

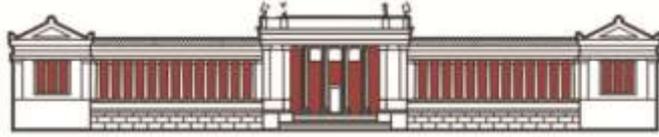
**XXI SEAC conference**  
*Astronomy:*  
*Mother of Civilization and*  
*Guide to the Future*



1<sup>st</sup> September to 7<sup>th</sup> September 2013

at the National and Kapodistrian University of Athens, the National Archaeological Museum,  
the Numismatic Museum, Société Européenne pour l'Astronomie dans la Culture





**XXI SEAC conference**

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***Book of abstracts***



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Cover:

Helios (the Sun) and Eos (the Dawn) drive a chariot in the sky.

EAM/NAM 17983. Attic red figure pyxis. 430 BC. Lid Painter.

Acknowledgment Credit line: National Archaeological Museum, Athens

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## **ORGANIZERS OF THE CONFERENCE:**

**SEAC, Société Européenne pour l'Astronomie dans la Culture  
the National and Kapodistrian University of Athens,  
the National Archaeological Museum, Athens, Greece and  
the Numismatic Museum, Athens, Greece**

## **SUPPORTERS**

**AINIANES<sup>1</sup>,Greece**



---

<sup>1</sup> Since 1976 “the Aenianes”, the educational & cultural Association of Ipati has gone through a significant progress in the cultural and social life of Fthiotis regional area. It has almost 300 active members and consists of a women group, environmental branch and also a “blood bank”. Its dancing group consists of 100 amateur dancers, of all age groups, and aims to revive and maintain the tradition and unique customs of Ipati. It has take part in lots of cultural events and has won several prizes and honors e.g. 1<sup>st</sup> prize in the central Greece dancing contest (1980) , 1<sup>st</sup> prize in the pan-Hellenic dancing and singing contest (1984) and more.

**Société Européenne pour l'Astronomie dans la Culture**  
**The XXI SEAC Conference, 2013, Athens, Greece**  
**Monday 2<sup>nd</sup> September to Friday 6<sup>th</sup> September 2013.**

Conference SEAC 2013 has the theme “*Astronomy, mother of Civilization and Guide to the Future*”. Emphasis will be to reveal the crucial role of astronomy in societies, countries, continents, at all eras.

Since the dawn of humanity Astronomy is the cardinal socio-anthropological activity that led to the development of Culture, Mathematics, Philosophy and Civilization.

Human, ANTHROPOS [ANΘΡΩΠΙΟΣ] in Greek according to a popular etymology means the one that looks up, sees the sky, and admires the harmony of the celestial sphere with the stars and the planets and develops the will to try to understand and explain the Cosmos [ΚΟΣΜΟΣ means ornament in Greek]. In their effort to understand the Cosmos humans develop logic, causality, and civilization. Philosophy is born.

This is the theme of the conference.

Astronomy, as a practice, was always interconnected with other realms of social discourse, such as mythology, religion, philosophy, and with the emerging Cosmo-systems, and introduced a strong connection between the celestial phenomena and human activities. Observing and studying these harmonious of the celestial bodies, civilizations learned to stay in tune with the cycle of the seasons and the various variations of the behavior of their landscapes, thus providing means for their long – standing survival on their fight against the natural forces and the taming of Nature itself that eventually led to the development of science and philosophy.

Astronomy, as an exact science, is born within the movement of the Ionian Renaissance, from the great Pre-socratic spirits, and is always interconnected with the birth of philosophy, as well, from the very same masters of the human thought. Its first acme, after its birth and as an advanced scientific discipline, appears in the Hellenistic Era. As an autopoietic structure, in its complete form, grounded and established by giants, such as Archimedes, Hipparchus, Posidonius, Claudius Ptolemy appears and flourishes in all the forthcoming great civilizations and empires, unchanged in its aims and internal structure, that is as a specific way of observing nature, unraveling the secrets of Cosmos, and placing humans within it.

The evolution of astronomy leads to the great scientific revolution and the modern world, through Galileo, Copernicus, Kepler and Newton, to mention only a few of the giants that set the foundations of the modern world.

In our days, Astronomy strongly refers to the global heritage of all the human civilizations, as a bond and a point of reference between them, while it opens new roads for our globalized society, towards the space exploration, and the gigantic leap of mankind towards leaving its place of birth, our planet Earth, and expanding to new frontiers. Astronomy, as a science, and as the fountain of various technological achievements inspired by the needs of space exploration, opens novel roads towards our common fate, while it always remind us the common bond which exists between cultures and civilizations.

This is the canvas SEAC 2013 conference will be interwoven, in the very nice environment of central Athens, at the National and Kapodistrian University of Athens(central building), the National Archaeological Museum and the Numismatic Museum (H. Schliemann's house).

If we have the time we can visit the two ancient observatories, the 5<sup>th</sup> century BC observatory of Meton at Pnyx and the 2<sup>nd</sup>-1<sup>st</sup> century BC observatory and astronomical clock of Andronikos of Kyrrhos (the so called *Aerides* – tower of winds at Aeolos street). The Academy of Plato and the Lyceum of Aristotle, the University of Proclus (just opposite Dionysus theatre), Keramikos, Hadrian Library (and University and research center) and other libraries, the Agora are relatively close and worth visiting.



The Antikythera Mechanism, detail from a painting by Evi Sarantea

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**The largest fragment of the Antikythera Mechanism, National Archeological Museum, Athens**

### **Topics and Sessions**

1. Astronomy and Philosophy
2. Theory and Methodology of Archaeoastronomy
3. European Prehistory, Folklore and Archaeoastronomy
4. Astronomy in Europe and the Mediterranean at Historical Times
5. Archaeoastronomy in Mesoamerica
6. Archaeoastronomy in North and South America
7. Astronomy and Archaeoastronomy in Near East, Asia, and Oceania
8. Astronomy and archaeoastronomy in Africa
9. Research History of Astronomy and Current Issues
10. Educational Aspects of Astronomy

### Works of Art and Exhibitions presented during XXI SEAC 2013

[1]. During the XXIth SEAC conference we will present an exhibition of paintings by Ms Evi Sarantea based on her series of portraits of Ancient Philosophers (invited).



Pythagoras, Plato and Aristotle by Evi Sarantea



[2a]. Projection of 2 compositions from the performance PYR AEIZOON (*Pur A-ii-zo-on*), *FIRE EVERLIVING*, Alexandros Hahalis, composer, Athens, Greece

Music, Logos & Visuals create – under the Tholos of the Planetarium- a unique atmosphere, a multimedia journey through space & time. The totality of Alexandros' musical work, based on Heraclitus the great Ephesian philosopher, travels along the inexhaustible wealth of the Ancient Hellenic Spirit and through his own musical "language" converses with science.

Specifically will be projected:

A. Orphic Hymn to the Stars (fragment), with soprano Dimitra Theodossiou, live in Monntopolis of Italy, *dedicated to the Spring Equinox of 2003*

I am calling the sacred light of the celestial stars,  
with holy voices I invoke the pure gods;  
Celestial stars, sparkling, fiery,  
ever bearers of all...

B. Pyr Aeizoon / Fire Everliving - Heraclitus, *at the Eugenideion Planetarium, dedicated to the Spring Equinox of 2010*

*This world, the same for all,  
none of the gods or humans created  
but always was is & shall be  
Fire Everliving, inflamed by laws  
and by laws extinguished.*

[2β] Προβολή 2 συνθέσεων από την Παράσταση «Π Υ Ρ Α Ε Ι Ζ Ω Ο Ν», του συνθέτη κυρίου Αλέξανδρου Χάχαλη

Ο λόγος, η μουσική και η εικόνα δημιουργούν –κάτω από το θόλο του πλανηταρίου- μία ατμόσφαιρα μοναδική, ένα πολυμεσικό ταξίδι στο χώρο και το χρόνο. Συνολικά, το μουσικό έργο του Αλέξανδρου Χάχαλη, έχοντας ως βάση τον Ηράκλειτο, ταξιδεύει στον ανεξάντλητο πλούτο του αρχαίου ελληνικού πνεύματος και μέσα από τη δική του μουσική «γλώσσα» «συνδιαλέγεται» με την επιστήμη.

Συγκεκριμένα θα προβληθούν

A. Ορφικός Ύμνος Άστρων (απόσπασμα), με τη σοπράνο κα Δήμητρα Θεοδοσίου, στην Μοντόπολι της Ιταλίας, αφιερωμένη στην Εαρινή Ισημερία του 2003  
[http://www.youtube.com/watch?v=BwiU9eH\\_vpl](http://www.youtube.com/watch?v=BwiU9eH_vpl)

*Άστρων ουρανίων ιερόν σέλας εκπροκαλούμαι  
ειέροις φωνήσι κικλήσκων δαίμονας αγνούς·  
Αστέρες ουράνιοι, ανταυγείς, πυρρόεντες  
αεί γενετήρες απάντων...*

B. Πυρ Αείζων – Ηράκλειτος, με τη σοπράνο κα Μαρία Κανελλοπούλου, στο Ευγενίδειο Πλανητάριο αφιερωμένη στην Εαρινή Ισημερία του 2010

<http://www.youtube.com/watch?v=NSH4kvtEw0o>

# ABSTRACTS

ORDERED ALPHABETICALLY

## A

***The depiction of the star and the moon on the coins of the Numismatic Museum, Athens, collections (to be given in Greek)***

**Andreou Alexandros**

*Archaeologist, Numismatist, Numismatic Museum, Athens*

Session: Astronomy in Europe and the Mediterranean at Historical Times

### ABSTRACT

The constellations, the comets and the moon fascinated the ancient Greek people so much so that they were depicted them from the Archaic to Hellenistic time on their coins. The presentation of the star and the moon on the ancient Greek coins was always connected with specific deities, like Artemis, Aphrodite and Apollo and demigods like the Dioskouroi. Their depiction was also connected with the religious beliefs of kings and rulers well as with their propaganda and their legitimation of power. The aim of this article is to represent through specific examples of the Numismatic Museum, Athens, collections the manifold use of their iconography and the meaning which they reflect.

***Η απεικόνιση των αστερών και της σελήνης μέσα από τα νομίσματα των Συλλογών του Νομισματικού Μουσείου***

**Ανδρέου Αλέξανδρος**

*Αρχαιολόγος-Νομισματολόγος, Νομισματικό Μουσείο Αθηνών*

### Σύνοψη

Οι αστερισμοί, οι κομήτες και η σελήνη άσκησαν ανέκαθεν έλξη στους αρχαίους Έλληνες με αποτέλεσμα ήδη από τους αρχαίους έως τους ελληνοιστικούς χρόνους να τα απεικονίσουν στα νομίσματα τους. Η παρουσία της σελήνης και των αστεριών στα νομίσματα τους συνδέεται τόσο με συγκεκριμένες θεότητες, όπως π.χ. την Άρτεμι, την Αφροδίτη και τον Απόλλωνα καθώς επίσης και με ημίθεους, όπως τους Διόσκουρους. Η απεικόνιση τους επίσης συνδέεται και με τις θρησκευτικές πεποιθήσεις, την προπαγάνδα και την

νομιμοποίηση της εξουσίας βασιλέων και ηγεμόνων. Η παρούσα ανακοίνωση αποσκοπεί μέσα από συγκεκριμένα παραδείγματα των συλλογών του Νομισματικού Μουσείου να παρουσιάσει την ποικίλη εικονογραφική τους χρήση και να ερμηνεύσει τη σημασία τους.

***The dichotomy between ‘practical’ and ‘theoretical’ astronomy in Plato’s school  
(invited 20 minutes including discussion)***

**Antonello Elio**

*INAF- Osservatorio Astronomico di Brera E-mail: elio.antonello@brera.inaf.it*

Session: Astronomy and Philosophy

**ABSTRACT**

The importance of sky-gazing for the human knowledge was pointed out at the previous SEAC meeting taking into account also Plato and his school (Antonello, 2013). Here we will consider again *Epinomis*, that stressed on the relevance of astronomy as the main discipline: «Let us try, then, to set forth in our statement [...] how one should learn in what manner one will learn the proper reverence of the gods. It is, indeed, a rather strange thing to hear; but the name that we, at any rate, give it [...] is astronomy; people are ignorant that he who is truly an astronomer must be wisest, not he who is an astronomer in the sense understood by Hesiod and all the rest of such writers, the sort of man who has studied settings and risings; but the man who has studied the seven out of the eight orbits» (*Epinomis*, tr. W.H. Lamb). We will discuss briefly the (possibly far-reaching) negative implications of such a specific distinction between ‘astronomers’, since one could interpret that distinction as an implicit ranking: the ‘practical’ astronomy (that applied to agriculture) may be considered less important than the ‘theoretical’ one (i.e. the study of the orbits).

***Gian Rinaldo Carli and Atlantis***

**Antonello Elio**

*INAF- Osservatorio Astronomico di Brera, E-mail: elio.antonello@brera.inaf.it*

Session: Astronomy in Europe and the Mediterranean at Historical Times

**ABSTRACT**

Gian Rinaldo Carli (1720 – 1795) was a learned polymath that gave important contributions to the studies of political economy and public finance, particularly in the Duchy of Milan during the Milanese Enlightenment. His interests included poetry and literature, history, numismatics

and (human) geography. After his retirement, in 1780-1783 he published *Le Lettere Americane* (*The American Letters*) where he discussed the South American pre-columbian civilizations. He made a comparative study with the European and Asian civilizations, with the purpose of demonstrating the high level of South American cultures, particularly that of Incas (Carli, 1783). The *Lettere* were appreciated by his contemporaries (e.g. Wolf and Hayes, 2006), and were translated in foreign languages. In that work, Carli addressed also the issue of the myth of Atlantis, and proposed his own hypothesis about it. We will discuss this fanciful hypothesis as a possible case study of cultural astronomy; according to Carli, astronomy began in Atlantis and then spread in Europe, Africa and America.

## References

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## ***The PLATO space mission***

**Antonello Elio**

*INAF- Osservatorio Astronomico di Brera, E-mail: elio.antonello@brera.inaf.it*

Session: Research History of Astronomy and Current Issues

## **ABSTRACT**

PLATO is a medium (M) class mission in the framework of the ESA Cosmic Vision 2015-2025 program, and its goal is to study other "solar" systems, that is, exoplanets, their formation and the conditions for the emergence of life. It may be considered an example of how Plato's philosophy is still influencing the present day astronomical research.

## ***Temple orientation trends in Bronze Age Southern Levant***

**Artelaris Gerasimos<sup>1</sup> and Liritzis Ioannis<sup>2</sup>**

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Session: Astronomy and Archaeoastronomy in Near East, Asia, and Oceania

## **ABSTRACT**

Here we investigate the presence and the variety of temple orientation trends in Southern Levant, during the Bronze Age (i.e. 3600 – 1200 BC) and their relation to the already established astronomical orientation of contemporary monumental buildings in the Near East and the Aegean. Levant, the geographical area between Egypt and Mesopotamia, has always been acrossroad for neighboring civilizations. Since the Early Bronze Age we have evidence of systematic trade and exchange of goods and knowledge with nearby and distant regions, namely Egypt, Mesopotamia, Anatolia and the Aegean Islands (Ben-Tor, 1992). Throughout the Bronze Age, Southern Levant was also conquered several times by neighboring states (Van de Mieroop, 2004). For various reasons the people of Southern Levant never managed to form a centrally governed state, as it happened in adjacent regions (e.g. Pharaohs in Egypt). Instead, for most of the Bronze Age era they followed the city-state model (Chesson et al, 2003; De Miroschedji, 1999). This is clearly evident in the orientation of temples and public buildings in general, which do not follow a common pattern but vary considerably from place to place. Due to the small number of contemporary buildings with the same architectural design, it is almost impossible to reach solid conclusions about the reasons of the observed orientations. However, by comparing the features of these buildings to similar structures of the neighboring regions where more evidence is available we can better understand their purpose. The orientation of more than 50 buildings identified as temples was measured, especially in locations that were inhabited almost for the entire Bronze Age (e.g. Megiddo, Hazor). We examine whether their orientation was affected or not during the occupation periods and the possible effect of this change in religion and ritual practices. The supposed power of the conquering rulers – as it is manifested in other archaeological evidence – is compared to the changes in building orientation. Also, we compare known trade relations to orientation similarities between regions. We suggest that while Southern Levantine people were influenced through contact with other cultures (either by trade or conquest), they managed to retain their individual style in temple orientation.

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Session: North South America

**ABSTRACT**

In a paper presented at the SEAC 2012 conference held at Ljubljana the Authors have demonstrated that Intimachay in Machu Picchu, was an astronomical observatory far more complex and precise than it has been previously believed. It was most probably an “astronomical instrument”, intended for use by a narrow group of Inca priests-astronomers, mentioned in some sources.

The present paper is dedicated to another, very interesting structure, called “El Mirador”, located on the slopes of Huayna Picchu. It was probably another “astronomical instrument”, for precise observations of a very narrow part of the Sky. An hypothesis concerning the practical function of this structure will be presented.

# B

***On the origin of the alphabet in a cosmological aspect***

**Barinova Ekaterina E.**

ACS Academy, Shanghai, China, E-mail: [barinova.e.e@gmail.com](mailto:barinova.e.e@gmail.com)

Session: Educational Aspects of Astronomy

**ABSTRACT**

The problem of the origin of the alphabet as a result of symbolic rationalized conceptions of the universe is under review in this report. Many researchers on the history of written language note the constancy of the sequence of letters in the phonetic alphabet, but only a few try to find out why this order has been so stable. According to some hypotheses the alphabet is being viewed as a chronological and a topological model of the universe. Etymological studies demonstrate that the semantics of ancient letters' names in different alphabet systems was associated with the idea of world order, has an axiological component and also reflects the idea of the duality of the world. But why such a global world image was reflected in the system of graphic symbols designed to record the sounds of speech? And why exactly this order of letters was established? Perhaps the answers of these questions could be found in the ancient ideographic dictionaries and "elementary texts" (syllabary and hieroglyphic writing) in which the sky and celestial objects occupy the top of the hierarchy in

the conception of the world image, as well as in an even more archaic graphic language of petroglyphs reflecting the ancient astronomical ideas.

***The Epistemological and Cosmological Foundations of Indian Astrology and Divination (invited)***

**Prof. Beinorius Audrius**

*Center of Oriental Studies, Vilnius University, Lithuania, E-mail: audrius.beinorius@oc.vu.lt*

Session: Astronomy and Archaeoastronomy in Near East, Asia, and Oceania

**ABSTRACT**

In India, from their inception, astronomy and astrology have operated concurrently and in complementary fashion providing a grammar and syntax for a single semantic universe. This cosmos was above all relevant to the terrestrial world, especially to the proper functioning of Aryan society. The structures and movements of celestial phenomena provide an arena in which philosophical insights and religious traditions, mythological vision, and social reality are expressed, mediated, and objectified. Therefore, to know the grammar and the syntax of the heavens – the unfolding chronology, the modulations of meaning – was essential if the order of the world and of society was to be maintained. (Friedman, 1986) Thus, in present paper I will try to reveal the epistemological and cosmological foundations of Indian astrology and divinational practices by relying mostly on the early Sanskrit sources. The famous phenomenologist of religions M. Eliade has demonstrated the significance of celestial archetypes in contributing to the unity and cohesiveness of the cosmological vision imbedded within the cultural fabric. He has also examined the ontological conceptions that underlie the celestial archetypes that permit and facilitate, for traditional societies, a necessary intercourse between the conditioned and the transcendental. (Eliade, 1974) An earlier generation of European scholarship had, with rationalistic bias, assumed that astrology represented the consistent application of *post hoc ergo propter hoc* (“after this, therefore because of this”), and judged the system to be little more than an antiquated and fallacious epistemology. Indian astrologers were certainly not thought to be engaged in any extended historical project of inference and deduction ( *anumāna*) by which their astrological system was conceived; but in fact, such a project, individually implemented along heuristic lines probably accounts for the variation in astrological traditions encountered in texts and in practice. (Dasgupta, 1975) Rather, the Indian astrological system, as system, implies its own epistemological foundations that must be understood within the broader context of an Indian cultural and intellectual agenda. Formal cosmological structure together with a rich mythological tradition supports a living, meaning-filled cosmos. This cosmos is above all relevant to the human world and Indian epistemology ensured this relevance in the concept of “likeness” or “resemblance” (*sādṛśya*). (*Yavanajātaka* 36.1-4) The concept of “likeness” (*sādṛśya*) is fundamental to the

operation of the Indian astrological system. The world is then the image of the heavens, and to know the structural components and interactional dynamics of the astrological system – to know the patterns of being as these are continuously generated by this system of meanings – is, through the “correspondence” that a dialectical imagination makes possible, to know the world. The astrological system thus objectifies human experience and ensures a universe of participation in which the individual and the cosmos are fundamentally relevant to each other. (Pingree, 1981)

Therefore, the Indian astrological system both generates and prefigures karmic conditions: an individual’s *karma* and *dharma* are reified in the horoscope. Astrology in its entire operational schema becomes a language that is used not only in constructing a myth of the self but also in connecting such myths to society, thus creating a dialectics of self and society. Opposing the common assumption that astrology is merely an expression of archaic – and degrading – superstition, my paper concludes that the Indian divinational system – as cultural system (Geertz, 1973) – is based on a particular cosmic vision and lends human experience value and meaning. Thus, astrological practices cannot be differentiated from other social practices on the basis of their symbolic exchange or their rhetorical powers.

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### ***Ancient constellations of the Central Asia: to astronomical interpretation of some subjects of petroglyphs***

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Session: Astronomy and Archaeoastronomy in Near East, Asia, and Oceania

#### **ABSTRACT**

What do we know about perception of the starry sky of the Central Asian ancient inhabitants?

How deep and far can we take a glance into centuries in this question?

Ethnographic materials of Turkic and Mongolian people show a generality in the representations and names of some constellations, which I call, core ones. Those are constellations of the Taurus (the Pleiades), the Ursa Major together with the Ursa Minor, Orion and Polar star.

The purpose of the present research is a reconstruction of star patterns deep into centuries till the Bronze Age, by the way of comparison of the main world outlook ideas, occurring on the given region with their possible reflections on the sky. In the given work, ways of their evolutions also are considered. For this purpose petroglyphic plots from the Bronze Age till ethnographic time in a context of astral myths, folklore and calendar practice of the Central Asian people and their neighbors are analyzed.

1. The image of a bull becomes one of leading rock art drawings of the second millennium BC. I suppose that constellation of Taurus or prominent part of them the Pleiades was perceived

as an image of a bull during epoch of neolith and bronze. It is an obvious fact that the image of the bull played a great role in world outlook of that epoch. Among them especially interesting and important argument in favor of our hypothesis are drawings of bulls with the image on its body from 5 to 7 round relief "spots" reminding with its appearance close group of stars of the Pleiades.

2. Orion, most likely, had been closely associated with red deer - a maral and in certain cases with the mountain rams, pursued by a heaven marksman. The given subject is widely spread among petroglyphs of Early Iron Age and widely reflected in myths and the eposes. Subsequently, at ethnographic time the marksman appears with fused gun.

3. The Ursa Major and Ursa Minor as a mega constellation that was recognized with the images of elk or deer with its calf. The image of Deer Goddesses also ascends to the Early Iron Age and in quality Space Deer Helgen as the Mistresses of the Universe (Jacobson, 1993) and Deer Mothers (Horned Mother) had lived up to now at Evenks (Anicimov, 1959) and Kyrgyz (Abramzon, 1990).

4. At a following stage, with development of a cult of the horse, two stars of the Ursa Minor are perceived as an image of two horses adhered to Polar star. There are among petroglyphs of that time there were images of two horses adhered at the column. In my opinion, they are the sacrificial or devoted horses to heavenly gods, for example to Ulgen, the supreme deity of Altaians. In the Middle Ages, at the Ancient Turks epoch, the 7 stars of the Ursa Major have turned to the Seven Soldiers and Seven Burhans. The first of them is linked to Altay epic tradition, whereas the second one goes back to an Old Indian representation of Seven Wise Men, which are connected, with the dissemination of the Buddhism in the East Altay. The common feature inherent to above-stated constellations is that all of them played an important role of calendar markers.

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***"The Waters I am Entering No One yet Has Crossed"<sup>2</sup>: (invited)***

***Alexander Friedman and the Origins of Modern Cosmology***

**Belenkiy Ari**

<sup>2</sup> **Note of the editor:** *Ποταμὸς οὐκ ἐστὶν ἐμβῆναι δις τῷ αὐτῷ*, You cannot enter in the same river twice, Heraclitus (544 to 484 BCE).

Session: Research History of Astronomy and Current Issues

### **ABSTRACT**

Ninety one year ago, in 1922, Alexander Friedman (1888-1925) demonstrated for the first time that the General Relativity equations admit non-static solutions and thus the Universe may expand, contract, collapse, and even be born. The fundamental equations he derived still provide the basis for the current cosmological theories of the Big Bang and the Accelerating Universe. Later, in 1924, he was the first to realize that General Relativity allows the Universe to be infinite, thus adding another dimension to Einstein's original theory. Friedman's ideas initially met strong resistance from Einstein, yet from 1931 the creator of General Relativity became their staunchest supporter.

After a general introduction to the subject, I intend to describe Friedman's little known topological and astronomical ideas of how to check General Relativity in practice. Recently discovered corpus of Friedman's writings in the Ehrenfest Archives at Leiden University sheds some new light on the circumstances surrounding the writing of his 1922 work and his relations with Paul Ehrenfest. I explain the origin of double "n" in Friedman's name. Finally, I connect Friedman's cosmological ideas with the 1998-2004 astronomical observations that led to the 2011 Nobel Prize in Physics. Because of the recent debates among science historians, I compare Friedman's contributions to those of Georges Lemaitre, Vesto Slipher and Edwin Hubble.

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3. "The Waters I am Entering No One yet Has Crossed: Alexander Friedman and the Origins of Modern Cosmology" in *Origins of the Expanding Universe: 1912-1932*, M. J. Way & D. Hunter, eds., ASP Conf. Ser. **471**, 2013, 71-96 <http://arxiv.org/abs/1302.1498>

***On the orientation of Early Bronze Age tombs in ancient Magan (invited)***

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Session: Astronomy and Archaeoastronomy in Near East, Asia, and Oceania

## **ABSTRACT**

Fortunately, orientation studies have recently received considerable attention in the archaeological domain as a source of information that may shed light on a number of anthropological issues such as beliefs systems or landscape and territory apprehension by past cultures. This is especially important in those cultural contexts, such as the 'megalithic' phenomena, where there are no written additional sources (Hoskin 2001, González García and Belmonte 2010). This is for example the case of the Haffit and Umm an Nar cultures that dominated the northeast of the Arabian Peninsula during the Calcolithic and the Early Bronze Age (EBA, Third Millennium BC), in the so-called land of Magan (present day Oman and the Emirates). This culture includes the World's Heritage sites at Bat and Al Aïn. In a field campaign in January 2012 several ancient EBA necropolises of the region were visited and (when possible) measured in an attempt to shed some light on the orientation customs of these ancient people. The sample, of c. 70 monuments, consists of two different types of tombs: earlier (c. 3000 BC) dry-stone cairns of the so-called Haffit type and later (c. 2500 BC) megalithic structures of the so-called Umm an Nar type. Some of these enigmatic monuments have recently been excavated (see e.g. Böhme and Al-Sabri, 2011). This talk will present the preliminary outcomes of the fieldwork, showing that certain customs which are far from being easily understood were present in the data. This is the first systematic archaeoastronomical approach ever conducted in the Arabian Peninsula.

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***The astronomical inscriptions of the Antikythera Mechanism: the research and the online educational program (20 minutes including discussion)***

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Session: Astronomy and Philosophy

**ABSTRACT**

The inscriptions of the Antikythera Mechanism have often been designed as an "user's" or "owner's" manual. They certainly accompanied the device, giving the astronomical context of its functions. Here, we will give an overview of the astronomical inscriptions of the Mechanism and of the period numbers that are the key to its understanding, both from the point of view of the researcher and from the side of the pupils browsing the online educational program of the National Archaeological Museum.

