledge and understanding of the celestial landscape.

This was, however, a long process, whose origins reach far back into human history. The creation of zodiacal constellations in Mesopotamia took several millennia according to archaeological finds and written sources. Obviously the same can be assumed for the non- Mesopotamian constellations. This means that one should avoid theories which presuppose a single place and time for developing the classical sky map as was suggested by Maunder, Ovenden and Roy (1984). Moreover, in the case of prehistoric Europe there are no written sources dealing with this process as in Mesopotamia or Egypt. Therefore, methodologically, research should rely on archaeological features and anthropological observations. Without them no scientific certainty can be achieved.

5. Characteristic of the Identification of Paleolithic "Astronomical Depictions"

The dating of constellation figures back to the Paleolithic is based on the assumption that the figures depicted are true representations of the constellations as seen in that time period (Joseph 2011). Quite often the position of the different hypothetical astral depictions is also supposed to be directly equivalent to the real arrangement and the size of the dots represented in the cave painting. It is even argued that the size of the dots corresponds to the brightness of the compound stars. In the case the animal or human figures chosen for analysis by researchers these are ones that have counterparts in the classical star map, which takes for granted both the Paleolithic origin and cognitive continuity of the constellations in question across many millennia.

Arguments against such attempts to identify constellations dating back to the Paleolithic are the followings:

- Many depictions of aurochs are found in cave paintings with dots nearby. Thus the correspondences identified in the representations selected seem to be coincidental. In the Lascaux cave, for example, there is another auroch with dots around its eye; in Iberian caves there are also “Pleiades” dots.

- There is a several-thousand-year time gap between the classical and the hypothetical Paleolithic analogue constellations. Moreover, the assertion of cognitive continuity is not supported since no evidence for similar depictions from the Neolithic/Bronze Age has been discovered yet.

- The assumed constellation depictions are always torn from their contexts, while the rest of the figures in the cave painting or mobliary artifact are generally ignored.

- Anthropological research proves that representations of the sky and celestial bodies hardly follow their true arrangement and alignments; the depictions are generally symbolic, guided by ritual and controlled by prevailing belief systems. Thus, such portrayals are not scientifically exact and cannot be used for precise calculations of the actual position of these bodies in the sky in times past.

- Systematic contextual studies (hunter-gatherers’ ecological background, spiritual life, etc.) in connection with possible astronomical knowledge have yet to be carried out.

-That equinoxes and solstices were of great importance in the life of prehistoric communities is taken from granted by the investigators although there is little evidence of this even for the later Neolithic or Bronze Age.

6. Conclusion

Interest in the sky is certainly as old as mankind itself. However, we must exercise caution in our attempts to reconstruct the cognitive processes that were operating in the minds of our prehistoric ancestors as they created these artifacts. Until now no research into prehistoric European cave and mobiliary art has brought about the definitive identification of astronomical knowledge. Rather the hypotheses put forward to date concerning the existence of such astronomical knowledge during the European Paleolithic seem to be grounded primarily on the researchers' enthusiasm and desire to find such correspondences rather than on the interpretation of genuine, archaeological evidence. Despite this rather negative assessment, we need to recognize the value of the work carried out to this point for it calls attention to new methodological approaches and fields of inquiry and in the process, stimulates others to investigate these questions. This is the path of scientific research.

In conclusion, our inability to give irrefutable proofs for the existence of astronomical knowledge in cave paintings and mobiliary artifacts does not mean that Paleolithic people were not interested in the sky. Celestial phenomena might also have had significant influence on them, like on many other groups and communities around the world. However, it is very difficult to bring to light such "hidden" knowledge for to do so requires, quite inevitably, that interdisciplinary approaches be brought to bear on what is unquestionably a highly complex interpretative task and one for which astronomical calculations may not provide significant insights (Pásztor and Priskin 2011).

Acknowledgments The author would like to acknowledge Annamaria Priskin, a paleontologist and Roslyn M. Frank Professor Emeritus for their essential cooperation.

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3. The Cosmology of the Paleolithic

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Abstract

The emergence of cosmological consciousness and its symbolism, is directly linked to the evolution of the Cro-Magnon peoples who may have developed the first cosmologies, 20,000 to 30,000 years ago. These ancient peoples of the Upper and Middle Paleolithic believed in spirits and ghosts which dwelled in a heavenly land of dreams, and interned their dead in sleeping positions and with tools, ornaments and flowers. By 30,000 years ago, and because they believed souls ascended to the heavens, the people of the Paleolithic searched the heavens for signs, and between 30,000 to 20,000 years ago, they observed and symbolically depicted the association between woman's menstrual cycle and the moon, patterns formed by stars, and the relationship between Earth, the sun, and the four seasons. These include depictions of 1) the "cross" which is an ancient symbol of the fours seasons and the Winter/Summer solstice and Spring/Fall equinox; 2) the constellations of Virgo, Taurus, Orion/Osiris, the Pleiades, and the star Sirius; 3) and the 13 new moons in a solar year. Although it is impossible to date these discoveries with precision, it can be concluded that cosmological consciousness first began to evolve over 30,000 years ago, and this gave birth to the first heavenly cosmologies over 20,000 years ago.

1. Cro-Magnon Cosmology and the Frontal Lobes

When humans first turned their eyes to the sun, moon, and stars to ponder the nature of existence and the cosmos, is unknown. The Cro-Magnon people were keen observers of the world around them, which they depicted with artistic majesty. The heavens were part of their world and they searched the skies for signs and observed the moon, the patterns formed by clusters of stars, and perhaps the relationship between the Earth, the sun, and the changing seasons. Although it is impossible to date cave paintings with precision, the first evidence of this awareness of the cosmic connection between Sun, Moon, Woman, Earth and the changing seasons are from the Paleolithic; symbolized in the creations of the Cro-Magnon of the Paleolithic.

As based on cranial comparisons and endocasts of the inside of the skull, and using the temporal and frontal poles as reference points, it has been demonstrated that the brain has tripled in size over the course of human evolution, and that the frontal lobes significantly expanded in length and height during the Middle to Upper Paleolithic transition (Blinkov and Glezer 1968; Joseph 1993; MacLean 1990; Tilney 1928; Weil 1929; Wolpoff 1980).

It is obvious that the height of the frontal portion of the skull is greater in the six foot tall, anatomically modern Upper Paleolithic H. sapiens (Cro-Magnon) versus Neanderthal and archaic H. sapiens (Joseph 1996, 2000b; Tilney, 1928; Wolpoff 1980). The evolution and expansion of the frontal lobe is also evident when comparing the skills and creative and technological ingenuity of the Cro-Magnons, vs the Neanderthals (Joseph 1993, 1996, 2000b).

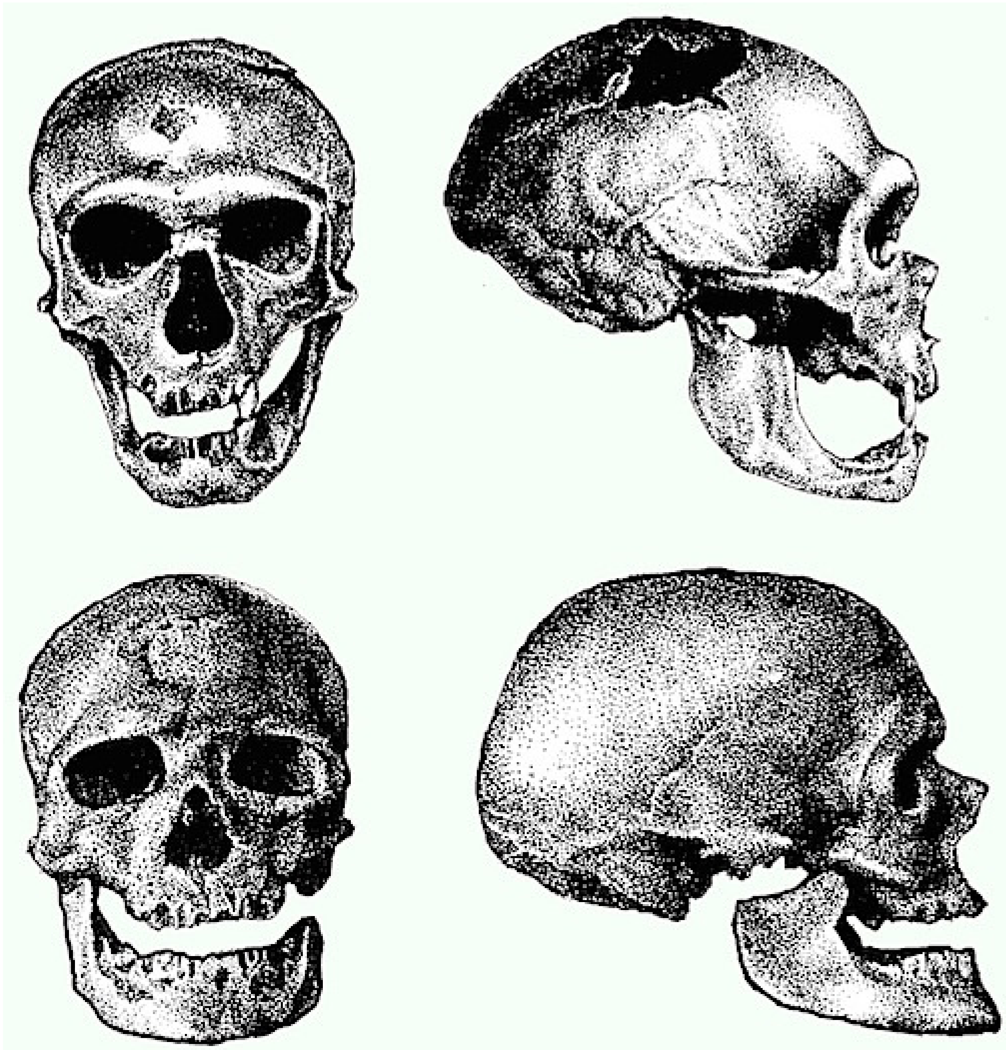


Figure: Neanderthal (top), Cro-Magnon (bottom)

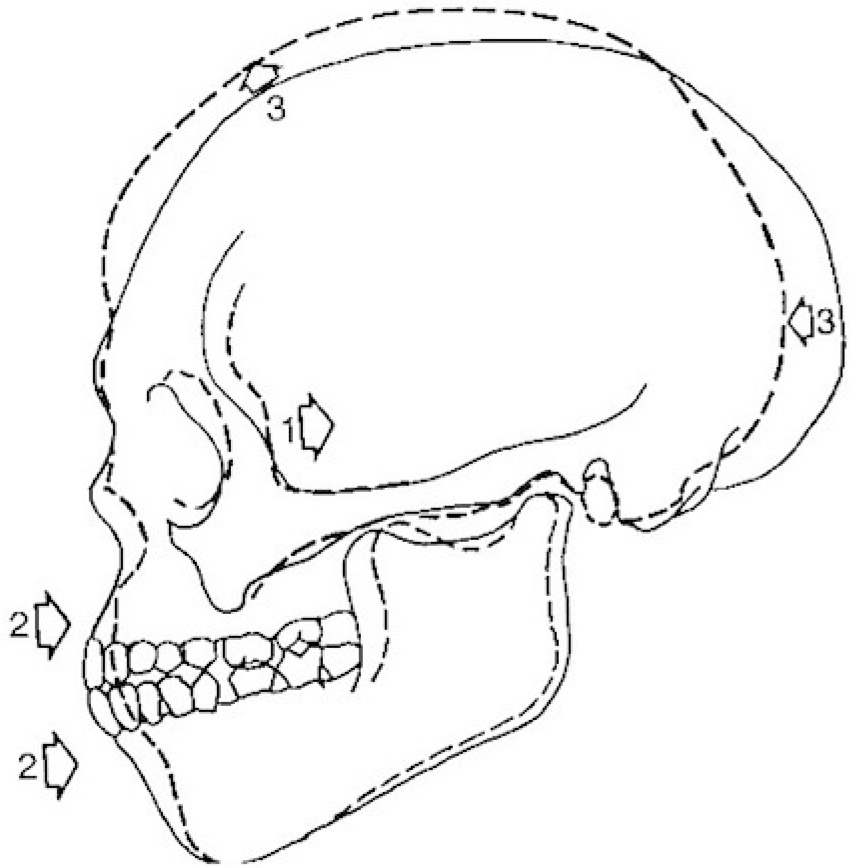


FIGURE A modern (dotted line) mesolithic cranium compared with a more ancient cranium (solid line). Arrows indicate the main average changes in skull structure including a reduction in the length of the occiput and an increase and upward expansion in the frontal cranial vault. Reproduced from M. H. Wolpoff (1980), Paleo- Anthropology. New York, Knopf.

Therefore, whereas the temporal, occipital and parietal lobes were well developed in archaic and Neanderthals, the frontal lobes would increase in size by almost a third in the transition from archaic humans to Cro-Magnon (Joseph 1996, 2000a,b, 2001). It is the evolution of the frontal lobes which ushered in a cognitive and creative big bang which gave birth to a technological revolution and complex spiritual rituals and beliefs in shamans and goddesses and their relationship to the heavens, and thus the moon and the stars.

FIGURE: Cro-Magnon

It is well established that the frontal lobes enable humans to think symbolically, creatively, imaginatively, to plan for the future, to consider the consequences of certain acts, to formulate secondary goals, and to keep one goal in mind even while engaging in other tasks, so that one may remember and act on those goals at a later time (Joseph 1986, 1990b, 1996, 1999c). Selective attention, planning skills, and the ability to marshal one's intellectual resources so as to to anticipate the future rather than living in the past, are capacities clearly associated with the frontal lobes.

The frontal lobes are associated with the evolution of "free will" (Joseph 1986, 1996, 1999c, 2011b) and the Cro-Magnon were the first species on this planet to exercise that free will, shattering the bonds of environmental/genetic determinism by doing what had never been done before: After they emerged upon the scene over 35,000 years ago, they created and fashioned tools, weapons, clothing, jewelry, pottery, and musical instruments that had never before been seen. They created underground Cathedrals of artistry and light, adorned with magnificent multi-colored paintings ranging from abstract impressionism to the surreal and equal to that of any modern master (Breuil, 1952; Leroi-Gourhan 1964, 1982). And they used their skills to carve the likeness of their female gods.

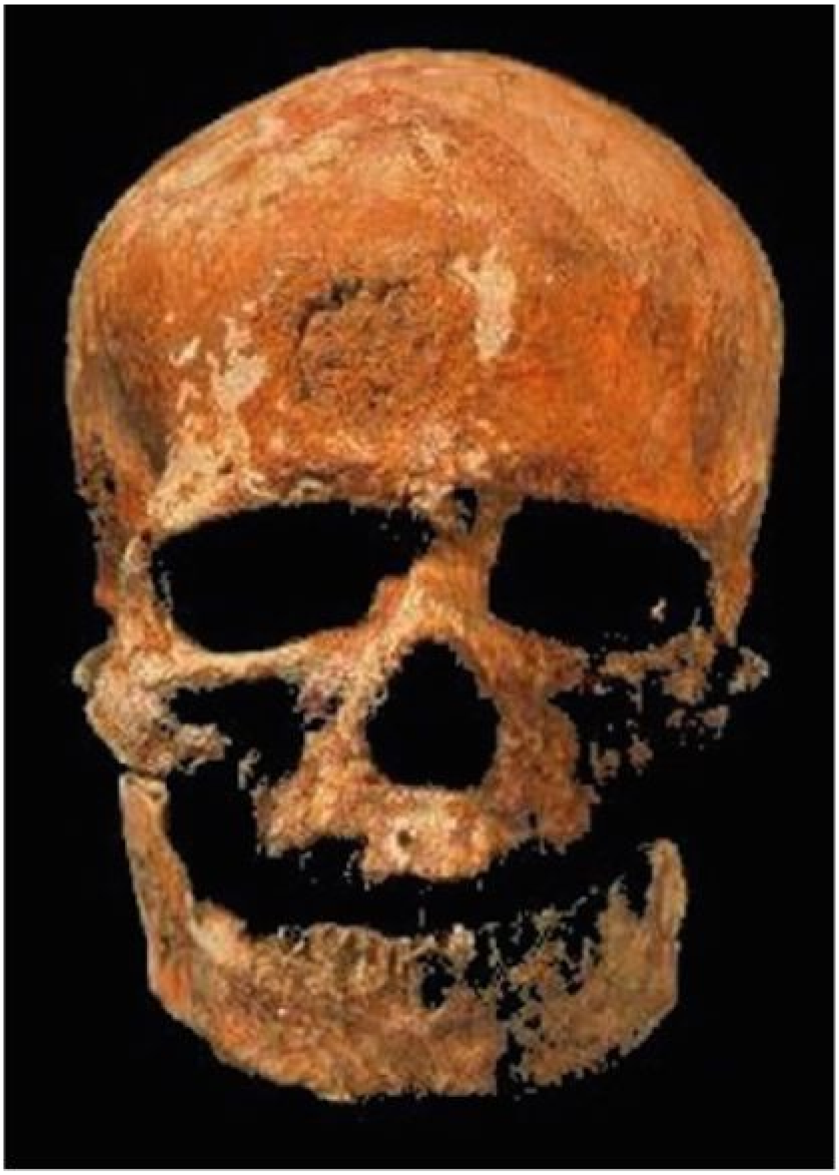


FIGURE: Paleolithic Goddess

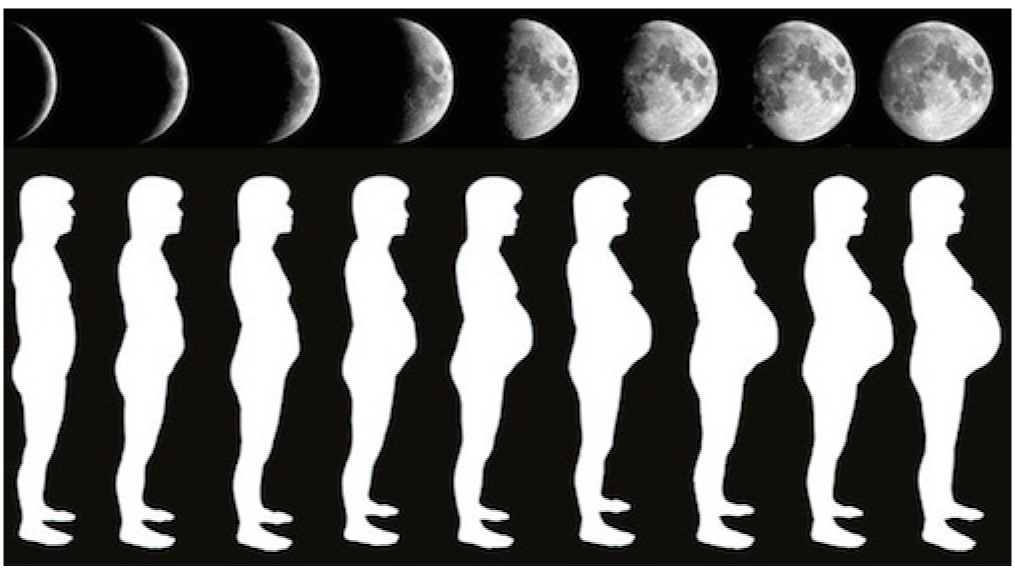
Thirty five thousand years ago, Cro-Magnon were painting animals not only on walls but on ceilings, utilizing rich yellows, reds, and browns in their paintings and employing the actual shape of the cave walls so as to conform with and give life-like dimensions, including the illusion of movement to the creature they were depicting (Breuil, 1952; Leroi-Gourhan 1964, 1982). Many of their engraving on bones and stones also show a complete mastery of geometric awareness and they often used the natural contours of the cave walls, including protuberances, to create a 3-dimensional effect (Breuil, 1952; Leroi-Gourhan 1964, 1982).

With the evolution of the Cro-Magnon people, the frontal lobes mushroomed in size and there followed an explosion in creative thought and technological innovation. The Cro-Magnon were intellectual giants. They were accomplished artists, musicians, craftsmen, sorcerers, and extremely talented hunters, fishermen, and highly efficient gatherers and herbalists. And they were the first to contemplate the heavens and the cosmos which they symbolized in art.

FIGURE: The cosmic clock and some of the constellation symbolized by bulls in the Lascaux Cave in Dordogne? There is a group of dots on the back of the bull to the far right (Taurus) which may represent the Pleiades (the seven sisters).

2. GODDESS OF THE MOON

Among the ancients, the Sun and the Moon were of particular importance and the Cro-Magnon observed the relationship between woman and the lunar cycle. Consider, the pregnant goddess, the Venus of Laussel, who holds the crescent moon in her hand (though others say it is a bison's horn). Although the length of a Cro-Magnon woman's menstrual cycle is unknown, it can be assumed that like modern woman she menstruated once every 28 to 29 days, which corresponds to a lunar month 29 days long, and which averages out to 13 menstrual cycles in a solar year. And not just menstruation, but pregnancy is linked to the phases of the moon.



3. THE FOUR CORNERS OF THE SOLAR CLOCK.

When the Cro-Magnon turned their eyes to the heavens, seeking to peer beyond the mystery that separated this world from the next, they observed the sun. With a brain one third larger than modern humans, and given their tremendous power of observation, it can be predicted these ancient people would have associated the movement of the sun with the changing seasons which effected the behavior of animals, the growth of plants, and the climate and weather; all of which are directly associated with cyclic alterations in the position of the sun and the length of a single day over the course of a solar year which is equal to 13 moons.

FIGURE: The entrance to the underground Upper Paleolithic cathedral. The Chauvet cave. Note the sign of the cross. Reprinted from Chauvet et al., (1996). Dawn of Art: The Chauvet Cave. Henry H. Adams. New York.

The four seasons, marked by two solstices and the two equinoxes have been symbolized by most ancient cultures with the sign of the cross, e.g. the "four corners" of the world and the heavens. The "sign of the cross" generally signifies religious or cosmic significance. The Cro-Magnon also venerated the sign of the cross, the first evidence of which, an engraved cross, is at least 60,000 years old (Mellars, 1989). Yet another cross, was painted in bold red ochre upon the entryway to the Chauvet Cave, dated to over 30,000 years ago (Chauvet et al., 1996).

The illusion of movement of the Sun, from north to south, and then back again, in synchrony with the waxing and waning of the four seasons, is due to the changing tilt and inclination of the Earth's axis, as it spins and orbits the sun. Thus over a span of 13 moons, it appears to an observer that the days become shorter and then longer and then shorter again as the sun moves from north to south, crosses the equator, and then stops, and heads back north again, only to stop, and then to again head south, crossing the equator only to again stop and head north again. The two crossings each year, over the equator (in March and September) are referred to as equinoxes and refers to the days and nights being of equal length. The two time periods in which the sun appears to stop its movement, before reversing course (June and December), are referred to as solstices—the "sun standing still."

The sun was recognized by ancient astronomer priests, as a source of light and life-giving heat, and as a keeper of time, like the hands ticking across the face of a cosmic clock. Because of the scientific, religious, and cosmological significance of the sun, ancient peoples, in consequence, often erected and oriented their religious temples to face and point either to the rising sun on the day of the solstice (that is, in a southwest—northeast axis), or to face the rising sun on the day of the equinox (an east-west axis). For example, the ancient temples and pyramids in Egypt were oriented to the solstices, whereas the Temple of Solomon faced the rising sun on the day of the equinox.

Thus the sign of the cross is linked to the heavens and to the sun. Understanding the heavens and the sun, has been been a common astronomical method of divining the the will of the gods, and for navigation, localization, and calculation: these celestial symbols have heavenly significance.

Regardless of time and culture, from the Aztecs, Mayans, American Indians, Romans, Greeks, Africans, Christians, Cro-Magnons, Egyptians (the key of life), and so on, the cross consistently appears in a mystical context, and/or is attributed tremendous cosmic significance (Budge,1994; Campbell, 1988; Joseph, 2000a; Jung, 1964). The sign of the cross was the ideogram of the goddess “An”, the Sumerian giver of all life from which rained down the seeds of life on all worlds including the worlds of the gods. An of the cross gave life to the gods, and to woman and man.

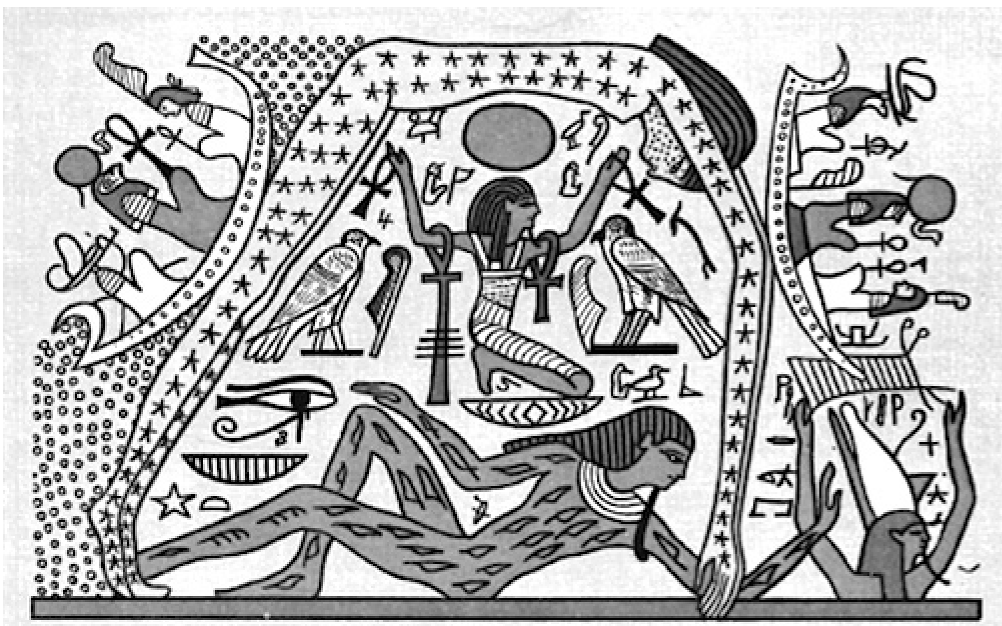


FIGURE: The God Seb supporting the Goddess Nut who represents heaven and possibly the Milky Way galaxy. Note the repeated depictions of the key of life; i.e. a ring with a cross at the end.

The symbol of the cross is in fact associated with innumerable gods and goddesses, including Anu of the ancient Egyptians, the Egyptian God Seb, the Goddess Nut, the God Horus (the hawk), as well as Christ and the Mayan and Aztec God, Quetzocoatl. For example, like the Catholics, the Mayas and Aztecs adorned their temples with the sign of the cross. Quetzocoatl, like Jesus, was a god of the cross.

In China the equilateral cross is represented as within a square which represents the Earth, the meaning of which is: “God made the Earth in the form of a cross.” It is noteworthy that the Chinese cross-in-a-box can also be likened to the swastika—also referred to as the "gammadion" which is one of the names of the Lord God: "Tetragammadion." The cross, in fact forms a series of boxes when aligned from top to bottom or side by side, and cross-hatchings such as these were carved on stone over 60,000 years ago.

FIGURE: Quetzocoatl the Mayan and Aztec god of the cross. The round shield encircling the cross represents the sun.

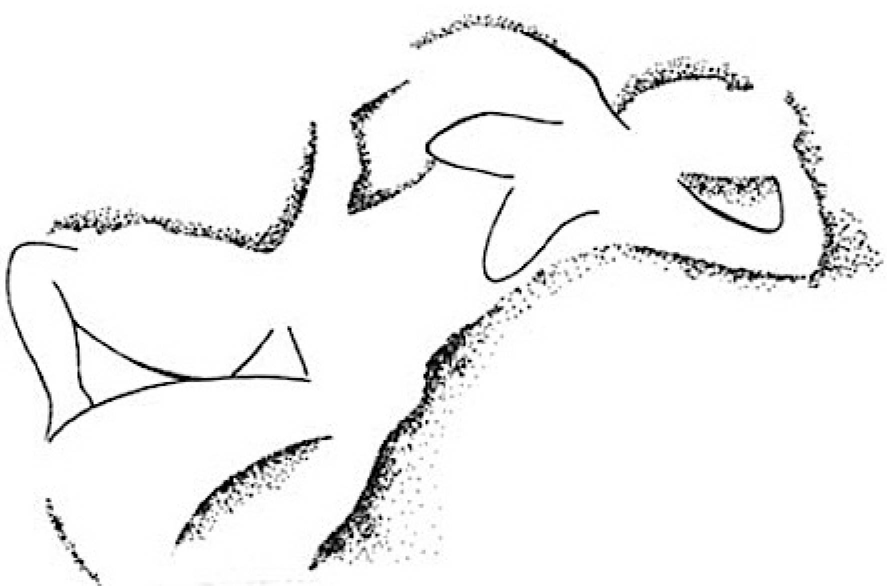
FIGURE: Ochre etched with crosses, forming a series of cross-hatchings, dating to 77,000 years ago.

FIGURE: Sign of the cross (far left)

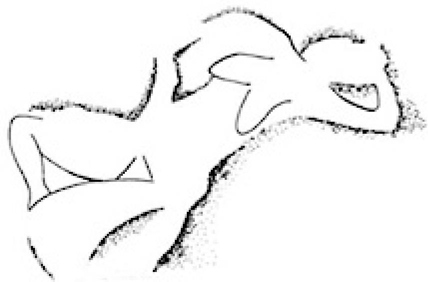
Among the ancient, the sign of the cross, represented the journey of the sun across the four corners of the heavens. The Cro-Magon adorned the entrance and the walls of their underground cathedrals with the sign of the cross, which indicates this symbol was of profound cosmic significance. However, that some of the Cro-Magnon depictions of animal-headed men have also been found facing the cross, may also pertain to the heavens: the patterns formed by stars, which today are refereed to as “constellations.”

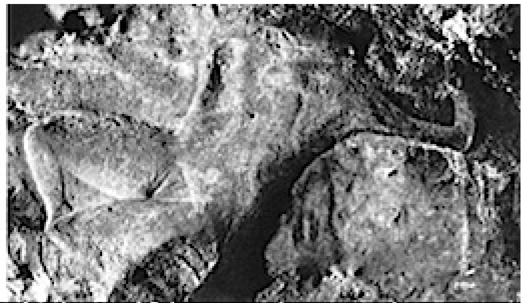
4.. THE CONSTELLATION OF VIRGO

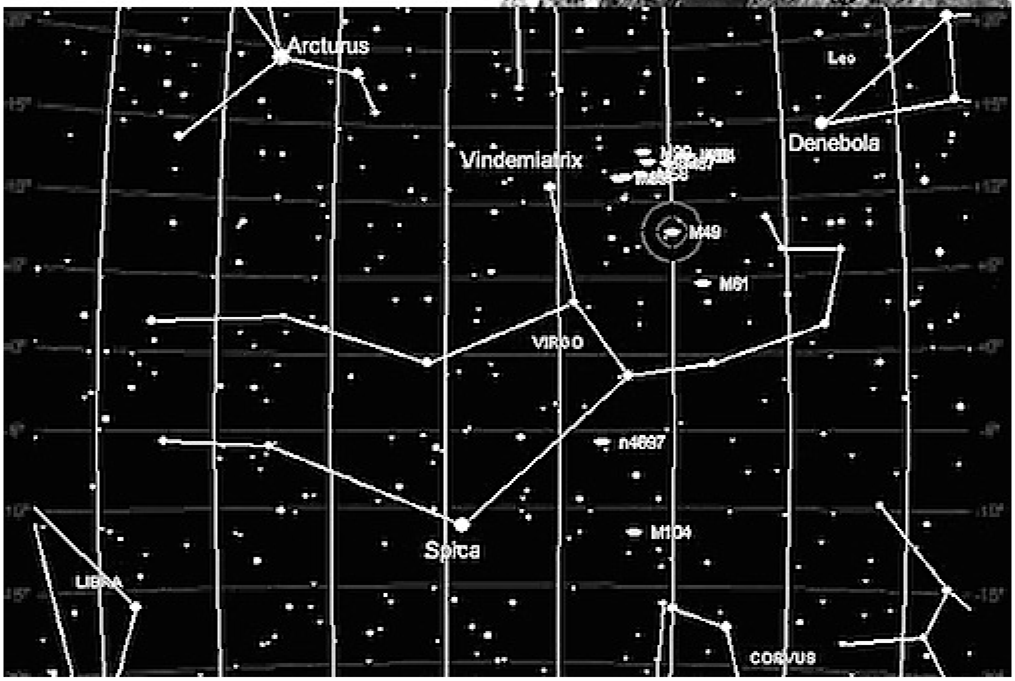
here is nothing “virginal” about the constellation of Virgo. The pattern can be likened to a woman in lying on her back with an arm behind her head, and this may have been the visage which stirred the imagination of the Cro-Magnon.



FIGURES (above and below) Cro-Magnon / Paleolithic goddess, depicting the constellation of Virgo. La Magdelain cave.







5. THE CONSTELLATIONS OF OSIRIS

It would be unreasonable to assume that the Cro-Magnon would not have observed the heavens or the illusory patterns formed by the alignment of various stars. Depictions of the various constellations, such as Taurus and Orion, and "mythologies" surrounding them, are of great antiquity, and it appears that similar patterns were observed by the Cro-Magnon people.

Consider, for example the "Sorcerers" or "Shamans" wearing the horns of a bull, and possibly representing the constellation of Taurus; a symbol which appears repeatedly in Lascaux, the "Hall of the Bulls" and in the deep recesses of other underground cathedrals dated from 18,000 to 30,000 B.P. And above the back of one of these charging bulls, appears a grouping of dots, or stars, which many authors believe may represent the Pleiades which is associated with Taurus. These Paleolithic paintings of the bull appear to be the earliest representation of the Taurus constellation.

FIGURE: Ancient shaman attired in animal skins and stag antlers, graces the upper wall directly above the entrance to the 20,000-25,000 year-old grand gallery at Les Trois-Freres in southern France. Possibly representing the constellation of Orion.

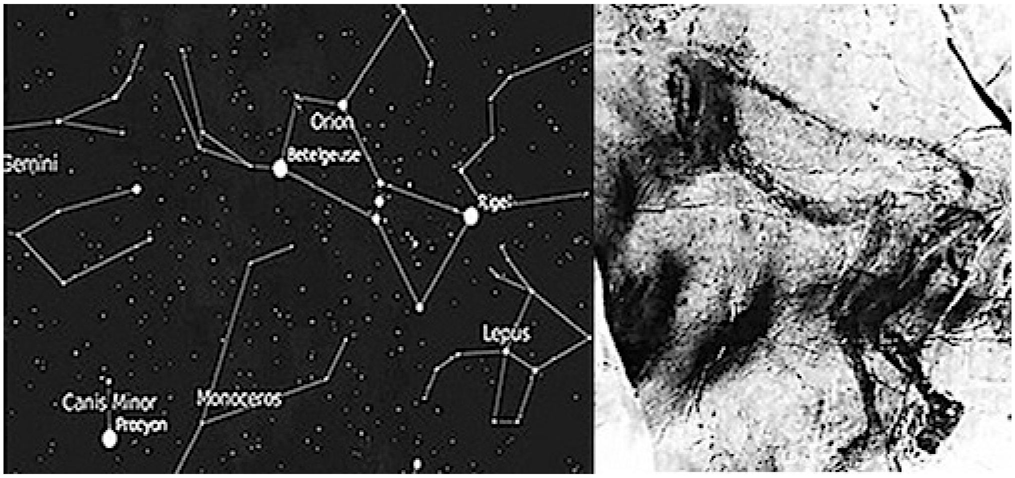
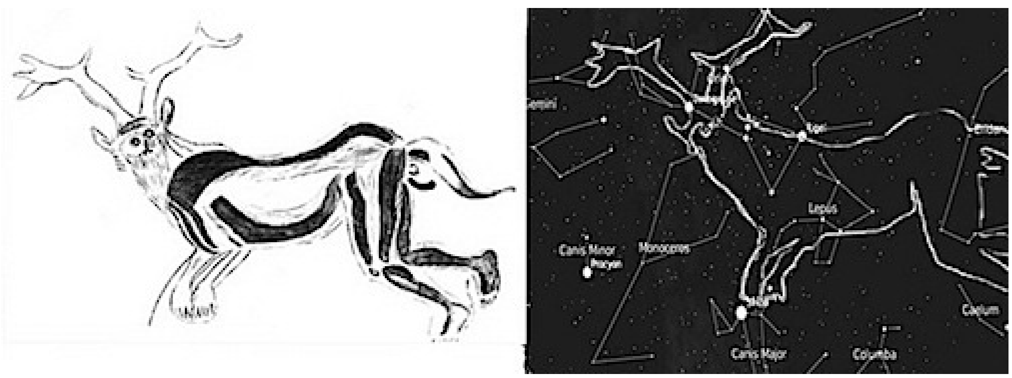


FIGURE. (Upper Right / Lower Left) The “Sorcerer” Trois-Frères cave. (Upper Left / Lower Right) Constellation of Orion/Osiris.



6. THE PLEIADES AND THE CONSTELLATIONS OF TAURUS AND ORION

In the “modern” sky, the constellation of Orisis/Orion the hunter, faces Taurus, the bull; and these starry patterns would not have been profoundly different 20,000 to 30,000 years ago. In ancient Egypt, dating back to the earliest dynasties (Griffiths 1980), Osiris was the god of death and of fertility and rebirth, who wore a a distinctive crown with two horns (later symbolized as ostrich feathers at either side). He was the brother and husband of Isis. According to myth, Orisis was killed by Set (the destroyer) and dismembered. Isis recovered all of his body, except his penis. After his death she becomes pregnant by Orisis. The Kings of Egypt were believed to ascend to heaven to join with Osiris in death and thereby inherit eternal life and rebirth, symbolized by the star Sirius (Redford 2003). The Egyptian "King list" (The Turin King List) goes backward in time, 30,000 years ago to an age referred to as the "dynasty of gods" which was followed by a "dynasty of demi-gods" and then dynasties of humans (Smith 1872/2005).

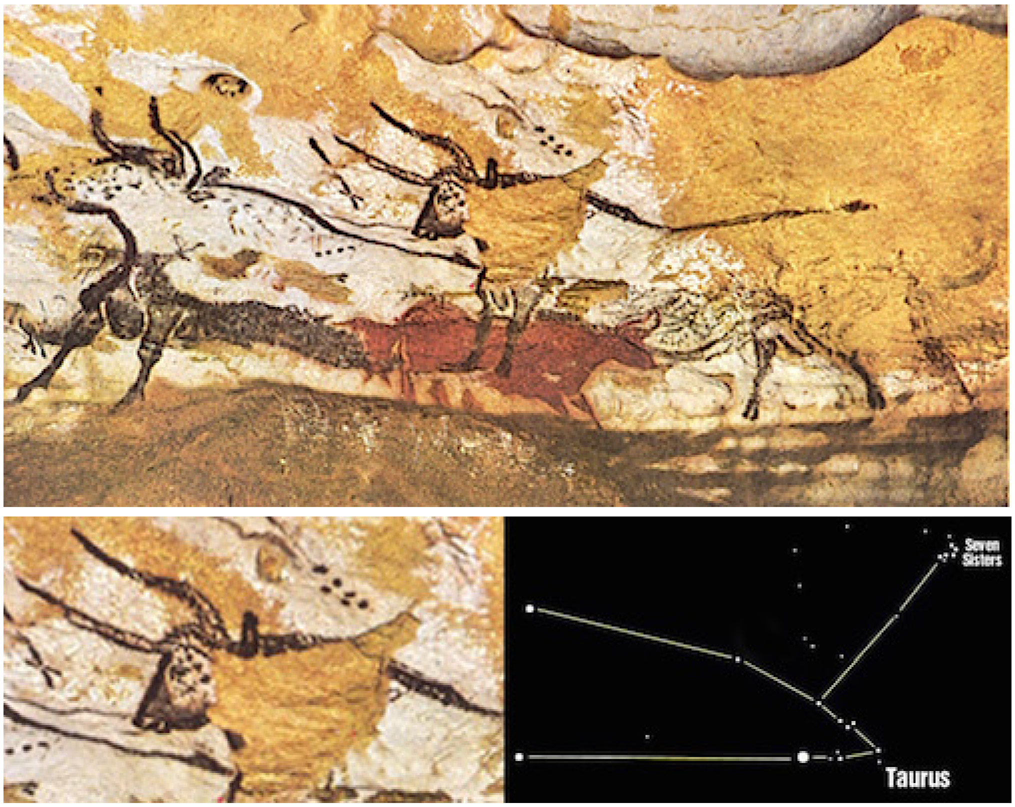
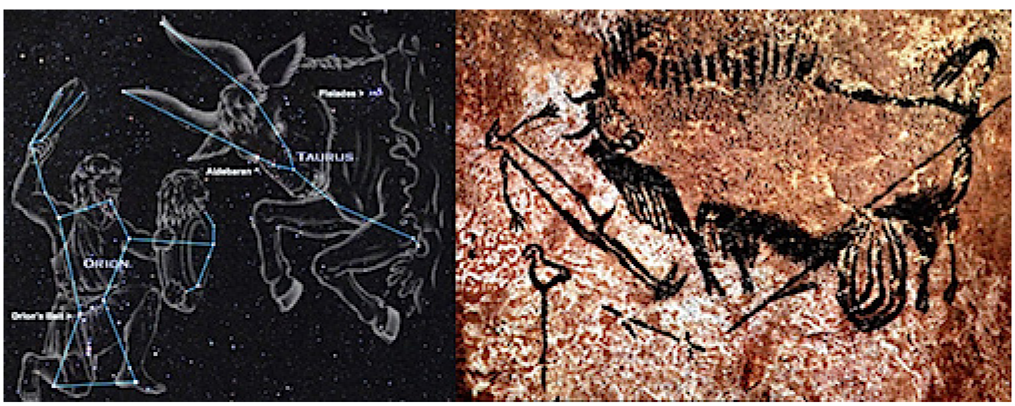
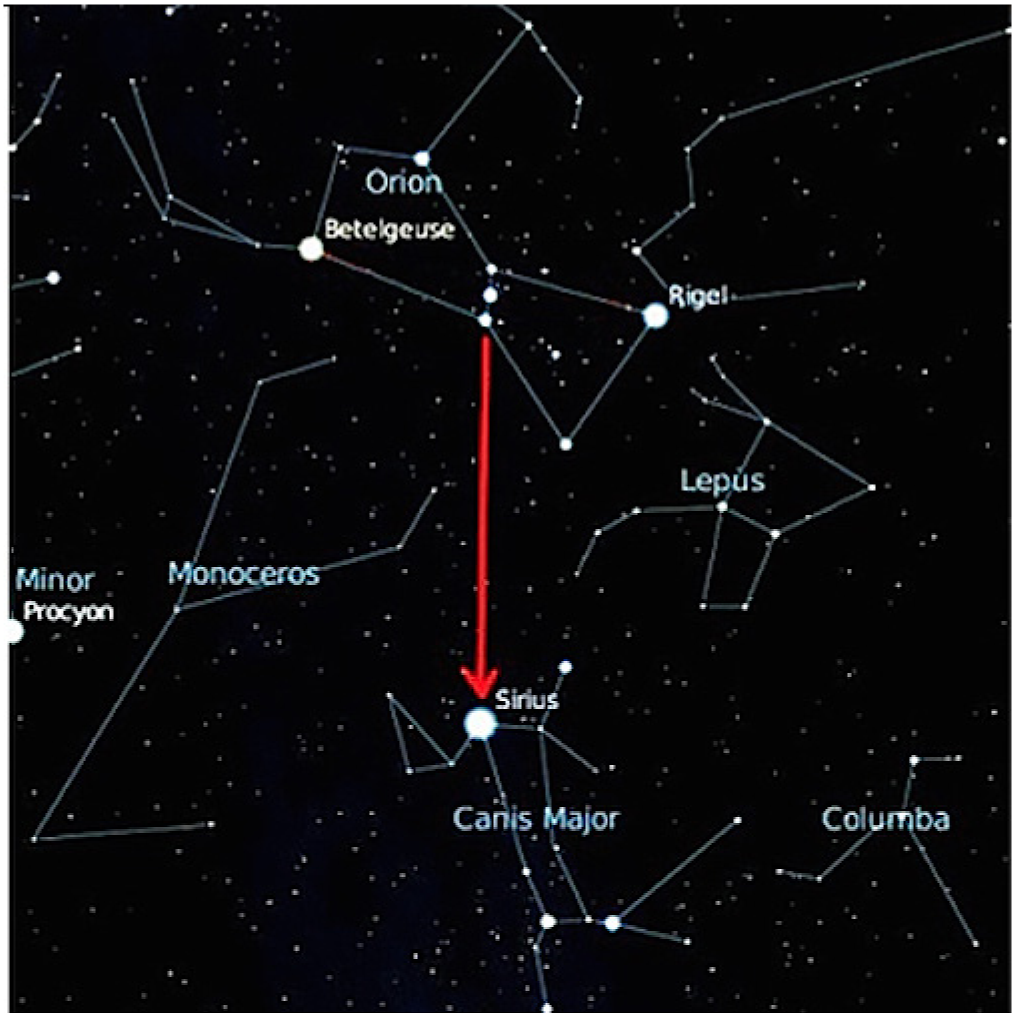


FIGURE: (Top) The main freeze of the bulls in the Lascaux Cave in Dordogne. There is a group of dots on the back of the great bull (Taurus) which may represent six of the seven stars of the Pleiades (the seven sisters). As stars are also in motion, not all would be aligned or as bright or dim today, as was the case 20,000 to 30,000 years ago.


Pleiades
TAURUS
Aldebaran
ORION
Orion's Belt



Over 20,000 years ago, the 6ft tall Cro-Magnon, with their massive brain one third larger than modern humans, painted a hunter with two horns who had been killed. And just as the constellation of Orion the hunter faces Taurus, so too does the dead Cro-Magnon hunter who has dismembered/disembowled the raging bull. And below and beneath the dead Cro-Magnon hunter, another bird, symbol of rebirth, and perhaps symbolizing the star Sirius.

The constellation of Osiris (Orion the hunter) in Egyptian mythology is the god of the dead who was dismembered; but also represents resurrection and eternal life as signified by the star Sirius. (Upper Right) Constellation of Osiris/Orion and Taurus. (Upper Left) Cave painting. Lascaux. The dead (bird-headed or two horned) hunter killed by a bull whom he disemboweled. (Bottom) Constellation of Orion/Osiris in relation to Sirius.

7. THE PALEOLITHIC AND NEOLITHIC MILKY WAY GALAXY

These peoples of the Paleolithic were capable of experiencing love, fear, and mystical awe, and they believed in spirits and ghosts which dwelled in a heavenly land of dreams. Because they believed souls ascended to the heavens, the people of the Paleolithic searched the heavens for signs. By 30,000 years ago, and with the expansion of the frontal lobes, they created symbolic rituals to help them understand and gain control over the spiritual realms, and created signs and symbols which could generate feelings of awe regardless of time or culture. They observed and symoblically depicted the association between woman and the moon, patterns formed by stars, and the relationship between Earth, the sun, and the four seasons.

The Milky Way galaxy can be viewed in the darkness of night, edge-on, snaking in a curving arc, forming part of a circle. If the peoples of the Paleolithic, through careful observation, deduced the existence of a spiraling galaxy, of which Earth, and the constellations circled round, or which circled round forming a cosmic clock, is unknown.

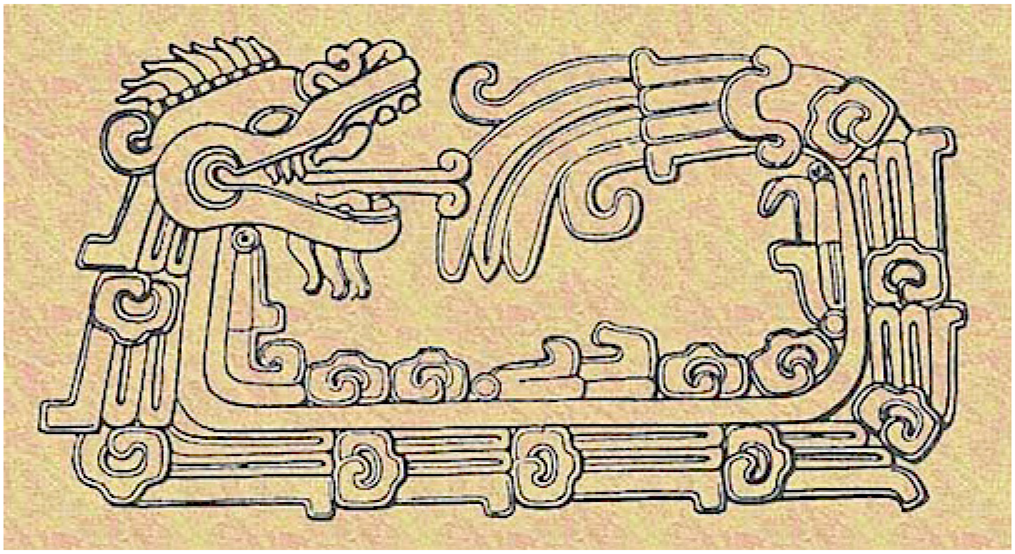


FIGURE: Quetzalcoatl Maya Galaxy

FIGURE: Petroglyph, date unknown.

FIGURE: Colliding Galaxies

FIGURE: 12,000 B.C.

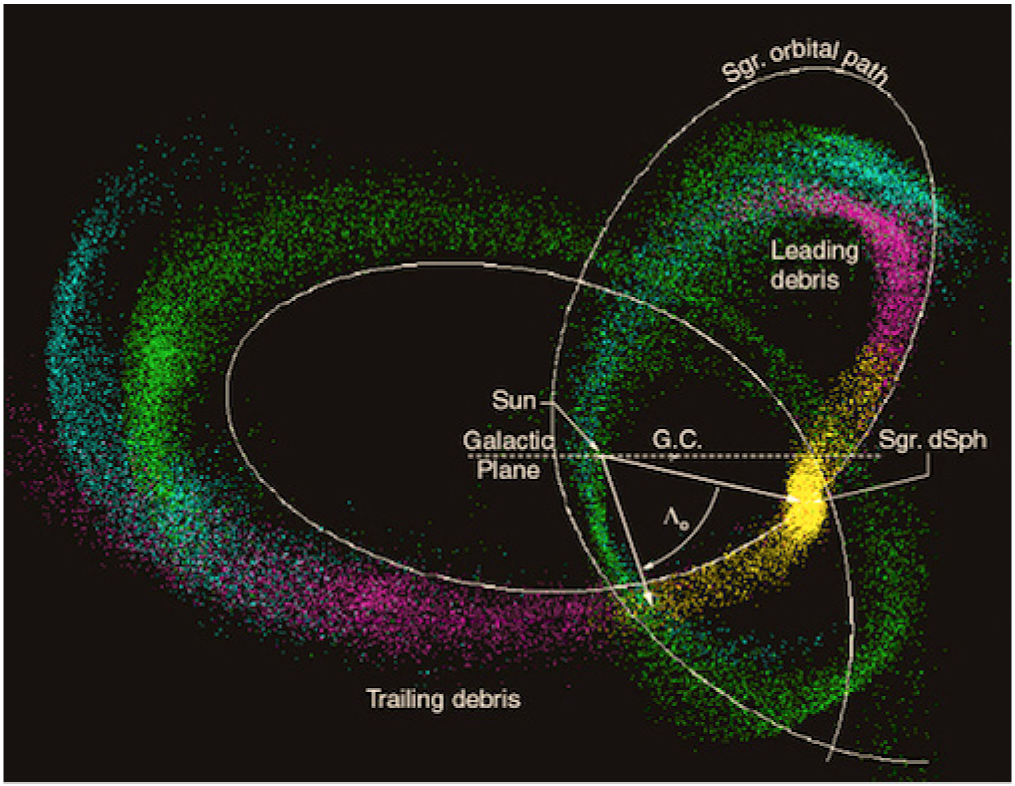


FIGURE: Sagittarius dwarf galaxy orbiting the Milky Way

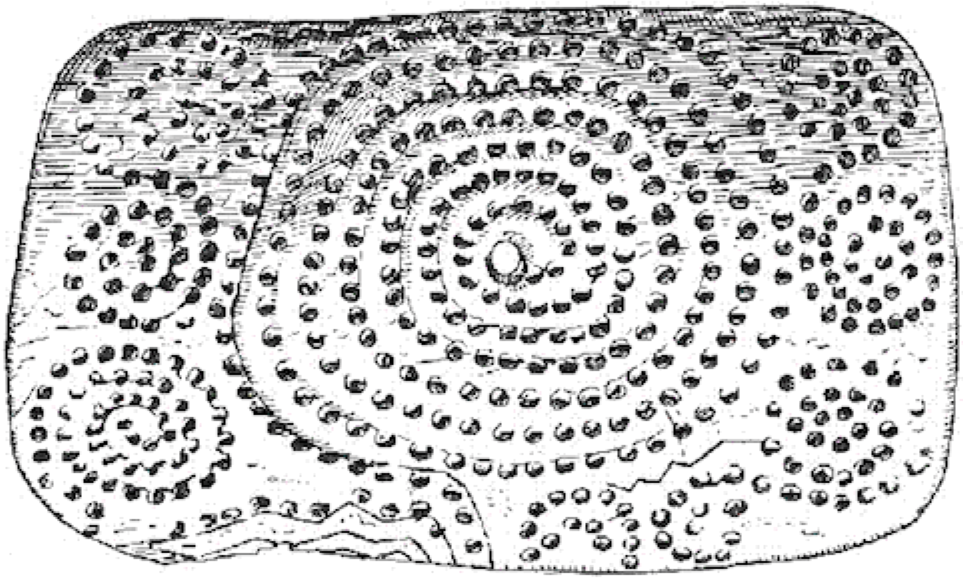


FIGURE: Mal’ta, Irkutskaya Oblast, Russia, 12000-15,000 B.C.

FIGURE: Milky Way Galaxy, viewed from Earth, with some of the constellations depicited. Not position of Orion (Osiris) and Gemini (compare with figure below)

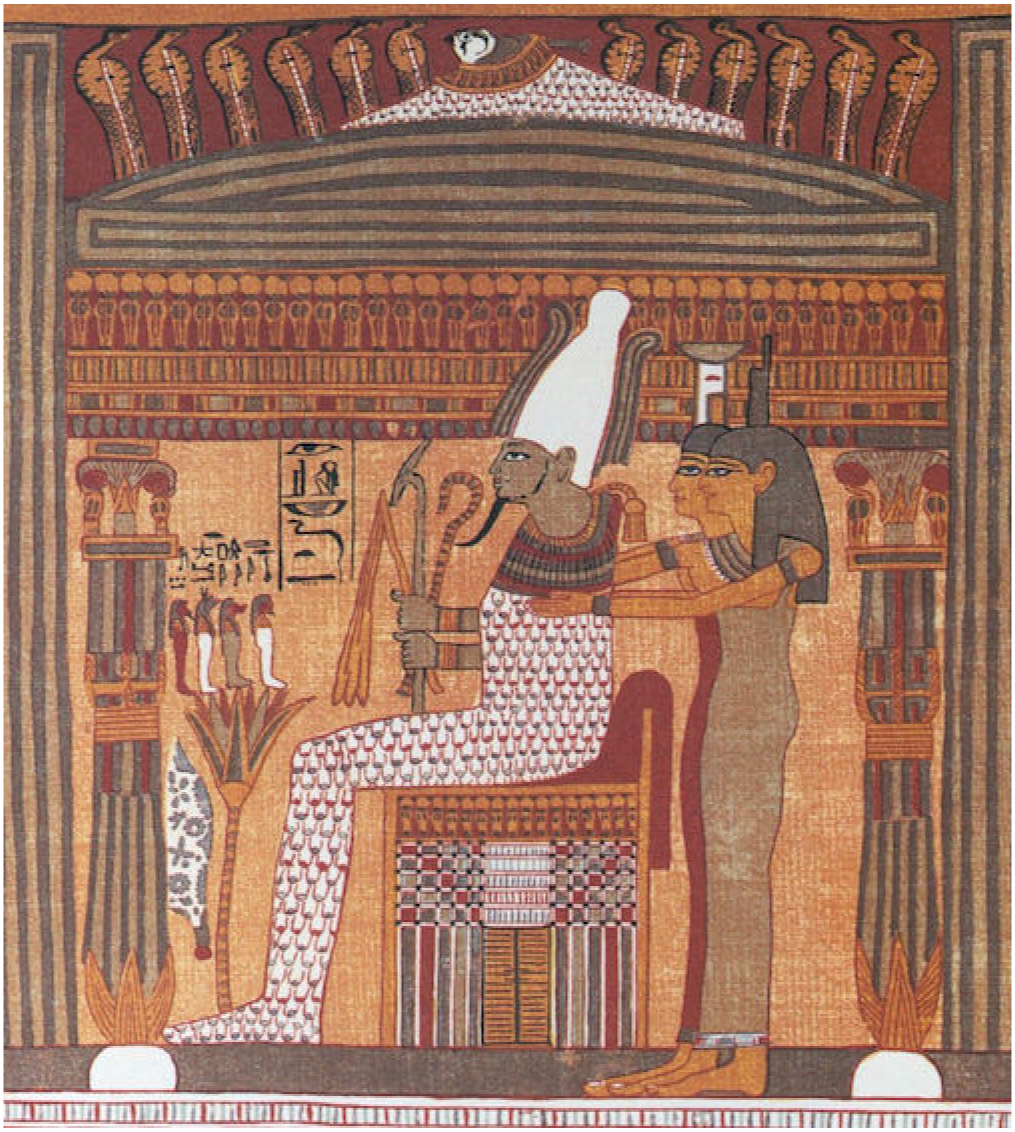


FIGURE: Ancient Eguypt: Osiris atended by the Gemini twins, and above: the Milky Way galaxy, and 12 constellations of the zodiac represented by snakes.

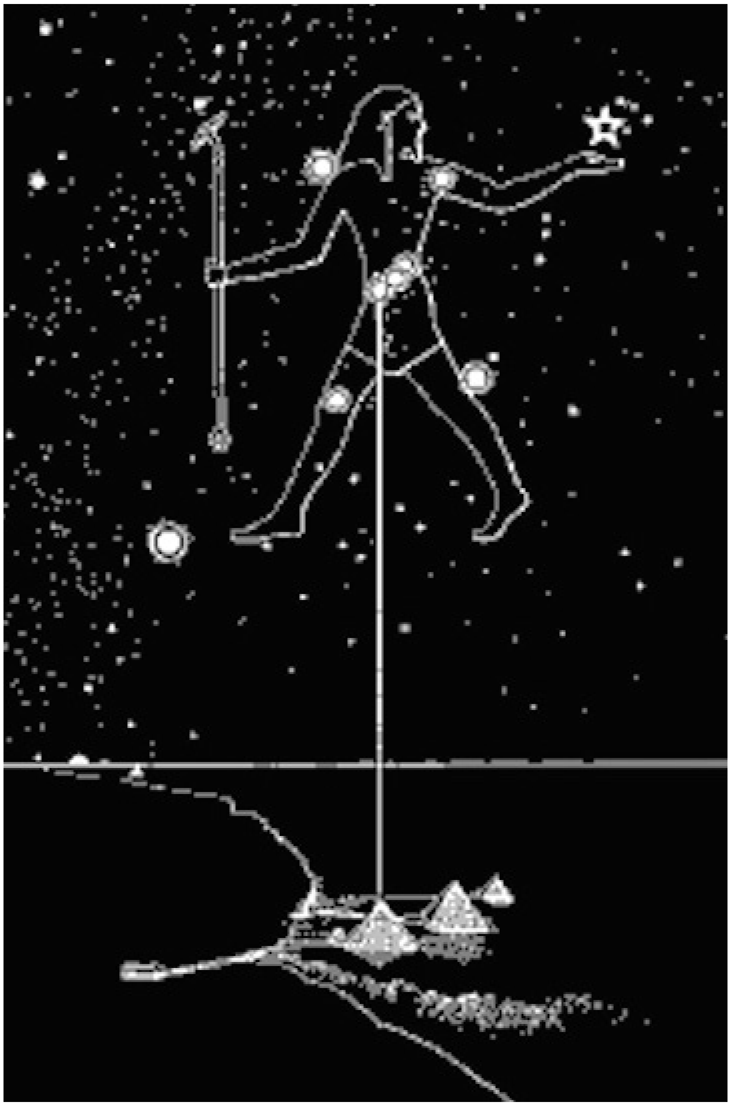


FIGURE: Three belt stars of Osiris (above) Three Pyramids of Giza (below)

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4. Neolithic Cosmology: The Equinox and the Spring Full Moon.

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Abstract

The Neolithic may have ushered in an intellectual revolution where humans began to develop cosmic views of the universe. The Neolithic conception of the cosmos may have consisted of their territory as marked by the "distant" horizon, of the sky where the heavenly bodies move, and an awareness of the periodicity of various solar bodies so as to make accurate predictions about the Sun and Moon. Clues to Neolithic cosmology, perception of the Spring Full Moon in the Neolithic period, may reveal some measure of abstract thinking capable of suggesting awareness of the cosmologic order, and of its appropriation by humans. Rather than a comprehensive discussion of Paleolithic and Neolithic views of the cosmos, the present paper, analyzing this awareness, is a speculation on the possible development of the concept of Spring Megalithic Equinox and how it may have provided the Neolithic humans with a simplified cosmological model. This speculation considers the plausibility of a puzzling observation involving the values of the elongations of the lunar major standstills at Almendres in Portugal, Stonehenge in England and Goseck in Germany.

1. Introduction

The use of symbols is probably an early kind of abstract thought dating almost 50,000 years. Bone and stone carvings from more than 30,000 years ago, including "The Venus of Laussel" already involve some degree of data recording, marking for example, what may be the phases of the moon

(Joseph 2010). The Venus of Laussel is 1.5 foot high limestone bas-relief of a pregnant female with swollen distended breasts, painted with red ochre. She holds what some believe to be a bison horn with 13 cuts. Joseph (2010) believes the “horn” might instead represent the crescent moon, and the 13 cuts a symbol of the relationship between the lunar cycle and the menstrual cycle. Yet others believe some of the symbolism deep within the recesses of ancient Paleolithic underground caves and caverns may represent the stars and constellations (Belmonte 2010). Together with other substantial evidence this clearly seems to document an early observational and registration stage of the intellectual analysis of nature and astronomy.

Figure 1. According to Joseph (2010), the cross, painted in bold red ochre upon the entryway to the Chauvet Cave, and dated to over 30,000 years, could be interpreted as a representation of the solstice and equinox which marks the shortest and longest days of the year (December and June) and the beginning of Autumn and Spring and thus an awareness of these solar cycles during the Paleolithic.

Figures 2, 3, Phases of the moon. There are 13 new moons in a solar year, and females have 13 menstrual cycles in a year. According to Joseph (2010), the pregnant goddess, the Venus of Laussel, signifies her pregnant belly while holding the crescent moon in her right hand. The 13 cuts in the crescent moon represent the 13 menstrual cycles and 13 lunar cycles during a solar year, thus demonstrating an awareness of this association 20,000 years ago.

The Neolithic may be the first intellectual revolution from which we may aspire to have glimpses of the earlier cosmic views of the universe (i.e. of the sky and of the celestial bodies), possibly embedded in the large stone monuments that we can still see today. That landscape includes symbols of the celestial bodies (Ruggles 1998) created 5000 to 10,000 years ago. Analysis of these creations, suggest that the humans of that period, in their magic religious ritualization of time and space, tried to incorporate the surrounding cosmic order in their stone monuments. Possibly these behaviors reflect the belief that this appropriation would confer them some control over the celestial bodies or the forces of nature.

The Neolithic humans view of the surrounding cosmos may have been composed of their territory, loosely limited by the “distant” horizon, and of the sky above. This distant horizon would separate their world where they could walk, from the sky where they could not, but where some powerful heavenly bodies seemed to move in some kind of order. The celestial bodies would emerge and disappear in that unreachable line separating their territory from the celestial realm. They could not fail to have noticed, long before the Neolithic, that the activity of these bodies repeats in cycles that seem to find counterparts in their territory (Joseph 2010).

Continued observation of the celestial regularities, over centuries, would have provided an intimate perception of the cycles of the most prominent astral bodies, the Sun and the Moon. Surviving detailed registration of such regularities by the Babylonians circa 2500BC lead us into the modern views of the sky.

The geographical orientation of dolmens over vast regions seems to have been made with reference to the sky (Hoskin 1998), and as based on orientation, the occurrence of eclipses, the Moon seems to be favored (Clausen et al. 2008). Thus, we speculate that some of this symbolism and monumental architecture represents the Equinox about the middle of the up and down swing of the sunrise on the horizon in a close and intimate relation with Spring.

The present paper is a speculative discussion on the symbolic value of the ritual practice related to the spring equinox, and on its possible association to the distribution of the major megalithic sites, from the Sahara to the Artic Circle. The terms, Equinox and Spring are almost interchangeable in this paper, the first relating to our present day knowledge and the second to Neolithic ritual symbolic practice. We suggest that intelligent perceptions of nature, in the Neolithic, may involve second order concepts. In this case, the equinox would not be a result of a direct observation, e.g. of the sun against the horizon, but rather a method using, for instance, the count of days or the sunmoon cross over, etc. Also, an imaginary entity in the center seems to provide a consistent view of the observed cosmos.

1.1. The Equinox. As opposed to the solstices, which are marked by very clear indications in the sky (provided by the standstills at the extremes of the Sunrise and Moonrise sweep of the horizon) the equinoxes are not marked by such a simple and direct observation methodology. Very early in the 1960's Alexander Thom introduced the concept of the Megalithic Equinox (Thom 1967, p. 107). He supported it with data on particular solar orientations, with declinations close to zero, observed in some megalithic sites. Thom based this concept on the very simple technique of counting days and on the possible registration of those counts in the monuments or artifacts. Increased plausibility was derived from the observation that these data clustered around 0.5ºN from the East-West direction; a consequence of Earth's slightly elliptical orbit which causes the true equinoxes to separate the orbit in two halves of unequal length. Therefore the division of the year in two halves with the same number of sunrises results in the indicated azimuth offset. This view highlights both the mid-swing ritual importance and the need to resort to a second order concept to materialize it. Nevertheless the lack of objective and consistent evidence on equinoctial markers has always been controversial (Ruggles, 1997).

An alternative indication of the equinox might have been employed by humans of the megalithic period. This is based on the observation that, close to the solstices, the full Moon and Sun, rise in opposite extremes of the swing on the horizon. When the sun is close to the winter solstice the full Moon rises close to the direction of the summer solstice sunrise, and vice versa. However, as the sunrise departs from the winter solstice moving north, the full Moon rise moves south, until they cross close to the equinox. The awareness of the cross over and of its observation was the basis of the "Spring Full Moon" concept of Megalithic Equinox in southwest Iberia (da Silva 2004) and is evident based on data from M. Hoskin (1998). The variability of the azimuth of the Spring Full Moon rise, i.e. of the first fullmoonrise to pass over the sunrise, exhibits a bell shaped distribution centered about 9º south of true east. This has been found to be remarkably compatible with the orientation of the megalithic dolmens in this region, but it can also be observed in Hoskin (2001) data for other parts of the Mediterranean and Brittany. This analysis reinforced previous observations of astronomical directions between isolated megalithic monuments and conspicuous hills in the eastern horizon (da Silva & Calado 2003a), i.e, as based on particular directions of stones in the internal architecture of some stone circles in this region, and by the fact that these stone enclosures are generally set on top of a hill on a slope facing east toward the rising sun and moon (da Silva & Calado 2003b). Some of these astronomical alignment provide equinoctial markers within 0.5º.

The major monument in southwest Iberia exhibiting these features is the Almendres enclosure near Évora, which is clearly oriented due east. Since it is set on a gentle slope (6º), facing east, the observation of the sunset on a truncated monolith situated on the western apex, can not be made from the axis but rather from a station located at the eastern end of the northern wing. This is a very accurate alignment (less than 0.5º) for the observation of the spring equinoctial passage of the sun, and the features of this station suggest that this passage could be anticipated by two to three weeks and followed day by day. These findings indicate that people of that period placed great importance on the ritual observation of the passage of the Sun and of the Moon close to the direction that we now call the equinox (Oliveira & da Silva 2010) and with the average azimuth of the Spring Full Moon rise (Fig. 5). Figures 5 and 8 are two examples of these orientations about 9º south of east, the first coinciding within 0.5º with the symmetry axis of the horseshoe monument and the second using a prominent hill in the landscape to be sighted in that direction from an isolated menhir.

We may speculate that the neolithic early view of the cosmic order was mostly related to the passage of these celestial bodies in the horizon rather than the diurnal arch in the sky. Lack of permanent references would not imprint in the human mind much more than the variation of the length of the shadows of the sun during the day, i.e. long shadows at the beginning and end of the day, changing fast, and a shortest shadow around the "middle" of the day when the sun is at its highest.

