Penka Maglova & Alexey Stoev
Editors

Cultural Astronomy & Ancient Skywatching

28th Annual Meeting
of the European Society for Astronomy in Culture
Société Européenne pour l'Astronomie dans la Culture (SEAC)

September 6 - 10, 2021
Stara Zagora, Bulgaria

CULTURAL ASTRONOMY & ANCIENT SKYWATCHING

Book of Abstracts

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CONTENT

PREFACE

CULTURAL ASTRONOMY AND ANCIENT SKYWATCHING

People have always contemplated their environment, including the sky and celestial phenomena. They acted in accordance with these phenomena, reflected them in their places of habitation and constructed their worldviews. Cultural Astronomy - Archaeoastronomy and Ethnoastronomy - studies humankind's perceptions and understanding of astronomical phenomena, throughout human history and among all cultures, and shows how astronomy was woven into everyday and spiritual life, revealing insights into people's concepts of space and time. Research in Cultural Astronomy is interdisciplinary and unites the contributions from different natural, social and formal sciences like astronomy, anthropology, history (also the history of art, science, and religions), archaeology, architecture and mathematics. Studies, which yield evidence for the astronomical practices and beliefs of peoples from Ancient epochs links the earliest skywatchers to modern astronomers and cosmologists.

Cultural Astronomy & Ancient Skywatching is the theme of the 28th SEAC annual meeting. The conference will take place at Stara Zagora - a city with a thousand-year history, the town of linden trees and poets, after 28 years, when in 1993 it was the host of the Oxford 4 conference and the First SEAC meeting was held in Smolyan.

Stara Zagora is situated in the central part of South Bulgaria. It is one of the main economic centers in the country, as well as a major railway and highway junction. It is the center of the municipality, district and regional association of Trakia municipalities. The city is the sixth largest in the country with a population of 136 000 residents. Stara Zagora is home to the Thracian University (9000 students), which provides education in the fields of agriculture, veterinary medicine, economics and medicine in Bulgarian and in English.

Here is the oldest Bulgarian theater - Geo Milev Drama Theater (1870), the ancient Forum of Augusta Trayana, and 14 km away from the center of the city - the national resort Stara Zagora Mineral Baths (SPA). In 1925, the second opera house (after Sofia) in the country was opened - the South Balkan Opera (today Stara Zagora State Opera) and in 1895 - the first park of European type in Bulgaria - Ayazmoto (Park "Metropolitan Metodi Kusev"). The city also houses the Museum of Religions. It is located in the Eski Dzhamiya (Old Mosque - a medieval building in the center of Stara Zagora), which in the distant past was a Thracian sanctuary, a sanctuary from the Roman era, dedicated to the Thracian horseman, and in the tenth century a Christian church.

The first signs of life in Stara Zagora date from the Neolithic era. History of the town goes way back in time to **8 000 years ago.** Humans appreciated the abundant natural resources and settled in the area. **Europe's best-preserved Neolithic dwellings** can be seen even today. Their numerous ritual and everyday objects are enchanting with their aesthetics.

In a close proximity to the contemporary city of Stara Zagora the largest mining center in Europe, where copper ore was mined in the V millennium BC - Early and Late Chalcolithic is discovered. The copper ore was exported in a vast region of Southeast Europe reaching the middle parts of the Volga river.

Beroe is the first ancient Thracian settlement in the region of today's Stara Zagora founded about 2500 years ago. The Roman Emperor Trajan built the city **Augusta Traiana** in 106-107. The city gradually became the second biggest economic, administrative and cultural center in the Thrace province and it thrived. Forum complex of the ancient town is preserved

The city changed its name several times. **Stara Zagora** was called, **Vereia, Irinopolis, Boruy, Eski Zagra and Zheleznik.**

Stara Zagora has a wonderful climate. It is protected by two mountains - Sredna Gora and Stara Planina. And between them is the famous Rose Valley with the massifs of Kazanlak rose, which has the highest quality rose oil in the world and the Valley of the Thracian rulers with numerous tombs and megalithic monuments.