***Swastica as a representation of the sun of Helios and Mithra*****Burillo-Cuadrado M<sup>a</sup> Pilar , Burillo-Mozota Francisco**

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Session : European Prehistory, Folklore and Archaeoastronomy

**ABSTRACT**

In the "20th International Conference of the European Society for Astronomy in Culture", which was celebrated in Slovenia in 2012, Reza Assasi presented the communication *Swastika: The Forgotten Constellation Representing the Chariot of Mithra*, where he identified a Mithra and his quadriga with the constellation Draco, center of the zodiac in the star map. However, there is an agreement between the Mithra religion researchers in identifying the Mithra with the sun. In the Avesta are some passages that identify a Mithra with a glittering individual who rides on chariot with golden wheels. The carriage is pulled on four white horses, the same description for the god sun Helios, who is the god that Mithra is equated in Occident in the helenitic stage. In Iran, Mithra is represented with a ray beam or a sun crown on the head. The representations appear in one embossed in the Antiocho I sanctuary of Nemrut Dagi and other in Taq-e Bostan in the sasanian stage.

The mitreos decorations, where the Mithraic mysteries were celebrated, have a clearly cosmological significance. Mithra appears in the Tauroctony representation between two torchbearers: Cautes and Cautopates who were interpreted like double of Mithra. These characters represent the day and the night or the winter solstice and the summer once. On the other hand, Mithra represents the central point or the equinoxes and in both of them Mithra is identified with the sun.

Mithra is encircled by zodiac in some Tauroctony. This thing symbolizes his supreme power to move the entire universe according to David Ulansey. Helios/Sun appears in the zodiac center in some synagogue mosaic pavements in Israel. In the case of Sepphoris/Zippori synagogue each zodiac figures has the name of the corresponding month and the sun is the center and the universe motor.

The Roman Saturnalia festival finished the 25 of December in the winter solstice, when the sunrise was celebrated, *Natalis Solis Invictis*. This tradition is similar in the Mithraic mysteries as seen in several roman epigraphs (*Sol Invictus Mithras*, *Deus Sol Invictus Mithras*, *Sol Mithras*) which identify a Mithra as Sol Invictus. The Pope and Martyr Fabián was the person who set on this date the Christ birth, who is known with the same appellation.

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# C

## ***William Shakespeare and the Philosophy of Astronomy (invited)***

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Session: Astronomy and Philosophy

## **ABSTRACT**

Athens was the focus for the development of three philosophies of astronomy – Platonism, Aristotelianism and Stoicism - which were to dominate the classical world up to the fifth century. All three were vital component of Renaissance European culture, combining notions of purpose, order and an ensouled cosmos in which all things were interdependent, including people and planets. This consensus was dramatically challenged by the publication of Galileo's *Siderius Nuncius* in 1610. This paper will examine the use of astronomy by William Shakespeare, perhaps the greatest writer in the English language, the majority of whose plays were written prior to 1610, and will explore how key passages and themes in his work relate back to classical Athenian astronomical theory. It will argue that, through his dramatic

narratives, Shakespeare was the last great exponent of classical astronomical theory before the Galilean revolution.

### ***Iberian megalithic tombs: A possible link to Scandinavia?***

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Session: European Prehistory, Folklore and Archaeoastronomy

#### **ABSTRACT**

Recent investigations of Danish and Swedish passage graves and their orientation pattern show dominating orientation directions, which mainly can be explained by full moon rises during the summer period. Both the Danish and Swedish passage graves tend to form clusters and each cluster has very similar orientation patterns.

Some Portuguese and Spanish megalithic tombs seem to have similar orientation patterns as the Scandinavian ones (Hoskin, 2002).

A group of 323 Portuguese and Spanish megalithic tombs located at west Iberia are chosen for a statistical test using same model as used for the Scandinavian passage graves. The test model used is based on the cross over full moons, i.e. “the spring full moon” (da Silva, 2004) and “the autumn full moon” defined as the Equinoctial Full Moons (EFMs) by Fabio Silva (Silva, 2011), the first full moon after the EFM at spring, the first full moon before the EFM at autumn and the most southern full moon rises.

The result shows a remarkable high statistical probability factor  $P$  when the observed distribution and the model are compared. For the overall distribution  $P = 0.92$ , which means that it is possible to assume the 0-hypothesis. Especially the EFMs are interesting because the 0-hypothesis is achieved ( $P = 1$ ).

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## D

### **Cosmologies in place: archaeoastronomy and folklore of Bronze Age mounds in the Mongolian Altai**

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Session: Astronomy and Archaeoastronomy in Near East, Asia, and Oceania

### **ABSTRACT**

#### **1.Introduction**

There are trends of human action played at different epochs and by different peoples indeed deeply connected. In the mountains and desert steppes of Mongolian Altai, where the scarce population and their herds live over an immense territory, archaeology and astronomy, written sources and oral narratives are forced to mix. In the easternmost Gobi-Altai chain, an Italian-Spanish archaeological team<sup>5</sup> surveyed and measured the orientation of classic *khirigsuur*

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<sup>3</sup> Speaker or corresponding author

<sup>4</sup> Speaker or corresponding author

<sup>5</sup> I am especially grateful to Yolanda Seoane-Veiga, of Incipit-CSIC, for her precious support in taking astronomic measurements and for her early intuition of the importance of Khalbagant Uul Mountain in the organization of ancient skyline.

Bronze Age mounds scattered in clusters over a vast surface of mountain high pastures and slopes.

A specific mounds cluster, at Pongsag Ovoo hill, seems to present a consistent alignment towards a specific lunar event. On the other side, folk rituals connected with traditional lunar calendars and moon-related festivals, characteristic of the wider Mongolian and Central-Asian context, have been investigated, in order to build a significant interpretative frame for the results of our archaeo-astronomic study.

Archaeo-astronomy methodology applied to Bronze Age landscape and material culture of Mongolia and Central Asia was quite a previously unexplored field, where comparable investigation is scanty. Only recently few contributions on Central Asia archaeo-astronomy were published in English, thanks to the efforts of scholars of the ex-sovietic world (Bekbassar, 2005; Koiva, 2006; Marsadolov, 2003; Potemkina 2002; Zdanovich and Kirillov, 2002). Mongolian Bronze Age mounds' orientation had been taken into consideration by a promising seminal study by Allard and Erdenebaatar (2005), but unfortunately it has not been followed by further specific investigation. For this reason, it is difficult to find the appropriate material to compare with the data-base we built during 2011 fieldwork, being statistical comparative among wide databases a key-element of modern archaeo-astronomical methodology (Hoskin, 2001). Nonetheless, we believe that this archaeo-astronomic analysis might provide some significant elements for a tentative reconstruction of past cosmologies and orientation patterns over centuries in Ikh Bogd Uul Mountain and the Altai area.

## **2. Pongsag Ovoo hill and Ikh Bogd Uul Mountain: a ritual and funerary site on the roof of a sacred mountain**

Ikh Bogd Uul, a large massif of the easternmost part of Gobi-Altai range, is a monumental mountain that reaches reaching almost 4 thousand metres of altitude and host several impressive archaeological sites. Here, Central Asian and Mongolian traditional folklore connected to mountains, regarded as sacred natural places, has been modulated in specific place names and legends (Davaa Ochir, 2008).

In high pastures of Ikh Bogd Uul Mountain rises Pongsag Ovoo, a flat volcanic hill which dominates one of the most important and currently used mountain pass. Besides being a node for regional mobility of local herders, who conduct their animals in the area during summer months, other important ceremonies such as traditional games (*naadam*) took place at the foothills of Pongsag Ovoo.

On the top of Pongsag Ovoo hill, a remarkable Bronze Age *khirigsuur* mound, with 60-metres wide spoked circular outer fence, satellite smaller mounds, stone platforms and a row of 13 cairns with two fragmented deer stone stelae, have been documented by Italia-Spanish team. Most of these archaeological features, in particular the *khirigsuur* mound and deer stone *stelae*, can be confidently dated to the Bronze Age epoch (end of the second, beginning of the first millennium BC), thanks to typological comparisons with other excavated and

radiocarbon dated sites of Northern and Western Mongolia, (Fitzhugh 2009a and 2009b:189; Littleton and Frolich 2012; Marcolongo et al. 2005; Volkov, 1995).

Moreover, along the eastern slope of Pongsag Ovoo hill, four more *khirigsuur*, one with circular outer fence and three rectangular-fenced mounds have been mapped. Some recent publications suggest that *khirigsuur* and *stelae* could be related to feasting rituals which implied fire and horse sacrifices, because most of excavated satellite mounds and standing stones contained traces of fire and horse skulls oriented to the east (Allard and Erdenebaatar, 2005; Fitzhugh 2009a and 2009b; Wright, 2007). Indeed, localization on eastern slopes and eastern direction seemed to be very important in ancient Bronze Age cosmologies. Curiously, nowadays east is considered a privileged, main cardinal direction for orienting purposes in all Ikh Bogd Uul area, for instance in the orientation and inner organization of the habitations, the Mongolian traditional round felt tents (Lacaze, 2006; Vaté, 2006).

### 3. Archaeoastronomical investigation

On the base of archaeological and ethnographic suggestions, we investigated the hypothesis that eastern horizon could be important also for astronomic alignments in the past. In considering both the special reverence that had been traditionally paid to mountains and the importance of cardinal orientation (Evans and Humphrey 2003; Holmberg, 1927; Lindhal, 2010), we took several sets of measurements from mounds towards relevant physiographic features of the surrounding skyline. Among those 54 measurements, we recognized a consistent pattern: those mounds of Pongsag Ovoo cluster seem to have an astronomically significant focus towards a mountain top in south-eastern skyline. Indeed, the declinations of those alignments towards Khalbagant Mountain, in the south-eastern sky, register a peak between  $-27.1^\circ$  and  $-28.1^\circ$ . In other words, five *khirigsuur* mounds of Pongsag Ovoo complex, the one on the hilltop and those on Pongsag Ovoo hill eastern slope, aligned in a rough row towards that direction, present a consistent pattern of orientation to the major southern lunar standstill, relative to the south-eastern skyline limit marked by Khalbagant Mountain, a Mongolian name which means 'spoon mountain'<sup>6</sup>. Given the reiteration of lunar alignments within all mounds of Pongsag Ovoo complex and others mounds on the mountain, the importance of moon for *khirigsuur* builders of Mongolia might reliably be argued. Moreover, the main Bronze Age *khirigsuur* mound and deer stone *stelae* on the Pongsag Ovoo hilltop are spatially and structurally associated with a row of thirteen small cairns, north-south oriented, positioned at the eastern side of the mound and incorporating the two Bronze Age *stelae*. This line of *ovoo*-like cairns finds a direct comparison with other examples documented ethnographically in modern and contemporary Northern and Inner Mongolia (De Priest 2008:105; Evans and Humphrey 2003). Interestingly, the 13 *ovoo* cairns are connected

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<sup>6</sup> Significantly, spoon is a ritual object in Mongolian folklore and spoon-shaped objects had been found in several Central Asia burials since Bronze Age. Khalbagant mountain is located around 40 kilometres straight SE from Pongsag Ovoo Hill. Given this considerable distance, the same orientation to that point of skyline marked by Khalbagant top would be possible also shifting a little the sighting point. So, for example, other mounds located one kilometre around Pongsag Ovoo could result aligned with Khalbagant Uul. However, no other *khirigsuur* mound as large as Pongsag Ovoo and in such commanding position has been found in the high pastures of Ikh Bogd Uul Mountain.

with traditional milk offerings to the local master spirits before migrations in autumn and with various elements of luni-solar calendric feasts such as *naadam* games and *tsagaan sar* celebration (Gerasimova, 1981; Charleux, 2006; Pedersen, 2006: 96-97; Pegg, 2001:108-112)<sup>7</sup>.

#### 4. Discussion and conclusion

The importance of moon's cycles disclosed by the archaeoastronomical analysis might be understood only in comparison with the study of ancient cosmologies and astronomical knowledge. For instance, in Sanskrit sources, a language that has been likely spoken by populations crossing Central Asia at the end of the second millennium BC, moon is *masa-krit* 'the maker of the month' (Sidarth, 1998)<sup>8</sup>. Being moon a fundamental time-counting device, moon's phases and particular moments of moon's cycles could have been marking cyclical ritual moments. Indeed, also Turchik-Mongolian medieval and modern calendars present a clear connection with ancient Indian cosmology and astronomy (Petri, 1967; Kelley and Milone, 2005:496), besides other influences by the Chinese world since the end of the first millennium BC (Di Cosmo, 2002:278-279; Didier, 2009; Major, 1999; Pankenier, 1992). Within Mongolian calendar, the celebration of *tsagaan sar*, the traditional New Year's Eve and one of the most important Mongolian holidays, is especially significant in showing distinct Asian connections and a strong relation with moon both at ritual and calendric level (Baumann, 2008). *Tsagaan sar*, which means either 'white month' or 'white moon', marks the official beginning of the year, with a three-day feast<sup>9</sup> that involves family roots, kingship and identity, maintaining at the same time a specific bond with the living traditional landscape, populated by local deities, spirits of place and spirits of the house (Davaa Ochir, 2008; Tucci, 1966).

*Tsagaan sar* and all related cosmologies could work as an ethnographic frame for interpreting those astronomic and cosmological principles that inspired the people who build Bronze Age mounds of Ikh Bogd Uul Mountain. On the base of ancient textual evidences, archaeological and ethnographic comparisons (see for instance Kristensen, 2004; Roux, 1963), it would be possible to open a small window on the creative cross-cultural interactions in Mongolian astronomy and cosmology along different epochs.

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7 Unfortunately we did not take any specific measurements relative to this row of cairns during our fieldwork. Anyway, being 13 a significant number in lunar calendars and Mongolian traditions, the orientation and localization of this structure certainly will be taken into consideration in further steps of our research project.

8 Generally speaking, the month as a practical unit of time derives naturally from the cycle of phases of the moon, the synodic period or synodic month (Kelley and Milone, 2005: 95). Among all Indo-European roots the main word for moon often coincide with the idea of measuring time (Mallory & Adams 2006: 128-129). In the sense of 'the measurer of time', which implies an active role, it is a masculine in Sanskrit (West, 2007:351). It is worth saying that in modern Mongolian the word *sar* equally means moon and month and it is also masculine.

9 In order to illustrate the importance of *Tsagaan Sar* and its connection with moon's cycles, it is worth saying that New Year celebrations and the use of intercalary month are often connected and included in a compatible ceremonial calendar. This special link between the (thirteen) intercalary month and the Mongolian New Year celebration of the White Moon/month is visible for instance in the reiteration of the white colour, associated in the Tibetan and Mongolian lists of thirteenth (Ekvall, 1959:190-191). White is also in Mongolia the colour of the ritual, of what is pure and sacred and indeed the colour of the celebration of the moon festival, reiterated in food, clothes etc...(Halemba, 2006:111).

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### **Research of the Greek and Biblical myths by astronomical methods**

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Session: European Prehistory, Folklore and Archaeoastronomy

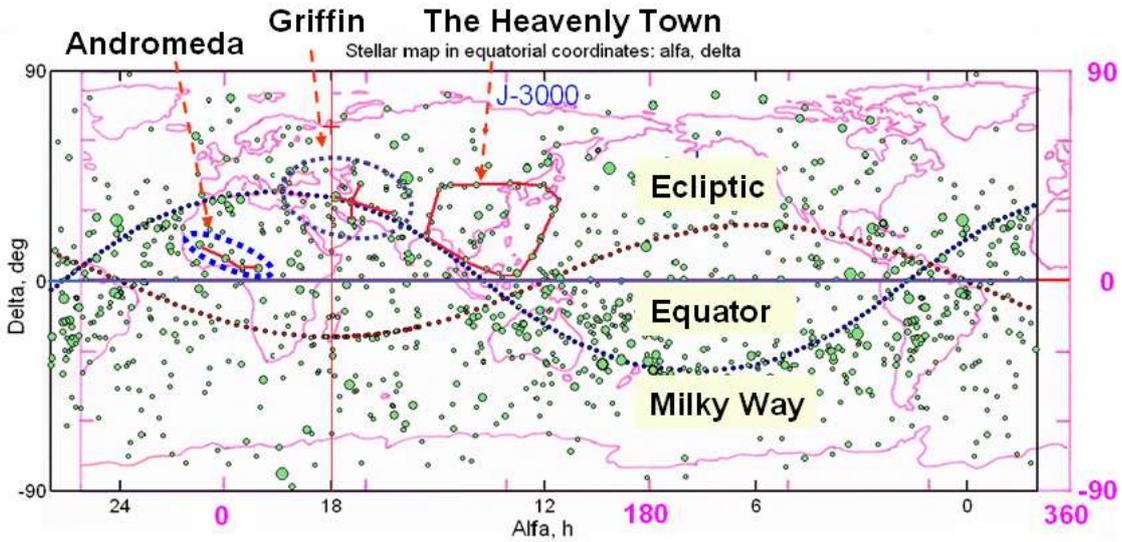
#### **ABSTRACT**

The Greek myths about Atlas and Prometheus, Europe, Minotaur, and also the Biblical myth about the Flood are discussed. All of them are interpreted with application of ideas (Dement'ev, 1997; 2000). In the first work the stellar map (for the epoch 3000 BC) was compared with the geographic map. In the last work the mythological Universe was discovered in the constellation of Swan (further the micro-universe). Both maps were built in the equatorial system of coordinates, the right-angled projection and of the same scale. The former map was put on the later one. The constellations Andromeda (the daughter of the Ethiopian king), Swan-Griffin and Ophiuchus (the Heavenly Town in Chinese) were projected on the Western coast of Africa, Caucasus-Mesopotamia and China, respectively. It should be

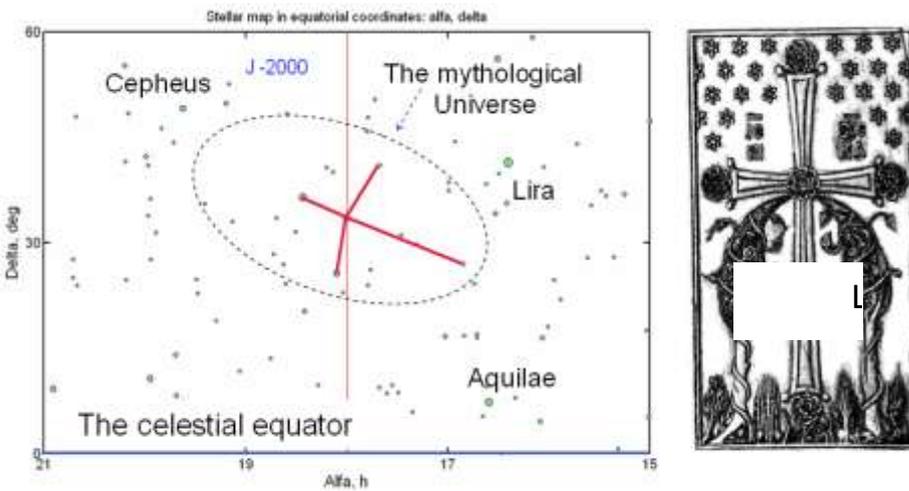
noted that in Ukraine and Estonia the constellation of Swan (Cygnus) was called the Big Cross. The world tree was represented often in the form of the cross. The genealogical tree Noah (Hall, 1928) is considered identical to the world tree. Locations of Noah and his sons on the tree are noted by tablets, and they form the cross. We have superposed the Noah tree on the Big Cross, using tablets. Noah has incorporated with  $\alpha$  Cygnus, and his sons (Shem, Ham and Japheth) – with ( $\eta$ ,  $\epsilon$ ,  $\delta$ ) Cygnus, accordingly. On these maps Noah Ark was projected on the mountain Ararat, and his sons (in the epoch 1000 BC) fell on the territories of Mesopotamia, Egypt and Caucasus. Myths about Europe and Minotaur describe translational movement of the micro-universe relatively the earth surface, and about the titans describe rotational movement. The conclusion about rotation of the Big Cross follows from analysis of the drawing depicted on a vase in the epoch 550 BC (MPW, 1992). If the drawing was combined with the Big Cross the northern end of the Cross ( $\delta$  Cygnus, i.e. heavenly fire) will be at the level of the Prometheus feet, and the southern end ( $\epsilon$  Cygnus) – on the Atlas breast. In the epoch 5500 BC the situation was contrary. The titans have turned the Cross. Both types of movements are caused by the precession of the Earth axis. The analysis of these myths points out fact that ancient astronomers studied the precession movement of the constellation of Swan and described results of the observations in myths. It should be noted that titans and other heroes are in the plane of maps. The Flood was connected with the revolution of the micro-universe. The idea of replacement of top and bottom in the micro-universe has appeared in the epoch 2000-3000 BC. It is connected with slow passage (because of the precession) of the micro-universe through the celestial meridian which, probably, was considered as “the earth surface”. The constellation of Swan was observed in a summer solstice, near to midnight. The celestial meridian for the given moment of time coincides with hour circle at  $\alpha=18$  hour. We incorporated the meridian and hour circle with the mountain Ararat when myths about Europe, Minotaur and other heroes were investigated.

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- Application



The combination (superposition) of the stellar (3000 BC) and the geographic maps



The mythological Universe in the constellation of Swan (Cygnus) and the world tree.

The constellation of Swan was observed in a summer solstice, near to midnight. Possible, it was used as the initial (second) point for the measuring of longitude of the planets.



Fig. . The tree Noah (M. P. Hall).

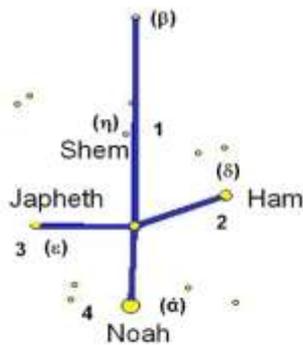
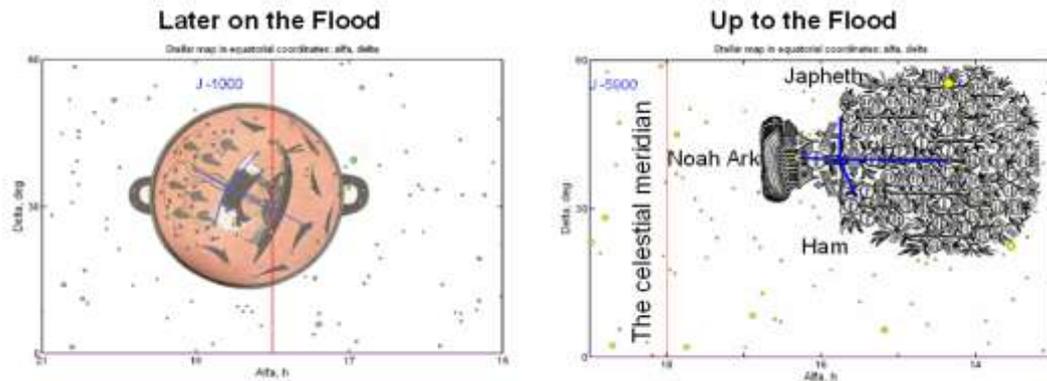
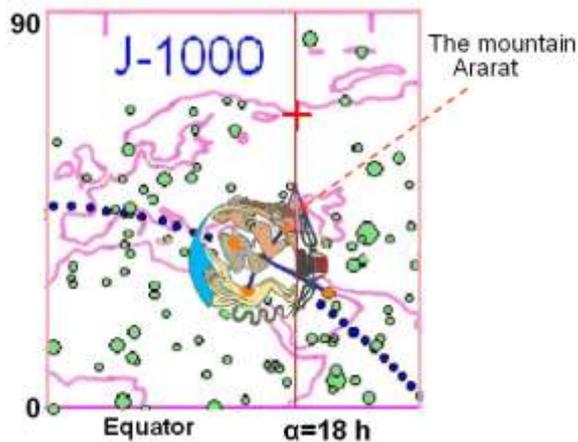


Fig. . The Big Cross (Cygnus).



The god Dionysos in boat (500 BC) and the genealogical tree Noah.

The revolution of the micro-universe in the epoch 2000 BC



Titans Prometheus and Atlas have turned the Cross. The epoch 1000 BC.

E

### ***An Evanescent Vision of the Divine.***

#### ***The Equinoctial Sun at the Iberian Sanctuary of Castellar***

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Session : European Prehistory, Folklore and Archaeoastronomy

### **ABSTRACT**

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In the last years, we have discovered a significant number of sanctuaries belonging to the Iberian Culture showing striking markers of the sunrise or sunset at the equinoxes or a date very close to it (Esteban 2002, 2003; Esteban & Moret 2006). In this paper, we present results for the Iberian cave-sanctuary of Cueva de La Lobera in Castellar (Jaén, Spain), whose foundation can be set in the second half of the fourth century BC.

This territorial-cult sanctuary is part, along with the worship place of Collado de Los Jardines (Santa Elena, Jaén), of the political project that the Iberian *oppidum* of Cástulo (Linares Jaén) began at the fourth century BC. This settlement placed those two sacred spaces at the head of its territory, thus controlling the two main paths to the High Guadalquivir area and the rich mines of Sierra Morena. The sanctuaries were converted, at the time, in key elements to understand the processes of territorial expansion and political and ideological legitimation (Rueda, 2011, Ruiz et al., 2010). In this context, we need to understand the important role that these sacred spaces should have to the central rituals of the community, such as rites of aggregation or of passage. Both the configuration of the space (which highlights the cave as an important landmark) along with the ritual objects and images (including the thousands of bronze votive figurines found at the site) would be related to the set of basic beliefs of the Iberians.

The sanctuary at Castellar, consisting of different terraces, has its main area at the cave called Cueva de La Lobera; a cavity with two parts that have been artificially modified. The main axis of the cave is oriented along the east-west and at the sunsets around the equinoxes, are the only moments of the year where the innermost part of the cave (a relatively small niche) is illuminated through an aperture located at the western edge of the cavity. We have made a photographic follow-up of the evolution of the illumination pattern inside the cave, finding that the patch of light and the shape of the niche should coincide at the moment of the temporal mid-point between the solstices, which is between one and two days apart from the exact date of the astronomical equinox. Moreover, the shape of the patch of light —just before it gently disappears where the sunset completes— resembles the side face of one of the most common kinds of votive figurines, which has been interpreted as an image of a feminine deity or a high priestess.