The natural cycles of the horizon crossing by the celestial bodies would have been very clear and prominent in the case of the Sun, occurring in a fixed interval of the horizon. The Moon (particularly the Full Moon) would display a similar pattern, sometimes overshooting the Sun limits, sometimes not quite reaching those limits. Their observations that the astral bodies most influential in their territory were confined to a narrow strip of the horizon, associated with the fact that, as the sun approached those limits, life in his territory seemed to become increasing hard (freezing cold in one of the limits, and boiling hot in the other extreme), might have imprinted in their minds that life was more comfortable during the periods in which the sun was closer to the "center" of his swing in the horizon. We can even speculate that they may have attributed a magical power to this "centrality" perception that would retard progressively the sun as it approached the limits. In their minds this central region in the horizon could possibly be the home of a mighty force that kept their world stable and under control. They may then have felt inclined to praise and pray, or even rejoice, when the effect of this “force” was seen to to bring the sun back to a more comfortable situation. These events may have been the beginning of the summer and winter festivities close to the solstices followed by the spring rebirth of nature, or the welcoming of the autumn close to the equinoxes.

Fig. 5 – The Spring Full Moon rise close to the direction Z=099 of the megalithic equinox (Val d’El Rey, Portugal) (Oliveira & da Silva 2010), observed along the symmetry axis of the horseshoe enclosure (the bush on the left hides partially the left arm of the “horseshoe”).

2. The Monument

The Almendres Cromlech near Évora, Portugal (Fig. 6) is a megalithic enclosure discovered by H. Pina in the 1960’s (Pina 1971, p. 151). It consists of about 95 stones, many very large and weighing a few tons, distributed in a layout roughly elliptical. The monument sits on top of a small hill and the 60m major axis develops along a gentle slope facing East. Since its discovery several measurements have been performed that confirmed the East-West alignment of the long axis. This is also clearly a symmetry axis, and no one questions its possible importance as a place of ritual cult involving the observation of Sunrise or Moonrise close to the Equinox. It is a very large version of smaller enclosures in the surrounding 100Km region, of a type designated as “horseshoe” from its layout. In the case of Almendres the two long arms of the horseshoe almost touch and seem to embrace the rising sun near the equinox. Detailed analysis of the layout has identified precise features that may have been dedicated to the the equinoctial transit of the Sun, as seems common in the surrounding area. A few very precise solstice alignments (within 1º, in some cases 0.5º) have been identified and measured, as well as lunar major and minor standstills (da Silva 2000).

Fig. 6. The Almendres Cromelech near Évora, Portugal, looking southeast. (Photo of M. Rodrigues; courtesy of M. Calado).

From the Almendres enclosure it is possible to observe a conspicuous hill (Évoramonte) in the far distant horizon (≈20Km), very sharply close to the winter major standstill lunar rise. A hill that due to its prominence and conspicuous nature seems also to be a precise target to see the summer solstice sunrise from nearby megalithic sites marked by menhirs (e.g. Caieira) and enclosures (e.g. P. Mogos). The internal analysis of the layout of stones in the Almendres enclosure has also suggested that some other internal alignments may be supported, particularly by the identification of some distribution of stones that seem to materialize purpose built corridors to provide observation lines of sight, in particular to the Spring Full Moon.

Although the monument was constructed to be used facing East, it should be mentioned that, facing west, from the top of the monument (and of the hill) it is possible to identify features in the horizon that seem relevant to identify the passage of the sun through the equinox, and also the major and minor winter standstills of the setting Moon. Altogether, it looks like that the whole layout indicates that the monument was erected in such a place as to satisfy multiple celestial alignments.

2.1. The (Latitude) Speculative Conjecture. The lunar major standstill elongation observed over the Évoramonte hill in the winter standstill moonrise indicates an association between the value computed for the major lunar standstill elongation (ex. ±38º 36´, 2000BC) and the value of the latitude of the implantation of the Almendres enclosure (38º 33.5´N). This coincidence is within minutes of arc and can be made exact if very small elevations of the horizon (e.g. <1º) were taken, or by changing the date used in the calculations. We all know that there is no practical way in which we may invoke human knowledge of the Earth curvature in that period that could suggest a deliberate choice of placing the monument at such latitude, and therefore the capability to measure it. These observations have led to the question: given a value ∂ for the declination, at what latitudes can the corresponding elongation E equals the latitude value λ?

The spherical trigonometry regularly used to compute the azimuths provided the following equation,

$$\sin \partial = \sin (E) * \cos(\lambda) \text{ , for } E=\lambda.$$

This, when solvable, has two solutions E1 and E2 that complement i.e. $E1+E2=\pi/2$. Using a declination close to the major lunar standstill we find one solution at the latitude of Almendres, and the other at the complement latitude, which is very close to those of Stonehenge (51º 10.5´N) and Goseck (51º 12'N). The small differences, in the order of minutes of arc, are again subject to the same comments given above.

The detailed trigonometric treatment shows that there are no solutions for declinations greater than 30º. We can see in Fig. 7 that for the northern hemisphere there are two solutions far apart as ∂ is increased from zero, but the two solutions approach each other until they coincide both at 45º for ∂=30º. Note that –E is a solution for –∂. Fig. 7 shows the two solutions for declinations close to the cases of the sun standstill and of the moon minor and major standstills, representative of an epoch around 2000BC.

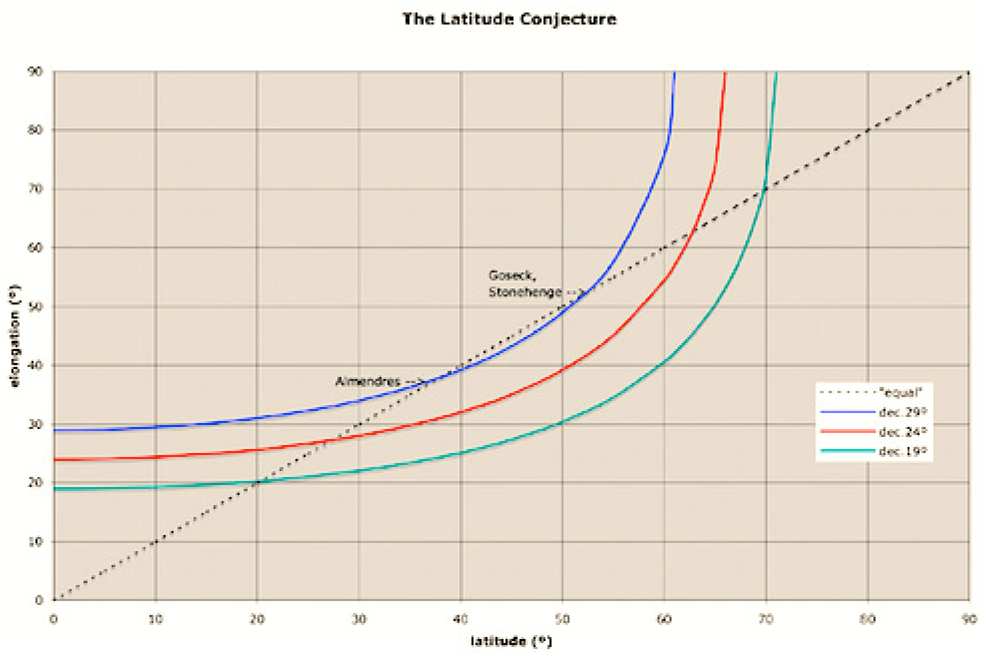

Fig. 7. Graphical solution of the Eq. 2.1 (elongation "equals" latitude) for values of declination ∂=19; 24; 29.

This interesting coincidence acquired, in this way, the status of an astronomical conjecture in search for a megalithic explanation, and was reported in earlier publications (da Silva 2000; da Silva & Calado 2003a). With our modern understanding of the world we seem to be able to speculate on and relate the latitude values of some megalithic monuments, using the consequences of the spherical model of the earth, and wonder if this may have been fortuitous.

3. Discussion

The observation and associated importance of the equinox may have provided Neolithic and even earlier cultures with a cosmology which helped them to understand nature and the universe. We can only speculate and there are a variety of models which purport to explain the underlying belief system, including, perhaps attempts at controlling the movements of the sun and of the moon, and the corresponding events on Earth. The agent of that force being situated in the horizon close to what we now call the direction of the Equinoxes, i.e. the East-West line. This view requires no more than just one intellectual concept: that of centrality, in the sense of Mircea Eliade(1964). Man is always in the center of his territory and this may be divided in two halves: the one where the sun, the moon and the stars rise, and the other where they set. These two halves are separated by the smallest shadow of a vertical pole (a representation of his “axis-mundi”).

The concept of spring (equinox), with its prominent anthropological importance, might have produced an important artifact, “the staff” (or pole). We know that when placed vertical at noon, during the equinox, the geometry of its shadow (i.e. of the right-angled triangle whose legs are the staff and its shadow) incorporates the latitude. If this was understood 6000 years ago is unknown. However, this vertical triangle when placed on the ground, by letting the staff point in the direction of the equinox, would encompass the ranges of sunrises and moonrises in the horizon (i.e. the hypotenuse would provide a limit to the elongation of the sunrise/moonrise). This observation might have added to the anthropological value of the equinox for it provided a method for them to measure, and thus keep control over the observed cosmological order. As they perceive cycles in time, as the sun rises in the horizon, the axis of the observers becomes horizontal and the middle point of the swing is just another form of “center”. This model becomes dynamical (i.e. non geometrical) as the “influence” in the center seems to control the swing. Other particular horizontal directions become important in this ritual. From the dynamical point of view, i.e. from the perception of a central direction, the axis in the direction of the equinox may have played the role of a geographical orientation. Also, the displacement of the sun and of the moon, as they rise in the horizon, could be viewed as displacements left or right of that direction, sweeping the small range of the horizon where they occur. It may well have bordered on a mystical experience to see the full Moon rise when the sun is setting straight opposite relative to the center where the observer stands.

This preference for a direction close to the center of the swing, seems well represented in the geographical orientation of various groups of funerary megalithic monuments, as a result of the observation that the full Moon rise and the Sunrise cross over on the horizon close to the equinoxes, as discussed above. The cross over assumes the role of a Megalithic Equinox and seems to be very frequent in regions of Brittany, Iberia and parts of the Mediterranean. We have observed also in the region around Almendres several examples of such orientation, for instance in the alignment of the horseshoe axis of the Vale d’El Rey enclosure (Fig. 5) and in alignments defined by menhirs and prominent hills in the landscape (Fig. 8). Other horseshoe enclosures are not sufficiently preserved, and therefore not so clear, but they seem to align in the same general direction.

The above analysis assumes that Neolithic monument builders had at best only a rudimentary understanding of the solstice and equinox, and could not possibly have conceived of a round Earth or the 365 day periodicity of Earth’s orbit around the Sun. It is easy to assume that the monument builders were not scientists, technicians, or astronomers, but may have based their beliefs on ritualistic magic and rudimentary observations and perceived coincidences without any real understanding of the underlying celestial dynamics. Certainly this may have been true of Neolithic people in general. Yet, at the same time it must be recognized that those who built these monuments had in fact studied, observed, analyzed, understood these celestial events, and were able to make extremely precise scientific predictions. They were also able to mobilize the local population to undertake massive engineering projects resulting in the creation of monoliths whose orientations have obvious celestial significance. These were not the creations of a primitive mind, but were the product of very precise scientific observation. Certainly, it can be said that the monument builders need only walk up or down along the general direction of the mid day shadow until a match is found and then proceed to build. However, they had to know what to look for and why.

As demonstrated in Figure 7 we can walk Iberia and France until reaching Brittany always with values of the major lunar standstill elongation smaller than those provided by the shadow of the pole. However, to find a clear departure to values of the elongation greater than the latitude it would have been necessary to come as far south as M'soura in the Sahara, marked by a cromelech with a large central menhir (Belmonte 1999), or to go as far north as Lituania where a flourishing community worshiped the sun and the moon in times past (Straižys & Klimka 1997). These two sites, however seem to satisfy the requirements of Eq. 2.1 for a declination of the moon closer to 28º in the major standstill, which could possibly place them later in time than the previous sites.

It is also interesting to note that the equinoctial marker in Gran Canaria (Esteban et al. 1996) may satisfactorily share with the Kings Tombs in Sahara (Belmonte et al. 2002) the solution where the elongation of the sun standstill equals the latitude, as may the Finland structures of Kastelli and Raahe (Ridderstad 2009) at the same latitude of the Faroe Is. It is however true that it may be possible to find a megalithic monument at any designated latitude.

At the latitudes derived from Eq. 2.1 we seem to find large Neolithic structures, either constituted by single monuments of reasonable size, or by large aggregations of smaller structures in a short geographical area. Also, it is interesting to note that no structures close to 20º and to 70º (the lunar minor standstill solutions) have been discovered. But, if the anthropological interpretation is correct then, symbolically, we speculate that it might be sufficient to contain (or control) the major deviations and, particularly, those of the mighty astral bodies, i.e. those that most influence the events in the territory. This may even be applicable to other prominent celestial bodies since man is now in the possession of a "yardstick" that can measure the cosmos and relate it to his own territory. Sirius might have been an example because this star had an elongation close to the latitude of Abu Simbel for a few centuries around 2000BC, before the precession of the ecliptic has thrown it out of alignment.

Translating into magic-symbolic language this might have appeared as a means of appropriation of the cosmological order. Or, a few Neolithic geniuses may have in fact understood what they had observed.

If this speculative conjecture finds any support in the role of the equinox then we may envisage the Neolithic man as master of the universe for he is able to contain the variations of the sun and of the moon within limits derived from the centre of the celestial swing where the Spring full Moon rises (Figs. 5 and 8). The maximum elongation at the solstice standstill, for the sun in particular, never exceeded the limit given by the equinox mid-day shadow from the level of Morocco and Tenerife to the level of the Faroe Is. north of Scotland. Beyond those limits life again was not very comfortable.

Although admittedly the above discussion is highly speculative, and controversial, we consider that the observed data seem to reveal an interesting conjecture suggesting further analysis.

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5. Ancient Greek-Roman Cosmology: Infinite, Eternal, Finite, Cyclic, and Multiple Universes

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Abstract

Ancient Greek cosmologists were not of one mind and did not generally embrace Aristotle's cosmology, in spite of the unrivalled long-term importance of his theories during the Middle Ages. Every one of its basic tenets – eternity, changelessness, spatial finitude, uniqueness and the separation in a sublunar and superlunar region – was at some stage questioned by Greek philosophers either before or after Aristotle. Among the alternative cosmologies that are worth reconsidering are the cyclic models proposed by Stoic thinkers and the finite-age, infinite-space ideas favoured by some authors of the atomistic school. These alternative cosmologies are not only of interest in their own right, but also because they include elements that turned up in much later scientific theories of the universe, including steady state, multiple worlds, cyclic, "big crunch" and recent conceptions of an infinite recycling universe.

1. Aristotles' Cosmos

Aristotles' view of the universe is a natural focal point for discussions of ancient cosmologies, whether these belong chronologically before or after Aristotle. (To speak of non-Aristotelian cosmology before Aristotle is of course anachronistic, but it nonetheless makes good sense.) The long-term significance of Aristotle's picture of the universe can hardly be overrated, not least because the major part of it became integrated in the natural philosophy of the middle ages, where it obtained a nearly doctrinal status. In fact, in Greek antiquity Aristotelian cosmology held considerably less authority that in did in the medieval and renaissance eras. At any rate, no account of Greek-Roman cosmology can avoid relating to the issues discussed so influentially by Aristotle. The books of relevance for cosmology are principally On the Heavens and parts of Physics, and secondarily Meteorology, On Generation and Corruption, and book 12 of Metaphysics (Barnes 1984). A further work, known as On the Universe, is relevant as well, but it is generally believed to be pseudo-Aristotelian, that is, written by a later author. Aristotle's main works are often known by their Latin titles, in this case De Caelo, Physica, De Meteorologica, De Generatione et Corruptione, Metaphysica Lambda, and De Mundo.

So, what were the defining features of the Aristotelian universe? Briefly put, it can be described as a two-region universe in a steady state. According to Aristotle, the universe at large consisted of two essentially different realms, the sublunar and the superlunar world. The first region, covering the Earth and the air up to the Moon, was composed of bodies made up of the four terrestrial elements with their rectilinear motions, either towards the centre of the Earth (earth, water) or away from it (air, fire). Beyond the Moon, the bodies moved naturally in eternal, uniform circular motions. The stars, planets and celestial spheres were composed of an entirely different kind of matter, an ethereal semi - divine substance or fifth element, what Aristotle called the aither but is better known by the later Latin name quinta essentia. The aither resided exclusively above the Moon and its natural motion was, contrary to that of the terrestrial elements, circular. In the Meteorology Aristotle said that the purity of the aither increased in proportion to its distance from the sublunar world. Whether in the sublunar or superlunar region, a void could not possibly exist, and hence the universe was a plenum.

Aristotle's cosmos was in a steady state in so far that it was eternal and local changes were restricted to the sublunar world. He argued that the universe as a whole was ungenerated as well as indestructible. Among several arguments against cosmic creation, Aristotle referred to what is known as the ‚why not sooner?' argument: If the universe came into being a finite time ago, what reason could there possibly be for just this time rather than some other time? He also denied that the universe (or any other body) could be created out of nothing, because that would require a pre-existing void, which he considered an impossible notion. A spatially infinite world was another impossibility, for by its very nature the world – meaning the heavens – revolved in a circle, and Aristotle pointed out that such motion was impossible as it would lead to an infinite velocity. What was enclosed by the outermost sphere comprised everything. In summary, Aristotle maintained that the universe was unique, eternal, and all inclusive:

The world as a whole includes all of its appropriate matter... So that neither are there now, nor have there ever been, nor can there ever be formed more heavens than one, but this heaven is one and unique and complete. It is therefore evident that there is also no place or void or time outside the heaven. For in every place body can be present; and void is said to be that in which the presence of body, though not actual, is possible; and time is the number of movement. But in the absence of natural body there is no movement, and outside the heaven < body neither exists nor can come to exist. (Barnes 1984, Vol. 1, p. 462)

It was this conception of the universe that was incorporated into the medieval world view, except for the controversial and most un-Christian claim of the universe being past eternal.

2. Cyclic Conceptions

Ideas of cosmic cycles were well known in ancient Greece, both before and after Aristotle. Empedocles from Acragas in Sicily famously postulated four basic elements (earth, air, water, fire) which permanently kept their character and the arrangements and rearrangements of which accounted for what appeared to be generation and destruction in nature. He described the cosmos as a self-contained sphere passing through cycles of rest and change, with recurring stages of conflict which produced forms of life. In a characteristic vitalistic terminology Empedocles called the polar opposing forces or principles for philia (‘Love’) and neikos (‘Strife’). The changes between dominance by Love and Strife proceeded eternally, corresponding to continual creations and destructions of the world. However, the two forces were not simply creative and destructive, for the conditions of life demanded a certain balance between them. When Love dominated, the elements were mixed up into a uniform mass, while at the time of Strife's complete dominance they were fully separated from one another and arranged in concentric spheres. Only in between the two extremes was the universe hospitable to processes generating life.

Empedocles' cycles were symmetric, so that the events in one phase were repeated in the opposite phase, but in reverse time order. Thus a process from birth to death would be followed by one from death to birth. Without requiring an identical repetition, Empedocles posited a cosmos without beginning or end. In one of his enigmatic fragments he speaks of a 'double birth' and a 'double passing away,' for 'the unity of all things brings one generation into being and destroys it, and the other is reared and scattered as they [the elements] are again being divided' (Wright 1995, p. 142; O'Brien 1969). The periods of the cosmic cycles were said to be very long, but Empedocles did not specify their length.

The later Stoic philosophers adopted the idea of temporally multiple universes, which they associated with thermal phenomena. What Empedocles poetically had named Love and Strife was now conceived more naturalistically or mechanically, namely as condensation and rarefaction. In what has been called "a first tentative approach to the conception of thermodynamic processes in the inorganic world" the Stoics assigned a dynamic role to fire in all areas of natural phenomena, indeed to the cosmos itself (Sambursky 1959, 1963, p. 133). Fire was the agent that caused change and decay in the universe, eventually to lead to its conflagration – evidently a most un- Aristotelian notion. However, the conflagration would not be the absolute end of the universe, for it was thought to be reborn and from the primeval fire to return identically to its former state. In a lost book known as On the Cosmos, Chrysippus from Cicilia is to have said that "after the conflagration of the cosmos everything will again come to be in numerical order, until every specific quality too will return to its original state, just as it was before and came to be in that cosmos" (Sambursky 1963, p. 202).

Assuming the physical world to be placed in an infinite non-physical void, the Stoics conceived the cosmos as a gigantic sphere oscillating through cycles of expansion and contraction in the void surrounding it. The agent responsible for the cyclic changes was ultimately the fire element.

According to a Stoic source, “the material world preserves itself by an immense force, alternately contracting and expanding into a void following its physical transmutations, at one time consumed by fire, at another beginning again the creation of the cosmos” (Sambursky 1963, p. 203). For the idea of cosmic conflagration Zeno of Citium and later Stoic philosophers used the term ekpyrosis, meaning ‘out of fire.’ According to Plutarch, “When ekpyrosis takes place, [Chrysippus] says that the universe is totally alive and is a living being, but thereafter, as it is quenched and becomes concentrated, it turns into water and earth and things substantial” (Lapidge 1978, p. 183). Another Roman author, Marcus Tullius Cicero, adopted a version of the Stoic universe, such as appears from his treatise On the Nature of the Gods. We Stoics, he said, conclude that in consequence of this consumption the thing... will come to pass, I mean the final conflagration of the whole universe; for when moisture has been exhausted the earth could not be nourished, and there would be no returning stream of air, as its creation would be impossible when the water had all been used up; nothing, therefore, they say, is left except fire as the agency, vivifying and divine, by which the universe should be renewed again, and the same external order called into being (Cicero 1896, Book 2, Chapter 46).

It is tempting to think of the ekpyrotic state as a violent conflagration, perhaps a kind of ‘big crunch’ in which all matter collapses and is turned into hot radiation energy. But the Greek texts mostly describe the decay process as a very slow, almost imperceptible combustion. Some of them liken the conflagration of the world to the gradual transformation of swamps into dry grounds.

More than two thousand years later, the name ‘ekpyrosis’ reappeared in cosmology, now in a cosmological model based on concepts of string theory proposed by Paul Steinhardt, Neil Turok, Bert Ovrut and Justin Khoury in 2001. As they explained in their paper in Physical Review, “We refer to our proposal as the ‘ekpyrotic universe,’ a term drawn from the Stoic model of cosmic evolution in which the universe is consumed by fire at regular intervals and reconstituted out of this fire” (Khoury et al. 2001). The new ekpyrotic model depicted a kind of phoenix universe and was subsequently transformed by Steinhardt and Turok into an eternally cyclic model of the universe intended as an alternative to the standard inflationary scenario of the big bang. According to Steinhardt and Turok, the association to Stoic cosmology was suggested by two classics scholars, Joshua Katz from Princeton University and Katharina Volk from Columbia University (Steinhardt & Turok, 2007, p. 149).

Other modern authors have found a different kind of inspiration in Empedoclean and Stoic cosmology, seeing them as similar to the much later cosmological views of the twentieth and twenty first century, such as the steady-state theory of Hoyle and colleagues (2000), the quantum theory of an infinite universe which continually recycles itself (Joseph 2010a,b), or the relativistic theory of a closed cyclic universe with initial and final singularity (Ćirković 2003).

3. Cosmic Beginnings and Multiple Worlds

The cyclic universe is not the only modern cosmological idea that with some justification can be traced back to Greek-Roman antiquity, if of course only in a qualitative sense. The same is perhaps the case with the controversial idea of many universes – presently known as the multiverse – and its associated notion of the anthropic principle (Carr 2007). The cyclic universe of the Stoics thinkers constitutes one kind of multiverse, but in a temporal version only.

In sharp contrast to Aristotle, Epicurus (ca. 342-271 BC) advocated an original version of atomism according to which atoms moved ceaselessly in an infinite void, constantly forming and reforming the world. And not only that, for he also disagreed with Aristotle's conclusion of the uniqueness of the world. Boldly stating that "there are infinite worlds both like and unlike this world of ours," Epicurus argued as follows: "For the atoms being infinite in number... have not been used up either on one world or on a limited number of worlds, nor on all the worlds which are alike, or on those which are different from these. So that there nowhere exists an obstacle to the infinite number of worlds." He further stated that "we must believe that in all worlds there are living creatures and plants and other things we see in this world" (Crowe 1999, p. 3; Trimble 2009).

Epicurus' atomistic ideas greatly influenced the Roman poet Titus Lucretius Carus who about 50 BC composed his famous work On the Nature of Things (Latin: De Rerum Natura), one of the masterpieces of Greek-Roman natural philosophy. After having affirmed that the universe is spatially infinite--"All that exists... is bounded in no direction" --Lucretius proceeded with arguing for an infinity of inhabited worlds, of "other orbs of Earth in other regions of space, and various races of men and generations of beasts." He further explained that although the cosmos is infinite in space, it is of finite age and "there will be an end to the heaven and the Earth." He thus opted for a combination of space -time finitude-infinitude that was opposite to the one argued by Aristotle. Lucretius based his argument on the shortness of human history, which he found to be inexplicable if the world had existed eternally in the past:

"If there was no origin of the heavens and Earth from generation, and if they existed from all eternity, how is it that other poets, before the time of the Theban war, and the destruction of Troy, have not also sung of other exploits of the inhabitants of Earth? < How is it that they no where survive in remembrance, and are no where stamped on everlasting monuments of fame? But, as I am of opinion, the whole of the world is of comparatively modern date, and recent in its origin; and had its beginning but a short time ago" (Lucretius 1997, p. 45 & p. 205).

According to Lucretius, not only did the universe have a beginning, it was also decaying towards a final end. "It is vain to believe that this frame of the world will last for ever," he wrote, "for neither do its veins, so to speak, submit to receive what is sufficient for its maintenance, nor does nature minister as much aliment as is needed." Here we have an early statement of what anachronistically can be considered the universal principle of dissipation or what in the nineteenth century became known as the heat death of the universe, supposed to be a consequence of the law of entropy increase.

The problem of the eternity of the world was raised by Stoic philosophers long before Lucretius. For example, Theophrastus reported how Zeno of Citium used the observed surface of the Earth, characterised as it is by mountains, valleys and plains, to argue that it could not have existed in an infinity of time (Freudenthal 1991, p. 50). This may be the first instance of a general line of reasoning that in the late nineteenth century was dicussed as the "entropic creation argument": From the existence of unidirectional natural processes, such as the steady increase of entropy, it can be inferred that the world is not eternal in the past (Kragh 2008).

Lucretius' reasoning has been read as "an almost modern formulation of the anthropic argument against the past temporal infinity" (Ćirković 2003, p. 883), which is a reference to what is sometimes known as the Davies-Tipler argument. The essence of this argument, due to Paul Davies and Frank Tipler, is that in an infinitely old universe one would expect colonization all over by technologically advanced civilizations. Since this is contradicted by observation, the world cannot have existed in an infinity of time (Barrow & Tipler, 1986, pp. 601-608). However, the Davies-Tipler argument is far from unproblematic and it is questionable if it qualifies as an anthropic prediction. At any rate, Lucretius' anticipation of the argument was not the only one of its kind and it is unjustified to speak of "the historical blindness of subsequent generations' to this form of argumentation (Ćirković 2003). In fact, from late antiquity over the middle ages and the renaissance to the modern period many philosophers and scientists have argued in similar ways for a universe of limited age (Kragh 2008).

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6. Astronomy and Psyche in the Classical World: Plato, Aristotle, Zeno, Ptolemy

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Abstract

The history of classical astronomy tends to emphasise the development of mathematical astronomy and the origin of astronomical instrumentation. Religious and philosophical issues are generally dealt with separately. However, the practice of classical astronomy was conducted within a context in which the cosmos was permeated with soul, or psyche. This paper examines the work of Plato, Aristotle, and Zeno, and applies theory of "psychological astronomy" to the classical world, so as to provide a context and and understanding of the motive for the development of mathematical astronomy, concluding with the work of Claudius Ptolemy.

1. Introduction

We can distinguish at least four schools of theoretical cosmology in the classical Greek world: the Platonists, Aristotelians, Stoics and Atomists (Campion 2009a). To this list we might add the religious edifice of celestial deities evident in written accounts since Hesiod's Theogony (1972), but in this paper the focus is on the four philosophical schools in view of their body of speculative literature. Of these four, the first three, the Platonists, Aristotelians and Stoics, regarded the cosmos, in their various ways, as meaningful, purposeful or characterised by the connection of all things, either psychically, physically or through networks of causation; only the Atomists inhabited a directionless, meaningless cosmos and, I would argue, theirs' was very much a minority view. In spite of their substantial differences, Platonists, Aristotelians and Stoics all agreed that the entire cosmos, in both its terrestrial and celestial parts, was bound together by psyche. From an individual perspective, the cosmos therefore possessed an interior aspect as much as an external one, and astronomy was a psychological practice as well as an observational or mathematical one, the evidence for which is scattered throughout the philosophical literature of the classical world. At the heart of all these models was the notion of the cosmos either as divine or as a path to the divine.

2. Plato: the Soul Mainly Transcendent

The conventional structure of the classical world finds its earliest extant form in Plato's works, in which w encounter a geocentric cosmos with the earth at the centre, surrounded by crystalline spheres on which planets rotated, with the fixed stars at the outermost limit (1914c 108E-109A, 110B, 1931, 46D-47A, 1937, X.614-621). However, the concern here is with the moral structure of the universe was based on the premise that the world emanated from the mind of God and was permeated by soul. The initial phase in the Platonic creation myth involved the development of the world soul, out of which matter itself was created. In spatial terms, the cosmos, though inherently perfect, therefore became ever more degenerate as it became more distant from the creator. The fixed stars, whose appearance never changed were most divine, being closest to God, while the planets become steadily less divine as the crystal spheres on which they revolved moved closer to the earth in the order Saturn, Jupiter, Mars, Mercury, Venus the sun and, lastly, the moon, whose rapidly changing appearance was proof of its profound imperfection. Eventually we arrive on the earth which is round and held at the centre of the universe by the whole system. Plato defined the planets as gods (1931 30D, 41A) in the sense that they are beings borne of the same living, divine material as the rest of the cosmos, but the individual human soul was to have a direct relationship with the fixed stars, its location between incarnations in material form (1931 41E-42A, 1937, X.614-621).

The concept of the relationship between soul and stars finds its fullest expression in Plato's psychological theory - his view on the nature and function of psyche - which, in turn needs to be understood in terms of his theory of the soul's origin in the stars and classification into different functions. As Bartel van der Waerden argued, Plato's theory of soul takes us to the heart of the development of this particular feature of Greek astronomy: "The soul comes from the heavens", he wrote, "where it partook of the circulation of the stars. It unites itself with a body and forms with it a living being. This explains how human character comes to be determined by the heavens" (van der Waerden 1974, p. 147). Each soul, Plato wrote in Timaeus, has its own star (1931, 41E-42A). He was, of course, speaking metaphorically but, in his view, metaphor was often the most effective means of revealing truth.

Plato set out his theory of the soul's origin in the stars in Timaeus and elaborated it in the Republic (1937, X.614-621) in which the precise mechanics of the soul's incarnation into human form were set out: it originates in the sphere of the fixed stars, to which it later returns, following a descent and ascent through the planetary spheres. Plato's text gives an account of the means by which the soul selects a possible life and then descends through the planetary spheres to the Earth, a process during which its future fate is determined. From the cosmogony which is so carefully set out in Timaeus, we can draw two significant conclusions. The first is that soul pervades the entire cosmos. The second is that soul takes priority over matter. Plato was most emphatic on this point. 'God', he wrote, 'constructed Soul to be older than Body and prior in birth and excellence, since she was to be the mistress and ruler' (1931, 34C). "Soul", he wrote in Phaedrus, "has the care of all that is soulless" (1914a, 246 b-c). It exists independently of body and may incarnate - or may not. The Cosmos, for Plato, was a "Living Creature endowed with soul and reason owing to the Providence of God" (1931, 30B-C). The concept of the entire universe as alive and resting in soul, or psyche, also enabled Plato to see the cosmos as psychological in the modern sense, as having personality, driven by manners, habits, opinions, desires, pleasures, pains and fears (1914b, 207E).

Plato's ideas on the soul evolved throughout his various writings. However, as with his cosmology, we can generalise. The divine unfolded in stages, first through soul and mind, and finally through its self-realisation in physical form. Human beings, Plato believed, consisted of four different parts; on the one hand, the body and, on the other a soul divided into three.

In Phaedrus he represented this three-fold structure as a charioteer and his two horses (1914a, 246A, 253C-D). The highest part, as he explained in Timaeus, was the charioteer himself, the rational soul, mind or intellect, which discerns what is true, judges what is real and makes rational decisions (1931, 28A). Next was the spirited soul, the active part, the will, whose function was to carry out what reason has decided. Last, and lowest, was the appetitive soul, the seat of emotion and desire, which needed to be restrained by the higher, rational, soul if the individual was to be saved from self-destructive behaviour. Sometimes these three souls are regarded as distinct, separate entities, but it is better to see them as functions which exist on a smooth spectrum from the rational to the emotional, an extension of the emanationist principle of Platonic cosmogony, in which all existence emerges in a continuous flow from the creator. There is no firm dividing line between the human and the divine in Platonic theory and, significantly for the understanding of Plato's astronomy, none between humanity and the stars: all are embedded in the world soul, of which individual souls are a part (1931, 41D-E).

We might view Plato's model of the soul's relationship with the stars as leading, variously, to enlightenment or salvation, in which respect he issued the following inspirational advice: "we ought to fly away from earth to heaven as quickly as we can; and to fly away is to become like God, as far as this is possible; and to become like him, is to become holy, just, and wise" (Plato 1949, p. 41). The consequence of engagement with the stars might, for Plato, be psychological transformation. God himself was rational and it was the very act of observing the motions of the stars and planets which enhanced rational powers in the observer and drew him or her close to God, the source of reason, of thought and goal of all intellectual inquiry (1931, 28C, 41B, 42E, 47C). Theology and psychology are therefore, in Plato's terms, inseparable. The theme was taken up from a Stoic perspective by Marcus Manilius, one of the few classical astrologers to have written in Latin. In his Astronomica, composed probably at the end of the first century BCE, Manilius drew attention to the rational soul's role in astronomy:

Who could know heaven save by heaven's gift and discover God save one who shares himself in the divine? Who could discern and compass in his narrow mind the vastness of this vaulted infinite, the dances of the stars, the blazing dome of heaven...had not nature endowed our minds with divine vision, had turned to herself a kindred intelligence...? Who, unless there came from heaven a power which calls us heavenward to the sacred fellowship of nature? (Manilius 1977, 2.115-129).

The belief that to engage with the stars in a contemplative manner might benefit one's soul proved an enduring feature of the deep Platonic strain in classical cosmology. Typical was the Roman emperor Marcus Aurelius (1964, p. 112), who was deeply influenced by both Plato and the Stoics, and who prescribed the following remedy for world-weariness in the second century CE.: 'Survey the circling stars as though you yourself were in mid-course with them. Often picture the changing and re-changing dance of the elements. Visions of this kind purge away the dross of our earth-bound life'. One's soul, the emperor believed, might be cleansed by means of an imaginative union with the stars.

3. Aristotle: the Soul Partly Embedded in Matter

Aristotle's theories parallel Plato's in his use of a tripartite division, but differ in his emphasis on the embodiment of psyche in matter; whereas, for Plato, soul was both immanent and transcendent, in matter and above it, Aristotle seriously restricted its transcendent portion. The Aristotelian soul, like the Platonic, is a kind of animating force, without which the natural world could not operate. "Soul", Aristotle wrote, "is substance in the sense of being the form of a natural body, which potentially has life. And substance in this sense is actuality. The soul, then, is the actuality of the kind of body we have described" (1936, II.I.412a). That is, it is soul, exactly as in the Platonic sense, which allows matter to live and turns human beings into individuals. Soul is the "cause" of the body, and so, in a sense, has priority over it (1936, II.IV.415b).

Like Plato, Aristotle also employed a tripartite division of the soul into three levels, which were arranged hierarchically, in ascending order from the lowest, the 'nutritive' (possessed by plants, animals and people), to the sensitive (possessed by animals and people, but not plants) and, finally, the highest, the intellectual (possessed by people alone) (1936, II.III.414a-b). Aristotle's descriptions of the lower two souls differ slightly from Plato's equivalents. For example, Aristotle's sensitive soul is that which allows individuals to use their senses, such as sight and touch, and cope with the desires, pains and pleasures which the senses arouse; the sensitive soul has to deal with the consequences of physical desire.

Although, unlike Plato, Aristotle did not explicitly relate the soul to the stars, he did presuppose a world in which the entire terrestrial realm is connected to the celestial spheres and the soul-star connection is therefore implicit. Even though Aristotle proposed that the physical composition of the cosmos in the sublunary realm, consisting of the four elements, differed from that above, which was composed of ether, but he also postulated a fundamental unity which connected stars to earth, and hence, implicitly, to the soul:

The whole terrestrial region then is compounded of these four bodies [fire, earth air, water] and it is the conditions which affect them which, we have said, are the subject of our inquiry. This region must be continuous with the motions of the heavens, which therefore regulate its whole capacity for movement. For the celestial element as source of all motion, must be regarded as first cause (1937, 339a.19-24).

For Aristotle, the soul's relationship with celestial motions may not have been explicit, but it was implicit: the soul is moved by the heavens which are themselves, animate. 'The fact is' he wrote, 'that we are inclined to think of the stars as mere bodies or units, occurring in a certain order but completely lifeless; whereas we ought to think of them as partaking of life and initiative. Once we do this, the events will no longer be surprising' (1921, II.xii.292a). The cosmos, therefore was alive and purposeful. Moreover, with the exception of a fragment of the intellectual soul, the "agent" or "active" intellect, the Aristotelian soul was entirely embedded in the material world (1936, III.V.430a; Caston 1999 p. 199).

4. Zeno of Citium: The Soul Entirely Embedded in Nature

The naturalistic perspective was adapted and emphasised by the Stoics, founded by Zeno of Citium (c.334-262 BCE). Zeno shared much with Plato, in particular the concept of an intelligent, reasoning cosmos. However, whereas Plato insisted that psyche, as intangible consciousness was the source of the material world, Zeno insisted that matter, rather than soul, was the origin of everything. Indeed, for the Stoics, there was nothing in this cosmos which could not have physical form. Even ‘voice’, Zeno claimed, was a “body”. (Diogenes Laertius, 1925, VII.156-7).

Zeno’s concept of the soul bears comparison with Aristotle’s: his work on the soul is lost but we have an account of his ideas from the summary by Diogenes Laertius in the third/fourth centuries CE. “They believe”, Diogenes Laertius wrote of the Stoics (1925, VII.156-7), “that...soul is a nature capable of sense-perception. And this soul is the inborn pneuma in us...by this means we live and breathe and by this we are moved’. The Stoics shared with Plato the notion of a cosmos which was permeated by the world soul and in which all things, including emotions, thoughts and bodies, were intimately connected. For the Stoics such connections operated through webs of “sympathy” and, being universal, connected stars to people (1925, VII.134,140-2).

5. Psychological Astronomy

The development of the term “psychological astronomy” (Campion, 2009b) to describe the psychological application of astronomy recommended by Plato, is derived from various commentaries on Aristotelian cosmology. In particular, Christopher Shields (2007, p.270) considered what he called the “psychological” applications of Aristotle’s hylomorphism. Hugh Lawson-Tancred (1986) spotted the potential importance of Aristotle’s theories for modern psychology when he asked of Aristotle’s intentions, “is he not directly anticipating the Physicalist theories so dominant in contemporary philosophy of psychology?” Thus, it is argued, that the Platonic, Aristotelian and Stoic models of astronomy contains a psychological strand and carry psychological consequences and applications (Campion, 2009b).

6. Claudius Ptolemy: Practical Applications

The theoretical cosmic psychologies proposed by Plato, Aristotle and Zeno found their practical application in the work of Claudius Ptolemy, the last of the great astronomers of the classical world (Jones, 2010). Ptolemy has a claim to being the most influential of classical astronomers on account of the respect with which his encyclopaedic work on mathematical astronomy, the Syntaxis, or Almagest, was held, first in the Islamic world, and then in Medieval European culture. While the Almagest, is usually the centre of attention when Ptolemy's astronomy is examined, if his cosmology is to be understood on its own terms, its purpose cannot be understood independently of two of his other works, the Harmonics and the Tetrabiblos, in both of which he raised the soul's relationship with the stars.

Ptolemy appears to have drawn his philosophical influences from Platonists, Aristotelians and Stoics. Sambursky (1987, pp. 140-5), for example, indetified the origin of Ptolemy's regard for the independence of planetary motions in Platonic notions of the living cosmos. However, as Robbins (1949, p ix) noted, he also appears to have been deeply attracted to Aristotle's philosophical naturalism. Liba Taub (1993, p. 15), meanwhile, drew attention to the discussion of possible Stoic influences on Ptolemy. However, rather than adhering to one philosophical school, Ptolemy was typical of philosophical thought in the second century CE in which "pure" forms of earlier philosophical schools had been replaced by syncretism in which facets of each could be combined in various forms. We would therefore expect to see him drawing on all earlier notions of soul.

Ptolemy divided the work of the astronomer into two phases: the first was concerned with the measurement of celestial positions, which we find in the Almagest, the second with the measurement of their effects, which he discussed in the Tetrabiblos , and which is one of the foundations of western astrology (Ptolemy 1940, I.1). Those effects might be felt in the natural world but also in the psychological, the realm of the soul. Ptolemy's psychological astronomy can be divided into two forms, the contemplative and the analytical. The first was devoted to the contemplation of the cosmos with a view to attaining personal peace and harmony (Taub, 1993, p. 137), and clearly draws him into the Platonic orbit. The second which is set out Tetrabiblos, required the use of planetary motions to analyse the condition of the individual soul. The two forms of psychology come together in that the latter, by providing foreknowledge of predetermined events, calms the soul; by knowing that the future is inevitable, one accepts it with grace. As the Stoic philosophers had claimed, the virtue which encourages a calm soul and cautious action comes from a knowledge of what one must do (Diogenes Laertius 1925, 91, 92-3, 122, 126). And, as Plato argued, a knowledge of philosophy, in which he included astronomy, leads to happiness (Plato, 1914a, 256 A-B).

In the Stoic conception, which was undoubtedly an influence on Ptolemy, animals were compelled to action by a movement in the soul/psyche called the hormê – an impulse or drive (Sandbach, 1975, pp. 60-1). There is a kind of celestial mechanics at work here, in which the movement of a planet is connected to a disturbance in the individual soul, and with a consequent tendency to action. In the Tetrabiblos, though, Ptolemy is concerned with the symptoms of such motions – their manifestation in the psychology of the individual, rather than the mechanics by which the stars and planets act as causes. The planets' psychic or psychological, and physical functions were related to the essential nature of the cosmos, as well as to humanity, a system in which person and planet, mind and body, were absolutely interrelated.

Ptolemy's preferred model of the soul appears to have been a version of the Platonic-Aristotelian three-fold division arranged in hierarchical order, in the Platonic sense, as rational, emotional and "cupidinous" (2000, III.96.27). Whether his principal source for the tripartite division was Plato or Aristotle (the distinctions resemble the Platonic rather than the Aristotelian, but his naturalism is closer to Aristotle than to Plato), in his Platonist and Stoic personas he would have believed that self-control of the lower two parts of the soul was necessary if the rational-intellectual part was to achieve its full potential. He also divided the rational soul into seven qualities all of which are varieties of sharp, critical thinking, experience and wisdom, in an apparent - but undefined - analogy with the planets, which are not, though, mentioned explicitly (2000, II.12-13). Ptolemy's purpose was to describe the soul's life within nature.

According to Stoic teachings, the natural world was something to accept gracefully, not an arena of suffering from which to escape. The soul was then embedded, in Pythagorean style, in a series of mathematical formulae and musical scales related to the zodiac signs and planets. The rising of Mercury and Venus, for example, related to a particular sound, a harmony which, if one could hear it, would represent the perfect contemplation of the divine.

Ptolemy set out his detailed rules for identifying the condition of the soul, or psyche, in the Tetrabiblos, composed around 120 CE, although there he appears to have been concerned only with two levels of the soul (1940, III.13), rather than, as in the Harmonics, three. He compressed the three levels of soul, for astrological purposes, into two, the “rational” and “irrational”. Also, whereas Plato had written of the soul’s descent through the planetary spheres, but retained its primary theoretical relationship for the stars, Ptolemy identified the positions of the planets as sources of the soul’s quality. In Ptolemy’s view the higher of the two souls was the ‘rational’ the character of which, he claimed, was determined by the placing of Mercury. The lower part, the “irrational”, was characterised by the Moon and its associated stars. Ptolemy had taken Plato’s system, in which the descent through planetary spheres infers a relationship between planet and soul. Also, apparently relying on Aristotle’s scheme, he associated the intellectual, or rational, soul with Mercury and both the nutritive and sensitive souls to the Moon, writing that

Of the qualities of the soul, those which concern the reason and the mind are apprehended by means of the condition of Mercury...and the qualities of the sensory and irrational part are discovered from the one of the luminaries which is the more corporeal, that is, the moon (1940, III.13).

From these simple rules the classical astronomer – and astrologer - might then construct a simple psychological analysis. Mercury and the Moon located sympathetically might denote a pleasing character but, if in a difficult relationship according to the rules Ptolemy set out, the personality would be beset by difficulties. We know that this system was still in use by the time that Galileo cast the horoscopes for his daughters (Galileo, no date, pp. 21-2, 24-6, 29).

7. Conclusion

An understanding of classical astronomy, and of the history of western astronomy in general, should take into account the context provided by conceptions of the cosmos within which mathematical models of planetary and stellar motion were situated. However, the widespread belief that soul pervaded the material universe provided one such context, even though Platonic, Aristotelian and Stoic versions of the relationship between soul, nature and stars, differed. The the term and concept of “psychological astronomy” has been developed in order make a contrast with mathematical astronomy.

Claudius Ptolemy’s work provides a key example of the practical application of psychological astronomy, which can be divided into forms: psychological astronomy of the contemplative variety provided the overall motive within which Ptolemy’s analytical psychological astronomy and his mathematical astronomy can be understood. The significance of contemplative psychology for his mathematical astronomy is set out in the opening passage of the Almagest in which, as a Platonist, Ptolemy recognised that divinity stood at the heart of his cosmology. What he imagined, in his cautious way, as divinity, was described in Aristotelian terms as the “first cause of the first motion of the universe’, impersonal and remote, like an ‘invisible and motionless deity” (Ptolemy 1998, I.1). His goal, he wrote, was to “strive for a noble and disciplined disposition…to devote most of our time to intellectual matters, and especially those to which the epithet “mathematical” is particularly applied” (Ptolemy 1998, I.1).

In words which both Plato and Marcus Aurelius would have recognised, Ptolemy defined the purpose of astronomy as to increase “the love of the contemplation of the eternal and unchanging”, the divine source of all life in the cosmos (1998, I.1). In his short poem, the Anthologia Palatin he imagined his soul – his psyche - extending to the stars “I know that I am mortal, the creature of one day. But when I explore the winding courses of the stars, I no longer touch with my feet the Earth: I am standing near Zeus himself drinking my fill of Ambrosia, the food of the Gods” (Luck, 1987, p.348).

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7. “Let There Be Light!” The Genesis of Biblical Cosmology

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Abstract

Genesis 1:1-2:3 is the most “natural” and carefully crafted account of creation in the Hebrew Bible. This “report” proceeds methodically to outline a sophisticated cosmology whose chronological framework reflects the structural features of a typical Syro-Palestinian temple in antiquity and whose spatial contours suggest a three-tiered astrodome. The account begins not with God creating ex nihilo, as is commonly assumed, but with the deity working with undifferentiated matter, a cosmic mishmash. Primordial light, the first act of creation, is distinguished temporally from the light transmitted by the sun and stars. As a whole, the Genesis account charts the progressive differentiation of the cosmos from a formless chaos to an intricate structure that supports the diversity of life.

1. Introduction

Written in the 6th century BCE, Genesis 1:1-2:3 (hereafter referred to as “Genesis 1”) is the most cosmically oriented and carefully crafted text of the Hebrew Bible. It is also the Bible’s closest thing to a “natural” account of creation. Compared to the rough-and-tumble drama of the Babylonian myth of creation, the Enūma Elish (late 2nd millennium BCE), Genesis 1 reads like a dispassionate treatise. Through the near-monotonous repetition of literary motifs and structural devices, the Bible’s first account of creation resembles more a report than a story, more an itemized list than a flowing narrative. It reflects a literary austerity, an abstractness that rigorously avoids the fray of mythic conflict, on the one hand, and eschews the pathos of ancient poetry, on the other. Its closest intellectual cousins are found among the cuneiform astronomical diaries of ancient Mesopotamia. This would include the Sumerian and Akkadian versions of the *Enūma Anu Enlil* (usually dated around the mid-second millennium BCE), a vast compendium of omens that includes precise astronomical observations, as well as the later MUL.APIN ("Plow Star"), around the beginning of the first millennium BCE (Evans, 1988, pp. 5-17; for a general discussion of the relationship between Mesopotamian astronomy and science, see Rochberg, 2004).

In this brief essay, I examine the ancient cosmology of Genesis 1, the best known, but by no means the only, creation account in the Bible (see Brown, 2010). I do so not to argue for its relevance for contemporary readers of science. As a biblical scholar, I fully acknowledge the religious, indeed mythic, dimensions of this ancient account. Genesis is not science. Rather, I examine this cosmogonic text in the hope that scientists, and particularly historians of science, continue to hold an abiding interest in how the ancients accounted for the origins of the universe.

2. Primordial Soup

In Genesis 1, the curtain rises to reveal a cosmic mishmash. I offer my own translation of the Hebrew the first two verses. (For the host of translation issues, see Brown, 1993, pp. 62-72; Smith, 2010, pp. 50-51.) [1:1]When God began to create the heavens and the earth, [1:2]the earth was void and vacuum, and darkness was upon the surface of the deep while the breath of God hovered over the watery surface.

This initial state of creation is described in verse 2 as *tōhû wābōhû*, here translated as "void and vacuum," but typically rendered as "formless void" (so NRSV). The Hebrew, however, is more vivid. The phrase is what grammarians call a "farrago," an alliterative meshing of words or syllables whose overall semantic sense transcends its individual components, such as in "topsy-turvy," "vice versa," "mishmash," or "hodgepodge." In fact, the French Le tohu-bohu, meaning "hubbub," is a Hebrew loanword that captures well the biblical sense, a dynamic undifferentiated condition that lacks both substance and form. Such was the "soupy" state of the universe in the beginning according to the biblical cosmologist. One could call it chaos, but not in any mythically threatening sense. Darkness, water, and emptiness do not make a monster. Neither do they constitute mere “nothing” (nihil). To find the deity creating from nothing (ex nihilo), one must look elsewhere in the biblical tradition (e.g., 2 Maccabees 7:28; see May, 1994). The chaos described in Genesis 1:2 designates a state of dynamic disorder poised for order. For whatever reason, the ancient cosmologists surmised that creation commenced in extremis, amid the “chaos” of turbulent *tōhû wābōhû*, a state of cosmic potential or readiness for creation. God’s breath suspended over the dark waters sets the stage for a generative fluctuation of astronomical or (I can’t resist) biblical proportions.

3. The Temple and the Astrodome

So begins the Genesis report. The text recounts God’s fashioning form out of formlessness. The end result is a cosmos replete with variety and structure, a fully differentiated universe. To achieve this, God goes about “separating out” creation: light from darkness (1:4), waters above from waters below (vv. 6-7), day from night (vv. 14, 18). The cosmos began in “chaotic” unity and proceeded to be structured in the course of creation. Through separation, discrete domains are established during the first three “days”: light, water, sky, and land, each accommodating various entities, living and otherwise. In the course of the Genesis narration, both the domains and the “members” of these domains reveal an overarching symmetry as the following table illustrates.

According to their thematic correspondences, the first six days of creation line up to form two parallel columns (see McBride, 2000, pp. 12-15; Middleton, 2005, pp. 74-76). Their chronological ordering gives rise to a thematic symmetry. Days 1-3 establish the cosmic domains, which are subsequently populated by various entities or agencies (Days 4-6). Read vertically, the two columns address the two abject conditions of lack described in Genesis 1:2, formlessness and emptiness. The left column (Days 1-3) gives form to creation, with Day 3 climactically depicting the growth of vegetation. This concluding act vividly changes the earth’s primordial condition from its formless state of barrenness: the earth is no longer a “void” (tōhû) but a fructified land, providing the means for sustaining life on the land. Covering Days 4-6, the right column reports the filling of these domains with their respective inhabitants, from the celestial bodies, which "rule" both day and night, to human bodies, who exercise "dominion." The creative acts on Days 5 and 6 specifically change creation's primordial condition from "vacuum" or emptiness (bōhû) to fullness (Tsumura, 2005, p. 354). Genesis 1, in short, describes the systematic differentiation of the cosmos that accommodates and sustains the plethora of life.

Void & Vacuum (1:2)

Day 1 (1:3-5) Light	Day 4 (1:14-19) Lights
Day 2 (1:6-8) Firmament Waters below	Day 5 (1:20-23) Aviary life Marine life
Day 3 (1:9-13) Land Vegetation	Day 6 (1:24-31) Land animals Humans Food

Day 7 (2:1-3)
Creation completed

While the six-day schema exhibits a well-calibrated correspondence, the symmetry is not perfect. Within its literary patterning, Genesis 1 features a number of "nonpredictable variations" (Middleton, 2005, p. 278). Vegetation, for example, occurs on the third day, concluding the left column, even though plants, like the animals, populate the land. The sixth day would have been a better fit for the creation of plants. Days 5 and 6, moreover, are one-sidedly weighted with the language of blessing (see verses 22, 28), which bears no correspondence to Days 2 and 3.

Structurally, certain literary building blocks such as the fulfillment report ("God made . . .") and the transition formula ("and it was so") either do not appear in a consistent order or, in certain cases, are entirely absent. Finally, of all the days enumerated in the account, only "the sixth day" and "the seventh day" bear definite articles in Hebrew. The text, in short, manifests an overarching symmetry that allows for and accommodates variation. These small variations, however, pale in comparison to the most significant case of dissymmetry in the text, namely, Day 7. Having no corresponding partner, the seventh day is unique. By its presence, the tight six-day symmetry of the Genesis account is broken. Nevertheless, this distinctly odd day does establish a vertical correspondence to creation's initial condition, as described in 1:2, which one could call paradoxically "Day 0." Together these two "days" form a subtle correspondence, the static "day" of non-creation and the "theo-static" seventh day. The timeless character of "Day 0" shares an implicit affinity with Day 7: the final day lacks the temporal formula "evening came and then morning." It, too, is a day somehow suspended above temporal regularities. Yet these two "days" could not be more different: "Day 0" refers to creation's empty formlessness; Day 7 marks creation formed and filled (2:1). The final day serves as the capstone for the entire structure, for it shares something of God's holiness.

Without this symmetry-breaking seventh day, the creation pattern would lose a distinction that remains hidden to modern readers not acquainted with the ancient architecture of sacred space. Many temples of the ancient Near East, particularly in the Syro-Palestinian region, exhibited a threefold or tripartite structure, which can also be found in the literary symmetry of the Genesis text.

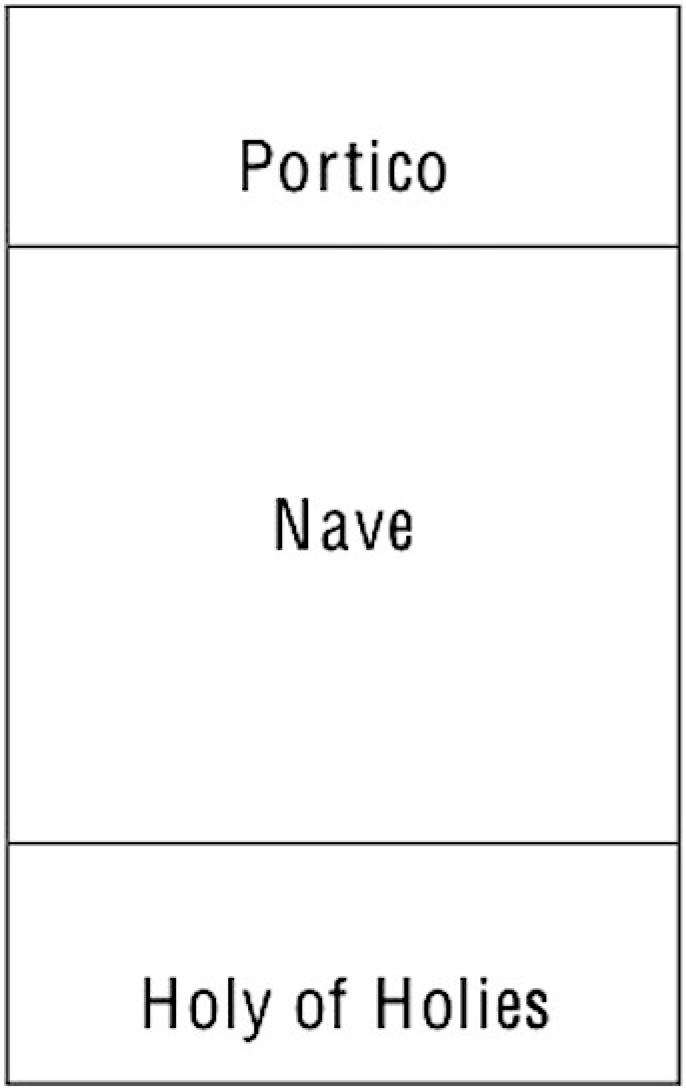
For example, Solomon's temple as described in 1 Kings 6 consists of three parts: an outer vestibule or portico, the nave or main room, and an inner sanctuary or holy of holies (dĕbîr), as diagramed below.

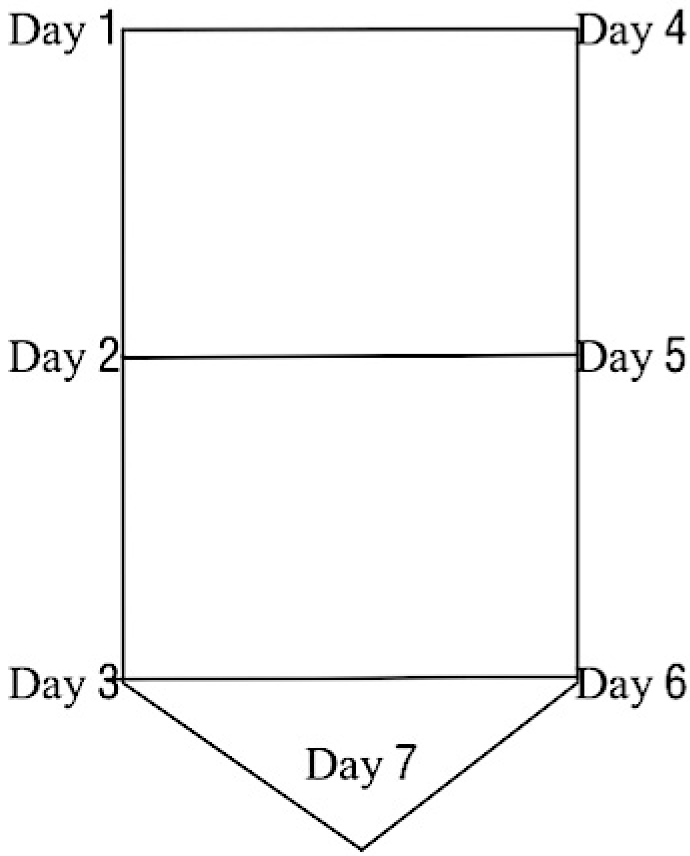
This threefold arrangement of sacred space corresponds to the way in which the various days of creation are distributed both chronologically and thematically. The first six days, by virtue of their correspondence, establish the architectural boundaries of sacred space. The last day, given its uniqueness, is lodged in the most holy space.

The universe, it turns out, is a cosmic temple in time. Its “entrance” is demarcated by Days 1 and 4, together designating the creation of light and lights, respectively. Not coincidentally, the Solomonic Temple in Jerusalem faced eastward to welcome the rising sun.

Such is the temporal ordering of the cosmos according to Genesis. On the spatial level, the world according to Genesis is a three-tiered universe: the celestial waters above are held aloft by a dome or “firmament” (1:6-8), constituting the sky, and the waters below are bounded by the land (1:9-10). The stars interspersed across the celestial vault on the fourth day transmit the primordial light created on the first day. In between the firmament above and the waters below lies a band of space within which terrestrial life flourishes. What we call the atmosphere, the ancients viewed as a protective vault, a sort of glass ceiling that separates the transcendent realm from down-to-earth creation.

There are, thus, two complementary frameworks that characterize creation in Genesis 1: the temple framework that defines the chronological contours of creation and the “astrodome” model that characterizes creation’s spatial structure. Both serve as templates that highlight the critical significance of creation’s primordial beginnings, particularly the “creation” of light, the first act of creation.


Portico
Nave
Holy of Holies



4. The Big Flash

Among the various acts of creation described in Genesis, the "creation" of light is special: light is only spoken into being (1:3). More typically, throughout Genesis 1 creation involves the pairing of God's speech and act (see 1:14-16, 20-21, 24-25, 26-27). The "creation" of light marks the first day:

1:3Then God said, "Let there be light." And there was light. 1:4And God saw that the light was good, and God divided between the light and the darkness. 1:5God named the light "Day," and the darkness he named "Night." Evening came and then morning, day one.

The distinctive feature of this exclusively verbal creation could suggest that the genesis of light according to Genesis 1 was not a matter of creation at all but that of light "emerging out of the darkness" (so Smith, 2010, pp. 73, 80). As a parallel creation account, Psalm 104 depicts light as the deity’s clothing, and thus as uncreated (verses 1-2). One could also cite a passage from 4 Ezra (dated ca. 100 CE), which depicts God commanding “that a ray of light be brought forth from your treasuries, so that your works might then appear” (6:40). Could it be that, according to the Genesis cosmogony, God commanded pre-existent light to separate itself from the darkness?

Perhaps, but doubtful. Verse 4 makes such a separation explicit, but only as a subsequent act. “Let there be light” refers within the larger narrative to a prior moment in which the appearance of light is called forth, and thus created, amid the darkness. But whether generated or emergent, light in Genesis 1:3 is unique among the other elements of creation. As the product of God’s first creative act, light bears a certain kinship to the divine. The ambiguity of light’s genesis reflects its mysterious yet primary role within the larger creation account. It is under the gleam of such light that everything else is created, including the celestial bodies (Day 4). The light of Day 1 is not reducible to the light emitted by the sun, moon, and the constellations, for they only transmit or reflect such light. By divine light, God “sees” all that is and declares it “very good” (1:31). Such light is, moreover, associated with the temple, wherein the lamp stands are symbolic of God’s eyes (Zechariah 4:2, 10; so Smith, 2010, pp. 83-84).

“[T]he most obvious and fundamental medium of our connection to the universe is light,” according to physicist Lee Smolin (1997, p. 27). More than a medium, the light of Day 1 in Genesis, like land on Day 3, is considered the primary domain of the cosmic temple. With the creation of light, and its subsequent separation from the darkness (verse 4), space itself is defined. So also time: evening and morning mark the first day (verse 5). By virtue of their common origin, Genesis regards space and time as fundamentally related; they are the foundational constituents of physical reality, hence their priority in cosmic history.

Remarkably, the biblical author(s) of Genesis discerned a significant temporal separation between the creation of primordial light (Day 1) and the light emitted by the stars (Day 4). Modern cosmology also discerns at least a half-billion-year gap between the Big Bang and the formation of the first generation of stars. Absorbing visual and ultraviolet light, the growing dominance of neutral hydrogen gas engulfed the nascent cosmos in visual darkness in less than a million years after t=0. Visible light returned only through the widespread re-ionization of the universe nearly a billion years later. For the author(s) of Genesis 1, the realm of primordial light was created first, and it lay inaccessibly beyond the firmament or cosmic vault fashioned on the second day. Such transcendent light was transmitted, the ancients concluded, by the astral bodies that God set in the firmament, but not until the fourth day. "There was light," but only thereafter—three "days" according to Genesis but actually a billion years—did stars make their luminous appearance to the naked eye.

The author(s) of Genesis regarded the celestial luminaries as agents serving a specific function: to establish special times throughout the year. In addition to regulating the rhythm of day and night as well as the seasons, the celestial bodies also determined the "appointed times" or "signs" for various religious festivals (1:14). The theo-logic is clear: by transmitting primordial light, the celestial luminaries bore the preeminent role of establishing the rhythm of worship on Earth.

5. Conclusion

To state the obvious, the Genesis account of creation is theological to the core. It begins with God creating (1:1) and concludes with God completing (2:1-3). Nevertheless, there is a certain naturalism that pervades the account. Between the preface and the conclusion, the account proceeds methodically and incrementally as cosmic domains are established and various forms of agency come to fill these domains: the stars populate the domain of light, aviary life fills the sky, the seas team with marine life, and the land is populated by animals, including human. The elements and agencies of nature lack any hint of deification, and yet they are recognized as active and productive. Water and land, for example, have a hand in the production of life (1:12, 20-21, 24). As "members" of the primordial domain of light, the astral bodies of the fourth day are analogous to the life forms that populate the domains of land and sea. Though not divine, the sun, moon, and the stars have their active roles to play in determining the times of worship but not as the objects of worship. Finally, the intricately wrought, symmetrical structure of the Genesis account reflects the integrity of creation as the ancients viewed it: a vibrant, intricately ordered world endowed with the natural capacities to bear life. From seeds (1:11-12) to reproduction (1:22, 28), creation's temple is a living cosmos.

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8. The Cosmic Landscape in the Age of the Pyramids

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Abstract

The pyramids of Egypt are to be counted among the most outstanding works of architecture in the whole of human history. The sites for their construction were chosen in accordance with topographical criteria which, while taking practical needs into account, were also profoundly and intimately connected with Maat, the cosmic order. As a consequence, the pyramid's fields are criss-crossed by geometrical axes which were - and partially still are - easily perceptible on the ground. In the 4th and the 5th dynasty, such axes ideally connected the monuments with the temple of Heliopolis on the opposite bank of the Nile, while during the 6th dynasty new pyramids were ideally connected with older ones by means of meridian - south to north - alignments. In recent years, the present author attempted to provide a comprehensive analysis of this sacred landscape, and of its astronomical and symbolical interpretation in terms of the "cosmovision" of the ancient Egyptians. The present paper offers a brief but complete overview of the results of this analysis.

1. Introduction

In Egyptian history, the so-called Old Kingdom (2686 BC - 2181 BC circa) is distinctive for what we might call the Age of the Pyramids, a short, intense burst in human history during which the most amazing funerary monuments of humanity were created (Lehner 1999, Verner 2002).

Pyramid-building commenced with king Djoser - around 2630 BC, according to Baines and Malek (1984) chronology - who built the so-called

Step Pyramid in Saqqara, and was to continue up to the reign of Pepi II (2278 BC). The pyramids were built on the edge of the desert, just above the floodplain on the west bank of the Nile. With the single exception of Meidum, all the royal pyramids tend to be concentrated in "clusters" (Giza, Abusir, Saqqara, Saqqara South) along a relatively short line which goes from Abu Roash down to Dashour, less than 30 Kilometres to the south.

It is known from the end of the 19th century that an interesting feature exists in the layout of the 4th dynasty "cluster" of pyramids at Giza: the presence of a main topographical axis (Lehner 1985, Goedicke 2001). This axis governed the placement of the subsequent buildings, connecting the south-east corners of Khufu, Khafre and Menkaure's pyramids. A similar axis exists in Abusir, the pyramid field of the kings of the 5th dynasty, connecting in this case the north-west corners of the pyramids of Sahure, Neferirkare and Neferefre (Verner 2002); a somewhat similar feature can be seen at Saqqara as well (Lehner 1985).

Figure 1. Giza. A view from the east of the Great Pyramid of Khufu, looking south-west. The main axis of the Giza Necropolis, touching the south-east corners of Khufu (foreground) Khafre (in the middle) and Menkaure (in the background) pyramids is clearly perceptible.

In recent years, the author investigated on such topographical features in order to put in evidence their underlying symbolic meaning. In the course of this work, several interesting points emerged; for instance, new hints at the possibility that the two main pyramids of Giza belong to a single project initiated by Khufu (Magli 2009a,b), the likely existence of further "axes" at Abusir and Saqqara south (Magli 2010a,b) and a proposal for the location of a long-sought pyramid, that of king Userkare (Magli 2010b,c). From a general point of view, it turned out that the alignments of the pyramid's have nothing to do with utilitarian purposes; on the contrary, in some cases, the desire to align monuments in harmony with pre-existing axes involved enormous technical difficulties, as, for instance, in the Unas project in Saqqara. In order to understand the underlying reasons which moved the ancient Egyptians to such huge efforts, Archaeoastronomy must be used in its broad, modern sense of "science of the ancient sky and landscape" (Ruggles 2005, Magli 2009b). It is, indeed, necessary to consider the ancient Egyptian concept of Maat, the "cosmic order" on which the power of the pharaohs was founded. It was a complex interplay between a solar-stellar religion and the contemporary presence of the living God, the pharaoh himself. The king was the keeper of the cosmic order on the earth and was later doomed to live in eternity - as well as his dynastic ancestors before him - together with the circumpolar stars and the Sun God. As a consequence, astronomy played a key role for the builders of the pyramids. These monuments were indeed the maximal expression of art, ideology, and power during the Old Kingdom, and were designed and placed with the aim to show such "cosmographical" principles. The result is that the pyramid's fields are magnificent examples of sacred landscapes, conceived in accordance with the Cosmic Order as "applied" on the ground; the role of the alignments is to recall explicitly this idea.