Stara Zagora is also a space city! The first Public Astronomical Observatory in Bulgaria was established here 60 years ago. In May 1961, during a visit to our city, immediately after his flight, the first man who had circled the Earth and saw it from space - Yuri Gagarin gave his consent for it to bear his name. August 7, 2021 marks the 40th anniversary of the launch of the Bulgarian satellite Intercosmos "Bulgaria-1300" on the occasion of 1300 years since the founding of the Bulgarian state. The aim is to study the ionospheric plasma and high-energy fluxes of charged particles, constant and alternating electric currents and magnetic fields, the glow of the upper atmosphere in the ultraviolet and visible spectrum. Three of a total of 13 devices flown on the satellite were designed and manufactured in the Space Research and Technology Institute of the Bulgarian Academy of Sciences in Stara Zagora.

Venue of the 28th SEAC annual meeting is the Public Astronomical Observatory "Yuri Gagarin". It is located on the roof of today's Romain Rolland Foreign Language School. The building has an impressive architecture, in the spirit of "modernized classicism", built in the period 1939 - 1946. The decoration on the facade is quite strict and clean, and the interior is one of its most interesting elements - mosaics with abstract shapes and impressive columns in the interior.

This Book of Abstracts presents sixty scientific works of researchers from 19 countries of Europe and North and South America - Argentina, Austria, Bulgaria, Estonia, France, Finland, Germany, Greece, Italy, Mexico, Poland, Romania, Serbia, Slovenia, Spain, Sweden, Switzerland, UK and USA. The authors attempt to reflect the most important stages of the development of human understanding and gaining knowledge, with practical and sacred meaning, on the structure of the world around us based on the results of skywatching since the very beginning, from the study of ancient monuments (astronomical observatories, sanctuaries with burials and altars, petroglyphs and paintings, megalithic monuments with calendar creation purpose), through medieval and modern astronomy towards methodology, philosophy and teaching in cultural astronomy and astrophysics and even careers of contemporary scientists.

The 28th SEAC annual meeting meant to be held in early September 2020 in Stara Zagora (Bulgaria) was postponed because of the Covid-19 pandemic, the consequent confinement and the restrictions for traveling and gathering now in force in many countries around the Globe. As security measures continue today and many of our colleagues and friends cannot travel despite their wishes, we decided that the conference would be of a mixed type - on site and remotely. We were very disappointed and hoped that everything would pass faster, but at present this is the new reality. Let this not interfere with our research and our desire to share the results!

We wish all the participants an interesting and fruitful conference, inspiration for new research, cheerful mood and a wonderful stay in our ancient and at the same time modern Stara Zagora.

Penka Maglova Alexey Stoev

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THE SECRET (ASTRONOMICAL) LORE OF YOGINIS I

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Written records of considerable antiquity on the Sidereal lunar cycle can be found in the scriptures of ancient India. The *Atharva Veda* (Book 19, hymn 7), dated to c. 1000 BC, lists 28 (27 + 1) asterisms, known as Nakshatras or "Lunar mensions" denotingthe positions of the Moonin the sky, during its sidereal cycle of 27.3 days. A similar system of asterisms was known in ancient China and it is not entirely certain which of these two systems is older.

Atharva Veda (Book 19, hymn9) mentions Rahu, the divine personification of the ascending Lunar node, in one verse only, as "the forces who seize the Moon".Rahu is mentioned several times in *Ramayana* (i.e. Canto 4, v. 62-65), while in *Mahabharata* his name appears many times, along with his mythical biography (Book 1: *Adi Parva*: *Sambhava Parva*, Section LXV and *Astika Parva*: Section XIX). Therefore, there is a reasonable assumption that the draconian Lunar Cycle was also known in India as early as the first millennium BC. Aryabhatta knew the exact duration of the cycle in the fifth century AD, but he did not give any explanation as to whether he received this knowledge from his teachers or it was the result of his own observations and calculations.

It is these two lunar cycles, sidereal and draconian, that are the subject of study in this paper. We wanted to know if and to what extent the knowledge about these two cycles was incorporated into the religious understandings of early medieval Tantra of Kaula tradition. If it turned out to be, we would get a firmer position to look for this knowledge in the more distant past.

According to many scholars, The *Atharva Veda*was not originally counted among the *Vedas*. Olson (2007, p. 13-14)states that the ultimate acceptance of *Atharvaveda* as the fourth Veda probably came in the 2nd half of the 1st millennium BCE.The last two chapters, in which both the system of Nakshatras and Rahu were mentioned, were added to the text subsequently,and the origin of these concepts is not clear enough.This is not unusual. Cultural exchange between different communities has been happeningcontinuously. India is a huge country, with many peoples and languages. Each of these peoples (and languages) has its own past and its own sacred knowledge, which could have contributed to religious beliefs in medieval India.