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## F

### **ASTRONOMY AND MESSAGES FROM ANCIENT TIMES**

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Session: Research History of Astronomy and Current Issues

#### **ABSTRACT**

This paper is about the advanced knowledge of ancient civilizations in the order of the heavens and Earth and of the cyclic order of our solar system, and the importance of their messages that survived periodic destruction for our time. To the Greek philosophers the map of the universe was ten concentric heavens. In the Babylonian creation epic *Enuma Elish*, the universe is seven heavens and seven earths.(1) The Pharaohs believed in the layered universe and the lower human world.(2) Doctor Edmund Halley theorized multiple inner layers in the Earth, and presented his paper "Hollow Earth" to the Royal Society in 1692.(3) For the Mayan culture the universe is nine layers or steps of creation; each with its own pace of evolution.(4) In the Quran the universe is a trumpet containing seven heavens and of the earth like them.(5) Old civilizations also shed light on the ancient history of Earth, and their archeology revealed their knowledge of the periodic destruction that repeated re-creation and Noah's Ark many times on earth. This cyclic destruction explains the sudden appearance of the Sumerian civilization as a very advanced society, around the same time of the Mayan civilization's last destruction around 6000 years ago, and the appearance of the Pharaohs in Egypt after the sinking of Atlantis of superior evolution. Plato mentioned that Atlantis sank 9000 years before his days, about 11,500 years ago.(6) It is possible the Egyptians and ancient Americans shared a common heritage, and were survivors of Atlantis.(7) There is extensive recent documentation of Sunken Atlantis in "Atlantis the Lost Continent Finally Found".(8) The Sumerian tablets mention the story of the flood as they speak of the biblical story of creation and the solar cycle, which the Pharaohs and Mayans warned brings destruction by the end of a solar cycle as a sand hour glass. Certainly advanced civilizations

in the distant past point to the cyclic rise and fall of human cultures and races extending much farther back into "prehistory" than currently accepted. Anthropologists admit that the last Adam appeared before 450 thousand years after and among much less advanced human races. The pyramids of Egypt point to the critical importance of an astronomical alignment in the skies that occurred 10500 years ago, even if built or completed later (c. 2450 BC). The arrangement of the three pyramids mirrors the Orion's belt of three stars.(9)(10) The rise and fall of world civilizations seems to coincide with an alignment in the skies and the sunspot cycle, maintaining that reduced sunspot activity coincided with a decline in fertility and the sudden end of the Mayan civilization.(11) The evidence in these volumes includes recognition of the ancient knowledge of the sun's precessional cycle when its rising at the spring equinox occurs in a new place within the zodiacal "houses" needing almost 26,000 years to complete the cycle. When our Solar system completes a 26,000 year cycle, it would have spent 2200 years in each of the twelve constellations of the zodiac. The cyclic order of the solar system was revealed by leading research dating back to two centuries ago, by Serbian astronomer Milutin Milankovitch who introduced contributions to the interpretation of climatic changes on Earth, resulting from the position of the Earth to the sun on the long term, now known as the Milankovitch cycles. Melutin was the first to clear the relationship of these changes with the ice Ages that have occurred in the geological past of the Earth, as well as climatic changes on Earth that can be expected in the future. The end of a solar cycle of 26000 years leads to the phenomenon of coup of north and south poles, which has happened repeatedly in the history of the earth.(12) In the Quran there is a link between the cyclic alternation of the sun rising from the east and west with changing the people of the earth. {And the sun runs to its settling point. That is the determination of the Exalted in Might, the Knowing. 36:38}. {I do not swear by the Lord of risings and settings that We are able. To replace them with better than them and We are not to be outdone. 70 : 40, 41} And the Prophet PBUH said (The sun goes until it prostrates under the throne, and is about to prostrate but is not permitted, asks permission but is not given permission, it is said to her: Return to where you came from, so it rises from the west, that is Allah's saying : And the sun runs to its settling point That is the determination of the Exalted in Might, the Knowing). (15) Edmund Halley wrote about the cycle of the photon belt that comes to encase the eight suns in the Pleiades constellation (our sun is one of eight suns within the Pleiades constellation). This cycle is part of the 26,000-year cycle, which is divided into two periods of darkness, each of 11,000 years and separated by two phases of around 2000 years of full light in the photon belt. The energies from the Photon Belt are recalibrating dormant DNA strands, where originally humanity was endowed with 12 DNA strands, with each representing one of the 12 aspects of multi-dimensional consciousness. These contain the blueprint of ourselves from before the "descent" as fully conscious beings. In the early 1950s Doctors Watson and Crick made an epic discovery of a third separated strand in the center of the double helix.(13) By mid-1980s, researchers determined that the third strand was starting to connect to the four ladders inside the double helix. And during the 1995 Conference on Genetics in Mexico City, scientists debated

whether to conceal this odd problem from the public or to give out false information, pending the completion of further studies. Many geneticists saw this phenomenon as the potential beginning of a new global catastrophe, now much more widespread in secret. They failed to see it as a portent of the ever-evolving integration of body mind and Spirit, as Adam was before the fall in consciousness. The Quran spoke of a light consciousness that succeeds in the earth and the succession of angel like humans before the hour. {He (Christ) is but a servant on whom We bestowed our favor, and We made him an example to the children of Israel. And had We pleased, We could make angels from amongst you to be successors in Earth. And certainly it is knowledge of the hour, therefore have no doubt about it and follow me: this is the right path. 43: 59, 60, 61}. Every culture developed their own legend of the perfect God Human who will emerge at the end of human evolution, these prophecies - in many of their details - met with the Abrahamic religions concerning the signs of the end and the return of paradise on Earth (Atlantis). The Mayan inscriptions that describe the meaning of the end of the Mayan calendar, say that at this stage of time the nine foundation entity will descend, will appear in his full glory, which means that the nine cosmic forces are going to manifest together fully. The end of the calendar is about the completion of the process of evolution, which was going on since the beginning of time and led the world to what it is today.(4) The Hopi spoke of the rise of the fifth peace world, and one of the Hopi leaders said lately: "We are the ones we were waiting for". {As He started you, you shall return. A party He has guided and a party has deserved the loss of their way in that they took the devils as guides in preference to Allah and think that they are guided. 7: 29, 30}.

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## G

### ***The Antikythera Shipwreck, The Ship, the treasures, the Mechanism***

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The tragical event of the Antikythera shipwreck turned out to be a valuable source of information and an incomparable adventure of delving into the past...

-The collection of the planks confirmed that the vessel had been constructed following the “shell-first” technique

-The cargo of the vessel gives evidence for the aesthetic preferences of the Romans for Greek works of art as well as their desire to acquire luxury goods

“The Mechanism of Antikythera”, the first portable astronomical calculator, revealed both the flourishing of the science and the level of achievement of the ancient Greek technology

The mobilization for retrieving the shipwreck inaugurated the submarine archaeological research in the whole world.

### ***Realism vs Verisimilitude in Astronomical Contents of Renaissance Works of Art: the Borderline Case of Raphael’s Astrologia in the Stanza della Segnatura (invited)***

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## Session: Astronomy in Europe and the Mediterranean at Historical Times

**ABSTRACT**

Very often in art history, the deciphering of astronomical/astrological meanings in medieval or renaissance works of art remains uncertain due to vagueness and/or inaccuracies of the representation. For this reason, critics choose to adopt a conservative stance each time imprecision or lack of details (and of known counterparts in other specimens) affects the object in study, trying to escape the dangers of over-interpretation. They maintain the work is illusionistic, painted just in order to “give an idea of” and not to indicate a precise date or a particular celestial configuration or heavenly phenomenon. But sometimes the reading, while still speculative, may be considered possible and even likely if too strict a schematisation “realism vs verisimilitude” is avoided. The artist is not an expert of the sky and could convey his message using details that are relevant and meaningful even in a sloppy context.

After a brief review of famous and still contested examples of “astronomical codes” in frescos and paintings, I will concentrate on Raphael’s Astrology on the Vatican vault of Stanza della Segnatura, addressing the Rash-Fabbri (1979) proposal that its celestial globe represents the sky over Rome on the night of Julius II election, hence a quasi-horoscope of the event. I will argue in detail in favour of this reading analyzing the overlooked reference frame depicted in the fresco, despite Lippincott (1994) recently refuses whatever dating and considers the globe just a “visual metaphor” of the sky. Finally, in sharp contrast with this case, I will present a couple of clear examples of verisimilitude in the depiction of the sky and astral symbols.

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***The 1st August at Lugdunum (Lyons, France)***

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Session : Astronomy in Europe and the Mediterranean at Historical Times

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<sup>11</sup> Speaker or corresponding author

**ABSTRACT**

The festival known as *Concilium galliarum* was held at *Lugdunum* (ancient Lyons, France) on the 1<sup>st</sup> August during the Roman Empire, however there exists a debate on the interpretation of such date. The *Celtist* position, inaugurated by H. D'Arbois de Jubainville (1881; 1884) stresses the parallelism with the *Lugnasad* festival of pagan Ireland to propose some kind of local heritage on the chosen date. The *Romanist* position, first stated by C. Jullian (1889; 1920) stresses the lack of factual information of the *Celtists* and the importance of the date in the Roman Imperial cult. Audin (1962; Charrière, Audin 1963) proposed an incipient archaeoastronomical agenda on the question. But new local archaeological knowledge and new ways to understand the relevant texts invite us to renew Audin's questions. First: we could measure the urban layout of primitive *Lugdunum* as it is actually better known. This shows an orientation towards the sunrise on the 1<sup>st</sup> august. The same layout was maintained later on in the municipal imperial cult temple that balances the pan-Gallic cult of the *Concilium galliarum*. Second: the naturalistic examination of the animals mentioned in the troublesome text known as *the foundation myth of Lugdunum* shows that the shad (a fish) and the raven are both migratory species. They are present in the surroundings of Lyon nearly during the summer and winter periods as they are defined by the calendar of Coligny. Our argument seems to support the Celtist position, but we prefer to stress the post-colonial historical views indicating the creativity of the situations of cultural contact. Two special people, C. Iulius Vercoradidubnos, an Eudeen and first priest of the *Concilium galliarum*, and C. Iulius Rufus, a Santon descendent of local Santon aristocracy and the sponsor of the amphitheatre of *Lugdunum* represent this culturally mixed situation.

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***The Iron Age Saunas of NW Spain from an archaeoastronomical perspective***

**García Quintela Marco V.<sup>12</sup>, González-García A. César , Veiga Yolanda Seoane**

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Session: European Prehistory, Folklore and Archaeoastronomy

## **ABSTRACT**

The so-called Saunas are one of the most intriguing public buildings found in the Iron Age settlements of NW Spain. They are normally divided into two regional groups, one on the north, found in hill-forts placed along the Cantabrian seacoast, and those in the south, in hill-forts between the Douro and Miño rivers. The way towards the constitution of a communis opinio about their use as saunas was long (Silva 2007; Villa Valdés 2012). But there are still a lot of disputed questions about them as the true epoch of construction, its indigenous or Roman character, and the social function of the sauna bath in an Iron Age and/or Roman context. Indeed, the northern and southern saunas show two different models for the building. While the northern are near the gates of the habitat in some kind of public zone and are open air buildings, the southern ones are somewhat outside of the habitat (normally a very big hill-fort), they are buried in its main parts and about a half of the cases shows a peculiar decoration in a monolithic stone that divides two of the rooms (García Quintela, Santos-Estévez in press). As the decoration motives used in this stone are vaguely 'astronomical' we measured the orientations of the whole cases known. The result is open to interpretation.

The differences between northern and southern buildings is confirmed also from this point of view as the northern do not present a definite pattern, but it exists perhaps in the southern ones: possible moon and sun associations seem to support the astronomical interpretation of the above-mentioned decorations.

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<sup>12</sup> Speaker

***Cosmological Aspects of Empedocles***N.I.Georgakellos, *Independent scholar, Athens, Greece*

The pillars on which Empedocles has based his theory about Genesis and Nature are:

The four rhizomes (roots) i.e., Air, Earth, Water and Fire from the mixture of which in various proportions and ways everything is created.

Love (*Philotis*) and Strife (*Neikos*) which are the motive powers of all mixtures and changes.

Sphaeros (*Sphere*) which practically represents the Universe in its various stages.

The axiom that nothing can be created from zero and nothing can be destructed to zero.

Cosmology in his philosophy is divided in four phases:

Phase 1: Sphaeros exists in absolute tranquillity. It stands alone, in equilibrium, endless, calm and "Godlike".

Phase 2: Tranquillity is interrupted because the pair Strife-Love appears with Strife initially dominating. Imperfect and unstable beings are created.

Phase 3: Love begins to dominate over Strife and the situation is gradually normalized. Complete beings are created gradually which follow the eternal cycle "genesis-death-genesis"

Phase 4: Regular developments continue. The Universe has been created.

***On the orientation of Roman cities in Hispania: preliminary results*****González-García A. César<sup>1</sup>, Andrea Rodríguez Antón<sup>2</sup> & Juan Antonio Belmonte<sup>3</sup>**

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Session: Astronomy in Europe and the Mediterranean at Historical Times

**ABSTRACT**

A number of rituals needed to be performed at the time of foundation of a Roman settlement in order to set either cities, towns or even *castra* at the right place, on the right time and with the need orientation (Briquel, 2008). Despite the fact that ancient writings indicate a clear necessity to orientate the towns according to the path of the sun (Hyginus Gromatius, *Constitutio*, 1), early work by Le Gall (1975) seemed to set the question in terms that there was no clear preferred orientation pattern. However, Le Gall's analysis was done taking into consideration a spare number of Roman towns and from widely different latitudes ranging from England to Algeria. Besides, recent results show that when a restricted geographic area is considered, some patterns of orientation do arise (Magli 2008, González-García & Costa-Ferrer 2011). In this talk we will present the preliminary results from a survey to obtain a statistically significant sample of orientation of Roman cities in Hispania. This region was

where more cities were founded in the western part of the Roman Empire, both during the Republic and the Empire (Laurence, Esmonde Cleary & Sears, 2011) and provides a perfect test bed for ideas on orientation of Roman towns: Do they imprint some Roman template in the case of *ab initio* foundations? Do they recover pre-Roman traditions when using previously existing settlements? Presently, we have measured nearly 40 Roman settlements in Hispania, making of this the largest sample measured so far in the ancient Roman world.

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### ***On the orientation of Roman cities in Hispania: preliminary results (invited)***

**González-García A. César<sup>1</sup>, Andrea Rodríguez Antón<sup>2</sup> & Juan Antonio Belmonte<sup>3</sup>**

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Session: Astronomy in Europe and the Mediterranean at Historical Times

## ABSTRACT

A number of rituals needed to be performed at the time of foundation of a Roman settlement in order to set either cities, towns or even *castra* at the right place, on the right time and with the need orientation (Briquel, 2008). Despite the fact that ancient writings indicate a clear necessity to orientate the towns according to the path of the sun (Hyginus Gromaticus, *Constitutio*, 1), early work by Le Gall (1975) seemed to set the question in terms that there was no clear preferred orientation pattern. However, Le Gall's analysis was done taking into consideration a spare number of Roman towns and from widely different latitudes ranging from England to Algeria. Besides, recent results show that when a restricted geographic area is considered, some patterns of orientation do arise (Magli 2008, González-García & Costa-

Ferrer 2011). In this talk we will present the preliminary results from a survey to obtain a statistically significant sample of orientation of Roman cities in Hispania. This region was where more cities were founded in the western part of the Roman Empire, both during the Republic and the Empire (Laurence, Esmonde Cleary & Sears, 2011) and provides a perfect test bed for ideas on orientation of Roman towns: Do they imprint some Roman template in the case of *ab initio* foundations? Do they recover pre-Roman traditions when using previously existing settlements? Presently, we have measured nearly 40 Roman settlements in Hispania, making of this the largest sample measured so far in the ancient Roman world.

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## **Solar and Lunar alignments on the Island of Mull, western Scotland**

**Gough Thomas T.**

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Session: European Prehistory, Folklore and Archaeoastronomy

## **ABSTRACT**

There are 30 standing stone sites on the island of Mull. No comprehensive assessment of possible alignments using foresight features has previously been undertaken. Alexander Thom assessed a few sites, finding some evidence for lunar alignments (Thom 1971). Clive Ruggle undertook a study of the stone rows in northern Mull when he determined approximate indicated declinations using only the stones (Ruggles 1999). He did not consider possible alignments using distant indicated skyline features.

Fourteen of the 30 standing stone sites were not assessed for a variety of reasons. E.g. Trees, possibly not genuine, fallen with no indicated direction etc. Four of the remainder in the south west of the island are very probably medieval waymarkers erected to guide pilgrims

to the important early Christian island of Iona. Of the remaining twelve sites, eight give alignments for the sun and four for the moon.

All of these twelve sites were assessed using the same method as used in the neighbouring mainland region of Argyll as reported at SEAC 2012 in Slovenia (Gough 2013).

In the 1960s Alexander Thom published a gaussian graph of the declinations obtained from measurements of a large number of megalithic remains (Thom 1967). The graph contained peaks for significant declinations for the moon, sun and possibly some stars dated about 1800BC. For the moon, observation of the standstills was indicated. For the sun the peaks on the graph gave evidence for a solar calendar. The solstices and the equinox were shown, the latter being found by halving the number of days between the solstices. Halving again gave the 'quarter days', Martinmas, Candlemas etc., (the old Celtic Samhain, Imbolc etc.) . There was also some evidence for a further subdivision which would give eight approximately equal divisions of about 23 days each between the solstices, or sixteen divisions for the year. Thom designated these 'epochs' and calculated the declinations to be expected (Thom 1967). The eight solar sites on Mull, several of which have multiple alignments, give alignments for more than half of the expected solar declinations.

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## ***The Hellenic Linear A', the stars and the foundation of the Chinese Writing***

**Gregoriades Panagiotes D.**

*Independent Researcher and Writer, Athens, Greece*

Session: Astronomy and Archaeoastronomy in Near East, Asia, and Oceania

## **ABSTRACT**

Scripts in use by the Minoans in the Hellenic Island of Crete were the *Linear A' and B'*. *Linear A'* was in use from 3500BC and during *Late Minoan II* (1500BC) was developed to the *Linear B'* (1800-1500BC) which was brilliantly deciphered by Ventris in 1952. *Linear A'* cannot yet be

read. *The decoding of Linear A' pass through the Chinese Writing the only immutable writing since 3140BC.*

According to our opinion and documents the Minoans reached China about 3140BC using *the Minoan Labyrinth the oldest map of the Sky* and they gave to the Chinese people *the Writing and the Calendar*, "*The Minoan Calendrical Abacus*" a calendar of four years duration, today, all the above are exhibits of Herakleion Museum in Crete Island. The Greeks from the *Linear A' and B'* moved to the new Hellenic invention of the "*Alphabet*". The Chinese *Priesthood continued to use the Linear A'*. From the contact with the Greeks and the Hellenic invention of the "*Alphabet*" absorbed and started to use Greek letters as Ideograms, with the Greek pronunciation. The Hellenic capital Letters  $\Pi$  (*Pi*),  $\Sigma$  (*Sigma*) and  $\Phi$  (*Phi*) are ideograms for the Chinese Language.

The letter  $\Pi$  (*Pi*) is a depiction of the *lintel*, the letter  $\Sigma$  (*Sigma*) as ideogram corresponds to the *silk* material and the letter  $\Phi$  (*Phi*) to the *limit of light* (middle) half of our planet is under daylight and the other half has night.

The *letters*, the ideograms and the *numbers* are depictions of the Sky, Stars, Constellations and Physical Phenomena as the *Time*.

### ***The Huaca Sanctuary Below Machu Picchu***

**Gullberg, Steven R.<sup>1</sup> Malville, J. McKim<sup>2</sup>**

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Session: Archaeoastronomy in North and South America

#### **ABSTRACT**

Below Machu Picchu, near the confluence of the Aobamba and Urubamba rivers, lies a large and complex shrine, initially identified by Bingham as the Intihuatana of the Urubamba River. The massive granite huaca lies on the solar axis of Machu Picchu that connects June solstice sunrise with December sunset. The line crosses the Sacred Plaza, continues for 5 km to the double-jamb doorway of Llactapata's Sun Temple and continues to the Reinhard Site on the Llactapata Ridge. The huaca contains carved symbolic steps, fountains, two caves, a tower, and carved basins. Small residences may have housed the keepers of the huaca. While many of these motifs are known at other sites, it is less common to find them all at the same shrine. The solstice line may have a symbolic meaning similar to that of the ceques of the Cusco basin.

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## H

***PYR AEIZOON, FIRE EVERLIVING .Projection of two compositions from the performance PYR AEIZOON (Pur A-ii-zo-on), EVERLIVING FIRE, performed at the Eugenideion Planetarium, dedicated to the Spring Equinox of 2010 (invited).***

**Hahalis Alexandros**

*Composer, Athens, Greece*

***Thales of Miletus, Archimedes and the solar eclipses on the Antikythera Mechanism (invited)***

**Henriksson Göran**

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Session: Astronomy and Philosophy

### **ABSTRACT**

Many attempts have been made to understand which method Thales of Miletus (640?–546 BC) used when he made the famous prediction of the total solar eclipse that took place during the end of a battle between the Lydians and the Medes, first mentioned by Herodotus in *History* (I, 74). According to Pliny, *Naturalis historia*, (XII, 53), Thales was the first among the Greeks to investigate the cause of eclipses, and in the fourth year of the forty-eighth Olympiad (585/4 BC), “he predicted an eclipse of the sun which took place in the reign of Alyattes in the year 170 A.U.C.” (Ab urbe condita, “from the founding of the city” (of Rome)). Thales visited Egypt and Babylon, but it was only the Babylonian astronomers who were able to predict eclipses and they had access to a long record of eclipses. However, they were only able to formulate rules of thumb mainly based on the Saros cycle of 18 years, 11 days and 8 hours and the Exeligmos cycle of 54 years and 33 days.

At the SEAC conference in Alexandria in 2009, I presented the paper *Ten solar eclipses show that the Antikythera Mechanism was constructed for use on Sicily*. Five Exeligmos cycles that started in 351, 297, 243, 189 and 134 BC have been determined by identification of 10 solar eclipses. The hour of the eclipse can only be read for 9 of the solar eclipses.

Professor Xenophon Moussas, University of Athens, helped me to read the hour of these eclipses. I developed a computer program that compared the predicted pattern of solar eclipses on the mechanism with my tables for Syracuse, Taormina, Athens and the city of Rhodes, computed for 600 BC - 2 AD. The median deviation was 3 minutes for Syracuse and 4½ minutes for Taormina, with standard deviation of 15 minutes. The median value was 50 minutes for Athens and 84 minutes for Rhodes, with standard deviation of 25 minutes. The hours for the eclipses have most likely been calibrated in Syracuse by observations during the lifetime of Archimedes (287-212 BC) because the best defined Exeligmos started in 243 BC. The inscriptions on the Antikythera mechanism were made in 100-150 BC and the last Exeligmos started in 134 BC. The next Exeligmos was expected to start in 80 BC but it failed. This year corresponds to the estimated date of the accident when the ship with the mechanism sunk close to the island of Antikythera.

The Antikythera Mechanism was an advanced technical construction that was possible thanks to new mechanical inventions. However, the fundamental astronomical principles behind all the scales had not been possible to formulate without a great collection of data preserved on clay tablets and papyri.

I decided to test the hypothesis that Thales made his prediction according to the same principles used on the Antikythera Mechanism and based on solar eclipse observations recorded in Babylon. All solar eclipses, with magnitude greater than 0.01, visible in Babylon between 2 AD and 1100 BC, were calculated. The simplest method to predict a solar eclipse is from the Exeligmos cycle, but the solar eclipse in 585 BC was the first one in a new Exeligmos cycle and there was no earlier eclipse from which to make a prediction. However, if Thales had used the result from the solar eclipse in 603 BC, on 10 May, at 09h 15m, he could predict, by adding 8 hours, that the solar eclipse in the next Saros cycle in 585 BC, on 21 May, Gregorian calendar (28 May, Julian calendar), would take place before sunset. If he had observed the solar eclipse in 603 BC from Miletus he had recorded the central phase at 08h 00m which made it possible to predict that the eclipse one Saros cycle later would take place at about 16h 00m and be easily observed from Miletus. The probability was indeed very high that there should be a solar eclipse in the evening of 21 May 585 BC and, according to Herodotus, Thales announced this solar eclipse publically to the Ionians. The eclipse was partial in Miletus, with magnitude 0.970, but at the battle field between the Halys River and Lake Tatta it was total with magnitude 1.003, about 9 degrees above the horizon.

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**Mathematics and Astrology****Herrera Rosa Maria**APYCE & UPM Madrid, Spain E-mail: [herrera.rm@gmail.com](mailto:herrera.rm@gmail.com)

Session: Research History of Astronomy and Current Issues

**ABSTRACT**

Astrology and Mathematics, in occidental culture, are probably similar origin: to predict and to understand nature. I argue that, in a sort of 'periodical motion', qualitative methods to study differential equations inspiring us to go back towards the 'origin' (in a very sophisticated matter) and so mathematics could predict their self-evolution.

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***The Classic Maya 6940-day/260-day cycle revisited (invited)*****Iwaniszewski Stanislaw**

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Session: Archaeoastronomy in Mesoamerica

**ABSTRACT**

In 1931 John Teeple first proposed that the dates recorded on Stela A at Copan had evidenced the Classic Maya knowledge of the Metonic cycle. While his Determinant Theory has long been fully discredited, scholars' explanations of a 6940-day period have been diverse (e.g. Aveni 2001, Chambers 1965; Helen 1988). The information, however, is not self-evident. At best, the use of the 235-lunation cycle may only be inferred from a limited corpus of documents, but cannot be confirmed (Bricker and Bricker 2011). Deviations from the Metonic cycle can also be sufficiently attested in the Maya epigraphic record (Iwaniszewski 2012a), and the recent discovery of the Lunar Table at Xultun (Saturno et al. 2012a, 2012b; Zender and Skidmore 2012) suggest that the Maya reckoned lunations in a quite different way (Iwaniszewski 2012b). While it may be imprudent to firmly dismiss the hypothesis

concerning the Maya awareness of the Metonic cycle, it seems that even if the Maya somewhat discovered it, in practice this knowledge had never been consistently used or disseminated.

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## J

***Greco-Roman Zodiac Sundials and their links to Mesopotamia and Qumran (invited)***

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Session: Astronomy in Europe and the Mediterranean at Historical Times

## ABSTRACT

It is noticeable that sundials, particularly zodiac sundials, are absent among ancient Near East archaeological finds but it is evident that they flourished and were popular in late classical Greece and Rome (c. second century BCE to the second century CE).

This paper argues that the arrangement of the zodiac signs in Greco-Roman sundials is reflected in contemporaneous fragments from the Aramaic *Astronomical Book of the Enoch* in the Dead Sea Scrolls, found at Qumran (second century BCE to the first century CE).

We shall examine a number of Greco-Roman zodiacal sundials (including one now in the Archaeological Museum of Naphlion) in relation to late Babylonian astronomical texts and the *Astronomical Book of Enoch* in Ethiopic. Fragments of the Ethiopic book overlap with Greek fragments from Oxyrhynchus and also the Aramaic manuscripts from Qumran.

The study shows the complexities of the transmission of ancient astronomy between the ancient Near East and the Mediterranean and asks why zodiac sundials flourished in the Greco-Roman world, but not in the Levant and Babylonia even though related scientific texts existed.

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## ***John Philoponus on the Movement of Celestial Bodies***

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Session: Astronomy and Philosophy

### **ABSTRACT**

John Philoponus (490-570), one of the most significant scholars of the Byzantine period, rejected several aspects of the aristotelian philosophy of nature, such as the cause of movement of celestial bodies. Aristoteles considered aether as the cause of movement of the stars, an argument which was not approved by Philoponus, whose Christian faith was inconsistent with the existence of aether. Instead, Philoponus suggests the existence of a divine kinetic force which causes the movement of all celestial bodies (moon, stars, Earth, sky). Philoponus considers this kinetic force as incorporeal and superior, properties which can be attributed only to God. Therefore, God is the only cause that sets the celestial bodies in motion. This view of John Philoponus has a significant scientific and religious value, because explains the movement celestial bodies based on physical laws whose origin however is divine.

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### ***Astronomy and Numismatics (invited)***

**Dr Kakavas George, Dreni Stella**

*Numismatic Museum, Athens, Greece*

Session: Astronomy in Europe and the Mediterranean at Historical Times

### **ABSTRACT**

The observation of the sky played a key role in human life since the prehistoric times. It has excited the admiration, became an object of study and was connected with everyday life, as it is documented in literary sources and pieces of art.

Astronomical phenomena, such as planet conjunctions, comets, eclipses etc, are depicted on ancient Greek and Roman coins. Their representation on these official products provides important information on the



chronology of these events and supplements the written sources. The personification of planets and constellations, the mythological names of the celestial objects, the association of astronomical events with certain historical events or persons that affected history and civilization and the representation of the zodiac circle or the signs of zodiac on coins will be presented.