Figure 2. Abusir. A view from the summit of the south wall of the Neferefre monument, looking north-east. The pit of the unfinished pyramid is visible in the foreground. In the background, the huge mole of the Neferirkare pyramid covers Sahure's monument. The main axis of the Abusir necropolis passes to the extreme left of the picture and points to the outcrop of the Cairo citadel (and to Heliopolis straight behind) on the other bank of the Nile.

Figure 3. Saqqara. A view taken from the south of Unas pyramid (foreground) looking north-east. The Saqqara axis connecting Unas' base diagonal with the south-east corners of the Step (middle) and Userkaf (background) pyramids can still be perceived today, in spite of the ruined state of the monuments.

It is the aim of the present paper to give a brief but systematic overview of all these alignments and of their interpretation. To this end, I shall classify the alignments into three "families": a "Heliopolitan" family, a "quarter-cardinal" family, and a "meridian" family. Of course, we are talking about very small families: each one contains very few lines and each line contains very few monuments per line. However, the reader should bear in mind that to give concrete form to such lines it was necessary to build some of the most magnificent examples of architecture ever produced by humanity.

The first - or "Heliopolitan" - family is composed by axes which run straight from the pyramid's fields of Abu Roash, Giza, and Abu-Gorab/Abusir to the Sun temple of Heliopolis, on the other bank of the Nile (Section 2). Their principal meaning is, therefore, symbolic: they call attention to a direct ascendance of the pharaohs from the Sun God.

Interestingly, two of these lines correspond to pyramids that had a “stellar” name; further, Heliopolis (whose Egyptian name was Iunu - pillar) besides being the most important religious center of that period, was a place were astronomy was practiced. This raises the possibility that, further to the “solar” character of being oriented towards the Sun temple, these lines might also have a “stellar” character, and therefore that astronomy may have influenced the choice of the sites. Indeed, at the time of the construction of the pyramids, all the azimuths of the pyramid’s fields as seen from Heliopolis can be associated to the setting of Decanal stars, i.e. those stars used to (ritually) count the hours of the night.

The second family can be defined as “quarter-cardinal” (Section 3). It probably originated as an imitation of the most important of the Heliopolitan axes, that of Giza, which, besides being aligned to Heliopolis, is directed along the north-east/south-west axis; this was also the azimuth of the setting of the brightest part of the Milky Way during the pyramid age. Finally, the third family is composed by “meridian” (i.e. north-south) alignments (Section 3). Here, the interplay between astronomy and power becomes even clearer. There is indeed no doubt that astronomy was practiced in Egypt, at least at the site today called Nabta Playa, since the Neolithic period, and therefore already in pre-dynastic times (Malville, Wendorf, Mazar and Schild 1998, Malville, Schild, Wendorf and Brenner 2008). Later in the age of the pyramids, the planners of the king’s monuments were skilled skywatchers (see Magli and Belmonte 2009 and references therein). Determination of true north using precise observations of stars’ motion is indeed a key component of the architecture of the pyramids from Meidum onward; in particular, the two giant pyramids of Giza were oriented with an astonishing accuracy (3 arc minutes for Khufu and 6 arc minutes for Khafre). Such an accuracy was probably obtained with nocturnal observations aimed at the transit of “imperishable” stars, i.e. either circumpolar or, at any rate, sufficiently close to the north pole to be visible every night of the year (Krauss 1997). Besides their practical function, these stars play a fundamental role in the Pyramid Texts, i.e. those texts aimed to assure the “rebirth” of the king which are carved in the funerary chambers of all the 6th dynasty pyramids belonging to the meridian family. As an example, a famous passage of these texts can be mentioned:”I will cross to that side on which are the Imperishable Stars, that I may be among them" (Pyramid Texts 520, §1223, transl. by A. Faulkner).

In the present overview, I will thus put the accent on the astronomical-symbolical features of such topographical choices, which were operational during the relatively short - about 300 years - "Age of the Pyramids". The main inspiring criteria were the sky, on the one hand, and the pre-existing monuments - the "dynastic" element - on the other. In spite of the existence of persistent claims to the contrary in scores of "fringe" books and websites, no "pre-ordained" or "universal" plan comes to light. I cannot stress strongly enough, therefore, that from the comprehensive study I will briefly outline here, no "hidden", arcane or esoteric legacy emerges from the Architecture of the Old Kingdom; quite the reverse - as we shall see, the pharaohs wished to make their ideas and the origins of their power as explicit and concrete as possible in the planning of their funerary complexes.

2. The "Heliopolitan" Family

Topographical alignments first appear with the 4th dynasty at Giza (Lehner 1985, Goedicke 2001). As mentioned above, the "Giza axis" connects the south-east corners of the main pyramids (as well as other features, such as the diagonal of the first subsidiary pyramid of Khufu). It points north-east (43° north of east) towards the area where the temple of the sun of Heliopolis once stood, on the opposite bank of the Nile. This area is quite far from Giza (about 24 km) and today there is no possibility of seeing the pyramids from there. Yet a simple calculation shows that, in spite of earth's curvature, a sign-post - say 20 meters tall - placed in Heliopolis would have been visible from Giza, and of course the reverse was true for the pyramids when viewed from Heliopolis. Khufu - the first king to choose Giza - must thus have wished to emphasize the importance of the Heliopolitan temple. According to authoritative scholars such as Stadelmann (1991) and Hawass (1993) Khufu depicted himself as the incarnation of the Sun God Ra. If this is true, then it appears quite natural that his building location and those of his descendants were chosen in such a way as to be visible from Heliopolis. In this way the kings could declare their "affinity" with the Sun God in their funerary complexes (Jeffreys

1998). Moreover, as a consequence of the alignment, when looking from Heliopolis, the images of the Giza pyramids created a perspective effect, a sort of mirage: they “contracted” on each other, merging into that of the Great Pyramid. The axis was therefore also meant to give a visual, explicit representation of the lineage of the subsequent Pharaohs and thus of the divine ascendance of their power.


1
2
3

Figure 4. A satellite image of the Giza pyramids with the Giza axis highlighted. 1-Pyramid of Khufu 2-Pyramid of Khafre 3-Pyramid of Menkaure (image courtesy of Google Earth, diagram by the author).

A similar effect was present also at Abu Roash, a site some 5 km north of Giza, where Khufu's son Djedefre built his pyramid (Magli 2010b). Indeed, the line which connects Heliopolis with Djedefre pyramid's south-west corner crosses the south-west corner of a second Abu Roash pyramid (Lepsius 1), which probably dates from between the end of the 3rd and the beginning of the 4th dynasties (Swelim 1983). The two pyramids thus form a "Abu Roash axis" again pointing to Heliopolis.

At the end of the 4th dynasty - around 2472 BC - a break in the funerary traditions occurred: in fact Shepsekaf preferred to build a sort of giant Mastaba at Saqqara South. The monument was located in an area quite far from both the two pre-existing necropolises of Saqqara and Dashour, and its placement probably aimed at establishing a visual, perspective connection with the two pre-existing pyramids of Snefru, Khufu's father (Magli 2010a).

The successor of Shepsekaf, Userkaf, devised a building program aimed at a return to old traditions: to show his affinity with the 3rd dynasty he built his pyramid as close as possible to that of Djoser in Saqqara. To demonstrate explicitly his connection with Heliopolis and the "solarised kings", he chose to erect a completely new monument, the first of the so-called sun temples, in Abu Gorab. Interestingly, the temple was constructed very near the southernmost available point of the west bank of the Nile from which Heliopolis is still visible (Kaiser 1956). With Userkaf's successor, Sahure - whose name means "Close to Re" - kingship definitively returned to the solar tradition. The natural choice for Sahure's pyramid building site would surely have been Giza, to the south west of Menkaure along the "Giza axis". However, building a pyramid complex so far away in the desert would have been nonsensical. Thus, the architects had to come up with a new way of allowing the monument of their king to fit in with both the solar and the dynastic lineage. It has been suggested by the present author that this was the reason for placing the pyramid in the first available location in the south of Giza from which Heliopolis is not visible: Abusir, some 500 meters further south in relation to Abu Gorab. Approaching Heliopolis from the north and looking west, an observer would indeed have seen the king's pyramid - called "Sahure's soul shines" - disappear on the horizon and merge with the profile of the rocky outcrop today occupied by the Cairo citadel, while the shining golden apex of the Userkaf sun temple remained in view, to testify to the solar character of the king's bloodline.

Once a new Necropolis had been inaugurated by Sahure at Abusir, the successors Neferirkare and Neferefre aligned their pyramids in such a way as to create the "Abusir axis" mentioned above.

To summarize, then, the Heliopolitan axes are three ideal lines which, originating from Heliopolis, align three clusters of pyramids: two pyramids at Abu Roash and three pyramids at Giza and Abusir. A further line from Heliopolis can conveniently be traced up to the pyramid field of Zawiet el Arian, where a huge but unfinished monument of the 4th dynasty - supposedly belonging to an obscure king called Nebka - is located.

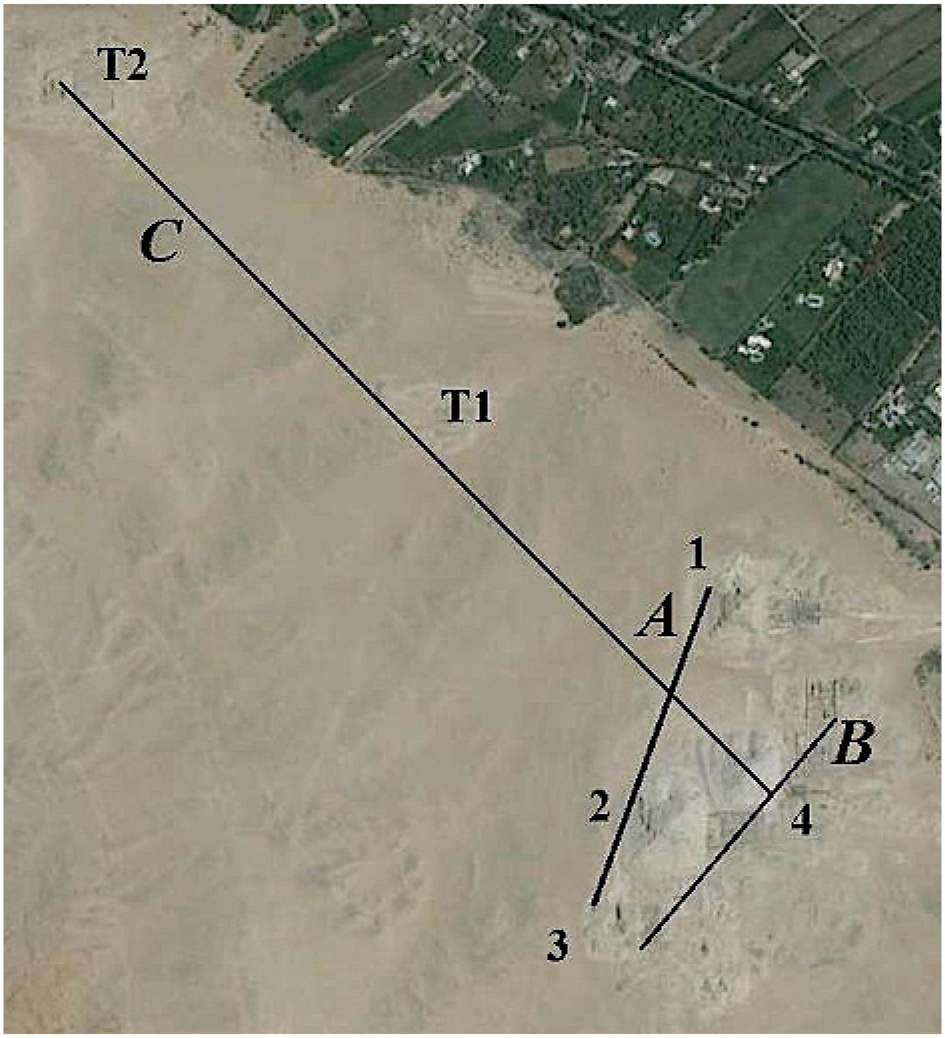

Figure 5. A satellite image of the Abu Gorab - Abu Sir area. Numbering of the monuments is in chronological order. Abu Gorab: T1- Userkaf Sun temple, T2- Niuserre Sun Temple; Abusir: 1/2/3/4 Pyramids of Sahure, Neferirkare, Neferefre, Niuserre. The Abu Sir main axis (A) the Niuserre "dynastic" axis (B) and the Niuserre-Sun Temples axis (C) are highlighted. (Image courtesy of Google Earth, diagram by the author).

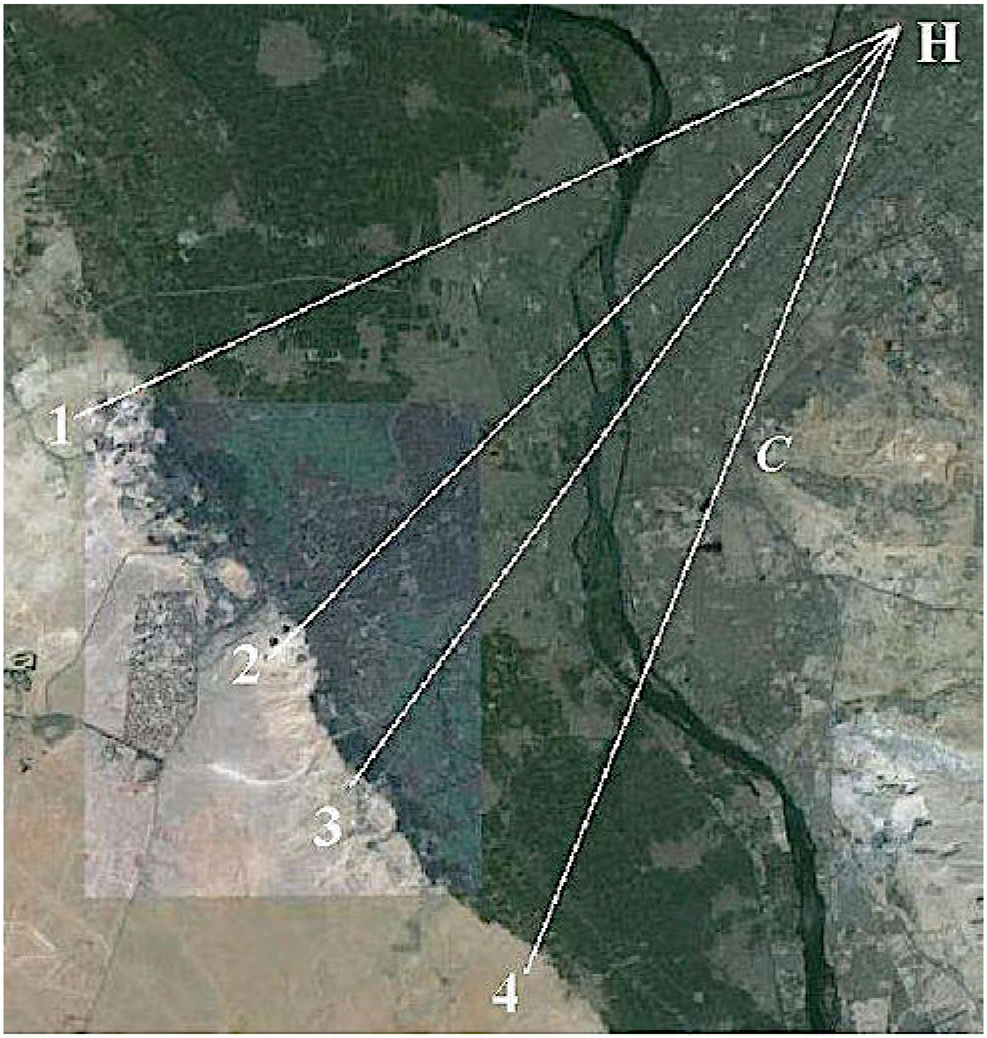

Figure 6 . The “Heliopolitan” lines connecting the pyramid fields with Heliopolis (H): 1-Abu Roash, 2-Giza, 3-Zawiet el Arian, 4-Abu Gorab-last visibility line. Abusir lies a few hundred meters to the south, but visibility is obstructed by the outcrop of the Cairo citadel (C). The azimuth of each of these lines as measured from Heliopolis corresponds to the setting of a Decanal star at the (likely) time of construction of the pyramids as follows: 1-Djedefre-Sirius, 2-Khufu-Rigel, 3-Nebka-Fomalhaut, 4-Sahure-Canopus. See text for more details. (Image courtesy of Google Earth, diagram by the author).

Each royal pyramid had a “name” aimed at glorifying his owner, and two of the Heliopolitan lines correspond to pyramids that had a “stellar” name (“Djedefre is a shining star” and “Nebka is a star”). This raises the possibility that, further to the “solar” character of being oriented towards the Sun temple in Heliopolis (this topographical feature being certain and proved without any doubt, see appendix) these lines might also have a “stellar” character, which may have influenced the choice of the sites. Such “stellar” alignments actually exist, although the reader must be warned that the will of the builders in obtaining them is difficult to prove. Looking at the azimuths of the pyramids from north to south as measured from Heliopolis, one can easily see that they start with the azimuth of the winter solstice sunset (~26° south of west) corresponding to the Abu Roash axis. This means that the Abu Roash axis acts as a boundary: the sun can never be seen setting on any other pyramid from Heliopolis. At the time of the construction of the pyramid, however, this azimuth was close also to that of the setting of Sirius, the first of the Decans, the stars used for the (ritual) count of the hours of the night (Belmonte 2001, Belmonte, Shaltout and Fekri 2009). Actually, it turns out that all the azimuths of the pyramid’s fields as seen from Heliopolis can all be associated to the setting of Decanal stars, and that these stars had heliacal setting in successive periods of the year. From north to south we have the following associations: Sirius-Abu Roash, Rigil-Giza, Fomalhaut-Zawiet el Arian, Canopus-Abu Sir (for technical details and a discussion of related problems see the appendix).

3. The Inter-Cardinal Family

In the Age of the Pyramids the brightest part of the Milky Way - to which the star Rigil belongs - set at azimuths close to 45° south of west (and accordingly, with a flat horizon, rose 45° south of east). As a matter of fact, there exist in the pyramid fields several topographical axes aligned closely to such “inter-cardinal” directions; the Giza axis might be considered as the first member of this family.

The first to inaugurate new quarter-cardinal axes was the “solar” king Niuserre. He reigned after Neferefre (the pyramid of the intermediate king Shepseskare has not been identified with any degree of certainty), and so the place destined for him was to the south-west of Neferefre along the Abusir axis, unquestionably too far off in the desert. Consequently, the planners of his monument had to find another way to exhibit the lineage of the king and his solar ascendance. The solution they came up with was to split the dynastic and the solar content inaugurating two new, different axes. The king's pyramid is in fact located to the east side of that of his father Neferirkare in such a way that a "dynastic" line (oriented ~41° north of east) connects the south-east corner of the pyramid with that of Neferefre to the south and of Neferirkare to the north (Lehner 1985). In this way, the dynastic problem was solved; naturally, however, the line does not point to Heliopolis. Perhaps it was for this very reason that Niuserre was inspired to construct his own Sun Temple, located at Abu Gorab, north-west of the Userkaf's one and therefore in plain view of Heliopolis. What remained to be done was to connect the project of the temple with that of the funerary complex: to achieve this goal Niuserre's architects planned the temple in such a way that another inter-cardinal axis (this time ~45° south of east) connects the base of the obelisk of the temple, the south-east corner of Userkaf's temple and the apex of the Niuserre pyramid (Magli 2010b). If the line is extended further to the north-west, it intersects with the south-west corner of a 3rd dynasty pyramid in Zawiet el Arian and appears to end at the centre of the unfinished pyramid in the same site (whether such an alignment was deliberate or not is a moot point and requires further study).

Yet another "quarter cardinal" axis was inaugurated with the project of king Unas, the last king of the 5th dynasty (Lehner 1999, Magli 2010a). The pyramid of Unas is located near the south-west corner of the precinct of Djoser's Step Pyramid, quite a distance from the Nile floodplain. The likely reason for this inauspicious choice is symbolic: for in this way the king instituted a "Saqqara axis". The Saqqara axis is again a line oriented roughly NE-SW (~39° east of north), which connects the south-east corner of Userkaf's pyramid with the south-east corner of Djoser's pyramid and then crosses over Unas' base diagonal, ending at the north-west corner of the (unfinished) 3rd dynasty pyramid of Sekhemkhet. The result is that, after the building of Unas' monument, the placement of the three pyramids of the Saqqara central field resembles that of the three pyramids of Giza. Clearly, the axis does not point to Heliopolis, and therefore this similarity has to be construed as an ideal relationship with the pre-existing Giza monuments, perhaps first conceived of by Userkaf (Goedicke 2001).

If extended north-west, the Saqqara axis touches the north west corner of Teti's pyramid (Lehner 1985). Teti was Unas' successor, and therefore the "natural" position for his pyramid would have been to the south-west of Unas. For the third time, however, (after Menkaure at Giza and Neferefre at Abusir), it proved impossible to place a new pyramid to the south west along an existing line, and a new idea was needed. Teti evidently elected to put his pyramid "at the beginning" of the line. Probably to respect the "dynastic" perspective of the pre-existing axis, it is the north-west corner of the pyramid which lies on the line.

At Teti's death an obscure king called Userkare succeeded to the throne. We do not know where it was planned to position Userkare's pyramid. His successors Pepi I, Merenre and Pepi II chose an area to the south of the Saqqara central field, where there stood only the pyramid of the 5th dynasty king Djedkare. The Merenre project was located to the south-west of Pepi I, in such a way as to place the pyramid along the diagonal of the latter. We thus have a new quarter-cardinal axis initiated at Saqqara south, oriented ~41° east of north and therefore roughly parallel to the Saqqara one. The monument of Pepi II does not lie on this axis, though. The "natural" position of his pyramid to the south-west of Merenre would actually have been in a wadi (dried river): building a pyramid there would have inadvisable. And so the king's tomb was constructed to the immediate south of this area, near Shepsekaf's monument. To sum up ,then, the "quarter-cardinal" family is made up of the Giza axis, the two Niuserre axes, the Saqqara axis and the Pepi I-Merenre diagonal alignment.

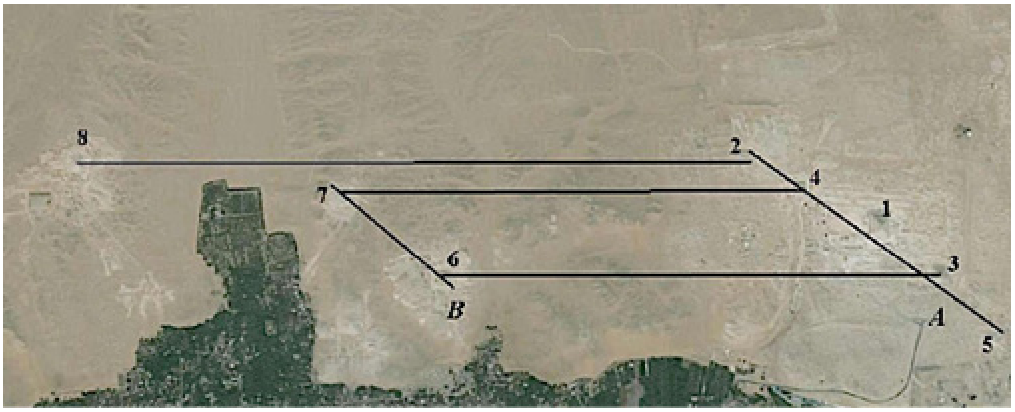

Figure 7. A satellite image of Saqqara (numbering of the monuments is in chronological order; Shepsekaf's Mastaba and Djedkare pyramid are not highlighted). 1- Djoser Step Pyramid, 2-Pyramid of Sekhemkhet 3-Pyramid of Userkaf, 4- Pyramid of Unas 5-pyramid of Teti 6-Pyramid of Pepi I 7-Pyramid of Merenre. The Saqqara axis (A) and the Pepi I-Merenre axis (B) are highlighted, as well as the three meridian alignments Pepi I-Userkaf, Merenre-Unas, Pepi II-Sekhemkhet. (Image courtesy of Google Earth, diagram by the author).

4. The Meridian Family

In the planning of the 6th dynasty pyramids a new kind of topographical pattern also emerges. In fact, the positions of the three monuments appear to have been selected according to "meridian" axes. Such lines run from south to north, in the sense that each new monument has been constructed due south of an existing one. To be precise, the apex of Pepi I aligns with that of Userkaf and the apex of Merenre aligns with that of Unas (Goyon 1977); furthermore, the apex of Pepi II aligns with the apex of the last pyramid of the Saqqara axis, that of Sekhemkhet. Curiously, the position in meridian alignment with the Djoser pyramid is vacant, and I have therefore proposed that the - unfinished - monument of Userkare might still be lying under the sand right there (Magli 2010c).

As discussed in the introduction, to interpret the meridian alignments it should be recalled that determination of true north is a key component of the architecture of the pyramids. It was probably carried out with nocturnal observations aimed at the transit of "imperishable" stars, i.e. those stars to which the “rebirth” of the pharaoh is closely connected by the Pyramid Texts. These invisible meridian lines crossing the desert and connecting pairs of monuments are therefore, and again, clearly conceived in such a way to harmonize the human-built landscape with the pre-existing one on the earth and with the sky above.

5. Discussion and Conclusions

The choice of the pyramid construction sites had to take various practical factors into consideration (Barta 2005). Nevertheless, at least in many cases, no one such practical factors can be deemed decisive. In particular, three clamorous examples can be cited, where a different mechanism, clearly of symbolic - as opposed to utilitarian - nature must have had a role. These are the three pyramids which were constructed “far in the desert” along south-west/north-east axes, namely Menkaure at Giza, Neferefre at Abusir, Unas at Saqqara. A clear willingness is also shown by the meridian alignments of the 6th dynasty pyramids with those of the Saqqara central field.

Of course, the problem of the interpretation of these evidences in absence of specific, written sources is actually doomed to remain, at least in part, at the speculative level. However, as discussed at length in previous works (see e.g. Magli 2009a, 2010a,b,c), it can be backed up by a series of clues pointing to the close relationship between astronomy and power during the Old Kingdom. A full discussion of this topic requires a careful chronological analysis king after king and monument after monument, and is given elsewhere (Magli 2010b,c). As a fundamental step, however, we can concur with the Egyptologist George Goyon who observed that alignments between new and previously constructed monuments where aimed to express connection to an ancestor or to sacred sites (Goyon 1977); a similar viewpoint inspired Goedicke (2001) analysis of Saqqara. Further, the connection with the cult of Ra, the Sun god, helps in explaining the fact that attention is called towards Heliopolis, starting with Giza and therefore with the first “solar” pharaoh, Khufu (Stadelmann 1991, Hawass 1993, Jeffreys 1998). Finally, it is worth mentioning again the fundamental role played by the northern stars in the rebirth “procedures” described in the Pyramid Texts, which were written in the funerary chambers starting from

Unas and are present in all the 6th dynasty pyramids which are in meridian alignment with those of the Saqqara central field.

The alignments discussed here were plainly visible in antiquity: each king chose his site and planned his monument in accordance with pre-existing ones, with the aim of preserving the cosmic order - Maat - in the sacred landscape where his embalmed body was to rest for eternity. The pharaohs spelled out this message so plainly that, even though more than 4,300 years have passed, their burning desire to express their profound connection with their ancestors in stone, and their hope to live forever amid the imperishable stars, can still be clearly perceived today.

Appendix

The existence and willingness of the topographical alignments we have discussed in the present paper is attested beyond any doubt. Most of them were repeatedly noticed since the 19th century and then documented in the authoritative surveys made by Egyptologists Mark Lehner (1985), Miroslav Verner (2002) and George Goyon (1977) at Giza, Abusir and Saqqara respectively. Further, the present author has taken many direct measures, from which the data given in the text are taken. On field measures have been taken with a precision magnetic compass and corrected for magnetic declination. The nominal accuracy of the instrument is ½ °; magnetic anomalies have not to be expected in Egypt, however it is perhaps safer to assume a precision of ±1°. All data have also been cross-checked with topographical maps whenever available, and by using the Google-earth program. The satellite mapping of Egypt and Nubia provided by this program is quite accurate, to the point that a comprehensive archaeoastronomical research on the Egyptian monuments of Sudan has been recently carried out using this program (Belmonte, Fekri, Abdel-hadi, Shaltout and García 2010). Further, 3D rendering distortion effects, which are the major source of errors for this program, are negligible in the case of the flat-desert pyramids plateaus.

The possible astronomical alignments to Heliopolis proposed at the end of section 2 requires instead a delicate discussion. First of all, it involves the problem of dating the monuments. Indeed, of course, stellar alignments depend strongly on precession, while the precise dates of construction are unknown. Actually, different chronologies may differ for as much as 80 years. What has been done here is to take as a working framework one reliable chronology for the Old Kingdom, that given by Baines and Malek (2000). From such a chronology the dates of accession of the king who “inaugurated” the alignment were extracted, since pyramid construction likely commenced immediately after accession (the king Nebka is not documented in the royal annals, and therefore as a reference date 2500 BC has been assumed).

Then, the sky in correspondence of the alignments’ azimuths were investigated around such dates, searching for the setting of bright stars. Several effects have to be taken into account here. First of all, the horizon, which is however flat from Abu Roash down to the azimuth of Abu Gorab/Abusir, where the Cairo citadel blocks the view but also defines the last line of visibility of interest here. Second, the atmospheric effects have to be taken into account to estimate the minimal altitude of visibility. Refraction is negligible at Cairo latitude, while extinction may have a considerable effect. This effect may vary in dependance of the value of the visual extinction coefficient (Schaefer 1986). In optimal conditions however, and considering only very bright stars, extinction is negligible for stars with negative magnitudes and can be assumed equal to 1° for stars with magnitude around 1. Proceeding in this way, the following results are obtained: Djedefre at Abu Roash (2528 BC, ~26° south of west) Sirius; Khufu at Giza (2551 BC, ~45° south of west) Rigil; Nebka at Zawiet el Arian (2500 BC, ~54° south of west) Fomalhaut; Sahure at Abusir (2458 BC, ~70° south of west) Canopus. These results are valid within 1° or less, provided that the dates are valid as well.

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9. Was There A Ptolemaic Revolution in Ancient Egyptian Astronomy? Souls, Stars & Cosmology

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Abstract

This paper will consider developments in astronomy in Hellenistic Egypt, during the Ptolemaic period, applying a wider historiographical model, the concept of scientific revolutions. It argues that the combination of traditional cultural-astronomical beliefs, such as the notion of the soul's journey to the stars, with Greek and Mesopotamian concepts, led to the codification of divinatory and theological models of the cosmos into two forms. These were, firstly, the horoscope, which should be seen as a technology for analysing the soul's fate through the disposition of the stars and planets and, secondly, the literature of the Corpus Hermeticum, which may be considered as a technology for salvation from fate, enabling the soul to return to the stars. These ideas were so important for subsequent developments in astronomy that, following the notion of the 'Copernican Revolution', it will be suggested that we can refer to an 'Egyptian' or, more properly, a 'Ptolemaic Astronomical Revolution'. I make a distinction, drawn from Mesopotamian astronomy, between mathematical astronomy and non-mathematical astronomy. The paper summarises theories concerning Babylonian, Greek and Egyptian notions of the soul and the stars in order to provide a foundation for the hypothesis. My purpose is to draw a neglected area of the history of astronomy and encourage further debate.

1. Introduction: Astronomical Revolutions

The notion of an astronomical revolution, which was initiated with the publication of Copernicus' De Revolutionibus in 1543 and concluded with the publication of Newton's Principia in 1687, is an accepted part of the history of western science (Hall 1967, Cohen 1994). The concept was put into colourful prose by Colin Ronan (1983, p. 334), who wrote of the sixteenth century that 'We come now to a period in which modern science was finally launched and set out on its unprecedented voyage of conquest'. However, popular as the idea of the astronomical revolution is, its nature has been seriously questioned, in a process initiated by Thomas Kuhn (1957, 1970). Later detractors such Kusukawa and Maclean (2006, p. 471) wrote of 'the so-called "astronomical revolution"', calling it 'an historiographically somewhat dodgy concept'. The revisionists' primary objection is not to the notion of change. Rather, they question two ideas often associated with revolutions: first, they reject the concept of a complete break with the past and, second, they recognise profound elements of philosophical continuity between pre- and post-revolutionary periods. For example, in relation to the supposed revolution of the fifteenth and sixteenth centuries, Charles Webster (1982) does not challenge the innovatory consequences of Newton's cosmology, but does argue that Newton's philosophy as a whole is better understood if the ideological connections between his theories and those of sixteenth century Hermeticists and alchemists, are accepted rather than ignored, the latter being the fashion amongst what Schaffer (1996) defined as eighteenth and nineteenth century Newtonians. The recent volume by Osler (2000a) therefore retains the name and concept of the 'revolution', but reframes it as a complex, diverse phenomenon. Osler (2000b, p. 22) wrote 'What we customarily refer to as science in the seventeenth century was not a single thing, and neither was the Scientific Revolution'.

It is therefore necessary to appreciate that the use of the word revolution in relation to the history of science is entirely different to its application to political upheavals. A revolution in science does not therefore require the dramatic overthrow of an existing order as in a political revolution, but rather a period of identifiable change which may last for a century or more, as in the one-and-half centuries which separated the publication

Copernicus' De Revolutionibus of 1543, and concluded with Newton's Principia in 1687. Like political revolutions, though, a scientific revolution may consist of different, not necessarily compatible, strands of inquiry.

The conclusion of such debates has been the recognition that there was not just one 'astronomical', or 'scientific' revolution in the history of science, but many, following Cohen's (2004, pp. 21-2) redefinition of 'Scientific Revolution' as a generic rather than specific category.

The hypothesis presented in this paper is that, first, developments in non-mathematical Ptolemaic astronomy were so substantial as to constitute the possible title of 'revolution' and, second, that an important component of this revolution, namely the incorporation of a transcendent soul into astronomy, was Egyptian in origin. In addition, the proposed revolution was, to borrow terminology from Mesopotamian astronomy, not in works on mathematical astronomy, but was in what is now recognised as non-mathematical astronomy. The distinction between the two types of text was recognised by Neugebauer (1975, p. 351-2). David Brown (2000, p. 4) defined them as Mathematical Astronomical-Astronomical Texts (MAATs) and Non-Mathematical Astronomical- Astronomical Texts (NMAATs), respetively. We can then refer to non-mathematical astronomy-astrology as NMAA.

2. The Mesopotamian Astronomical Revolution

The notion of an astronomical revolution, in Cohen's generic sense, has been applied to Mesopotamian culture by David Brown (2000, p. 9). The dating, though, is even wider than that for the European revolution, and cuneiform scholars locate the critical changes in a wide span of time between the eighth century and the fourth centuries BCE (Neugebauer, 1975, II, 613). The period commenced with the beginning of the systematic collation of astronomical omens in the Enuma Anu Enlil and the collection both of eclipse data and of the astronomical, meteorological and economic information which, Herman Hunger has argued, constituted an attempt to place astronomical omenology onto an empirical basis (see Sachs 1988). The conclusion of this Mesopotamian revolution included the development of the birth-chart (the observation of astronomical patterns based on the date of birth), and the invention of codified techniques for interpretation of these patterns which no longer required direct observation of the sky

(Rochberg 1998). The Babylonian birth-charts are conventionally known by the term horoscope (Rochberg 2008, Sachs 1952).

The earliest two examples of the Babylonian horoscope genre are both dated to 410 BC, followed by a third from 298 BCE, the gap of over a century indicating the shortage of documentary sources. The interpretative component of the surviving examples is minimal but, what there is, either in the texts themselves or in the supporting works, the so-called 'nativity omens', does not indicate any concept of transcendent 'soul', only of relative good or bad fortune (Sachs 1952, pp 49-75). There is some slight indication of psychological qualities in the modern sense, in the use of such terms as 'brave', but the overwhelming emphasis of the surviving texts is on external matters.

3. The Ptolemaic Astronomical Revolution

A scientific revolution may therefore build on the past and have significant connections with it. Such continuity is, it will be argued, a principal characteristic of what I shall suggest, is the Egyptian, or Ptolemaic, astronomical revolution of the last two centuries BCE in Hellenistic Egypt. An essential feature of this period was the further codification of Babylonian omen-astronomy. This codification took two forms. The first was the development of a complex technical form, based on the Babylonian birth-chart, later known by the word horoscope, in order to analyse astronomical meanings in terms of individual existence. The second was the development of a theoretical system by which such destiny might be transcended. I call this second form soteriological on the grounds that its purpose was salvation.

Greenbaum and Ross (2010) argue that Hellenistic astrology remained Greek in that Greek was its language of transmission, yet consider that its application to individual destiny consisted of a reworking of Mesopotamian practices to incorporate Egyptian traditions (Greenbaum and Ross 2010, p. 177). The argument developed in this paper is that these Egyptian traditions was less technical than metaphysical, and that the Egyptian contribution to Hellenistic astronomy was focused on the inclusion of the soul. It must be acknowledged that there is some debate concerning the relation between Greek and Egyptian communities in Hellenistic Egypt. For example, Bingen (2007: 113) observed that the Greeks tended to prefer an urban, rather than a rural, environment. Bowman (1986: 122-164) has argued that, although the interaction between Greek and Egyptian in the period of Ptolemaic rule was complex and, even though it was possible to identify each culture as distinct, there is also evidence of considerable inter-action. Fowden (1986, p.17) concluded that such uncertainties introduce a complication into our understanding of the relationship between Greek and Egyptian religion: he noted that syncretism was encouraged by bi-lingual Egyptian priests translating their texts into Greek on the one hand, yet Greek communities often remained resistant to Egyptian customs on the other. Nevertheless, it is clear that there was considerable religious syncretism and, for example, both Egyptians and Greeks appeared to agree on the identification of the Egyptian god Thoth with the Greek Hermes.

4. Mathematical Astronomy in the Ptolemaic Period

The accomplishments in mathematical astronomy in the Ptolemaic period are wellknown. Notably, Eratosthenes (c.285/80-c.194 BCE), the second librarian at Alexandria measured, with remarkable accuracy, the circumference of the earth, while Hypsicles (c. 190 BCE - c. 120 BCE) is known for calculating the exact degree of the zodiac sign ascending over the eastern horizon (Evans 1998, pp. 121-5). While John Steele (2011) has argued that astronomy for its own sake did exist in the ancient near east in the later first millennium BCE, generally it was designed to serve practical functions, whether navigation, calculation of the calendar or the identification of divine intentions, as in Mesopotamian omen-astronomy. The concern of this paper is with the latter, with NMAA in Brown's typology.

5. Non-Mathematical Astronomy in the Ptolemaic Period

The concept of the Ptolemaic revolution depends, as already stated, on two applications of non-mathematical astronomical technology in Ptolemaic Egypt, for both of which I will use the word τέχνη, or techné, in its Hellenistic form, meaning craft. The first of these is the horoscope, technically the rising degree of the zodiac, but in a looser sense, a birthchart, in which the rising degree plays a critical role in interpretation. In relation to the use of the word techné, Claudius Ptolemy, in post-Ptolemaic second century CE Alexandria, referred to what would now be called astrology, but which he described as the analysis of astronomical effects, as a stochastic techné, that is, a craft dealing with probability and conjecture (Ptolemy 1940; I.2. Barton 1994, p. 7, Greenbaum 2010, p. 180). The second astronomical techné which was documented in Ptolemaic Egypt, was the soteriological form which was designed to prepare the soul for its journey to the stars, and found its textual expression in the body of literature known as the Corpus Hermeticum (Scott 1982). The astronomical texts were produced in Hellenistic Egypt in both genres were designed to serve the existential needs of the individual should be classed, and so should be classed as NMAATs.

The use of the word 'astrology' to describe Ptolemy's work in the Tetrabiblos can be seen as anachronistic; he himself did not use it. The words astronomy and astrology were not firmly distinguished until the seventeenth century. In the thirteenth century Thomas Aquinas referred to astrologers as astronomers (1975, III.84.14) while in the early seventeenth century Shakespeare, in King Lear I.2, used the term 'sectary astronomical'. Nevertheless, astrology is the term in common use, so we must use it. I shall also use the term omen-astronomy, though, in order to reinforce the point that a prime function of astronomy was the reading of warnings in the sky. Whatever the terms we use, it has been argued elsewhere that the final purpose of Ptolemy's astronomy was not the measurement of celestial positions, but the analysis of the soul's incarnation in flesh (Campion 2010, 2011) and this, it is argued further, was a concern which arises out of millennia of Egyptian theology.

Both Hellenistic astrological genres, horoscopic and soteriological, were to be central to the practice of astrology in medieval and Renaissance Europe, a cultural phenomenon which reached a crisis during the scientific revolution, to use the phase, of the sixteenth and seventeenth centuries.

6. Egyptian Astronomy

From Mesopotamia, let us turn to the question of the Egyptian contribution to astronomy. The Egyptians possessed an extraordinarily rich astral theology in which the entire universe was a single 'cosmic state', a term adapted from Thorkild Jacobsen's (1946) analysis of political astronomy in Mesopotamia, in which the function of astronomy was to assist in the mutual harmonisation of celestial and terrestrial realms.

However, the Egyptian contribution to astronomy tends to be underplayed, largely due to Neugebauer's denial that the Egyptians possessed an exact mathematical astronomy (Neugebauer, 1975, Vol. 2, p.559). Neugebauer's statement has permeated the literature on Egyptian culture. For example Lloyd (2000) has nothing to say about astronomy in the Ptolemaic period. Neither do recent general texts such as that by Bingen (2007). Taub (1997), has identified the problem and proposed that due attention be paid to Hellenistic Egyptian astronoy owm its own terms.

The sources for Egyptian cosmology in the wider sense describe a world in which there was a belief in a universal order, in which the human relationship with the cosmos was essentially participatory and spiritual (Frankfort 1978, Parker 1971, 1974, Wilson 1946). The cosmos was also moral, the evidence for which, as Wilson pointed out, is found in the belief in the judgment of the dead (Frankfort 1946, p. 105, Stilwell 2005, pp. 132-162). The primary task of Egyptian astronomy, though, was regulation of, and harmonisation of the state with, the sacred calendar, timing religious rituals precisely according to, for example, the rising of the sun or of particular stars. Egyptian astronomy was primarily observational in practice and religious in intent: the motions of the stars were the movements of the gods and goddesses: by watching the sky the priests were both the observers of a divine drama - and, through their rituals - active participants in it. Of equal importance is the persistent, almost obsessive role, played by the rituals surrounding death and the soul's subsequent fortunes, in Egyptian religion (Wilson 1946, pp. 31-124).

7. The Soul in Egypt

The literature on the Egyptian soul is complex, perhaps because the texts on which it is based, such as the Book of the Dead, are vague, impressionistic and concerned with general varieties of experience rather than with precise ontological classifications. In general, the soul in Egypt should be seen as a form of animating 'life-force'. It was divided into various forms (Stilwell 2005, p 114) but we should not imagine that these are necessarily entirely distinct. Nevertheless the ren is an individual's name, the sheut their shadow and the ib the heart. However, while ka is often translated as spirit, it is the ba which is normally considered to most closely resemble 'soul' (Frankfort 1978, p. 61). The distinction is a fine one and. whereas the ka, as a universal life-force, leaves the body at death, it is the ba which possesses some chance of transcendental immortality (Frankfort 1978, p. 65). The ba, is sometimes said to be responsible for human individuality (Zabkar 1968), and is described by Smith (2009, p. 3) as the ‘whole person’, but also the part of the individual which enables travel between the earth and the sky.

There is a persistent argument that initially, in the Old Kingdom, only the king, god and goddesses possessed a ba, and that, as Morenz (1992, p. 204) argued, the ‘concept of heaven’... ‘was at first accessible only the deceased king, but then, either late in the Old Kingdom, or in the New Kingdom, became “democratrized” as it were, and opened up to commoners’ (see also Spencer 142, p. 142, Stilwell 2005, p. 109). Questions of chronology aside, there is a general assumption that, by the New Kingdom, there was an assumption that there was an immortal soul which might journey to a celestial afterlife. However, this hypothesis is questioned by Mark Smith (2009), who argues that the ba, with its ability to reach a celestial heaven, was always accessible to commoners. There has been some discussion of whether the ba resembled other ancient concepts of soul. Stilwell (2005, p. 118) claims that it is not the same as the Platonic soul. Zabkar (1968) has cautioned against an identification of the ba with the Christian soul in the grounds that what the modern west (but not the ancient Egyptians) would regard as inanimate objects, could also possess ba. Such niceties, though, are less important than the observation that the ba was immortal and might go where it liked, including the stars.

Some commentators have traced an evolution in the Egyptian astral afterlife arguing, for example, that an early belief that the soul dwelt amongst the circumpolar stars was replaced in the Pyramid age by the notion that it joined the sun (Faulkner 1985, pp. 11- 14). However, for the current argument, the important consideration is confirmation of the soul’s ability to travel to the stars.

The Pyramid Texts, which first occur in the fifth dynasty pyramids, indicate that the king mounted to heaven on the rays of the sun. For example, Pyramid Text Utterance 508 reads ‘I have trodden those thy rays as a ramp under my feet whereon I mount up to that my mother, the living Uraeus on the brow of Re’ and Utterance 523 tells us that ‘May the sky make the sunlight strong for you, may you rise up to the sky as the Eye of Re' (Faulkner 1993).

The ascent to heaven was associated with the cosmology of Heliopolis, and are a counterpart to Osiris' dominion over the dead (Morenz 1992, pp. 205, 207, 211). There is, though, some debate as to the whereabouts of heaven, or the realm of the dead, due to the variable meanings of the duat, which generally belongs to the upper regions, but can mean 'twilight zone' or 'nocturnal sky' (Morenz 1992, p. 207). There is little specific about the destination of the soul except for generalised instructions as in the tomb of one of daughters of the pharaoh Akhenaten, that the ba will 'view the sun and move freely among the 'lords of eternity' (Baines 1991, p. 190). That said, the ba of the god Amon was in heaven, while his body in the realm of the dead and his image in the temple, and heaven was raised high for the ba of Osiris (Morenz 1992 pp. 151, 208). The pyramid texts talk of the double-doors of heaven opening, and Nut instructs the king to 'open up your place in the sky among the stars of the sky, for you are the Lone star' (Morenz, 1991, p. 205). The ba of the God and the ba of the king both belonged in the sky. But there was also a descent: the ba of the god may descend from heaven and enter its image (Morenz 1992, p. 115).

However, such debates on the antiquity of the idea of the ba as a property of any individual, or the location of heaven, are less important to the current argument than the Egyptians' acceptance, well before the rise of classical Greek culture, that a general property of being human was possession of a soul which could travel between earth and stars.

8. The Soul in Mesopotamia

In contrast the Mesopotamians, who had such a decisive influence on the astronomy of Hellenistic Egypt, appear to have been unconcerned with any concept of an immortal soul (Frankfort et al, 1978). In their cosmology humanity was made out of matter, flesh and bone, completely different in nature to the intangible, immaterial beings, the gods and goddesses (Speiser, 1969, p. 68). True, the evidence of the story of Inanna's descent to the underworld in search of her dead lover, Dumuzi, suggests the possibility of survival after death (Kramer and Wolkstein, 1983), and there is some evidence of the possibility of an ascent to the sky in the Gilgamesh epic (Jacobsen, 1976, p. 202). There is also some scholarly speculation that the

Mesopotamians might have had a concept of a soul, but the discussion is vague and unconvincing (Oppenheim 1977: 200-1). In addition, in complete contrast to Egypt, notions of immortality feature little in both myth and ritual (with the exception of the annual re-enactment of Dumuzi's resurrection) and the prevailing Mesopotamian attitude to death was essentially pragmatic: one lives, then one dies. The current evidence indicates that no concern with an invisible, transcendent soul was transferred to Egypt with Babylonian astrology.

9. The Soul in Classical Greece

The third component of Ptolemaic NMAA, along with the Egyptian and Babylonian, was Greek. While the notion of a transcendent soul which can survive the body and travel to the stars, was central to Greek philosophy from the fifth century BCE onwards, evidence from the eighth century BCE indicates that the earlier Greek version of survival after death was somewhat different. The Homeric personality was made up of different entities, the body soul, or souls, active when a person is awake, and the free soul, active after a loss of consciousness or death; the psyche was generally the breath of life that escaped at death and went to Hades (Stilwell, 2005, pp. 53, 67). The account of Odysseus's visit to Hades in Homer's Odyssey (1997, II.556-8) suggests that the standard model in the eighth century BCE held that the psyche survived in a miserable troglodytic condition in the ground; the Homeric soul had nothing to look forward to except an eternity bound to the earth.

The notion of a transcendent soul is thought to have appeared in Greek culture via Pythagorean and Orphic teachings, perhaps in the sixth century BCE (Guthrie 1952, Guthrie 1987, p. 32-3, 142, Stilwell 2005, pp. 41, 92). The substantial literary evidence, however, dates only the early fourth century: Plato (1931, 81B) claimed that 'certain priests' believed in transmigration of souls. Such details aside, the point is that the concept does not appear in the major works of classical literature, those of Hesiod and Homer in the eighth century BCE, so was introduced sometime between then and the fourth century, from when the first literary records survive.

The concept of a transcendental soul was, then, to be fundamental to Greek cosmology from the fifth century BCE onwards, and in western cosmology until the seventeenth century. This was largely as a result of the influence of Plato, together with Aristotle, both of whom emphasised the soul's immortality and relationship with the stars. Plato divided the soul's functions into three, one of which dealt with the body, one the emotions and the other, the rational soul, with access to divine wisdom, and taught that each soul is connected with a star and that, as outlined in the so-called Myth of Er, that it descends from the sphere of the stars at birth, returning via the planetary spheres after death (Plato, 1931, 41E-42A, 1937,X, 1914a, 246-8, 1914b 108-109A). Like the ba, Plato's rational soul was immortal, transcendent and could travel between earth and stars.

In general, unlike Plato, Aristotle argued that the soul died with the body, but he allowed for one part, later known as the Active Intellect, to be immortal (1936, III.V.430a). Aristotle himself did not specifically relate the soul to the stars but did describe a cosmos in which the whole terrestrial realm was animated and moved by the stars in their role as 'secondary' causes (1937, 339a 19-24). In each case, mainly in the Platonic, but to a lesser extent in the Aristotelian, soul is an integral part of the nature and function of the cosmos, and is therefore of vital importance for an understanding of the history of astronomy.

The Greek soul possessed certain similarities to the Egyptian, along with differences. Both cultures possessed the concept of the weighing of the soul and a leader of souls (Stilwell 2005, 167). Stilwell's (2005, 175) argument that the notion of the Orphic- Platonic soul as imprisoned in a corrupt body (Plato 1914a, 82E-83A) would have been abhorent to the Egyptians, with their reverence for the body, is initially persuasive, but not if the Platonists regarded the body more as the protector of the soul than its gaolor. Was the Greek Belief in an Immortal Soul Borrowed from Egypt?

The question, in view of the lack of evidence for its existence in the eighth century, is whether the Greek belief in a transcendent soul was indigenous or imported. The strongest testimony for an imported origin is Herodotus' view, regarded as controversial by many scholars, that the belief in an immortal soul was imported into Greece from Egypt. The Egyptians, Herodotus (1972, 11.123) wrote, 'were...the first people to put forward the doctrine of the immortality of the soul'. A series of modern scholars have lined up to claim that Herodotus must be wrong, in spite of his claims, perhaps that he never even visited Egypt in order to obtain such first-hand testimony (Armeyor 1978. See also Stilwell, 2005, p. 166). Zabkar (1963) used Herodotus' apparent lack of familiarity with certain complexities of Egyptian beliefs on the afterlife to shed doubt on his account. Some scholars, such as Guthrie (1952, pp. 170-1), who discussed the possible role of Herodotus as a bridge between Egyptian and Orphic beliefs, remain neutral. Jane Harrison (1947, p. 148) took a middle way, arguing that the Greeks 'need not have borrowed [the immortality of the soul] from Egypt, and yet it is probable that the influence of Egypt...helped out the doctrine'. Others have dismissed the doubters, including Thomas McEvilley (2002, pp. 126-9), who is both sceptical of such arguments and regards them as an attempt to preserve Greek purity from oriental pollution.

Contrary to Zabkar, Herodotus did not need to understand the details of Egyptian classifications of the soul, and neither did any Greeks, in order for them to have been inspired by Egyptian notions of immortality; much could have been lost in the process of borrowing. As far as the eastern Mediterranean is concerned, then, a strong argument can be made that the idea of an immortal, transcendent soul, originated in Egypt. A similar controversy surround the Eleusinian mysteries, with some scholars claiming they are 'Egyptian by execution and intention' as Stilwell (2005, 165) put it, others denying it. Such arguments can be understood through Pingree's (1991) concept of Hellenophilia, love of all things Greek, which holds that no worthwhile feature of Greek culture could have been the result of foreign influence. Thus, in Pingree's modl, critics of Herodotus' claim do so on a priori grounds, and offer neither evidence for their scepticism, nor alternative explanation for the development of the Greek idea of a transcendent soul.

10. Hellenistic Non-Mathematical Astronomy

The extensive influence of Babylonian mathematical astronomy on Greek is not open to doubt, and has been well argued by Otto Neugebauer (1963, 1975) and, more recently by Alexander Jones (1977, 1993, 1996) and Pingree (1998). Babylonian astrology began to penetrate Greek culture in the fifth and fourth centuries BCE, and the earliest explicit, and very brief discussion of it, was Plato's in the Timaeus, composed around 360 BCE (1931, 40 C-D). The earliest surviving possible documentary evidence of Greek use of astrology actually dates from half a century later; a cuneiform birth chart cast for an infant named Aristokrates, who was born on the morning of 3 June 235 BC (Sachs 1952, Rochberg 1998). The formal teaching of Babylonian omen-astronomy to Greeks was initiated sometime around, or shortly after, 300 BCE, when Berossus, a priest of Bel, or Marduk (the Babylonian Jupiter), established a school on the Aegean island of Kos, the site both of Hippocrates' medical school and the Asclepion, a healing sanctuary sacred to Asclepios, son of Apollo (Vitruvius, 1954, IX.6.2). Politically, Kos had been organised as part of the 'Islander's league', a federation of Aegean islands, by Antigonos Monophthalmos in 315/314 BCE, but came under the control of the Ptolemaic kings of Egypt by 'the late 290's or early 280's' (Shipley 2000, p. 205). Berossus' school, therefore, was both based in a historic centre of learning and directly tied to the emerging intellectual hub in Egypt.

The evidence suggests that Babylon remained a centre of activity and innovation until the first century (Rochberg 2004). Yet the focus of astronomical innovation shifted to Alexandria in the second century BCE. The familiar reason was the creation of the great library of Alexandria, a project initiated by Ptolemy I (323-283), and fully operational under his son, Ptolemy II (283-246). The coincidence of timing between the library's foundation and Berossus' arrival on Kos may itself be significant. The library's first superintendent was Zenodotus, himself a student of the scholar and poet Philetas of Kos (c. 340-285 BCE), tutor to the young prince, the future Ptolemy II. It made sense for there to be close connections between Kos and Alexandria, and hence a possible direct channel of omen-astronomy material to Alexandria. There is certain evidence for this assumption, or for other direct channels from Babylon to Alexandria. For example, Hypsicles' work was derived from Babylonian systems which had themselves been wellestablished by the previous century, even though he did not acknowledge Babylonian astronomers in his text, the Anaphorikos (Evans, 1998, p. 205).

Berossus' mission to the Greek world met with a receptive audience. According to later accounts Theophrastus (c.370-c. 285 BCE) the head of Aristotle's school, apparently admired his skill in predicting the weather and both public and private affairs (Neugebauer, 1975, p. 609). The literary result of Berossus' teaching was the beginning of the composition of astrological manuals in Greek, all of which are now lost. The astrological work apparently written by Hipparchus (c.190-c.126 BCE) has disappeared without trace, although it was used up to the fourth century CE, at least (Neugebauer, 1969, p. 168). The five books on divination written by the Stoic Posidonius (c.135-50 BCE), who is credited with taking astrology to Rome, have also been lost. The critical developments, then, in the development of western astrology occurred in Hellenistic Egypt between Berossus' move to Kos and the composition of the extant first and second century CE texts by Manilius, Valens, Dorotheus and Ptolemy, and it is these which linked the Babylonian original to the full-fledged classical version. It is accepted that the astrology which is known from the classical world, from the 1st c CE onwards, took place in Hellenistic Egypt. The most significant texts of these texts, though, like those of Hipparchus and Posidonius, are lost and known only in fragments.

The first was a lost work attributed to the seventh century BCE pharaoh Nechepso (Ray 1974) and the fourth century priest Petosiris, but now assumed to have been composed sometime around 150 BCE (Bohleke, 1996, p. 19). Another work, consisting of a series of 72 images, is only known by its name, the Salmeschoiniaka, a word which may be translated roughly as 'Pictures', or 'Images', or 'Images of the Seal Bearers' (Eisler and Chatley, 1941, p. 149). Greenbaum and Ross (2010, p. 176) are prepared to date Nechepso-Petosiris to the seventh century BCE (see also Campion 2009, pp. 104-7), but the technical development of the horoscope/birth-chart would still fall in the third or fourth centuries BCE at the earliest, as the origination of the form in Babylon in the fifth century BCE is not questioned (Rochberg 2008, Sachs 1952).

11. Soteriological Astronomy in Ptolemaic Egypt

While the technical manuals of Ptolemaic omen astronomy are lost, the Corpus Hermeticum, the literary origins of which, like Nechepso-Petosiris and the Salmeschoiniaka, in the second century BCE, survived intact: Fowden (1986, p. 3) argues that the earliest Hermetic texts were 'in circulation in the first century BC, and perhaps earlier'. It's in these texts that we find for the first time a detailed codification of the overt and persistent concern with the soul and its return to the stars which lay at the heart of much Greek cosmology, especially those schools influenced by Plato. The divine powers which bind the Hermetic cosmos together may be spoken of in terms of light and derived from the sun, together with the less celestial bodies, the planets and stars (Fowden, 1986, p. 77). Thus, in Hermetic philosophy, everything is in God, he is in everything and the sun is the primary vehicle for the transmission of his divine intent to the earth. In the words of the first century Roman natural philosopher, Pliny the Elder (1929, II.iv.13), the Sun is ‘the soul, or more precisely the mind, of the whole world…glorious and pre-eminent, all-seeing and even all-hearing’. Hermeticism’s abiding concern with the sun’s role as the spiritual centre of the cosmos, and with the soul’s ascent to the stars represented, in turn, a structural description of the cosmos and a profound view of its function; to facilitate the soul’s return to its celestial home. The universe was structured in three main divisions. There was one supreme God, the Father of all’, the supreme creator who, ‘in making all things, makes himself’. From God the entire universe emanated first the ‘intelligible’ world of ideas and then the ‘sensible’ world - the material, visible world accessible to our senses. God’s benevolent powers flow through these worlds to the sun, the Demiurge (‘craftsman’), the creator of our world, ‘a mighty deity…who is posted in the midst of the universe and watches over all things done on earth by men’ without whom there would be no physical life (Scott, 1982, p. 273, Fowden 1986, p. 77). The Demiurge then operated through the Kosmos, the eight spheres on which the stars and planets rotated, the planet-gods and the daemons they ruled. Men were, in turn subject to the daemons, ‘who mould all things on earth’ (Scott, 1982, p. 273).

This left humanity in an ambivalent position, both distant from God and separated from him by the daemons and planet-gods, yet, in that everything that God makes is itself God, all creation is an inseparable part of him. This problem of simultaneous intimacy and alienation was resolved by the simple formula that it is the physical body, together with those parts of the soul which are subject to physical desires, that are dominated by daemons and gods. Meanwhile, the rational soul, if the individual makes the right choices, is in direct contact with God. Elaborating Plato’s Myth of Er, the Corpus Hermeticum (Scott, 1982, p. 271) relates how,

The planets replace one another from moment to moment; they do not go on working without change, but succeed one another in rotation. These daemons then make their way through the body, and enter the two irrational parts of the soul; and each daemon perverts the soul in a different way, according to his special mode of action. But the rational part of the soul remains free from the dominion of the daemons, and fit to receive God in itself. If then the rational part of a man's soul is illumined by a ray of light from God, for that [in] man the working of the daemons is brought to nought; for no daemon and no god has power against a single ray of the light of God.

This passage, whose message is mirrored elsewhere throughout the rest of the Hermetic texts, is of absolutely critical importance in the development of western cosmology. Plato's benevolent daemons are converted into the malicious demons of Christianity. The planets occupy a double role. On the one hand, through their responsibility for the daemons, they are co-opted into the essentially oppressive system and release, via the rational soul, is only possible through the light of God. On the other, in that they surround the sun, through which God's light is transmitted, they partake in his glory.

Hermeticism offered an essentially Platonic path to salvation, recognising the inner divine and the possibility of a return to the Light via the planetary spheres; the Pharaonic ascent to the stars was now structured via the nested planetary spheres of Platonic cosmology (Scott, 1982, p. 129). The emphasis was on active engagement with the cosmos. The set of instructions by which salvation might be achieved were quite explicit; the devotee was told: look 'at what you yourself have in you; for in you too, the word is son, and the mind is father of the word…Now fix your thought upon the Light…and learn to know it (Scott, 1982, p. 117). Such statements are reminiscent of the Pharaoh's ascent to the sun. Further, 'He who has recognised himself', that is, acknowledged the divinity within, then 'enters into the Good' (Scott, 1982, p. 125). The key to cosmological salvation lay in self-understanding. However, it seems that not everyone was capable of achieving self-knowledge which is why, the twin technologies of horoscopic interpretation and Hermetic salvation theology; the former identified one's current destiny, the latter enabled one to act to transcend or escape it.

For those virtuous individuals who are blessed with Nous (divine reason) the way back to God is through the planetary spheres (Scott, 1982, p 129). The soul's shedding of seven human qualities at each planetary sphere may be the origin of the seven cardinal sins (Blomfield, 1941). At any rate, at each one, the vices associated with that planet are shed, in a pastiche of Inanna's shedding of her jewellery and clothing on her descent to the underworld. As the soul passes the moon it sheds growth and decay, Mercury trickery, Venus deceit, the sun the qualities of being a ruler, Mars daring and recklessness, Jupiter greed and Saturn falsehood. At the eighth sphere, that of the stars, the soul beings to praise God, and is encouraged by the sound of voices from the higher levels. Finally the soul ascends to God and, in the logical climax of Platonic theology, it is reunited with God. In fact, it becomes God.

12. The Horoscopic Texts

The rules underlying the horoscopic texts themselves are highly technical and, as recorded in the extant classical texts of the first and second centuries, are apparently concerned with externals such as one's parents (Ptolemy 1940, II.4). However, the apparent overwhelming concern with the mundane details of daily life should not be taken at face value. Rather the notion of such externals as the outer manifestation of the soul's current incarnation is a given. For example, Vettius Valens (120 - c.175), who may have been from Syria but studied in Egypt, opened his the entire work with the explicitly Hermetic statement that 'The all-seeing Sun, then, being truly fire-like (is) the light of the mind, the organ of perception of the soul'(1993, I.1). The apparently trivial and highly detailed interpretations of the significance of astronomical motion in individual life can therefore only be understood within a context in which the Hermetic concept of an ensouled, spiritually heliocentric cosmos, is taken for granted.

One of the most influential of the early classical astrological authors, Claudius Ptolemy, attempted to locate the soul's relationship with the stars in two of his works, the Harmonics and the Tetrabiblos, providing the philosophical motive and context for his, to historians of astronomy, better known work in the Almagest. If we turn to the Tetrabiblos we find the following statement (Ptolemy, 1940, III.13), intended to allow the astronomer to identify the condition of the soul, using Plato's classification into rational and emotional, in each individual by working the planetary positions from their time, date and place of birth: 'Of the qualities of the soul, those which concern the reason and the mind are apprehended by means of the condition of Mercury...and the qualities of the sensory and irrational part are discovered from the one of the luminaries which is the more corporeal, that is, the moon'. Ptolemy's concern was partly with the horoscopic techné, but he was also partly inspired by notions of the ascent to the stars, 'Mortal as I am', he wrote, 'I know that I am born for a day, but when I follow the serried multitude of the stars in their circular course, my feet no longer touch the earth; I ascend to Zeus himself to feast me on ambrosia, the food of the gods' (Cumont, 1960, p. 81).

13. Conclusion

There has been, in recent years, a tendency to re-evaluate the Egyptian contribution to astrology. Conman (2009) has argued for an Old Kingdom origin of the Babylonian bit nisirti, significant zodiacal locations for the planets. Bohleke (1996, p. 11) is cautious but nevertheless insistent in developing the debate, arguing that 'if not the originator of horoscopic astrology, Egypt developed the craft into an art, having a significant effect on the Roman world'. He notes (1996, p. 15. See also Fowden 1986, p. 17) that Ptolemaic Egypt witnessed 'a concerted attempt to translate Egyptian texts into Greek', incorporating indigenous wisdom into the Hellenistic worldview. Greenbaum and Ross (2010, p. 151) argue for a combination of Egyptian and Babylonian input into the astrology of Hellenistic Egypt, but nevertheless emphasise the Egyptian contribution more than has often been the case.

The argument for the indigenous Egyptian contribution to astronomy is based partly on the syncretism which occurred during the Hellenistic period, in which Greek and Babylonian contributions were combined with Greek. However, if a substantial contribution from Greece was a refined notion of the relationship between and immortal soul and the stars, and if this concept was borrowed from Egypt sometime between the eight and fourth centuries BCE, the Egyptian contribution is seen to be far more significant.

Herodotus' claim that the Greeks borrowed notions of the immortality of the soul from Egypt are unconfirmed but persuasive, even if they were combined with theories that the Greeks themselves were developing. Theories of the soul's ascent to the stars were refined by Plato and Aristotle and re-exported to Egypt in the Ptolemaic period. We may therefore argue that there were two routes for Egyptian concepts of the soul to enter Ptolemaic astronomy, both directly and via classical Greece.

The Babylonians had prepared the schematic foundation for the horoscopic techné, but their concern was purely with material fortune in this life; the concern with the soul was a Ptolemaic contribution. The horoscopic texts themselves are highly technical but, as both Valens and Ptolemy make clear, the apparent overwhelming concern with the mundane details of daily life should not be taken at face value. Rather, the notion of such externals as the outer manifestation of the soul's current incarnation is a given.

Hermetic teachings then provided a model by which the motions of the planets might be seen to disturb the soul, and liberation might be achieved. These practices then provided the foundation for the form of practical astrology which spread through the Roman Empire, and westwards to India, flourished in the golden age of Islamic learning and was one of the major motives for the study of astronomy in Medieval and Renaissance Europe until the seventeenth century (Campion 2009a): the importance of astrology in the Roman Empire (Cramer 1996) and medieval Europe (Thorndike 1923 - 58), and its impact on developments in mathematical astronomy, is well-attested. The development of a 'psychological astronomy' (Campion 2009b) , or astrology - an astronomy whose concern was the soul, or psyche - in Ptolemaic Egypt was therefore so important for subsequent developments in non-mathematical astronomy that, following the notion of the 'Copernican Revolution', I suggest that we can refer to an 'Egyptian', or 'Ptolemaic Astronomical Revolution' of the first and second centuries BCE. This suggestion, I emphasise, is made in order to encourage debate on the significance of a neglected period in the history of astronomy.

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10. Ancient Cosmologies: Understanding Ancient Skywatchers, Mayas, and their Worldviews

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Abstract

Ancient and pre-modern worldviews of the cosmos originated in practical lifeworld structures and experiences and therefore cannot be analyzed in the same manner as modern cosmologies are. Being embedded in everyday activities, worldview categories received ontological statuses, in contrast to socially and culturally disembedded cosmologies relying on specific epistemological frameworks. Uaxactunian Group E astronomical alignments are discussed to show that both approaches, the ontological and epistemological ones are equally important within the cultural astronomical paradigm.

1. INTRODUCTION

Since the beginning of humankind, the fascination with the celestial vault has been regarded as an important element in human life, their future, and history. Regularities in the perceived motions of celestial objects provided the necessary context upon which specific cultural patterns were created to regulate human activities. The correlation of terrestrial and celestial events and processes allowed peoples around the world to move both in space and time and to plan and make predictions with accuracy. Skywatching was associated with calendar making and homogenous time reckoning, freeing humankind from the regime of irregular and unpredictable fluctuations of different environmental cycles, such as when to plant or harvest and the migratory patterns of animals. In addition, the order either perceived in the sky or imposed by the rotating heavens, gave the structure to the ways with which peoples perceived their realm as a structurally ordered entity, so they conceptually organized the universe in the form of cosmographies, worldviews, and cosmologies.

2. THEORETICAL FRAMEWORK: FROM LIFEWORLD TO WORLDVIEW

Generations of stargazers and skywatchers carefully tracked the motions of celestial objects in order to understand how to conduct the affairs of human life on earth. From the starry sky, and from naked eye observations, they gained practical knowledge of their natural environment transforming physical surroundings into meaningful lifeworlds, or "familiar worlds of everyday life" (Schutz and Luckmann 2003, pp. 25-29). The celestial phenomena perceived in the sky were rendered as meaningful and socially relevant and like all other components of human lifeworld, were understood or interpreted within the specific conceptual framework based on taken-for-granted or common-sense categories (Habermas 2006, pp. 161-215). Lifeworld structures enabled human societies to interact more effectively with their environment and to shape their worldviews, or "culturally organized systems of knowledge" (Kearney 1975, pp. 247-248).