### ***Αστρονομία και Νομισματική***

**Δρ Κακαβάς Γεώργιος, Δρένη Στέλλα,**

*Νομισματικό Μουσείο*

### **Σύνοψη**

Η παρατήρηση του ουρανού στερεώματος έπαιξε καθοριστικό ρόλο στη ζωή των ανθρώπων ήδη από την προϊστορική εποχή, αποτελώντας πάντοτε πηγή ονειροπόλησης, θαυμασμού και μελέτης. Η καθοριστική για την επιβίωσή τους παρατήρηση αυτή, φαίνεται τόσο μέσα από τη σύνδεσή της με την καθημερινή ζωή, την προσωποποίηση των αστερισμών, την ονομασία των ουρανίων σωμάτων και τη σχέση τους με τη μυθολογία, όσο και με τη σύνδεση διαφόρων αστρονομικών φαινομένων με συγκεκριμένα γεγονότα και προσωπικότητες, που επηρέασαν την ιστορία και τον πολιτισμό και ανιχνεύονται σε αρχαίες πηγές και έργα τέχνης.

Θα παρουσιασθούν κάποια αστρονομικά φαινόμενα, όπως αυτά αποτυπώθηκαν επάνω σε νομίσματα, τα οποία, εκτός από μέσο οικονομικών συναλλαγών, αποτέλεσαν μέσο προπαγάνδας, αλλά και ιστορική πηγή για φαινόμενα, που σε μερικές περιπτώσεις αποσιωπούν τα γραπτά κείμενα. Ιδιαίτερη μνεία θα γίνει και για τις απεικονίσεις των ζωδίων και του ζωδιακού κύκλου σε νομίσματα, με χαρακτηριστικότερο παράδειγμα τη σειρά κοπών της Αλεξάνδρειας επί Αντωνίνου του Ευσεβούς, επάνω στις όψεις των οποίων αποτυπώνονται διάφορες σύνοδοι πλανητών σε συνάρτηση με τα ζώδια.

***Astronomy and Star-divination. The case of the “Medicine women” of Hypate (20 minutes, talk and discussion)*****Dr Kakavas George***Numismatic Museum, Athens, Greece*

Session: Theory and Methodology of Archaeoastronomy

**ABSTRACT**

Hypate, the renowned fortress of Thessaly, was also famous in antiquity for its gifted enchantresses. The enchantresses – “medicine women” (Pharmakides) of this region, apart from their ability in using incantations and herbal remedies/potions, employed even the sun and the moon for their rituals. Already in the 5<sup>th</sup> c. BC Aglaonike, the daughter of Hegetor, foresaw accurately sun, and according to Apollodorus from Rhodes, lunar eclipses, becoming thus one of the first women “astronomers” in antiquity. Especially during the roman period the enchantresses of Hypate won a great reputation across the empire and had as their clients eminent persons. Hypate became a center for magic and its enchantresses that “brought down the moon and the sky” to assist them in their magic rituals are not only documented in the written sources throughout antiquity, but also until nowadays in oral tradition.

***Contemporary Rituals Addressing the Sun and Moon*****Kõiva, Mare<sup>1</sup>; Kuperjanov, Andres<sup>2</sup>***1 Estonian Literary Museum, Department of Folkloristics, Tartu, Estonia, E-mail: mare@folklore.ee**2 Estonian Literary Museum, Department of Folkloristics, Tartu, Estonia, E-mail: cps@folklore.ee:*

Session: European Prehistory, Folklore and Archaeoastronomy

**ABSTRACT**

This paper investigates and compares two kinds of contemporary rituals dedicated to the Sun and Moon: 1) the ethnic (Pagan) rituals performed around equinoxes and solstices, and 2) occasional rituals performed by Urmas Sisask, amateur astronomer, composer, master of rituals. The rituals reflect combinations of Pagan, Christian, and secular approaches, use texts from old manuscripts. The aim of the paper is to reevaluate and deconstruct these rituals using Hobsbawm and Ranger’s (1983) concept of invented tradition, studies of new religiosity/spirituality (cf. York, 2001), and C. Bell’s ritual theory (Bell, 1992).

In both cases under examination the rituals are tailored to resemble traditions of the past, including prayers to stellar objects. Typically to modern rituals they are very much person/individual-centered, led by a master who is believed to be endowed with intuition and knowledge. The purpose of the rituals is to involve participants in the cultural process of constructing a ritual, to direct city dwellers in finding a new inner balance. In ethnic (Pagan)

rituals the kinetics, common food and re-interpreted mythology play an important role. Methods for uniting people are similar: common singing, chanting and ritual communication. Recurring elements, in addition to music and drumming, include the revived custom of sacrificing to the elements and addressing ancestors, nature spirits and cosmological powers. Rituals are performed in conjunction with „significant“ times (solstices, major calendar feasts, also community or society events, cultural events) and in sacred landscape (e.g., wild nature, places dedicated to neopagan rites, arboraceous suburbs or forests). Although suitable places also include archaeological sites and historical monuments, rural or forestry environment is preferable.

The reinvention and reconstruction of ancient rituals is one of the key features of modern society that carries on old cosmological rituals.

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DOI: 10.1080/1353790012007717 7

### ***Konstantinou Gordatou Horizontal Dial and Portable Solar Quadrant***

**Kriaris Dionysios**

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Session: Astronomy in Europe and the Mediterranean at Historical Times

### **ABSTRACT**

*Gnomoniki* was the science of ancient Greeks in order to design and build instruments appropriate for the accurate measurement of large intervals (months, seasons, years), but also small intervals such as hours of days, in order to serve the sciences which developed from the 6th century BC. The geometry, trigonometry and astronomy were the tools in the hands of gnomonists for the construction of such organs. Solar watches, gnomons and horoscopes were just a few of the institutions which give us accurately the position of the Sun-indicating the time and date – for each day of the year with a shadow. The gnomonists could interpret or mark (obelisks) manufactures whose shade on any surface to indicate the time and date of that particular moment. There were also practical rules that someone who wasn't gnomonist could construct some, standard, at least sundials. This old astronomical tradition viewed through the work of scholar Konstantinos Gordatos (1690-1750) of Chios

who in his work "on the Spheres and their use" he present to us the preserved work of philosopher Proclus (412-485) from Lycia titled "about sphere" in which includes topics about the axis of the world and the earth of the cycles of the Earth's sphere, in other worlds is a practical cosmography with the fundamentals of spherical astronomy. Gordatos then describes how the use of such sphere (practical way) can construct a sundial and a solar quadrant.

***The astronomical relation of the ritual platforms of the mountain sanctuary Kokino (invited)***

**Kuzmanovska Olgica<sup>1 13</sup>, J. Stankovski J.<sup>2</sup>**

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Session: European Prehistory, Folklore and Archaeoastronomy

**ABSTRACT**

The rituals performed on the mountain sanctuary "Taticev Kamen" (Tatic Rock), located near village Kokino, Macedonia, were connected with the agricultural activities of the Bronze Age people in the surrounding area and the change of seasons. For that purpose the motion the Sun and some other celestial objects were observed in the course of several centuries and their position on particular dates marked by stone notches. We present new results of the archaeoastronomical research of the site that indicate the mutual relation of the solar markers on two different observational platforms; the one with the thrones, on which a ritual that had solar characteristics had been arranged and the platform located on the north part of the locality which was probably used as a observation point of the heliacal rising of Aldebaran and Pleiades.

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***The Sky of Johann Bayer: Early Catalog of Binary Stars*****Kuzmin Andrey V.***The S.I. Vavilov Institute of History of Science and Technology, Moscow, Russia*

Session: Astronomy in Europe and the Mediterranean at Historical Times

**ABSTRACT**

The early history of optical observations in astronomy still keeps a lot of either little known or unknown episodes concerning the first attempts of stargazing by the means of glass lenses.

A casual trace (or maybe, a symbolic astronomical record as well) of the earliest attempts of use of optical elements in goniometrical instruments may be guessed while examining the star atlas known as *Uranometry* by Johann Bayer (1572 – 1625). (Bayer, I., *Uranometria: Omnium asterismorum continens schemata...* Augustae Vindel., 1603) The atlas was published in Augsburg in 1603 and it was, for the most part, a fruit of labour of Tycho Brahe (1564 – 1601) and his co-workers in the field of astronomy. The edition was fulfilled two years after Brahe's death. Our attention was drawn by several stars depicted in a specific manner. These stars constitute optical pairs if observed by means of a simple telescope. (To note, other optical pairs observable by unaided eye were depicted in the same way.)

The examination of this fact leads us to a conclusion that the wide spread confidence in complete absence of elementary optical devices in Tycho Brahe's observatory might be considered as unjustified.

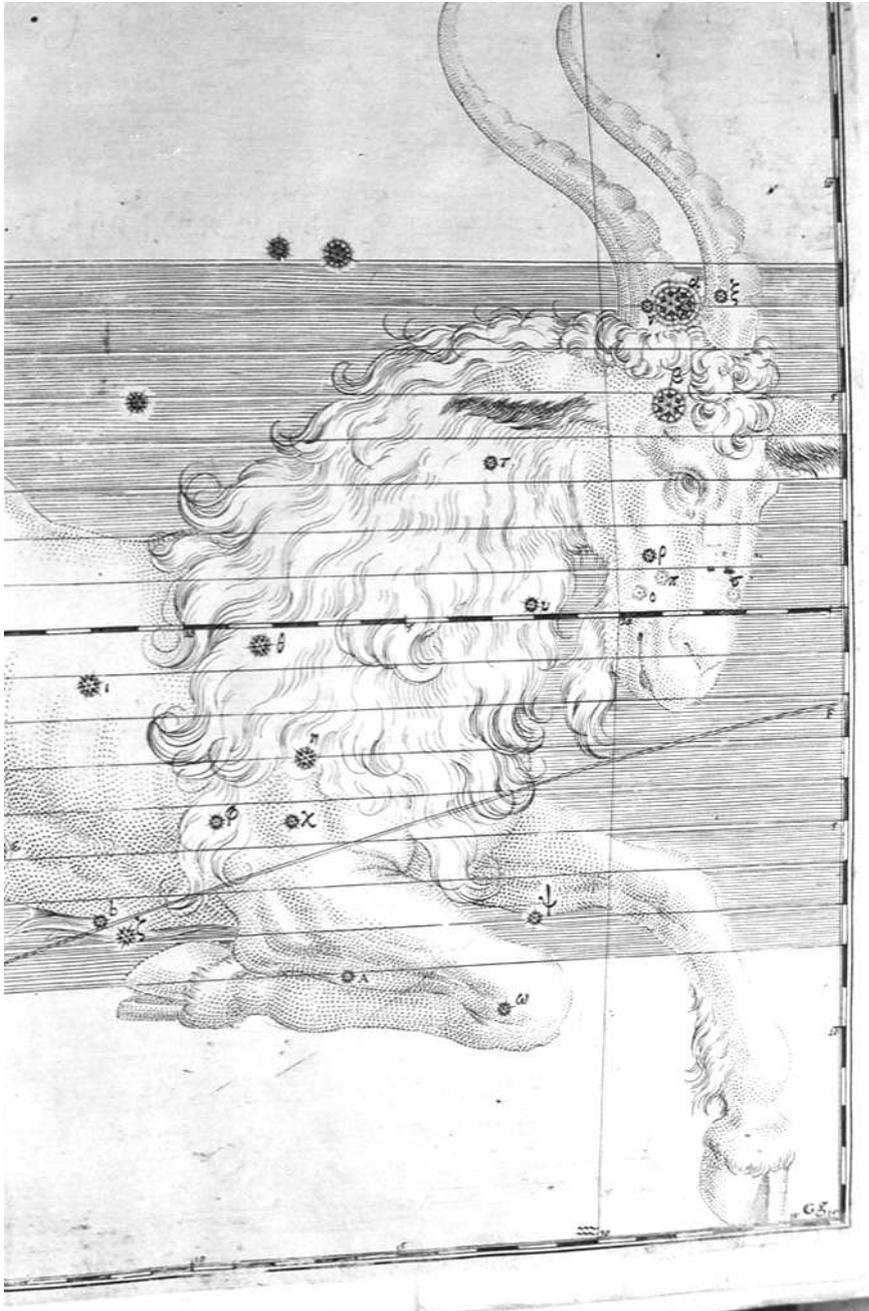
If one examines thoroughly the charts of *Uranometry* by Johann Bayer (1572 – 1625). (Bayer, I. *Uranometria: Omnium asterismorum continens schemata...* Augustae Vindellicorum, ..., 1603), one may find there several stars which are depicted in a somewhat unusual way. The inner space of the graphical symbols depicting these stars, has no dark-painted core inside them, unlike all other stars in the atlas. As a result, these stars appear whitish and are clearly distinguished from other star symbols, which are all depicted in an identical manner and differ only by size, according to its magnitude. This special graphical manner is found in nine stars in the charts of Cetus, Lupus, Cancer, Orion, Sagittarius, Capricornus, and Hercules. The tenth whitish star, in Cassiopeia, differs from other stars also by enormously large size.

How did it happen so, that these ten stars in different sky areas had drawn a separate attention of the astronomer and the painter?

A description of these stars is given in the table below.

1. The object in Cancer, to which Bayer ascribed the Greek letter  $\epsilon$  (epsilon) (which remained attached to it up to the present day), is nothing else than the open star cluster called Beehive or Praesepe (M44). It has been known to astronomers from the times of antiquity.
2. The star depicted as  $\nu$  Sagittarii consists of two stars, both of 5th magnitude, seen close to each other. On contemporary charts, they are drawn separately as  $\nu 1$  and  $\nu 2$ .

3. The object next in turn is a star lying eastward from Orion. It has no literal notation. I guess that Bayer was not accurate enough in positioning of the object. To my opinion, it is a pair of stars westward from the  $\gamma$  Monoceri, positioned close to each other in the present-day charts. But in the Bayer's atlas, the constellation of Monoceros was not present at all, this "white" star being placed just by the side of Orion.



4. The fourth star is  $\nu$  Lupi. Here again, like those in the case of the  $\nu$  Sagittarii, we may see two stars close to each other, one of the 5-th and the other of the 6-th magnitude. The first one, lying a little more northward, is marked now as  $\nu 1$ , and the other, as  $\nu 2$ .

Fig. 1. The Capricorn

The first four cases are easy to understand. The first of them, is an open star cluster, and the three others, pairs of stars aligned close to each other, or so called optical pairs, two of them lying

very close to the ecliptic, in Cancer and Sagittarius.

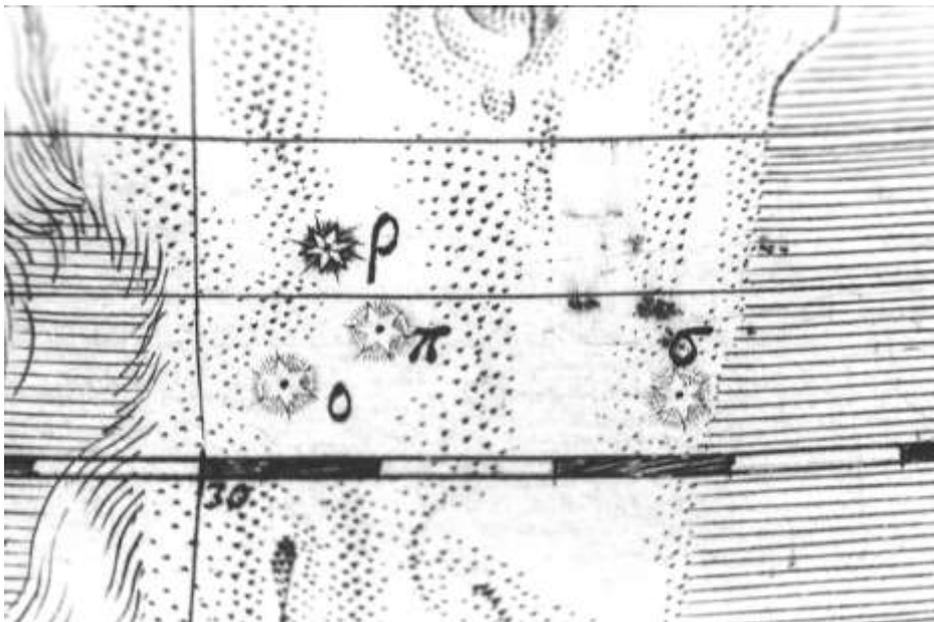
More queer are three other objects, two of them lying close to the ecliptic, too, and one near the north pole of ecliptic.

5. The fifth white star is placed in the constellation of Cetus, in the part aligning to Aries. In contemporary charts, it is  $\xi 2$  Ceti, a star of the 5th magnitude, which has no companion in its close neighbourhood.

So why did Bayer depict this star in a non-standard way, as if it were also a binary star? Could it be the planet Uranus, not known yet by astronomers of that time, which, coming close to the star, formed an optically binary object with it for a certain period of time? In fact, this planet may be sometimes observable by an unaided eye. At the turn of the centuries 16-17, Uranus passed through that very area of sky, so that a skilled astronomer was able to see it without knowing what it really was. So, it is not impossible that either J. Bayer himself or another astronomer, whose data Bayer used while drawing his atlas, could mistake it for a companion star to the actual star in Cetus. (The connection of Uranus with  $\xi 2$  Ceti could last for a rather long time, about a one year period.)

An observation like this could really take place in the history of astronomy. A more curious coincidence took place, when even a still less bright planet Neptune was mentioned by Galileo as an unknown "star" being captured by chance in the field of his telescope.

In the case of Uranus, for Tycho Brahe and his assistants, it would be enough to notice a slightest movement of this "star" against other stars in its neighbourhood, for this planet to be identified before the onset of the 17th century! They would be certainly able to notice that this "star" was moving in loops similar to those of the two other upper planets (Jupiter and Saturn), have they only attached a little more attention to its behaviour, and the discovery of



Uranus would occur by about two centuries earlier than it happened in the real history of astronomy!

In Capricorn (Fig. 1 and 2), three stars were depicted by Bayer in the same specific way, the  $\pi$ ,  $\circ$ , and  $\sigma$  of this constellation. They

are all placed together, within one degree of arc northward from the ecliptic. It is known at present time that the  $\pi$  Capricorni is a binary star, consisting of two components, of 6th and of 9th magnitude respectively, separated from each other by only 56 seconds of arc, which is in fact very close to the limits of human perception. (It is proven that the discriminative limit of an unaided human eye is approximately one minute of arc).

The next one,  $\circ$  Capricorni, is also a binary star, the two components of which, both  $m=7$ , are separated from each other by only 23 seconds of arc. The third one,  $\sigma$  Capricorni, is a triple stellar system. Its most bright component, a star of 6th magnitude, is separated from its nearest counterpart (9m) by only three seconds of arc(!).

And finally, the star in Hercules, just near the borderline of Draco, which has no literal notation, is a three-component stellar system, the most bright component (6m) being separated from the next one (8m) by 27 seconds of arc which, again, surpasses the discriminating ability of an unaided human eye.

. Fig. 2. The Capricorn. Fragment with  $\pi$ ,  $\sigma$ , and  $\sigma$

The tenth unusual object depicted by Bayer in *Uranometria* was a Nova which appeared as a very bright star in Cassiopeia in the early November, 1572. It remained visible to the naked eye for about two years, gradually fading until it disappeared from view. It is known as Brahe's Nova or Supernova, or SN 1572, according to the year of its burst. Its symbol in the Bayer's atlas also differs from the most stars: its inner core was not painted in a dark colour and was left white, which assimilates this bright star to the nine stars mentioned above. And, notably, for the present-time astronomers, it is a well-known fact that the Novas are typically binary stars, which is not untrue also for the Brahe's Supernova, whose remnants are now optically seen only with an aid of a strong telescope. The second component of this dual star was discovered in 2004.

Can one reveal the fact of duality of such objects without the aid of optical devices? The answer would be certainly 'No'. So, it would be wise to suppose that Tycho Brahe and his assistants had conducted some experiments with the use of magnifying lenses as early as in the end of the 16th century, that is some decades earlier than the famous discovery of Galileo who is considered the first astronomer who came to an idea of looking at the sky through a system of glass lenses. We may also assume that Tycho and his co-workers did not hurry to reveal publicly their new method of sky observation because these first timid attempts had not yet taken a definite form so as to be presented to the scientific establishment of that time, which adhered closely to conventional attitudes and with certainty would not appraise any kind of innovation in the science of observation of heaven. Even more, could not it be true that the astronomers were not yet ready to realize all the meaning of their revolutionary invention even for themselves, or maybe they have chosen to keep it in secret for some unknown reason?

We find it possible to suppose that the whitish star figures in Bayer's charts refer to visually binary stars seen by unaided eye as well as to such pairs whose binary status can be revealed only by means of optical devices.

**Table**

Objects in <i>Uranometria</i> by J. Bayer (1603)	<i>Contemporary data</i>	Commentary
Supernova in Cassiopeia (burst in November, 1572)	Supernova SN 1572, of type Ia. During its burst in 1572, it reached -4 by magnitude, but now it is only seen in a strong telescope as a very faint nebula.	Objects of this type are usually binary stars. The second component was actually found in 2004

$\nu$ Sagittarii	Two stars, both 5m, $\nu 1$ and $\nu 2$ Sagittarii	Seen with unaided eye
$\epsilon$ Cancri	$\epsilon$ Cancri Open star cluster M44	Beehive or Praesepe star cluster, known from the times of antiquity
A whitish star eastward from Orion (no literal notation)	Two stars in close position to each other, westward from $\gamma$ Monoceri	Seen with unaided eye
$\nu$ Lupi	Two stars (5m and 6m) in close position to each other, $\nu 1$ and $\nu 2$ Lupi	Seen with unaided eye
$\pi$ Capricorni	A binary star, two components (6m and 9m) are separated by only 56 of arc	Duality observed by the aid of an optical device
$\omicron$ Capricorni	A binary star, two components, both of magnitude 7, are separated by only 23 of arc	Duality observed by the aid of an optical device
$\sigma$ Capricorni	A triple star, the most bright component (6m) is separated from the next one (9m) by only 3 of arc	Triplicity observed by the aid of an optical device
A star in Hercules "above the right ear of Dragon (Draconis)" (no literal notation)	A triple star system, the most bright component (6m) is separated from the next one (8m) by only 27 of arc (In Hercules, near the border of Draco)	Triplicity observed by the aid of an optical device
$\xi$ Ceti	$\xi 2$ Ceti (near the border of Aries). A star of 5th magnitude, no other stars in close position	Planet Uranus was observed more or less close to this star at the turn of centuries 16-17

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Brahe Ticho. Tichonis Brahe ASTRONOMIAE INSTAVRATAE PROGYMNASMATA Quorum haec Prima Pars. DE RESTITVTIONE MOTVVM SOLIS ET LVNAE STELLAR VMQVE INRRANTIVM TRACTAT it Praeterea de admiranda Nova Stella Anno 1572 exorta lucukenter agit. Typis Incoata Vranibvrgi DANIAE. ABSOLVTA PRAGE BOHEMIAE M.DC.II.

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***The Cross Torch of Eleusis & The Astronomical Secret of the Mysteries***

**Latura George**

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Session: Astronomy in Europe and the Mediterranean at Historical Times

## **ABSTRACT**

How did the Mysteries of Eleusis, the primary religious pilgrimage of the Hellenistic world – attended by Roman emperors over centuries – originate and operate? Using the method of ‘intra-cultural triangulation,’ we can pinpoint a locus – a juncture of relevant data sets – that allows us to conclude that the Mysteries sprang from a recurring and predictable astronomical event. Literary evidence reveals a night-time procession with torches from Athens to Eleusis (c. 20 km), a critical element of the Eleusinian rite that points to its astronomical dimension – today observatories still open their domes at night. Plastic arts of Magna Graecia (Trendall, 1989) display a unique permutation of the Eleusinian torch – the cross-torch – whose intersecting shape indicates a specific celestial phenomenon. Calendrical evidence places the celebrations of the Lesser Mysteries and the Greater Mysteries in spring and in fall – when the ecliptic stands most upright along the horizon in temperate climes. At these rare times, the ethereal glow of the zodiacal light embraces the planets along the ecliptic, giving to those who know (initiates) an astounding vision of the stairway to the heavens – already described by Pindar around 450 BC (Race, 1997). And where the zodiacal light meets the Milky Way (the abode of souls), one could witness the heavenly gates that – according to the Roman writer Macrobius – were located at the intersections of the zodiac and the Via Galactica (Stahl, 1990). The crossroads in the sky were linked to celestial portals over at least seven hundred years, from Macrobius back to Cicero, and thence to Plato (Latura, 2013). Numismatic and textual evidence shows that already during the Republic, cultured Romans – like Cicero – attended and glorified the Mysteries of Athens, as they would for centuries during the Empire. Octavian headed for Eleusis right after his legions defeated Marc Antony, and he would return a decade later as Augustus. Subsequent emperors followed in his footsteps, with the goddess of Eleusis appearing on numerous Imperial coins, while the intersecting paths on a celestial sphere would grace the coins of Augustus, Domitian, Antoninus Pius, Marcus Aurelius, Macrinus, etc. Even Constantine’s coins show Jupiter or Sol Invictus presenting a heavenly orb with intersecting lines to the emperor, granting control of the celestial portals to the Pontifex Maximus, the highest priest of the Roman Empire, an office passed down from Julius Caesar (Hamlyn, 2011) and Augustus to every emperor until near the end of the western Empire. When the Mysteries and their astronomical secret passed away, so did the Empire that for centuries they had legitimized.

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**DELPHI AND COSMOVISION: APOLLO'S ABSENCE TO HYPERBOREANS AND THE TIME OF CONSULTING THE ORACLE (invited)**

**Liritzis Ioannis and Castro Belen**

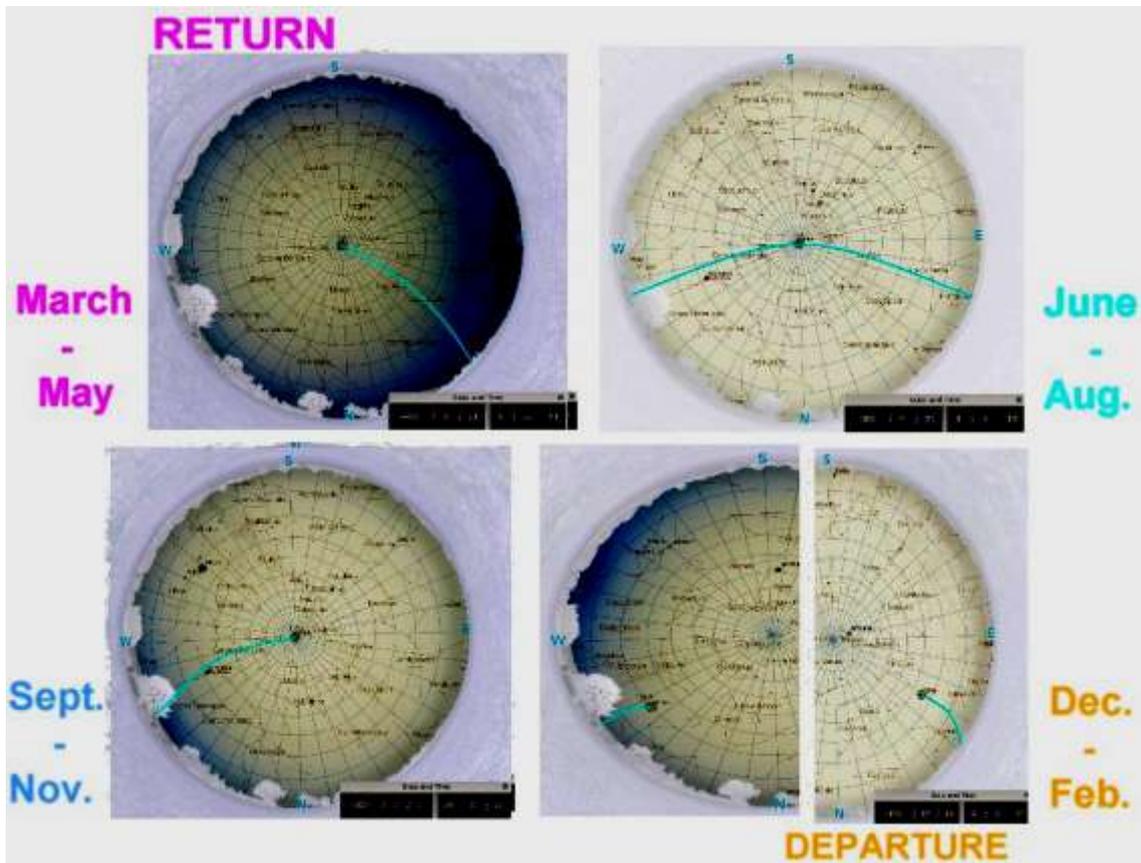
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Session: European Prehistory, Folklore and Archaeoastronomy

**ABSTRACT**

Keeping an exact calendar was important to secure Delphic festivals (Hannah, 2005). The proper day for prophecy was a meticulous calculation led obviously by the learned priests and ancient philosophers, preserving their beliefs by allegorical means (Liritzis & Coucouzeli, 2007). The month of Bysios on average is February but in effect it could be any 30 days interval between January and March. Bysios starts with a New Moon, but the beginning of a month is not easily pinpointed and thus the Bysios and the 7<sup>th</sup> day of giving oracle cannot be identified and be corresponded to the Gregorian calendar. Lyra and Cygnus celestial orbit with regards to sunrise and sunset is related to temple's orientation and the high altitude of steep cliffs of Faidriades in front. Sun rise shines at the backside of the temple where the statue of the god. While the appearance and disappearance of Lyra and Cygnus, two favorite star constellations of Apollo in the Delphic sky, mark the period of absence of the god to the Hyperboreans. This coincides with the 3 month interval of end of December to the middle of March. At the later part of this period, the 7<sup>th</sup> day of Bysios, the oracle was given (Fontenrose, 1981; Flacelier, 1938). At any rate, the Delphic calendar was properly adjusted to coincide and preserve the seasonal movements of those constellations). Due to the proximity of the Temple to Faidriades this Angular Altitude of Skyline for the NE direction varies greatly from backside and front entrance side of the Temple towards Faidriades between 23° - 35° and a corrected  $Az=56\pm 2^\circ$ , that is well beyond the solar rise. Several softwares for ancient sky, declination calculation in conjunction with Google earth simulations of landscape. The star configuration of the Lyra, Cygnus and Delphinus with Apollo are shown in a red-figured ceramic hydria, and the instrumental observations is related to written source, while the whole

scenario is related to the seasonal emanation of hydrocarbons from beneath the temple, too (de Boer et al., 2001). The priestess gave oracles on days determined by astronomical means, following the long pre-existing astronomical tradition recorded on ancient texts, mythology and art. The Delphic calendar was a luni-solar-stellar one.



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## M

***On the Origin and Evolution of the Universe: Chaos or Cosmos? (invited)***

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Session: Research History of Astronomy and Current Issues

**ABSTRACT**

We consider the evolution of the Universe based on the standard Big Bang model, quantum models of creation, and recent theory of nonlinear dynamics, including deterministic chaos and fractals. We show that these modern studies looking for an order and harmony in the complex surrounding real world give also new insight into the most important philosophical issues exceeding the classical ontological principles, e.g., providing a deeper understanding of an old philosophical questions: why does something exist instead of nothing?. In fact, in mathematical-natural sciences we ought to look for the sense of the world in the mystery of rationality; the sense of every existence is the justification of the Universe. Finally, we argue that this scientific view provides also sense and hope to a human existence.

***Appia Regina Viarum: Archaeoastronomy as a key to the project of a Roman masterpiece. (invited)***

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Session : Theory and Methodology of Archaeoastronomy

**ABSTRACT**

Straight roads are the fastest way to connect two points on a plane surface. Of course, since the earth is round, no “straight lines” exist at all on it. However, provided that the two ends of a road are not too far apart, the line which can be traced starting from one end and pointing to the final destination does not differ, in practice, from the true shortest path between the same points (which of course is the arc of great circle which passes through them). Minimization of the distances was certainly a reason in the project of many straight roads built in ancient times, for instance by the Romans. However, this is not the end of the story. Indeed, in many cases ancient straight roads do not bend even when reasonableness would require a local change of direction; in other cases, the width of the roads or even their existence is due to symbolic – as opposed to utilitarian – reasons. This holds true, for instance, for pre-Columbian roads constructed by the Hopewell, the Anasazi, and the Maya (see e.g. Magli

2009 and references therein). Further, the ancient methods of construction employed geometry and astronomy, in some cases in a rather sophisticated way. As a result, in many cases Archaeoastronomy reveals itself as a powerful tool in the exercise of “reverse engineering” of the project of ancient roads. In particular, we have recently studied the case of the most famous of the Roman roads, Via Appia, “the queen among the longest roads”, constructed by the Roman consul Appio Claudio around the year 312 BC to connect Rome with Capua. The first section, leading to Terracina, is composed by two perfectly straight segments connected by a short zig-zag section aimed to cross the Alban hills at Colle Pardo. The first of such segments runs for 36 kilometres, the second crosses the Pontine Marshes going straight for as long as 62 kilometres (Humm 1996). To our knowledge, no one has ever tackled seriously before the problem of the project of such an astonishing rectilinear path. To study the road we performed a high-precision GPS survey finding that the road was almost certainly constructed together with the planning of a centuriation of the Pontine marshes. We found many fossil traces of this centuriation - originally hypothesized by Cancellieri (1990) - and we have shown that it was oriented with extreme precision to the cardinal points, furnishing an optimal base grid for the road. Appia in itself turns out to have been orientated quite precisely to the setting of the star Castor, a fact which has many chances of being intentional, since it matches closely with the “military” character of the road, constructed during the Samnite wars. The Dioscures were indeed, since the 5 century BC, the patrons of the Roman army.

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## ***Ancient Portuguese nautical and geographical information***

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Session: Astronomy in Europe and the Mediterranean at Historical Times

## **ABSTRACT**

During the first decades of the sixteenth century, the Portuguese sailors became in contact with the sailors of the Indian and the Western Pacific Oceans, changing with them nautical

and geographical information, which allowed for the future exploration of that area by European powers.

That meeting between European and Eastern cultures began immediately after the arrival of Vasco da Gama on the area, by the end of 15th century, and it is incredible how fast the Portuguese collected information, which allowed for the design of cartography and other nautical information on the result of direct observation, but also on regional sources. This process is not yet sufficiently known by scholars.

In the Indian Ocean and Western Pacific, were already developed methods and techniques of navigation, mainly with recourse to astronomy, which were perfectly adapted for that area of the globe, and by the end of the 15th century, pilot books and navigation books circulated among the pilots of the ships that for centuries navigated on those seas.

The well known navigation and pilot books of Ibn Majid and Suleyman al Mahri are partly translated and studied by famous scholars but the navigation manual of the Turkish Admiral Si'di' Al Chelebi, known as the Mohit, written in 1554, is not yet completely translated and studied. This work, which is based on the work of the well known Arab sailor, Sulaiman al-Mahri and also on Portuguese sources, needs a closer attention, because, being produced on a period when the Portuguese sailors were well established in the area, can give more light to the interchange of information among the Europeans and the cultures of the Indian Ocean.

We have to note also, that the pilot book of Sulaiman al-Mahri, is not also completely translated and studied.

The purpose of my paper will be to call the attention to the important scholars present in this meeting for the need of translating the original works of the above-referred sailors, which will allow a deeper study of what happened in the area during the first decades of the sixteenth century.

### ***Peruvian Astronomy Before the Inca***

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Session: Archaeoastronomy in North and South America

#### **ABSTRACT**

The brilliant architecture, complex astronomy, and rich symbolism of the Inca Empire were the culmination of 4500 years of Peruvian. Cosmological motifs can be traced back to the Late Archaic Period (3100-1800 BCE) of Norte Chico when platform mounds and sunken circular plazas, such as those of Caral and neighboring sites in the Supe Valley, were associated with a solstitial axis connecting December solstice sunrise and June solstice sunset. A ritual

theme of ascent from the lowest to the highest world is suggested. Ceremonies on the summits of the platforms may have represented those powers on sacred mountains that generated rainfall and water for irrigation. In the Casma Valley during the Intermediate Period (1800-900 BEC) larger mounds were built, such as that of Sechin Alto, along axes oriented to June solstice sunrise. With a volume of some 2 million cubic meters, Sechin Alto was the largest structure in the western hemisphere at that time, and it has rarely been surpassed. The contemporary structure A at Poverty Point in northeastern Louisiana had a volume of 240,000 cubic m.; Monks Mound of Cahokia had a volume of 622,000 m<sup>3</sup> and the Pyramid of the Sun in Tenochtitlan had a volume of 1,200,000 m<sup>3</sup>. These immense platform mounds of the Casma Valley would have displayed the prestige and power of leaders who probably engaged in ceremonies on their summits. These mounds were precursors to the Inca ushnu and probably the huaca. The sacred power of flowing water, responsible for transforming huacas into living beings and manifest in nearly every Inca site that contains evidence of visual astronomy, appears in the interlaced underground channels Chavín de Huantar. The site with the most elaborate astronomy in the Casma valley is Chankillo, which has a solar axis connecting December solstice sunrise and June solstice sunset. Tiwanaku, on the southern shore of Lake Titicaca, an influential precursor of the Inca, has a primary east-west axis, evidence for a horizon calendar utilizing ashlar, and channels for transforming water.

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## ***Lick Observatory and the Early Development of Astrophysics (invited)***

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Session: Research History of Astronomy and Current Issues

## **ABSTRACT**

During the years 1898 to 1932, Lick Observatory organized a remarkable series of 17 solar eclipse expeditions extending from 1898 to 1932, all the more remarkable because for most of this time no one on the staff at Lick Observatory had a serious research interest in the sun or engaged in the analysis of the results. The science of these expeditions involved three issues of major significance during the development of astrophysics during the first three decades of the twentieth century: (1) testing of General Relativity; (2) significant departures from thermodynamic equilibrium in extended stellar atmospheres and gaseous nebulae; (3) magnetic fields in the sun.

Soon after the 36" refractor saw first light in 1888, the first director of Lick Observatory, Edward Holden, organized an eclipse expedition to test his idea that coronal filaments were produced by streams of meteorites falling into the sun. It is an enduring puzzle that non-magnetic interpretations of solar activity continued to be favored by Lick astronomers well after Hale's 1908 discovery of the Zeeman splitting of spectral lines in sunspots.

After he became director in 1901, W.W. Campbell took over personal leadership of the expeditions. While Campbell was organizing elaborate eclipse expedition and carrying out complex eclipse experiments in remote part of the world, George Ellery Hale was building a major observatory with the world's largest telescopes at Mt Wilson. These contrasting approaches to astronomical research were due to differences in the cultures of the two observatories, available funding, and personalities of the two directors. Even though the Lick astronomers were skeptical of astrophysics and Hale and his colleagues emphasized astrophysics, both observatories were to play fundamental roles in the application of fundamental physics to astronomy during the first decades of the 20<sup>th</sup> century.

As a spectroscopist, Campbell initiated the program of spectroscopy of the chromosphere and corona, as well as an unsuccessful search for Vulcan. Campbell had also attempted to test for the predicted deflection of starlight in Russia in 1914, and Goldendale Washington in 1918, but had not succeeded due to weather. Campbell had considerable distrust of Einstein's theory, considered Eddington's 1919 results to be suspect. He would have been pleased to disprove the Einstein prediction. Although Eddington is often given credit for confirming Einstein's prediction, it is to Campbell's great credit that his results confirmed the predictions of Einstein with greater precision than Eddington had reported.

Donald Menzel joined the staff of Lick Observatory in 1926 as their first astrophysicist, and he was given the analysis of the flash spectra of the chromosphere previously taken by Campbell. The work was published in 1931. The beginning sentence of Menzel's major monograph conveys his sense of the revolutionary nature of his endeavor: "*Physicists and astronomers are becoming 'atom-minded'.*" His results concerning the high temperatures and large deviations from thermodynamic equilibrium in the chromosphere cast doubt upon standard analysis of stellar atmospheres and gaseous nebulae. By the 1950s it became clear that non-local thermodynamic equilibrium was so extensive in both astronomical and laboratory situations that extensive knowledge of atomic parameters such as collision cross sections and f-values were needed. To acquire such data, the Joint Institute for Laboratory Astrophysics was established in Boulder.

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## ***Problems with the Presentation of a New Cosmological Model***

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Session: Research History of Astronomy and Current Issues

## **ABSTRACT**

We would expect that the presentation of a new cosmological model, clearly superior to the established one, would be welcomed by the scientific journals. This should be especially true in our time, when the standard cosmological model is unable to justify fundamental observational data. The nullification of the work of the reviewers as well as of the majority of the already published articles and the ones slated for publication in scientific journals, and the billions worth of research programs in progress, are just some of the causes of problems in the presentation of the new model. The superiority of the new model comes from the fact that it stems from a single equation which contains as information and justifies the totality of cosmological data. The problems to the standard cosmological model caused by modern

observations, are precisely focused on the points where the two models make different predictions.

***The Conception of Time in the Cosmos and the microcosmos***

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Session: Research History of Astronomy and Current Issues

**ABSTRACT**

A slight continuous increase of rest masses and electric charges of material particles can cause both the quantum effects and the cosmological data. The increases are strictly determined by the law of selfvariations. The selfvariations affect any process of the measurement of physical quantities which takes place either in the macrocosm or the microcosm. This happens because the selfvariations affect the measurement units, i.e. the mass or electric charge with which we compare and measure other masses or electric charges respectively. In the macrocosm this expresses as the arrow of time, which is strongly recorded in the measurements which we call cosmological data. In the microcosm the same equations give us a completely different result. The law of selfvariations in the microcosm gives us the distribution of the rest mass of a material particle in spacetime. The Schrodinger equation and related equations appear to play a central role in this distribution.

***Do Mycenaean Tholos Tombs Encode Astronomical Alignments?***

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Session: Theory and Methodology of Archaeoastronomy

**ABSTRACT**

Starting in 1998, Reijs (1998) made numerous observations of the sun's passage into the treasury of Atreus through the relieving triangle around the times of the spring and autumn equinoxes. He suggests that this solar orientation was intentional in the design of the tomb and that the relieving triangle was at least, for a time, open to provide observations of these phenomena. This paper takes a different approach regarding the orientation of these Mycenaean Tholoi based on architectural and geographical-topological considerations. Como (2009) describes in detail the construction methodology used in Mycenaean Tholoi and in particular that of the Treasury of Atreus. That paper gives a detailed analysis of the complex

forces involved in this structure which explain the stability of the monument. The purpose of the relieving triangle is well known in Mycenaean architecture, Cavanagh et al. (1981) as a means of reducing loading on the lintel over the stonion where masonry courses in a wall are corbelled. It is widely accepted that the relieving triangle was filled with a decorative design as in the Lion Gate at Mycenae. As an alternative to orientations based on astronomical considerations, one might consider topographical characteristics of these sites which dictate the orientation and to a large extent the construction of the tomb, Maravelia (2002). The nine tholoi in the general area of Mycenae are examined with respect to their topological siting and relative to possible astronomical phenomena. The methods of Archaeoastronomy must include all aspects of the site; its topology, the architectural practice of the period, artistic expression, and the cultural aspects of the monument, not just the correlations of the site with respect to astronomical phenomena.

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## ***The astronomical significance of Atlas' myth***

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Session: Astronomy and Philosophy

## **ABSTRACT**

Atlas is, according to Herodotus, a very high mountain in North Africa, narrow and circular, which the natives called *the column of the sky*. The fact of the transfer of support of the sky dome from Atlas to Hercules and vice versa might have an astronomical significance.

Specifically, on account of the phenomenon of equinox precession, a change in the position of the earth's axis modifies also the poles of the celestial sphere, tracing circles, the northern and southern one, whose completion requires 25,800 years. Today, the north pole of the sky is in a distance of one degree from the "*alpha*" star of the Little Bear. During the third millennium BC, the polar star was *Thuban* or "*alpha*" of the constellation of Draco. At the end of the eleventh millennium BC, the north pole of the sky was among the stars "*Iota*" and

"*Theta*" of the constellation of Hercules. The transfer, therefore, of support of the sky from Atlas to Hercules and vice versa probably means this change in the north pole of the sky. Even the killing of the dragon that guarded the apples of the Hesperides by Hercules may have astronomical significance. The north pole of the sky was during the third millennium BC in the star *Thuban* or "*alpha*" of the constellation of Draco. Later, the north pole of the sky moved. This move resulted in the constellation of Draco as the north pole being sidelined, or, according to the mythical terminology, Draco being "killed". Since it was then considered that Draco (the dragon) was "killed", a great hero such as Hercules should have killed him. In other myths as dragon killers appear Apollo, who killed the dragon Python in Parnassus, Jason, who killed the dragon in Colchis with the help of Medea in order to grab the Golden Fleece, and finally Cadmus, who killed the dragon in Thebes and sowed his teeth, from which sprouted wickers.

### ***An archaeoastronomical analysis of the Mayan "E-group" in Mesoamerica***

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Session: Archaeoastronomy in Mesoamerica

#### **ABSTRACT**

In this work we outline the results of an archaeoastronomical investigation dealing with a number of Mayan "*E-Group*", that are particular structures of the pre-Columbian architecture in Mexico, Belize and Guatemala. These structures were already recognized to be astronomically significant and related with the observation of the points of rising of the Sun at the solstices and the equinoxes at the local horizon. Following our analysis, the "*E-Structures*" seem to be suitable to observe the rising of the Moon at the lunar standstills along the 18.61-years lunar nodal period also. In addition such structures could be suitable to mark the extreme northern and southern points of rising of the five naked-eye planets reached at their extreme declination on the celestial sphere. This kind of astronomical observations were fundamental in order to get accurate estimates of the synodic as well the syderic periods of them.

There are significant evidences that the Mayan "*E-Structures*" could be used, by the Mayan skywatchers, in a more general ways with respect to the pure understanding of the motion of the point of the solar rising at the local skyline for the planning of the agriculture and the religion. In fact these characteristic structures represent a more general architectural tool in order to fix some calendrical dates required by the social and political life in the Mayan world and, in a more general way, to do Astronomy.

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## ***The Oldest Computer, the Antikythera Mechanism: An Epitome of Greek Philosophy (10 minutes)***

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*"The origin of all technical achievements is the divine curiosity [of Socrates/Plato] and the play instinct of the working and thinking researcher as well as the constructive fantasy of the inventor..."* Albert Einstein, speech on the radio at the opening of the 7 Deutsche Funkausstellung in Berlin, 1930.

Session: Astronomy and Philosophy

## **ABSTRACT**

The so called *Antikythera Mechanism*, or *Pinax* or *Sphere*, as its original name was, is the oldest known advanced scientific instrument, the first computer and mechanical universe. Subverts everything believed about the lack of interest of the Greeks in technology. Seems to be off season, in fact it is the epitome of Greek Philosophy.

It is the epitome of philosophy because to build a mechanical Cosmos, such as the mechanism, you need to understand, embrace and practice the Greek philosophy, the philosophy of the Ionian philosophers, and you got to put it to work. We can say, in fact, that the signature of Pythagoras is in the mechanism, as on one of the gears the Pythagorean pentagon is engraved right in the middle of a gear, around its shaft. The Mechanism is the culmination of Pythagorean philosophy, their teaching and understanding that led to our knowledge of the Cosmos with the introduction of mathematics to understand and predict natural phenomena. This process was based on observations, experiments and the perception that Nature is harmonious, and that the Cosmos vibrates with the so called *Music of the Spheres*. The Pythagoreans discovered all these with properly designed and realized

experiments with musical instruments, hammers, strings etc and appropriate measurements followed with appropriate theoretical analysis with mathematics that eventually led them to the inductive thinking formulation of the laws of physics and modern civilization with today's technology.

Built by Greeks, probably between 150 and 100 BC and, as demonstrated by appropriate calculations based on our measurements on the mechanism, the instrument is based on measurements taken by Archimedes and his students at a philosophical school that he had in Syracuse. It turns out now that Archimedes was a physicist and astronomer and had school and his students continue astronomical work for at least few decades, obtain measurements of eclipses using a clock (like the one we know from detailed description Archimedes constructed). The pupils of Archimedes eventually send tables with astronomical data, including eclipses observations, to another Greek who constructs the instrument. As Hipparchus is perhaps the only and the greatest astronomer Greek at that time who works in Rhodes, that has a lot of money and excellent tradition in metallurgy and technological constructions.

The mechanism is a complex exact analog and digital computer that works with carefully designed and manufactured gears (Bytes) with small teeth (bits). The gears perform certain mathematical operations as they move around and drive shafts and indicators and pointers showing the position of various heavenly bodies, the Sun, the Moon and possibly the planets in circular and spiral scales (analog part). That was the first mechanical universe, the first planetarium.

Findings of the wreck (statuettes and conical weights) combined with ancient texts, lead us to a working hypothesis that perhaps the mechanism was at a weight and float and might have read in automatically as texts describing clock of Archimedes or as medieval clocks.

Of particular importance is the discovery that the motion of the Moon follows to a good approximation Kepler's second law, and perhaps even all three laws of Kepler, discovery completes initial study five years ago. The motion of the Moon is very realistic using a train of 4 gears, two of them linked with an elliptical bond (pin in an elliptical slot) and the trajectory and velocity of the Moon probably follows the three laws of Kepler.

The Mechanism probably had a system for planets with planetary gears, as we read in the manual and in ancient texts describing similar mechanisms.

All technical achievements of today are based on the Antikythera Mechanism.

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***The Antikythera Mechanism: the signature of Archimedes on the eclipses, operation of the instrument, planetary pointers and Kepler before Kepler? (10 minutes)***

**Moussas Xenophon**

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Session: Astronomy and Philosophy

**ABSTRACT**

We will refer to the latest discoveries recently presented in a book (X Moussas, *Antikythera Mechanism, PINAX, the oldest computer*, published by the Hellenic Physical Society, Athens 2011 and 2<sup>nd</sup> ed. 2012).

The Antikythera Mechanism is the earliest known scientific instrument, the first computer and the oldest mechanical universe. Built by Greek scientists, probably between 150 and 100 BC and as demonstrated by our analysis is made with measurements taken by Archimedes and his students who continued after the murder of the greatest of all Mathematicians, who as implied by our results, was a physicist and astronomer.

The instrument is an exact dedicated astronomical complex analog computer that works with carefully designed and manufactured gears with very small teeth. The gears perform appropriate mathematical operations as they move around the axes and shafts. The movement of the pinion moves indicators that give the position of various heavenly bodies, the Sun, the Moon and possibly the planets. We shall also show that it is possible that this mechanism had a movement with weights (similar to the ones made of lead, found in the ship wreck) and float (buoy) which resemble those of Archimedes clock. We suggest that he Mechanism was probably an astronomical clock and not just a dedicated astronomical computer. It shows several similarities with the most advanced astronomical clocks of middle ages.

Five years ago we discovered that the Lunar trajectory followed in the mechanism to a good approximation Kepler's second law. Of particular importance is the recent discovery that the motion of the moon, as it is evident by a link between two eccentric gears gives more precise orbit than initially thought, probably following three laws of Kepler.

We will answer important questions such as who made it, and if the mechanism had forefathers? What is the likely name of the Mechanism in antiquity, probable uses and why we do not have other examples of similar mechanisms.

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## **Greek Roots of Astrophysics (10 minutes)**

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Session: Theory and Methodology of Archaeoastronomy

## **ABSTRACT**

Modern Astrophysics (see review by Kim Melville) started at the second half of the 19th century. In reality early astrophysics is the root of all philosophy and science and goes back at the first Ionian Philosophers, the Physicists and pre-Socratic philosopher (Physikoi Philosophoi) starting at the 7th Century b.C. Astrophysics and Physics that emergent fro

Astrophysics and Astronomy are very important component of present day civilization. The beginning of reason and scientific thought is associated with astronomy and it started at the time of pre-Socratic philosophy.

Since the dawn of humanity, humans observe the sky and try to understand the cosmic environment. This is the beginning of reasoning that is closely related with astronomy that eventually led to the creation of civilization. Humans develop Mathematics and Physics for astronomy and to keep calendars. They develop reasoning. Humans study the trajectories of celestial bodies and try to reproduce them with mathematics. At the same time they study the nature of celestial bodies and the cosmos.

The study of the Cosmos becomes significant social component. Astronomy is in human nature in many ways. According to a popular etymology the word *Anthropos* [ΑΝΘΡΩΠΟΣ], human in Greek, means the one that looks up, the one that observes the sky, and this make us different than the rest of the animals. Humans, unlike other living creatures look up and not down, as animals do to collect their food. Of course there are some birds that we know that they find their way using the position of some stars at night, but this is outside the scope of this article. Humans observing the universe discover the harmony of the motions of celestial bodies. Night after night they observe the circular motion of stars “around” them, around the Earth. They observe the repetition of movements of the stars, the reappearance of the Moon, they set the length of time that we call month, they observe the changing position of sunrise and sunset during the year and the very important change of the altitude of the Sun over the horizon during the year.

They understand that there are laws of Nature. In the Orphic Hymns we read: I call the celestial law, the star positioning, which sets order to the stars. Thales (624-546 BC) is probably the first to use scientific reasoning to explain nature. He was a mathematician, astronomer, engineer and meteorologist. Thales establishes Theoretical Geometry with Theorems and proofs. Pythagoras of Samos (570-500 BC) gives theoretical proof of the Pythagorean Theorem and systematically studies the numbers. Of great importance is the fact that he performs some systematic experiments with measurements and understands that the Universe and everything in Nature has to be described in numbers. Heraclitus (6th-5th CBC) proposes that matter is made of four elements: fire, air, water, earth. All substances come from these simple bodies that he terms elements. Introduced dialectics, causality, humans are responsible for their fate. Anaxagoras (500/488-428 BC) understands that celestial bodies are not gods but are made of matter. He comes to Athens from Ionia (Asia Minor, Aegean coast) and establishes a school (University). This changes drastically the course of Philosophy, as he puts the seeds of philosophy in Athens. His most important pupil was the great statesman Pericles who changes completely Athens to a very important city-state with Acropolis and the Parthenon. Anaxagoras School in Athens puts the foundations to the Academy of Plato and Lyceum of Aristotle and establishes Philosophy, as we know it. Anaximander (610-545 BC) introduced the term Principle, constructed the first map of the

Earth, solar clocks, introduced the first theory of evolution of species, life comes from the water, where some worms developed first, humans come from a kind of shark that has fetus similar to human. Measured the change of the inclination of solar altitude during the year (solstices, equinoxes). Anaximenes (585-525 BC) introduced a mechanical model for the Universe. Defines stars and planets as different celestial objects. He also studies the cycle of water (evaporation, clouds, rain, snow, rainbow).

Leucippus (b. 480 BC) and later his student Democritus (460.-370.BC) established causality. They established the atomic theory for the matter. Matter is made of atoms, the smallest possible particles that cannot be divided further. Leucippus (and Democritus) atoms are what today physicists call elementary particles that make matter and not what we call today atoms. The Universe is made of a large vortex of atoms. The heaviest atoms go to the center; The Universe is made of matter that is initially in fluid form. Matter heats up due to the fast rotation. Stars are made of this hot matter. Earth is made of fast rotating atoms that form a vortex. The stars are made of fast rotating vortices of atoms and become hot as they rotate very fast. The Sun gets additional heat from the stars. There are an infinite number of Cosmoi (Earths or Solar Systems or Universes) and stars in the Universe. They are made of an infinite number of atoms and they are in an infinite space. Vision is caused by images of the objects we see that enter into our eyes through the pupil of the eye. The Galaxy is made of many stars, which we cannot see as we do not see the atoms matter is made of. Worlds (planets and stars) are created and die.