The notion of lifeworld evokes the description of an environment in terms of meaningful patterns that are relevant within the context of some activity. Viewed from this perspective, activities such as skywatching and stargazing should to be articulated within all other human activities performed in order to perceive, explain and/or interpret the world around it. Phenomenological notions of "being-in-the-world" proposed by Ingold (2000, pp. 5, 185-187) imply that celestial lore, like other types of cultural knowledge, is acquired, altered, represented and shared in the process of dwelling-in-the-world. Since acting in the environment is the peoples' way of knowing it (Ingold 2000, pp. 40-60), then the different worldview categories should be embodied in their practical engagement with the world, in their practical actions, functional uses, symbolic representations, and the collective and shared acting in-the-world. It may be expected that the celestial lore was instrumental in creating people's structural relationship to their lifeworld (and after world), and was embodied in their daily activities, and ritual practices, in the negotiation of social roles and in symbolic representations and classifications of the world and the rules which governed the heavens. Celestial patterns were explained in terms of the same conceptual categories as those relating to the human body and its functions, to the house and its elements, to the village and its parts, etc. (such as the notions of male, female, right, left, top, bottom, light, darkness, and the like). Ancient celestial lore often relied on existential (ontological, embedded, local) rather than logic (epistemological, universal) meanings, though this was not always the case in all ancient societies.

In contrast to modern cosmologies, ancient conventional worldviews were not always abstract and formalized bodies of specialized knowledge subjected to systematical examination and testing supported by reason and logic; though there are notable exception (e.g. ancient India, Egypt, Babylon). Furthermore, because of not being separated from everyday activities, ancient worldviews were not always able to transcend specific cultural and social barriers. Rather, they were often embedded in lifeworld structures, in people's social frameworks and practical actions.

When it comes to the ancient conventional celestial lore, a good deal of the interpretation of the motions perceived in the sky was made in terms of taken-for-granted and familiar categories. Prehistoric and non Western peoples often conceived their lifeworld as an extension of their own bodies, so when they observed the sky, the perceived patterns were often explained in terms of metaphors, analogies and symbols derived from the conceptual systems grounded in the familiar events, processes and objects that were present in everyday life. It must be recognized, of course, that many ancient cosmologists guarded their wisdom, and often communicated that knowledge through metaphors; and not uncommonly these simplified concepts were communicated to the people in terms they could most easily understand and apply to their own lives and that of their rulers.

Relationships between significant parts of their lifeworld were often represented in mythical narratives, and emphasized and transmitted through cyclic rituals and recurrent practices, leading to the idea of converting patterns perceived in the sky into effective tools for understanding the world.

This needs to be emphasized because some astronomers, in their eagerness to describe the ancient roots of their discipline sometimes define astronomy as the oldest of all sciences (Pannekoek 1961, p. 13; Moore 1996: p. 9). Needless to say, historians of science usually define the observations made either by prehistoric skywatchers or by ancient astronomer-priests as insufficiently scientific at most (Dicks 1970, pp. 27-40; Neugebauer 1975, pp.1-2; Pedersen 1993, pp. 5-6). however, these claims are also based on the evidence available, and not that which may have been destroyed, lost, or purposefully disguised so that this knowledge was shared only among the ancient scientific elite.

Naturally, the differences between ancient skywatching and modern astronomy may be studied from different standpoints, but the enormous intellectual gap that emerged in 16th – 17th centuries in Europe, separated these two domains of human knowledge forever. The modern astronomy that was born of the Copernican Revolution and Galilean geometrical space was not a natural continuation of ancient pre-telescopic astronomy, as is often supposed, but involved a systematic repudiation and almost a total abandonment of an earlier celestial lore. The rise of modern astronomy, symbolized by the declaration of the International Year of Astronomy, constituted a revolutionary change in peoples' approach to understanding the world; for the first time scientific explanation had little to do with commonsense or taken-for-granted statements (Husserl 2006[1940]).

This last fact has a tremendous impact on cultural astronomical studies. It is misleading to think of the practices of sunwatching or stargazing in terms of fixed bodies of knowledge consisting of systematic observations in the same way as today we think of modern science. Furthermore, the attitudes like presentism or whiggism that enable some astronomers to claim or deny that ancient skywatchers were behaving like modern astronomers, tend to ignore the social and cultural context within which they acted. Celestial lore is a culture-dependant phenomenon, so the knowledge of context is absolutely critical to modern interpretations as it puts limits to the extent of scientific analysis. It is important to distinguish between scientific inquiry that satisfies human need for explaining or interpreting the world in rational and logic terms from the human spirit of inquiry, a kind of human intellectual response to the need of living a life within the meaningful and understandable lifeworld. In attempts to avoid any interpretative pitfalls resulting from the ethnocentric attitudes, celestial lore and astronomical observations should be should be elicited within the context they functioned.

3. UAXACTUN GROUP E WORLDVIEW MEANING

The so-called Group E architectural complex from Uaxactun, Guatemala, has often been described as one of the oldest Mesoamerican astronomical observatories. The complex consists of the three west-facing small temples (called E-1, E-2, and E-3, respectively) built atop the elongated terraced artificial platform (E-16), a radial stepped pyramid (E-7) occupying the western side of the Group, and a ceremonial plaza extended between them. Group E was located in the easternmost extreme of Uaxactun and separated by built-in water reservoirs, called aguadas, from other upland architectural assemblages, known as A, B and D Groups. Its architectural features were continuously modified during the Late Formative and Early Classic Periods (roughly 300 BCE – 550 CE). Even though the construction activity at Group E seemed to have been interrupted after the Early Classic Period, the place was used for ceremonial purposes during the rest of the Classic Period, till c.a. 889 CE when the whole site was abandoned following the fate of other Central Petén Maya city-states.

The spatial relationship between the pyramid and the east elongated platform constitutes one of the most known and earliest examples of astronomically defined alignments. As Aveni and Hartung (1989) showed, the platform which is approximately East-West aligned, extends in such a manner that its southern and northern corners, as seen from a staircase atop the pyramid, match the positions of the sun at solstices. Furthermore, any observer located in this place could have observed that the upper level of the platform had been elevated to the height of the more distant skyline. It seems therefore that the builders of Group E deliberately transferred solstitial points from a skyline behind to the artificial horizon line in front. During the Early Classic (250 – 550 CE) three temples were placed atop the platform in positions to fit the places where the sunrise was observed at solstices and equinoxes. This, of course, obstructed direct sights towards the sun, making the whole arrangement astronomically non-functional.

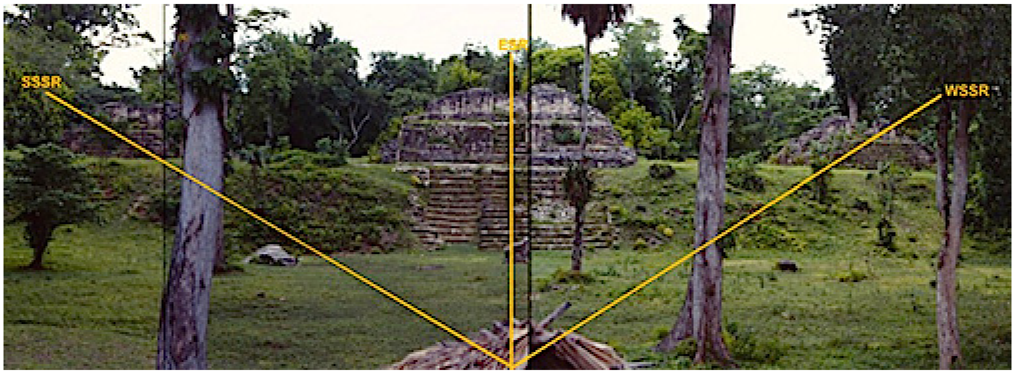

Figure 1. Group E astronomical alignments. Symbols: SSSR – Summer Solstice Sunrise, ESR – Equinox Sunrise, WSSR – Winter Solstice Sunrise. The photo made from the eastern stairway, above the first body, about 3.5 meters above the ground level. Photo: Stanisław Iwaniszewski.

Group E structures were built on a small natural promontory surrounded by bajos (namely the Bajo de Juventud, see Puleston 1983, fig. 1), or low-lying seasonally flooded swamps. The pyramid E-7 was built at the place highest elevation and the plaza was artificially leveled (Ricketson and Ricketson 1937, pp. 44-45). The place offered unrestricted views to the north-east, east and south-east. Today, no distant landscape features can be seen beyond the immediate setting, but the map (Puleston 1983, fig. 1) shows that the skyline features are located between 4.5 and 7.5 km eastward, and if there was limited tree cover in the way, they would have been visible from Group E. It may be speculated that during the dry season, from January through May, when bajos partially dried out, visibility conditions were improved.

Astronomically significant events might have been discovered at this spot in the distant past and a series of rounded platforms (Structures E, F and G) erected during the Middle Formative Period (600- 300 BCE) could have been connected to this fact (Ricketson and Ricketson 1937, pp. 109-13, 134, 136-137; Rosal et al. 1993, p. 72). Archaeoastronomical interpretations of Group E alignments can be traced back to the phase 2 of Late Formative (300 - 100 BCE) when the earliest versions of pyramid E-7sub-1 and of East Platform E-16-1 were erected. In providing a clear material barrier between the plaza and the bajos, the elongated and high platform (h = 4 m) also served to replace the natural horizon with the built one. The data provided by Aveni and Hartung (1989, pp. 444-445, Table 35.1) imply that top of the platform was high enough to coincide with the skyline extending over thebajos, as seen from the top of E-7sub-1 (h = 3.5 m). The bajos behind the platform remained invisible. This was only a very crude approximation intended to mark the passage of the sun along the eastern and now artificial horizon; the total length of the platform, as reported by Rosal et al. (1993, p. 73) yields 62 meters and is not long enough to be projected onto the annual path of the sun along the eastern horizon, as seen from the spot onto E-7sub1. The only access to the top of the pyramid was through a stairway placed on its eastern side.

About two hundred years later, during the Late Formative phase 5 (100 – BCE – 100 CE) both structures were again modified. The top of E-7sub2 was raised to 8.07 m, while the platform E-16-2 to some 4.52 m only, making the whole arrangement astronomically non-functional. Any observer located atop the pyramid would have seen the sunrise much above the top of the platform, along the skyline features created by the hills on the other side of bajos. In addition the platform E-16-2 was topped by a small temple impeding direct views towards the equinoxes. However, approximate astronomical alignments with solstitial extremes were still available for an observer located on the first platform of E-7sub2 (h=3.5 m).

Visual conditions discussed by Aveni and Hartung (1989) together with the archaeological reconstruction of the construction sequence of Group E (Rosal et al. 1993) imply that astronomical alignments between the pyramid E-7 and the East Platform E-16 were functional between Late Formative phases 2 and 5, covering a span of some 150-200 years.

The phase 5 modifications of the pyramid E-7sub2 totally altered its form and shape. Four stairways were added at four sides, transforming the structure into a radial or four-directional pyramid. However, the central stairway remained attached on its eastern side, since it was the only one leading to the fifth and highest platform where a temple was erected (Ricketson and Ricketson 193, p. 33 Plate 30; Rosal et al. 1993, p. 73). The structure received huge plastered masks displayed on all four sides and flanking the stairs. They were disposed in three levels, however the masks placed on the third and highest level were only attached to the balustrade of the stairs leading up to the temple, on the eastern side. According to current research (Schele and Mathews 1998, pp. 39, 331; Schele and Kappelman 2001, pp. 41-42), the masks were used to transform the pyramid into the image of Snake Mountain, the mythical place where the gods travelled to pick up maize for the first human beings. The masks attached to the bottom body of the structure depict snake heads, in reference to Snake Mountain, the masks in the middle level maize-mountain monsters in reference to Sustenance Mountain and the masks on the eastern façade depict the Principal Bird Deity or Itzam-Ye mythical bird.

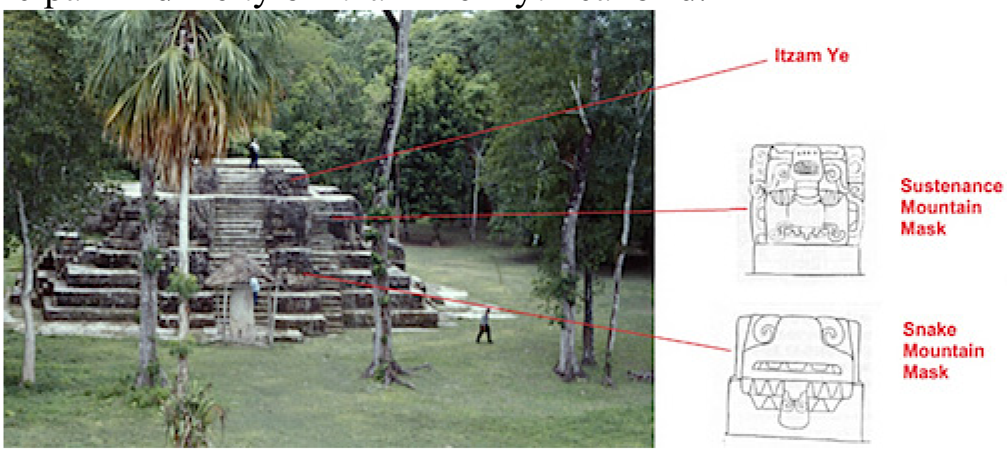

Figure 2. Radial Pyramid E-7sub2 Iconographic Program. Photo: Stanisław Iwaniszewski, sculpture drawings according to Ricketson and Ricketson (1937).

All this suggests that the sculptural program associated with E-7sub 2 referred to the origins of the social and cosmic order. Metaphorically, the structure represented a mythical place of origin, called Snake Mountain, carefully positioned in order to be placed in the center of the world. Considered as a nawal of Itzamna, Itzam Ye, or the long beaked bird, was associated with acts of sorcery and shamanic trance (Schele and Mathews 1998 pp. 46-47), while the figure of Itzamna was connected to divination, esoteric lore and writing. This provides meaningful contexts for the kinds of ceremonies performed.

The extension and shape of the plaza between the pyramid and the platform together with its unobstructed entrances suggests that it was intended as a public space. Scholars have already emphasized that this part of Group E was intended to enable ceremonies with a participation of a large group of commoners (e.g. Chase 1985, p. 37). Archaeological research in Group E provided enough evidence (e.g. burials and caches) to suggest that the plaza was associated with the performance of rituals related to the cult of ancestors. At the same time this complex was clearly associated with the observations of the sun´s annual movements, implying that rituals were performed at astronomically defined temporal cycles (Coggins 1980), possibly being related with important agricultural dates (Cohodas 1985, pp. 57-58). By assuming that potentially important and meaningful ritual loci could have also existed in contemporary Groups A and D, the suppression of the natural horizon at Group E and its replacement with a new architectural feature (Platform E-16-1) may be indicative of the efforts of getting separate families or family groups together within the framework of a single and coherent worldview. It should be emphasized that during the time when the complex was astronomically functional (300 – 100 BCE), the first rulers of Uaxactun built their residence in the southern part of Group E (Rosal et al. 1993; Valdés and Hansen 1995, pp. 199-200), suggesting that the efforts to create a shared identity were made under the supervision of the elite in power.

Some minutes after a (winter solstice, summer solstice) sunrise, the rising sun dispersed the mists over the bajos and shone directly onto the pyramid masks illuminating the ritual performers, while a large number of commoners remained in shadow cast by a 4 meters high platform. It may be speculated that commoners stayed in shadow observing how iconographic symbols related to shared mythological narratives located in the center of their Universe, together with elite members engaged in public rituals, became illuminated by the rays of the rising sun. Therefore, the purpose of Group E arrangements was to produce an effect of the ruling elite members as individuals standing at the center of the world, mediating between the supernatural world and the humans.

Group E arrangement provides a means to produce the shared worldview pattern and the new context appropriate for the creation of meaningful and controlled communal rituals. With the suppression of local skylines associated with the histories of particular groups or families, both the elites and commoners were able to develop collective representations of time and space attached to the solstitial directions created by Group E alignments. In due course, with the emergence of a local ruling family, a new program of directional symbolism was created to legitimize its political aspirations.

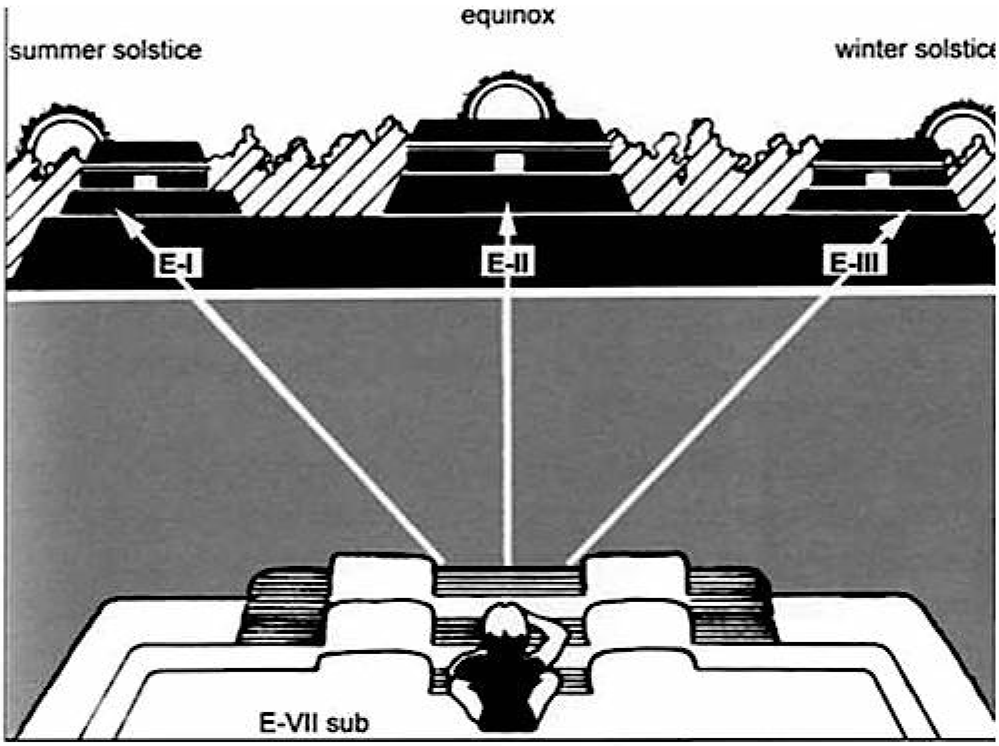

Figure 3a. Group E interpretations. Group E as an astronomical observatory. Drawing by P. Dunham from Aveni, A.F. (2001) – Skywatchers, The University of Texas Press, Austin, Figure 109.

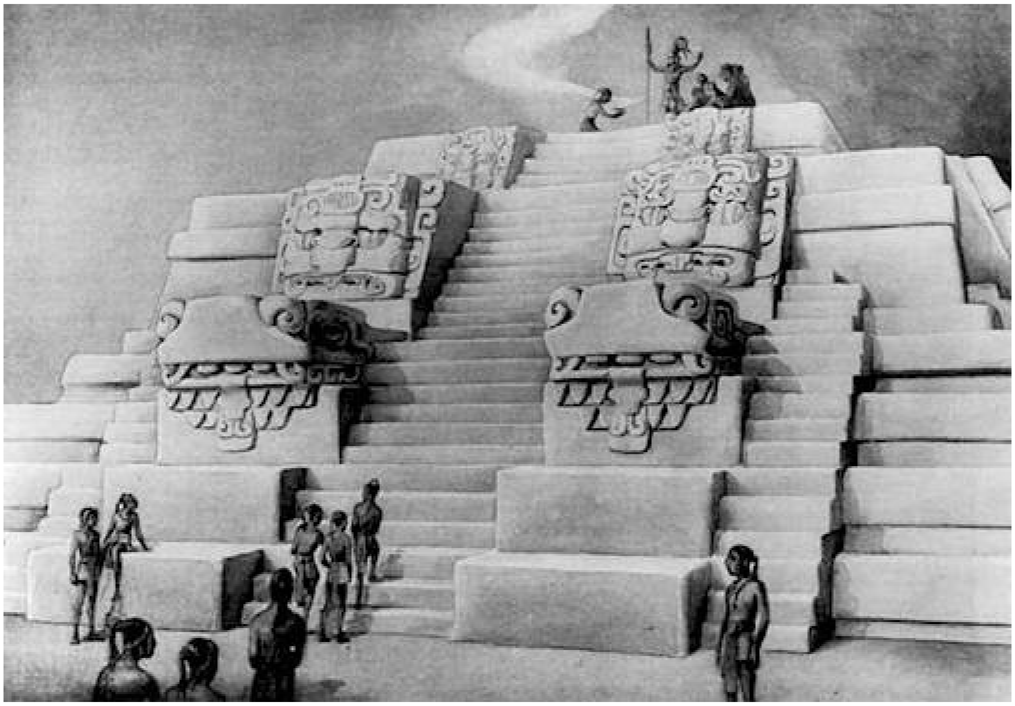

Figure 3b Group E as a ceremonial plaza. Drawing by T. Proskouriakoff from Proskouriakoff, T. (1946) - An Album of Maya Architecture, Carnegie Institution of Washington, Publication 558, Washington, D.C., p. 5

In contrast to modern observatories, ancient and non-Western skywatching locations functioned as places. In anthropology (Augé 2004, pp. 49-79) a place is the particular location which constitutes a physical means and conditions for practices of a particular discourse. Drawing on his proposal, a sky/sun/moonwatching place may be defined as the location created by the virtue of observing the celestial vault, in a way in which a fraction of the sky (eastern, western horizon, solstices, equinoxes, heliacal risings of a single object) becomes meaningful within some social activity (basic subsistence activities, rituals, divination, time-keeping, political or military events, etc.). It provides an observer with a limited perspective on the sky, a perspective which is partial, concrete, and local.

To conclude, it is observed that when the object of inquiry is lifted out of the context in which it functions and analyzed in terms of modern astronomy, Group E is typically described as an (astronomical) observatory. The same Group E remaining embedded in its proper time-space, is seen as a type of monumental architecture that served as a big arena for rituals attracting dispersed and competing families to promote shared values and worldviews and to legitimate political aspirations of a ruling elite. It was part of the process leading to the emergence of royal families in the Classic Period. The role of Cultural Astronomy is to have a balanced view of both interpretations at the same time.

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11. Astronomy in Ancient Mesoamerica:

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Abstract

The observation of the sky was of considerable imortance to the Maya, Aztecs and other rehisanic eoles of Mesoamerica. Their familiarity with the regularities of the aarent motion of the Sun, the Moon and bright lanets is attested in a large amount of astronomical data contained in codices and monumental hieroglyhic inscritions. The study of architectural alignments has also disclosed that civic and ceremonial buildings were largely oriented on astronomical grounds, mostly to sunrises and sunsets on certain dates, allowing the use of observational calendars that facilitated a roer scheduling of agricultural and the associated ritual activities in the yearly cycle. Both accurate knowledge and other astronomically-derived concets reveal that the significance attributed to certain celestial events by the ancient Mesoamericans can be exlained largely in terms of the relationshi of these henomena with secific environmental and cultural facts, such as seasonal climatic changes and subsistence strategies. It was articularly due to its ractical utility that astronomy, intertwined with religious ideas and ractices, had such an imortant lace in the worldview and, consequently, in the cosmologically substantiated olitical ideology of Mesoamerican societies.

1. INTRODUCTION

Mesoamerica is a culturally defined geograhical area corresonding to central and southern arts of modern Mexico and the northern art of Central America. The term refers to the territory on which civilizations, with common cultural traits, flourished since the 2nd millennium B.C., when the first comlex societies emerged, until the Sanish conquest in the early 16th century A.D. The history of Mesoamerica is traditionally divided into three main eriods or evolutionary stages: the reclassic (ca. 2000 B.C. – A.D. 250), Classic (250 – 900) and ostclassic (900 – 1519). The earliest urban societies aeared during the reclassic along the southern art of the Mexican Gulf Coast, in central Mexico and in the Maya area in the Mesoamerican southeast. The greatest slendor, articularly notable in fine arts, architectural achievements and writing systems, was reached during the Classic, whereas the ostclassic eriod was characterized by intensified migrations, ronounced militarization and, articularly in the Maya area, by increased olitical fragmentation.

The antiquity of astronomy and its imortance in all ancient civilizations (cf. Waerden 1974) can be accounted for by its ractical uses. Celestial motions allow orientation in both time and sace. Seasonal changes in natural environment coincide with various cyclical events observable in the sky. However, since the eriodicity of the latter is much more stable and exact, the observation of these regularities allowed ancient societies to redict annual changes in their environments and to regulate their activities in time. The need for astronomical observations increased notably with the origin of agriculture as farming requires an orderly scheduling of labors in the yearly cycle such as lanting and harvesting. Since astronomical knowledge offered adative advantages to the societies ossessing better secialists in this field, it acquired great imortance in early states, contributing to the legitimation of ower of the ruling class (cf. Reyman 1975; Broda 1982; Aveni & Hartung 1986, . 56; Iwaniszewski 1989, . 28f; Šrajc 1996, . 20ff).

Astronomical observations resulted, on the one hand, in a corus of exact and ractically useful knowledge. On the other hand, the celestial order, aarently invariable and erfect, came to be considered suerior to the terrestrial and human order, and this notion gave rise to an enormous variety of myths and beliefs which exlained why and how events on Earth deended on celestial henomena observed in the heavens.

2. MESOAMERICAN ARCHAEOASTRONOMY

In any articular social grou, the exact concets and those defined in terms of our current knowledge as “non-scientific” are normally intertwined and integrated in a relatively coherent worldview, which can be roerly understood only if examined as a whole and in the light of the secific natural, social and historical context; both correct and false ideas can shed considerable light on the society being studied. This holistic aroach has been adoted by archaeoastronomy, a relatively new anthroological disciline focused not only on exact knowledge but rather on all astronomically derived concets and related cultural manifestations. Taking into account secific environmental eculiarities, subsistence strategies, socioolitical structure and historical antecedents of the society under study, archaeoastronomy searches for answers to a number of questions: Why did certain astronomical henomena acquire a revailing imortance? What were the social functions of astronomical knowledge? Which were the observational bases of the concets embedded in myths, iconograhy, attributes of gods, etc.? In its attemts to solve roblems of this kind, archaeoastronomy articiates in common efforts of anthroological discilines and contributes to a more comrehensive understanding of ancient societies, as well as of general rocesses of cultural evolution (Aveni 1989; 2001; 2003; Broda 1982; 1992; Iwaniszewski 1989; 1994; Ruggles 1999; Šrajc 2005).

Mesoamerican archaeoastronomy relies on a variety of sources. Astronomical concets and ractices are referred to in the iconograhy and hieroglyhic texts in rehisanic manuscrits or codices, monumental inscritions, mural aintings, reliefs and other archaeological objects.

Comlementary information is contained in early colonial documents and, considering that fragments of rehisanic cultural heritage survive in modern indigenous communities, even in the ethnograhic material. Furthermore, relevant data on rehisanic astronomy are embedded in satial distribution of archaeological vestiges, articularly in architectural orientations and other alignments detected in ancient cultural landscaes.

3. MESOAMERICAN ASTRONOMY IN WRITTEN SOURCES, ICONOGRAHY AND ETHNOGRAHIC MATERIAL

3a: Calendrical System: Like any other recise calendar invented in the history of humankind, the comlex Mesoamerican calendrical system was based on astronomy (Aveni 2001; Caso 1967; Kelley 1976; Lounsbury 1978; Thomson 1950). The relation between the troical year and the 365-

day Mesoamerican year, comosed of 18 months of 20 days and an additional 5-day eriod, is evident. While the origin of the other an-Mesoamerican calendrical cycle, which had 260 days, is less clear, it has been noticed that the length of two 260-day eriods corresonds, with reasonable accuracy, to three eclise half-years of 173.31 days, and that the synodic eriod of Mars (779.94 days) equals almost exactly three 260-day cycles.

It has also been suggested that the 260-day count was invented somewhere along the 15th arallel north, because at this latitude the Sun's assages through the zenith are searated by intervals of 105 and 260 days (Aveni 2001, . 184ff; Malmström 1997, . 47ff; Šrajc 2001a, . 279f). Whatever its origin, this cycle, unique in the history of humankind, had an enormous imortance in all calendrical and astronomical comutations.

3b. The Sun and the Moon: The 365-day calendrical year was likely derived from the observation of the Sun's annual movement along the horizon. This is suggested by the imortance of solstitial extremes, attested since early eriods and reflected not only in architectural orientations (see below) but also in the concet, aarently an- Mesoamerican, that the sky corners are located at the four solstitial oints on the horizon (cf. Milbrath 1999, . 19; Šrajc 2001a, . 281).

The zenith assages of the Sun were also observed, and of articular imortance the first annual transit; though its exact date deends on the latitude, this event occurs throughout Mesoamerica in late Aril or May and thus announces, or coincides with, the onset of the rainy season, a crucial moment in the agricultural cycle (Aveni 2001, . 40ff; Tedlock 1992; Šrajc 2001a, . 281ff).

A wide variety of sources demonstrate the imortance of the Moon in Mesoamerica (Milbrath 1999; Thomson 1939; Galindo 1994). Chronological information in Maya hieroglyhic inscritions regularly includes the data on the "age" of the Moon exressed in the so-called Lunar Series. To kee their lunar months of 29 or 30 days in ste with lunations of 29.53059 days during longer eriods, the Maya alternated them using different formulae. This enabled them to achieve a remarkable degree of recision reflected in lunar data calculated for dates in distant ast and future (Lounsbury 1978; Aveni 2001, . 155ff; Cases et al. 2004; Fuls 2007).

In all ancient traditions the eclises were considered as bad auguries. This is because they are relatively rare and difficult to redict and, therefore, are associated with bringing disorder and disruting the cosmic harmony.

Various rehisanic codices and early colonial sources contain information on native beliefs about eclises and on ritual erformances intended to revent their negative influences (Caso 1967, . 93ff; Aveni 2001, . 26ff; Galindo 1994, . 70ff). On the other hand, the Mesoamerican astronomers-riests achieved a rather sohisticated knowledge about the eriodicity of eclises. The most exlicit information can be found in the Dresden Codex, one of the few Maya manuscrits that survived to our time: the dates listed on the ages constituting the so-called Lunar Table are saced at tyical eclise intervals (177 and 148 days). The urose of such tables was astrological: if the ossibility or “danger” of an eclise could be redicted, the aroriate ritual acts could be erformed on time (Thomson 1972; Lounsbury 1978; Aveni 2001, . 173ff; Bricker & Bricker 1983; Justeson 1989; Martin 1993; Knowlton 2003).

Figure 1. Fifth age of the Dresden Codex Venus Table. The bar and dot numerals in the bottom line (each bar reresents five, a dot is equivalent to one, and the shell symbol stands for zero), comose numbers written in the Maya vigesimal ositional notation (11.16; 4.10; 12.10; 0.8), which corresond to the canonical eriods of morning star visibility (236 days), invisibility around suerior conjunction (250 days), evening star visibility (250 days) and disaearance around inferior conjunction (8 days) in one synodic eriod of 584 days. The intervals searate the first and last aearances of the morning and evening star, falling on the dates of the 260- day and 365-day cycles listed in the uer rows. The accomanying text and images

refer to the deities residing over this synodic cycle, and to the victims of the baleful first aearances of the morning star.

3c. lanets and Stars. Among the lanets observed in Mesoamerica, Venus had a aramount imortance. The finest examle of the knowledge on this lanet is the Venus Table in the Dresden Codex. The five ages of the table, each of them covering one synodic eriod, reflect the commensurability of five synodic eriods and eight calendrical years. The comlete run of the table embraces 37,960 days or 104 years, which is the lowest common multile of the canonical Venus eriod of 584 days and of the 260-day count (37,960 = 65 x 584 = 146 x 260 = 104 x 365; Fig. 1). It is notable that even if the difference between the true mean length of Venus synodic revolution (583.92 days) and the canonical value assigned to this eriod by the Mesoamericans (584 days) resulted in an error of 5.2 days, accumulated after the comlete run of the table, an introductory age reveals that the table was "recyclable." In fact, occasionally, correction mechanisms were alied, intended to maintain the dates of Venus henomena redicted by the table (first and last aearances of the morning and evening star) in accordance with observational reality (Lounsbury 1978; 1983; Aveni 1992; 2001, . 184ff; Šrajc 1996, . 50ff).

While Venus as morning star at its first aearance after inferior conjunction was believed to inflict harm on nature and humankind (Thomson 1972, . 67ff; Aveni 2001, . 195f), the evening star had a revalent role in the beliefs about rain, maize and fertility. The main observational motive of the latter concets must have been the seasonality of the lanet's maximum and minimum declinations observable as extreme rising and setting oints: the evening star extremes, constantly occurring in Aril-May and October-November, coincide with the beginning and the end of the rainy season and, therefore, also delimit the agricultural cycle in Mesoamerica.

Venus also figured rominently in ideas and ritual ractices linked to warfare and sacrifice, and was also believed to be an eclise agent (Carlson 1991; Closs 1994; Closs et al. 1984; Milbrath 1999; Šrajc 1993a,b; 1996).

While other lanets seem to have had much less imortance, one section of the Dresden Codex has been interreted as a Mars Table, and references to Juiter and Saturn have been found in some Maya texts (Aveni 2001, . 196ff;

Aveni, Bricker & Bricker 2003; Aveni & Hotaling 1994; Bricker & Bricker 1986; Fox & Justeson 1978; Love 1995; Lounsbury 1989).

A number of rehisanic constellations or asterisms have been identified (Aveni 2001, . 29ff; Galindo 1994, . 90ff; Köhler 1991; Luo 1991; Tedlock 1992; Justeson 1989; Milbrath 1999). A table in the Maya manuscrit known as aris Codex, containing dates accomanied by different animals hanging from celestial bands, has been interreted by various researchers as a Maya zodiac (Fig. 2). However, there is no general agreement about the functioning of the table and the identity of the constellations reresented (Kelley 1976, . 45ff; Aveni 2001, . 200ff; Justeson 1989; Bricker & Bricker 1992; Love 1994, . 93ff).

Figure 2. Zodiacal almanac in the aris Codex.

4. ASTRONOMICAL ROERTIES OF MESOAMERICAN ARCHITECTURE

Systematic research carried out during the last few decades has revealed that Mesoamerican architectural orientations exhibit a clearly non-uniform distribution and that civic and ceremonial buildings were largely oriented on the basis of astronomical considerations, articularly to the Sun's ositions on the horizon on certain dates (Aveni 2001; 2003; Aveni & Hartung 1986; 2000; Galindo 1994; Tichy 1991; Šrajc 2001b). The earliest orientations in Mesoamerica refer to solstitial sunrises and sunsets, robably because the solstices, marked by easily ercetible extremes of the Sun's movement along the horizon, must have been the most elementary references for orientation in time (Fig. 3). Two other rather easily determinable dates are the so-called quarter-days of the year, or mid-oints in time between the solstices (March 23 and Setember 21, ± 1 day). While there is no comelling evidence that the true equinoxes were known in Mesoamerica, the orientation of architecture to sunsets on the quarter-days of the year are quite common (Aveni 2001, . 245ff; Aveni, Dowd & Vining 2003; Aveni & Hartung 1986; 2000; Tichy 1991; Šrajc 1995; 2001b; 2008). The solstitial and quarter-day orientations are not limited to the early eriods of Mesoamerica; in later times, however, more comlicated orientation rinciles began to revail.

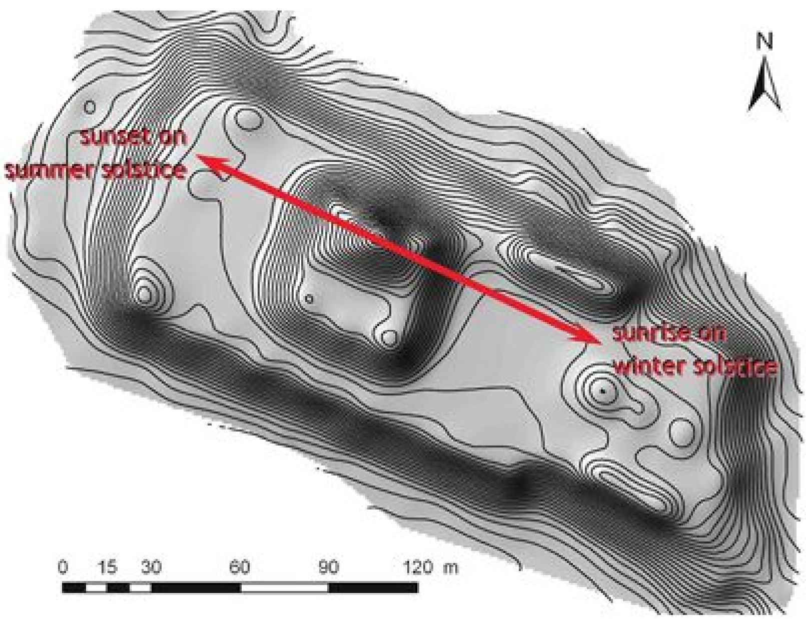

Figure 3. Grou F of Yaxnohcah, a large Maya urban center discovered in 2004 in southeastern Cameche, Mexico, exhibits a solstitial orientation (digital relief model by Tomaž odobnikar). As the surface ceramics indicates, this huge acroolis was built as early as midfirst millennium B.C. (Middle reclassic eriod; Šrajc 2008: 236f).

Recent studies based on a number of archaeological sites with monumental architecture in central Mexico and in the Maya area have revealed that the alignments enabled the use of observational calendars comosed of calendrically significant and, therefore, easily manageable intervals. The intervals searating the sunrise and sunset dates recorded by orientations at a articular site tend to be multiles of 13 or 20 days, i.e. basic eriods of the Mesoamerican calendrical system. The corresondence between the most frequently recorded dates and the crucial moments of the cultivation cycle suggests that the observational schemes, reconstructed for a number of sites, served for redicting imortant seasonal changes and for accurately scheduling corresonding agricultural and ritual activities (Aveni & Hartung 1986; Aveni, Dowd & Vining 2003; Šrajc 2001b; 2008; Šrajc et al. 2009).

It should be recalled that the Mesoamerican calendrical year of 365 days, due to the lack of intercalations, did not maintain a eretual concordance with the troical year of 365.2422 days; direct astronomical observations were, therefore, always necessary. The orientations of ublic buildings, marking critical and canonized moments of the year of the seasons, not only allowed their determination by means of direct observations: since the observational schemes were comosed of elementary eriods of the formal calendrical system, it was relatively easy to anticiate the relevant dates (this was imortant because cloudy weather could imede direct observations on these dates). Knowing the structure of a articular observational calendar and the mechanics of the formal one was of crucial imortance to these societies.

Particularly imortant for these uroses must have been the 260-day calendrical count, in which the cycles of 13 and 20 days were intermeshing: every date had a name comosed of a number from 1 to 13 and a sign in the series of 20. Given the structure of this calendrical count, the sunrises and sunsets, searated by 13-day intervals and their multiles occurred on the dates with the same numeral, while the events searated by eriods of 20 days and their multiles fell on the dates having the same sign (Fig. 4; Šrajc 2001b). In some cases, the relevant dates were marked by attractive light-and-shadow effects roduced by aroriate satial arrangement of certain architectural elements including stairways (Fig. 5; Anderson et al. 1981;

Aveni 2001, . 265ff, 295ff; Aveni et al. 2004; Carlson 1999; Galindo 1994; Šrajc 1995).

Figure 4. Along the east-west axis of the central and uermost art of the Acroolis at Xochicalco, Morelos, Mexico, the sun rises on February 12 and October 30 (Left) and sets on Aril 30 and August 13 (Right). The four dates, recorded by a number of orientations in Mesoamerican architecture, must have been canonical dates of a ceremonial agricultural cycle: on the one hand, they delimit intervals of 260 days (from February 12 to October 30, and from August 13 to Aril 30), equivalent to the length of the Mesoamerican ritual calendrical count; on the other, these dates aroximately coincide with four critical moments in the maize cultivation cycle, i.e. the rearation of fields (February), the onset of the rainy season and the time of lanting (around May 1st), the aearance of the first corn cobs or elotes (August), and the end of the rainy season and the beginning of harvest (around November 1st).

While the orientations in Mesoamerican architecture are redominantly solar, a few alignments to Venus extremes have also been identified. The referred targets were the evening star extremes, robably because they aroximately delimit the rainy season (see above) (Aveni et al. 1975; Šrajc 1993a; 1996). A few architectural alignments might also refer to major lunar standstills (Aveni & Hartung 1978; Šrajc 2009) and, ossibly, to the rising or setting oints of some brilliant stars (Aveni 2001, . 262ff).

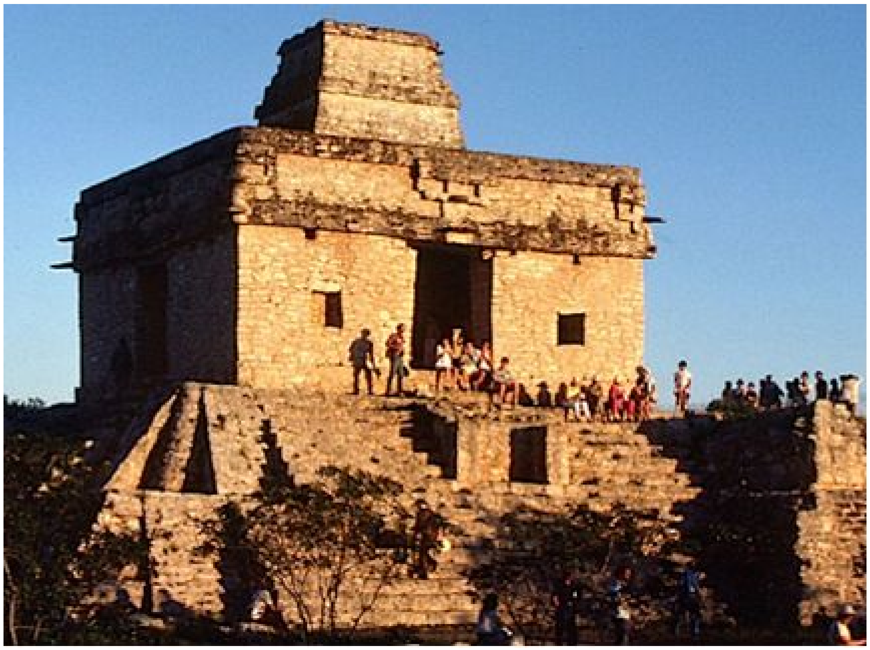

Figure 5. At Dzibilchaltún, Yucatán, Mexico, an interesting light-and-shadow effect can be observed twice a year in the Classic eriod Temle of the Seven Dolls. In late afternoons, when the Sun rays enter the building through two windows and two smaller oenings in the western wall (To), illuminated rectangles are rojected on the oosite inner wall, moving u as the Sun descends, and disaearing at the moment of sunset; on the quarter days of the year (March 23 and Setember 20), they disaear aligned exactly with the corresonding oenings in the eastern wall (bottom Right and Left).

5. CONCLUDING REMARKS

In Mesoamerica, just like in other ancient civilizations whose subsistence was based on intensive agriculture, the ability to redict imortant seasonal changes in natural environment was of aramount imortance. In the absence of a calendar accurately reroducing seasonal cycles, reliable redictions could only be based on astronomical observations erformed by secialists familiar with cyclical celestial henomena and their concomitance with annual climatic variations. This was a lot of ower to be ut in the hands of a few. Considering that an efficient distribution of activities in the agricultural cycle increased roductivity and secured survival to a larger oulation, the astronomers-riests' rofessional skills were vital for a successful economy and a smooth functioning of the existing social and olitical system.

Figure 6. A throne in a monumental building at Toniná, a large Maya site in Chiaas, Mexico, is decorated with a giant Venus glyh elaborated in stucco.

In view of the arallelism observed between the movement of celestial bodies and the alternation of seasonal changes in natural environment, and because the intervals at which astronomical henomena recur are much more constant and recise than those searating other cyclical events in nature, the sky was considered, since time immemorial, to be the image of divine erfection and sureme order to which human and earthly order was subordinated. With the origin and develoment of social stratification, such beliefs were modified and incororated into the ideology that was elaborated, declared and imosed by the ruling elite, with the urose of sanctioning and maintaining the existent social order.

The rulers were believed to be men-gods resonsible for erforming ritual activities that guaranteed a roer develoment of natural cycles and the reservation of the ideal cosmic order (cf. Lóez Austin 1973). Advances in astronomical knowledge made the achievement of these objectives more effective, as they allowed the most aroriate moments for every ceremonial act to be determined with greater recision. Moreover, reliable redictions of celestial events and the corresonding astrological auguries contributed to the legitimation of ower, justifying the rivileges enjoyed by the rulers and their collaborators dedicated to the riesthood, astronomy and the calendar (Aveni 1989; 2001; 2003; Broda 1982; 1992; Šrajc 1996; 2005).

The aarently immutable and erfect order observed in the sky, obviously suerior to the one reigning on the earth, must have been the rimary source of deification of heavenly bodies. Therefore, the cyclic behavior of the stars and lanets was not viewed as being simly correlated with seasonal transformations in natural environment, but rather as rovoking them. It comes as no surrise, then, that the rulers ersonifying imortant deities were also associated with the latter's celestial avatars, articularly the Sun and Venus (Fig. 6). On the other hand, due to the belief that the roer movement of the Sun, Venus and other celestial bodies were resonsible for timely occurrences of cyclical natural changes, the directions to the oints of their rising and setting on crucial dates of the yearly cycle also acquired a sacred dimension. Consequently, the alignments reroducing significant astronomical directions in civic and ceremonial architecture can be interreted not only as a sanctified materialization of the union of sace and time, whose imortance in the Mesoamerican world view is attested in different sources, but also as a manifestation of the attemts of the governing class to legitimate its ower by recreating and eretuating the cosmic order in the earthly environment. Hence the alignments in Mesoamerican architecture, just like other tyes of evidence, clearly show that ractical use of astronomy was intimately related to social organization, religion and olitical ideology of rehisanic societies.

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12. Cosmology in the Inca Empire: Huaca Sanctuaries, State-Supported Pilgrimage, and Astronomy

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Abstract

Huacas (shrines) and ushnus (ceremonial platforms) are ever-present elements of millennia-old Andean cosmology extending backward at least to Chavín de Huantar (1500-300 BCE). A major theme of Andean cosmology appears to be shamanic transcendence and transformation involving the three worlds of the cosmos. To avoid ethnocentrism, a new ontology may be necessary to grasp the full meaning of Andean astronomy. All of the known cases of astronomy in the archaeological record of the Inca appear to be associated with huaca sanctuaries that may also have been state- supported pilgrimage centers. The Sanctuary of Isla del Sol is a paradigmatic example of such a center. Its characteristic features are stone-lined channels, sacred rock, gateways for controlling access to ritual space, physical separation of space according to social status, and areas designated for observing the solstice sun. Most of the sites considered in this paper are associated with the June solstice, contain huacas consisting of natural and carved rocks, show evidence of social differentiation of participants, and have channels for natural or offertory liquids.

1. Andean Cosmology: Not Just a Different World-View, But a Different World?

Andean cosmology has deep roots, extending at least back to Chavín de Huantar, 1500-300 BCE, where it is revealed by uniquely Andean artifacts: huacas (Malville et al. 2006; Bray 2009; Gullberg 2010),i.e., shrines with extraordinary power, often sculpted rocks; and ushnus, which are raised ceremonial platforms sometimes with basins or wells into which offerings were poured (Staller 2008). The carved 4.5 meter tall shaft of the Lanzón of Chavín is a well-known example of an early huaca, an evocative axis mundi, a link between the three worlds of sky, earth, and the underworld (Burger 1992). Although it thrusts upward toward the sky, it is set deep in the interior of the Old Temple, reached by labyrinthine passageways. It is carved with the image of the supreme deity of Chavín, a fierce transformation of a shaman priest into a fanged jaguar with swirling snakes.

Huacas, which continued to be central elements in Andean cosmology for at least another 2000 years, continued this tradition of penetrating the three worlds through their verticality and shamanic-like power of transformation (Eliade 1964;Burger 1992; Staller 2008). Huacas possessed supernatural power and an animating essence for people, crops, and animals (Malville 2009; Staller 2008). A primary role of Andean religion and ritual was to keep the universe in balance and harmony. Some of the ritual offerings to huacas were water, corn beer (chicha), or blood, which were poured into basins or channels as a form of sympathetic magic to stimulate the flow of energy through the cosmos. Shamanic transcendence through the three planes of the cosmos was a continuing theme in Andean cosmology (Figure 1). Symbolic stairways, linking the dark underworld of caves and labyrinths to the earth and sky are ubiquitous such as at Chavín (Figure 2), Chankillo (Figure 3 and 4), Chinchero (figure 5), and Machu Picchu (Figure 6).

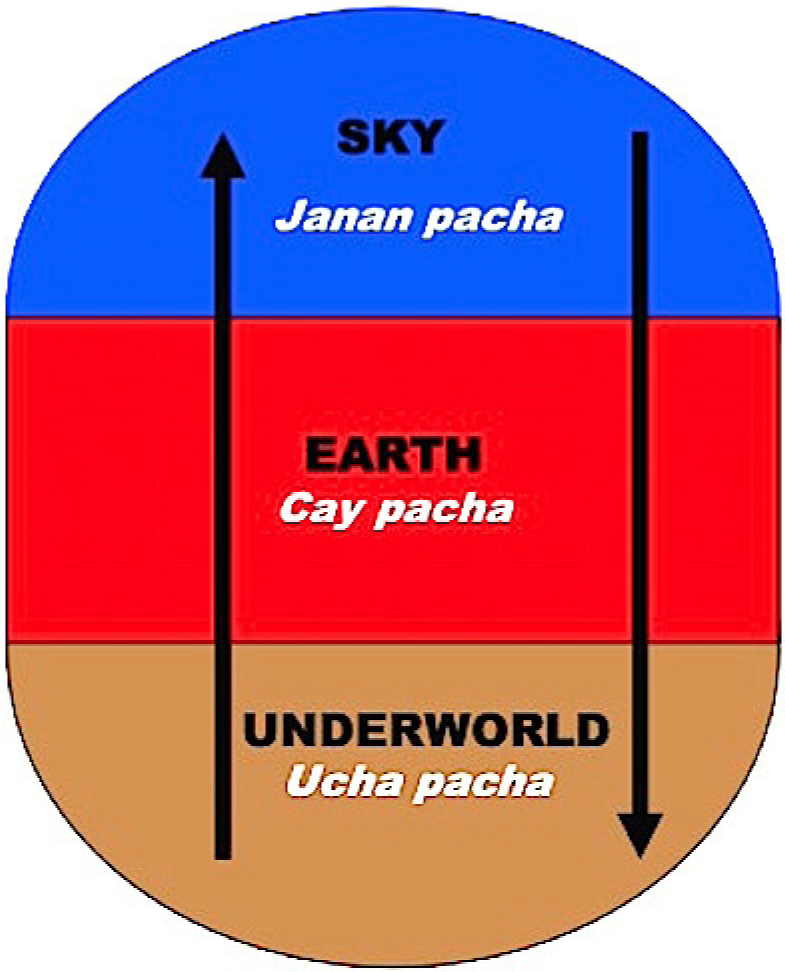


Figure 1: The Andean Cosmos: Movement between the worlds was symbolized by stairs, underground labyrinths, caves, huacas, and ushnus.

Figure 2. Chavín de Huantar, the underground Gallery of the Labyrinths: an example of shamanic transformation from priest to fanged feline (Burger 1992:158). Note the eyes and nostrils formed by coiled snakes, symbolic of the underworld. (photo by the author.)

Chankillo in the Casma-Sechín river basin followed the collapse of the Chavín civilization and was occupied between 320-200 BCE (Ghezzi 2006). With its hill-top fort, cloistered temple, thirteen towers, and extensive structures, Chankillo seems to be a complex mixture of warfare and ceremony. The major axis of the site is solar, extending from December solstice sunrise to June solstice sun set. There also is evidence for interest in major lunar standstills. Ghezzi (2006) presents a convincing argument that the great fortress may have been a scene of ritual battles. Kaulicke (1995) suggests a similar interpretation for nearby Cerro Sechín such that mythical battles were performed as a form of ritual dance. The towers of Chankillo may have been the scene of ritual processions. Each of the thirteen towers has double stairways, suggesting that they were huacas and that shamanic movement between the worlds was their raison d'être. Furthermore, the orientation of each tower is gradually changed from terrestrial to solar as one ascends to the sky (Malville et al. 2009).

The interactive parallelism of the three worlds is another feature of Andean cosmology. The Milky Way was understood to be the celestial counterpart of the Urubamba River (Urton 1981) and dark sky constellations such as the Celestial Llama provided the life force for terrestrial llamas (Solomon and Urioste 1991; Bauer and Dearborn 1995).

Figure 3: The Huacas of Chankillo: an example of ritual movement between worlds. Each tower has two sets of stairs. Successively higher towers are rotated from a terrestrial orientation to a solar orientation. (photo by C. Aranibar.)

Figure 4: High Huacas at Chankillo: stairway after stairway (photo by C. Aranibar.)

The Spanish were immensely puzzled by huacas. For them huacas were very alien features in an already alien land. As documented by the chroniclers, huacas were carved and uncarved rocks, idols, buildings, springs, caves, poles, trees, nails, hair and body parts of Incas, mummies of ancestors, children born with deformities, piles of stones on mountain passes, and places where lightning had struck (Van de Gutche 1990). Andean huacas still can be puzzling to us today, but they are deeply embedded in millennia-old Andean cosmology, and to ignore their meaning puts one at the risk of not fully understanding Andean astronomy.

Figure 5: Chinchero: Huaca of Titicala. The stairway and cave lead to an ushnu. (photo by the author.)

The archaeologist Tamara Bray (2009) is a major advocate for the emerging paradigm in anthropology that uses the ethnohistoric record to explore alternate Andean ontologies. In particular she recommends that to understand the Andean world, we need to break out of Cartesian dualism in which living and non-living are fundamentally different. Applied to the astronomy of the Inca, this "different understanding of the nature and categories of being on the part of indigenous people in the Andes" implies that we should free ourselves of the notion that the stones of Cusco or Machu Picchu were inert lumps of inanimate matter, the sole meaning and function of which was to mark astronomical sightlines (Bray 2009:357). Such is the kind of thinking that leads to identifying as "observatories" those artifacts that give any hint of astronomy, whereas a term such as "sky watching place" might be more appropriate (Iwaniszewski 2009: 106). The authors of "Thinking Through Things" suggest that we need to be open to "moments of ethnographic revelation in which unanticipated, previously inconceivable thing become apparent" and propose that we move away from questions of epistemology to those of ontology (Henare et al. 2007: 1). Instead of assuming that nature is one and culture is many, we should consider that there may be genuinely different realities encountered and created by other cultures. An emic approach to culture, grounded in ethnography, is being increasingly encouraged in archaeoastronomy (whether it be of the old world or new world: Sims 2010). Instead of picking out those features that are astronomical, the cultural context needs to be considered in depth (Iwaniszewski 2010), requiring thick descriptions such as proposed by Geertz (1973).

The ethnography of huacas indicates that they were regarded as living beings possessing extraordinary powers and the great wisdom of ancestors (Salomon and Uriste 1991; D'Altoy 2000; Bray 2009). They had vibrant lives, functioned as oracles, dispensed wisdom; they were fed and dressed in clothes; they could be married, abducted, or even destroyed by enemies. The personhood of huacas blurs the distinctions between the living and the dead, between animate and inanimate (Bray 2009: 358).

In addition to the calendrical functions they may have had, the 328 or so huacas surrounding Cusco (Zuidema 1964; Bauer 1998) must have served as powerful protectors of the Inca state. They were a standing army and a council of wise advisors always in residence.

Outside of Cusco, huaca sanctuaries are found in Royal Estates such as Chinchero, Quespiwanka (Urubamba), Pisac, Ollantaytambo, and, of course, Machu Picchu, with the largest density of huacas of all. Machu Picchu was more than a vacation lodge for the Inca Pachacuti: everything and everyone contained within the place would have been imbued with the power of its huacas.

One of the most impressive huacas of Machu Picchu is the single rock that contains the Torreon on top and the cave of the Royal Mausoleum below. This huaca penetrates the three worlds, like a gigantic Lanzón. It combines a cave, symbolic stairs, niches for ancestors, illumination at June solstice, and proximity to transformative water.

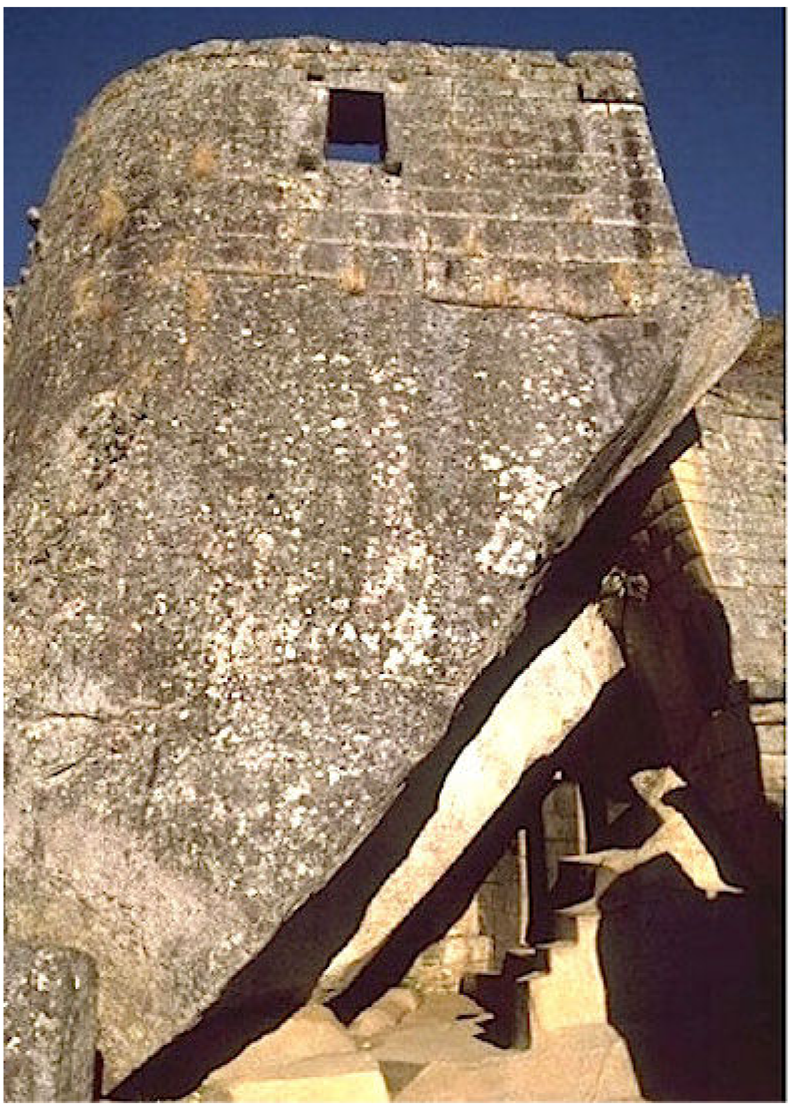


Figure 6: The Great Huaca of Machu Picchu. Torreon on top and Royal Mausoleum below. Inside the cave of the Mausoleum there are stairs and niches for the ancestors. Both the window of the Torreon and the cave receive light of the sun on the morning of June solstice. (photo by C. Ruggles.)

2. Water and Camay

Running water was understood to be an energizing and animating life force in Andean cultures, associated with the Quechua verb, camay. The agent of camay, the "camayer" is known as camac (Bray 2009; Malville 2009; Solomon and Uriste 1991). The dark constellation of the Celestial Llama is the camac of llamas, responsible for giving llamas the vitality to flourish on the earth. The Pleiades, also known as the storehouse or granary, Collca, was especially revered because that asterism was considered the supreme camac or mother from which flowed all the energy for animals (Cobo 1990:30). It seems quite possible that the sun was understood to be a camac for certain huacas, such as the rocks of the Torreon and the Palace of Huayna Capac (see below), which are touched by light of the rising sun at June solstice. People skilled in their crafts, such as sculptors, engineers, and weavers would be camayers. As early as AD 600, drainage canals in Tiwanaku may have served the ritual purpose of energizing sacred buildings through the process of camay (Couture 2004). We find evidence for similar energizing of sacred buildings at Machu Picchu where the canal was diverted toward the huaca of the Torreon/Royal Mausoleum. At Tipon, the major aqueduct was diverted under its Intiwatana and the Ceremonial Plaza.

3. Ceremonial Centers as Huaca Sanctuaries

Every known instance of astronomy in the Inca Empire appears to be associated with huacas and public/private ceremony. Distinguishing characteristics of these ceremonial centers are suggested in Table 1.

Table 1/ Features Common to Ceremonial Centers with Visual Astronomical Event

A	Empowerment by Camay	1. Stone-lined channels 2. Fountains and aqueducts 3. Pouring of water or chicha 4. Lake
B	Sightlines to horizon sun	1. Markers on horizon 2. Alignments toward horizon sun
C	Huacas	1. Natural rocks 2. Carved rocks 3. Platforms 4. Horizon pillars 5. Caves 6. Sacred mountain
D	Plazas, courtyards, terraces	1. Open 2. Enclosed
E	Physical separation of social classes	1. Barriers and walls 2. Separate platforms
F	Gateways	1. Double-jamb doors 2. Triple-jamb doors 3. Ceremonial gateways
G	Structures	1. Storehouses for pilgrims 2. Quarters for attendants

3a. The Huacas of Cusco The most detailed descriptions of Inca astronomy by the Spanish chroniclers involve the solar pillars of Cusco, where as many as 16 horizon pillars on the horizon once marked the annual changes in the location of the rising or setting sun (Aveni 1981; Zuidema 1981, 1982; Bauer and Dearborn 1995). None of the pillars that were on the Cusco horizon has survived the Spanish campaign of eradication of indigenous cosmology and religion. On sunrise of the feast day of June solstice, Inti Raymi, the Inca and his relatives watched the rising sun from the plaza of Haucaypata (Plaza de Armas) while others watched the event from the Plaza Cusipata, to the west across the Huatanay River. After drinking to the Sun, the celebrants poured chicha and or water from Lake Titicaca into a basin from which it flowed in a channel to the House of the Sun (Zuidema 1981; Bauer 2004).

The horizon pillars on the surrounding horizon and the ushnu in the Plaza of Cusco were important features of Inca ceremonialism in Cusco, but it seems likely that the most powerful ritual objects in the Cusco basin were the 328 or so huacas tied together by 41 ceques which radiated outward from the Coricancha (Zuidema 1964; Bauer 1998). The personhood of these huacas may have been of primary significance because they may have been understood to be powerful protectors of the capital of the Inca Empire and valued sources of advice and wisdom for the Inca.

3b. The Sanctuary of Isla del Sol The Sanctuary on the northern end of Isla del Sol in Lake Titicaca and its pilgrimage traditions have been documented by Bauer and Stanish (2001) and Dearborn et al. (1998). The difficult journey to the island and along its spine gave it a sense of otherworldliness for the pilgrims. The most important feature of the Sanctuary was the Sacred Rock, known as Titicala, out of which, according to legend, the Sun had first emerged. The concave portion of the rock was reportedly covered by gold and silver and the entire rock was sometimes clothed by a large finely-woven cloth (Bauer and Stanish 2001). The first European visitors to the area reported numerous women attendants who made large quantities of corn beer, chicha, which was poured into a stone basin at the base of the sacred rock. The basin had a hole in its center and stone-lined channels carried the chicha away from the rock. Only Inca nobility and priesthood were allowed to pass through the several gates to reach the plaza in front of Sacred Rock. Lower status pilgrims were limited to a platform just before one of the gates, from which they could watch the ritual in front of the sacred stone from a distance of some 400 meters.

3c. Machu Picchu. In a manner similar to Isla del Sol, pilgrims would have had to pass through gates on the Inca trail as they approached Machu Picchu, first at Intipunku, the Gate of the Sun, and then at a security station half way down to the primary gate (Wright and Valencia Zagarra 2004). The station contains a carved huaca, which may have both protected the area and received offerings from pilgrims. Having reached the southern terraces of Machu Picchu, pilgrims would have encountered a second major carved huaca, the Ceremonial Rock. They could have gathered at the adjacent upper kallanka, which served as a storehouse and shelter. Entry to Machu Picchu itself was limited by the main gate and may have been closed to non-elite pilgrims. Ceremonies in the Sacred Plaza and the ushnu on Huayna Picchu were viewed from the Terrace of the Ceremonial Rock.

Figure 7: Sacred Rock on Isla del Sol (Squier 1877).

For those allowed to enter Machu Picchu, they could not help but note that the main gate beautifully frames Huayna Picchu. The northern side of Huayna Picchu is protected by the largest double-jamb doorway of Machu Picchu. The Temple of the Moon with its beautifully prepared double-jamb niches for ancestors is a major huaca. This area, which could have been reached by a not-yet-located trail from the Urubamba River, was an elegant entry to the steep steps leading to the summit of Huayna Picchu.

Machu Picchu is distinguished from the other royal estates in the Sacred Valley by its large plaza and by its many huacas (Reinhard 2007). Salazar (2004:41) counts some 30 “religious structures”, many being carved rocks. The density of huacas is high compared to Ollantaytambo, Pisac and Chinchero. A number of its huacas appear to be associated with astronomical sight-lines such as the Torreon (June solstice), Temple of the Condor (anti-zenith sunrise), and Intimachay (December solstice sunrise) (Dearborn and Schreiber 1986; Dearborn et al. 1987; Dearborn and White 1983; Westerman 2003). We can perhaps understand a little more about what a royal estate meant. It was a place for feasting and hunting, but in the case of Machu Picchu it was a place of great power wherein Pachacuti would have been surrounded by a remarkable cluster of huacas that drew upon the powers of earth, water, sun, and ancestors.

Figure 8: Main Gate of Machu Picchu framing Huayna Picchu (photo by the author).

Llactapata and Machu Picchu probably served as combined huaca sanctuary and pilgrimage center. Llactapata is reached by the narrow and dangerous trail that starts at the Draw Bridge and leads across the face of Machu Picchu Peak (Malville et al. 2004, 2006). Many features of the major structure at Llactapata duplicate the Coricancha of Cusco. Access to the Coricancha was extraordinarily limited and its ceremonies were clearly private. Because of the difficult and limited access to Llactapata, ceremonies at its temple were probably similarly private. A stone-lined channel leads from the double-jamb doorway toward Machu Picchu and the direction of June solstice sunrise. A 33 meter long ceremonial corridor may have been the setting for a procession toward the rising sun on June solstice (Malville et al. 2006). There are no carved huacas in Llactapata because there is no granite on that ridge. A major huaca, the River Intiwatana, which is associated with fountains, a tower, and two caves, lies between Llactapata and Machu Picchu and appears to tie the two places together.

Figure 9: Temple of the Moon. Northern entrance to Huayna Picchu with the largest double-jamb doorway at Machu Picchu (photo by the author).

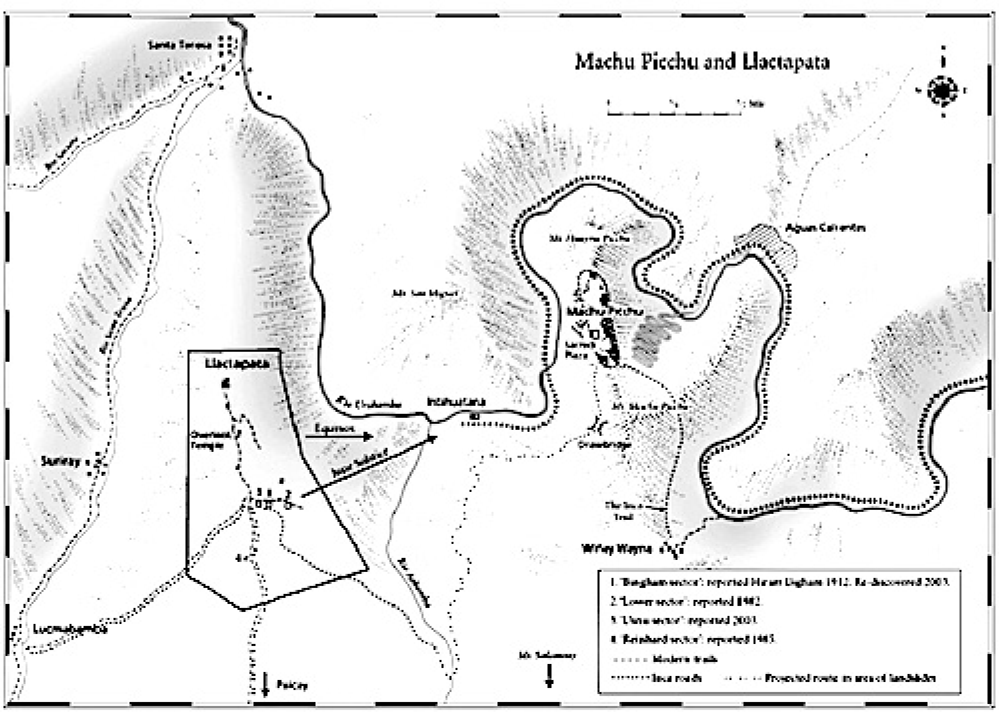


Figure 10. Llactapata and Machu Picchu.

Figure 11: River Intiwatana. The huaca that ties together Llactapata and Machu Picchu. Note the multiple scales of steps (photo by the author).

3d Tipon (Quespichancha): With its aqueducts, elaborate water channels, and multiple fountains, Tipon seems an excellent example of the action of camay. It was a place for pilgrimage during the Inti Raymi festival (Zuidema 1981). There are two areas of modern Tipon that might have been the destination of the pilgrimage, either the peak of Cruz Moqo or the vicinity of one of its thirteen terraces. The summit of Cruz Moqo is remote and lacks the features expected at a pilgrimage center such as a plaza, solar markers, storehouses, or residences for attendants. On the other hand, the buildings of Iglesia Raqui are adjacent to the largest of the terraces. From those buildings the sightline to June solstice sunset passes over the terrace and over the sacred rock and rooms of the Intiwatana some 350 meters away. The trail upward to the Intiwatana contains a double-jamb gateway. The major canal carrying water from Cruz Moqo was diverted in order to pass beneath the Intiwatana (Wright et al. 2006). Pilgrims could gather in the vicinity of Iglesia Raqui to observe rituals taking place in the large terrace below them and at the Intiwatana some 350 meters distant.

Figure 12: Intiwatana of Tipon (photo by S. Gullberg).

3e Urubamba (Quespiwanka): The courtyard of the palace of Huayna Capac, Quespiwanka, in the town of Urubamba, contains a large granite boulder in its center, after which the palace had been named (Farrington 1995; Niles 1999). From its vicinity the June solstice sun can be seen to rise between two pillars on the skyline high above the palace (Zawaski 2007, Malville et al. 2009). Today a stone-lined channel carries naturally flowing water into the vicinity of the boulder. The massive triple-jamb entrance to the courtyard indicates that only those of high status could participate in ceremonies held within it. The area outside the south wall of the palace contains 40 unusual double-jamb nice and granite boulders. This ceremonial area outside the palace compound may have been the location where lower status celebrants could observe the rising sun.

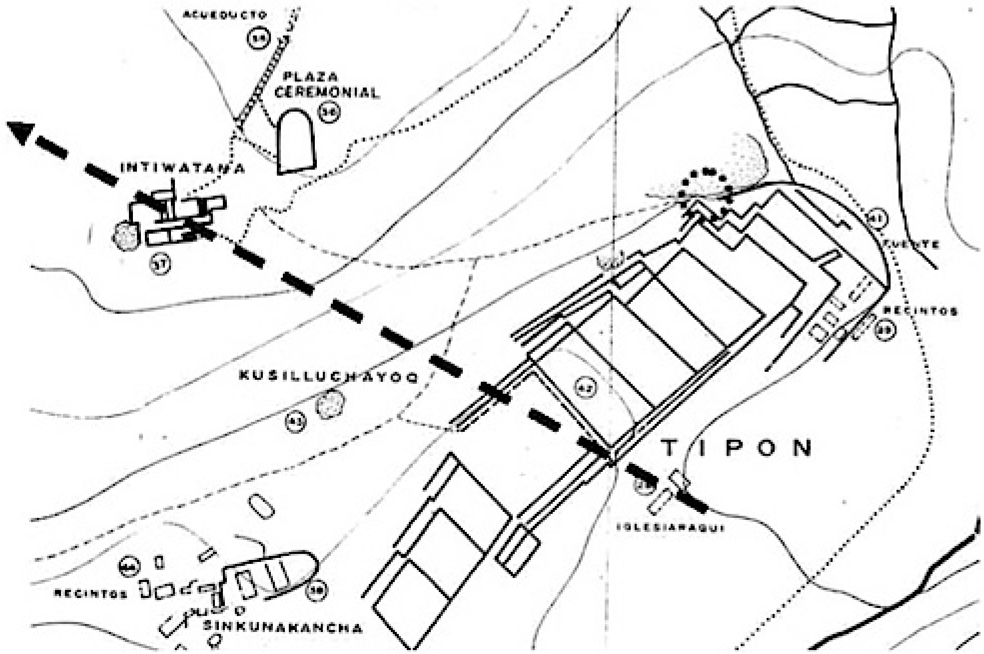
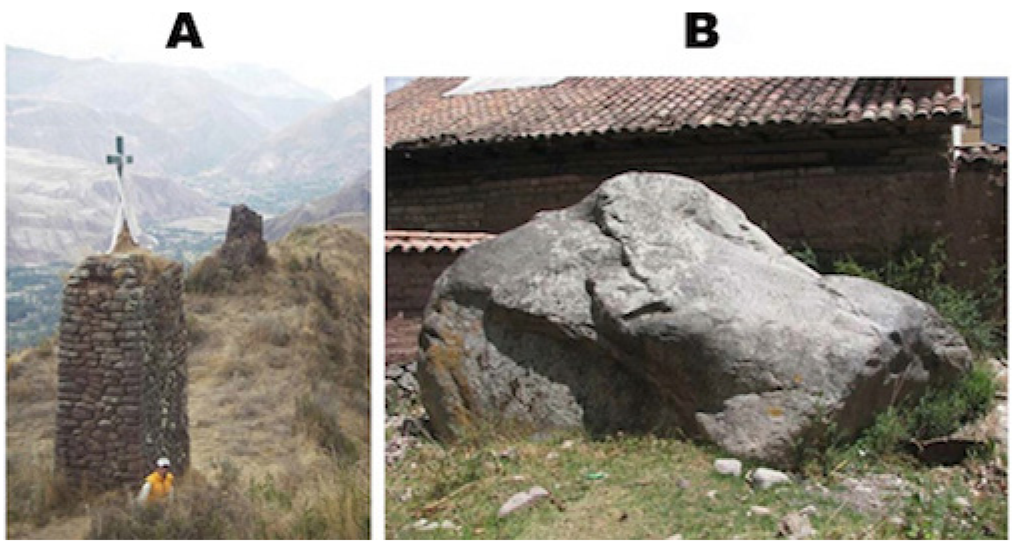


Figure 13: Tipon Showing the sightline from Iglesia Raqui to the June solstice sunset and the location of a double-jamb gateway (circle) (Adapted from Wright et al. 2006).



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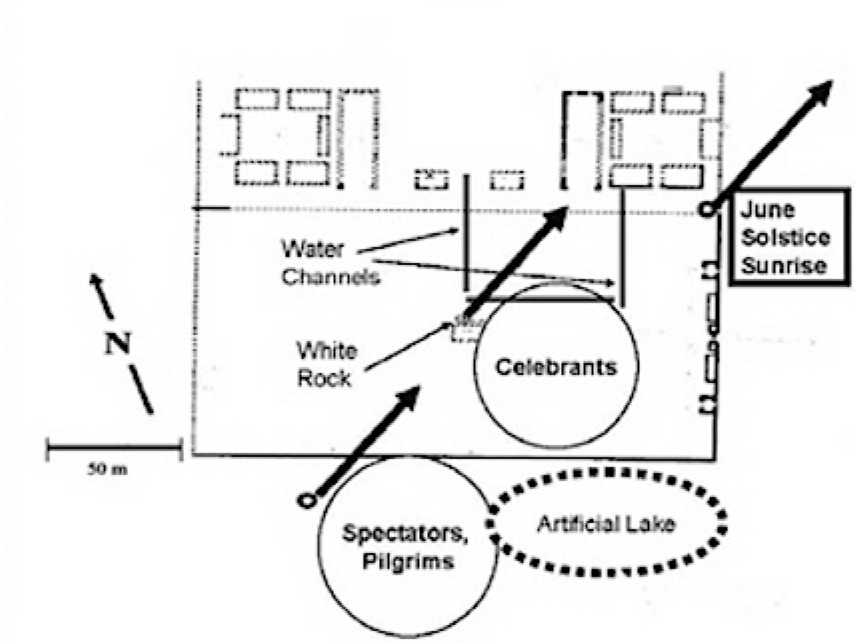

Figure 14. a. Sun Pillars above Urubamba (photo by M. Zawaski). b. Granite boulder of Quespiwanka (photo by the author); c Quespiwanka showing locations where June solstice sunrise between pillars can be viewed (Adapted from Niles 1999)

Figure 15: The massive southern wall of Quespiwanka with 40 double jamb niches and a shaped granite boulder in the foreground (photo by the author).

3f. Saihuite Known primarily for its Principal Stone, Saihuite is an elaborate and complex huaca sanctuary, which contains three carved stones, fountains, a double-jamb doorway, and a cardinally-oriented platform. A large niche faces June solstice sunrise. On the elaborately carved Principal Stone a network of grooves carries liquids past a myriad of figures (humans, pumas, llamas, frogs, monkeys, lizards). The stone may have been a representation of the Inca cosmos, which could be empowered by liquids flowing across it (Paternosto1989; Zawaski 2007).

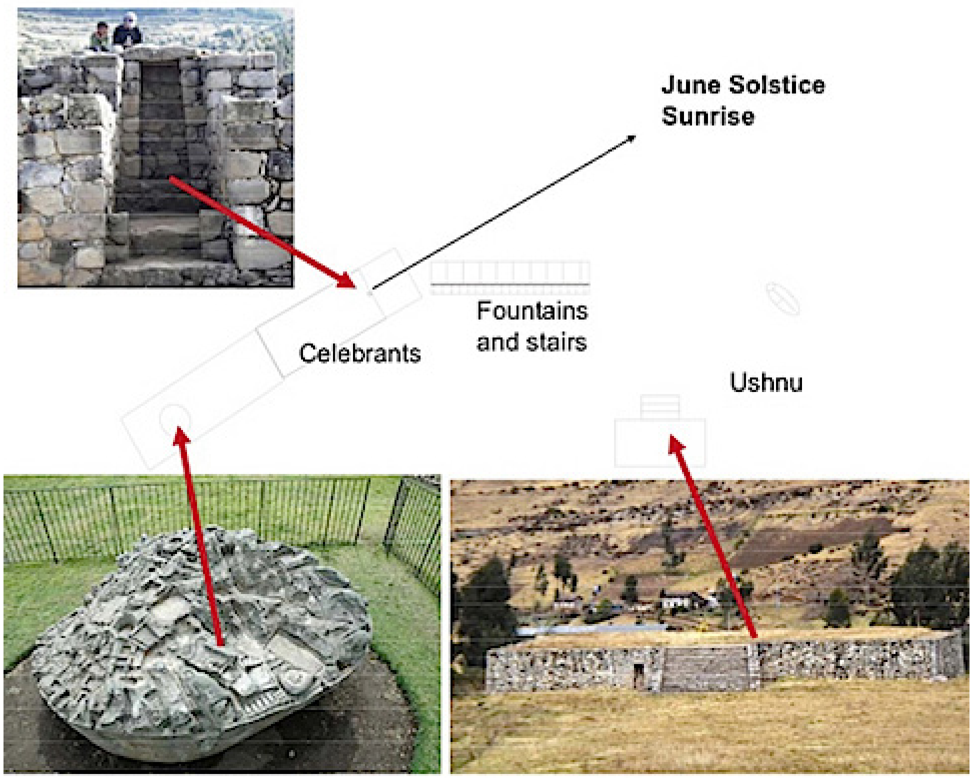

Figure 16. Saihuite (photos by M. Zawaski).

Figure 17: Rumihuasi at Saihuite. Note the fractal-like sets of stairs of different sizes (photo by S. Gullberg).

3g. Sondor. Located about 300 km from Cusco and 21 km from Andahuaylas, Sondor is the most impressive Inca site in the Andahuaylas region (Mendoza Bellido 2004). The conical hill of Apu Muyumuyu contains six terraces with a stairway leading to stone huacas on the summit. In order to reach the summit one must pass through two double-jamb gateways.

Sondor is the only astronomical huaca discussed in this paper without June solstice alignment or a major water feature. There are three clusters of buildings beneath the conical, terraced Apu Muyumuyu. The easternmost cluster of structures encloses a courtyard from which the rising sun at the day of zenith sun can be seen. Since the stairway is parallel to that sight-line to the rising zenith sun, it would appear that the zenith sun is the primary solar phenomenon of Sondor. As the sun rises in the sky the shadows of the terraces become shorter and disappear when the sun reaches the zenith making a dramatic visual spectacle.

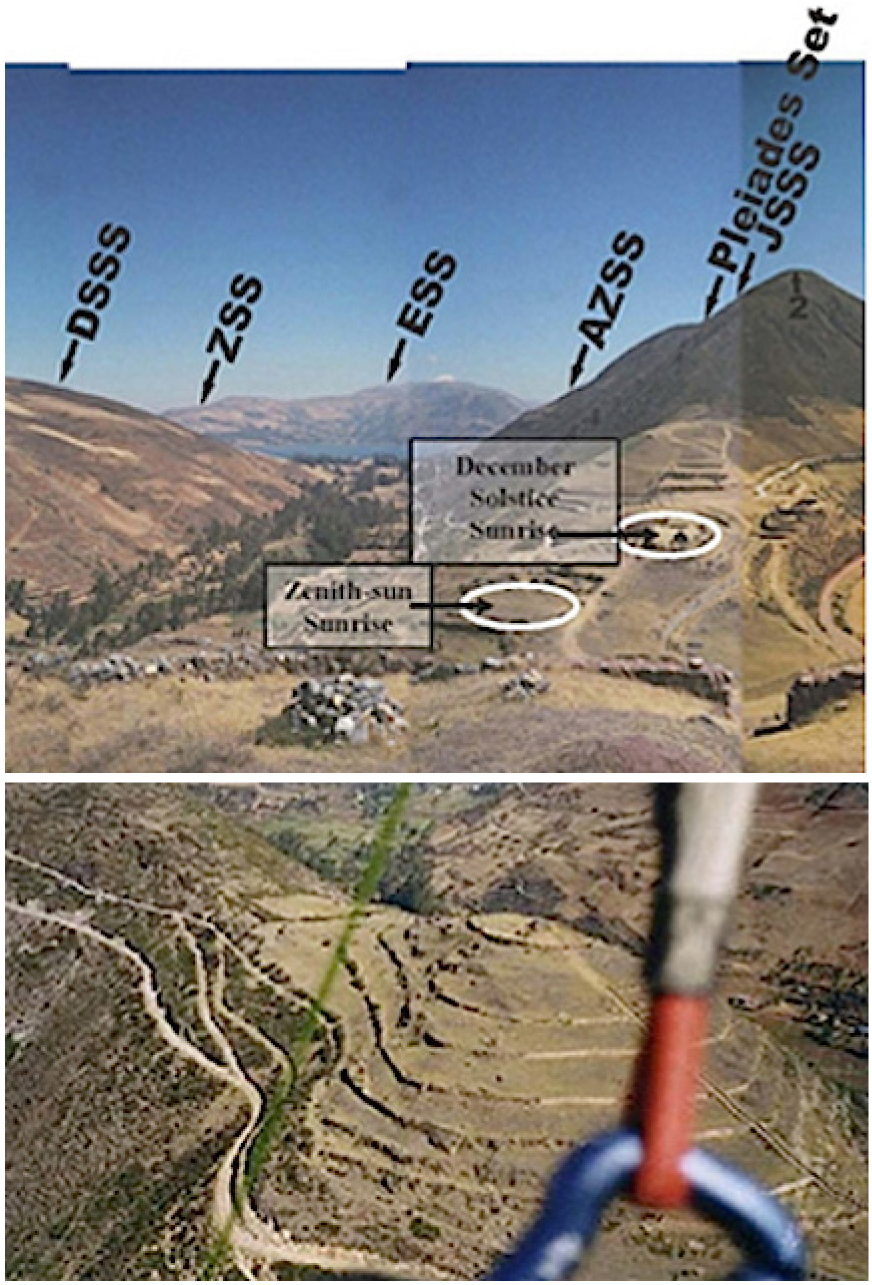

Figure 18. a. View from the summit of Apu Muyumuym. The locations where sunrise can be seen over the summit are indicated. Note that these involve December solstice sunrise and Zenith sunrise. Other sunrise positions on the horizon are shown (photo by M. Zawaski). b. Apu Muyumuyu from a hang glider (photo by G. Breitenbach).

Figure 19 Sondor: Stairway to the Zenith Sun. Note the double jamb doorway at the entrance to the stairway (photo by R. Hurvitz).

4. Summary and Conclusions

How should the new ontological paradigm in anthropology influence our interpretation of Inca astronomy? First, the meaning of these ceremonial centers is clearly enriched by consideration of possible alternate realities. Secondly, we should pay attention to the difference between epistemology and ontology in our analysis. Not only were huacas engaged in activities that were astronomical in an epistemological sense, but the presence of living huacas may have filled places like Machu Picchu and Cusco with special power. Some of the huacas may have been animated through the action of water and chicha. Others may have been animated by the light of the sun on June solstice. In the case of the Torreon, the northeastern window may not have been designed for an observer looking outward but for the sun to look in and touch the huaca.

In Table II the centers considered in this paper are ranked by the number of the attributes that are given in Table I. The Sanctuary of Isla del Sol and the Llactapata-Machu Picchu ceremonial complex contain the greatest depth of cosmic symbolism. It should come as no surprise that the Inca royalty and pilgrims would undertake arduous journeys to visit these powerful places.

Table II

13	Isla del Sol
13	Llactapata/Machu Picchu
10	Tipon
10	Quespiwanka, Urubamba
8	Cusco
8	Saihuite
6	Sondor

Acknowledgements: I am grateful to Carlos Aranibar, Gary Ziegler, Amy Finger, Hugh Thomson, Mike Zawaski, Steve Gullberg, Nancy Malville, and Susan Ellwood for their many contributions to this work. I thank Gerd Breitenback for paragliding with his camera over Sondor.

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13. Inca Solar Orientations in Southeastern Peru

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Abstract

The Incas venerated many features of both natural and man-made landscapes that they felt to possess supernatural powers. In Quechua these shrines were known as huacas, and soon after conquering the Inca Empire the Spaniards began a campaign against indigenous religion that included a systematic eradication of such shrines. Those that were large carved stones and outcroppings survived, however, and form part of this study. Many were found to have astronomical meaning, marking events such as the solstices and equinoxes.

1. INTRODUCTION

The Incas practiced solar worship and considered their emperor to be the sun's direct descendant, "the son of the sun." As such, evidence of astronomical veneration should abound and this study searched for solar orientation in features found at 29 sites surrounding Cusco, within the nearby Sacred Valley, and in the area between Machu Picchu and Llactapata (Figures 1 and 2). The sites selected were taken from those presented by Bauer (1998), Hemming and Ranney (1982), Gasparini and Margolies (1980), and Malville (personal communication).

Many features of the Andean landscape were worshiped by the Incas as they felt them to be endowed with supernatural powers. Cobo (1990 [1653]: 44-45) stated that the Incas venerated large trees, roots, springs, rivers, lakes, hills and mountains. He continued "They also did reverence to these places and made offerings," and that they worshipped anything natural that was perceptibly different. "All of these idols were worshipped for their own sake, and these simple people never thought to search or use their imaginations in order to find what such idols represented." These shrines were called huacas and were systematically worshipped and cared for and were integral parts of Inca religion and culture. They often were shrines to ancestors who, it was believed, could influence the living. The most powerful huacas required maintenance, care-taking, and offerings. Salomon and Urioste (1991: 17) state that "a huaca was any material thing that manifested the superhuman: a mountain peak, a spring, a union of streams, a rock outcrop, an ancient ruin, a twinned cob of maize, a tree split by lightning." Twenty-three of the sites studied were either carved rock huacas or sanctuaries that included carved or otherwise significant rocks. The remaining six sites were huacas or sanctuaries with structures, but lacked intrinsic rock shrines. These rock and non-rock huacas were categorized further as to whether or not they exhibited any potential astronomical orientation. Field research in the Region Surrounding Cusco included huacas at 19 locations, seven sites were in the region of the Sacred Valley, and the remaining three sanctuaries were related to Machu Picchu (Figure 2).

Figure 1. Peru and Cusco (modified from Zuidema, 2008).

Many facets of Inca astronomy were examined. Photographic evidence of light and shadow effects was recorded and solar orientations were cataloged. Research considered astronomical sightlines and/or light and shadow effects at times of the solstices, equinoxes, and zenith and anti-zenith (nadir) suns. Zenith passage occurs within the tropics on the two annual dates when the sun is directly overhead and vertical objects cast no shadows. The anti-zenith, or nadir, occurs on the two dates when the sun is directly beneath the observer on the opposite side of the world. This cannot be viewed directly, but Zuidema (1981b) describes Inca marking of the anti-zenith as taking place with a solar horizon observation when the sun sets 180° from the position where the sun rose on the day of zenith passage.

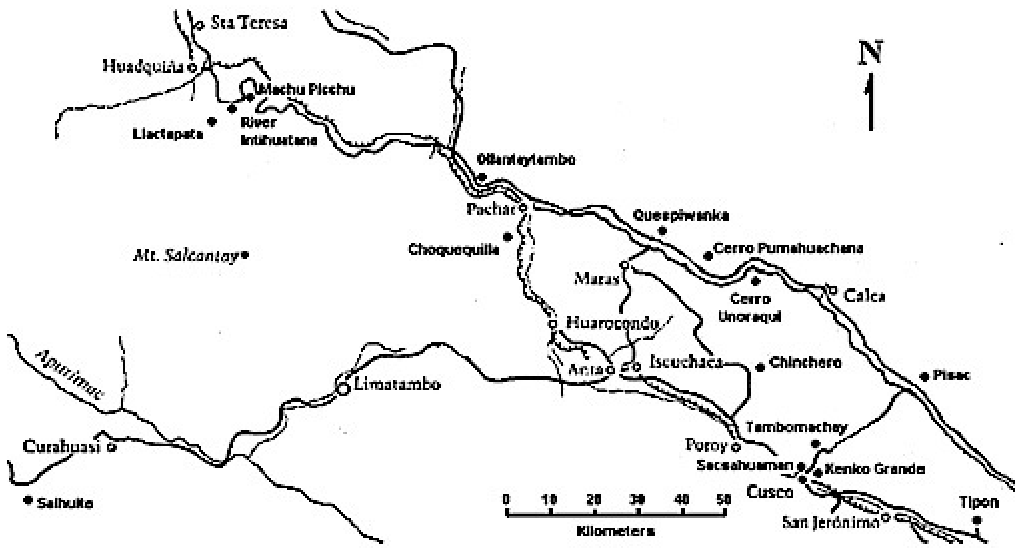

Figure 2. Locations of the research sites listed in Tables 1, 2, and 3. The remaining sites in the Region Surrounding Cusco that are not depicted here due to scale are located near Cusco (lower right) on its northern through eastern sides (modified from Hemming and Ranney, 1982).

2. METHODS

The solar horizon orientations of azimuth and elevation were measured by using a sighting compass and supplemented where necessary with a surveyor's transit. GPS coordinates of latitude, longitude and altitude above sea level were recorded at all locations for subsequent trigonometric comparisons. Orientations of features for sunrise or sunset at significant times of the year were documented. Specific locations of sunrises on mountainous horizons were accounted for with spherical trigonometry. Light and shadow effects at the huacas were recorded by digital imagery.

Huacas were first classified by region and then divided into two groups – those that were or included rock shrines and those that didn't (Tables 1, 2, and 3). Further division regarded astronomical orientations, or lack thereof. For the purposes of this study a huaca was considered astronomical if it, or an element of it, was found to have a solar light and shadow effect or orientation(s) related in any way to the sun. If an orientation was found to exist and was available for potential use it was included. This was the case with certain east-west alignments that might have been used at the time of the equinoxes, even though it remains to be proven that the Incas were concerned with horizon positions of the sun on those days.

Table 1. Huaca Classifications for the Region Surrounding Cusco.

Huaca	Astronomical Rock	Astronomical Non-Rock	Non-Astronomical Rock
Kenko Grande	X		
Kenko Chico	X		
Mesa Redonda			X
Tetecaca			X
Patallacta			X
Kusilluchayoc	X		
Lacco	X		
Solar Horizons	X		
Lanlakuyok	X		
Puca Pucara		X	
Tambomachay	X		
Sacsahuaman		X	
Mollaguanca	X		
Sapatiana			X
Rumiwasi Bajo		X	
Rumiwasi Alto		X	
Kusicallanca		X	
Tipon	X		
Saihuite	X		

3. RESULTS

Solar orientations were found to be common in the huacas of this study. Of the 29 shrines examined 23 were found to fit at least one of the specified criteria. Sixteen of the sites included ceremonial rocks with solar orientations and seven more had structures oriented with the solar horizon. The sixteen sites that include rocks with solar horizon orientations are categorized as "Astronomical Rock." The remaining sites displaying celestial alignments were placed in the "Astronomical Non-Rock" category. Five sites with boulders displayed no evidence of solar orientations and were categorized as "Non-Astronomical Rock." These mainly were huacas among those in the study closest to Cusco and likely served purposes independent of the sun. One site without a rock or specific solar alignment was placed in the "Non- Astronomical Non-Rock" category. The existence of astronomical orientations at 79% of the sites studied supports that many Inca huacas were associated with solar observation and ceremony. If equinoxes are discounted then this figure lowers to 72%. Percentages are shown graphically in Figure 3.

Table 2. Huaca Classifications for the Sacred Valley Region.

Huaca	Astronomical Rock	Astronomical Non-Rock	Non-Astronomical Rock	Non-Astronomical Non-Rock
Chinchero	X			
Pisac	X			
Quespiwanka	X			
Cerro Pumahuachana				X
Cerro Unoraqui			X	
Choquequilla	X			
Ollantaytambo	X			

Statistics regarding the specific types of solar events observed at the individual huacas are of particular interest. Nineteen of the solar huacas were found to exhibit orientations for the solstices and nine displayed specific effects of light and shadow. Seven had east and/or west orientations that potentially included the equinoxes and five had zenith or anti-zenith (nadir) orientations (Tables 4, 5, and 6). Ten of the sixteen astronomical rock huacas had orientations for the June solstice sunrise, six for the June solstice sunset, nine for the December solstice sunrise and four for the December solstice sunset. Five had east orientations with possible utility at an equinox sunrise and three had west orientations with similar potential for an equinox sunset. There were three instances of zenith sun orientations and one anti-zenith (nadir) orientation.

The number of examples for June and December solstice is fairly even, somewhat unexpected since the solstice in December is in the rainy season when observations of the horizon on specific days would be expected to be far less reliable. There is a marked difference between the numbers of orientations for solstice sunrises in both seasons when compared to those for the associated sunsets. The data implies a much greater ceremonial interest in the rising sun.

Table 3. Huaca Classifications for the Machu Picchu Region.

Huaca	Astronomical Rock	Astronomical Non-Rock
Machu Picchu	X	
River Intihuatana		X
Llactapata		X

Two of the seven astronomical non-rock huacas had June solstice sunrise orientations, none for the June solstice sunset, three for the December solstice sunrise and none for the December solstice sunset. Of the 23 huacas with any astronomical association 22 held at least one orientation for one of the six primary solar horizon events of sunrise and sunset at June solstice, December solstice and the equinoxes. If the equinoxes are removed then this number of huacas becomes 19. There were a total of five possible examples of zenith sun alignments and two instances of potential alignments related to the anti-zenith (nadir) sun. June solstice sunrise orientations were noted 19 times in all (including multiple instances at the same site), June solstice sunset 7 times, December solstice sunrise 12 times, December solstice sunset 8 times, east/equinox sunrise 10 times and west/equinox sunset 9 times.

Ninety-six percent of solar huacas appear to have incorporated direct observation of horizon events when both solstices and equinoxes are included, and 83% when the equinoxes are not.

Percentages for each solar feature per huaca category are given in Figure 3. By definition all shrines in the Astronomical Rock Huaca category had at least one orientation for a solar horizon event. Solstice sunrises played a prominent role in certain annual Inca festivals, and orientations for sunrises on the June and December solstices were found to be the most common. Astronomical Rock Huacas led or tied in all but the zenith and anti-zenith categories when compared with the Astronomical Non-Rock category. This reversal, in part, is due to the nature of the Astronomical Non-Rock sites (Tables 1 and 3) where astronomically aligned features were constructed rather than carved into rock. The overall lesser occurrence of zenith-related orientations makes this difference less statistically significant, but would seem to imply that such observations may have been less common in the more highly represented rural areas of this study, although they were reported to have been of significant interest within the limits of Cusco (Zuidema, 1981b). Clear sightlines outside the city facilitated solar horizon observations, while vertical zenith observations could readily have been performed among urban structures.

Table 4. Huaca Astronomical Orientations in the Region Surrounding Cusco. Legend: JSSR–June Solstice Sunrise DSSR–December Solstice Sunrise ESR–Equinox Sunrise

Huaca	JSSR	JSSS	DSSR	DSSS	East/ESR	West/ESS	Zenith	Anti-Zenith
Kenko Grande	X		X		X	X		
Kenko Chico			X					
Mesa Redonda								
Tetecaca								
Patallacta								
Kusilluchayoc		X						
Lacco	X						X	
Solar Horizons	X	X	X	X	X	X		
Lanlakuyok					X			
Puca Pucara					X	X		
Tambomachay			X					
Sacsahuaman							X	X
Mollaguanca	X			X				
Sapatiana								
Rumiwasi Bajo			X					
Rumiwasi Alto			X					
Kusicallanca			X					
Tipon		X						
Salhuite	X							

4. DISCUSSION

This section provides illustration and discussion of orientations found at several of the sites that were explored. Examples such as the "Eyes of the Puma" at Kenko Grande demonstrate a considerable knowledge of horizon astronomy and the degree of the creativity that the Incas were capable of in the development of their shrines. On the top of the outcrop they carved two cylinders that form the puma's eyes and then created a fissure in a nearby wall that allows light to fall upon those carved cylinders appropriately during the June solstice sunrise in a manner that completes the "puma" visual effect (Figure 4). The puma was one of three creatures most venerated in Inca cosmology - the condor being associated with the world above, the puma with this world, and the snake with the world below.

Table 5. Huaca Astronomical Orientations in the Sacred Valley Region. JSSS–June Solstice Sunset DSSS–December Solstice Sunset ESS–Equinox Sunset

Huaca	JSSR	JSSS	DSSR	DSSS	East/ESR	West/ESS	Zenith
Chinchero	X			X	X	X	
Pisac	X		X				
Quespiwanka	X	X	X				
Cerro Pumahuachana							
Cerro Unoraqui							
Choquequilla			X				
Ollantaytambo	X	X	X				X

Table 6. Huaca Astronomical Orientations in the Machu Picchu Region.

Huaca	JSSR	JSSS	DSSR	DSSS	East/ESR	West/ESS	Zenith	Anti-Zenith
Machu Picchu	X	X	X	X	X		X	X
River Intihuatana					X		X	
Llactapata	X							

The chamber within Kenko Grande exhibits traditional motifs such as niches and steps. The primary altar is finely carved and may have served in one or more types of ceremonial functions. The opening in the cave's upper northwest corner admits light that could have been reflected by gold plates in the niche below it to illuminate the entire chamber. During the time surrounding the June solstice it also facilitates an effect of light and shadow on the ceremonial steps beneath it that are adjacent to the primary altar (Figure 5).

Lacco's caves demonstrate the interest and ability the Incas had for solar orientation. Each of the three has altars that the Incas illuminated at certain times by the sun or moon. The Northeast Cave's altar is fully illuminated in the early morning on days approaching, during, and following the June solstice. On the horizon shown in Figure 6 the point of sunrise emerges from the right (east) and progresses daily toward the center. At the solar standstill (when the apparent travel of the sun stops near and on the day of the solstice), the alignment of the center of the cave opening with the sunrise is striking. The sun's rays fall directly upon the cave's altar and reflections brightly illuminate the rest of the chamber. The point of sunrise in the center of Figure 6 has reached its maximum extent to the left. After the solstice the movement of sunrise on the horizon reverses direction and proceeds back to the right.

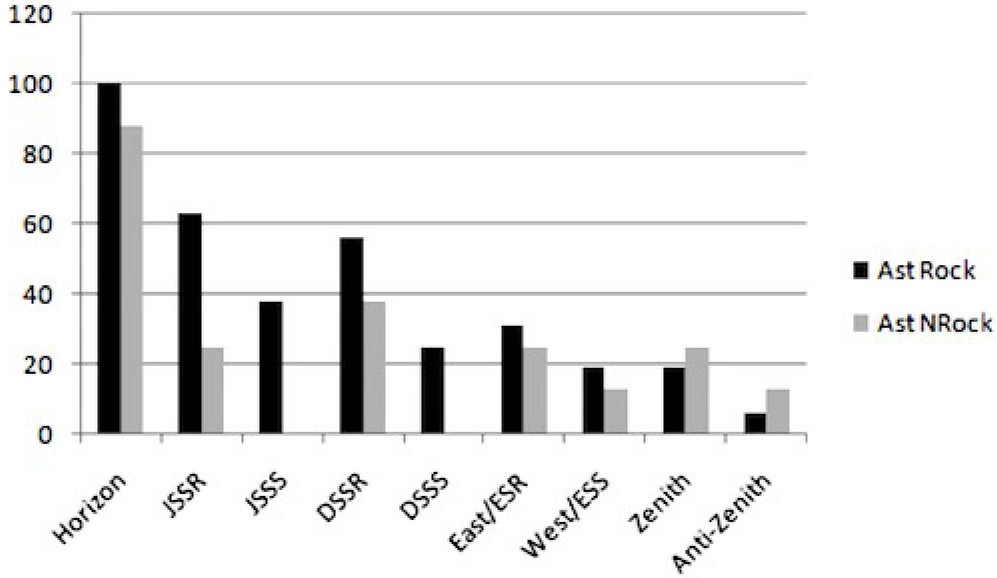

Figure 3. Percentages of Astronomical Orientations per Huaca Category. Legend: JSSR–June Solstice Sunrise DSSR–December Solstice Sunrise ESR–Equinox Sunrise

Figure 4. The "Eyes of the Puma" at Kenko Grande.

Figure 5. Kenko Grande’s internal ceremonial steps.

Figure 6. June solstice sunrise from Lacco's Northeast Cave.

The Southeast and Southwest Caves incorporate specifically oriented light-tubes to admit the rays of the sun or moon. The Southwest Cave is the smaller of the two and also has a smaller altar. Its light-tube's alignment with the path in the sky traveled by the sun and moon was shown on October 26, 2006 by the crescent moon displayed in Figure 7.

The Southeast Cave appears to have been the most prominent of the three as evidenced by the degree of workmanship in its sculpture, complete with fine carvings of a puma and snake near its entrance and the highly polished altar within its inner chamber. The altar is of an appropriate size and height for ceremony and sacrifice and is brilliantly illuminated by the sun near the time of zenith passage when it is overhead at 90° above the horizon (Figure 8).

Located between Kenko Grande and Lacco is a small huaca (Solar Horizons) with two carved circles that exhibit orientations for the horizon positions of solstice and equinox/east-west solar events (Figure 9). I first measured the east-west orientations of the circles and then recorded the additional orientations for the solstices. For reasons yet to be determined, watching sunrises and sunsets on days of the soltices and equinoxes appears to have been important here. The many seats carved upon the huaca underscore this relationship as there is at least one oriented for each of the associated solar risings or settings, with the exception of the June solstice sunset where that part of the outcrop has eroded extensively.

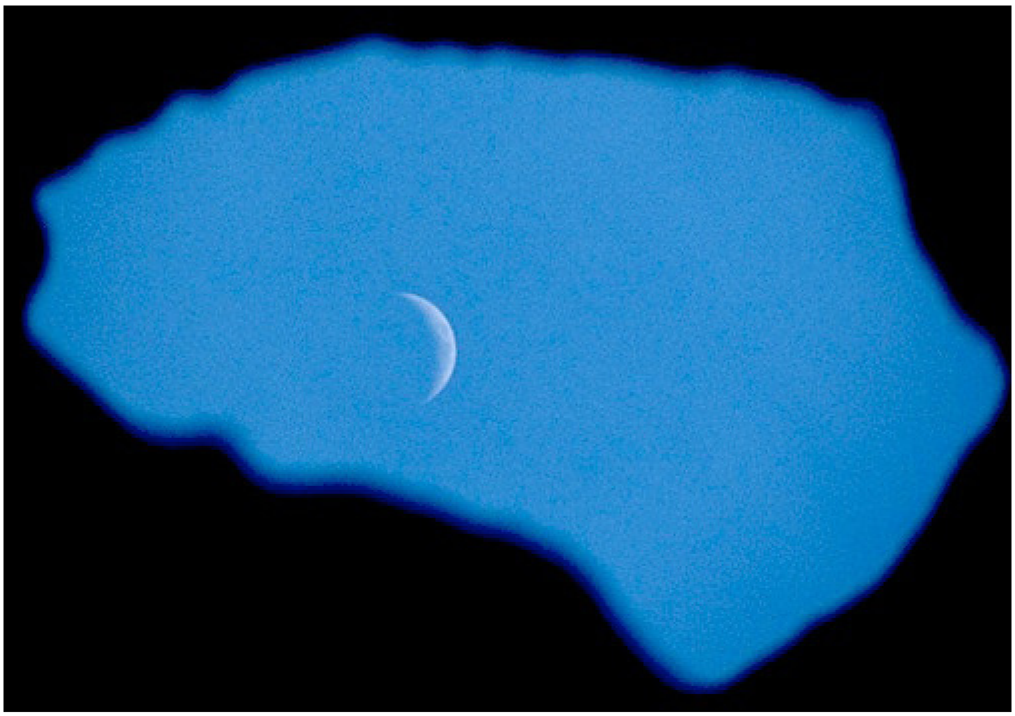

Figure 7. Crescent moon through light-tube of Lacco's Southwest Cave.

Figure 8. Illuminated altar in Lacco's Southeast Cave.

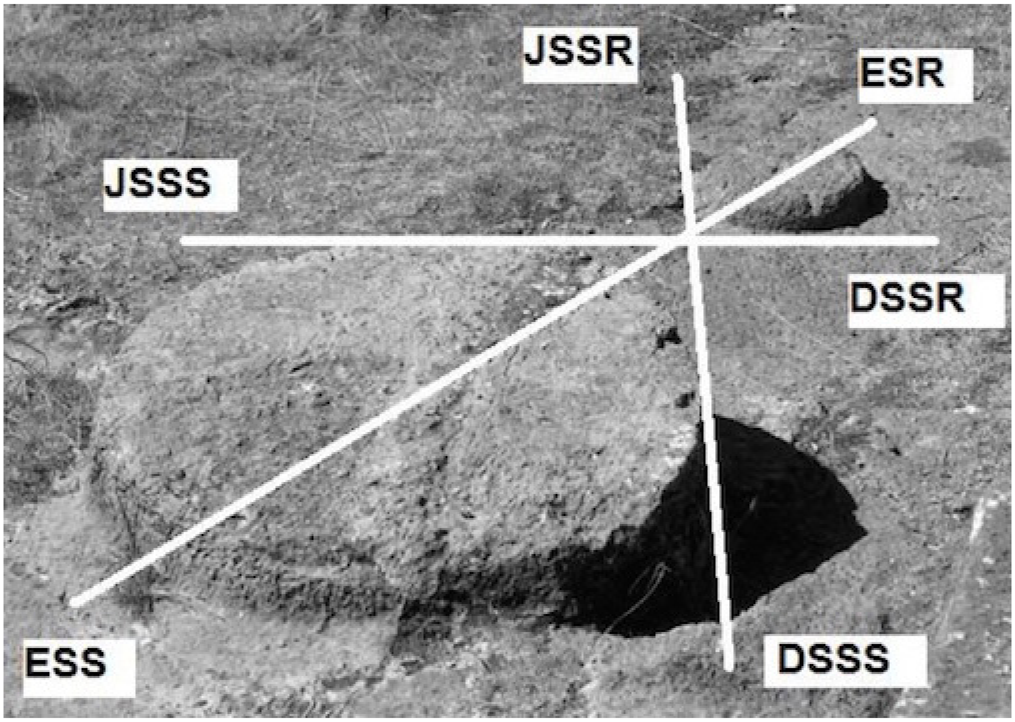

Figure 9. Orientations found at the huaca of Solar Horizons.

Spanish chroniclers recorded solar pillars on the horizons of Cusco but all were eradicated, presumably in the post-conquest Catholic purge of Inca idolatries. Their locations were recorded, but there are no extant remains in Cusco. Two pillars near the modern village of Urubamba lie above Huayna Capac's palace, Quespiwanka, give credibility to the Cusco reports, and enable direct study of this form of horizon astronomy (Figure 10). These towers on the Cerro Sayhua ridge demostrate the feasibility of this method for marking the June solstice sunrise when viewed from the vicinity of a granite boulder in the center of the palace courtyard. Their alignment supports Bauer's and Dearborn's 1995 hypothesis with regard to these pillars as well as Niles' (1999) suggestions regarding the prominence of the granite boulder and an adjacent platform, no longer extant, that she argues were central features of Huayna Capac's palace grounds. The utility of the boulder and platform as the focal point of the plaza is supported by this orientation and, to a lesser extent, by other potential alignments with natural horizon features for the December solstice sunrise and the June solstice sunset.

Figure 10. The pillars on Cerro Sayhua.

The ceques of Cusco served as a system of intangible lines to connect, organize, and facilitate the care for the many huacas that surrounded the city. Polo de Ondegardo (1965 [1571]) tells us that each Inca village had ceques connecting shrines and it appears possible that such an organizational system may have been established at Machu Picchu, smaller but similar to the one in Cusco. Within Machu Picchu the Sacred Plaza is part of an oriention for the June solstice sunrise and December solstice sunset and might possibly have formed one end of what could have been an intentional ceque that included Llactapata's Sun Temple and the River Intihuatana (Figure 11). An additional potential ceque is found in the alignment of Llactapata's Overlook Temple with the River Intihuatana and Mt. Machu Picchu. These alignments of huacas near Machu Picchu lend themselves in support of the concept that ceques existed away from Cusco and ultimately may serve to validate Polo de Ondegardo's claim.

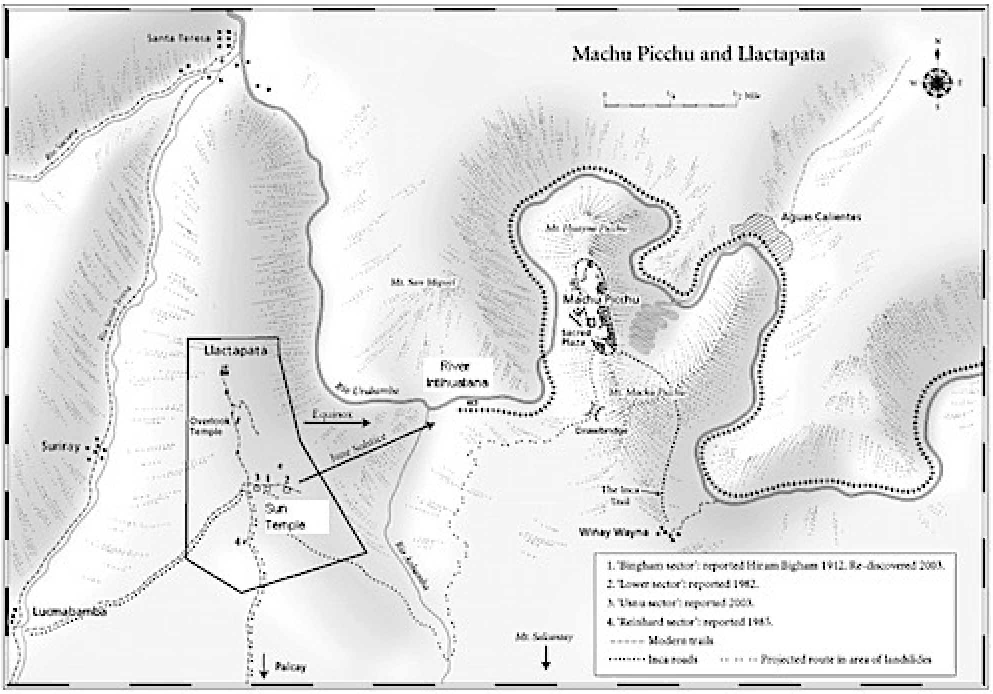

Figure 11. Machu Picchu, Llactapata, and the River Intihuatana (modified from Malville, Thomson, and Ziegler, 2006).

The 2003 rediscovery of Llactapata has given rise to many new questions regarding the overall extent, orientation, and function of the entire Machu Picchu ceremonial complex. Its many structures represent a significant enlargement of the overall estate and lend support to the possibility that a ceque system here organized huacas similarly to the one found in Cusco. The orientation of the stone-lined channel at the Sun Temple of Llactapata with the River Intihuatana and Machu Picchu's Sacred Plaza is impressive (Figure 12), especially so when viewed from Llactapata at sunrise on the time of the June solstice. An orientation with the first rise of the Pleiades star grouping after it emerges from passage behind the sun also exists from Llactapata's Sun Temple. Pleiades observations were a part of Inca predictions for crop success.

The River Intihuatana (Figure 13) may have played a much more significant role in the overall complex surrounding Machu Picchu than was previously thought. An intihuatana is said to have been a “hitching post of the sun,” or a place where the sun was ceremoniously tied to prevent it from disappearing as it grew progressively lower in the winter sky. This term, however, might be a more modern invention. The River Intihuatana provides a distinct link between the structures of Machu Picchu and Llactapata and serves as a part of two axes between them. In addition to lying in line with the Llactapata Sun Temple and Machu Picchu’s Sacred Plaza, the River Intihuatana also is part of an east-west/equinox alignment between Llactapata’s Overlook Temple and Mt. Machu Picchu. These orientations emphasize the potential significance of the River Intihuatana as it is positioned at the junction of these two prominent axes. The locations of Llactapata’s Sun Temple and Overlook Temple may have been specifically selected to form these alignments.

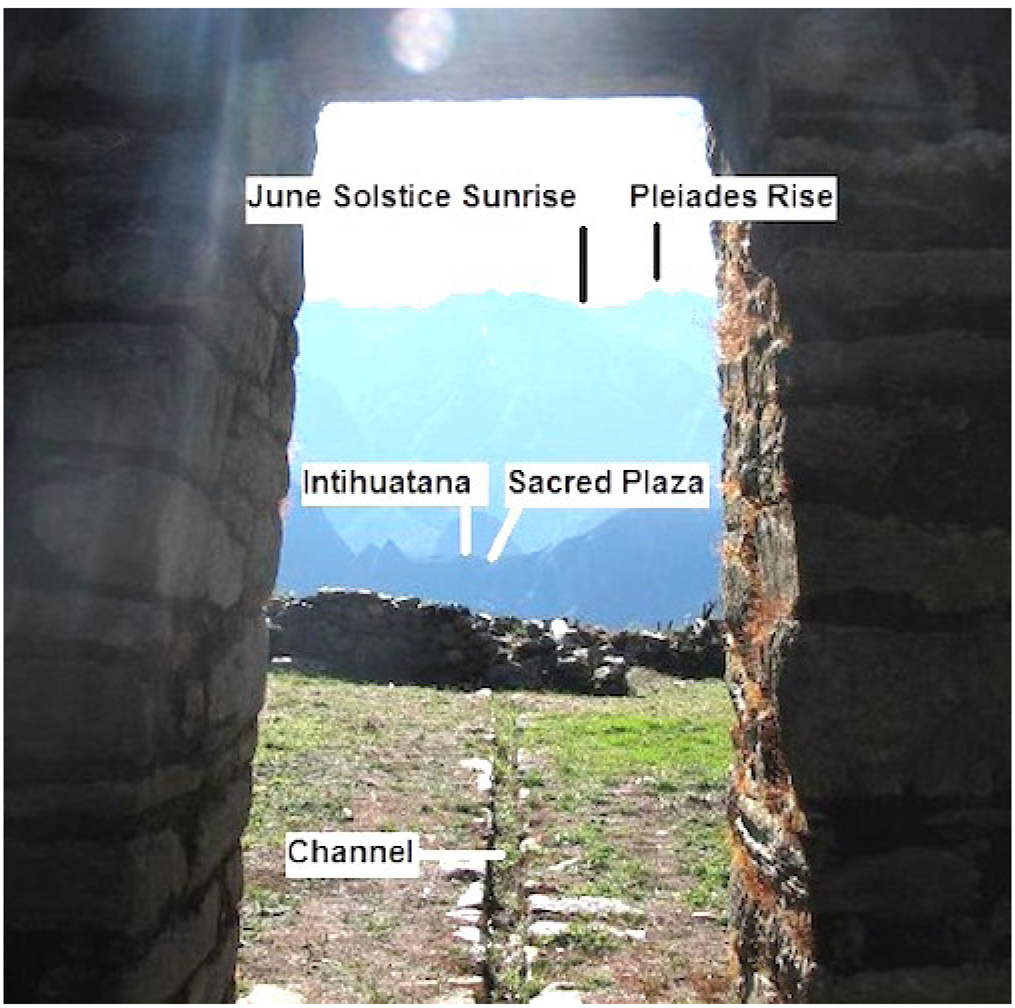

Figure 12. Alignment from Llactapata's Sun Temple to the Machu Picchu Sacred Plaza.

Figure 13. The River Intihuatana

5. Concluding Remarks

The Incas were practitioners of solar worship and, as such, a logical assumption is that they might have designed many of their important buildings and shrines with features related to their veneration of the sun. This study set out to find evidence of solar orientations and/or effects of light and shadow at 29 sites in southeastern Peru. Overall 23 of these sites, or 79 %, were found to have at least one astronomical orientation. Features aligned for the solstice sunrises were found to be more common than the rest and slightly more of them were associated with the June solstice than were those for the solstice in December. The solstice sunsets were also notable, but of somewhat lesser relative interest. Also found were east-west orientations and as well some related to the zenith and anti-zenith suns.

The hypothesis of this study was therefore supported. As shown by the many examples identified in the research, a picture emerges of a culture interwoven with cosmology and astronomy. The Incas possessed celestial knowledge and as solar worshippers they chose to incorporate orientations and effects related to the sun, their god, in many of their temples and shrines. The huacas of this study point to a society that was both devoted to the sun and that possessed the technical ability to use their celestial knowledge in the design of any structure or carving.

Acknowledgements: The assistance of Kim Malville was indispensible, as were the suggestions of Tom Zuidema, Ken Wright, and Bernard Bell. Carlos Aranibar provided excellent support in the field and I am greatly indebted to Mike Zawaski who assisted the project with both insight and theodolite measurements. Jessica Gullberg, Steven Gullberg II, Gregory Gullberg, and Jesus Villafuerte also contributed to the fieldwork.

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14. Cosmic Cycles of Hindu Cosmology: Scientific Underpinnings and Implications

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Abstract

Ancient Hindu Texts indicate that cosmic processes are driven by two cycles: a Primary cycle possibly some 311 trillion years long that begins with the formation of the universe and ends with its dissolution and regeneration for a new cycle; and a Secondary cycle of 8.64 + 0.12 billion (Gy) years that begins with the formation of an Earth-like planet that supports life, or by extension the formation of a Solar system, its demise, and its rebirth. Using the history of the secondary cycles described in the Texts we deduce: 1) that our universe is at least, but not much older than 13.2 + 0.15 Gy, in excellent agreement with current scientific data; 2) that primeval planets formed within less than a billion years of the beginnings of the universe, in agreement with the observations of NASA's Hubble Space Telescope; and 3) show that the Texts predict the demise of the Earth in the next 4.2 Gy and describe the nature and sequence of events leading to its incineration that are remarkably similar to those inferred from current models of Solar evolution. The Secondary cycle and its history implies: 1) that our Solar System is the successor to a primeval parent that formed < 0.7 Gy after the dawn of the universe; 2) that the Solar system has the capacity to essentially replicate itself approximately every 8.64 Gy; and 3) that human life may have existed on an Earth-like planet about 8.7 Gy ago. These results and implications, covering 18 Gy from the inception of the universe to the demise of the Earth, are independent of any and all scientific theories and religious speculation concerning the origins of the universe or how stars and planets formed; nor do they rest upon any uncertain interpretations of the Texts. Therefore, the cosmic cycles of Hindu cosmology (HC) are not products of fanciful imagination of ancient Hindus, but most probably have scientific underpinnings. The cyclic universe of HC fits well with the Cyclic Model of Steinhardt and Turok (2002, 2004); and the Sun's capacity to replicate itself/planets can be explained in terms of the Solar Nebular Model and the evolution of the Sun through the red giant phase.

1. INTRODUCTION

The late astrophysicist Carl Sagan (1980) noted that "the Hindu religion is the only one of the world's great faiths dedicated to the idea that the Cosmos itself undergoes an immense, indeed an infinite, number of births and deaths. It is the only religion in which the time cycles correspond, no doubt by accident, to those of modern scientific cosmology. Its cycles run from our ordinary day and night to a day and night of Brahma, 8.64 billion years long, longer than the age of the Earth or the Sun and about half the time since the Big Bang. And there are much longer time scales still."

Despite the intriguing correspondence noted by Carl Sagan, there have been scant attempts to elicit or discover a plausible scientific basis for the cosmic cycles. This absence is all the more surprising because the cosmic time scales involved are not religious beliefs that must be accepted on faith, but appear to be deductions subject to scrutiny and to the rigors of rational analysis. Two factors may account for such an absence. First, as discussed later, untenable interpretations of segments of ancient Hindu Texts have led to erroneous assertions that the universe is trillions of years old, and thus in conflict with the prevalent scientific view. Confusion caused by such careless misrepresentations may have thwarted efforts to find a scientific basis. Second, the Hindu Texts invoke non-material elements and metaphysics, subject to uncertain interpretations, in explaining the creation of the universe. Therefore, attempts to discover scientific bases that begin with creation as a starting point immediately run into difficulties and ambiguities.

This paper overcomes these hurdles by: 1) separating the core tenets of Hindu cosmology (HC) that are beyond reproach from the more tenuous or speculative interpretations; 2) debunking the erroneous assertions that have somehow crept into the literature; 3) focusing first on those parts of the HC that deal with material processes and comparing their descriptions and any deductions drawn thereupon with scientific evidence and data; 4) evaluating the tenets of HC in the context of modern scientific theories only after the first three steps have been completed. Thus, we shall clearly separate inferences, deductions, or implications drawn from HC and their comparisons with scientific data, observations, or computations of Solar evolutionary models from subsequent discussions of scientific theories that might account for the cycles of Hindu cosmology. It is, however, not the purpose of this paper to debate/test the weaknesses and strengths of competing cosmological theories or models of planet formation; nor should the results of this paper be construed to support or oppose a particular model or hypothesis.

2. Principle Tenets of Hindu Cosmology

2.1. Sources and Methodology The tenets of HC including the creation of the universe, the destruction of the Earth, and the cyclic nature of these processes are described at times in rather great details in the Vishnu Purana (VP) and more succinctly in the Bhagvata Purana. Manusmriti, or the Institutes of Hindu Law, another post- Vedic Hindu Text, also contains details concerning the beginnings of the universe. In judging the importance and credibility of revelations contained therein we weigh them using considerations of internal consistency, consistency across multiple Texts, consistency with scientific data, their relative ages (older the better), and by giving greater weight to literal than to broad translations. Moreover, we have deliberately stayed away from allegories and popularizations of revelations into stories and have stuck to those portions of the Texts that directly speak to the events of interest.

The VP and BP are part of an ensemble of 18 post-Vedic Texts collectively denominated as Puranas, or literally "of ancient times" in Sanskrit. The Puranas are a vast literature of stories and allegory pertaining to Hindu cosmology, history, geography, and genealogies of kings (Krishnananda, 1994), and not religion per se that requires adherence or blind faith. Not all Puranas were, however, created equal or written at the same time. The VP and the BP are the finest (Krishnaananda, 1994). Of the two, VP is considered to be among the oldest dating back to the first century B.C. for its written form and many centuries older in its oral form (Wilson, 1840). Hence, we have used the VP as the primary and the BP as a secondary source, followed by the Manusmriti and other scriptures such as the Bhagavad-Gita when deemed necessary. Collectively these sources are referred to as Texts.

The Puranas are rather lengthy, but much of what follows is contained in the first few chapters of Books 1 & 6 of VP translated by HH Wilson (1840), the first few chapters of Canto 12 of BP translated by Swami Prabhupada (1962), and the first chapter of Manusmriti or the Institutes of Hindu Law translated by Sir William Jones (1796).

2.2. Cosmic Time Scales and Cycles Just as modern astrophysicists concocted notions of astronomical unit and light year to measure large distances, Hindu Rishis conjured up notions of divine year, Brahma's day, or Brahma's life to measure long spans of time. The basic unit of time in HC can be considered to be a Maha Yug (Great Age) comprising 12,000 divine years that correspond to the combined span of four unequal human ages or Yugs. A day of Brahma is equal to 1000 Maha Yugs, his night is equally long, and his life is apparently equal to 100 years of such days and nights. Each divine year is equal to 360 human or solar years. Therefore, a Maha Yug is 4.32 million years; Brahma's day or night is 4.32 Gy, and his life span about 311 trillion years long (see, e.g. Wilson, 1840; Kak, 2010). Brahma's day or night is also known as a Kalpa (aeon), and the two-combined together form a period of 8.64 Gy or two Kalpas. There is some uncertainty as to the length of Brahma's life and is discussed later. Additionally, we note that if the number of days in a divine year were taken to be 365 (solar year) instead of 360 used in HC, Brahma's day or night would be longer by 0.06 Gy and Brahma's cycle by 0.12 Gy.

The VP describes two kinds of creations - primary and secondary - and associated dissolutions - elemental, and incidental (Wilson, 1840; Bk 1, Ch, 2; Bk 6, Ch. III). Synthesizing the descriptions contained therein with those of similar nature in the BP, one discerns two distinct cycles. The time span from the beginning of primary creation to the elemental dissolution corresponds to the life of Brahma and pertains to the creation and dissolution of the universe. This time span is apparently some 311 trillion years long and the associated cycle is denoted here as Vishnu's cycle. Creation in HC, however, is not an event or point in time but an evolutionary process that takes time. In fact, the principle of evolution in all its aspects, whether affecting life or matter, is firmly embedded in the descriptions of the material and life processes (e.g. Wilson, 1840). Similarly, elemental dissolution is not a destructive event but a process of reversion and regeneration that begins when the universe is exhausted and the conditions required to support life cease to exist. In this reversion and regeneration the creative (forward) process reverses direction and the remaining elements fold back into the original state and are recreated; thus completing the cycle and setting the stage for a new cycle of evolution. This cycle of creation and dissolution continues unabated for eternity. Time, therefore, in HC is eternal, without a beginning and its end is not known (e.g. Wilson, 1840, Ch. II), but finite when measured for example from the beginning of the present cycle.

The time span from the beginning of the secondary creation to the completion of incidental dissolution corresponds to the day and night of Brahma and pertains to the creation and destruction of Earth and life on it and the emergence of a new Earth-like planet (earth). This time span is 8.64 + 0.12 Gy long and the associated cycle is termed here as Brahma's cycle. During the first half of Brahma's cycle (Brahma's day) life evolves and flourishes on the Earth. During the second half (Brahma's night) degradation ensues ending with the incineration of the Earth and birth of a new earth. The current Brahma's cycle began with the formation of the Earth. And since the Earth and Sun, indeed the Solar system, are known to be essentially coeval, and since an Earth-like planet supporting life cannot exist without a Sun, it is apparent that Brahma's cycle does not pertain solely to Earth but also to the Sun and Solar system. The Texts suggest that there is a short time lag between the onset of Vishnu's cycle or the beginnings of the universe and the commencement of the very first Brahma's cycle or the formation of the first Earth capable of supporting life. The exact time lag, however, is not specified, but results from the fact that evolution is a process and not an event. Brahma's cycles continue apparently for trillions of years until the universe is exhausted and can no longer support life. The process of creation then reverses direction and dissolution begins and the universe folds back towards the stage from where it began, completing the Primary or Vishnu's cycle (Wilson, 1840, Bk. 6, Ch. IV).

2.3. Age of the Universe and Primeval Planets The Texts do not explicitly state the age of the universe, but it can be deduced rather precisely from the history of past Kalpas described in the Texts. Note, as stated earlier, two Kalpas each 4.32 + 0.06 Gy long constitute a Brahma's cycle and that the cycle begins with the birth of an earth. We know rather precisely from radiometric data that the oldest rock minerals on Earth are about 4.4 Gy old (Wilde, 2001) and that the oldest Solar System material is about 4.57 Gy old (Amelin, 2002). For simplicity, we shall adopt for all subsequent calculations the mean value of 4.48 + 0.1 Gy for the common age of the Earth and Sun and the beginning of the current Brahma's cycle.

The current Kalpa that began with the formation of Earth is called Vraha in VP, BP and in BP and other Puranas. In addition, VP names a Maha or Great Kalpa called Padma that preceded Vraha (Wilson 1840; Bk. 1, Ch. III, page 15); whereas the BP identifies two Kalpas - Brahma and Padma - preceding Vraha (Prabhupada, 1962; S.B. 3.11. 34 -37). Analogizing with the fact that a Maha (Great) Yug is the sum of constituent Yugs, it appears that a Maha (Great) Kalpa is the sum of two constituent Kalpas that form a Brahma's cycle. Therefore, Padma, the Maha or Great Kalpa, named in VP is apparently the sum of the constituent Kalpas - Brahma and Padma - mentioned in BP. About thirty additional Kalpas are named in the Linga and similar Puranas belonging to a group of Puranas considered to be the least reliable among the 18 Puranas. Wilson summarily dismisses such claims of additional Kalpas as clear sectarian embellishments, and notes that the only Kalpas usually specified in the Puranas are Vraha, the current one; Padma, the one preceding Vraha; and Brahma preceding Padma and considered by BP to be the very first one of Brahma's life (Wilson, 1840; Foot Notes 25:9, Ch. III, page 26).

Thus, we may confidently conclude that two and only two Kalpas or one Brahma's cycle has preceded the current one. Adding the length of time (8.64 + 0.12 Gy) for the past cycle to the time expired (4.48 + 0.1 Gy) since the beginning of the current cycle, we obtain a value of 13.12 + 0.22 / - 0.1 Gy, or about 13.2 + 0.15 Gy. As stated earlier there is a short time lag, albeit unspecified, between the beginning of the universe and the onset of first Brahma's cycle or the formation of the first earth. Therefore, the universe is at least, but not much older than about 13.2 + 0.15 Gy; a result in excellent agreement with the age of the universe (13.7 + 0.13 Gy) deduced from WMAP (2010) data. This result implies that planets, indeed solar systems, formed within < 0.7 Gy of the birth of the universe; an implication supported by scientific observations. In a 2003 news release NASA stated: "Long before our Sun and Earth ever existed, a Jupiter-sized planet formed around a sun-like star. Now almost 13 billion years later, NASA's Hubble Space Telescope (HST) has precisely measured the mass of this farthest and oldest known planet. Its very existence provides tantalizing evidence that the first planets were formed rapidly, within a billion years of the Big Bang,"

The erroneous conclusion that the universe is trillions of years old stems from the following statement in VP: "Of such days and nights is a year of Brahma composed; and a hundred such years constitute his whole life. One Pararddha, or half his existence, has expired, terminating with the Maha Kalpa called Padma ". (Wilson, 1840; Bk 1, Ch. III, page 25). This assertion implies that the Brahma's life is some 311 trillion years, that half of his life is over and therefore the universe is some 155 trillion years old, and that thousands of Kalpas must have preceded the current one. We showed above that thousands of past Kalpas are not admissible. Also, the assertion that half of Brahma's life has expired does not find resonance in either Manusmriti or the Bhagavad-Gita; nor is it supported in the Puranas with additional evidence or discussion. Therefore, if Brahma's life span is indeed some 311 trillions long, then the statement that half of his life is over is not tenable; and if half of his life is indeed over then his life span cannot be some 311 trillions years, but much shorter in the vicinity of 18 Gy or roughly equal to two Brahma's cycles. Of the two choices, the latter is rather unlikely; which leaves us with the conclusion that in HC the universe may have a life span of some 311 trillion years but half of its life is not over.

2.4. Destruction of the Earth It is generally accepted that the Sun is halfway through its life of about 10 Gy on the main sequence and that the fate of our planet Earth is closely tied to the evolution of the Sun as it becomes more luminous on its way to the red-giant phase and its final stage as a white dwarf in billions of years (e.g. Schroeder and Smith, 2008). First, we note that the length of Brahma's cycle (8.64 + 0.12 Gy) is similar to the

Sun's life span on the main sequence. Second, since 4.48 + 0.1 Gy have already elapsed in the current cycle, we are at present about halfway through Brahma's cycle just as the Sun is. Third, it follows that the Earth has just entered or is about to enter Brahma's night or the destructive phase of the cycle.

The events that may affect the Earth and life on it during the second half of the current cycle are described in impressive details in VP (Wilson, 1840; Bk.6, Ch. III & IV) and are summarized in Table 1, column 1. The BP essentially describes the same set of events with minor differences. In column 2 we show for comparison the events affecting the Earth identified by Schroeder and Smith (2008) from their computations of the Sun's evolution. Schroeder and Smith (2008) reviewed current models and their (SS Model) results are representative of the current status of scientific knowledge on the evolution of the Sun and its effect on planet Earth. They conclude that the Earth will be engulfed by the expanding Sun. A comparison of the two columns shows that the events leading to the total destruction of the Earth are essentially identical in the two predictions. In both cases we have an extinction of significant life on the Earth in a relatively near future; a complete drying up of the Earth including its oceans; a green house effect that increases Earth's temperature setting it on fire; the turning of the Earth into a life-less molten rock or a shriveled and wrinkled remnant resembling the back of a tortoise; and the total incineration of the Earth and space around it or the engulfment of the Earth, Venus, and Mercury by the Sun. In the VP the runaway greenhouse effect (evaporation of oceans) precedes the wet-greenhouse effect (saturation of atmosphere and increased luminosity), whereas in the SS Model it is vice-versa. In VP the destruction begins with the demise of humanity caused by environmental factors that result in a prolonged drought. It is quite feasible that much before the Earth dries up and the oceans boil over, the increasing luminosity of the Sun will render the Earth virtually unusable for cultivation of large quantities of food grains causing widespread famine. Even if this prediction of an early demise of humanity does not pan out, the subsequent set of events clearly predict an extinction of all significant life on Earth as it dries up, and water - generally considered to be a necessary ingredient of life - disappears.

The major difference is that the SS Model predicts the engulfment of Earth in 7.6 Gy, whereas in the Texts it occurs within 4.2 Gy. Secondly, the SS Model predicts a small planetary nebula and a mild stellar wind, whereas the Puranas predict the formation of a huge nebula and strong winds. These differences are discussed and explained in section 5. The significance of a cosmic ocean predicted by VP, however, is not understood.

3. Implications

In the preceding section we laid out the principle Tenets of HC and showed: 1) that the application of these Tenets to the history of Brahma's cycle yields an age for the universe that agrees remarkably well with that deduced from scientific data; 2) that the formation of primeval planets and solar systems within less than a billion years of the beginning of the universe predicted by HC is supported by observations of NASA's HST; and 3) that the events leading to the destruction of the Earth in the next several billion years described in the Texts are strikingly similar to those inferred from current scientific models of Solar evolution. These concurrences, covering a time span of 18 Gy from the beginnings of the universe to the future destruction of the Earth, cannot simply be fortuitous. Therefore, the cosmic time scales and cycles so aptly noted by Carl Sagan are not an accident but apparently driven by the laws of universe, and we may confidently proceed to explore a scientific framework for HC. And hopefully in the process we may even discover new insights into the nature of cosmic processes.

But before we do so, it is worthwhile separating the implications of the foregoing results from theories concerning the beginnings of the universe or the formation of planets and stars. The characteristics of the Secondary cycle and its history imply: 1) that an Earth-like terrestrial planet capable of supporting life was part of a Solar system similar to ours that formed within 0.7 Gy of the dawn of the universe; 2) that our Solar System is the offspring of this primeval Solar system; 3) that the Solar system has a life cycle of about 8.64 + 0.12 Gy, and has the capacity to reproduce its essential constituents; and 4) that human life presumably existed on this primeval Earth, and the most likely timing of such an occurrence would be around

8.7 Gy if deduced from a comparison with the evolution of human life on planet Earth.

4. Cyclic Universe and Big Bang

As noted earlier, creation in HC is not an event but an evolutionary cyclic process. In this process a manifold universe emerges or unfolds spontaneously from a singular-self existent entity (Vishnu) that is without beginning or end. Vishnu, however, is the universal mind or spirit (Purusha) as well as primary matter (Pradhana) or nature (Wilson, 1840, Ch. II); and therein lies the difficulty of interpreting in purely physical terms this metaphysical duality of a self-existent singular entity. Nonetheless, if we are willing to set aside momentarily this difficulty and explore a bit further we may gain some insight into the creative processes of HC, the beginnings of which are described in the following paragraph. Primary matter is described as "subtle, uniform, durable, self-sustained, illimitable, undecaying, stable; devoid of sound or touch, and possessing neither color nor form. It is apparently cause and effect, mother of the world, without beginning; and that into which all that is produced is resolved; and by which all things were invested in the period subsequent to the last dissolution of the universe and prior to creation" (Wilson, 1840, Ch.II, pages 10 & 11). This unobservable primary matter, through successive transformations, created material "elements" (ether, air, water, and earth) and radiation (light and heat) endowed with one or more property of sound, touch, form, color, taste, and smell. Combining together, these "elements" formed an incipient universe in the form of a vast egg that "gradually expanded like a bubble of water. In that egg were the continents and seas and mountains, the planets and the divisions of the universe, the gods, the demons, and mankind." (Wilson, 1840, Ch. II, pages 18,19). It is clear therefore that the creative process in HC begins with the transformation of the unobservable primary matter into observable material elements and radiation. And the following principles, gleaned from the Texts, define or drive the creative process. 1) Time is without beginning or end. 2) Space too is without a beginning and inferred to be so from the fact that in HC matter apparently never ceases to exist. 3) Primary matter is limitless. 4) Nothing is ever created or destroyed and matter simply undergoes a change of state; or matter/energy is conserved in accord with the first law of thermodynamics. 5) The durations of cosmic cycles do not vary with time.