Plato (429-347 BC) is the most important Greek philosopher. Extremely influential to philosophy. He puts provocative, fundamental and profound questions to be answered, following his teacher Socrates. Influenced by Socrates to his methods and by philosopher Cratylus, student of Heraclitus, to his view of the Cosmos. He adopts the Ideas, of Socrates, that preexist and of which real objects are just mere shadows or projections. He believes in the great importance of mathematics in understanding the Universe and in Philosophy too. He writes in the door of his School, the Academy, Do not enter if you do not know mathematics. Plato's elementary particles are triangles. Everything in the Universe is made of them. Combination of these triangles (Plato's elementary particles) give Plato's «chemical elements»: the tetrahedron or pyramid for the fire (made of 24 triangles), the octahedron (made of 48 triangles) for the air, the icosahedrons (made of 120 triangle) for the water and the cube (made of 24 triangles) for the earth. Aristotle, from Macedonia, Greece, the most important student of Plato has been extremely influential for centuries in Christianity as well as in the Muslim world. He has been extremely influential to his most important student, Alexander the Great. He establishes his School in Athens, the Lyceum (which has been excavated recently downtown Athens, Greece). Thousands of students study in the Lyceum.

The influence of the school of Aristotle in Athens is enormous for the entire World, especially

the modern world. Aristotle influences enormously Alexander the Great, Alexander's education is exclusively made by Aristotle who for a long period returns to Macedonia, to King Philipp the 2nd of Macedonia, to exclusively educate his son, Alexander. The new prince gets a proper philosophical education by Aristotle, including mathematics and science and logic. Alexander, pupil of Aristotle, becomes probably the first king that understands the importance of science, not just technology, for military operations and it is said that he had Homer's books continuously with him during all the military campaigns around the then known world. Alexander has with him not only Homer but scientists and philosophers that accompany him not only offering scientific advices, but who gather all important scientific information, collecting new unknown species of plants, astronomical knowledge etc. The Museum and the Library of Alexandria are children of the Lyceum.

The Aristotelian model for the motion of the Stars, the Sun, the Moon and the planets is the one of Eudoxus and Callippus with 59 nested concentric to the Earth spheres. The role of small city-states, democracy and organization of societies as well as the influence of Alexander the Great will be discussed too.

***The Antikythera Mechanism as an educational device to teach modelling and change of paradigm***

**Moussas, Xenophon; Kriaris, Dionysios; Bampasidis, Georgios; Papaspirou, Panagiotis; Filintisis, Panagiotis; Solomonidou, Anezina; Coustenis, Athena; Bitsakis, Yanis; Anastasiou, Magdalini; Efstathiou, Kyriakos; Kakavas, George; †Bouyia, Polyxeni; Fasoulopoulos, Georgios; Kiolooglou, Isidoros; Edmunds, Mike; Zafeiropoulou, Mary; Roumeliotis, Manos; Malzbender, Tom; Ramsey, Andrew; Spandagos, Evangelos; Giannopoulos, Nikos; Dreni, Stella; Porligi, Amalia; Daniels, Eleni; Wright, Michael T.; Sabry, Reem; El-Mikaty, Hoda; Henriksson, Göran; Munktel, Ing-Marie; Vafea, Flora; Koufos, Stratos; Prassopoulos, Dimitrios; Zafiropoulos, Vasili; Karakonstantis, Andreas; Aggeioplasti, Katerina; Delidou, Eleni; Papoulias, Costas; Papoulias, George; Haley, Paul; Tsefalas, Costas; Mimouni, Jamal; Valls-Gabaud, David; Biggs, Matt; Chochol, Drahomir; Szubiakowski, Jacek; Plucinska, Ela; Jacyno, Anna; Pal'uš, Pavel; Jančušková, Danica; Czart, Krystof; Xenakis, Nikos; Gkini, Magda Evgenia; Perpyraki, Eva; Antoniou, Panagiotis Costas Rapatzikos, Sotiris Raptis, Dimitris Gikas, Photini Villioti, [xmoussas@gmail.com](mailto:xmoussas@gmail.com) [xmoussas@phys.uoa.gr](mailto:xmoussas@phys.uoa.gr)**

**ABSTRACT**

The Antikythera Mechanism is the most sophisticated ancient astronomical instrument and analogue and digital calculating machine (bytes are the gears and bits are the teeth) known to the scientific history. It is the most sophisticated device from the ancient Hellenic world constructed somewhere between 150 and 100 B.C.

The Mechanism has enormous educational potential as it attracts children and the general public to science, mathematics, physics, astronomy, technology, philosophy.

It has an enormous interdisciplinary value. It can be used as an educational device, to engage the general public, and especially to attract students to both the exact sciences and to the humanities. Using it we can teach the meaning of causality, the laws of nature, the importance of mathematics, modelling, the meaning and evolution of paradigms.

I had had several exhibitions or contributed to exhibitions: New York (Children Museum of Manhattan), NASA, Italy, Germany, Portugal, Slovenia, UNESCO (Paris, beginning of the International Year of Astronomy, Upsala Gustavianum Museum (the exhibition doubled the number of visitors in the year), Library of Alexandria, Slovakia (Institute of Astronomy of the Slovak Academy), Olsztyn Planetarium (Copernicus observatory in Poland), Budapest, the Greek School of Cairo, the Greek School of Alexandria (Egypt), the Hellenic Foundation in Alexandria (Egypt), Constantine (7eme salon' astronomie, Algeria) and many in Greece (Ionian Center, The University of Athens, University of Patras - permanent, at many schools). The exhibition usually consists of:

- 20 panels (0.7m X 1m) describing the Mechanisms and giving the history of science in Greece,
- two interactive programs with simulations of the Mechanism,
- one or two short movies and
- several interactive 3D photographs of the Mechanism.

That are in

- 4 to 7 computers and
- perhaps a DVD player with large plasma display.

***The traditional ethnographic doll as an expression of celestial relationships in Slavic folk cosmology***

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Session: Educational Aspects of Astronomy

**ABSTRACT**

The main thesis of this paper is the idea of the renewing power of archaic cosmological world picture that are becoming more influential on contemporary cultural world picture. The bases of this thesis are the celestial relationships which take the central place in the Slavic cosmological model.

Slavic folk cosmology is based on the archaeoastronomical model in which the movement of stars and planets is explained by their rotation around the celestial pole (pillar, perch, stick, spindle). The celestial pole ("The Polar Star"), being an "axis of heaven", produces many of subsequent cosmological perspectives expressed in different manifestations of the life of traditional archaic communities. The social and cultural values of the heavenly relationships

are revealed through the interpretation of the cosmological sphere both the same (isomorphic) as and as a mirror of the Earth.

We will substantiate the regenerative power of archaic cosmological ideas through the unexpected effect which can occur when we substitute the indirect cultural meaning of the traditional doll for its direct meaning. When we do this, we find the traditional ethnographic doll is deeply cosmological. Furthermore, it is perhaps the first proper cosmological object of ancient civilizations.

*Stolbushka* (столбушка, pillar-form doll) is the first ancient Slavic model of dolls. This doll, as a part of the "mother culture" of ancient Slavic peoples, originated all other calendar-ritual and playing (sacred and secular) traditional dolls, keeping inherently a pillar and garrot.

Having thus raised the question of the ethnographic doll as a carrier of heavenly relationships in Slavic folk cosmology (as well as in archaic mythical-poetical world pictures of other peoples), we will get an opportunity to consider paleoastronomical and archaeocosmological concepts through the unique object environment of traditional dolls. This application will give us a fine unique educational model – the paleoastronomical ethnographic traditional doll.

## N

### ***Plato as Astronomer (invited)***

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Session: Astronomy and Philosophy

### **ABSTRACT**

The whole structure of the Universe as it appears in Plato's work *Timaeus*, reveals Plato's concrete astronomical and cosmological views which are based on the Presocratic cosmological theories. In many cases Plato uses certain arguments by which he interprets the existing problems of the construction of the whole world.

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### ***Space Exploration, Society and Religion (invited)***

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Session: Research History of Astronomy and Current Issues

### **ABSTRACT**

Space exploration advanced a lot through the last 20-30 years and has really affected the world. The consequences of space exploration occur on many levels: commercial applications, education and inspiration to youth, applications satellites, scientific benefits, and philosophical implications. Ethical problems posed by the utilization of outer space are examined and some important ethical questions raised from the new space activities are mentioned. The case that space science challenges religion and its guidance on how we should behave is also considered.

### ***From Alexandria to Rome: Poetical Astronomy and Female Psychology (invited)***

**El-Nowieemy Magda**

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Session: Astronomy in Europe and the Mediterranean at Historical Times

*Dido, statue from the Louvre, Christophe Cochet († 1634), Before 1634, Department of Sculptures, Richelieu wing, lower ground floor, Cour Marly, Credit line Deposit from the /Dépôt du Fonds national d'art contemporain (FNAC), 2000*



### **ABSTRACT**

It is admittedly acknowledged that ancient Alexandria contributed much knowledge to the field of astronomy, as well as ancient Greece did before. Consequently, the Roman poets of the empire were working within an established tradition of astronomical knowledge. It seems that this tradition was much on the Roman poets' minds that they embedded this sort of knowledge in their poetical production.

In several mythological love stories that were treated by the Roman poets, it is noticeable that at the moments of crisis of female intensified passion, or torment by conflicting emotions, the poet gives a prominent role, in the love story, to stars (their risings and settings) and to other astronomical elements (the first visibility of the new moon, etc..), while portraying the unspoken anguish, the intensity of the suffering, or the frenzy of the woman, who is overcome by obsessive love.

The notion that stars (or other astronomical elements) and female psychology are connected may seem odd to us at first. But the Roman poets' awareness of the advances of the Hellenistic knowledge of astronomy might profitably have been applied to these passages in their poetry.

If we look at the poets' words with attention centered on astronomy, several points stand out concerning the significant psychological sensitivity, which is essential to a fuller understanding of those very passages. This invites the reader to reflect at length on the underlying meaning of the passages of feminine agony.

This paper does not pretend to tackle astronomical theories or planetary phenomena per se. It is an attempt to locate certain correlating ideas in the history of ancient astronomy, not as



astronomy proper, but in the tradition of cosmological speculation. Consequently it is not a strictly scientific treatment of cosmological phenomena. One merit of the present treatment is to raise certain questions: Was the frequentative mention of stars or of any astronomical and cosmological aspects required to depict the heroine's agony, her sleeplessness, and her tragedy in general? Was the appearance of the stars in particular (and astronomical phenomena in general), intended to make the reader engaged in the perception of cosmological reality or to enhance the perception of this reality? Was there in the Roman

poets' conception a connection between the cosmos and the temperament and fate of a female in love? Was it based on philosophical considerations? Or was it a mere poetized vision of astronomy? Was it the poets' perception of the reality of the female soul in its connection to the cosmos? Or was it their perception of the cosmos animated by female soul? My aim in this paper is threefold:

First: To place this design of poetic thought within the Alexandrian tradition that is essential to a fuller understanding of the passages under discussion, on the basis of either familiarity with the topic or competence in the treatment.

Second: To explore the cumulative effects of the physical environment as a site for sustained poetic treatment, above and beyond what we would normally expect from poets.

Third: To cast new light on how we might understand the ideas of the Roman poets in the light of the increasing importance of astrophysics. That is to say how we are experiencing a mythological feminine tragedy in cosmological terms.

*Roman relief from sarcophagus Jason and Medea joining their right hands (dextrarum junctio), a gesture symbolizing marriage. late 2nd century CE., National Museum\_of Rome, Accession number Inv. 8648, Credit line Boncompagni Ludovisi Collection*

# P

## ***The Star-crossed Romance of the Weaving Maid and Ox-herd as Etiological Myth***

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Session: Astronomy and Archaeoastronomy in Near East, Asia, and Oceania

### **ABSTRACT**

The earliest textual reference to the Weaving Maid and Ox-herd occurs in China's earliest literary work, the Book of Odes (ca 800 BCE), where it is already clear that the reference is to two stars. Throughout East Asia everyone is familiar with the moving story of the star-crossed young lovers' painful exile to opposite banks of the Sky River and their annual conjugal visit on the night of the 7th day of the 7th month. There is no controversy about the astral identities of the pair as our Vega ( $\alpha$  Lyr) and Altair ( $\alpha$  Aql). After briefly highlighting the salient astral-temporal facts preserved in the myth, this talk will focus on explaining its original significance as an ancient teaching story about the seasonal stars, which will take us back to the dawn of East Asian civilization.

## ***Ancient Greek astronomers' contribution to accurate time measurements in antiquity***

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Session: Astronomy and Philosophy

### **ABSTRACT**

Humans perceived the fundamental concept of time by observing the periodic motion of celestial bodies, the alternation between day and night and the regular return of the seasons of the year. Significant philosophical theories concerning the origin of time were formulated and many time measurement units were invented. The observation of the movements of specific celestial bodies, such as the Sun and the Moon, contributed to the construction of many astronomical instruments for the purpose of measuring time intervals.

The great astronomer and natural philosopher Claudius Ptolemy in his treatise, *Almagest*, introduced the "first" and "second small parts" as time units for small time intervals, without naming them "minutes" and "seconds". His time calculations derived from the geometric data

of the dimension of space. However, the accuracy of ancient astronomical instruments was not more than 1 minute.

## References

Antonello E., 2013, *Cultural astronomy and archaeoastronomy: an Italian experience*, in *Ancient Cosmologies and Modern Prophets*, Anthropological Notebook, XIX Suppl.

### ***The ancient Greek conical sundial of the National Archaeological Museum of Athens***

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Session: Astronomy and Philosophy

#### **ABSTRACT**

The ancient Greek sundial described in this work is part of the Prehistoric and Classical Antiquities collection of the National Archaeological Museum of Athens with index catalog No. 3158. The sundial, which was recovered from the ruins of the ancient Dionysus Theater nearby Acropolis, is a marble construction of conical type with a gnomon. On the dial surface a few points of obvious damage can be observed.

The geometrical dimensions of this sundial are elaborately measured and calculations of its characteristic parameters, such as the angle formed between the cone's axis and the generatrix, the gnomon's length and the geographical latitude of operation, have been made.

### ***Homeric Lycabas (the sunlight is gone), the Apollo's Celebration and the New Moon after the Autumn Equinox (invited)***

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Session: Astronomy and Philosophy

#### **ABSTRACT**

Odysseus' re-appearance in Ithaca and the suitors' killing day coincides with three events: a) an Apollo's celebration with a Hecatomb b) characterization of this period or day as Lycabas

(the sunlight is gone) c) a New Moon's occurrence which is related with the first day of a lunar month. It seems that there is a connection between Lycabas and god Apollo which is characterized as Lycius via the common root Lyc=sunlight. The solar god Apollo was, among others, the expression of the solar energy. The Apollo's Hecatomb and its relation to the New Moon is reminiscent of the New Year's celebration in various calendars. Lycabas, the sunlight is gone, or on a theological basis the god Apollo's departure is explained well with the decrease of the daylight after the autumn equinox until the winter solstice (three months of Apollo's absence to the Hyperborean land). The latter time span is in accordance with the Homeric description of long – lasting nights ('αθέσφατοι') during this period.

In literature, there are two proposed dates for Odysseus' arrival to Ithaca (16th of April 1178 yr B.C. and the 30th of October 1207 yr B.C.) based on Homer's indication of a solar eclipse which occurred during the suitors' killing. Both of them are related to the new moon day after the spring and autumn equinox respectively. However, taking into account Homer's Lycabas (the sun light is gone), the correct corresponding date is only the 30th of October 1207 yr B.C. The latter was the first new moon after the autumn equinox (4 October).

We note that there are calendars with a New Year celebration related with autumn equinox, in various Hellenic cities. Also, the Celtic calendar includes the celebration of the departure of the long-lasting night named 'Halloween' (the analog of the Homeric Lycabas-the departure of daylight) which is celebrated until today on the 30th of October.

### ***Origins of Kepler's Thought***

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Session: Astronomy in Europe and the Mediterranean at Historical Times

### **ABSTRACT**

One of the greatest scientists of all times, the Giant of Astronomy Johannes Kepler, is famous for the statement of his three Laws of planetary motion. We examine the origins of Kepler's thought, in their religious, philosophical, physical, astronomical, and mathematical aspects. Kepler's conception of the Universe is strongly influenced by the mystic Christianic Neoplatonic tradition, especially by the idiosyncratic views of Nicholas of Cusa, by the Heliocentrism and the heliocentric heliostatic astronomical Paradigm of Nicholas Copernicus, a follower of the heliocentric doctrine, as firstly fully scientifically articulated within the work of Aristarchus of Samos and Seleucus of Seleucia, and by the great mathematical achievements of Archimedes of Syracuse, especially the calculation of volumes and surfaces, as presented for example in his treatise *On the Quadrature of the Parabola*, and of Apollonius of Perga, especially by his ingenious treatise *Conics*. Kepler, on the begin of his conquest

towards unraveling the true laws of motion of the planets within a heliocentric Cosmos, is also faced with the rival geocentric and geostatic Ptolemaic astronomical Paradigm, firstly exposed rigorously by Ptolemy of Alexandria in his famous *Mathematical Syntaxis*, and by the hybrid geocentric – heliocentric model of Tycho Brahe. We remark that all main elements of Kepler's thought trace back their origin within the framework and the Zeitgeist of the Hellenistic period of Science and Philosophy, a space of discourse where the mathematically structured Cosmos of Plato, the philosophical insights and the physical doctrines of Proclus and Plotinus, the astronomical achievements of Hipparchus of Rhodes and Claudius Ptolemy of Alexandria, of Aristarchus of Samos and Seleucus of Seleucia, the mathematical groundbreaking achievements of Archimedes of Syracuse and Apollonius of Perga, meet and cross-fertilize, within a unique combination. Within Kepler's thought we immediately recognize the Sacred Platonic Geometry, with its Symmetries, Analogies and Harmonies, the presentation of the Platonic solids and the, of Pythagorean origin, doctrine of the Harmony of the Spheres, combined with the heliocentric vision of Cosmos. We conclude our journey within Kepler's world of ideas by showing both his Hellenistic roots, but also the unique transformation of these, resulting to one of the greatest breakthroughs within the History and Heritage of Astronomy.

### ***Kepler's Harmonic Law***

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Session: Astronomy in Europe and the Mediterranean at Historical Times

### **ABSTRACT**

We investigate the origins of Kepler's Harmonic Law, or his third Law of the motion of the planets within the context of a heliocentric Universe. We propose that Kepler's investigation originated by his firm belief in the Pythagorean – Platonic doctrine of the Harmony of the Spheres, rooted in Kepler's mystic Christian Neoplatonic vision of the ordered Universe, the Cosmos. Kepler's Harmonic Law appears in his last great astronomical work, titled as *Harmonices Mundi*, within a passage serving as a corollary in his construction of a cosmic polyphonic Cantata, the Harmonies produced by the collective and harmonious motion of the Planets. Kepler's Universe constitutes an organic Whole, hierarchically structured, with all of its parts interacting with each other, and composing an overall Symmetry, both spatial and temporal. This Universe, at the era before the publication of his *Harmonices Mundi*, obeyed his first two Laws of planetary motion, thus Kepler feels compelled to search for another relation between the elements of the orbits of the planets, a relation which would express the collective polyphonic, noetically conceived, Song of the planets, an Idea within the Nous of

the Demiourge of Cosmos. Kepler uses the Harmony of the Spheres as a starting point within his investigation, and further, as a unifying variational principle which governs the physical structure of the Universe, by extending the Pythagorean harmonies produced by the Pythagorean scale, to the scale proposed by Giosseffo Zarlino, that is the Ptolemaic intense musical scale, achieving to construct the harmonies produced by the motion of the sole planets, but also the harmony produced by their collective motion within the Universe. Kepler's way of perceiving the Universe traces back to the Heritage of the Hellenistic period, and particularly, in the philosophical school of the Neoplatonic tradition and the Hellenistic Astronomy, Cosmology, and Mathematics, but also the Hellenistic Theory of Music. At the same time, Kepler expands the limits of this rigid and consistent framework even further, towards new horizons. We propose that Kepler stated his third Law on his struggle to unravel the Cosmic harmony produced by the motion of the planets, perceived as a whole, as expressed within the doctrine of the celestial Harmony.

***Astronomy and the Ultimate Culture: Cosmological Arguments in philosophy, religion and science.***

**Peerally Abed**

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Session: Research History of Astronomy and Current Issues

**ABSTRACT**

Humans have reflected on the identity and origin of our universe since the Magic Cosmology of the Neolithic Period of 20,000\_100,000 years ago. Its basis was the use of prayers and sacrifice to appease the adverse forces of nature. Next followed the birth of some form of cultural cosmology (20,000-5,000 years ago) in which there was interest to invoke supernatural beings as being behind existence and the world. This was Mythical Cosmology. In more recent periods we saw the emergence of civilisations like the Egyptian, Greek, Roman, Chinese and Indian Civilisations, amongst others, which engaged in various ways to understand the position of humans and of the world in the cosmos. The last two millennia saw the progress of more modern civilisations in Asia and Europe leading to the further empowerment of philosophy, religions and of astronomy and science. The astronomical discoveries of the last few centuries have created a lot of philosophical and scientific reflections on the realities of the universe. However recent decades have been quite widely infused with scientific concepts, often outside the bounds of experimental verification, which have made our notions of what is matter and existence more elusive to unfold thereby digging the gaps between philosophy, religion and science even more. The purpose of the present paper, its antecedents and those to follow, is to attempt to reverse this trend. It will be shown that science can explain in an objective manner what the universe and existence stand for thus bringing philosophy, science and religious thoughts closer together.

In this article the term Cosmological Argument is given a new definition: any argument which attempts to explain how the universe or the cosmos originated. In the traditional understanding of cosmological arguments it was restricted to views which attempted to link the origin of the cosmos to some divine intervention. Naturally that gave rise to those who are in favour, (theists) and those who are against (atheists) these arguments often passionately. Clearly such a unilateral approach limits the scope of cosmological arguments to an act of God, and one good reason why this should not be so is that the priority of science is to basically know how come we have a universe and not something else, irrespective of whether it was a divine act or not. When discussing the possible origin of the cosmos from the scientific angle there will be no assumption of a divine will. Readers will need to make their own judgements on where the argument swings.

Why an Ultimate Culture is a possible phenomenon is that there is a point of view that science, religion and philosophy ultimately look for interpretations and explanations for the same fundamental realities of the universe and of humans. We need to know whether the finely tuned and orchestrated manner the universe originated was some kind of masterminding as seen in Einstein's wish to understand the mind of God when the universe was created, or just a statistical accident as claimed by some more recent cosmologists. Arguments about the origin of the cosmos cover philosophical, theological to scientific arguments. Generally they were based on the idea of contingency to highly complicated concepts which theorize the existence of infinite universes of which our universe just luckily got all the qualities needed to produce energy, matter and life. However certain concepts like the very successful Big Bang Theory was scientifically very attractive as it was a direct emanation from Einstein's General Relativity, for if the universe is continually expanding, it must have been a tiny corpuscle of dense energy at some point in the past when it was created. The implication of creation in this concept alienated some scientists like Fred Hoyle who tried to circumvent the notion of a time of origin by bringing in a concept of an eternal continuously denser and expanding universe as time passes. However we yet have to see a new way of understanding the cosmos, which would be based on both circumstantial evidence at least to start with and eventually supported with experimental evidence that would allow philosophers, theologians and scientists to comfortably harmonize their interpretations and explanations of what humans and the cosmos represent in reality.

The ultimate solution humans agonizingly seek through Astronomy, as the universal arbiter of our realities, is an answer about our identity and position in the Cosmos based on a coherent, harmonious and mutually acceptable format.

### ***Sun's Observation, Nile River and Mathematics: Dawn of civilization***

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Session : Astronomy and Archaeoastronomy in Africa

## ABSTRACT

The meticulous observation of the Sun was, surely, one of the first astronomical practices in the ancient world, specifically, in Egypt. We can say with Calvino (2005) that since the moment when man recognized himself as a gnomon, he became aware by observing his shadow of the movement of the Sun. Then, his annual movement to the north and to the south was one of the tasks of the astronomer as Harkhebi left written (Bresciani, 2000). Nile River, on the other hand, was for Egyptians the origin of food and commerce through yearly inundations (Larry, 2010); with an additional fact: the Egyptian part goes from Aswan (Latitude 24° N and Tropic of Cancer in the antiquity) to the Mediterranean Sea (Latitude 31° N) through an almost constant longitude path (30.5° - 33.1° E). How did those things combined to bring up Egyptian mathematics based on unit fractions? A hypothesis about the possible astronomical origin of this mathematics is presented. Extending the idea of D. Magdolen on the solar origin of “sacred triangle” (2001) and with the use of *platonian gnomonic factor (fgp)* (Perez-Enriquez, 2000, 2013), a concept that could have been used by ancient cultures, the gnomonic origin of unit fraction mathematics is proposed. An identification of the cities of the early Egypt is done, suggesting that most of their locations and orientations of their main buildings (pyramids and necropolis) were obtained via the use of a method based on a gnomon and its shadows at Winter Solstice and other special dates along the year (when the Sun had an elevation of 45°); confirming the role of astronomical orientation reported by Belmonte (2012). Unit fractions Mathematics, gnomonic Sun observation and Nile River were the pillars of this important culture at the dawn of civilization.

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### **Plato's Triangle and gnomonic factor: an application to Herodotus' oracles (invited)**

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Session: Theory and Methodology of Archaeoastronomy

#### **ABSTRACT**

A modification to the *gnomonic factor* (**fg**) (Perez-Enriquez 2000) using the concept of *triangle of Plato* (introduced to us by Xenophon Moussas (*pers. comm.*) is presented. With the aid of the *platonian gnomonic factor* (**fgp**) as we called it, we find that the oracles mentioned by Herodotus in his *History* (Dodona in Greece and Ammon in Oasis Siwa, Libya) were placed there because the noon shadow of Sun of a vertical gnomon formed, back in 2000BC, the triangle of Plato the former, and the Egyptian "sacred triangle" (sides 3:4:5) the latter; sites where the value of **fgp** is equal to 1 and 1/3, respectively. This means that both concepts were known by Egyptians from Thebes long before they were formalized by the Greeks. The priestesses about whom Herodotus talks knew the right angled triangle concept as an idealization of Sun's observation and as it was proposed by D. Magdolen (2001); i. e. the triangle is the shadow cast by a gnomon. We propose that there must be cities along the Valley of Nile having other unit fraction values for the **fgp** (Perez-Enriquez 2013).

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Perez-Enriquez R. *Sun's Observation, Nile River and Unit Fraction Mathematics*. (to be presented at SEAC's Conference 2013)

***Astronomy, Metrics, and Proportionality in the Iberian necropolis of Tútugi (Galera, Granada, Spain)***

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Session: European Prehistory, Folklore and Archaeoastronomy

**ABSTRACT**

The necropolis of Tútugi (Galera, Granada Province, Spain) has been known archaeologically since 1920, but the state of neglect and abandonment of the site was notable, without undergoing any archeological activity. Recent action taken since the year 2000 has enabled not only the recovery of the necropolis for its evaluation, but also the archaeological data collected have served to make a new reading of its structure and articulation within the general framework of the Iberian societies of the south-eastern Iberian Peninsula.

The research performed on a sample of 16 burial chambers have been characterized metrically and geometrically, as well as in terms of noteworthy astronomical orientation. Furthermore, information compiled from the excavation records of Cabré and Motos (1920) regarding the necropolis, satisfactorily coincide with our current results.

The first important result in the metric study was the use of a measured pattern (the Tútugi foot) in all the monumental tombs of the necropolis, a pattern which we estimate at 0.294 m.

Also, the study classified the proportions into three typologies: the golden ratio, the Cordovan proportion, and the one-to-one proportion. The first two proportions were found only in a concrete zone (Zone I), which contained the largest and oldest graves, belonging to the founders of the lineage and the subordinates of that lineage.

In addition, and as the most important result, all the burials were oriented astronomically, without topographical orientations of interest. In these orientations, we found the recurrence of certain stars and constellations which present a scheme that we must interpret, though with scant data available on the religion and beliefs of the afterlife of the Iberian people, and all linked to Phoenician and Mesopotamian cosmogonies.