The cyclic nature of the universe in HC is clearly at odds with an ever-expanding universe. Additionally, the standard big bang/inflationary cosmology (consensus model) postulates a singularity when the temperature and density of the incipient universe were near infinity and prior to which nothing existed (space, time, matter or energy)) and the incipient universe inflated exponentially in an infinitesimally short time (e.g. Guth, 1997; Steinhardt and Turok, 2002). In contrast, space and time in HC are without a beginning and the universe does not emerge from nothing but apparently from a limitless, pre-existing primary matter that spontaneously transforms itself to create the primordial elements and radiation of the universe. Also, the incipient universe in HC apparently had a finite volume (cosmic egg) as opposed to a singularity and hence the initial temperature and density could be very high but need not be near infinity. The best fit for the cyclic universe of HC appears to be with the Cyclic Model of Steinhardt and Turok (2002, 2004). The Cyclic Model (CM) describes the bang as a "bounce" from a pre-existing contracting phase during which matter and radiation are "created" at a large but finite temperature. In their model, as is the case in HC, time and space are without a beginning and the universe apparently expands slowly compared to the unimaginably rapid inflation required by the consensus model. After trillions of years matter, radiation and large-scale structures are all diluted away (Steinhardt and Turok, 2002, 2004), a situation akin to the exhaustion of the universe in HC in many trillions of years when conditions required to support life cease to exist. This emptying of the universe, a crucial element of CM and a condition for the reversal of the creative process in HC, apparently overcomes the difficulties historically encountered by oscillatory models in their ability to retain an identical time span from cycle to cycle (Steinhardt and Turok, 2002).

Despite these differences between the consensus and cyclic models, it is quite remarkable that the age of the universe deduced from the Hindu Texts that ascribe to a cyclic universe is indistinguishable from the age deduced from the big bang picture; an outcome that suggests that the event that occurred some 13.7 Gy ago is not model dependent, irrespective of whether it is conceived as a bang (singularity), or as a transition from a contracting to an expanding phase in CM, or as the event in HC during which primary matter transformed into material “elements” and radiation. This seminal event is therefore the inception of the current universe when matter and radiation were created irrespective of the model used.

Lastly, we offer the following observations and proposals that further cement the commonalities between the cyclic universes of HC and CM. Theoretically, the universe in CM consists of two branes separated by a microscopic gap. Observable particles (quarks, leptons, photons, neutrinos, etc) lie on one brane, and the particles on the other brane are a dark form of matter that cannot be detected in the laboratories. The particles on the two branes can interact through gravity but not by strong or weak interactions. (Steinhardt and Turok, 2004). Recalling that primary matter (Pradhana) is unobservable, and that its products (ether, air, water, earth, light, and heat) have properties perceivable by the senses, it is tempting to equate the non-observable primary matter of HC with the non-detectable dark matter of CM, and the observable products of primary matter with the particles and radiation in CM. In other words, the observable universe lies on one brane, and the unobservable dark matter or the invisible primary matter lies on the other brane, and the two interact only through gravity. The collision of the two branes is the seminal event when the universe is infused with new matter and radiation in CM (Steinhardt and Turok, 2004) as well as in HC and a new cycle of evolution begins.

5. Secondary Cycle and Replication of Solar System

Of the two cycles, the Secondary or Brahma’s cycle is better defined and has far reaching implications. As noted above this cycle does not pertain to the Earth alone but also to the Sun and that its duration (8.64 + 0.12 Gy) is similar to the Sun’s life span on the main sequence. Any scientific model that attempts to successfully explain the characteristics of this cycle and its history must account for the implied capacity of the System to essentially replicate itself every 8.64+0.1 2 Gy. There are basically two models for the formation of the Solar System, the widely accepted nebular hypothesis or the Solar Nebular Model (e.g. Woolfson, 1993) and the primordial planet model of Schild and Gibson (2010). Schild and Gibson posit that super giant primordial planets of hydrogen and helium formed soon (380,000 years) after the big bang; that these gas planets often concentrate together to form a star with residual matter seen in pre-stellar accretion disks around the youngest stars; and that these planets grow smaller through collisions until they are whittled down to the size of the planets populating our Solar system. In the nebular hypothesis, matter in gravitationally unstable giant molecular gas clouds (GMC) coalesces into denser clumps that collapse to form a star. A protoplanetary accretion disk is formed around the young star in which planets form through the coagulation of dust grains into planetesimals and runaway accretion.

While the Schild and Gibson (2010) model may explain the formation of the "first" or the primeval Sun from super giant gas planets and possibly early planets, it is difficult to imagine how this model could account for the replication of the Solar system periodically as required by the Secondary cycle. Similarly, Joseph (2009) rogue-planet model, in which the outer planets are ejected from dying solar systems during the red-giant phase of a star before supernova only to be captured by another star, cannot explain the clockwork periodicity of the Secondary cycle and the periodic formation of an Earth-like planet required by HC. Unfortunately the Texts do not contain any information on how a Solar system is formed. The Texts, however, provide insight into the likely mechanism responsible for the Sun's capacity to replicate itself. This insight results from the comparison of events before and after the incineration of the Earth with models of solar evolution.

We showed earlier that events leading to the future incineration of the Earth described in VP are remarkably similar to those predicted by the Schroeder and Smith (2008) model. In the SS model the Sun loses 1/3 of its mass during the red-giant phase (RGB) and an additional 12% during the Asymptotic Giant Branch (AGB) before becoming a white dwarf. We propose that the ejected matter, rich with heavier elements manufactured by the Sun in its core and surrounding shell during RGB, seeds portions of a GMC creating a gravitational instability. Denser clumps are formed around the seeds that eventually collapse to form a protostar surrounded by a protoplanetary or an accretion disk. The disk continues to be fed with matter lost by the Sun as it passes from the RGB phase of the dying Sun towards the AGB tip, a total time span of about 130 million years (See Schroeder and Smith, 2008).

Within the disk the enriched dust grains coagulate to form planetesimals that merge or accrete to form planetary embryos and eventually a few terrestrial planets. The outer gaseous planets may form from the hydrogen-helium gas of the disk or could be the whittled down versions of the primordial gas planets of Schild and Gibson (2010) captured by the new Sun. It is noteworthy that the time taken by the dying Sun to reach the AGB tip from its rapid ascent towards the RGB tip is of the same order as the estimated time necessary (100 million years) to form the Solar system (Montmerle et. al, 2006).

Thus, the nebular hypothesis in conjunction with Sun's loss of mass during its RGB and AGB may adequately account for the Sun's capacity to replicate itself and attendant planets and no new model is needed. Two factors that make it possible are: 1) the Sun is apparently more massive than 95% of stars (Robles et al. 2008); and that the amount of heavier elements needed to form terrestrial planets similar to ours is but a fraction (<0.001) of the mass of heavier elements ejected by the dying Sun, even though heavier elements constitute only a few percent of the Sun's mass; 2) that, unlike a supernova, the Sun during RGB simply sheds its outer layers and does not explode, and hence the ejected matter is probably not dispersed far and wide as in a supernova, but much more locally and not thinned out into space. The large amount of mass lost during RGB in the SS model is the reason why in their model the subsequent planetary nebula during AGB is rather small and insignificant (Table 1). In contrast, the stellar nebula in the VP (Table1) is no ordinary cloud formation. Its detailed morphology (see Wilson, 1840, Bk. 6, Ch. IV) is reminiscent of the famous descriptions (NASA, 1995) of "Elephant trunks" and "Pillars of creation" found in the Eagle Nebula (M16) - a site of star formation - than that of a symmetrical pattern expected of a planetary nebula. We suggest that the stellar nebula described in the VP is indeed a solar nebula surrounding the young star, and that the subsequent stellar winds (Table 1) that disperse the stellar nebula are the solar winds that eventually blow away the cocoon surrounding the young Sun. In the case of a planetary/ejection nebula the stellar winds would be expected to precede or be contemporaneous with the formation of the nebula, just the opposite of the sequence in VP. Thus, not only are the events preceding the destruction of the Earth in good agreement with those predicted from the evolution of the dying Sun, but the events following the destruction are also in good agreement with events expected to be associated with the formation of a new Sun. The only significant difference is that in the SS model the time span to the engulfment of the Earth is about 12 Gy whereas the Secondary cycle is 8.64 + 0.16 Gy long. This difference, although appreciable, is not fatal given the assumptions and approximations inherent in solar models and uncertainties in Sun's life on the main sequence (known only to its first order approximation) arising from such parameters as the rate of fusion and the amount of hydrogen available.

6. Concluding Remarks

The two major results of this study, if they survive the test of time and I have no reason to believe that they would not, will have major implications. The demonstration that ancient Hindu seers may have unraveled some of the mysteries of the universe begs the question: How did they do it without the technological assets that modern science possesses? The finding that the Sun apparently replicates itself periodically is profoundly important for the understanding of cosmic processes and for the evolution of life and its distant fate. Lastly, the conclusion that the event that took place some 13.7 Gy ago marking the onset of the (current) universe was a seminal event irrespective of whether the universe is conceived to be cyclical or one that began with a bang may turn out to be equally important in reconciling conceptual differences between competing models of the universe.

Acknowledgments: I thank the two anonymous referees; their suggestions and comments helped improve the paper significantly. I thank my wife Hemu who first directed my attention to the Bhagavad-Gita, which eventually led to the personal discovery of the Hindu Texts.

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15. Visions of the Cosmos: Archaeoastronomy in Ancient India

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Abstract

This paper is an overview of archaeoastronomy in ancient India. It describes the Vedic conception of the cosmos and the representation of the knowledge of the motions of the sun and the moon in the design of fire altars. Sites of archaeoastronomical interest described include Neolithic and Megalithic sites and the Sanchi Stupa.

1. Introduction

Archaeoastronomy in India has the benefit of ancient texts that describe cosmological ideas, their basis in astronomy, and their representation in architecture. These texts provide us crucial understanding of the astronomy and cosmology of the historical period.

In the Indian view, the cosmos is seen as being tripartite and recursive (see Kak, 2000a and Kak, 2008 for review and additional references). The universe is viewed as three regions of earth, space, and sky (Dumézil, 1988) which in the human being are mirrored in the physical body, the breath (prāna), and mind. The processes in the sky, on earth, and within the mind are taken to be connected.

Indian narratives about the cosmos are characterized by the central role of the observer. The cosmos is seen both as real and arising out of the phenomenal contents of the mind. At a practical level, agreement on the phenomenal contents of many minds is taken to imply real existence, and the question of the nature of the qualities of the objects is raised. The question that is asked in the Indian narrative is: Do these attributes or concepts have a real existence or do they arise from the intuition of the observers?

The examination of this and related questions leads to theories of the cosmos, both at the universal and personal levels, that form part of the philosophical systems of Sānkhya and Vaiśeshika. The Vedic view of India (spanning a long period that goes back to at least 2000 BCE) classifies knowledge in two categories: the higher or unified and the lower or dual. Higher knowledge concerns the perceiving subject (consciousness), whereas the lower knowledge concerns objects. Higher knowledge can be arrived at indirectly through intuition and contemplation on the paradoxes of the outer world. Lower knowledge is analytical and it represents standard science with its many branches. There is a complementarity between the higher and the lower, each being necessary to define the other. This complementarity mirrors the one between mind and matter.

The Vedic thinkers were aware that formal descriptions of the universe lead to logical paradox. The one category transcending all oppositions is Brahman. Figure 1 represents this world-view schematically. In this figure, logic is shown as a subset of the capacities of the mind, and likewise models of reality (which are based on logic) do not capture all aspects of the material world. Machines have been grouped together with logic in the figure since they must be constructed according to a logical framework. This figure may be viewed as a representation of the incompleteness of formal systems of knowledge. Vedic ritual is a symbolic retelling of this conception. Notable features of this world view that are relevant here are (Basham, 2004):

An Extremely Old and Large Cyclic Universe: The Vedic texts speak of an infinite universe with ages of very large time periods, or yugas. The recursive Vedic worldview requires that the universe itself go through cycles of creation and destruction. The encyclopedic Purānas speak of the universe going through a current cycle of 8.64 billion years, and the period of the largest cycle is stated to be 311 trillion years.

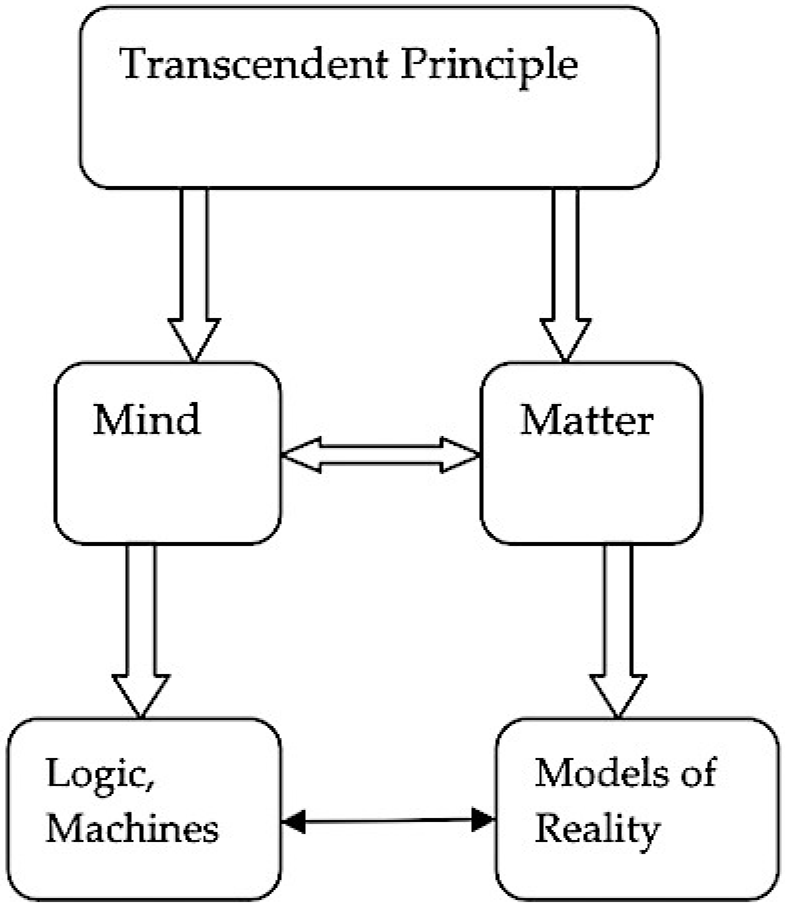


Figure 1. Universe as projection of a transcendent principle.

An Atomic World: According to the atomic doctrine of Kanāda, there are nine classes of substances: ether, space, and time that are continuous, four elementary substances (or particles) called earth, air, water, and fire that are atomic, and two kinds of mind, one omnipresent (the universal self) and another that is the individual mind.

Relativity of Time and Space: That space and time need not flow at the same rate for different observers is encountered in the late Vedic and Purānic stories, and in the Mahābhārata and the Yoga Vāsishtha (Dimmitt and van Buitenen, 1978, Kak, 2008).

Many Solar Systems: Indian mythology assumes an uncountable number of worlds (solar systems) (Dimmitt and van Buitenen, 1978). In Purānic texts, the diameter of our own solar system is taken to be about 500 million yojanas which is about 7.5 billion kilometers (Kak, 1999, Rao and Kak, 2000).

With the above as background to the general ideas regarding the cosmos current in ancient India, we come to the discussion of archaeoastronomy in ancient India. A considerable part of the archaeoastronomy of this period is based on the author's research (see, e.g., Kak, 1992, 1993, 2000a, 2000b, 2005a, 2009). Due to the importance given in Indian culture to the abstract and the symbolic, many of the archaeoastronomical sites are temples. The king was consecrated at the temple. The consecration served to confirm the king as foremost devotee of the chosen deity, who was taken to be the embodiment of time and the universe (Kak, 2002).

The Indian sacred city has been viewed as a structured mesocosm, situated between the microcosm of the individual and the macrocosm of the culturally conceived larger universe (Levy, 1991). Such a city is constructed of spatially connected and recursively layered circles, each of which is sustained by its own culture and performance. Although Levy's city is not very ancient, it is built according to an old tradition (Volwahsen, 2001). The Harappan city of Dholavira (Bisht, 1997) is also recursively structured. Furthermore, temples were taken to be define the meeting ground between the macrocosm and the microcosm, and, therefore, they provide much information on the relationship between astronomy and cosmology.

India's archaeological record has unbroken continuity going back to about 7500 BCE at Mehrgarh (Kenoyer, 1998, Lal, 2002), and it has a rock art tradition, next only to that of Australia and Africa in abundance, that is much older (Pandey, 1993, Bednarik, 2000). Some rock art has been assigned to the Upper Paleolithic period. There is surprising uniformity, both in style and content, in the rock art paintings of the Mesolithic period (10,000 – 2500 BCE) (Wakankar, 1992).

The setting for the hymns of the Rigveda, which is India's most ancient literary text, is the area of Sapta Saindhava, the region of north India bounded by the Sindh and the Ganga rivers although regions around this heartland are also mentioned. The Rigveda describes the Sarasvati River to be the greatest of the rivers and going from the mountains to the sea. The archaeological record, suggesting that this river had turned dry by1900 BCE, indicates that the Rigveda is prior to this epoch.

The Rigveda and other early Vedic literature have astronomical references related to the shifting astronomical frame that indicate epochs of the fourth and third millennium BCE which is consistent with the hydrological evidence. The nakshatra lists are found in the Vedas, either directly or listed under their presiding deities, and it one may conclude that their names have not changed. Vedic astronomy used a luni-solar year in which an intercalary month was employed as adjustment with solar year.

The foundation of Vedic cosmology is the notion of bandhu (homology or binding between the outer and the inner). It was estimated correctly that the sun and the moon were approximately 108 times their respective diameters from the earth (perhaps from the discovery that the angular size of a pole removed 108 times its height is the same as that of the sun and the moon), and this number was used in sacred architecture. The distance to the sanctum sanctorum of the temple from the gate and the perimeter of the temple were taken to be 54 and 180 units, which are one-half each of 108 and 360 (e.g. Kak, 2005a). Homologies at many levels are at the basis of the idea of recursion, or repetition in scale and time. The astronomical basis of the Vedic ritual was the reconciliation of the lunar and solar years.

2. The Cosmological Plan of the City and the Temple

According to the Vāstu Śāstra, manual of sacred architecture, the structure of the building mirrors the emergence of cosmic order out of primordial chaos through the act of measurement. The universe is symbolically mapped into a square that emphasizes the four cardinal directions. It is represented by the square vāstupurushamandala, which in its various forms is the basic plan for the temple, the house, and the city. There exist further elaborations of this plan, some of which are rectangular.

Yantric buildings in the form of mandalas, dated to about 2000 BCE, have been discovered in North Afghanistan that belong to a period that corresponds to the late stage of the Harappan tradition (Kak, 2005b, 2010) providing architectural evidence in support of the idea of recursion at this time. Although these building are a part of the Bactria- Margiana Archaeological Complex (BMAC), their affinity with ideas that are also present in the Harappan system shows that these ideas were widely spread..

Recent studies haves shown that the unit of dhanus has been used consistently in India in town planning and architecture for over 4,000 years, going back to the Harappan period. By considering the largest measure which leads to integer dimensions for the various parts of the Harappan age city of Dholavira, which was excavated in the 1990s (Bisht, 1997, Bisht, 1999), it was found that this measure is the same as the Arthaśāstra (300 BCE) measure of dhanus (bow) that equals 108 angulas (fingers) (see Kak, 2009, 2010, for details).

The measure of dhanus is seen to apply not only to the Mauryan and Gupta era structures, but even to more recent grid and modular measures in the town planning of Kathmandu Valley. The measures used in ancient India are summarized in the table below.

The three different hasta measures have been called the Prājāpatya (P-hasta), commercial (C-hasta), and forest (F-hasta) by Balasubramaniam (2008), and used variously in different situations. Here we are concerned primarily with dhanus, although we will also encounter pāda and aratni.

With the measure of dhanus (D) of 1.9404 m, the dimensions of Mohenjo-Daro's acropolis turn out to be 210 x 105 D, Kalibangan's acropolis turn out to be 126 x 63 D. The dimensions of the lower town of Dholavira are 405 x 324 D, the width of the middle town is 180 D, and the inner dimensions of the castle are 60 x 48 D (Danino, 2008). The sum of the width and length of the lower town comes to 729 which is astronomically significant since it is 27 x 27, and the width 324 equals the nakshatra year 27 x 12 (Kak, 2009).

The layout of Dholavira is unique in that it comprises of three "towns," which is in accord with Vedic ideas (Bisht, 1997, Bisht, 1999). The feature of recursion in the three towns, or repeating ratios at different scales, is significant. Specifically, the design is characterized by the nesting proportion of 9:4 across the lower and the middle towns and the castle. The proportions of 5/4, 7/6, and 5/4 for the lower town, the middle town, and the castle may reflect the measures related to the royal city, the commander's quarter, and the king's quarter, respectively, which was also true of Classical India (Bhat, 1995).

Measure	angulas	centimeters
angula	1	1.763
vitasti (tāla)	12	21.156
pāda	14	24.682
aratni, P-hasta	24	42.312
C-hasta	28	49.364
F-hasta	54	95.202
daṇḍa	96	169.248
dhanus	108	190.404

Table 1.

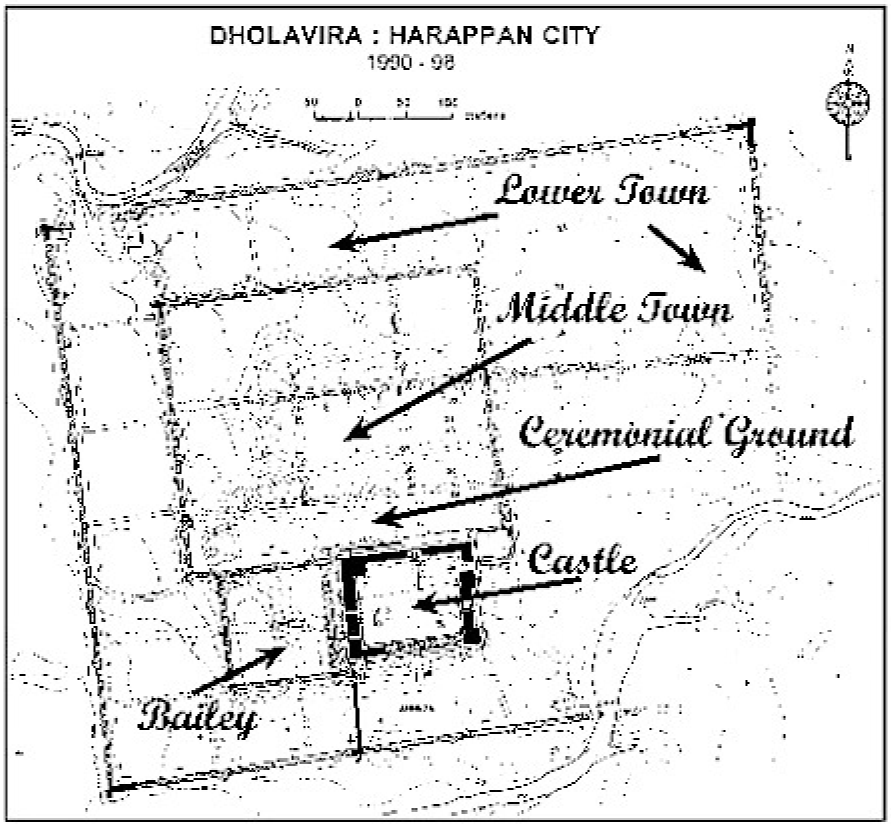


Figure 2. Map of Dholavira (Bisht, 1997).

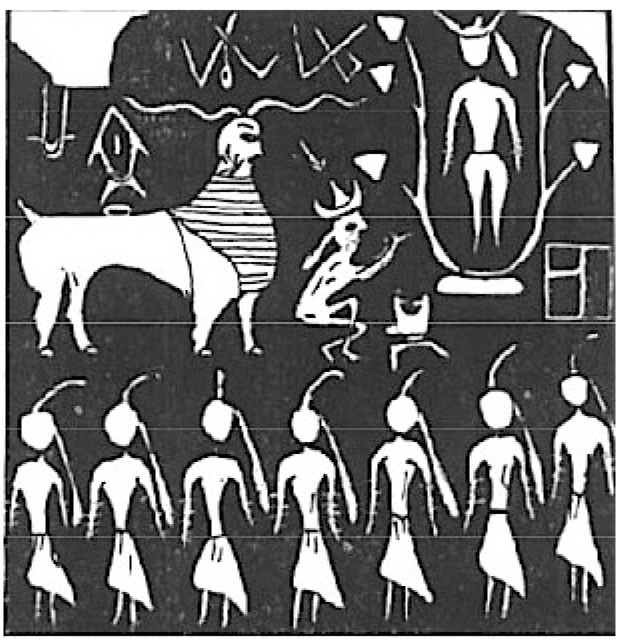
The Somapura Mahāvihāra of Pāhārpur has dimensions of 280x281 m, which when converted to dhanus become nearly 147x147 D, or 49x49 with the units of three times dhanus, which would be a natural plan for a vāstupurushamandala. The base of the temple was generally in a square grid of 8 or 9 units (64 or 81 squares) in the Brihat Samhitā (Bhat, 1995), but according to other texts it could range from one to 1024 square divisions. Another text gives special importance to the 7x7 plan. The Brihadīśvara temple (which was completed in 1010 CE), has a sanctum tower of 30.2x30.2x66 and it is within an enclosure of 240x120 m. In dhanus units, this amounts to 16x16 D plan in an enclosure of 126x63 D, where the error is less than one percent in the sanctum and almost zero for the enclosure. This indicates that the sanctum used a vāstupurushamandala of 64 squares where each square had a length of one-fourth dhanus. The dhanus unit also explains the chosen dimensions of Angkor Wat and Prambanan temples in Southeast Asia.

3. More on Harappan and Vedic Records

In this section we consider additional evidence from Harappan and Vedic periods. The absence of monumental buildings such as palaces and temples makes the Harappan city strikingly different from its counterparts of Mesopotamia and Egypt, suggesting that the polity of the Harappan state was de-centralized and based on a balance between the political, the mercantile, and the religious elites. The presence of civic amenities such as wells and drains attests to considerable social equality. The power of the mercantile guilds is clear in the standardization of weights of carefully cut and polished chert cubes that form a combined binary and decimal system.

Mohenjo-Daro and other sites show slight divergence of 1° to 2° clockwise of the axes from the cardinal directions (Wanzke, 1984). It is thought that this might have been due to the orientation of Aldebaran (Rohinī in Sanskrit) and the Pleiades (Kritikkā in Sanskrit) that rose in the east during 3000 BCE to 2000 BCE at the spring equinox, the word "rohinī" literally means rising. Furthermore, the slight difference in the orientations amongst the buildings in Mohenjo-Daro indicates different construction periods using the same traditional sighting points that had shifted in this interval due to precession of the equinoxes (Kenoyer, 1998).

Mohenjo-Daro's astronomy used both the motions of the moon and the sun (Maula, 1984). This is attested by the use of great calendar stones, in the shape of ring, which served to mark the beginning and end of the solar year.



Figures 3A,B. Astronomical seal from the Harappan era (left: picture, right: sketch of same).

The seal of Figures 3a,b has been viewed by many as representing the Pleiades. The conjunction of this constellation with the sun at the vernal equinox marked the New Year around 2400 BCE. The Pleiades, the wives of the seven sages, are important in Vedic mythology as representing the seven mothers who nurse the war-god Skanda.

The seal of Figure 4 is taken to represent the opposition of the Orion (Mrigashiras, or antelope head) and the Scorpio (Rohini of the southern hemisphere which is 14 nakshatras from the Rohini of the northern hemisphere) nakshatras. The arrow near the head of one of the antelopes could represent the decapitation of Orion. It is generally accepted that the myth of Prajapati being killed by Rudra represents the shifting of the beginning of the year away from Orion and it places the astronomical event in the fourth millennium BCE (Kak, 1996, 2000a).

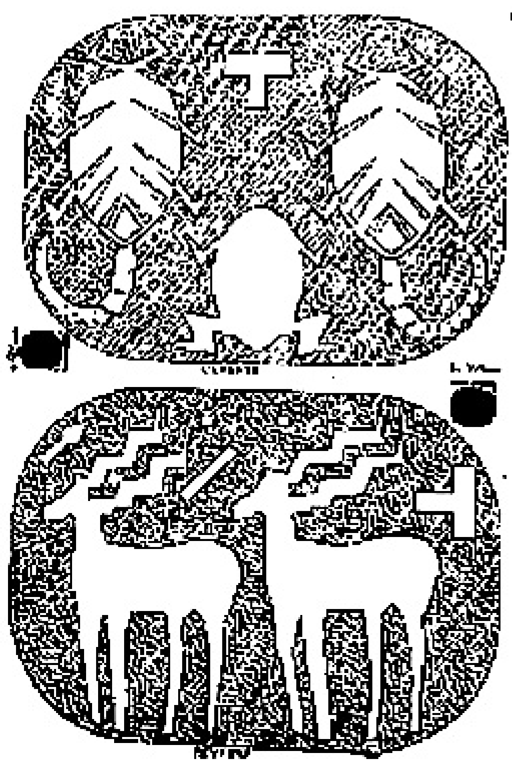


Figure 4. A 3rd millennium seal from Rehman Dheri.

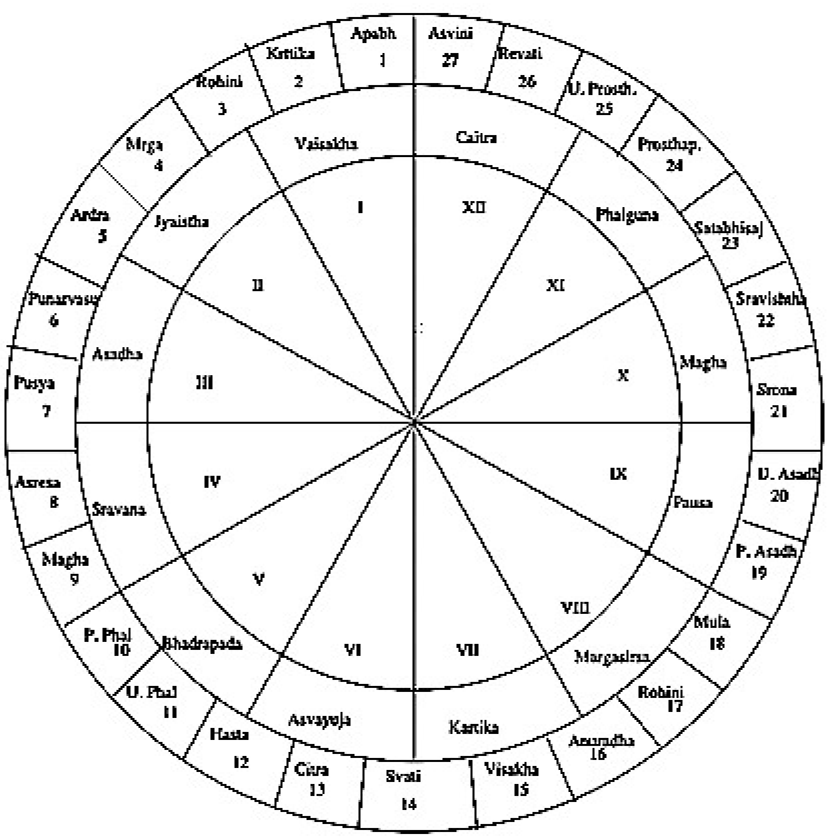


Figure 5. Mapping of the nakshatras to the solar months.

Figure 5 presents the 27 nakshatras of the Indian astronomy together with the 12 solar segments (rāshis). It is significant that the 27 nakshatras contain 24 names together with three which are further subdivided. This indicates that the 24 divisions may have preceded the 27 divisions of the Vedic astronomy.

Fire altars, with astronomical basis, have been found in the third millennium cities of India. Vedic texts describe the design and ritual of the fire altars which were oriented towards the east and whose design, using bricks laid in five layers, coded astronomical knowledge of its times (Kak, 2000a). The best known of the fire altars is the falcon altar of Figure 6. Texts that describe fire altar designs are conservatively dated to the first millennium BCE, but their contents appear to be much older.

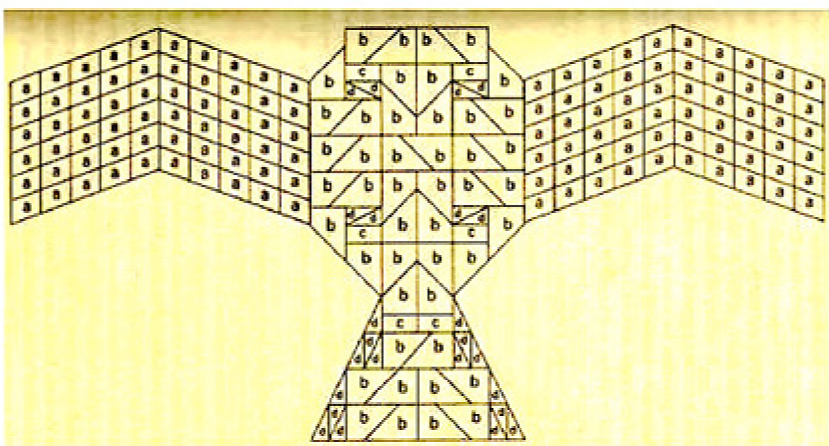


Figure 6. Fire altar designed as a falcon.

Vedic ritual was based on the times for the full and the new moons, the solstices and the equinoxes. There were two years: the ritual year started with the winter solstice (mahāvrata), and the civil one started with the spring equinox (vishuva). The passage of the rising of the sun in its northward course from the winter solstice to the summer solstice (vishuvant) was called gavām ayana, or the sun's walk. The solar year was divided into two ayanas: in the uttarāyana the sun travels north, in the dakshināyana it travels south. The movement of the moon was marked by its nightly conjunction with one of the 27 or 28 nakshatras. The Rigveda 1.164 also speaks of another tradition of dividing the zodiac into twelve equal parts. It appears that these divisions were called the Ādityas. The incommensurability between the lunar and the solar reckonings led to the search for ever-increasing cycles to synchronize the motions of the sun and the moon. This is how the yuga astronomical model was born. In the lunar month, there were separate traditions of counting the beginning of the month by the full-moon day and the new-moon day.

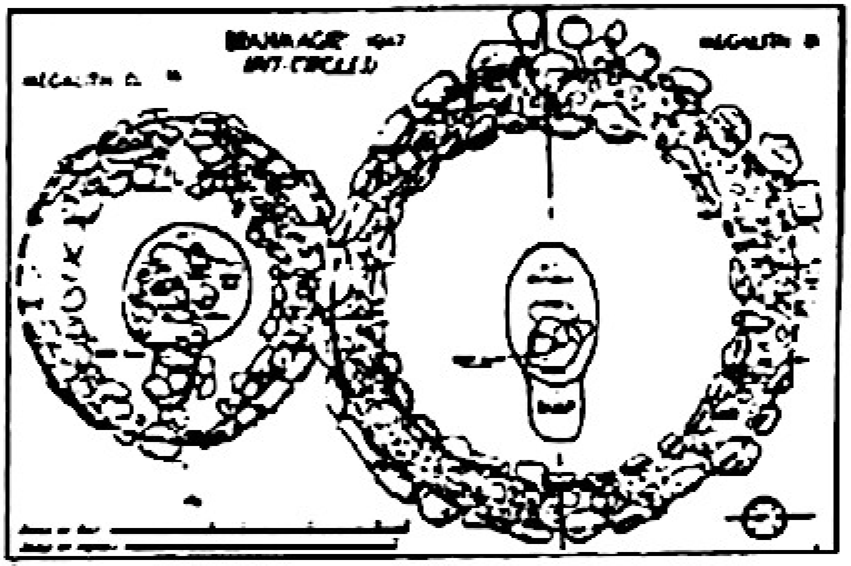
4. Neolithic and Megalithic Sites

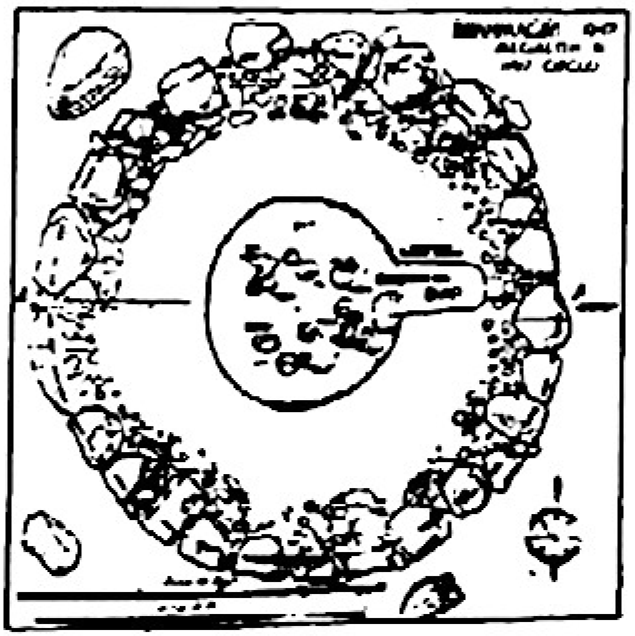
Sites of archaeoastronomical interest include the Neolithic site of Burzahom from Kashmir in North India, and megalithic sites from Brahmagiri and Hanamsagar from Karnataka in South India. The dates for these specific sites are provided in the text. The importance of these sites arises from the fact that they present astronomical knowledge that was most likely outside the literary tradition.

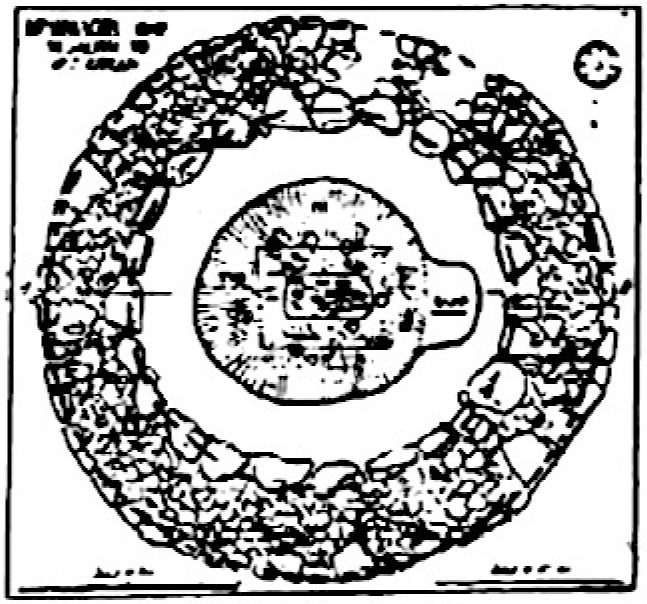
Burzahom, Kashmir. The Burzahom site is located about 10 km northeast of Srinagar in the Kashmir Valley on a terrace of Late Pleistocene-Holocene deposits. Dated to around 3000 - 1500 BCE, its deep pit dwellings are associated with ground stone axes, bone tools, and gray burnished pottery. A stone slab of 48 cm x 27 cm, obtained from a phase dated to 2125 BCE shows two bright objects in the sky with a hunting scene in the foreground. These have been assumed to be a depiction of a double star system (Rao, 2005).

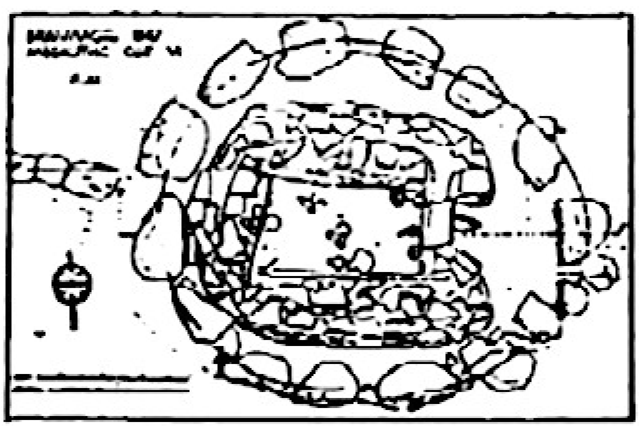
Figure 7. Burzahom sky scene.

Brahmagiri, Karnataka. The megalithic stone circles of Brahmagiri (latitude 14o 73’, longitude 76o 77’), Chitradurga district of Karnataka in South India, that have been dated to 900 BCE, show astronomical orientations. Rao (1993) has argued that site lines from the centre of a circle to an outer tangent of another circle point to the directions of the sunrise and full moon rise at the time of the solar and lunar solstices and equinox.









Figures 8A,B. Megalithic stone circles of Brahmagiri

Hanamsagar, Karnataka. Hanamsagar is a megalithic site with stone alignments pointing to cardinal directions. Since the megalithic period of Karnataka is believed to belong to the first millennium BCE, it may be assumed that this is the period of the site. The site is located on a flat area between hills about 6 km north of the Krishna river at latitude 16o 19’ 18” and longitude 76o 27’ 10”. The stones, which are smooth granite, are arranged in a square of side that is about 600 meters with 50 rows and 50 column (for a total of 2,500 stones), with a separation between stones of about 12 m. The stones are between 1 to 2.5 m in height with a maximum diameter of 2 to 3 m. The lines are oriented in cardinal directions. There is a squarish central structure known as chakri katti.

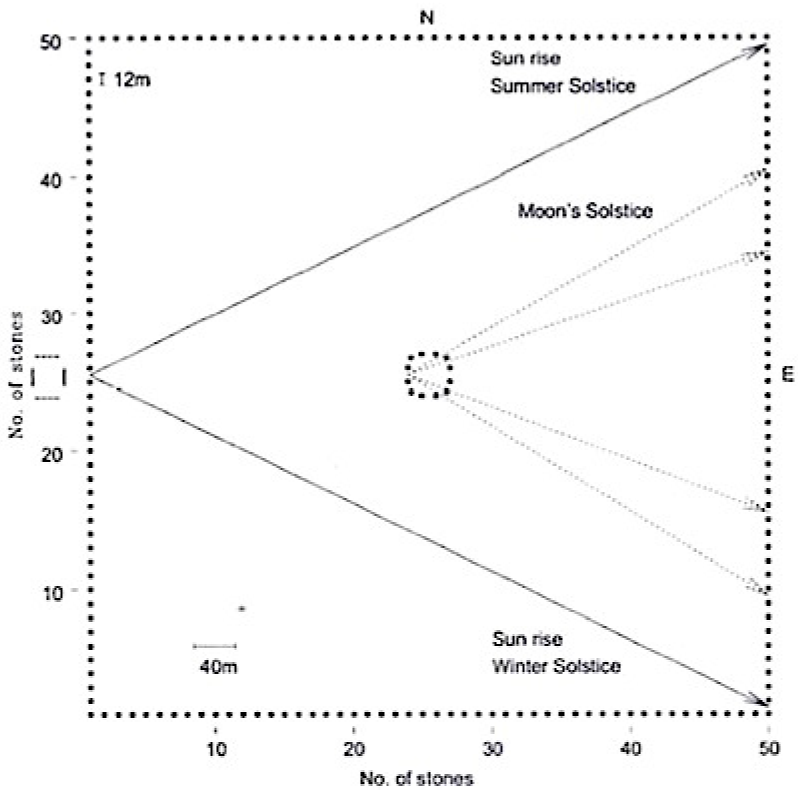


Figure 9. Alignments at Hanamsagar (Rao, 2005).

It has been argued that the directions of summer and winter solstice can be fixed in relation to the outer and the inner squares. Rao (2005) suggests that it could have been used for several other kind of astronomical observations such as use of shadows to tell the time of the day, the prediction of months, seasons and passage of the year.

5. The Sanchi Stupas

The Sanchi Stupa, a hemispherical domed structure with a flattened top meant to contain the relics of the Buddha, is believed to have been built by King Aśoka in around 250 BCE, an enlargement to double the size was done by the Śungas (this dynasty ruled between 185 and 73 BCE). It is surrounded by a balustrade that represents the sun's circuit. The Buddha did on full moon day of the lunar month Vaiśākha, and this day is observed as the Buddha pūrnimā day. At full moon the moonrise and sunset are observed in the eastern and western horizons.

It is likely that the astronomical basis of the Stupa was inspired by the Vedic altar that represented the circuit of the sun. It has been shown elsewhere (Millar and Kak, 1999) how this representation of the sun's motion remained common knowledge and it was used in Angkor Wat.

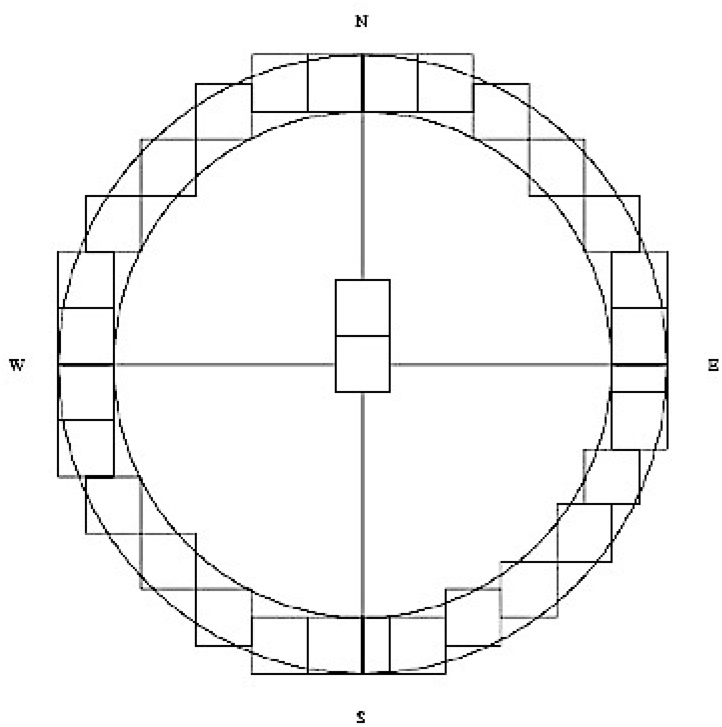


Figure 10. A Vedic fire altar representing the circuit of the sun.

Two further Stupas were built by the Śunga kings and it is believed that they fixed the orientation of the Stupa. G.M. Ballabh and K.D. Abhyankar found that the Buddha pūrnimā occurred at Sanchi on April 28, 109 BCE with the sunset and moonrise of the full moon to the east-west orientation of the Stupa (azimuth of the Sun and Moon equal to 285.2 and 105 degrees, respectively, with an altitude of about 1 degree). This also corresponds to the setting and rising of the Pleiades (Krittikā) and δ Scorpii (Anurādhā) (Rao, 1992).

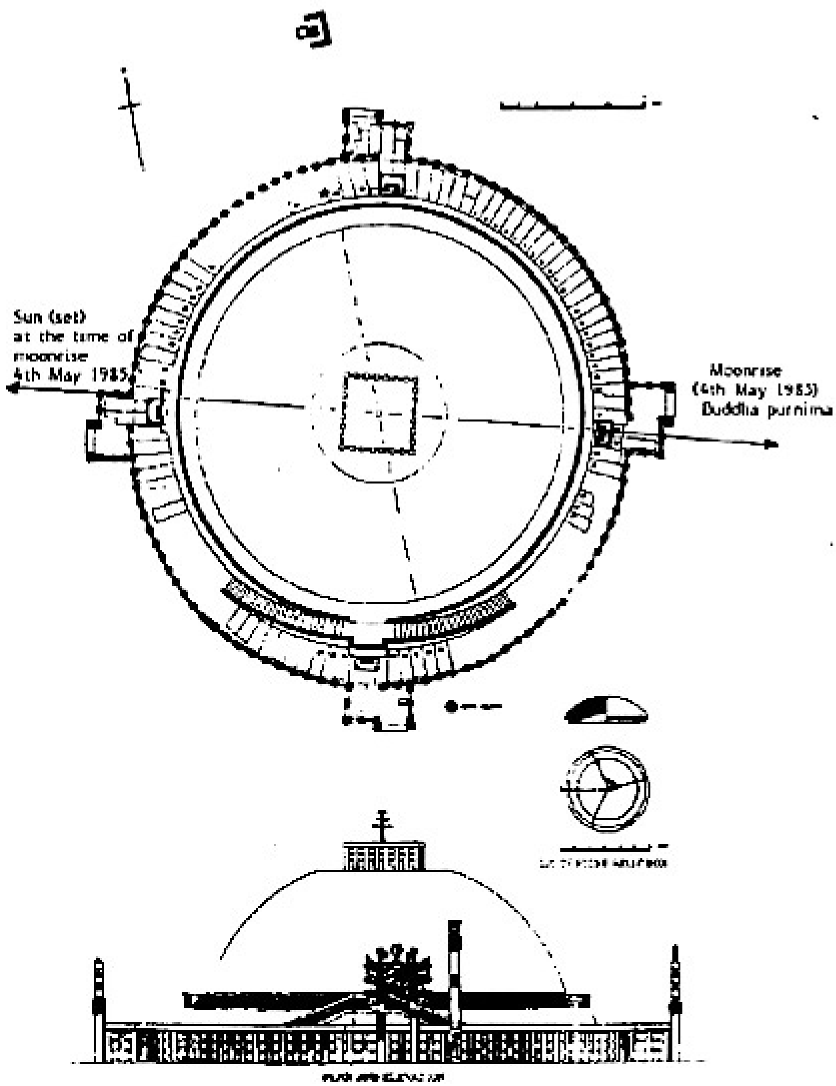


Figure 11. The Sanchi Great Stupa (Rao, 1992).

Figure 12. The Sanchi Great Stupa from Eastern Gate (picture Raveesh Vyas).

There is further astronomical significance to the design of the outer balustrade in the Stupas.

Great Stupa. The outer balustrade has 120 posts arranged in 4 quadrants and they are joined by three rows of 29 horizontal crossbars. Starting with the 30 posts in the first quadrant, 29 crossbars of the second quadrant, 30 posts of the third quadrant, and 29 crossbars of the fourth quadrant, we have a count of 118. Three such rounds correspond to the number of days in the lunar year. Rao (1992) adds that to arrive at an undistorted full circle it would require 108 (i.e. 120-16+4) posts, where the 16 entrance posts have been subtracted and 4 missing posts at each entrance required have been added for reasons of symmetry. We have already mentioned the significance of the count of 108 in Indian astronomy. Rao (1992) speculates that the total number of outer balustrade posts (120) and slabs (115) gives a count of 235 corresponds to the lunations of the Metonic cycle. The harmika balustrade at the top has 28 posts, which equals the number of nakshatras.

Stupa 2. The count according to Rao (1992) for the posts and the crossbars is also 354, the number of days in the lunar year. Rao further speculates that the location of Sanchi may have astronomical significance since its latitude is close to the declination of the sun on the summer solstice day.

6. Concluding Remarks

This paper presents a broad overview to the archaeoastronomy of ancient India. Indian archaeoastronomy provides unique insights into the nature of ancient science and society in India for this region has vast number of texts belonging to different ages. The assumed homologies between the outer and the inner cosmoses meant that the same vocabulary was used to speak of their respective structures. While this becomes an obstacle for those who do not understand the system, it has within it the potential to explain many attitudes in Indian mythology, religious practice, science, and art.

In concluding, there was continuity between the archaeoastronomy of the early period covered in this essay and that of the medieval period where pilgrimage and temple centers mirrored conceptions of the cosmos. Medieval sites of archaeoastronomical significance include Sisupalgarh, Chitrakut, Vijayanagara, Gaya, Konarak, Khajuraho, and the Suryapuja temples in Tamil Nadu (e.g. Malville, 1989, Malville and Gujral, 2000, Malville and Swaminathan, 2005, Singh, 2009). For example, the temple complex of Khajuraho in Madhya Pradesh, built in 9th -12th century CE by the Chandela kings, form three overlapping circles, with centers at the Lakshmana (Vishnu), the Javeri (Śiva), and the Duladeva (Śiva) temples. Their deviation from true cardinality is believed to be due to the direction of sunrise on the day of consecration (Singh, 2009). The Lakshmana temple, one of the oldest of the complex, is considered the axis mundi of the site and it is oriented to the sunrise on Holi.

The sun temples of Varanasi (Malville, 1985, Singh, 2009) are interesting in that six of these lie along one side of an isosceles triangle with a base of 2.5km. The triangle surrounds the former temple of Madhyameshavara, which was the original center of the city. Pilgrims walking along the triangle are symbolically circumambulating the cosmos. The subject of the medieval temples forms an important and fascinating chapter in India's archaeoastronomy that is beyond the scope of this paper.

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16. Cosmic Capitals and Numinous Precincts in Early China

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Abstract

Study of the role of astronomical alignment in shaping the built environment suggests that centuries before the ascendancy of mathematical astronomy in the Han dynasty, the Chinese had already developed practical, geometrical applications of astronomical knowledge useful in orienting high value structures. The archaeological record clearly shows this fundamental disposition was firmly established already by the formative period of Chinese civilization in the early 2nd millennium BCE. The imperative to conform precisely to celestial norms led to the cosmological design of ritual precincts like the Hall of Numinous Brightness described here. Moreover, the identity between the Celestial Pole and

the imperial capital and an intense focus on the circumpolar "skyscape" are manifested in the highly symbolic orientation of early imperial capitals.

1. The Mingtang "Hall of Numinous Brightness"

According to the Kang gao 康誥 chapter of Shangshu 尚書, following the establishment of the new Zhou dynasty (1046 – 256 BCE) capital at Luoyang in mid-11th century BCE, a precedent-setting assembly of all the vassals of the realm was convened. Classical texts consistently identify the location of this assembly as the Zhou sacred precinct called Mingtang "Hall of Numinous Brightness". The Mingtang was also the location of similar highly symbolic ceremonial events recorded in early Zhou ritual bronze inscriptions. This is not the place for a comprehensive survey of the cosmological symbolism of the Mingtang in tradition and practice, not least because the subject has already been extensively studied (Hwang Ming-chorng, 1996). Here I propose just to consider the astral associations of the Hall of Numinous Brightness and two early capitals of China's "Celestial Empire". The most authoritative early discussion of the design and function of the Mingtang is that of Cai Yong 蔡邕 (133 – 192 CE) found in his Mingtang yueling lun 明堂月令論 “Excursus on the Hall of Numinous Brightness and the Monthly Ordinances”:

The Mingtang is the taimiao (Grand Ancestral Temple) of the Son of Heaven, wherein the Emperor sacrifices to his ancestors in the company of the Supernal Lord. The lineage of Xia called this place shishi (Chamber of Generations); the Shang people called it chongwu (Multi-storied Chamber); and the people of Zhou called it Mingtang (Hall of Numinous Brightness). The eastern [chamber] is called qingyang (Green yang); the southern is called Mingtang; the western is called zongzhang (Assemblage of Emblems); the northern is called xuantang (Sombre Hall), and the central chamber is called taishi (Grand Hall). The Book of Changes says: ‘Li is brightness, the hexagram of the south. The sage faces south and attends (to affairs), all under heaven face the brightness and are ordered. For the ruler of men there is no more true position than this’ . . . Therefore, although there are five appellations, principal among them is Mingtang . . . Compare this to the Northern Asterism which dwells in its place while all the myriad stars circle it, and the ten-thousand things are regulated by it. [It is] the source from which springs governance and instruction, and the origin of all change and transformation, manifesting unity. Therefore, it is said of the Mingtang that its affairs are great and its meaning profound. If one invokes the aspect of purity, it is called qingmiao (Pure Temple); if one invokes its aspect as the hall of governance, then it is called taimiao; if one invokes the aspect of veneration, then it is called taishi; if one invokes its aspect of facing toward the light, then it is called Mingtang; if one invokes the aspect of the schools of the four gates, it is called the daxue (Great Learning); if one invokes the aspect of being surrounded on the four sides by [a body of] water, round like a jade bi, it is called biyong [Circular Moat]. They are all different names for the same thing—it is one thing. (Mingtang yueling lun, Siku quanshu, 3.6 a-b).

Summing up, Mark Edward Lewis (2006, 271) put it like this:

"the Bright Hall is a microcosm in which both cosmos and state are completely realized. It is a ritual complex that combines rites to ancestors and cosmic deities; an administrative center where all officials are gathered and all policies enacted; and an educational institution in which all true teachings are presented. It is also the summation of the ritual structures of earlier dynasties. As a chart of the cosmos, the source of order, and a summation of history, it becomes the perfect image of power."

1.1 The Mingtang as Celestial Simulacrum

It will be important to consider in more detail some features of the Mingtang that have a direct bearing on the notion of a normative celestial temple. The political and religious significance attaching to the Mingtang, held to inhere in the very design and layout of the Hall, indicates that in addition to the functions named above, the solar and lunar observations essential to calendrical astronomy would also have been performed within these precincts. Given the archetypal role of proper orientation based on the guidance derived from the "images" suspended in the heavens, it now seems clear that the Pure Temple (Great Square of Pegasus) displayed so prominently in the night sky above may actually have been the prototype of the Mingtang on the ground.

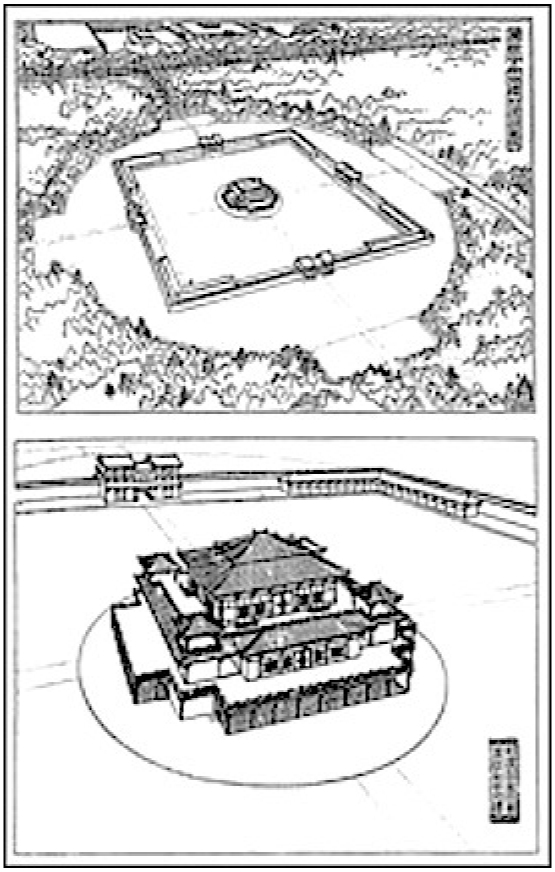

Figure 1a: Artist's conception of Wang Mang's 王莽 (45 BCE – 23 CE) Mingtang (after http-//tupian.hudong.com/s/王莽改制/xgtupian/1/8).

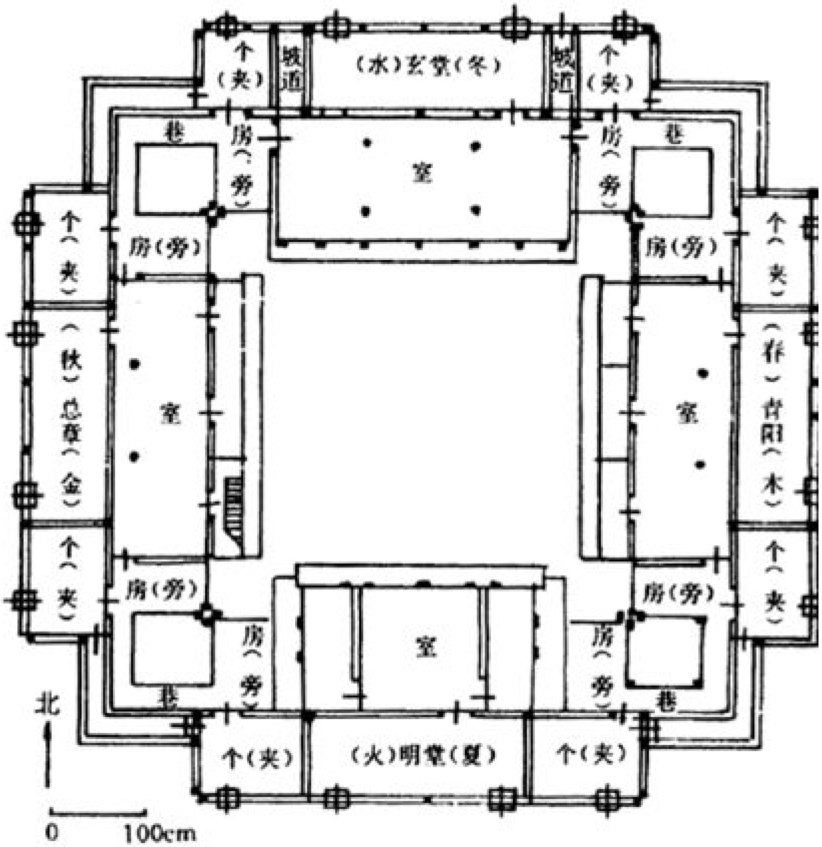

Figure 1b: Plan of Wang Mang's Mingtang based on the 1956 archaeological excavations south of the Han capital of Chang'an (after Yi Ding et al., 1996, 174).

Immediately following the passage above, Cai Yong quotes the Yueling ji 月令記 "Records of Monthly Ordinances":

The Mingtang is that wherein the unification of all things by Heaven and Earth is manifest. The stellar image in Heaven through which the Mingtang communicates is called the [Northern] Asterism

(UMa). Therefore, its twelve palaces here below are the [twelve solar] chronograms. The water surrounds it on the four sides, emblematic of the king's acting as the model for all under Heaven, his virtue reaching abroad to the Four Seas, like this water. (Siku quanshu, Yueling ji, 3.6 a-b).

Here we have it explicitly stated that the correspondence between Mingtang and Heaven is not merely one of cosmological analogy, but that, in fact, this sacred space is precisely the axis mundi through which the terrestrial sovereign communicates with his celestial counterpart at the Pole. Still another Han source, the Liji Mingtang yinyang lu 禮記明堂陰陽錄 "Yin-yang Record of the Hall of Numinous Brightness of the Classic of Rites", elaborates on the details of this resonance between the temporal and celestial realms:

The yin and yang of the Mingtang are the means by which the kingly ruler responds to Heaven. The scheme of the Mingtang is that it is surrounded by water, the water swirling leftward in imitation of Heaven. In the interior is the taishi "Great Hall", in imitation of the zigong (Purple Tenuity Palace; circumpolar stars in UMa and Draco); emerging [from it] to the south there is the Mingtang, in imitation of taiwei (Palace of Grand Tenuity; stars in Leo and Virgo); emerging [from it] to the west there is the zongzhang (Assembly of Emblems), in imitation of wuhuang (Five Ponds; stars in Auriga); emerging [from it] to the north there is the xuantang "Somber Hall", in imitation of yingshi (Lay-out-the-Hall; Square of Pegasus); emerging [from it] to the east there is the qingyang Green yang, in imitation of tianshi (Celestial Marketpace; stars in Ophiucus and Hercules). [Each of] the Supernal Lord Shangdi's four seasons govern its own palace, the kingly ruler too in carrying out Heaven's unification of all things attends to the affairs of the kingdom from the [appropriate] quarter. (quoted in Sui shu: Niu Hong zhuan, 49.1304; cf. Taiping yulan, 533.2b).

If this sounds somewhat idealized, compare Li Daoyuan's 酈道元 (d. 527) striking description in Shuijing zhu 水經注 "Annotated Water Classic" of the design of the Mingtang in the Northern Wei dynasty 北魏 capital of Pingcheng 平城 (present-day Datong 大同) in the early 3rd century:

The Mingtang was round above and square below, on the four sides there were twelve doors and nine rooms, without common walls. Outside the rooms, within the columns and beneath the silk atrium awning were installed mechanical wheels and pale blue-green silk decorated with blue semi-precious stones—looking up it resembled the sky. [On it] were painted the Polar Asterism and lunar lodges, so that it resembled the canopy of Heaven. Each month as the [Northern] Dipper pointed to [successive] chronograms, it revolved to correspond to the way of Heaven; in this respect [the Mingtang] departed from the ancient [model]. On top [of the Mingtang] was added a Numinous Terrace, and below water was led in to form a biyong [Circular Moat]. Along the water's edge stones were laid to form embankments, in this respect according with the ancient scheme. This is what was laid out and built during the Taizhong (227-232) reign period. (Siku quanshu edition, Shui jing zhu jishi ding'e, 13.10b).

2. The Qin Dynasty (221 – 206 BCE) Cosmic Capital

Conscious imitation of the celestial patterns is perfectly consistent with the heavenward orientation of rulership in China from the outset, and in early imperial times gained physical expression, not only in the Mingtang, but in the imperial capital itself.

There are ample historical instances of just such mimicry, which go well beyond the cardinal orientation and number symbolism of the Mingtang. In the "Basic Annals of the First Emperor of Qin" in Shiji "The Grand Scribe's Records" (ca. 100 BCE) there is the following description of the layout of the Qin capital of Xianyang 咸陽:

Thus he laid out and started to build the audience halls to the south of the Wei [River] in the Shanglin [Menagerie]. He started first with the E-pang 阿房 [palace], which was five-hundred paces from east to west and fifty rods from north to south . . . From all sides ran stepped passageways reaching directly from the Hall to the Southern Mountains. He built an elevated passageway from E-pang [palace] across the Wei [River] to connect that hall to Xianyang, thereby symbolizing the Gedao 閣道 "Stepped Passageway" (Cassiopeia), [which runs] from near the Celestial Pole across the Milky Way to connect with lunar lodge Yingshi 營室 Lay-out-the-Hall. (Nienhauser 1994, 148; tr. modified).

Note here the explicit identification of the capital of Xianyang with the Celestial Pole, and the focus on the connection between the Pole and the Celestial Temple, Yingshi Lay-out-the-Hall (Square of

Pegasus), communication between the opposite sides of the Milky Way being accomplished via the Stepped Passageway. Elsewhere in the same chapter, Sima Qian again mentions the link between the terrestrial palace and Celestial Pole:

In his [First Emperor of Qin's] 27th year (220 BCE) . . . He built the Xin 信 "Trust" Palace to the south of the Wei [River]. Shortly afterward, he renamed the Xin Palace the Jimiao 極廟 [Northern] Culmen Temple to symbolize the Celestial Pole. From the Culmen Temple a road led to Mount Li 酈, where he built the front hall of the Ganquan "Sweet Springs" 甘泉 Palace. He constructed a walled corridor to connect it to Xianyang (Nienhauser 1994, 138; tr. modified).

This cosmological analogy, redolent of the celestial source of the imperial charisma and legitimacy, was certainly widely recognized from Qin and Han times on. The Sanfu huangtu 三輔黃圖 "Yellow Plans of the Three Capital Commanderies" (ca. 3rd to 6th century), a widely circulated text compiled from Han sources and frequently quoted down through the Song dynasty (960 –1279), confirms that this astral-terrestrial correspondence was commonly understood. For example, Zhang Shoujie's 張守節

(fl. 725 – 735) Zhengyi 正義 commentary in Shiji quotes the Sanfu huangtu as follows:

The Sanfu huangtu says: ‘When the First Emperor of Qin unified all under heaven he made Xianyang his capital. Because he laid out a palace on North Hill, the Zigong (circumpolar Palace of Purple Tenuity) resembled the Emperor’s Palace. The Wei River ran through the capital, simulating the Milky Way, and the Transverse Bridge crossed [the Wei River] to the south, on the model of Oxherd Qianniu (lunar lodge #9, β Cap) (Shiji, 86.2535).’

In the First Emperor of Qin’s time, in late October to early November the brilliant silvery ribbon of the Milky Way arched across the sky from southwest to northeast, between the circumpolar palace of the heavens and lunar lodge Oxherd (β Cap), precisely like its terrestrial correlate, the Wei River. The Pure Temple (Great Square of Pegasus) was due south, perpendicular to the horizon and only at this moment capable of fulfilling its polar alignment function (Pankenier, 2010). Here we have the probable explanation for the Qin dynasty’s choice of precisely this time to begin the New Year—the highly symbolic celebratory moment when Heaven above and the sub-celestial realm below were exactly congruent.

3. The Han Dynasty (206 BCE - 220 CE) Cosmic Capital

Meticulous mathematical analysis by Stephen Hotaling using scale drawings of the layout and curious configuration of the walls of the early Han capital of Ch'ang-an (built 194 – 190 BCE) suggests that the contours of the northern wall of the city reproduced the shape of the Northern Dipper, while the southern wall reproduced the shape of the Southern Dipper (lunar lodge #8, ϕ Sgr) where the ecliptic intersects the Milky Way (Hotaling, 1978, 1-46, fig. 22; cf. Liu, 2007, 115). Hotaling (1978, 6) cites in evidence an account in the Sanfu huangtu which states explicitly:

The south of the city wall was in the shape of the Southern Dipper, the north was in the shape of the Northern Dipper; it is for this reason that until now people refer to the city wall of the Han capital as the 'Dipper (dou) wall'. (Sanfu huangtu, Siku quanshu, 1.7 a-b).

The east wall of the city, on the other hand, was aligned on true north, while the imperial palaces inside the city, such as the Weiyang 未央 “Everlasting” Palace, were rectilinear and cardinally oriented (Liu, 2007, 116).

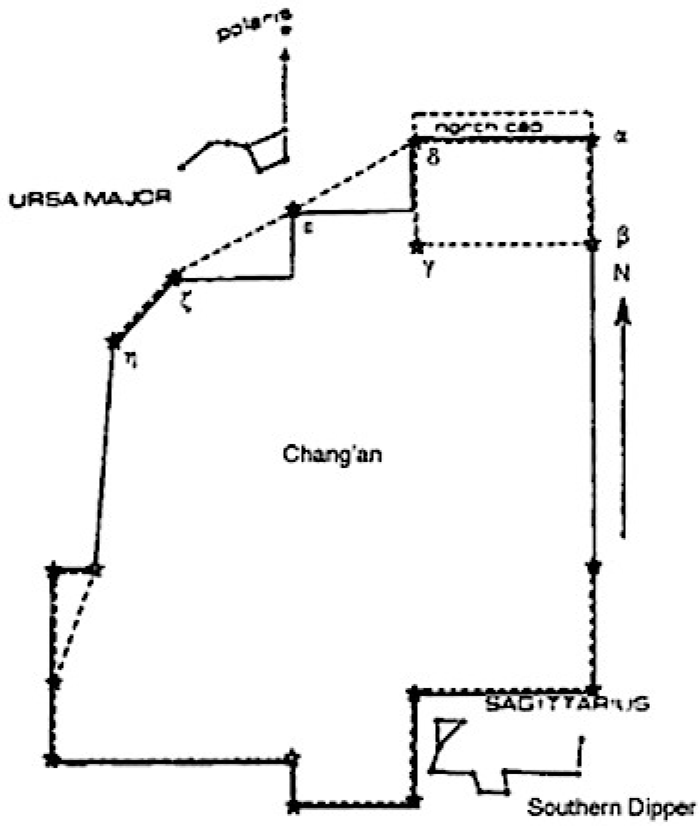

Figure 2: Stephen Hotaling’s proposed reconstruction of the walls of Chang’an (after Hotaling 1978, 39).

At the upper left in Fig. 2 is Hotaling’s inset drawing showing the stars Dubhe and Merak in the "bowl" of Ursa Major pointing toward Polaris. However, Polaris was not the Pole Star in the early Han, and the Southern Dipper, whose outline is supposedly replicated in the south wall, should not lie due south directly behind the Northern Dipper. Instead it should lie well to the north of the southwesterly direction in which the "handle" portion of Chang'an's north wall points in the reconstruction. Most problematical of all, if the design of the north wall of Chang'an had been conceived as Hotaling suggests, the fictive Pole in Chang'an such a configuration would imply would necessarily lie outside the city wall some distance to the north, much as would Kochab β UMi, the brightest star near the Pole in Han times. But placing the Celestial Pole, and hence the axis mundi, outside the walls of the imperial capital is an untenable proposition.

Hotaling's suggested configuration is one that would typically result from drawing the Dipper on a sheet of paper, then placing this chart face up on the ground in order to plan something according to the stellar pattern. However, proceeding in this fashion would invert the orientation of the Dipper, which is fine if the purpose is merely to draw a chart of the constellation. To exactly replicate the stellar pattern on the ground, however, one has to place the drawing of the Dipper face down, as if the circumpolar stars had floated down to the ground surface (or been projected through a template). This procedure correctly reproduces the precise configuration of the circumpolar sky on the ground, thereby preserving an exact correspondence between the imperial capital and the Supernal Lord's abode at the Pole.

Thus Hotaling's reconstruction, while otherwise ingenious, is conceptually flawed in a crucial respect. The contradictions can easily be resolved, however, if one imagines the Dipper "emptying" inward rather than outward as in Fig. 2 above; that is, configured in a manner identical to its depiction on shi 式 "cosmographs" (Fig. 3) and stone reliefs of the period (Fig. 4). It is extremely doubtful whether the diviners who made such cosmographs or the engineers who built Chang'an's walls ever imagined themselves actually looking down on the pole from a vantage point outside the cosmos. They simply followed the procedure described above: "looking up they took the images from Heaven", then floated them down unmediated to earth. They were not about mapping the sky, but about making a precise simulacrum of the Celestial Pole.

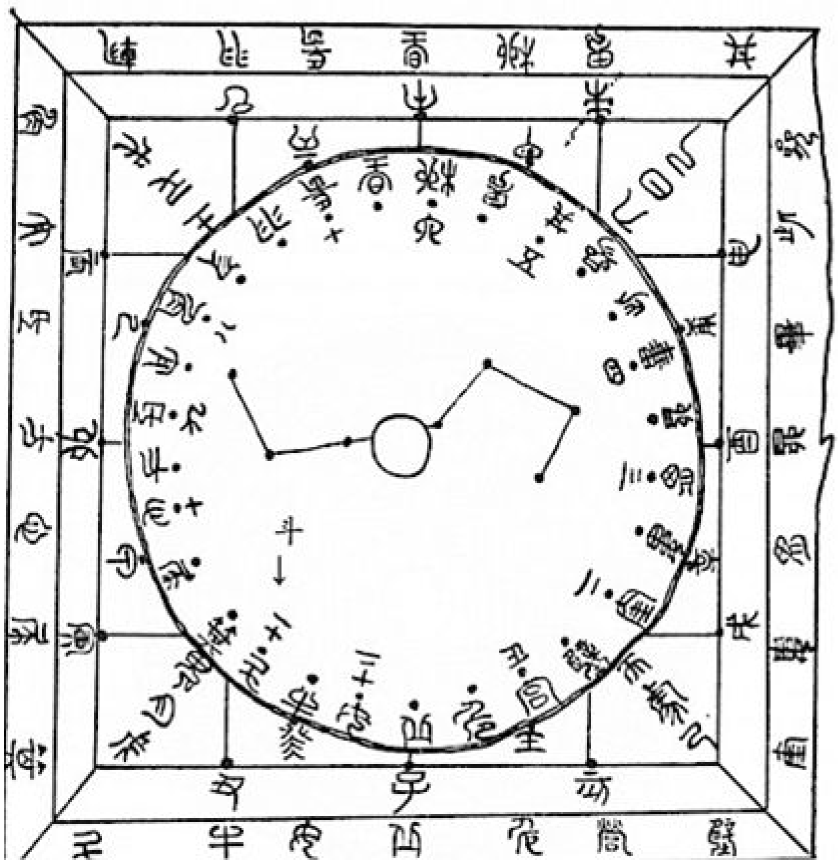

Figure. 3: Early Han cosmograph with the Dipper at the center of the rotating “Heaven Plate”; from the tomb of the Marquis of Ru Yin, ca. 168 BCE (after Major, 1993, 42).

Figure 4: Stone carving from the Wuliang Shrine (ca 2nd c. CE) showing the Supernal Lord Shang-di driving his heavenly chariot, the Dipper (after Major, 1993, 108). (Note the depiction of Alcor.)

On Hotaling’s drawing in Fig. 2 the proposed revision would simply entail flipping the north-south positions of the pairs of “bowl” stars—Megrez and Phecda, Dubhe and Merak—with the result that the Pole (and all the “imperial” stars of UMi) would then lie inside the walls of Chang’an. Admittedly, the position of the last star in the handle of the Dipper, Alkaid (η UMa), looks out of place and somewhat incongruous in Hotaling's drawing of the north wall, but it was the reconstruction of precisely this section of the wall that posed the greatest problems, leading to Hotaling's characterization of this part as tentative. Significantly, this modification of Hotaling's solution would also resolve the seemingly problematical identification in Fig. 2 of the south wall with the Southern Dipper (ф Sgr), because now the Southern Dipper's location vis à vis the north wall's Northern Dipper would correspond to its true position in the sky. On the Han cosmograph in Fig. 8 Nandou, Southern Dipper, is shown by the character dou 斗 in the 8 o'clock position. This would also explain the curious fact, which confounded Hotaling, that the moat along the south wall of Chang'an actually cut through the 'scoop' of the Southern Dipper where it protrudes from the wall. Given the precedent established by the First Emperor of Qin as documented above, who exploited the Wei River's course to make it flow through the capital of Xianyang, and given the fact of the Southern Dipper's actual location in the "silvery river" of the Milky Way, this curious feature of the south wall of Chang'an now also fits the pattern.

Whether or not we have recovered the precise explanation for the idiosyncratic configuration of the walls of Chang'an, we have it on good authority that the identification of the earliest imperial capitals with the Celestial Pole was certainly in the minds of their builders and imperial residents. Between early Zhou (early first millennium BCE) and the immediate pre-imperial period the picture remains somewhat confused, and confusing. A vast amount of new archaeological information has emerged since Wheatley's (1971) pioneering study, but the data on cardinal alignment has yet to be systematically compiled and analyzed. A significant obstacle is that many site plans in the archaeological reports fail even to indicate the direction of magnetic north, much less axial alignments of structures in azimuth. Mingtang from the earliest period are notoriously difficult to identify from excavated foundations, but there are notable examples of precise north-south orientation, such as the Eastern Zhou (8th – 7th century BCE) royal city of Wangcheng (von Falkenhausen 2006, 172). As in the case of the shift from the west-of-north to the east-of-north bias coincident with the Xia (1953 – 1555 BCE) to Shang (1554 – 1046 BCE) dynastic transition (Pankenier, 2004), changes in alignment can most definitely be indicative of significant socio-political or cultural transitions, as has been pointed out in the case of the Western Zhou devolution of power to Qin in Shaanxi:

Qin tombs differ in two respects from Eastern Zhou-period tombs elsewhere in the Zhou culture sphere: they are overwhelmingly oriented east-west rather than north-south, and they feature flexed rather than extended burial. These idiosyncracies have been taken as markers of an alien ethnic identity of the Qin people. And indeed it is impressive to observe how the predominant tomb orientation at central Shaanxi cemeteries suddenly shifted by 90 degrees at the transition from Western to Eastern Zhou, when the Qin took over the area from the royal Zhou (von Falkenhausen 2006, 215).

4. Conclusion

The ancient Chinese were intensely interested in the circumpolar region, and especially in the mysterious Pole itself, from the very beginning of Chinese civilization (Pankenier, 2004). Study of the role of astronomical alignment in shaping the built environment shows that centuries before the emergence of mathematical astronomy in the Han dynasty, the Chinese had already developed practical, geometrical applications of astronomical knowledge. A case in point is the sophisticated use by mid-1st millennium BCE of the parallel sides of Ding — the "Pure Temple" (Great Square of Pegasus) — to achieve a ritually correct polar alignment of symbolic structures (Pankenier, 2010; Ban Dawei, 2008).

I have traced the evidence of a persistent intentionality—a focus on the heavens, and especially the circumpolar sky—in symbolic representation, literary sources, and applied astronomy. There are innumerable references in classical Chinese literature to the vital necessity of maintaining conformity with the normative patterns of the cosmos. Long before this core idea became enshrined in the imperial ideology, the archaeological record clearly shows this fundamental noetic disposition was firmly established by the formative period of Chinese civilization in the early 2nd millennium BCE. The imperative to conform to Heaven made it essential to devise practical methods of achieving that objective. The practice of divination is one modality that exemplifies this impulse. Devising a calendar is another. The design and symbolism of ritual precincts like the Mingtang "Hall of Numinous Brightness” is another. And finally, as shown here, an age-old preoccupation with the circumpolar “skyscape” continued to manifest itself in the highly symbolic orientation of early imperial capitals.

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17. Cosmology and the Death of Gods: New Age Religions, Anti-Christ, and Precession of the Equinox

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Cosmology.com

Most calendars are based on astronomical, cosmic events, including the phases of the moon, the Earth's orbit around the sun, and the rotation of the 12 constellations. Calendars are linked to the cosmos and serve to predict the future, when to plant and harvest the crops, the coming of winter and summer, when leaves and rains will fall. Most calanders are based on rotating cycles, dates repeating themselves, and not just dates, but anniversaries, birthdays, and when to celebrate or lament historical events. Calanders also serve to regulate human behavior, to plan and predict the future, and the best predictor of the future is the past.

The Mayan and Aztec calanders were based on the solar year of 365 days, another on a 260 days year and the orbit of Venus. Yet another was called the long count, and was used to compute and calculate cosmic events which occurred hundreds, thousands, and even millions of years before, and to predict when similar events would happen again.

Mayan scientists learned to chart the heavens, visualize eternity, and to count in millions. Over a thousand years ago, the Mayans calculated the solar year at 365.2420 days (Coe, 2001; Thompson, 1993, Wright, 2011), which is remarkably close to the modern "scientific" figure of 365.2422: the exact length of a solar year. Likewise, the Mayas calculated that it took the moon 29.528395 days to orbit Earth—a figure nearly identical to that given by modern scientific instruments: 29.530588 days.

They also discovered the concept of zero, or nothing (Coe, 2001) and believed in the concept of infinity, as did the Hindu and Aryan sages of ancient India. They erected great pyramids, astronomical observatories to chart the stars, they speculated about death and the afterlife as related to the planets and the cosmos, and conducted complex mathematical rituals, and employed a variety of mind bending hallucinogenic substances to expand their consciousness and open their minds,

The Mayas may have even determinedthe orbit of our solar system around the Milky Way galaxy which in turn may have been depicted or conceptualized as the god, Quetzocoatl, or a cosmic serpent. Mathematical equations, calculations and predictions decorated public buildings, monuments, pyramids and temples. Some scholars believe, the Mayan priesthood worshipped math and the concept of time.

As summed up by Thompson (1993) “In the Maya scheme the road over which time had marched stretched into a past so distant that the mind of man cannot comprehend its remoteness. On a stela at Quiriga in Guatemala a date over 90 million years ago is computed; on another a date over 300 million years ago is given. These are actual computations, stating correctly the day and month positions, and are comparable to calculations in our calendar giving the month positions on which Easter would have fallen at equivalent distances in the past. The brain reels at such astronomical figures.”

The Mayan astronomer priests of ancient Mexico and Central America, also determined the synodical revolution of Venus, i.e. 584 days, which is the time it takes Venus to return to a specific point in the heavens as viewed from the Earth. Like the medieval Catholic Church, the Mayas (as well as the Aztecs) associated Venus (the Morning Star) with the Great Serpent.

The Mayas recognized that the figure of 584 was just a very close approximation, because the movements of Venus and Earth are not completely regular. The Mayans thus arrived at an “average” synodical period of 583.92 days (Thompson, 1993)—a figure nearly identical to modern estimates.

The Mayan/ Aztec calander predict not just the coming of the seasons and the days of the week, but when the hands of the cosmic clock would shift and the rising sun would appear in a new constellation, thus signifying the coming of a new age every 2,160 years.

CIRCLES WITHIN CIRCLES: MILKY WAY AND THE CONSTELLATIONS

The Milky Way galaxy can be viewed in the darkness of night, edge-on, snaking in a curving arc, forming part of a circle. Through careful observation, the ancient priest-scientists deduced the existence of a circular galaxy, of which Earth, and the constellations circled round, or which circled round forming a cosmic clock.

FIGURE: Milky Way galaxy

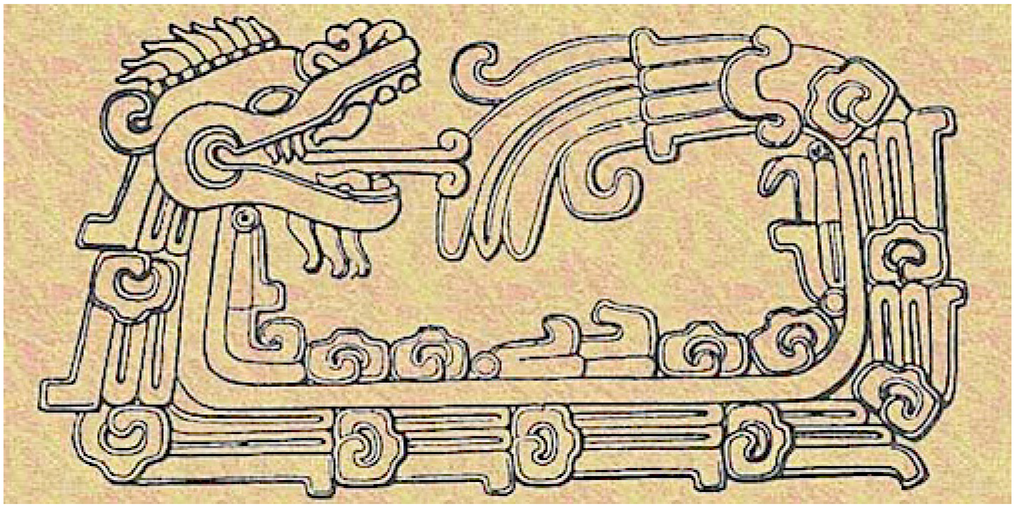


FIGURE: Quetzalcoatl Maya Galaxy

FIGURE: Milky Way galaxy

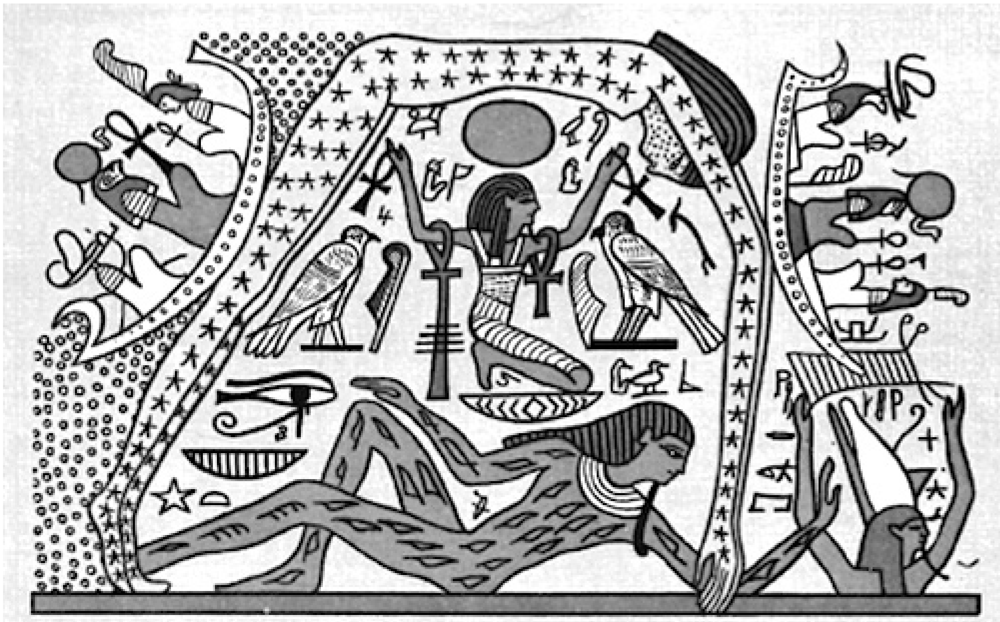


FIGURE: Egyptian: Note Key of life representing the sign of the cross, and coiled around are the stars of the milky way galaxy.

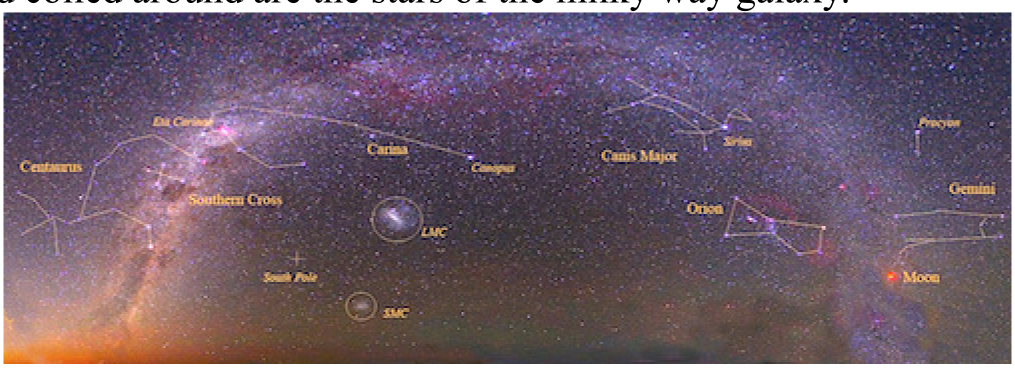


FIGURE: Milky Way Galaxy, viewed from Earth, with some of the constellations depicited. Not position of Orion (Osiris) and Gemini (compare with figure below)

FIGURE: Ancient Eguypt: Osiris atended by the Gemini twins, and above: the Milky Way galaxy, and 12 constellations of the zodiac represented by snakes.

The Milky Way Galaxy

FIGURE: Milky Way Galaxy


FIGURE: Quetzalcoatl

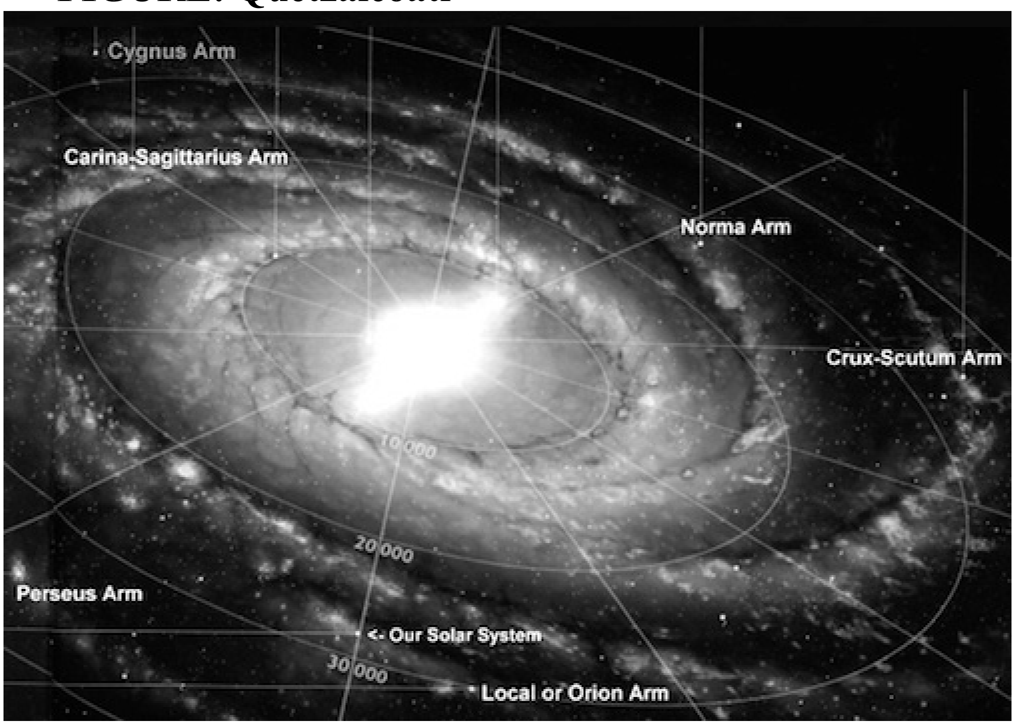


FIGURE: Milky Way Galaxy

FIGURE: Apep - Egyptian - Milky Way Galaxy

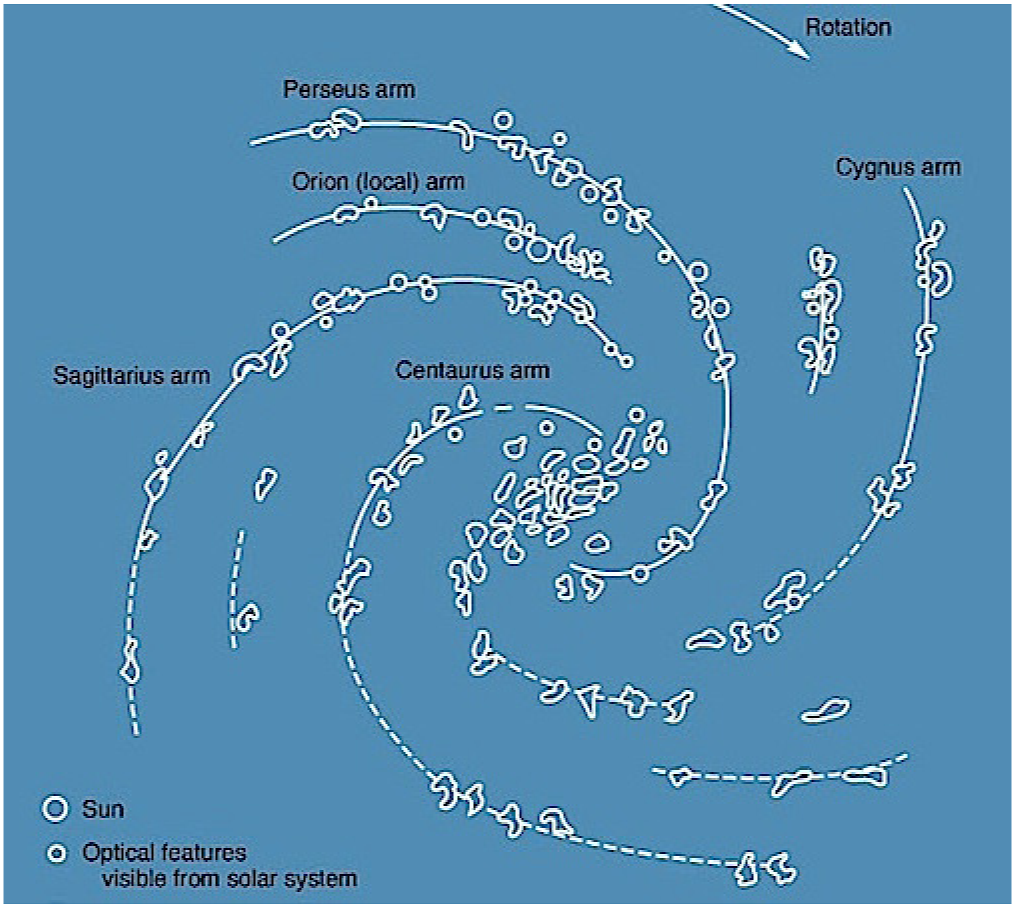
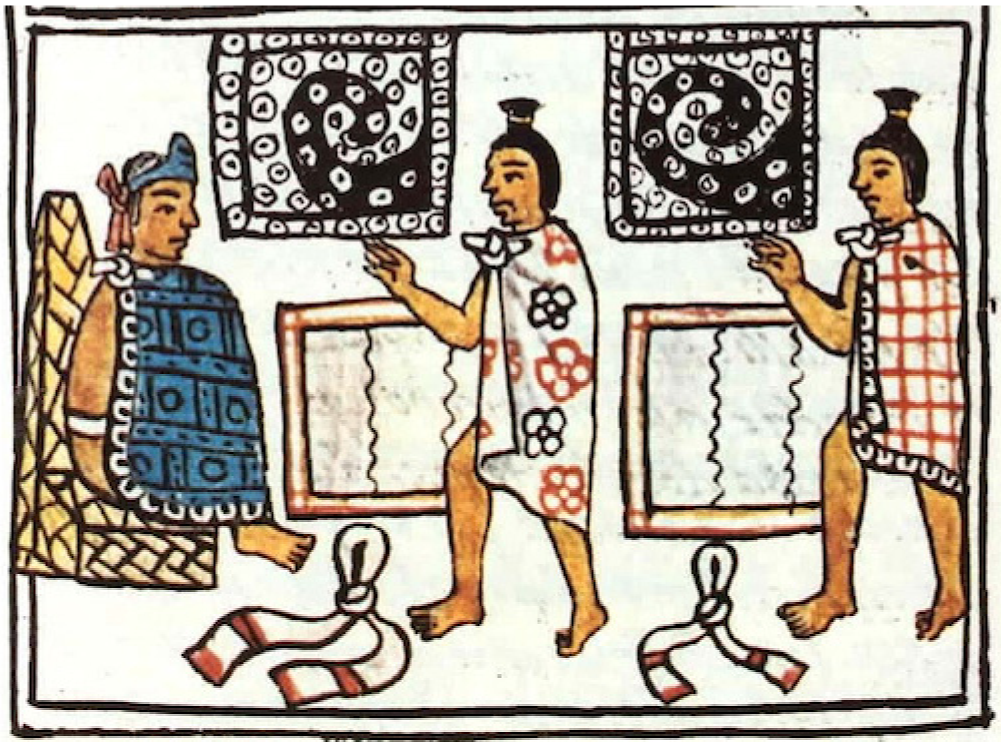


FIGURE: Milky Way Galaxy



FFIGURE: Aztec, Quetzalcoatl / Galaxy

The Cosmic Clock and the Equinox

The priests were scientists, mathematicians, and astronomers who believed by studying the movements of the stars and cyclic cosmic events, that they could scientifically predict what would occur in the future, as based on what has transpired in the past (Coe, 2001; Nigel, 1990; Thompson, 1993).

According to the Mayan/Aztec Calanders, cosmic cycles and each new age are linked to a cosmic clock, with the ticking of the hands, marked by the sun, as it rises in a different house of the 12 constellations on the equinox and solstice every 2,160 years; a precessional calendar that, in total, is 25,776 years in duration. In the year 2012, the cosmic clock, and the rising sun, marked the beginning of a new age ruled by Leo and Aquarius and the death of the previous age which was governed by Pieces and Virgo for the previous 2,160 years.

According to the Mayan and Aztec calandars, the clock has come not full circle, but half circle, for 13,000 years ago the cosmic clock marked time by the rising sun in the constellations of Leo on the day of the on

Spring Equinox and Aquarius on the Autmn equinox. Twenty six thousand years ago, the cosmic clock marked Aquarius on the day of the Spring Equinox and Leo on the Autmn equinox as is the case since 2012, having come full circle.

The Mayan priests devised a calendar which included a “sacred year,” the tzolkin of 260 days, and which was separated into 13 months of 20 days each. As we shall see “13” is a precessional number related to the cyclic movement of the cosmic clock and the onset of new ages and the ending of old ages. In addition, they devised a calendar based on the “Long Count” which incorporated their beliefs about the future and the past (Wright, 1991).

This Long Count Calendar was in turn based upon the even more ancient bar-and-dot calendar devised by the Olmecs. The Olmecs bar-and-dot calendar—with a current starting date of 8/13/3113 B.C. (4 Ahau 8 Cumku)—predicts that the onset of the new age of Aquarius and the the next great cosmic cycle began on December 23, 2012 (4 Ahau 3 Kankin). 2012 is also the date given by the Mayan and Atec calendars for the onset of the new age and the ending of the last age.

THE PYRAMIDS: HEAVEN ON EARTH

The Pyramids of Kukulkan

Kukulkan, the “feathered Serpent (also known as Quetzalcoatl by the Aztecs) was the Great God of the Maya--a god that coiled through the cosmos according to specific cycles and whose movements and coming and goings coincided with cosmic rebirth, and destruction. The Mayas, in honor of their god, and to track and record his movement through the cosmos, erected an observatory, the Temple of Kuklukan, located in Chinchen Itza, in northern Yucanta, Mexico.

Figure: Kuklukan

The Temple of Kuklukan, towers nearly 100 feet, and forms a perfect four sided ziggurat, a pyramid, with four stairways with 91 steps each. Coupled with the last step, the threshold to the top platform, the total steps come to 365 which corresponds with the number of days in a solar year.

The Temple of Kuklukan, was constructed with astronomical-geometric precision. The northern staircase was also designed to react to the sun, twice a year, by giving rise to the illusion of a giant serpent undulating across the steps. The illusion of a slithering snake lasts for a period of 3 hours and 22 minutes on the day of the spring and autumn equinoxes.

The Pyramids of Teotihuacan

Like the 3 great pyramids of Egypt, the pyramids of Teotihuacan appear to serve as a terrestrial map of the heavens. Teotihuacan is notable not only for its Pyramid of the Sun, but for its Pyramid of the Moon, the Pyramid of Quetzalcoatl, and the "Citadel," all of which form an axis referred to as the "Street of the Dead." The orientation of the "axis" however is slightly off center. The "Street of the Dead" is inclined 15 degrees by 30 degress east of north. The design is believed to have been purposeful and based on astronomical alignments which form a map of the heavens (Harleston, 1974; Nigel, 1990, Thompkins, 1987), “the sky-world where dwelt the deities and spirits of the dead” (Thompkins, 1987).

Figure: Teotihuacan

It has also been determined that Teotihuacan may have been designed to serve as a scale model of the solar system, with the center line of the Pyramid of Quetzalcoatl representing the position of the sun, with the temples and pyramids of the “Street of the Dead” denoting the precise orbital distances of the outer planets, i.e. Pluto, Neptune, Uranus, Saturn, Jupiter, and the asteroid belt (Thompkins, 1987).

What is even more striking is that Uranus was not “discovered” by Western scientists until 1787, Neptune in 1846, and Pluto in 1930. The “Street of the Dead” and its temples and pyramids appear to be at least 2000 years old (Nigel, 1990).

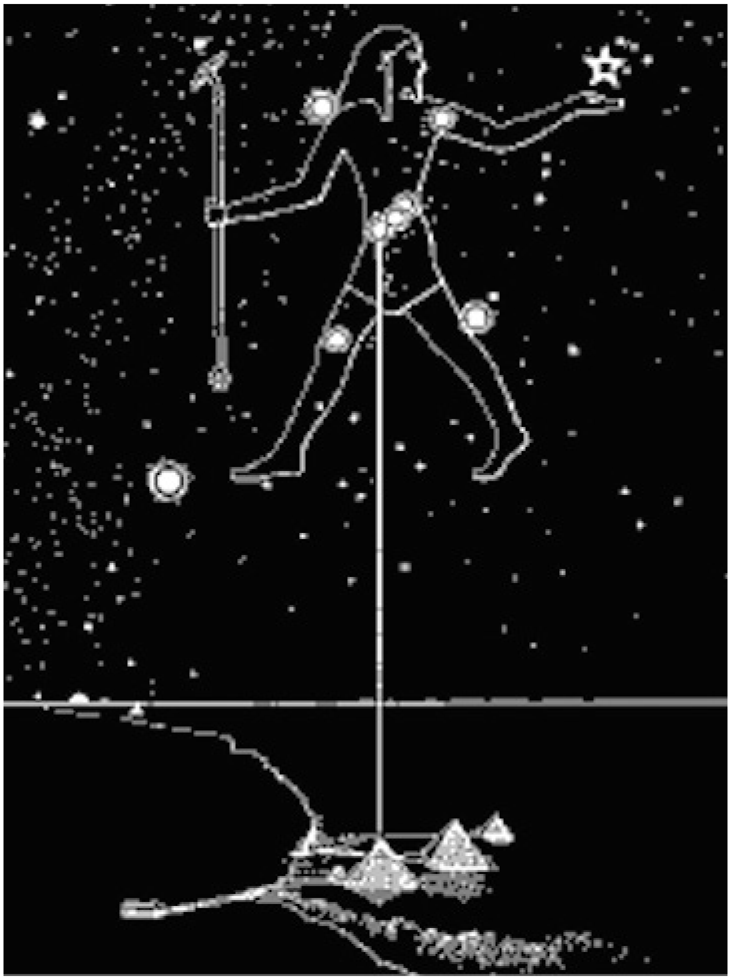
How did the ancients discover the presence of the outer stars? In the same manner as modern astronomers: Through mathematical calculations.

The city of Teotihuacan was a center of scientific study. It was believed by the “place of the gods” where the gods would gather. This included the god Huehueteotl—the god who gave life its beginning and who formed the first woman and man—humans who were also part god (Nigel, 1990). However, the gods were associated with the cosmos, the Milky Way galaxy, and the stars and planets.

Figure: Teotihuacan

The Pyramids of Giza and the Belt Stars of Osiris

The three great Egyptian pyramids of Giza appear to have been constructed to form a terrestrial map of the heavens, specifically, the three belt stars of the constellation of Orion and thus the house of Osiris. The three great pyramids are oriented closely together, and although the four corners of each pyramid point due East, West, North and South are oriented along an axis which mimics the three belt stars of Orion (Bauval, 1994).



As pointed out in 1994 by Robert Bauval, a Belgian construction engineer, the three pyramids of Giza, are aligned in the exact orientation and interrelationship of the three belt stars. Like (the lower) two of the three pyramids (Khufu, Khafre), the lower two belt stars, Al Nitak and Al Nilam, form a perfect diagonal. However, like the upper pyramid (Menkaure), the third, upper star, Mintaka, is offset slightly to the East.

According to Bauval: “It is really quite obvious that all these monuments were laid out according to a unified plan that was modeled with extraordinary precision on those three stars. What they did at Giza was to build Orion’s Belt on the ground.”

Specifically, when mapped against the Orion Constellation, it is apparent that the Great Pyramid of Khufu occupies the same position as Al Nitak, whereas the Pyramid of Khafre occupies the same position as Al Nilam, whereas the Pyramid of Menkaure occupies the position of Mintaka—moreoer, it has been argued that their position most closely matches the belt stars 12,500 years ago: on the same date that Orion’s Belt was at its lowest altitude in the precessional cycle. The figure of 12,500 years ago also corresponds to a date which marks the point at which the 3 belt stars began their upward cycle.

“At 10,450 BC—and at that date only—we find that the pattern of the pyramids on the ground provides a perfect reflection of the pattern of the stars in the sky. I mean it's a perfect match— faultless— and it cannot be an accident" (Bauval, 1994)

The three pyramids of Giza not only serves as a terrestrial map of the Orion Constellation, but by their differences in size, also reflect the different magnitudes of these three belt stars (Bauval, 1994). In addition, other structures on the Giza plateau correspond to the location and interrelationship of the stars of the Orion Constellation, and thus provide a map of the heavens.

THE PYRAMIDS: EARTH IN HEAVEN

Although one may speculate as to their meaning, the evidence clearly demonstrates that there was an objective, scientific, and astronomical basis for the design and construction of the pyramids of Egypt and old Mexico— an objective scientific basis which explains why there are so many similarities between the religious structures erected by people from completely different cultures and living on separate continents, thousands of years ago. The objective similarities are due to their being modeled on the same heavens and based on the same science.

For example, the Teotihuacan Pyramid of the Moon is shorter than the Pyramid of the Sun. However, their summits are level. Similarly, in Egypt, the summits of the Great Pyramid and the Pyramid of Khafre are the same, although the Khafre pyramid is shorter. This was accomplished by building the Pyramid of the Moon and the Pyramid of Khafre on higher ground (Smyth, 1990).

The pyramids of Giza and the pyramids of Teotihuacan, also incorporate, and in the same way, the value of pi. Pi is the constant that is multiplied by the diameter of a circle to give its circumferences (Harleston, 1974).

The area of the Great Pyramid's base (3023.16 feet) divided by twice its original height (481.3949 feet) gives the figure 3.1400000+ (pi). In addition, the ratio between its height and perimeter is the same as the ratio between the circumference and radius of a circle, i.e. 2 pi. And, if we multiply the height of the pyramid by 2 pi, we get the perimeter of its base.

FIGURE: Teotihuacan Pyramid of the Moon and Sun

FIGURE: Pyramids of Giza

The Pyramid of the Sun has a gentler slope compared to the pyramid at Giza, 43.5 vs 52 degrees and it is not as tall, 233.5 feet vs 481.3949. However, its base is almost the same, 2932.8 vs 3023.16 feet. Even so, the pi formula can be applied to the Pyramid of the Sun (Harleston, 1974). Its base divided by twice its height is equal to two pi, i.e. 6.2800. Its base divided by four times its height is equal to one pi, i.e. 3.1400... And, if we multiply the height of the pyramid by 4 pi, we get the perimeter of its base.

The builders of the pyramids of Egypt and ancient Mexico were well versed in geometry and astronomy and knew the relationship of the radius to its circumference. They knew the circumference of the Earth, and the distance of the center of the Earth to the poles. For example, the ratio of the Great Pyramid's altitude to its perimeter is the same as that of the polar radius of the Earth to its circumference: 2 pi, whereas the same ratio when applied to the Pyramid of the Sun yields the same figure if divided by two.

In fact, as determined by Charles Piazzi Smyth (1990), the Astronomer-Royal of Scotland, the Great Pyramid incorporates and reveals the distance of the Earth from the sun when its height is multiplied by the proportion of its height to its width, that is, ten to the ninth power.

In addition, the height of the Great Pyramid is 1:43,200 of the polar radius of the Earth and the perimeter of its base is 1:43,200 of the Earth's equatorial circumference. In other words, by multiplying the base and height of the Great Pyramid by 43,200 one can arrive at an astonishingly close approximation of the dimensions of the Earth (Smyth, 1990).

The builders of the Great Pyramid "had determined the shape of the Earth which they knew to be a true circle, its size, its precise circumference, the geographical distance from the equator to the poles, the fact that the Earth is flattened at the poles, degrees of latitude and longitude to within a few hundred feet, the fact that they were shorter at the equator and longer at the poles, and the exact distance of the Earth from the sun. They had designed the pyramid's base to correspond to the distance the Earth rotates in half a second" (Funrneaux, 1987, p 17). The same can also be said of the builders of the Pyramid of the Sun (Harleston, 1974).

In summary: the Great Pyramids of Egypt and Mexico, appear to have been built in accordance with precise geometrical and astronomical laws to serve as a map of heaven, and to record the dimensions of Earth and the duration of the solar year. The Great Pyramid and the Pyramid of the Sun not only served as scale models of this planet, but could be used to record the movements of the Earth around the heavens in relation to the sun and the stars—the dwelling place of the gods. Moreover, they may have been used to predict or signify the death of old gods and the birth of new gods as releated to which house the sun rises on the equinox.

THE DESTRUCTION OF ANCIENT KNOWLEDGE

“The mind has lost its cutting edge, we hardly understand the Ancients.” —Gregoire de Tours, 6th century

The astronomer priests of the ancient world made a number of startling discoveries about the cosmos, our solar system, and the Earth—startling because thousands of years would pass before modern western scientists would make the same discoveries.

Much of the science of the ancient world has been lost through natural and cosmic catastrophes, or destroyed by the hand of man. In consequence, we know almost nothing about the ancient past, and much of what we do know, is dismissed by “experts” who cloak their ignorance with derision and laughter.

We suffer from a collective amnesia as to ancient civilizations and those events which transpired six thousand years ago, ten thousands years ago, and so on.

This amnesia is in large part, purposeful, for the books detailing the pre-deluvial past, and the treasures of knowledge the ancients had acquired, have been deliberately destroyed by priests, princes, and conquering kings.

In 213 B.C., the Emperor Chou-Houng-Ti, destroyed a hundred thousand books. When the library of Alexandria was burnt, tens of thousands of manuscripts went up in flames. When Pergamo was burned to the ground, 200,000 ancient books were reduced to soot and ash. And what of the ancient books from the library of the Temple of Solomon, from the sanctuary of Phtah of Memphis, the libraries of ancient Athens? Dust. Ashes and dust, of which only fragments remain...fragments and those few ancient stone tablets, temples, and pyramids which escaped the destructive hand of man.

Yet, despite the destructive efforts of the conquerors of old, and the priests of the medieval church who preached: “Thou shalt not know,” we have learned that knowledge is not a sin, and that the ancients were men of great wisdom who had studied and learned from the stars.

Copernicus stated explicitly in the preface to his works, that it was from his reading of ancient authors that he learned of the movements of the Earth. And likewise, Newton and Galileo openly admitted their debts to the scientists of old. Indeed, Newton believed that the ancients had learned the secrets of the creation, transmutation, and destruction of matter, as well as the secrets of the stars.

"If I have seen further, it is by standing on the shoulders of giants" — Newton. Newton stood on those ancient shoulders because he desired a clear view of the stars.

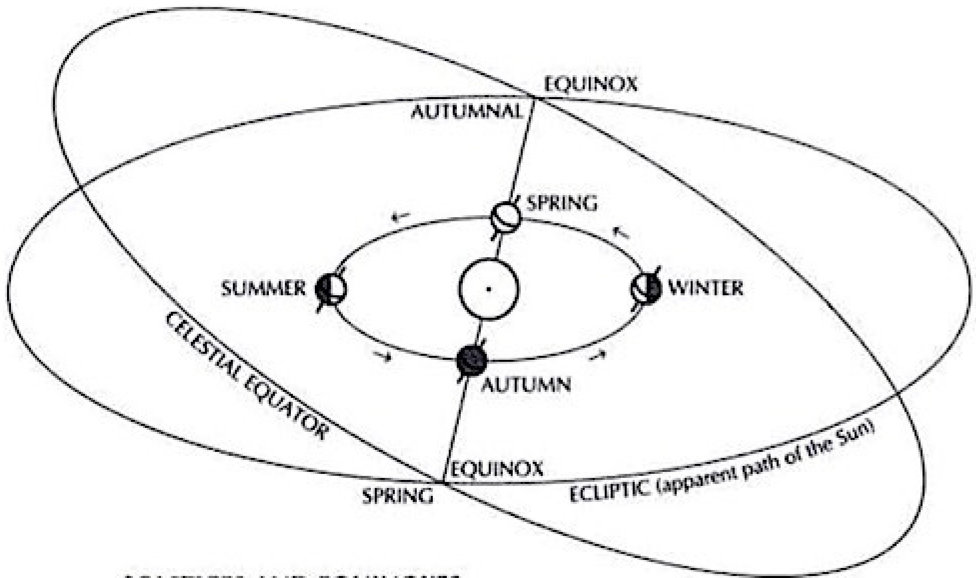
The ancients studied the stars because they believed the future could be predicted by the past, and that time itself was linked to the cyclic movements of the Earth through the heavens. These are not superstitions. Modern day calendars are based on the same principle.

However, whereas modern day calendars are based on the orbit and tilt of the Earth during a 365 day period, the ancients relied not only on a solar calendar, but a precessional calendar that was 25,776 years in duration—a calendar and cosmic clock that also predicts cycles of cosmic creation and destruction, and the birth and twilight of the gods as represented by the stars and the 12 constellations.

PRECESSION AND THE COSMIC CLOCK: THE FUTURE IS THE PAST

The illusion that the Sun moves, from north to south, and then back again, in synchrony with the waxing and waning of the four seasons, is due to the changing tilt and inclination of the Earth's axis, as it spins and orbits the sun. Thus over a span of 12 months it appears to an observer that the days become shorter (winter) and then longer (summer) and then shorter again as the sun moves from north to south, crosses the equator, and then stops (solstice), and heads back north again, only to stop (solstice), and then to again head south, crossing the equator only to again stop (solstice) and head north again.

The two crossings each year, over the equator (in March and September) are referred to as equinoxes. The two time periods in which the sun appears to stop its movement, before reversing course (June and December), are referred to as solstices—the "sun standing still."



SOLSTICES AND EQUINOXES

The sun was recognized by ancient astronomer priests, as a source of light and life-giving heat, and as a keeper of time, like the hands ticking across the face of a cosmic clock.

Because of the scientific, religious, and cosmological significance of the sun, ancient peoples, in consequence, often erected and oriented their religious temples to face and point either to the rising sun on the day of the solstice (that is, in a southwest—northeast axis), or to face the rising sun on the day of the equinox (an east-west axis).

For example, the ancient temples and pyramids in Egypt were oriented to the solstices, whereas the Temple of Solomon faced the rising sun on the day of the equinox.

Over eons of time ancient peoples were forced to slightly alter the orientation of their temples, due to precession and cyclic changes in the inclinations of the Earth’s orbital path (the ecliptic) and in its axis (obliquity). For example, the angle of the tilt of the Earth was 24 degrees in 4,000 BC, but has been reduced to 23.5 degrees in modern time. Eventually the angle of the tilt will reverse course and assume a greater angle of inclination.

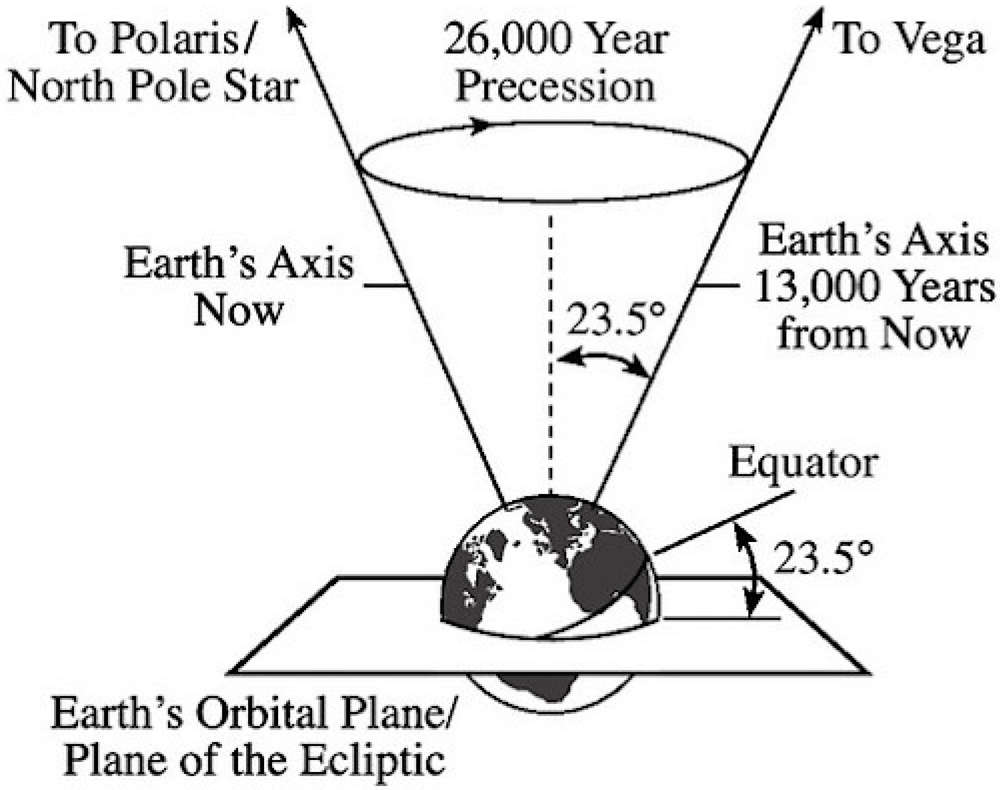
The gravitational influences of the sun and the moon, coupled with the angle of the tilt of the Earth—that is, the axis of the orientation of the north and south pole—also causes the planet to slowly wobble as it orbits the sun—a phenomenon referred to as “precess.”

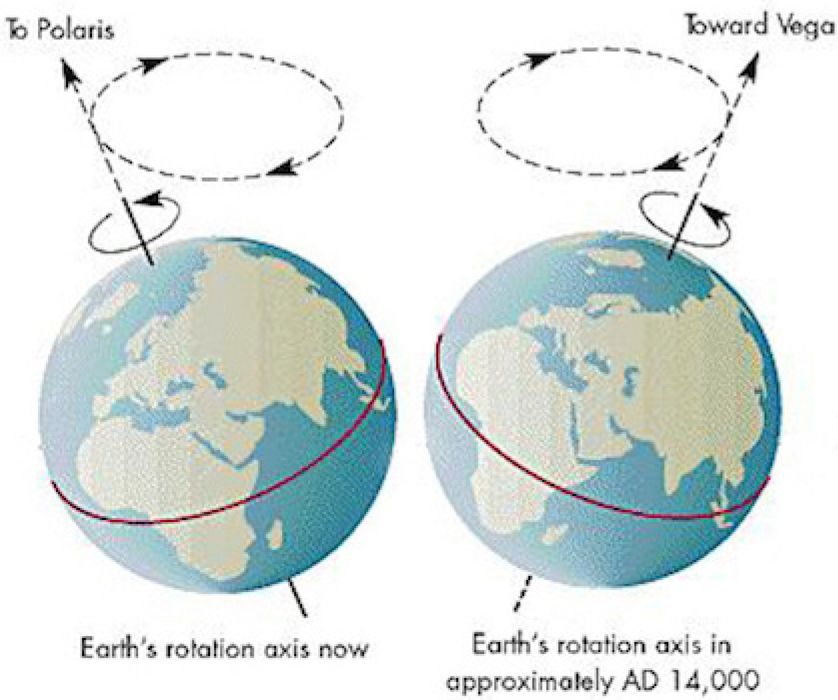
As will be detailed, the priests of antiquity discovered precess, thousands of years ago. The Earth spins at the rate of 1000 miles per hour (as measured from the equator) and orbits the sun at 67,000 miles per hour. This orbital and circular motion generates incredible centrifugal forces which cause the Earth’s equator to bulge outward whereas the poles are somewhat flattened, thus giving the planet a (sideways) egg-like shape of an oblate spheroid. However, this extra mass at the equator also serves to keep the Earth steady on its axis as it orbits the sun—like the outer rim of a spinning top or gyroscope.

It is said that this oblate spheroid shape of the planet was first discovered by Sir Isaac Newton. However, almost a thousand years before Newton, Muhammad describe the Earth as “shaped like an egg.” Muhammad was correct.

And because of the gravitational influences of the sun and the moon, coupled with centrifugal forces, the angle of the tilt of the Earth slowly alters over time as it spins and orbits the sun. The alteration in the tilt of the Earth is cyclic, and over the course of the last 41,000 years, the tilt has been reduced by 1.5 degrees, i.e., from 25 degrees to a little less than 23.5 degrees.

Because the angle of the tilt—that is, the orientation of the north and south pole—alters over time, and t he retardation of the Earth’s orbit, and thus due to a cyclic phenomenon referred to as “precession,” over time the north pole “points” at different stars, and the sun rises in different constellations, like the movements of the hand of a clock.


To Polaris/
North Pole Star
26,000 Year
Precession
To Vega
Earth's Axis
Now
23.5°
Earth's Axis
13,000 Years
from Now
Equator
23.5°
Earth's Orbital Plane/
Plane of the Ecliptic


To Polaris
Toward Vega
Earth's rotation axis now
Earth's rotation axis in
approximately AD 14,000

Precession

The ancient astronomer priests discovered “precession” thousands of years before modern western scientists (Santillana & von Dechen, 1969; Sellers, 1992).

There is a cosmic clock-like regularity to “precession”—like the hands moving around the circular face of a clock.

At present, the north pole points at the “pole star” referred to as Polaris (alpha Ursae Minoris). Five thousand years ago the north pole pointed at alpha Draconis. Thirteen thousand years ago it pointed towards Vega.

In thirteen thousand years, the north pole will again point at Vega. Twenty thousand years from now it will again point at alpha Draconis. And, in 25,776 years it will again point at Polaris.

Thus, it takes the Earth 25,776 years for the hands of the cosmic clock to make a complete circular rotation and to complete a full precessional cycle.

The Four Seasons and the Sign of the Cross

Because the orientation and tilt of the Earth also shifts as it orbits the sun, the amount of sunlight the Earth receives varies during the course of a single orbit, but in a predictable, clock-like fashion (Hays et al., 2006). As noted, this change in the tilt of the planet gives rise to the four seasons and what is referred to as the winter and summer solstices and the autumn and spring equinoxes.

To honor the sun god, ancient peoples oriented their temples and monuments to face the rising sun on one of the four days believed to have cosmic significance, on the morning of the first day of Summer, Winter, Spring, or Fall, also known as the Winter and Summer Solstice, and the Spirng and Fall Equinox. The four seasons, marked by the solstice and equinox, forms a cross, thereby giving the cross cosmic significance.

In the northern hemisphere, during the winter, the tilt is away from the sun, with the greatest degree of that tilt occurring on December 21. December 21 marks the winter solstice and is the shortest day of the year. By contrast, the greatest degree of tilt toward the sun occurs on June 21, the summer solstice, which is the longest day of the year. The equinoxes, March 20 and September 22, are the two days of the year which are of equal length.

There are two solstices, and two equinoxes, and these four events, represent the four corners of Earth and the cosmos, are are symbolized by the sign of the cross. This is why the sign of the cross appears across cultures and ages.

FIGURE: Quetzalcoatl/Kukulkan holding the sign of the cross, the four corners, representing the equinox and solstice, and the surrounding cosmic clock

FIGURE: Egyptian Key of Life.

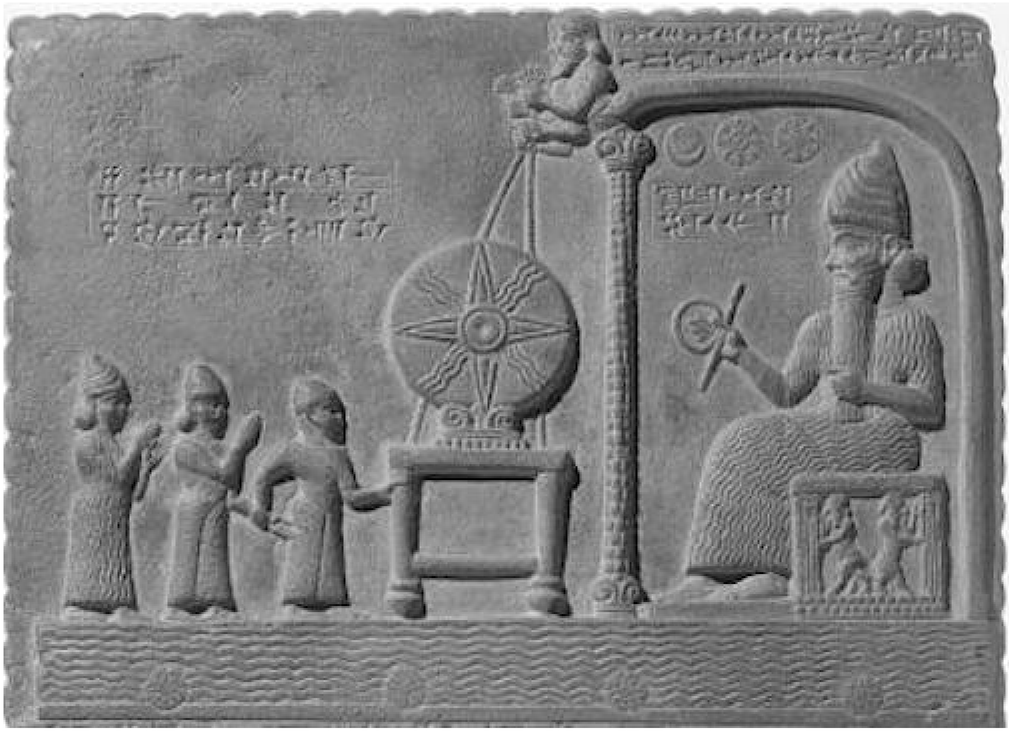
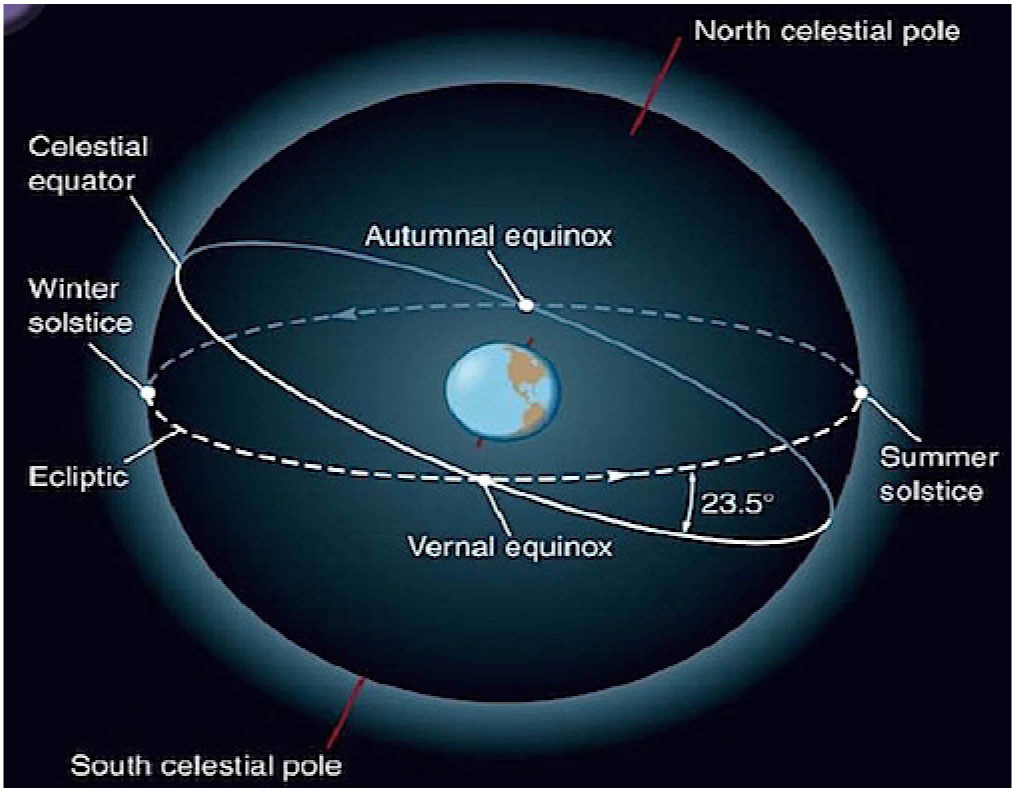


FIGURE: Babylonian

FIGURE: Missipian Native Pendant

Thus, the cosmic clock-like cycle of the Earth's orbit around the sun, gives rise to four significant astronomical events which the ancients deemed to be of the highest significance. However, as the ancients discovered, the equinoxes also undergo precession, and, precession has a repetitive, clock-like predictability (Santillana & von Dechen, 1969; Sellers, 2002).

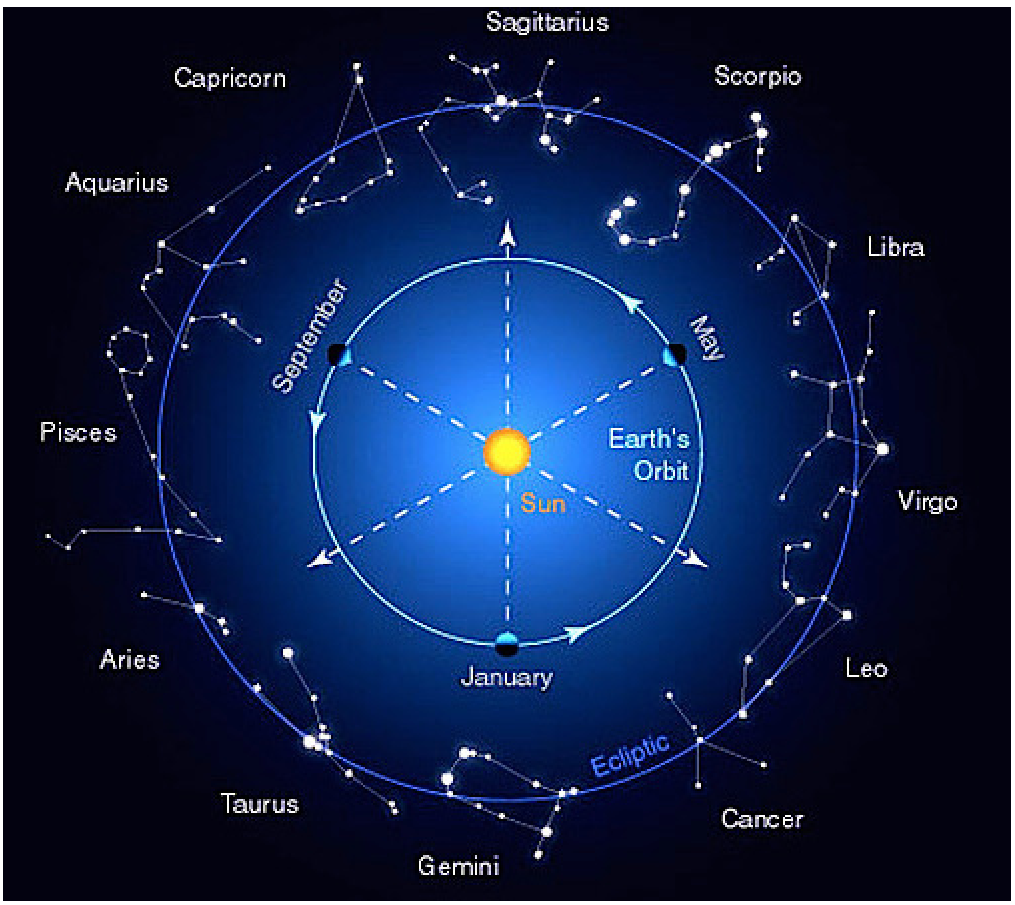


Worship of the sun is a custom that was embraced by most cultures throughout ancient history. The sun, like the 12 constellations, was viewed as a god. As the Earth orbits the sun it forms an imaginary circle referred to as the ecliptic. There is, however, a second, outer imaginary circle, an outer-ring that forms a belt that surrounds the Earth's ecliptic orbit. This outer circle is ringed with stars that form the 12 constellations of the zodiac: Aquarius, Pisces, Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricorn. The 12 constellations, although differing in size, are evenly spaced, occupying positions in the heavens that could be likened to the numbers on the face of a clock. During the course of a solar year, the sun passes through each constellation which lie along the ecliptic, every 30 days, much like the hands of a clock marking the 12 hours of a day.

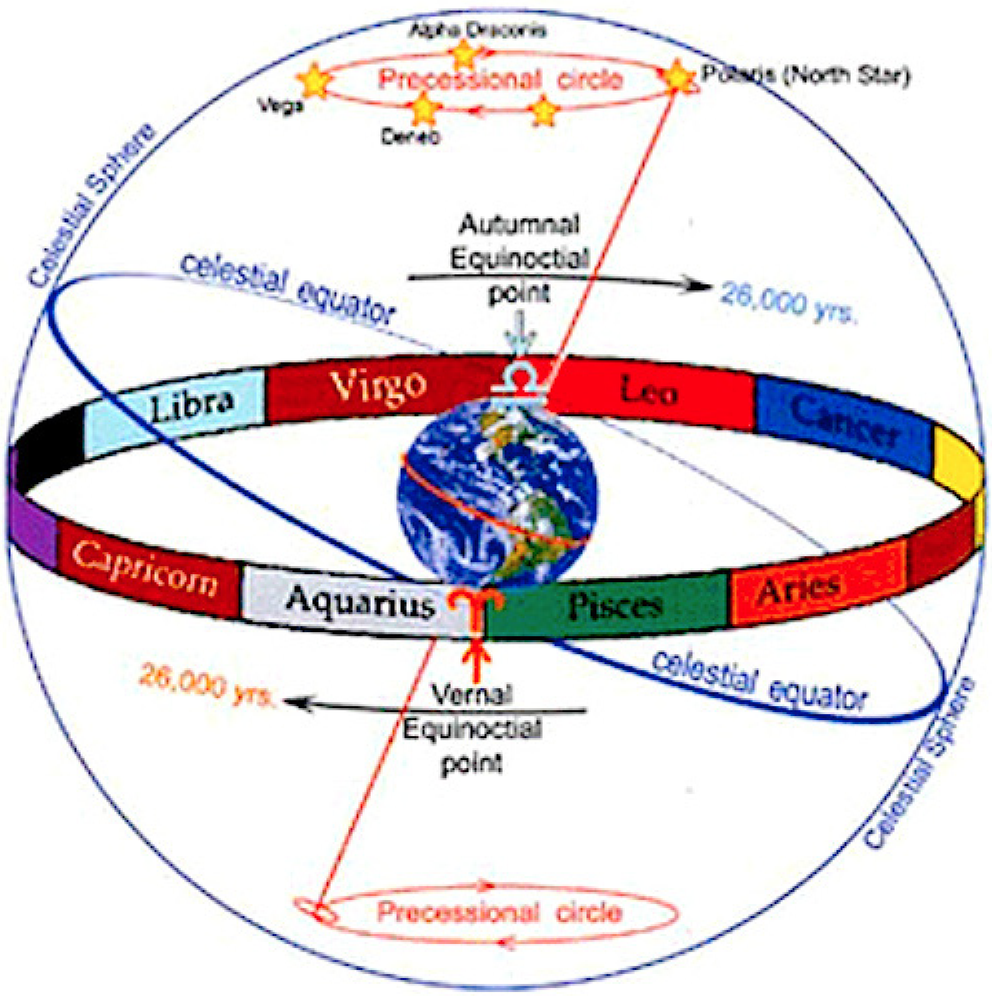
Each constellation occupies a space of 30 degrees along the ecliptic of the Earth's 360 degree orbit around the sun. Thus, as the Earth orbits the sun, every 30 days the Earth faces a different constellation during the morning sun-rise, and thus passes through a different house of the zodiac.