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### ***Rock caves and large rock piles in Azores islands – a possible solar ritual association? (invited)***

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Session : European Prehistory, Folklore and Archaeoastronomy

## **ABSTRACT**

In Terceira Island, Azores, a group of 4 caves cut in the rock may have been used in a ritual associated with the equinoctial setting sun. Particularly one of the caves show a set of 4 basins illuminated by the setting sun in successive months between equinox and summer solstice.

In Pico Island, Azores, a monumental landscape dominated by over 100 large rock piles, with stepped pyramidal shapes, some with corridor and chamber, present an orientation of the major axis roughly in the direction of the summer solstice sunset, behind nearby Faial Island - winter solstice sunrise, behind the slope of the volcanic peak of the Island, or the orthogonal direction.

We will present a preliminary study of their orientations and the first results of the recent excavations, including the laboratory dating of some of the findings.

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## ***A new Phaestos calendar or Saros cycle?***

**Pliakos Alexios**

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Session: European Prehistory, Folklore and Archaeoastronomy

## **ABSTRACT**

Pernier (1903) unearthed the above table of the 1st Palace of Phaestos and it is of ("epoca di Kamares" i.e. 2000-1700 BCE). Dussaud (1914) dates it on the MM I era. The so called Phaestos libation table is rectangular 55cm x 45cm and its perimeter is meticulously decorated by reverse S's and pictures of Bulls. At the eastern side of the table are 8 S's and 9 Bulls, at the southern side there are 21 S's, 6 Bulls and 7 S's, at the western side there are 25 S's and at the northern side there are 33 S's. Three of the four corners are decorated with 3 Bulls.

Whoever If a scholar tries to solve this riddle he must answer the following questions.

- 1) If this is a libation table, what was the need for this rare decoration?
- 2) Are the S's and the Bulls counted as equal units? Why is so?
- 3) Can a beginning for counting the S's and the Bulls be defined? And on what arguments do we have to base it on?
- 4) Are the reverse S's and the Bulls symbols of something?
- 5) What is the value of the 3 Bulls on the three corners of the artifact?
- 6) Why are the two bulls heading anticlockwise and the one who advances clockwise?
- 7) Why are the two groups of bulls facing at opposite directions?

I can answer the above questions and the one on the title.

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***Minoan prehistoric solar calendars carved in stones, the riddle of kernoi.*****Pliakos Alexios***Pliakos Foreign Language School, Argyroupoli, GR16451, Athens, Greece*

Session: European Prehistory, Folklore and Archaeoastronomy

**ABSTRACT**

Introducing the subject it is reasonable for me to give you the definitions of the key words which are in the core of the paper. A *kernos* (plural *kernoi*) is a pottery ring or stone tray in which several small cups for holding offerings are carved. A *calendar* is a managing time system by which the beginning, length, and division of a time period (e.g. the civil year) are fixed and by which days and longer divisions of time (weeks, months, and years) are arranged in a definite order Webster's Dictionary (1961). In his Ph. D. Thesis N. Hillbom (2005) presented a list of 167 Minoan kernoi which I have thoroughly studied and concluded that at least 80 of them may be either lunar, lunisolar or solar calendars Pliakos (2013). In this paper a Minoan solar year calendar will be presented and analyzed. The approach to this calendar will be made step by step, starting from the 9-day Minoan "week" to the 4-"week" Minoan "month", and finally reaching the 360-day Minoan solar year. I reckon that the 5 days left out of the 365 days were distributed as follows: 3 days at the beginning of the year and 2 days in the middle of it, as celebration days. Archaeoastronomers Blomberg & Henriksson (2011) assumed that the beginning of the Minoan year was on the autumn equinox (21<sup>st</sup> September). I consider the 22<sup>nd</sup> of September being the beginning of the Minoan solar year, the length of which is 365 days and its division is 10 Minoan "months" of 36 days each, plus 5 days.

Kernos, at Kommos Phaestos.

One kernos of 9 cups was unearthed by the archaeologist Whittaker (1966), at Kommos, and this may be used as a 9-day Minoan "week" calendar. (See illustration above).

One other kernos of 9 big cups (9 days) in a parallel-line configuration of 4+2+3 cups was unearthed by the archaeologist Hood (1995), at the Queen's Megaron, Knossos. On the surface of this kernos there were also 4 small cups (4 weeks) in a diamond configuration.

Queen's Megaron kernos 1.

The combination of 4 "weeks" multiplied by 9-days per "week" counts, 36 days i.e. one Minoan "month".

Queen's Megaron kernos 2.

Very close to the above-mentioned spot a slab-kernos was unearthed by Sir A. Evans with 5 cups on the right side and 2 groups of cups diagonally opposite each other. Five cups on

the left side of this kernos were missing and were reconstructed by him (1904), as shown above. According to Evans the kernos bears diagonally two groups of double cups but as everyone can clearly see these are groups of 3 and 2 cups.

The full interpretation of the three kernoi comprising ONE SOLAR CALENDAR will be given more thoroughly at a full presentation. However, the ultimate conclusion is that the 10-month Minoan solar calendar (10-month of 36 days each) was developed locally as no other civilization of the time developed such a solar calendar.

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## ***Comparative study of an Aegean and two Knossian kernoi, as lunisolar calendars.***

**Pliakos Alexios**

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Session: European Prehistory, Folklore and Archaeoastronomy

## **ABSTRACT**

The kernoi have been explained as “pavement games”, Sir Evans (1930) or “games like draughts or roulette”, Boyd (1900) or “libation tables”, Chapouthier (1928). Thus the scholars have not agreed on the subject yet. I propose and I will prove that a lot of the kernoi can be interpreted as calendars. The known calendars are the lunar, the lunisolar and the solar ones. In the lunisolar calendar an integer number of lunar months of 29.5 days is equal to an integer number of solar years i.e. in the 8-year lunisolar calendar 99 lunar months (or 2922 days) are equal to 8 solar years (or 2922 days). In the proposed article a comparative study of three lunisolar calendars is presented: an Aegean (2800-2300 BCE), from Cyclades Renfrew (1972) and two Knossian, the first of MM I era (2100-1900 BCE) and the second of MM I-II era (1900-1700 BCE), both unearthed from the Juktas Peak Sanctuary by Karetsou (2012) and explained by Pliakos (2013). The Aegean lunisolar calendar is the oldest of its type that I know of, and the ingenuity of its creator will be proved exceptional in the presentation!

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### ***Is a degenerated Ashtoreth plaque a lunisolar calendar? (10 minutes)***

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Session: Astronomy and Archaeoastronomy in Near East, Asia, and Oceania

#### **ABSTRACT**

R.A.S. Macalister (1907-1909) unearthed at Gezer a degenerated plaque of the middle-eastern goddess Ashtoreth of the Zidonians and the Phoenicians and he depicted it at his work. The artifact is  $\frac{3}{4}$ " thick and it consists of two circular discs of 2" and 3" diameters correspondingly joined together like a "head" and a "body" (without feet). On the "head" there are less than 10 small holes and on the "body" there are two central parallels of 10 and 10 small holes in straight lines opposite each other. In the periphery of the two sides of the "body" are about 20 (?) and 20 (?) such holes forming two mixed-curve lines. The artifact is of the 1400-1100 BCE period according to Macalister. It is worthwhile observing that usually every 5<sup>th</sup> small hole in the artifact is surrounded by a small circular spot of darker red. The previous observation complies with local calendars of that period Britannica on line, Θεοδοσίου (1995), and Pliakos (2008). The Ashtoreth finding reassures that the Babylonian and the middle-eastern lunisolar calendars do not have a standard rule of "intercalating" (i.e. adding a 30-day period when it is needed), Britannica on line. This process of "intercalation" was devised by the Greeks, Krupp (1991) and it is a way to bring the moon back in step with the sun.

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***The astronomical phenomena as a ground for a mythological sacral image of Prince Vseslav the Magician (Sorcerer) of Polotsk***

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Session: European Prehistory, Folklore and Archaeoastronomy

**ABSTRACT**

Prince Vseslav Brjachislavovich of Polotsk nicknamed the Magician (nearby 1029 – 1101), occupied for a long time a throne of the Polotsk principedom in the north of modern Belarus. He even became for a short time (1068 – 1069) the Grand Prince in Kiev during his saturated political biography. The first mention in 1067 about the town of Minsk, modern capital of Belarus, at the description of bloody battle on the banks of the river Nemiga also is connected with the name of Vseslav.

Prince Vseslav and his activity presented in various historical and epic sources. Biography in details described by annals "Primary Chronicle", a lot of mentions were in the well-known literary work "Tale of Prince Igor's Campaign", and also in the *bylina's* – epic epos. Combination of these sources gives the chance not only to restore the historical biography of Vseslav, but also the mythological plots connected with him.

In spite of the fact that Prince Vseslav was baptised and was a ruler of the Christian principedom, he built the well-known church of Holy Wisdom (Sofia) in Polotsk, nevertheless all sources knew his nickname the Magician (Sorcerer) and described many pagan motives connected with him. Meanwhile the epic epos clearly represents his as the powerful hero, the sorcerer and the *volkolak* – werewolf.

It is important characteristic feature that the image of Prince Vseslav is often connected with the astronomical phenomena. The Primary Chronicle most frequently correlated Vseslav with numerous "heavenly signs" which foretold troubles. Epos also constantly mentioned the mythological and cosmological events in connection with Vseslav's activity.

Under 1028 the Primary Chronicle tells about occurrence in the sky of the big *zmej*-dragon. The next year Prince Vseslav the Magician was born. The scholars describe that phenomenon as polar light or as comet's tail. But well-known Slavic mythological belief about flying on the sky *zmej*-dragon could be evident. The *bylina* directly explains Vseslav's birth from a *zmej*-dragon and speaks nothing about his real father. In Slavic paganism certain flying *zmej*-dragons turned into men's body and live with women in human society. In one old

Belarusian legend such sleeping *tszmok*—dragon was killed from a cloud by the god *Perun* (Belar. thunder).

In 1063 the Primary Chronicle mentioned that the waters of the river Volkhov in the town of Novgorod have begun to flow in the opposite direction, and after a while Prince Vseslav has grasped and burned Novgorod.

In 1065 prince Vseslav begun a war and the occurrence of a bright red star have preceded before. The chronicler considers that it has predetermined exclusively bloody result of that war. He compared events and the astronomical phenomenon to similar terrible events during the rule of the king Antiochus in Jerusalem.

In 1065 the Primary Chronicle also described a solar eclipse when the Sun didn't shine almost and its form was in common with a young crescent. The chronicler wrote that pagans spoke: «the sun was bit of a piece». The Slavs believed that the *volkolak's*—werewolves are able to do in this way. The epos described Vseslav the Magician as *volkolak*—werewolf who in an image of a wolf ran out at night from Kiev, ran across a way of the god Hors – Sun, at last has left Kiev as wolf from enemies.

In 1091 in Polotsk *navii's* – spirits of dead – killed many townspeople during Vseslav the Magician's rule. The big circle shone in the sky preceded that event. The chronicler compared that with the events in Constantinople during the rule of the Emperor Justinian.

It is known that the chronicler commits errors at the mentions of the astronomical phenomena, especially in the cases which correlate to historical events. It seems that those events and astronomical phenomena in people's mind were connected, even if they didn't correspond chronologically. The astronomical phenomena became a part of mythology.

## R

### ***Digging the archives: the orientation of Greek temples and their diagonals. (invited)***

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Session: Theory and Methodology of Archaeoastronomy

#### **ABSTRACT**

Archaeological plans of much more than hundred Greek temples have been put under observation with the intent of checking the displacement of the orientation of their diagonal from the cardinal directions (see e.g. Ranieri, 2011). Plans as old as end of nineteenth century to about half of the twentieth century have been searched in the archives from

archaeological journals and books, nova days more and more available on line on the web. Contrary to what normally thought by the archaeoastronomers, the indication of the N-S orientation with a arrow is often put with great care on the plans, arriving at drawing both a magnetic north arrow and an astronomical north arrow with the indication of the date to which the magnetic deviation is related. When considered sufficiently reliable, the plans were imported in Computer Aided Drawing software; the orientations of the diagonals were measured and an estimate of the uncertainty was deduced. Excluding temples with unequivocally cardinally oriented main-axis, the results show that about 70% appear to have their diagonal cardinally oriented within a standard deviation of less than about  $\pm 5^\circ$ . For the remaining 30% the cardinal orientation can be attributed to the direction of the diagonals of the half of the rectangular base of the temple, within the same uncertainty. Only a very small percentage escape from this, often attributable to the poor reliability of the plan. Possible meaning is briefly discussed.

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## ***The Educational Activities of the Salamis Astronomy & Space Society (in Greek)***

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Session: Educational Aspects of Astronomy

## **ABSTRACT**

We present the Educational activities of the Salamis Astronomy and Space Society. The Astronomy and Space Society of Greece is based in Volos. The Salamis annex was founded in June 2011 by a group of amateur astronomers of Salamis for the Promotion and Popularization of Science of Astronomy through the following objectives.

1. We organize Courses of Popular Astronomy in collaboration with municipalities of Salamis, with schools and other organizations.
2. We organize Astronights, with astronomical observations with several telescopes in rural dark areas all of the Salamis island and related astronomical talks.
3. We organize pupil and student competition with appropriate awards.
4. We organize visits at astronomical observatories.
5. We organize lectures by eminent scientists.
6. We are organizing the construction of a Municipal Observatory at Salamis.

***The Cosmic Deep Blue: The significance of the celestial water world sphere across cultures (invited)***

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Session: Astronomy and Philosophy

**ABSTRACT**

The aquatic world plays a most essential part in human ecosystems. Water is everywhere, above, on and below the ground. It rains down from the sky and pours up from the caves, flowing in rivers and filling lakes or giant seas. The wet element constitutes a cosmic sphere, which surrounds and intersperses the otherwise dry world. On Earth it provides the fertilizing, vital basis for life. Devastating giant flooding, especially a tsunami, however, was experienced as destructive and fatal for culture.

Archaic people identified the realm of the water world as the primeval and lasting cosmic ocean, out of which the respective land surfaces ("the Earth"), but also celestial bodies emerged, and in which they both swim as the first "aquatics". It isn't surprising that the prototypes of water animals and plants had been considered to be inhabitants of the cosmic water world, having counterparts in the seas, the lakes, rivers, and in groundwater shown up in caves or wells. People identified some of these, represented by different species, with the moon, single stars and asterisms, open star clusters, zodiacal star patterns, shooting stars, and the Milky Way. Still today the IAU's fixed scope of 88 constellations consists of several real aquatics or fantastic chimeras, coming mostly from older times, but also from the early modern period. The celestial fauna of other cultures worldwide contains shells, cephalopods, crustaceans, fish, amphibians, reptiles, mammals and especially undefined "sea monsters". Examples for the cosmic symbolism of aquatic plants are the water lily and the lotus, which often are closely connected to the world axis.

The chronobiology of aquatics, including eye-catching migrations (e.g. summer or winter salmon), related to specific seasons and weather conditions, was and is still used by man for purposes of time-reckoning and calendars. In addition certain star phases of single stars or open clusters, like the Pleiades, were correlated to the rhythms of water animals. A peculiar example for a unique connection of lunar chronobiological rhythms and time-reckoning is given by the Palolo worm and the calendar of Samoan Islanders. Hunting and exploitation of aquatics followed the course of the moon, certain stars and asterisms. In addition archaic people perceived fishing aids (nets, hooks, spears) in star patterns. The roots of these experiences and practices can be traced back at least into the Upper Palaeolithic.

Some celestial aquatics, e.g. certain fish asterisms, were important as navigation aids for seafaring cultures. Such star and fish based courses are well known from Oceanian people,

for example. Moreover vehicles to cross the waters (boats, ships) and navigation aids are to be found as asterisms.

Finally there are certain special significant topics of archaic cosmovisions relates to the cosmic water world and its inhabitants: In general aquatics are associated with the fertilizing but also destructive power of water, with clouds, rain, the celestial region of the winter solstice, the watery chthonic underworld, a hidden otherworld, and primeval matter. Some of them seem to be rooted in the Upper Palaeolithic time. People had special cosmogonic and cosmological ideas about the giant fish at the middle in the abyss of the cosmic ocean, causing earthquakes and tsunamis; the octopus holding sky and earth together, defining a center and eight cardinal directions; the slayed and split sea monster, from whose body parts the world is made; the monster water animal swallowing the sun every dusk, transporting it through the netherworld, and disgorging it at the new dawn; the creation of the world by a reptile or fish, which angles land up from the ocean's bottom. Finally the combat between a bird (raptor) and a reptile / fish, illustrating the antagonism and polarity of the upper and the lower world (highest and lowest pole of world axis), was an essential topic of archaic cosmovisions worldwide.

Based on selected examples and an integral methodology the talk sums up the main aspects of the topic.

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***Cosmic Dance. Correlations Between Dance and Cosmos-Related Ideas Across Ancient Cultures (invited)***

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Session: Astronomy and Philosophy

**ABSTRACT**

Men's integration into the cosmos is fundamentally shaped by the perception of structured movements: the rotation of the celestial sphere and the various regular paths of celestial bodies. Participating in these cosmic regularities is an objective of human cultures since paleolithic times. Reproducing their structures may serve to participate in their power, to manipulate or to stabilize their effects. Dance as a rhythmic pattern of movement is a cultural expression especially prone to re-enact the structured cosmic movements. Hence, ancient traditions have considered manifold relations between dance and ideas about the cosmos. Not only exist myths which tell of the whole cosmos having been created by the dance of a god. Dances imitated celestial movements like the circling of the celestial sphere around the polar axis and the apparent path of the sun or of the planets; dances reproduced a certain constellation; dances were performed at prominent astronomical dates (e. g. the solstices); celestial bodies, e.g. the Sun, were thought to dance themselves at special occasions and sometimes even to have taught people dancing.

This talk will on the one hand consider the definition of "dance" and the elements which make dance a "cosmic dance". On the other hand it will consider which astronomical phenomena might particularly fuel the idea of a cosmic "dance". Examples from different cultures worldwide will serve as illustrations.

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***Astronomical Iconography in Takamatsu Zuka and Kitora Tumuli: Anomalies in the Adaptation of Astronomical and Cosmological Knowledge in Early Japan (invited)***

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Session : Astronomy and Archaeoastronomy in Near East, Asia, and Oceania

**ABSTRACT**

Two of the more remarkable sites of early Japan that have astronomical iconography are *Takamatsu Zuka* and *Kitora Kofuns*. Located south of the ancient capital of *Fujiwara Kyou* in Asuka, these tombs contain star charts and paintings adapted from China and Korea in what was the first major wave of cultural diffusion of knowledge from the continent in the early centuries of the common era. While the overall layout of the two tombs is similar, the ceiling star charts are quite different. That of *Takamatsu Zuka* is square and includes the 28 *sei shuku* or moon lodges arranged in correspondence to the four animals of cardinal directions. That of *Kitora* is circular and contains all stars visible to an observer of the chart's base latitude.

Description of the sites has been available in Japanese sources and on the author's website, but little has been written about the cultural implication of the astronomical iconography of the tumuli. Following a discussion of the historical, geographical, and cultural context of the two tombs, this paper provides (1) an explanation of the astronomical and cosmological basis of the ceiling star charts and wall paintings, (2) consideration of anomalies and problems related to each tomb's iconography, and (3) a discussion of the implications of the iconography of the tumuli for understanding how astronomical knowledge developed in ancient Japan.

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### **Who is The Mithraic Leonthrocephalic Man?**

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Session: European Prehistory, Folklore and Archaeoastronomy

#### **ABSTRACT**

The modern term 'Mithraism' replaced the terms 'the mysteries of Mithras' or 'the mysteries of Persians' in antiquity. 'Mithras' is the name of the Indo-Iranian god 'Mithra', adopted into Greek. Because of the secret nature of this cult in Roman antiquity, almost no considerable written narratives or theology from the religion survive, but fortunately hundreds of materials related to Mithraism have been preserved. The majority of the research on Roman Mithraism focuses on interpreting the physical evidence, while the definition of Roman Mithraism remains problematic and controversial. Despite the fact that the Romans believed in an Iranian origin for this cult, finding its origins has been one of the controversies among 20th century scholars.

The most important artefact is a repeated bull-slaying scene, which leaves no doubt that this figure conveys the core divine message of the cult. In this scene a man wearing a Phrygian cap (generally accepted as the figure of Mithras) kills a bull. The bull always faces towards the right and the bull slayer turns his head while killing the bull. In the elaborated form, usually a dog, a snake, a cup, and a raven appear in the scene. In this scene a scorpion is attached to the bull's genitals. Two other men wearing Phrygian caps are standing one on each side with crossed legs, and bear torches in different positions. Sometimes a complete zodiac is depicted on top of the scene, and, rarely, a lion is also present sitting in the middle. The majority of the research on Roman Mithraism focuses on interpreting the physical evidence, while the definition of Roman Mithraism remains problematic and controversial. Despite the fact that the Romans believed in an Iranian origin for this cult, finding its origins has been one of the controversies among 20<sup>th</sup> century scholars.



The first surviving record of the name 'Mithra' dates back to 1400 B.C., spelled 'Mi-it-ra', in the inscribed peace treaty between the Hittites and the Hurrian kingdom of Mitanni in Asia minor. In Iranian mythology the god Mithra appears in the Avesta, the sacred texts of Zoroastrianism. The second longest Yasht (a collection of hymns) of the Avesta is named after him and has 146 verses. In this part of the Avesta, which is considered to preserve pre-Zoroastrian myths, Mithra appears to have Varahran (Bahram in modern Persian), a divinity associated with victory, as a companion. Varahran here is described as a boar with iron teeth running in front of Mithra's four-horse chariot, fighting for him.

The first major scholarship on Roman Mithraism was published in 1894–1900 by Franz Cumont. Cumont believed that Roman Mithraism is the "Roman form of Mazdaism", and that the god Mithra came to Rome together with a large representation of the Mazdean pantheon. Cumont's theories remained widely accepted until the first International Congress of Mithraic studies in 1971. In this congress, John Hinnells and R. L. Gordon posed severe criticism of Cumont's theories. Hinnells argued that Cumont's reconstruction of Mithraic iconography is not supported by Iranian texts and is in fact in conflict with known Mazdean theology. Gordon claimed that Cumont forced the available material and evidence to conform to his model of Zoroastrian origins. He suggested that Roman Mithraism was an entirely new religion with no Persian origins. Yet none of these scholars proposed a new model to explain Roman Mithraism. However, after 1971, a few scholars continued to maintain that new theories about Zoroastrianism make some form of transfer from the east to the Roman empire possible.

Michael Speidel, another scholar, associates some of the figures of tauroctony, or Mithras' slaughter of a bull, with figures of the zodiac, and the others to figures on the celestial equator. David Ulansey later suggested Taurus and Scorpius as the equinoctial constellations around the second millennium B.C., but argued that Speidel's model for the equatorial constellations is not convincing. He suggested instead that Mithras corresponds to Perseus, and believed that this concept originated in Asia Minor and developed in Rome as a new cult. Each of these theories suffers from a self-referential hypothetical nature and does not draw an acceptable framework to describe the reason for selecting these constellations, or explain their vital symbolic meaning in Mithraic theology.

The Author presented a paper in SEAC 2012 conference in Ljubljana and demonstrated how the repeated bull slaying scene, known as Tauroctony, is a complicated astrological code that reflects the ancient Iranian Zurvanite concept of the great year divided to six astrological ages in a developed form of Roman representation of the zodiac signs and other constellations. The author also proposed a new constellation represented by the symbol of the swastika as



the geometric celestial pattern in the north ecliptic pole. Based on archaeological evidences, he claimed this symbol to be used in Roman Mithraism as the four-horse chariot of Mithras or the ecliptic pole turned by four celestial horses in the direction of the axial precession. He also demonstrated identical astronomical alignments in Iranian structures called chartai and their contemporaneous Roman counter parts such as Heidentor in the Mithraic archaeological site of Carnuntum in Danube valley and the Arch of Janus in Rome and posed a question about the migration of the astronomical concepts upon which these structures are build.

Among Mithraic artifacts there is another important character that seems to be as important as the figure of Mithras himself. The details and attributes of this mysterious figure is even more complicated than the other figures to interpret and therefore its identity remains highly controversial yet crucial to decoding the mystery. This figure is a naked man with human body, entwined by a snake with lion head, an open mouth giving frightening impression. He usually has four wings, holds one or two keys, and a scepter in his hand. He often has a thunderbolt and the sign of Thor, the thunder god. In some instances he is standing on the cosmic sphere. Scarcely, he is also shown with human head. This figure is restricted to Mithraic iconography and has almost the same importance as the Tauroctony.

Cumont has identified this figure with Iranian Zurvan because of direct symbolic references to the concept of time in this figure and suggests it to be from an Egyptian origin corresponding with the Greek Aion and or Graeco-Phoenician Kronos. Like other interpretations by Cumont this was generally rejected by the new trend of scholars.

The identity of the lion-headed figure of Mithraic iconography was also treated in several of the papers of the first and the second conferences of Mithraic studies in 1971 and 1975. Cumont's view is maintained by Vermaseren but he also calls in Egyptian influence of the Hellenistic Age. A. D. H. Bivar relates the lion-headed figure to the Babylonian gods of death and the underworld, Nergal and Moloch.

Duchesne-Guillemin suggests Both Aion and Ahriman (the Iranian evil) are represented. John Hansman suggests an interpretation in his work and takes Hinnels concept, in which this figure is suggested as a being who presides over the ascent of the planetary ladder by the souls, and introduces the Lion-head god as a possible "divine soul inspired in part by the speculative writings of classical Greek philosophy."

Despite the obvious astronomical symbolism in this figure and its attributes of a time god, finding its meanings and true origins is one of the most controversial problems in Mithraic studies. This figure also shares some elements with the Roman god, Janus. Janus is also a time god, holding keys and a scepter. He is the god of beginnings, transitions, and ends, usually depicted with two heads and also known as quadrifrons or four-headed.

On the other hand, Iranian Mithra always have a companion named Varahran, or Bahram in modern Persian, who is a boar-headed or possibly a lion-headed warrior, fighting for Mithra in front of his celestial four-horse chariot. His weapon is the thunder, and thus is also known as the Iranian thunder god or the god of eternal fires. Indic Mithra is also accompanied Varuna and also has affiliation to Indra, the Indic thunder god.

In this paper the author argues that how this figure borrows symbolic elements from several cultures to demonstrate a uniform concept according to which Mithraist believed in a revolving universe through the ages of time, that is the consequence geocentric observational record of the axial precession. This figure is proposed as the gate keeper of the heavens standing in the ecliptic pole, the point in the sky which believed to be the center of the cosmos or the center of the zodiac around which the cosmos revolves slowly. The souls can ascend on an eight-step ladder representing the seven orbits of the ecliptic and then on the last passages of the firmament to arrive at the gate of Heaven, where the lion-headed god holds the keys.

By finding a common symbolic language among figures of Bahram, Aion, Janus, Mithras, and the Lion-headed god a conclusion might also be drawn to understand the single concept behind the identical astronomical alignments in Iranian chartaqi structures, Mithraic Heidentor, and the Arch of Janus in Rome that all symbolically reflect the same notion as in the form of architectural representation.

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***The Great Oak and other calendric myths of the Baltic Finns (invited)*****Ridderstad Marianna (1)**

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Session: European Prehistory, Folklore and Archaeoastronomy

**ABSTRACT**

The ancient calendars and the astronomical and calendric mythology of the Finnic peoples living around the Baltic Sea can be relatively reliably reconstructed from historical and ethnographical sources (e.g., Vilkuna 1950; Lintrop 1999; Ridderstad 2011; Siikala 2012). The central astronomically themed mythology related to the annual calendric cycle includes well known myths such as the Great Oak, the Robbery of Sampo, the Liberation of the Sun, and the Birth of the Bear. There seem to be several different layers of traditions of different ages present in the ancient calendric system of the Finnic peoples. For example, the ancient Finnish year could be divided into months or other periods in more than one way, some of which seem to be of great age. There were also local variations in the calendric traditions and the related mythology concerning the cycle of the year. In this paper, the content, age and origins of the central myths related to the annual calendric cycles of the calendars of the ancient Finnic peoples are discussed. While the myths were constantly reinterpreted and new relations were built, leading to the relatively young age of some important themes present in the mythology, some mythological motives turn out to have very distant origins both in place and in time, being several thousands of years old and having parallels in cultures as varied as, e.g., the ancient Minoan culture and the Native American cultures.

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# S

## ***Astronomical Changes in Relation to Characters' Attitudes and Destiny in Senecan Tragedy***

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Session: Astronomy in Europe and the Mediterranean at Historical Times

### **ABSTRACT**

It is agreed that Seneca the younger (4 B.C. – 65 A.D.) is one of the most significant and influential Stoic philosophers, and one of the most valuable references for Stoicism.

Physics is one of the important and fundamental elements of Stoicism, with its influence even on Stoic ethical philosophy that appears in the Stoic principle: "Live according to Nature".

As David E. Hahm mentions in his (1977) work *The Origins of Stoic Cosmology*: "it may not be much of an exaggeration to say that the Stoic physical world view was the ancient counterpart of our current, popular, scientific world view".

In his prose works, especially in his *Naturales Quaestiones*, Seneca dealt with the Stoic concept of physics, in which he displayed the nature of some astronomical phenomena and elements just as comets, lightning, thunder.....etc.

Specifically, this paper examines the following points:

- How did Seneca employ astronomy in his tragedies? Was it just a lesson in physics? Or did he employ it for a dramatic function?
- What was his view -through the characters in his tragedies- of heavenly bodies such as the sun, stars, etc.?
- How did the astronomical changes affect the characters in his tragedies?

### ***Portraits of Greek Philosophers***

**Sarantea Evi**

*Halkis, Greece*

Session: Art Exhibition

### **ABSTRACT**

The interest on ancient heroes of philosophy who created the physical sciences and especially astronomy, prompted me to paint the faces of some of them. The portraits which I drew emerged from a selection amongst several copies of busts, which were created by Greek sculptors mostly, for rich Romans. I have compared and studied all the available copies, to conceive the initial face that the ancient Greek sculptor used. I took into

consideration only secure archaeological findings, considering the identification of the person, the quality and accuracy of attribution, the dating of the head (herm, bust or statue).

This is a first painting approach to the faces of ancient personalities.

### ***Προσωπογραφίες Ελλήνων Φιλοσόφων***

**Σαραντέα Εύη,**

*Χαλκίδα, Ελλάδα*

#### **Σύνοψη**

Το ενδιαφέρον για τους αρχαίους ήρωες του πνεύματος και ιδιαίτερα για τους φιλοσόφους που δημιούργησαν τις φυσικές επιστήμες και την αστρονομία, με ώθησαν να ζωγραφίσω τα πρόσωπα ορισμένων από εκείνους.

Οι προσωπογραφίες που ζωγράφισα προέκυψαν μετά από επιλογή μεταξύ αντιγράφων προτομών, οι οποίες είχαν φιλοτεχνηθεί από Έλληνες γλύπτες ως επί το πλείστον, *κατά παραγγελίαν* Ρωμαίων. Συνέκρινα τα αντίγραφα, προς διερεύνηση του αρχικού στόχου του αρχαίου Έλληνα γλύπτη, και έλαβα υπ' όψιν ασφαλή αρχαιολογικά συμπεράσματα, μεταξύ των οποίων, η αναγνώριση του προσώπου, η ποιότητα και η πιστότητα της απόδοσης, η χρονολόγηση της κεφαλής (ερμαϊκή στήλη, προτομή ή άγαλμα).

Πρόκειται για μία πρώτη ζωγραφική προσέγγιση στις μορφές αρχαίων επιφανών.

### ***Homeric Calendar***

**Sarantitis George**

*Researcher of History E-mail: gs@plato-project.gr*

Session: Astronomy and Philosophy

#### **ABSTRACT**

In 2010 the researcher presented his work concerning the Methodology in Mythology® . Therein it becomes apparent that the Homeric and all the Platonic myths -at least- are singular scientific writings which contain a lot more historic or scientific knowledge than has hitherto been revealed. The Homeric epics, apart from the poetry and incomparable literary value of the writings and the hyperboles, metaphors or allegories they contain, also include a number of elements of information of importance or of lesser importance as well as items of knowledge pertaining to the times in which the epic was written. This has been done indeed masterfully. With the help of the Laws and Axioms that were discovered to govern these writings, a systematic breakdown of each myth has been made as to its factual and fabricated components. Moreover, two other types of meaning, one that contains both true and false and another that contains true or false, have been investigated by the researcher in recent years and he has managed to extract the factual element and to reveal historical data; all this having begun by redefining the meanings and concepts under examination.

The subject for presentation is the disclosure that the Homeric texts attest to there being a lunar calendar during that era that was also used in the region of Greece at least close to the start of the first millennium Before Present. Although it is generally accepted that the Greek, similarly to other civilizations, initially employed lunar calendars and from very ancient times, it is the first occasion of such information appearing so early on as in a Homeric epic.

In view of that, it is clear that besides the Synodic Month of 29.5 days, there was knowledge and usage of the Sidereal Month of 27.5 days (27.3) and most probably of the mean Calendar Month of 30.5 days. Also it is obvious that there was a calculation to relate the Synodic months with a solar year.

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### ***Teaching History of Astronomy to the Public: The Basic Course of Astronomy Experience***

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Session: Educational Aspects of Astronomy

### **ABSTRACT**

Astronomy plays and has always played a major role in the history of civilization, but this is not properly appreciated nor even widely known. A few works of Galileo, Newton and Einstein might be vaguely familiar to a moderate percentage of the world population, but the names of Eratosthenes, Aristarchus and Hipparchus, to mention just a few, are largely unknown outside the European world. The fact remains, however, that people from all walks of life find Astronomy extremely attractive and that this represents a great opportunity to fill important gaps in the people's perception of the development of civilization. The Astronomy

Area of the University of Sonora has offered the Basic Course of Astronomy (BCA) for 25 years to the general public in both presential and virtual mode. The BCA includes the History of Astronomy as one of the main topics, as well as History of Astronautics and Philosophy of Science, among several other theoretical and observational astronomical topics. We present here our experience teaching the History of Astronomy, which is presented comprehensively, trying to make it both informative and interesting to a very wide audience. This work is presented in the hope it might be useful to individuals or institutions committed to Science Outreach and STEM Education.

### ***New archaeoastronomical findings in the Jato Valley (Sicily)***

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3 Director, Archaeological Park of Monte Jato, 90040 San Cipirello (PA), Italy, [parco.archeo.iato@regione.sicilia.it](mailto:parco.archeo.iato@regione.sicilia.it)

Session: European Prehistory, Folklore and Archaeoastronomy

#### **ABSTRACT**

At the previous SEAC Conference, we presented an imposing megalith, visible from many kilometres of distance, sited near the top of the hill named Monte Arcivocalotto in the Jato Valley in Sicily (Scuderi et al., 2013). It is made by a single sandstone slab, shaped in triangular form with a large circular hole pierced at the centre. It is known to local people as *U Campanaru* (“The Bell Tower”) and it is oriented toward the sunrise of the winter solstice, when the Sun rises at the hole centre, becoming visible from a very large distance. We have also shown as this megalith is connected by archaeological evidences to the nearby important Early Bronze Age sacred site of Pizzo Pietralunga (see, e.g. Scuderi et al., 1998), a single, isolated rock pinnacle, about 150 m high, standing over the Belice River plain. We have recently discovered that, not far from Monte Arcivocalotto, on the top of a hill significantly named “Cozzo Perciata” (i.e., in local dialect “Hill of the pierced one”), there is another pierced rock. It collapsed a few decades ago, maybe because of the strong Belice earthquake of 1968; however a photograph, taken in the early 1960s, shows as it was quite similar to the *Campanaru* of Monte Arcivocalotto. Furthermore, the lower part of this rock, surrounded by the fragments of the upper part, is still in place: it was thus possible to measure the direction of the hole. It was found that it points to the top of Pizzo Pietralunga, with azimuth of  $60.6^\circ \pm 1^\circ$  and height over the horizontal plane of  $1.7^\circ \pm 1^\circ$ : this direction exactly corresponds to the one

of the sunrise over the local geographical horizon on the summer solstice of the beginning of the second millennium BC. Direct observations performed during the summer solstice of 2013 have actually shown that the phenomenon is still observable, because of the small change of the sunrise horizontal coordinates due to the precession during the last millennia. Also in the case of this pierced rock, there are various ethnographic evidences of the symbolical value of the claimed alignment. Concerning the archaeological evidences, in the area of a few meters around the pierced rock of Cozzo Perciata, fragments of Eneolithic and Early Bronze Age ceramics are visible. Thus, also waiting for further archaeological studies that can finally confirm the contemporary frequentation of the Monte Arcivocalotto, Pizzo Pietralunga and Cozzo Perciata sites, the probability that in this area could be found by chance two similar artificially pierced rocks (the ones of Monte Arcivocalotto and Cozzo Perciata), with different and complementary solstitial alignments (to winter and summer solstices) looks to be totally negligible (see, e.g. Schaefer, 2006).

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## ***The Antikythera Mechanism: Parapegmata, Pointers and Spirals***

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Session: Astronomy and Philosophy

## **ABSTRACT**

The Antikythera Mechanism, the first analog computer in human history, built around 120 BCE, was discovered (fragmented and calcified) in 1900 CE offshore the Greek island of Antikythera. It was an extremely advanced mechanical device that calculated several astronomical phenomena. We have analysed the astronomical events of a parapegma, inscribed on its front side in order to investigate the possible geographical latitude of its use. The two spiral dials on its back side were not Archimedean spirals, but constructed with consecutive half circles with precise and accurately designed divisions. The holder of the pointer of the Metonic dial (which has survived) was firmly pivoted on the shaft that drove its rotation by an interesting construction, which allowed both rotation and sliding.

***Orientations of Ancient Egyptian Heritage Sites Using Traditional and Remotely sensed Data***

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Session: Theory and Methodology of Archaeoastronomy

**ABSTRACT**

Many researcher and studies has been approved that ancient Egyptian temples had certain orientation: (1) astronomy (solar, lunar and stars); (2) topography orientations (Nile direction and hills) and (3) both astronomy and topography orientation. Reasons for changing orientation of ancient Egyptians Constructions: (1) Era or construction date; (2) change in the religious beliefs of with time and (3) Influence of the royal power. With existing of up-to-date commercially remote sensing data and advanced techniques, Archaeologists need to use it in their researches. Main research objective is using remote sensing data and techniques to determine t orientation of heritage sites. The proposed methodology based mainly on using very high resolution satellite images and involves many steps to get the direction of the main axis of the heritage site. A comparative study has been performed between traditional methods and the suggested method. Five case studies heritage sites located in Luxor city has been selected as study area. It covers by QuickBird 0.6 m resolution panshaped slandered images which radiometric and geometric corrected by venders. Also, digital elevation model DEM has used to normalize for topographic relief. So, in this stage, ground control points GCPs and check points CPs did not use. The results obtained of the study showed that using

remote sensing data in determined the orientations of heritage sites is accurate and saving time, cost, and effort.

Key words: Heritage Sites – Remote Sensing – Archaeology - Traditional Methods of Orientations

***Karnak Temple Orientation Based on Traditional and Remote Sensing Method: A Comparative Study (invited)***

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Session: Theory and Methodology of Archaeoastronomy

**ABSTRACT**

After the advent of modern computing and GPS technology calculating the exact azimuth alignment of a temple was an easy matter. Remote sensing can be used as a methodological procedure for detecting, inventorying, and prioritizing surface and shallow-depth archeological information. Main research objectives are to study use of QuickBird Panchromatic images with 0.6 meter resolution in archaeology, to evaluate the geometric accuracy and to the obtained results of traditional methods and the proposed method. The proposed methodology based mainly on using very high resolution satellite images to calculate the direction of the main axis of the Ancient site. Traditional method which has been used in this study is based on GPS measurements of points located in the axis of the temple. Karnak temple, Ancient Egyptian site located in Luxor city has been selected as study area. It covers by QuickBird 0.6 m resolution panchromatic slandered. A digital elevation model DEM has used to normalize for topographic relief. Ground control points GCPs and check points CPs has been used to rectified the satellite images. The results obtained from the study showed that the proposed method the proposed method which mainly based on remote sensing data and techniques is more accurate and saving time, cost, and effort.

Key words: Ancient Sites – Remote Sensing – Archaeology – GPS – Comparative study

***Toads and child sacrifice, moon and sun at Avebury and Stonehenge: using Greek myth to reconstruct the \*IE substrate. (invited)***

**Sims Lionel**

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Session: European Prehistory, Folklore and Archaeoastronomy

**ABSTRACT**

The main model in British archaeology for the Avebury and Stonehenge monument complexes is the materiality model of Mike Parker Pearson (2012). It argues that the meaning of the stone Stonehenge is revealed in the wooden Durrington Walls, linked to each other by river and Avenue. According to this model monuments of wood are for the living and monuments of stone for the dead. Elaborate ceremonies of ancestor worship begin with pig feasts at the wooden monuments that then culminate in the interment of the processed remains of the illustrious dead at stone monuments. It is claimed that this model also applies to the Avebury monuments.

Monuments of wood and stone are anomalous to this model, which exist at Woodhenge in the Stonehenge complex and the Sanctuary at Avebury – both of which combined wood and stone (Pitts 2001, Pollard 1992). This paper uses methods current within archaeology to reconstruct a prehistoric timber structure (North 1996), and archaeoastronomical method to test for alignments at these structures (Ruggles 1999). Recent research in linguistics (Pagel 2013) and molecular biology (Oppenheimer 2004) suggests that a Eurasian-wide substrate to myth must have existed in prehistory, much of it deriving from the Franco-Cantabrian refuge 15 thousand years ago (Stanford & Bradley 2012). A further test for meaning is conducted drawing from Greek myth as one early and detailed local outcome from this \*IE substrate. All three disciplines point to an alternative model of diacritical arrangements of materials and alignments intended to repair a cosmology perceived to be threatened with stasis.

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## T

### ***Time Models and archaiocalendars in Archaioheladic Civilization (20 minutes, talk and discussion)***

**Tsikritsis Minas<sup>1</sup>, Moussas Xenophon<sup>2</sup>, Tsikritsis Dimitris<sup>3</sup>**

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Session: Theory and Methodology of Archaeoastronomy

### **ABSTRACT**

In the *Archaioheladic* (Aegean) civilisation, sailing and trading were extensively developed since 3000 BC. Sailing and trading employs the recording of time as well as the various phenomena of celestial bodies. This talk is focused in the description of findings of that period at the Aegean space that were used for tracing or monitoring of such phenomena. These findings exhibit relationships between the movement of celestial bodies and human activities.

## V

### ***A rapprochement to the early History of the Astrolabe (invited)***

**Vafea Flora**

*Ph.D. History of Science & Technology, Univ. Paris 7, Abet Greek School in Cairo*

Session: Astronomy in Europe and the Mediterranean at Historical Times

### **ABSTRACT**

The aim of this paper is to shed new light to the history of the astrolabe up to the early Byzantine era, before the involving of the Arabs.

Although Hipparchus (2<sup>nd</sup> c. BC) is often mentioned as the inventor of the astrolabe, no relevant treatise of him has been preserved. The main reference for the invention of the stereographic projection by him is that of Synesius (4-5<sup>th</sup> c. AD) in his letter to Paeonius.

Neugebauer's article on "The early History of the Astrolabe" (1949) is a classic reference for the history of the astrolabe, but it contains a series of errors, underestimates Ptolemy's and Joannes Philoponus' contributions, while it frivolously identifies the Philosopher mentioned in Sebokht's treatise with Theon of Alexandria (4<sup>th</sup> c. AD). Neugebauer ascribes some of the errors that appear in Sebokht's treatise on the astrolabe to Theon, on the assumption that both Sebokht (7<sup>th</sup> c. AD) and Philoponus (6<sup>th</sup> c. AD) have preserved Theon's lost treatise on the astrolabe in their relevant treatises.

The description of the astrolabe preserved in Sebokht's treatise is a mélange of two different forms of astrolabe; one of them is an ancient, perhaps the initial form of the astrolabe, having

only one disc whose the surrounding circle is the antarctic circle, namely the greatest of the circles of perpetual occultation.

Combining the information coming from the letter of Synesius, the treatises of Philoponus and Sebokht on the astrolabe and the Planisphaerium of Ptolemy, we may arrive at new evidences for the contribution of Hipparchus to the invention of the astrolabe.

### ***Graeco-Roman Astro-Architecture?: The Temples of Pompeii (invited)***

**Vance Tiede**

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Session: Astronomy in Europe and the Mediterranean at Historical Times

#### **ABSTRACT**

The corpus of Classics literature demonstrates that astrology and astronomy played integral roles in ancient Greek and Roman religion (e.g., Cumot 1912; North 1990; Jones 1994). However, surviving historical texts contain gaps regarding temple orientation that astro-archaeology might be able to fill. For example, although the Roman architect Vitruvius (ca. 75-15 BC) wrote that, "The quarter toward which temples of the immortal gods ought to face is to be determined on the principle that...the temple...should face western quarter of the sky." (Vitruvius, 1914, V:1), his astro-architectural principle was largely ignored even in Rome (e.g., the Pantheon faces north), let alone at foreign temples throughout the Empire (Oudet 1992; Hannah & Magli 2011; Nell 2013).

In order to shed more light on the hypothetical role of astronomy in temple orientation, the author surveyed 11 temples at Pompeii, Campania, Italy (N 40d 45', E 14d 29') attended by Oscans, Phoenicians, Etruscans, Samnites, Egyptians, Greeks and Romans ca. 500 BC - 79 AD, viz.: Doric, Dionysus, Ceres, Venus, Apollo, Zeus Meilichios, Jupiter (Capitolium), Isis, (Caesar Augustus &) Vespasian, Sanctuary of the Public Lares, and Fortuna Augusta. In Phase I, a preliminary GIS/DEM/Remote Sensing survey measured the true azimuth and vertical angle to the horizon of each temple's major axis. In Phase II, the preliminary data was "Ground Truthed" by field survey with theodolite and GPS, 5-18 April 2013. The 3D vector survey data was analyzed with Program STONEHENGE (Hawkins 1983, 328) in order to identify major axes aligning with astro-targets on the local horizon and with declinations errors of less than  $< 30'$  arc.

Analysis suggests that the major axes of four temples are not oriented astronomically, but simply parallel to Pompeii's urban grid (i.e., Porta Vesuvio - P. Stabia and P. Sarna - P. Marina), itself oriented NW-SE on Mt. Vesuvius' slope to optimize urban sewer/street drainage (Hodge 1992). However, the remaining seven temples do appear to be oriented to

astronomical targets on the local horizon (to be photographed for confirmation in Phase III), viz.: Equinox Moonset Min. SS; Midsummer Moonset Maj. SS; Midwinter Moonrise Maj. SS and Equinox Sunset; Midwinter Moonset Maj. SS; May/August Cross-Quarter Sunset (2 each); and Rigel rise. An interpretation linking the observed temple astro-orientations to Classics literature is offered for consideration.

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## **ON THE SOLAR CORONA PETROGLYPH IN CHACO CANYON**

(Session: Poster)

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(2) *Department of Astrophysical and Planetary Sciences, University of Colorado, Boulder CO, USA*

Session: Archaeoastronomy in North and South America

## **ABSTRACT**

One of the petroglyphs on the south face of Piedra del Sol in Chaco Canyon may depict the solar corona during the total solar eclipse of July 11, AD1097. The petroglyph appears to

represent the solar corona during a coronal mass ejection (CME), which is common during the maximum of the solar cycle. This hypothesis can be disproven by assessing the degree of solar activity during AD1097. The year is located very close to an activity maximum, the first one after the Oort Minimum (AD 1010–1070) and the first one belonging to the period of high solar activity called the Medieval Solar Maximum (AD1100–1250). Analysis of a variety of metrics such as cosmogenic-isotopes,  $C^{14}$  from tree rings, naked-eye sunspots, and annual number of auroral nights establishes that the eclipse did indeed occur during a period of high solar activity, compatible with the hypothesis. On the east side of the rock a spiral petroglyph marks June solstice and provides a 15-16 day anticipation of solstice. Monitoring the sun after solstice could have continued past July 11, and hence sun watchers may have been in the neighborhood of Piedra del Sol at the time of the eclipse.

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*nomy in the Southwest*, Johnson Books, Boulder, 1989; second edition 1993, revised edition 2008.

## ***Celestial deities in the National Archaeological Museum (invited)***

**Dr Vivliodetis Evangelos, Dr Kavvadias George**

*National Archaeological Museum, Athens, Greece*

Session: Astronomy in Europe and the Mediterranean at Historical Times

## **ABSTRACT**

Philosophical contemplation and concepts of the Presocratics about the universe “as circle” or “sphere”, blended together with religious ideas and poetic literature are evoked into the art of the 6th and 5th cent. BC. Depiction of celestial deities prevails in the art from the mid-5th century onwards and culminates in the sculptural compositions of Pheidias at Parthenon. With regard to vase painting, already in the 6th cent. BC, the Sun riding his chariot rises from the sea on a black-figure lekythos of the National Archaeological Museum (NAM 513), while Selene (Moon) and Eos (Dawn) appear on both sides of a Boeotian crater (NAM 1383) of the 5th cent. BC. More explicit is the representation on a red figure pyxis cover (NAM 17983), dated to 430 BC, where Selene sinks away into an arched border, possibly indicating the boundaries of the Ocean, and, at the same time, the emerging from the earth chariots of the Sun and Eos signal the approach of dawn. This domed vase cover, depicting celestial deities, recalls the sky vault enacting the endless alternation of celestial bodies, moon and earth. Selene and Sun, as well as the symbols of the Dodecatheon (Twelve Gods), are carved on a

mould for the manufacture of a clay disc, dated to 350-250 BC, from Taras, which belongs to the Vlastos-Serpieris Collection of the National Archaeological Museum.

## Z

### ***Possible Mesoamerican Naked-Eye Observation of Sunspots-VI: Evidence from Yaxchilan Lintel 48***

**Zito Richard R.**

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Session: Archaeoastronomy in North and South America

#### **ABSTRACT**

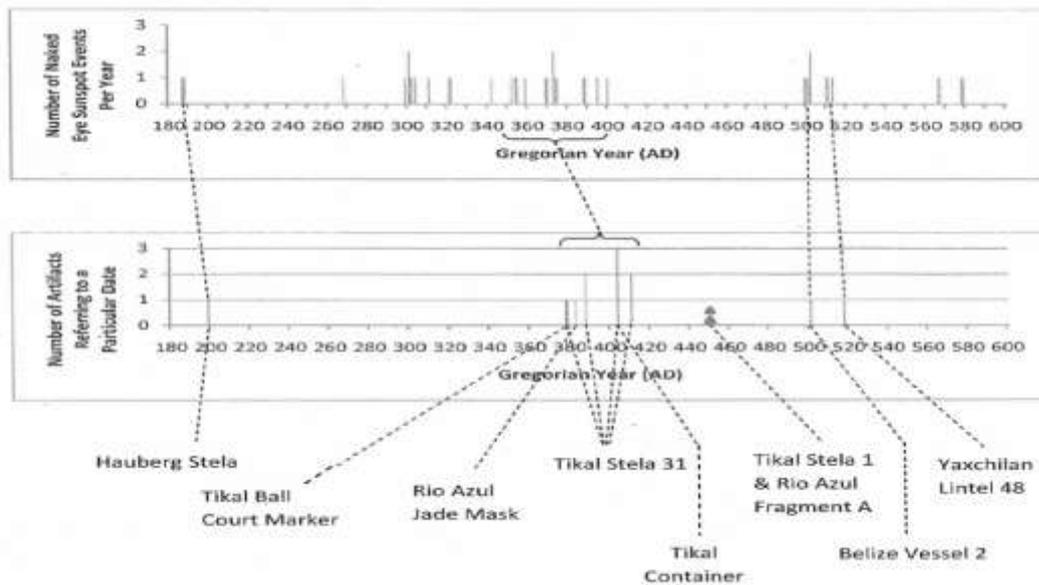
Many cultures of antiquity have made naked-eye observations of large sunspot displays. The Chinese, Japanese, Koreans, and Greeks, have all made such observations (Clark & Stephenson, 1978). Pictorial evidence on dated Mesoamerican monuments suggests that similar observations may have been made in the New World as well (Milbrath, 1999). In this regard, *Yaxchilan* Lintel 48 is of particular interest. After a century long gap in naked-eye sunspot observations from Asia, an outstanding cluster of events began in 499 AD and terminated on April 7, 513. Within 5 years of this date, Knot-eye Jaguar I was captured and, following an interregnum, *K'inich Tatb'u* Skull II ascended the throne in 526 (Martin & Grube, 2000). In retrospect, Mayan priests might have associated the sunspot displays with the change in political power, and recorded the phenomena on historical Lintel 48, dated to 526 AD, by the device of a spotted Sun God.

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### ***Possible Mesoamerican Naked-Eye Observation of Sunspots-V: Evidence from Río Azul Tomb I Murals***

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Session: Archaeoastronomy in North and South America

#### **ABSTRACT**

Many cultures of antiquity have made naked-eye observations of large sunspot displays. The Chinese, Japanese, Koreans, and Greeks, have all made such observations (Clark & Stephenson, 1978). Pictorial evidence on dated Mesoamerican monuments suggests that similar observations may have been made in the New World as well. In this regard, Tomb 1 at Río Azul is of particular interest (Adams, 1999). Within the tomb, murals depict a spotted Sun God as the “father” of Tikal king “Curl Snout.” Therefore, the murals of Tomb 1 corroborate the information gleaned from Stela 31. However, the iconography at Río Azul is more explicit, with the Sun God displaying two kin signs on his head! As in the previous report on Stela 31 (Zito, 2012), the spotted Sun God is probably a reference to the naked eye sunspot series terminating in 400 AD that presaged the end of Curl Snout’s life in 404 AD.

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***Towards Serious Gaming for Archaeoastronomical Simulation (invited)***

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**ABSTRACT**

Virtual reconstruction of ancient buildings has become a widely used medium for visualizing archaeological discoveries and models for research purposes, and for disseminating results to a wider audience. For archaeoastronomical visualization, we have to combine virtual architecture with a sky model. An extension for displaying and exploring virtual architecture with a patch of surrounding landscape inside a desktop planetarium has been presented earlier (Zotti and Neubauer, 2012). Increasingly, not only single artifacts or buildings can be studied, but larger building complexes and whole cities can be explored in virtual space.

The availability of affordable game engines that deliver attractive simulated environments opens up possibilities to model whole landscapes based on digital topography data and to add complex building structures into the correct location and enrich the scene with lots of ambient decoration like plants. While accurately placing the sun or other celestial objects is usually not a standard feature of game engines, it can be added by the developer, so the whole system can be used to study or demonstrate astronomical orientation of building structures and their possible appearance in earlier time, including the possible important effects of shadows (Frischer and Fillwalk, 2012). The model can be enriched by astronomical information usually available in desktop planetaria (e.g., coordinate systems, solstice pointers, ...).

Typically such game environments cover several km viewing distance, therefore far mountains may require the inclusion of a background horizon that can either be made from a panorama photo (Zotti and Neubauer, to appear) or computed from a digital terrain model (Smith 2012). Such a simulation has been created with the Unity3D game engine for demonstrating the astronomically most convincing site of two adjacent Neolithic circular ditch systems in Lower Austria (Zotti and Neubauer, 2013).

The main purpose of game engines is however computer games, so from here we could envision further development to reach not only experts but a broader audience, like context-

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sensitive information panels for a self-paced exploration of the reconstructed landscape, or, alternately, animated characters interacting in a role-player game, or multi-player excursions. All this may, during the game, also teach some astronomical basics and raise awareness about the presented piece of astronomical cultural heritage.

## References

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