Because the orbit of the Earth gives rise to the illusion of the movement of the sun, the sun also appears to be rising in and passing through a different constellation every 30 days. An observer who watches as the sun rises or sets, will also see the sun rising or setting in a different constellation, every 30 days.

It is this illusion which led the ancient Greeks and the Medieval Catholic Church to believe that the Earth was at the center of the solar system and that the sun orbited the Earth. The ancient astronomer priests of remote antiquity were not fooled. Thousands of years before the rise of the Greek civilization, these ancient priest/astronomers recognized that the sun was at the center of the solar system, and, they calculated not only precess, but precession (Santillana & von Dechen, 1969; Sellers, 2002).



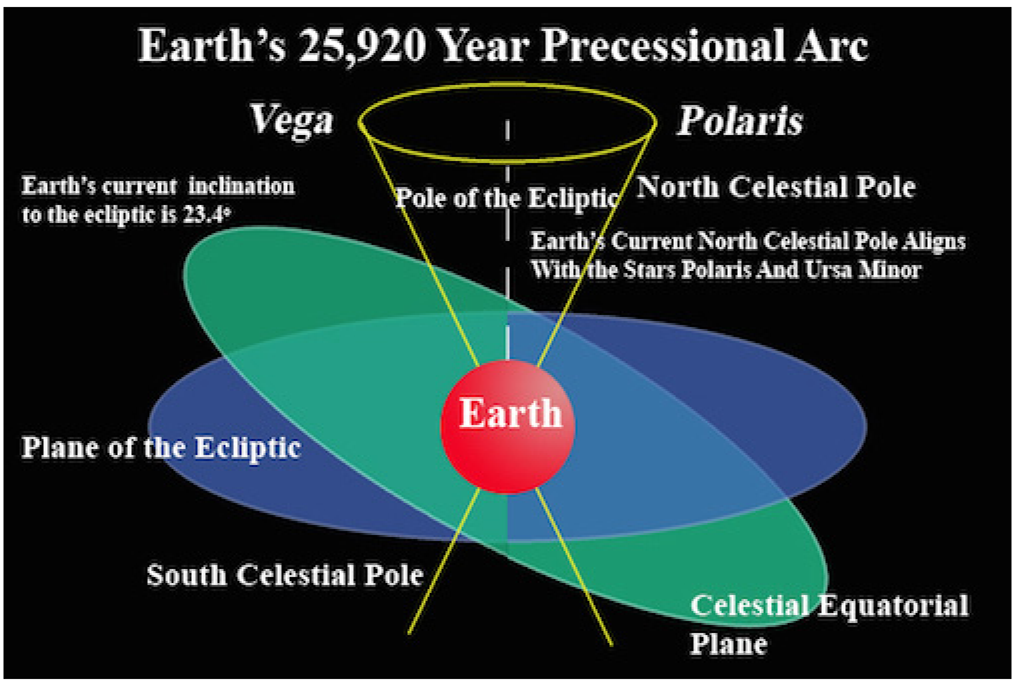
Because of the clock-like regularity of the changing seasons and the passage of the Earth through all the houses of the zodiac in a solar year, it can be predicted in which house of the Zodiac the sun would rise on any day of the year, including on the mornings of the summer and winter solstices and the spring and autumn equinoxes. These predictions can be made with accuracy for the following year, or even a hundreds years into the future: The future can be predicted mathematically based on the past.



What the ancient astronomer-priests discovered, however, was that over thousands of years of time, and because of precession, the sun slowly changes position, like the hands of a clock. Over thousands of years, the sun begins to rise in a different constellation on the mornings of the summer solstices, and a different constellation on winter solstices and different constellations on the spring and autumn equinoxes (Santillana & von Dechen, 1969; Sellers, 1992).

What the ancient astronomers discovered was that the sun's changing position, like the hands of a clock, pointed out the "hours" of the precessional cycle—a phenomenon referred to as the "precession of the equinoxes." Instead of every 30 days, the ancients determined that every 2160 years the sun would point at a different constellations on the day of the equinox or solistice. That is, it takes 2160 years for the sun to slowly move from house to house—like the ticking hands of celestial clock.

Due to the retardation of the Earth's orbital movement of 1 degree every 72 years, precession is a counterclockwise, or rather, an anti-clockwise phenomenon. Thus, every 2,160 years the sun rises in the previous house of the Zodiac. That is, the sun appears to move in a counterclockwise direction, such that the hands of the solar precessional clock also move backwards: Virgo, Leo, Cancer, Gemini, Taurus, Aries, Pisces, Aquarius, etc.



For example, the hands of the solar clock pointed at Aries, 4000 years ago, but slowly moved toward Pisces. For the last 2000 years the hand of the solar clock has pointed at Pisces, but moved slowly toward Aquarius. In 2012 we entered the age of Aquarius.

The ancient priests also determined that the precession of the equinoxes takes 25,920 years to complete its 360 degree circular cycle; i.e. 12 x 2160 years. Although modern "estimates" which gives the number as 25,776 (Hays, et al., 2006), it can still be predicted that 25,920 years from now, the sun will again leave Pisces and will enter the age of Aquarius.

THE DEATH OF GOD: NEW AGE RELIGIONS

The Age of Pieces/Christ and the Virgo/Virgin

As the ancient astronomer priests realized, a single year consists of 365 days. A Great Year consists of 25,920 years. The Great Year, like a single year, consists of 12 houses, but instead of 30 days per house/month, the duration of the time spent in each house/constellation is 2160 years.

It was also believed that as the hands of the cosmic clock shifted from one constellation to the next, this signified the ushering in of a "new world age," e.g., the age of Taurus followed by the age of Aries followed by the (current) age of Pisces, followed by the age of Aquarius; each lasting 2160 years.

However, every beginning is heralded by an ending and the death of a "god." As Aristotle long ago pointed out, in the truly ancient world, the "gods were stars," that is, constellations.

Thus, as the hands of the precessional clock moved from constellation to constellation, each new world age would be associated with the death of an old god and the birth and rein of a new god, who in turn would be directly linked to the prevailing constellation.

For example, the astronomical age of Pisces (the fish) began around the time of the birth of Christ, which is why the fish was and continues to be a symbol associated with Christ and Christianity. However, whereas the sun rose in the house of Pisces during the Spring equinox, it rose in the house of Virgo (the Virgin) in the autumn. Hence, the god Christ, is linked to Pisces and Virgo, i.e. the Virgin Mary

FIGURE: Constellation of Virgo

Again, there are two solstices, and two equinoxes, and a different constellation occupies each of the four, for a 2,160 year period. These four events, represent the four corners of Earth and the cosmos, are are symbolized by the sign of the cross. This is why the sign of the cross appears across cultures and ages.

The Age of The Ram

Due to centrifugal forces which influences and slows the Earth's orbit around the sun, on the days of the equinox and solstice the rising sun seems to slowly change position relative to the constellations, like the backward ticking of a clock.

Because the Earth slows by 1 degree every 72 years, over a period of 2,160 years, it moves backward by 30 degrees, and therefore the sun begins to rise in a different constellation on the morning of the equinox and solstice. This is known as the precession of the equinoxes.

We are now in the age of Aquarius. For the previous 2,160 years, the sun rose in the house of Pisces on the day of the Spring Equinox. Due to the backwards ticking of the cosmic clock, the Age of Pisces was preced by the Age of the Ram.

Specfically, beginning around 2,200 BC, and for the next 2,160 years, on the morning of the Spring equinox the sun rose in the constellation of

Aries, the Ram. Therefore, in ancient Egypt during the Age of the Ram, the Egyptians worshipped the Ram and numerous statues and monuments were dedicated to the Ram god.

Thus, whereas Jesus is associated with the Age of Pieces, during the Age of the Ram, Egyptians kings, most notably, King Ramses were associated with the constellation of Aries, and numerous statues of the Ram god including those protectively surrounding the image of Ramses, were erected throughout Egypt and as guardians in his temple and morturary complex. Moreover, Ramses magnificent mortuary temples were built to face the rising sun in the house of Aries, on the first day of Spring.

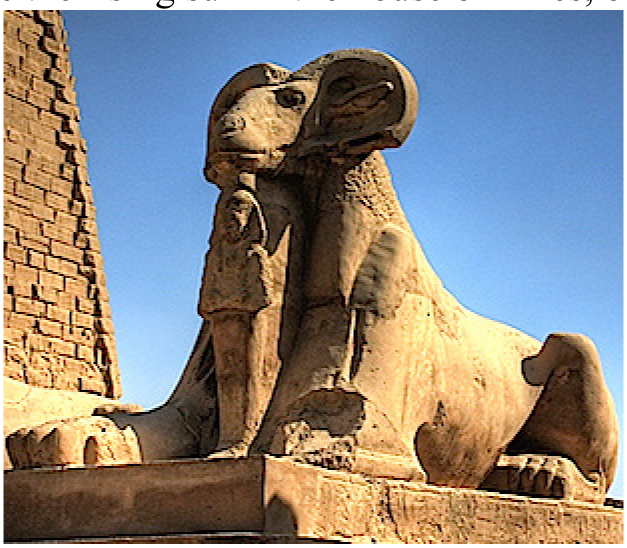


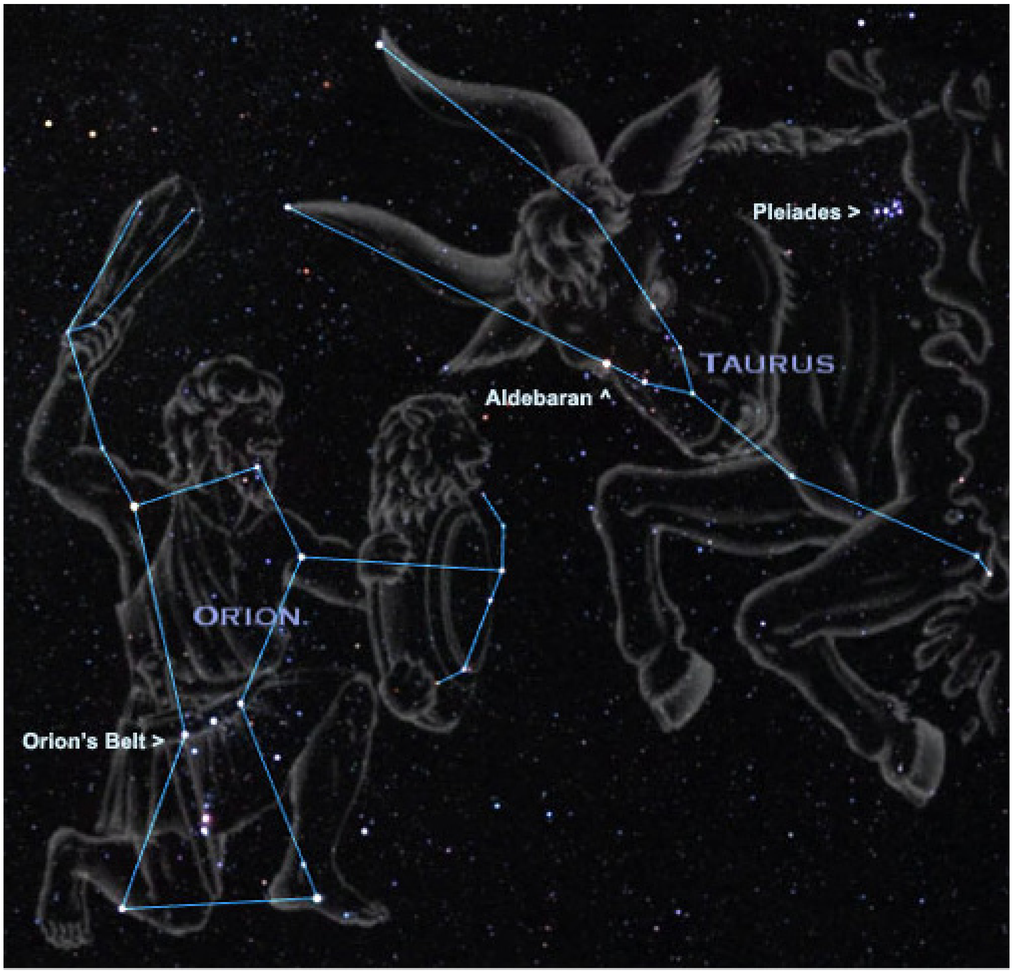
FIGURE: Ramses Mortuary Temple on the Sping Equinox

The Age of The Bull

Around the year 2,200 BC, the Age of Aries began. However, for the previous 2,160 years, peoples around the world were paying homage to Taurus, the Bull. The Age of the bull began around 6,000 years ago which is why ancient religions of that period employed the symbol of the Bull, e.g. the Bull-cult of ancient Crete, the Apis bulls of ancient Egypt.

Six thousand years ago the Sumerian civilization was in full flower and the Sun rose in the constellation of Taurus on the spring equinox. The Sumerian lists of the Zodiac begin with Taurus, the bull, and Sumerian stories frequently refer to the Bull of Heaven.

FIGURE: Sumerian depiction of the Bulls of Heaven, with the tree of life, with its four branches representing the two equinox and solstices at the center


Pleiades >
TAURUS
Aldebaran ^
ORION
Orion's Belt >

During the age of Taurus, Egyptian kings and the Egyptian people also paid homage to Osiris, who is linked to the constellation of Orion. According to legend, Osiris, the great cosmic god of the afterlife, had once been a king of Egypt and ruled during a golden age, before the great catastrophe which destroyed much of the world. According to legend, Osiris was murdered by 72 conspirators led by his brother Set in association with the great serpent, Apep.

Thus we see that slate palettes dating from the Age of Taurus, depicts the constellation of Taurus, and link the king of Egypt to the constellation of Orion and the god-King Osiris who ruled during the golden age.

The Narmer plate which is crowned on both side by the Bull, Taurus, and the image of the king which is linked to the constellation of Orion. It has been variably dated to 3100BC and to 4468 BC by some Egyptologists; dates which correspond to the Age of Taurus. However, if the Narmer plate was fashioned in 4468 BCE, it may have commorating the spring equinox, and the ending of the age of Gemini, the twins: hence the twin bulls.

FIGURE: “Narmer Plate” depicting twin bulls.

THE NEW AGE OF THE RAM AND THE JEWISH RELIGION

“God brought them out of Egypt; he hath as it were the strength of a bull.” - Numbers 23:22

“Whereupon the king took counsel, and made two calves of gold, and said unto them: behold thy gods, O Israel, which brought thee up out of the land of Egypt. -Exodus 32.8

The Transition From The Age of The Bull to the Age of the Ram

The Sumerians were largely a Semitic people, and Abraham, the patriarch of modern day Jews and the Jewish religion, hailed from Ur of the Chaldese, a Sumerian city, during the waning days of the Age of Taurus. And like the Sumerians, the ancient Jews worshipped a number of gods, including Taurus, the bull—also known as the "Golden Calf."

Moses appeared upon the scene during the new age of Aries: the ram—also known as the god of war. But, when he led the Jews from Egypt to the lands he claimed had been promised to them by the God of Abraham, Isaac and Jacob, they were not accepting of the new god and repeatedly rebelled in favor of the old gods, the gods worshipped by their fathers, and their kings:

"When the people saw that Moses was so long in coming down from the mountain, they gathered around Aaron and said, "Come, make us gods who will go before us. Aaron answered them, "Take off the gold earrings that your wives, your sons and your daughters are wearing, and bring them to me." So all the people took off their earrings and brought them to Aaron. He took what they handed him and made it into an idol cast in the shape of a calf. Then they said, "These are your gods, O Israel, who brought you up out of Egypt." When Aaron saw this, he built an altar in front of the calf and announced, "Tomorrow there will be a festival to the Lord."

"Then the Lord said to Moses, Go down, because your people, whom you brought up out of Egypt, have become corrupt. They have been quick to turn away from what I commanded them and have made themselves an idol cast in the shape of a calf." —Exodus 32

Moses immediately ordered the slaughter of all who had worshipped the golden calf.

The Age of the Ram

The age of the Bull was over. The hands of the precessional clock had shifted to a new constellation and a new world age. A new age required a new god. The God of Moses, the God of Abraham, Isaac and Jacob, was the new god heralded by the new age of the ram—Aries, the god of war, also known as the "Lord of Hosts" (armies) and the "Lord of Heaven."

The age of the ram began 4000 years ago—when Abram/Abraham was called by "God" and left for Egypt— and ended 2000 years ago, which is why ancient religions at that time were ramoriented and/or used rams in their symbolism. Indeed, rams appear repeatedly in the old testament and were important symbols in Egypt during this period.

Abram (Ab-ram) left Sumer during the opening days of the new age of the ram, and it is Abram (who became Abraham) who was the patriarch and thus the founder of a new religion, the Jewish religion—but first he had to prove himself to the new god—the god of the ram—by sacrificing his first born son, Isaac (Genesis 22):

"And it came to pass after these things, that God did tempt Abraham, and said unto him, Abraham: and he said, Behold, here I am. And he said, Take now thy son, thine only son Isaac, whom thou lovest, and get thee into the land of Moriah; and offer him there for a burnt offering upon one of the mountains which I will tell thee of.... and Abraham built an altar there, and laid the wood in order, and bound Isaac his son, and laid him on the altar upon the wood. And Abraham stretched forth his hand, and took the knife to slay his son. And the angel of the LORD called unto him out of heaven, and said, Abraham, Abraham: and he said, Here am I. And he said, Lay not thine hand upon the lad, neither do thou any thing unto him: for now I know that thou fearest God, seeing thou hast not withheld thy son, thine only son from me. And Abraham lifted up his eyes, and looked, and behold behind him a ram caught in a thicket by his horns: and Abraham went and took the ram, and offered him up for a burnt offering in the stead of his son." Instead, Abraham sacrificed a ram.

By sacrificing a ram, provided by “God,” and because he was willing to kill his first born son, Abraham proved himself worthy of being the father of a new age religion... “And Abraham called the name of that place Jehovah...” —Genesis 22

FIGURE: The sacrifice of Isaac by Abraham.

PRECESSION: DEATH OF RAM-GOD. BIRTH OF PISCES-GOD: CHRIST

For the last 2,160 years, the sun has risen in the constellation of Pisces on the first day of Spring, the vernal equinox, and in the constellation of Virgo on the first day of Fall. Thus we see that the birth of Jesus is associated with Pisces, the two fish, and the virgin, Virgo

However, due to centrifugal forces which influences and slows the earths orbit around the sun, on the days of the equinox and solstice the rising sun seems to slowly change position relative to the constellations, like the backward ticking of a clock.

Because the Earth slows by 1 degree every 72 years, over a period of 2,160 years, it moves backward by 30 degrees, and therefore the sun begins to rise in a different constellation on the morning of the equinox and solstice. This is known as the precession of the equinoxes.

On December of 2012 and June of 2013, the cosmic clock ceased to rise in Pieces and Virgo on the Spring and Fall Equinox. The New Age had begun, and with the onset of each new age there is the ending of the preceding age. And as each age is associated with a god, the new age is linked with the birth of a new god and the death of the old god. However, the followers of the old god, and the religions developed to serve the old god, are loath to accept the transition. Rather than with rejoicing, the onset of a new age and a new god are met with fear and trembling. The birth of a new god spells calamity and destruction for those who prayed allegiance to what they had believed is the “one true god.” Thus we see that the ancient Jews struggled against Moses and the new age god of the Ram, preferring to worship instead the old god, Taurus.

“Then the Lord said to Moses, Go down, because your people, whom you brought up out of Egypt, have become corrupt. They have been quick to turn away from what I commanded them and have made themselves an idol cast in the shape of a calf.” —Exodus 32

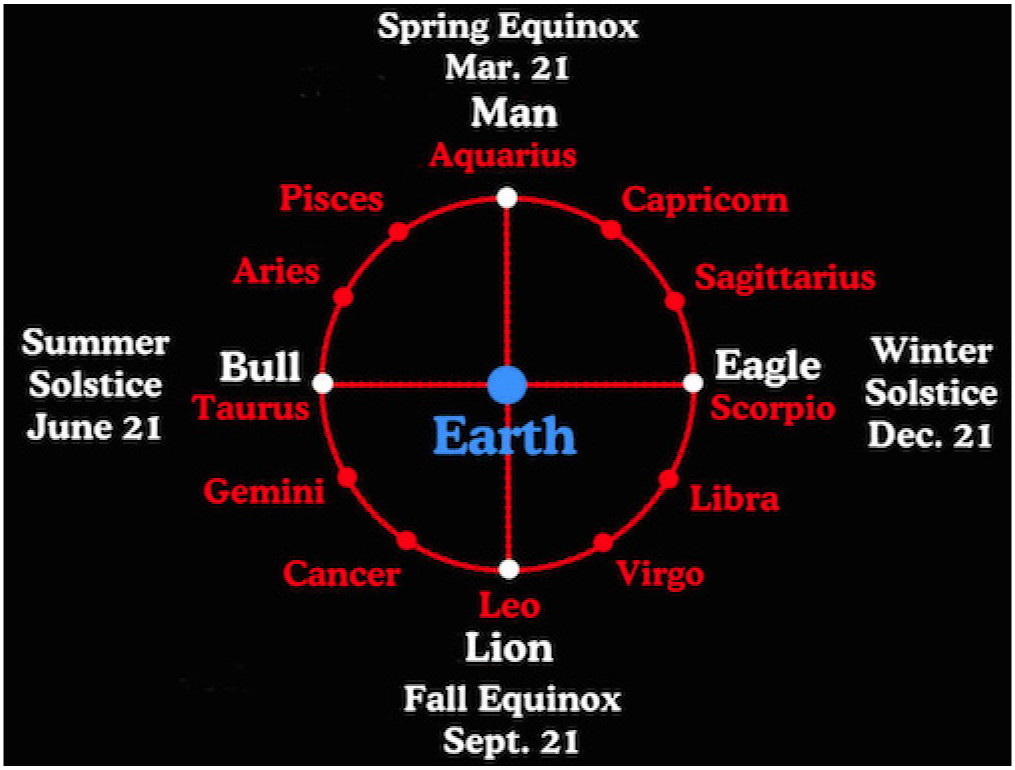
Around 60 BC. as it was recognized that the old age of the Ram was coming to an end, the astronomers, priests, kings, astrologers turned to the heavens searching for signs. In the Middle East, there was a fever of increasing excitement, a new god was to be born; what some believed would be a messiah. However, the priests of the old god struggled to destroy the new religion; but even so, a new religion was born of the virgin (Virgo): Christ, the god of the Pisces.

The founders of the new religion based on the age of Christ/Pisces/Virgo recognized that "his" time would also come to an end; and they incorporated this knowledge into their religion, warning all of great destruction heralded by an anti-christ: a beast, a lion (Leo) who would threaten the Virgin, a man who would flood the Earth (Aquarius, the water bearer), an Eagle (Scorpio) and and "ox" (Taurus). In fact, as of 2012, Aquarius and Leo govern the equinox, and Scorpio and Taurus rule the solstice.

Each new age heralds not just the birth of a new god, but periods of destruction and cosmic calamity followed by a new golden age.

The ancient astronomer priests believed that destiny, on a cosmic or global level, and the destruction and renewal of civilization, could be determined through the observation of the stars and via mathematical predictions based on precess, precession, and the orbit of the Earth as it made its journey through the heavens and the 12 houses of the zodiac; that is, the 12 constellations.

In the final passages of Revelation, we see not only references to precession and the 12 houses of the Zodiac, but we are told of a new golden age: "One of the seven angels... carried me away in the Spirit to a mountain great and high, and showed me the Holy City, Jerusalem, coming down out of heaven. It had twelve gates. The twelve gates were twelve pearls. I did not see a temple in the city, because... the city does not need the sun or the moon to shine on it, for the glory of God gives it light."



Periods of rebirth and destruction were believed to be linked to the Earth's movements from constellation to constellation, and this is also the overarching message of Revelation, i.e. Armageddon, in which Christians are warned of a war in heaven.

"And there appeared a great wonder in heaven: A woman clothed with the sun, and the moon under her feet, and upon her head a crown of twelve stars: And she being with child cried travailing in birth and pained to be delivered...

"And there appeared another wonder in heaven: And behold a great red dragon having seven heads and ten horns and seven crowns upon his head. And his tail drew the third part of the stars of heaven and did cast them to the Earth... -Revelation, 12

Thus we are told of "twelve stars" which are the 12 houses of the zodiac. And we are provided with the numbers: seven heads and ten horns and seven crowns. Seven + seven + ten = 24.

There are 24 hours in a day, a recurring cycle of 12 hours of light, 12 hours of darkness.

The number 24 is repeated again and again in Revelation, and the references is to repeating cycles: "...because he once was, now is not, and yet will come..."

And, as to "the third part of the stars," that Revelation tells us will be cast to Earth, this yields the number 8. What is the significance of number 8?

"Eight" refers to the eighth planet counting from the outer orbit of the solar system, i.e. the planet Venus, the morning star, also known as the great serpent, and by the name: "Lucifer."

"How art thou fallen from heaven, O' Lucifer star of the morning... the one that made the Earth to tremble, that did to shake kingdoms. That made the world as a wilderness, and destroyed the cities..." -Isaiah, 14

However, the same "warnings" and the complex science which predicts the coming and going of each Age, can be found in the ancient writings of many ancient peoples; beliefs based on observation, history, and mathematical analysis of the movement of the stars in relation to Earth.

There are hints in ancient records, for example, that cyclic periods of destruction were due to the Earth passing through regions of space that were in turmoil. We are told of wars in heaven, battles among the stars, in which the Earth was buffeted by debris from space and rocked by wayward planets, moons, comets and stars that snaked through the heavens like a giant serpent, or a like a dragon which swallowed (eclipsed) the sun and the moon, and then attacked the Earth. And we are warned that these cosmic catastrophic events are cyclic and will occur again in the future:

"Is this the one that made the Earth to tremble, that did to shake kingdoms. That made the world as a wilderness, and destroyed the cities...

"But beware and rejoice not because the rod of his that smote thee is broken: for out of the serpent's root and of his fruit shall be a fiery flying dragon... -Isaiah, 14

And, we are warned that these future cosmic catastrophic events, these wars in heaven, are directly related to precession and the passage of the Earth through the twelve houses of the Zodiac. The catastrophe is the death of the old god and the old age, and the birth of a new god and a new god.

Out of destruction comes rebirth, e.g. god and the son of god, the sun god and the sun of god.

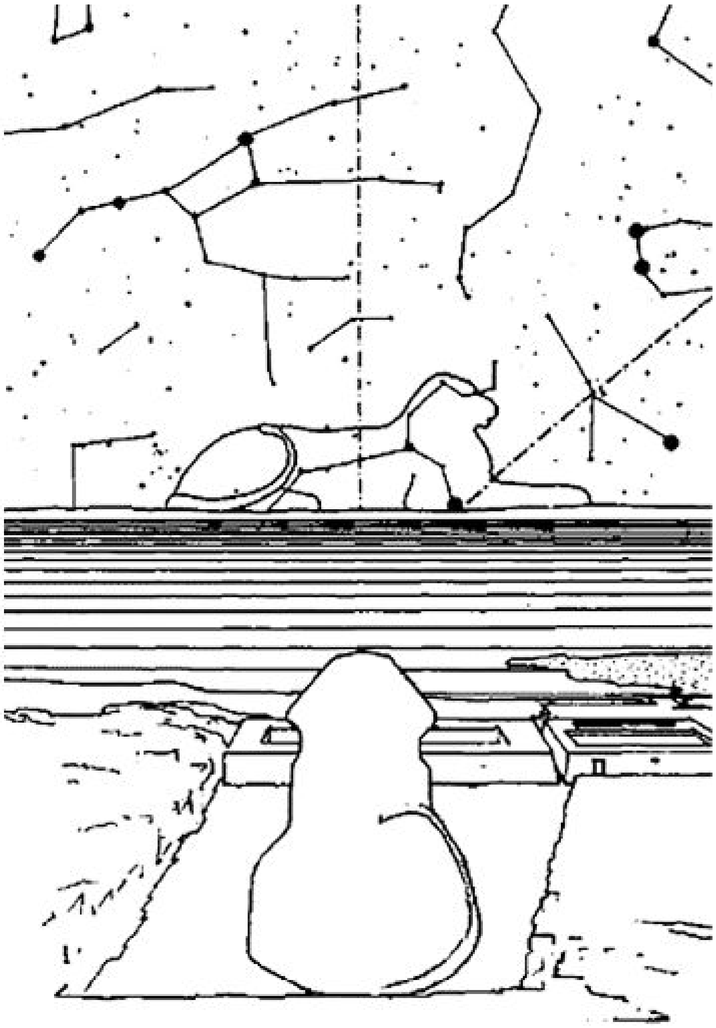
According to ancient Sumerian and Babylonian tradition: “Seven” refers to our planet, mother Earth—the seventh planet when counting from the outer rim of the solar system. In the passage above, mother Earth becomes: “A woman clothed with the sun, and the moon under her feet” (though, as detailed later, this passage may also refer to the constellation of Virgo—a Virgin about to give birth to a new god).

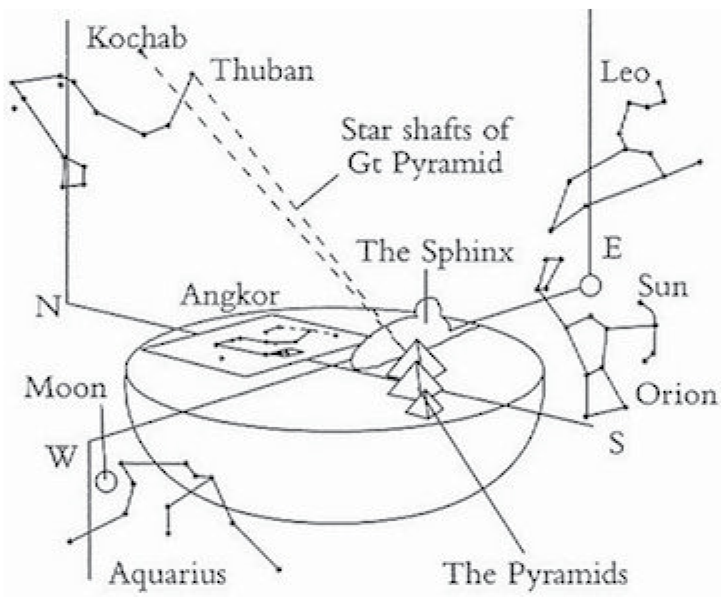
“Seven also refers to the seven stars of Ursa, the dominant stars of the north and which are believed to be linked to the operative powers controlling the universe. And, in Revelation, we are told of the “7 angels... 7 seals... 7 spirits... 7 stars...”

Because the ancients believed that the stars, and the movement of the Earth in its journey through the heavens was of fateful significance, the observations of the heavens and the cyclic nature of the dance of the stars, played a major role in decision making and in religious practices, including, as noted, in the orientation of ancient temples and predictions of destruction and rebirth.

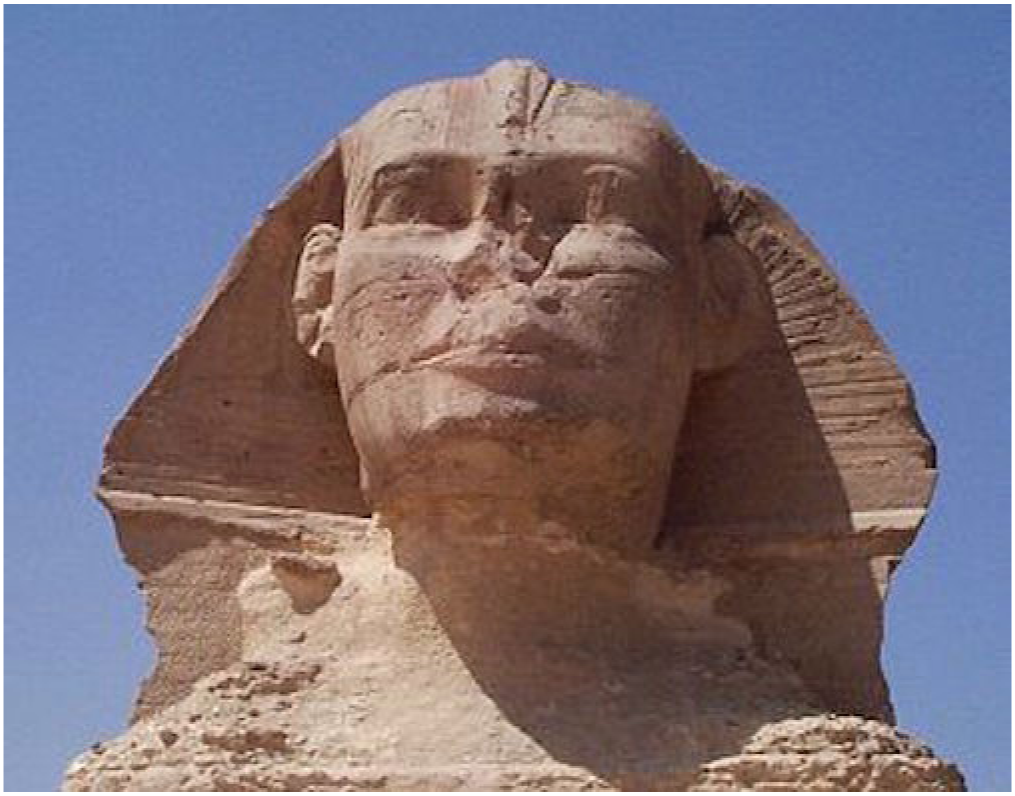
THE AGE OF LEO 13,000 YEARS AGO

The scribes of ancient Egypt tell us that the first kings of Egypt established their rule 15,400 years ago, as also documented by the ancient lists of Egyptian kings. According to legend, as the Egyptian civilization prospered and grew, and with the coming of the New Age of Leo, 13,000 years ago, the ancient Egyptians erected a great Sphinx, with the head and body of a lion which faced the rising sun in the constellation of Leo on the first day of the spring equinox.





Kochab
Thuban
Leo
Star shafts of
Gt Pyramid
The Sphinx
E
Sun
N
Angkor
Moon
Orion
S
W
Aquarius
The Pyramids



The sphinx, which still has the body of a lion, the king of beast, is believed to originally have had head of a lion, just as the ancient Egyptian statues of the Bull, the Lion, and the Ram have the heads of a bull, a lion and and a Ram. However, it is believed that the original Lion head became so badly eroded over eons of time that it was re-carved, growing smaller with each carving and due to erosion, and was finally reshaped into the head of a pharaoh.

Although the original nature of the head is debatable, that the sphinx has the body of a lion, and was erected to face the rising sun on the day of the vernal equinox is undeniable. Twelve thousand five hundred years ago and for the next 2000 years, the sun rose in the constellation of Leo, the lion, on the morning of the spring equinox. It is reasonable to assume the Sphinx was designed to greet the rising sun in the house of Leo, 12,500 years ago.

There is, however, considerable evidence that much of the erosion took place soon after the Sphinx was carved, when inundated by torrential rains and a great flood over 12,500 years ago, during the age of Leo.

As first discovered by Egyptologist R. A. Schwaller, the erosion on the Sphinx is quite different from the erosion observable on other structures in Egypt. On the back and upper portions of the Sphinx and its nearby walls, the rock is badly worn, edges are rounded, and deep up and down vertical fissures are prominent; conditions usually created, not by wind, but water, and torrential rains. By contrast the erosion seen on the Old Kingdom tombs is completely different in character and typical of wind and sand, not water or rain.

These observations were later verified by Egyptologist John Anthony West and geologist Robert Schoch who concluded that the vertical fissures were indicative of severe water erosion and were caused by a long period of torrential rainfall or severe flooding. The evidence indicates the water levels rose to the very head of the Sphinx with waves lapping at its shoulder and face. In fact, most of the erosion is not at the base or the walls of the Sphinx, but as the top of the back and neck--areas most accessible to direct rainfall. On the other hand, the body of the Sphinx was buried beneath the shifting sands for much of history whereas the head, back and shoulders were continually exposed, thereby making them subject to the greatest degree of erosion. However, again, much of the erosion appears to be due to water, not wind or sand.

Thus, it appears that the great Sphinx may have been erected over 12,000 years ago, during the age of Leo, and suffered a great deal of erosion when exposed to torrential rains and a great flood. In fact, according to the scribes of Egypt and the Egyptian King's List, the Egyptian King Osiris ruled Egypt during this epoch. Thus, according to legend, the great king, Osiris, who is associated with the constellation of Orion, was the last king of Egypt at the time of a massive flooding and thus a great catastrophe, some 12,000 years ago.

It has also been claimed that the three titanic pyramids of Giza were constructed over 12,000 years ago. Although there are claims and counter claims regarding who built the three pyramids of Giza, even the ancient kings of Egypt refer to them as being quite ancient.

In fact, although the grandest and oldest of them all is attributed to Khufu, many scholar believed that these claims are based on an obvious forgery and even a misspelling of his name by an archeologist who was hot to make a "great discovery." There is in fact evidence that Khufu claims that the Great Pyramid and the Sphinx, had been constructed long before his own time. Moreover, Khufu's funeral boat was not found in the pyramid, but buried outside, which certainly suggest that the Great Pyramid was never intended to be Khufu's final resting place, but a pyramid belonging to another, more ancient king.

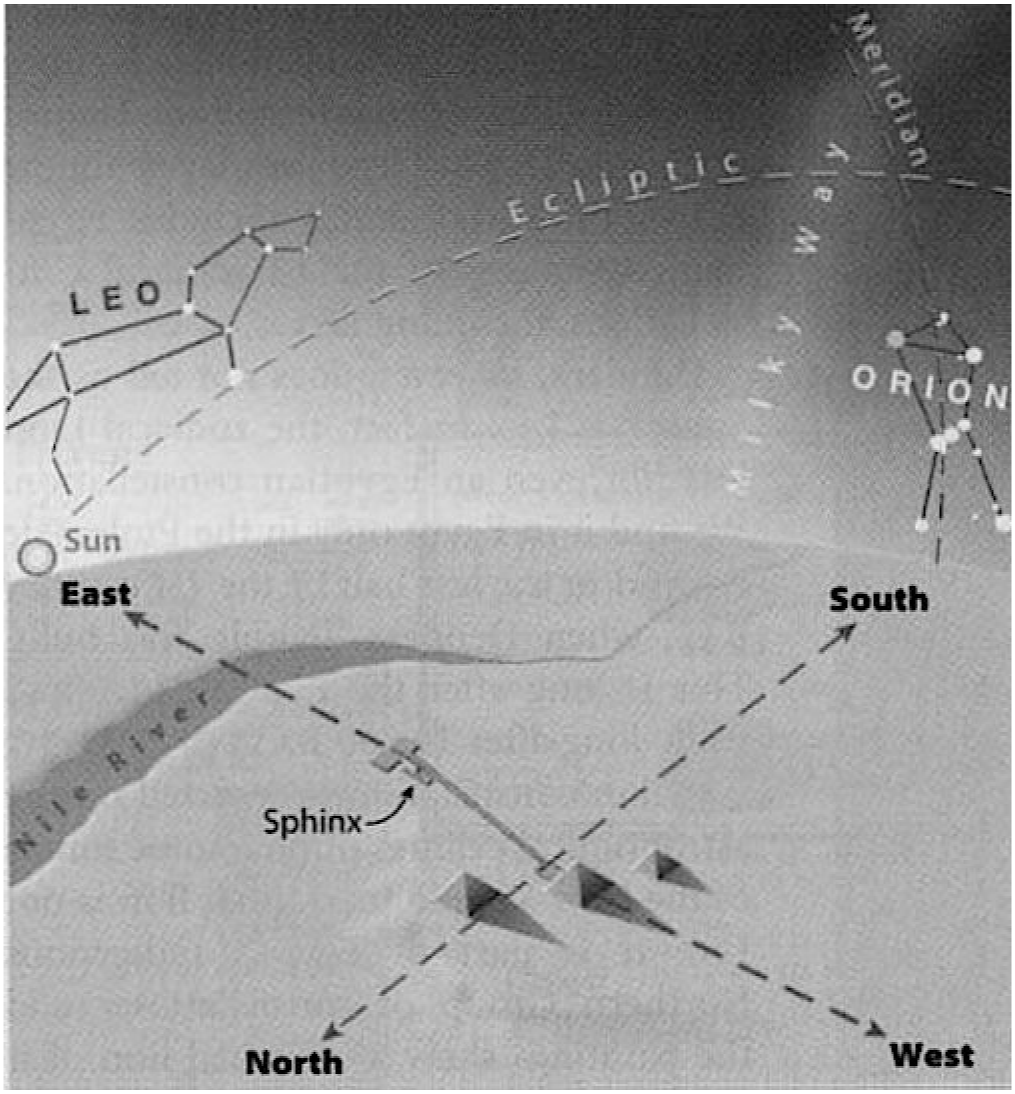
As discussed, the three great pyramids on the Giza plateau are oriented and mirror, in size and location, the constellation of Orion. The layout and orientation of the three great pyramids of Egypt are a mirror image of the three main belt stars of Orion, and they best match the positions of these three belt stars 12,000 yeas ago, during the age of Leo. Not just the earth, but our solar system, our galaxy, and the stars of the constellations are in motion and change position over time.

Most authorities agree that these first three great pyramids were constructed first, well before the erection of all other Egyptian pyramids. However, what has puzzled the experts is the fact that the first three pyramids are not only many times larger but have a degree of perfection not seen in all subsequent pyramids, over 100 which are known to have been constructed during and following the the reins of the 3rd dynasty some 4,500 years ago.

Indeed, the pyramids created by specific pharaohs during the 3rd dynasty, are stunted, lopsided, poorly constructed miniaturizations in comparison to the thee great pyramids of Egypt. This is exactly opposite to what would be expected; i.e. improvement in design and increases in size should appear in later copies but this is not the case. All subsequent pyramids are stunted, tiny in size, and poorly constructed in comparison. Those responsible for building the three great pyramids had access to a technology and science not available to those who came after.

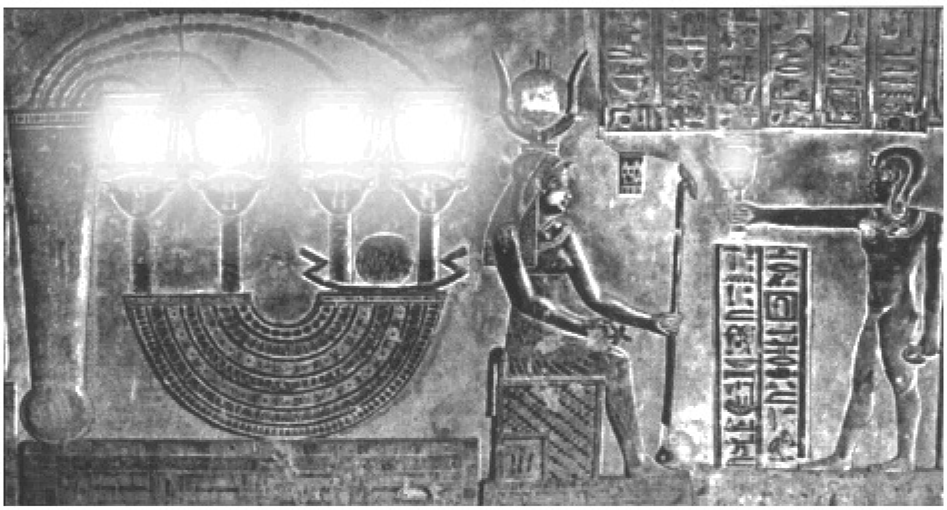
Coupled with their incredible size and utter perfection, and how they map the heavens and the Earth, as already noted, lends credence to the possibility that the three g pyramids of Giza were built by a different, technologically advanced civilization, 12,000 years ago, and the later, inferior pyramids were created 8,000 years later, some 4,000 years ago.

Some ancient Arabian historians explain that these first three Pyramids, which exceeds all other pyramids in size and perfection, were created in anticipation of the great flood and calamity which the ancient Egyptians realized might destroy much of their world. Basing their conclusion on ancient manuscripts, Arab historians, such as al-Murtadi, in 1584, claim that before the great flood, the king of Egypt decided to secure the treasures of all ancient wisdom. This king built the pyramids to preserve the records of the sciences and wisdom of the ages, which were engraved in tablets, and memorials and then stored within the great pyramids and made secure.



"Saurid...one of the kings of Egypt prior to the Great Flood... was the builder of two of the great pyramids....Saurid had a dream where the Earth turned upside down with all its people, the people fled in a blind rush, and the stars fell down..." -al-Maqrizi.

According to legend, all the kings advisors had the same dream and predicted the end of civilization. So, Saurid, the pre-deluvial King of Egypt, decided to build the pyramids to serve as great museums and libraries where all the worlds knowledge could be preserved. Indeed, the great pyramid itself, was to be a source of knowledge and wisdom, harboring the answers to all questions regarding the cosmos and the creation.



In fact, the great pyramid contains a number of chambers, one on top of the other, similar to many universities libraries. However, there is basically no evidence to suggest it was ever meant to serve as a tomb for an Egyptian king on his journey to the afterlife. As all who visit or who have studied these grand monuments can attest, the three pyramids are not just the oldest, grandest, largest, and architecturally superior to all those that came after, but they are completely un-Egyptian. Unlike all other Egyptian edifices, the chambers and inner walls of the three great pyramids of Giza are completely barren of hieroglyphics and are lacking in any markings whatsoever.

Typically, all Egyptian works, from 6,000 years ago to the end of their civilization, are covered with symbols, artistic renderings, hieroglyphics. Not so the great pyramid. The interiors are completely barren and lack ornamentation. Moreover, there is no evidence of torch light within the inner chambers. No smoke, no soot, no ash, nothing to indicate how the interiors were lighted; nothing except drawings of what appear to be giant electric lights, and the discovery of an ancient electric battery.

According to Plato: "We know nothing of what happened in ancient times... because of these great destructions and pestilence from heaven that comes pouring down, and which leaves few survivors, and because, after many generations, the survivors of that destruction die, leaving no written word.. Now these memories as myths."

Be it memory or myth, ancient peoples from throughout the world speak of a horrific cosmic cataclysm which destroyed the cities and civilizations of woman and man. And most blame the end of this golden age on a cosmic serpent--a serpent which may represent the Milky Way galaxy or the 12 major constellations which form circles within circles: and all circles repeat themselves in great cycles.

Twelve thousand years ago, on the morning of the Spring and Autumn equinox, the sun rose in the house of Leo and Aquarius. The cosmic clock has come half-circle and we have entered the new age of Aquarius--and with each new age, there is an ending of an old.

PRECESSION: THE COSMOLOGY AND GODS OF NUMBERS

"Newton was not the first of the Age of Reason. He was the last of the magicians, the last of the Babylonians and Sumerians.... He looked on the whole universe and all that is in it as a riddle, as a secret which could be read by... certain mystic clues...laid about by... an esoteric brotherhood. He believed that these clues were to be found...in certain papers and traditions handed down by the brethren in an unbroken chain back to the original cryptic revelation in Babylon. He regarded the universe as a cryptogram set by the Almighty." —John Maynard Keynes.

Throughout much of history, there have been secret societies consisting of men who believed that the discoveries of science should be kept secret from kings, ministers, government officials, and those who would exploit science for the purpose of evil and doing harm.

Asoka, the grandson of Chandragupta who had unified ancient India, was a warrior and a scientist, and he applied his understanding of science, to war. He was overcome by his own successes and developed a horror for war. Upon becoming emperor of India, Asoka forbid men to ever use their intelligence or their knowledge of science, for purposes of evil. Scientists and scholars of ancient

India, were forced to take vows of secrecy and to become members of a secret society who could only communicate openly through riddles, parables, and secret codes.

The ancient astronomer priesthood in many ways, also functioned like a secret society, with secret initiation rites, and hidden knowledge that only initiates were privy too.

For example, the Kaballa tells us that there are 72 angels and that those who know their names and numbers can use them to invoke or approach the divine powers—the Sephiroth.

In the ancient religion of China, the initiation ritual of the Hung League involved questions that involved the numbers 36, 72, and 108 (Ward, 1925)—all of which are multiples of 12:

"I saw two pots with red bamboo. In one pot were 36 and in the other 72 plants, together, 108. Who in the world knows the meaning of this?"

Indeed, what is the meaning of this?

All three are multiples of 12. Moreover, these numbers, as well as the numbers 9, 12, 30, 36, 108, 360, 2160, 25,920, 432,000, 1,296,000, repeatedly appear in ancient religious texts and in religious "myths" the world over.

In Arabic-pre-Islamic tradition, it was said that martyrs were rewarded in heaven with 72 Virgins.

"Man has not touched them before them nor jinni. Which then of the bounties of your Lord will you deny? Reclining on green cushions and beautiful carpets. Which then of the bounties of your Lord will you deny? —The Beneficent.

Hadith number 2,562 in the collection known as the Sunan al-Tirmidhi says, "The least [reward] for the people of Heaven is 80,000 servants and 72 wives, over which stands a dome of pearls, aquamarine and ruby."

The ancient Egyptian religious myth of Osirus tells us that 72 divine conspirators, led by Seth, plotted to kill Osirus (Budge, 1903, Sellers, 1992).

The mystics of the Kaballah believe that 72 is Yahweh's secret number.

Yahweh instructed Moses and Aron to take 70 of the elders of Israel to accompany them to the Holy Mount; i.e. Moses + Aron + 70 = 72. However, Moses and Aron also brought along 2 of Arons 4 sons. Thus Aron and Moses were accompanied by 72 men.

These numbers are significant because they are precessional numbers which yield 2160—the total number of years in which the sun was believed to spend in each of the 12 constellation.

For example, 30 times 72 equals 2160—the number of years the ancients believed it took the sun to pass from one to the next house of the zodiac.

Consider: 12 is the number of houses of the zodiac. There are 360 degrees to a circle and 30 is the number of degrees assigned to each house (360 divided by 12=30). 72 is the number of years for the sun to complete a precessional shift of one degree (the modern estimate being 71.6). And, 360 is the total number of degrees in the Earth's ecliptic.

Again, 72 x 30 yields 2160 which is the total number of years in which the sun spends in each house. 360 x 72 equals 25,920, as does 2160 x 12, which is a very close estimate of the number of years to complete a precessional cycle through all 12 houses of the zodiac, the modern estimate being 25,777 years.

Likewise, the value of 2160 is remarkably close to the modern estimate of 2148, which is the time it now takes for a precessional shift through a single constellation.

In some religious "myths," the number 36 is added to 72, to obtain 108:

"In one pot were 36 and in the other 72 plants, together, 108. Who in the world knows the meaning of this?"

The number, 108, can be multiplied by factors of 10 to obtain the number of years for a precessional shift through a single constellation, i.e. 20 times 108 equals 2,160.

The temple complex of Angkor, India, has five gates which lead to five roads, each of which is bordered by 108 gigantic stone figures, i.e. 540 stone figures total. These stone figures are bound to a huge Naga serpent, which they pull in order to churn the Milky Oceans of the Universe.

540, like 108, is a precessional number.

For example, 540 x 4 = 2,160.

The number "4" is derived from the four seasons (the two solstices and two equinoxes) and which also provides us with the sign of the cross.

Also, 540 x 48 = 25,920

In ancient Indian religion, the number 48 appears as a component of each divine year. For example, 4,800 is the duration of Krita Yuga.

The Rigveda also tell us of the "12-spoked wheel in which the 720 sons of Agni are established."

12 x 720 = 8640 which when multiplied by 30 = 25,920.

The number 12, of course, refers to the 12 houses of the zodiac. And, 12 has always been a very important number in ancient, as well as more modern religions, such as Judaism and Christianity.

The ancient Greeks and Romans believed in 12 great gods, the 12 Olympians of the Greek Pantheon. However, before the rise of the 12 Olympians, the Greeks tell us there were 12 Titans.

There are 12 months in a year, 12 hours in a day, and 12 hours in a night, and 12 constellations.

Osiris (The Lord of the Dead), was killed by Set in the company of 72 conspirators, and passes judgment on the dead with the assistance of a council of 12.

"The Holy City, Jerusalem, coming down out of heaven.... had a great, high wall with twelve gates, and with twelve angels at the gates. On the gates were written the names of the twelve tribes of Israel. There were three gates on the east, three on the north, three on the south and three on the west.

The wall of the city had twelve foundations, and on them were the names of the twelve apostles of the Lamb" —Revelations.

Jesus had his 12 apostles. Moses "erected 12 stone pillars" (Exodus 24:4). And Jacob and Ishmael each had 12 sons.

"As for Ishmael... of him twelve chieftains will be born, his shall be a great nation" —Genesis 17:20.

"Those were the sons of Ishmael...twelve chieftains each to his own nation" —Genesis 25.

"And the number of sons of Jacob was twelve." —Genesis 35

However, although Jacob had 12 sons, before the birth of his last (12th son) Benjamin, the number of his brood had also numbered 12 if we include his daughter Dinah. Likewise, the 12 constellations of the zodiac consists of 11 males and 1 female—Virgo.

The tribe of Benjamin, that is, the Benjaminites, also took on a female role. As detailed in the Jewish Bible (Tanakh), the Benjaminites were a tribe of notorious homosexuals.

As detailed in Genesis, Jacob's other sons were also linked to the zodiac: Juda was referred to as a lion (Leo), Zebulun was linked to Aquarius—he was to be a Dweller of the Seas—and Joseph was linked to Sagittarius as he was depicted as a bowman.

Also, Levi and Simeon were linked together, thus forming a Gemini (twins). Both brothers, Jacob prophesied, would forfeit their domains and their offspring would be dispersed among the other 10 tribes. However, the list stayed at 12 with the addition of Joseph's two sons, Ephraim and Manasseh.

Also, in the Jewish "Bible" —i.e, in the Nevi'm (The Prophets)— there are 12 minor prophets and 9 major prophets listed. Again, these are precessional numbers.

The ancients also counted 9 planets, the Earth being number 7, and Venus, number 8.

And, 12 x 9 = 108. These are all precessional number, and 9 and 12 are repeatedly mentioned in the Bible and were considered sacred numbers by a number of ancient religions:

The Aztecs and Mayas believed in a pantheon of 9 deities, as did the priests of Egypt during the earliest dynastic period, 4,500 years ago (Budge, 1903, Thomkins, 1987). The Mayas also believed that the underworld has nine levels through which the dead must journey over a period of 4 years (Coe, 1993).

We also know that the Hebrew word "Mazal-tov" (shouted during births and weddings) does not mean "good luck" per se, but a "good zodiac," or, a "good constellation/station." That is, a wish that the sun's station, in a specific constellation on the day of the birth/wedding, will bring good luck.

Again, there are 12 constellations and 12 is a precessional number.

Or consider the number, 432,000.

The Mayan calendar featured the number 432,000, as well as 2160 and others that allowed for the calculation of precession, i.e. 1 Tun = 360 days, 2 Tuns = 720 days, 6 Tuns 2160 days, 6 Katuns = 43,200 days (Wright, R. 1991).

The ancients believed that precession through one constellation takes 2,160 years. Precession through two houses of the zodiac (60 degree across the ecliptic) was believed to take 4,320 years.

In ancient Indian religion, Kali Yuga is believed to be one of the four ages of Earth . Kali Yuga is identified as the current and last age and consists of 1200 Divine years. This is equal to 432,000 years of mortal man.

There are also 10,800 stanzas in the religious text, the Rigveda, the most ancient of Vedic literature— 10800 being a multiple of 108. Each stanza consists of 432,000 syllables.

In the Sumerian King's list, it is asserted that the Anunnaki gods arrived on Earth, 432,000 years ago.

We are also told by Berossus of ancient Babylon, that gods and demi-gods ruled ancient Summer for a total of 432,000 years.

According to ancient Chinese traditions, all the world's knowledge, before the destruction of the last world by the worldwide deluge, were said to be written down in 4,320 volumes.

Berossus also tells us that there are 2,160,000 years between creation and universal catastrophe, which is the amount derived at when 432,000 is multiplied by 5.

The four seasons, plus the axis running through the Earth (passing through north and south pole) yields the number "5."

Likewise, 2,160,000 represents 1000 cycles of the number of years it takes the sun to pass from one to the next house of the zodiac.

As noted, by multiplying the base and height of the Great pyramid by 43,200 one can arrive at an astonishingly close approximation of the dimensions of the Earth.

Or, consider the Norse poem which describes the battle of the gods and the end of the world: "500 doors and 40 there are I seen, in Valhalla's walls; 800 fighters through each door fare, When to war with the Wolf they go."

500 plus 40 = 540. 540 x 800 = 432,000.

432,000 divided by 6,000=72

432,000 divided by 2,000=2,160

Again: "Coincidence" is not a scientific explanation.

Dr. Herman Hiprect, who participated in “The Babylonian Expedition of the University of Pennsylvania” has reported that in analyzing the numerous Mesopotamian mathematical tablets, that “all the multiplication and division tables from the temple libraries of Nippur and Sippar, and from the library of Ashurbanipal in Ninevah, are based upon the number 1296000.” He concluded that this number had to be related to precession.

12,960,000 divided by 500=25,920

500 x 25,920=12,960,000

As summed up by de Santillan and von Dechend (1969), “When one finds the same numbers reappearing under several multiples in the Vedas, in the temples of Angkor, in Babylon, in Heraclitius’ dark utterances, and also in the Norse Valhalla, it is not an accident... These refer to celestial events... and constitute... a language of awe inspiring antiquity... that concentrates on numbers, motions, measures, overall frames, schemas, and on the structure of numbers, on geometry.... which transmit... a precessional message...”

Yes, but is the message

The ancients believed that precession, the cosmic clock,was directly linked to cycles of creation and destruction, of death and rebirth. Precession was a key to predicting the future—a future based on the past, including past cycles of cosmic destruction: the old age replaced by the new.

“And the seven judges of hell raised their torches, lighting the land with their livid flame. A stupor of despair went up to heaven when the god of the storm turned daylight into darkness, when he smashed the land like a cup” - the Epic of Gilgamesh.

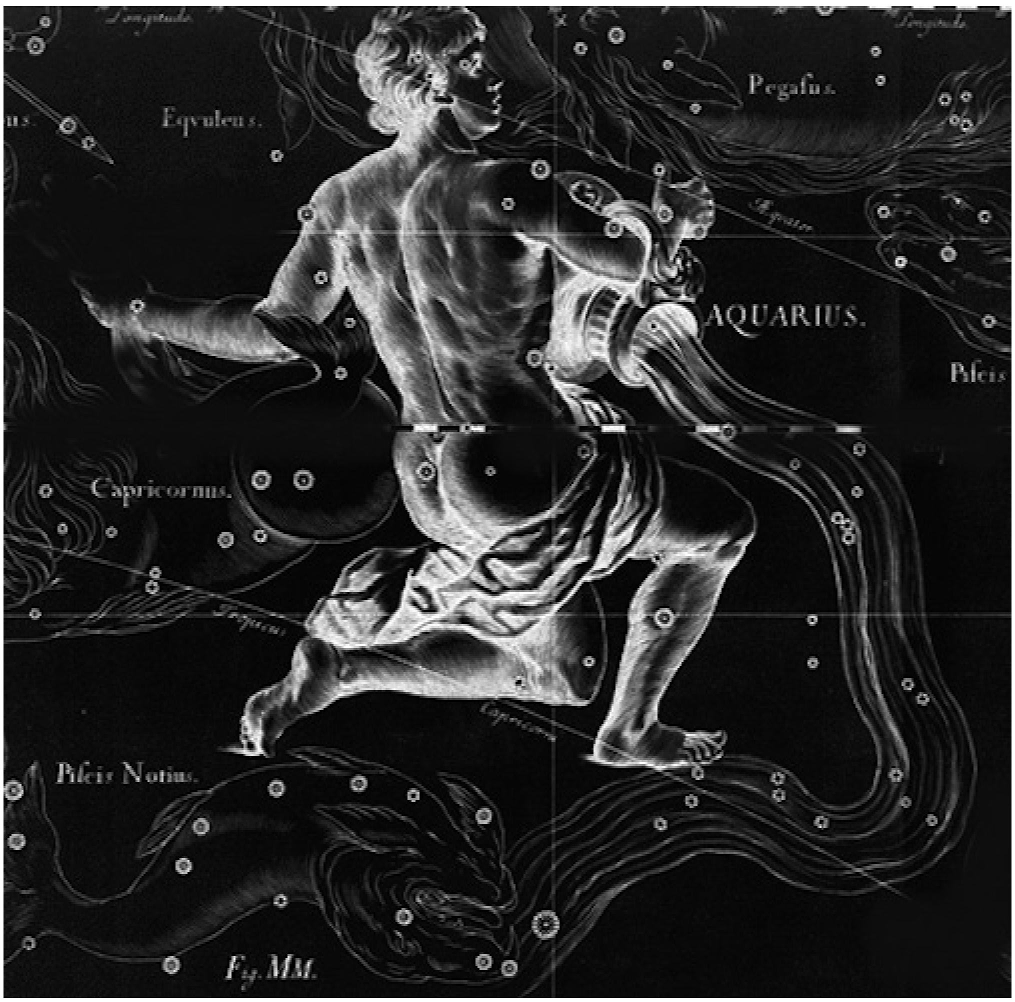
THE ANTI-CHRIST: **AQUARIUS, LEO, SCORPIO, TAURUS**

“And there appeared a great wonder in heaven: A woman clothed with the sun, and the moon under her feet, and upon her head a crown of twelve stars: And she being with child cried travailing in birth and pained to be delivered...

“And there appeared another wonder in heaven: And behold a great red dragon having seven heads and ten horns and seven crowns upon his head. And his tail drew the third part of the stars of heaven and did cast them to the Earth...

“And there was a war in heaven: Michael and his angels fought against the dragon: and the dragon fought and his angels. And the great dragon was cast out, that old serpent, called the Devil and Satan which deceivith the whole world: He was cast out and his angels were cast out with him...

"And the serpent cast out of his mouth water as a flood. And the Earth opened her mouth and swallowed up the flood which the dragon cast out his mouth. And the dragon was wroth and went to make war..." —Revelation, 12



The coming of Christ, a Messiah, the new god, and the onset of a "new Golden Age" was heralded by the sun's movement from Aries into the house of Pisces, 2000 years ago. In the mind of at least some of the ancients, the birth of the new god was also signaled by the conjunction of Jupiter and Saturn, which lined up together in the constellation of Pisces, in the year 6 B.C., thus forming a very bright "star"—the "star of Bethlehem."

These “blessed” events were immortalized two thousand years ago by Virgil, in his Fourth Ecologue: “Now the Virgin returns, the reign of Saturn returns, now a new generation descends from heaven on high. Only do thou, pure Lucina, smile on the birth of the child, under whom the iron brood shall first cease, and a golden race spring up throughout the world!”

And who was the “virgin?”

Virgo. With her return, Virgo the virgin would give birth to a new age and a new god.

Two thousand years ago, whereas Pisces governed the vernal equinox, the sun rose in Virgo during the autumn equinox. However, 12,000 to 14,000 years ago, Virgo governed the vernal equinoxes during the “golden age” and when she left, the “golden age ended” in a confluence of catastrophes.

Hence, Virgil’s poem, refers to the return of the Virgin which coincided with the new age of Pisces both of which ruled during the last “Golden age.”

Thus, the birth of Christ was associated not only with the new golden age of Pisces, but with a virgin—Virgo: The virgin birth of the new god. Virgo would rein for 2,160 years, and with her departure (in about 100 years), the god she gave birth to will die. However, a new god will not only take the place of the old god, but her departure will give birth to the new god as well—a god associated with the “beast” —Leo (the lion). The Virgin will flee only to be pursued by Leo who shall take her place.

Likewise, in Revelation, we are told that the ending of the next world will be associated with a “beast...like that of a lion...” and a “dragon” who “gave the beast his power and his throne and great authority...” and who “pursued the woman who...was pregnant and cried out in pain as she was about to give birth...” and who, upon giving “birth to the male child...fled into the desert.... where she might be taken care of for 1,260 days...the dragon...pursued the woman...”

The woman (Virgo) gives birth (a virgin birth) to a new God only to depart and to be pursued by the water belching dragon and anti-Christ who gives power to a lion-like beast (Leo) who will rule the heavens. However, by departing she also gives birth to a new god: the beast, Leo.

Revelations also gives us the number of the beast: “His number is 666. This calls for wisdom. If anyone has insight, let him calculate the number of the beast.”

“666” is obviously a reference to a repeating cycle. Yet, the author of Revelations asks us to look beyond the obvious and to “calculate the number of the beast.”

Calculating the Number of the Beast: 6 x 6 x 6 = 216. “216” is a precessional number: 2,160— the number of years to complete a precessional cycle.

“The dragon...which gave power to the beast... had...ten horns.” -Revelation.

10 x 216 = 2160.

The “Beast” is Leo: “The horses... I saw in my vision looked like this: The heads of the horses resembled the heads of lions....Then I saw another mighty angel coming down from heaven...he gave a loud shout like the roar of a lion....And I saw a beast coming out of the sea.” (Aquarius—the sea.)

“He had...a mouth like that of a lion.” -Revelation.

And his repeating cyclic number, 666, refers to precession: “The beast, which you saw, once was, now is not, and will come up out of the Abyss...The inhabitants of the Earth.... will be astonished when they see the beast, because he once was, now is not, and yet will come...” -Revelation

As noted, precession is a counterclockwise, or rather, an anti-clockwise phenomenon. Due to the retardation of the Earth’s orbital movement of 1 degree every 72 years, every 2,160 years the sun rises in the previous house of the Zodiac.

Hence, instead of moving forward from Pisces to Aries, in about 100 years the sun will rise in Aquarius, thereby signaling the death of the god of Pisces (the fish) and heralding the new age god of Aquarius who will rule the vernal equinox.

Likewise, Virgo (the virgin) will be replaced by Leo (a predatory “Beast”) who will rule the autumn equinox, just as he did 12,000 years ago: “The horses... I saw in my vision looked like this:

The heads of the horses resembled the heads of lions....Then I saw another mighty angel coming down from heaven...he gave a loud shout like the roar of a lion....And I saw a beast coming out of the sea.” (Aquarius—the sea). “He had...a mouth like that of a lion....” -Revelation

The age of Aquarius/Leo, therefore, is the anti-Christ: Symbolized by the movement away from Pisces/Virgo, and the end of that “god’s” rule.

“And the serpent cast out of his mouth water as a flood...”

Some 12,000 years ago, Aquarius (the god of the waters) ruled the autumn equinox and Leo ruled the vernal equinox. It is during this ancient period that the “Golden Age” is believed to have ended, and civilization along with it in a terrible flood that coincided with a “war in heaven.” Thus, the return of Leo and Aquarius (albeit in the opposite equinox) and the departure of Pisces and Virgo, is also believed to herald not just a new beginning, but a terrible ending—a confluence of catastrophes that will coincide with a celestial war in heaven and a battle among the stars that will begin with the rise of Leo, the “Beast:”

“Look, he is coming with the clouds, and every eye will see him... and there before me was a throne... In the center, around the throne, were four living creatures. The first living creature was like a lion” (Leo?) “the second was like an ox” (Taurus?) “the third had a face like a man (Sagittarius/Aquarius), “the fourth was like a flying eagle...”

And what is the “flying eagle?” Scorpio.

Again, as of 2012, the sun rises in the houses of Scorpio and Taurus on the solstice, and in the constellations of Leo and Aquarius on equinox.

Revelation continues: “the fourth was like a flying eagle... And I saw a mighty angel proclaiming in a loud voice, “Who is worthy to break the seals and open the scroll...Then one of the elders said to me... the Lion... has triumphed. He is able to open the scroll and its seven seals... and the stars in the sky fell to Earth. The sky receded like a scroll, rolling up, and every mountain and island was removed from its place. Then the kings of the Earth, the princes, the generals, the rich, the mighty, and every slave and every free man hid in caves and among the rocks of the mountains... Then the seven angels who had the seven trumpets prepared to sound them. The first angel sounded his trumpet, and there came hail and fire mixed with blood, and it was hurled down upon the Earth. A third of the Earth was burned up, a third of the trees were burned up, and all the green grass was burned up.

The second angel sounded his trumpet, and something like a huge mountain, all ablaze, was thrown into the sea....The third angel sounded his trumpet, and a great star, blazing like a torch, fell from the sky...” - Revelation.

THE COSMIC CLOCK

"Who among us can tell the future by letting us hear the First Things?" —Isaiah, 43.

Revelation repeatedly refers to a cosmic catastrophe associated with the house of Leo (the lion) and Aquarius (waters/sea). Ezekiel (38, 39) tells us that in the "End of Days" fire and brimstone will fall from the skies, and there will be great earthquakes, plagues, and wars.

Ezekiel, like Revelation and Isaiah, also contains precessional language, as does the Mayan/Olmec calendar. And, they base their predictions of the future, on what has happened in the past...that the End is anchored in the Beginning (e.g. Isaiah, 48; Zechariah, 1, 7).

The best predictor of the future, is the past.

However, neither Revelation, Ezekiel, or Isaiah, provide us with a date in which these terrible cosmic events are to recur, other than to warn that these disasters will begin with the return of the great serpent, the anti-Christ, and the beast: Aquarius/Leo.

The Mayas, basing their calculations on the Venus calender, were more exacting.

According to the Mayan/Olmec/Aztec Calendar, the date for the beginning of the end of the previous age and its gods, and the onset of a new age and its gods, will be "4 Ahau 3 Kankin" (December 23, 2012), "and it will be ruled by the Sun God, the ninth Lord of the Night."

Welcome to the Age of Aquarius.

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