Tantra is a religious system (a sect) within Shaivism and Shaktism, which originated and was flourishing in medieval times. It has never been incorporated into orthodox Hindu teachings, although it has indisputably exerted a strong influence on both Hinduism and Buddhism.Religious writings of Tantra are written in Sanskrit, but its priests still have a low status within the Brahmin caste. The architecture of the temples built by this sect differs sharply from the usual architecture of Hindu temples.

Shiva is a deity, who is not mentioned in the *Vedas*, although later Hinduism associates him with the Vedic Rudra, the storm god (ie *Rig Veda*1.43, 1.114, 2.33, and 7.46). The way Shiva is believed to be responsible for the creation of the world (as well

as for its destruction) is quite different from the Indo-European, Vedic myth of the giant Purusha (*Rig Veda*, 10, 90), from whose body parts the world was created.Religious writings of early Tantra often mention the Nakshatra system along with Rahu.

In this paper, we have considered the basic concepts related to astronomical lore in both Shaivism and Tantra, especially in the tantric Yogini cult. We performed an archaeoastronomical analysis of a tantric temple, built in 10th century AD, dedicated to Shiva, Parvati and 81 Yoginis, situated in Bhedaghat, near Jabalpur, (Madhya Pradesh).

Fig. 1. Eighty-one Yoginis Temple in Bhedaghat: the circular cloister was built in 10th century AD, while the Temple inside its courtyard was builth in 12th century AD, by the queen Alhanadevi of Kalchury dinasty https://www.patrika.com/tags/64-yogini-temple-bhedaghat/.

It is a circular structure, c. 40m in diameter, with 81 niches along its inner perimeter sheltering 81 statues of Yoginis, the female deities (manifestations of Devi, the suprime Goddess), depicted sometimes in partly teriomorphic form. The temple has two entrances: one of these is open to the east and the other (the main one) approximately to the north-west. The analysis shows that the construction of the temple is closely related to the Nakshatra cycle, and the number of statues along the temple's perimeter corresponds to the number of days in three consecutive sidereal lunar cycles (3 x 27 = 81), when an intercalation is needed. The main entrance (which can be understood as the 28th, intercalary Nakshatra) is aligned with the full Moon setting during the major northern Lunar horizon extreme, as seen from the centre of the circular Temple.

These findings prompted us to analyze the other preserved circular Temples of the same cult, which is the subject of our next paper.

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THE SECRET (ASTRONOMICAL) LORE OF YOGINIS II

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This research is practically a continuation of our previous work (*The secret / astronomical/ Lore of Yoginis I*). The results of the archaeoastronomical research of the 81 Yogini Temple in Bhedaghat prompted us to analyze other preserved circular and hypaethral temples, dedicated to this early Tantric cult. All these temples were built between the 9th and 11th centuries AD. All of these have a very similar structure, which clearly stands out from all other sacral buildings of medieval India. These are characterized by a circular wall, along the inner circumference of which niches are placed, containing the extraordinary statues of Yoginis. The Temples are roofless (hypaethral), with a wide open view of the celestial hemisphere.The height of the circular wall is usually at the height of the eyes of a (hypothetical) observer (standing in the center of the circular formation), providing a plane (mathematical) horizon. These sacral buildings were constructed either in the plains, or on the hilltops, so they are practically ideal for observing the sky and celestial bodies, as well as for astronomical measurements.

Fig. 1. The Yogini Tempe in Mitawali (Morena district, Madya Pradesh)
https://www.reddit.com/r/IndiaSpeaks/comments/clsxkk/chausath_yogini_temple_morena_mp/

We had to explain the traditional Hindu concept of Cardinal directions and the divine guardians of these, which differs from the Tantric concept, where Shiva in his five forms, known as Sadashiva(*Shiva Purana*, II, 4, v.4; II, 8, v. 38-39; II, 9 v. 12), guards the four cardinal directions along with Zenith (Sharma, B:1976, pp. 3–60).

Archaeoastronomical analysis of four Temples dedicated to Shiva, Parvati and Yoginis(the fifth one was analized in our previous paper) has shown that the entrances are, as a rule, aligned to the either major or minor southern lunar horizon extreme moonrise.

This orientation of the entrances led to the assumption that the lunar horizon extremes were of great importance in the Yoginis cult. We assumed that certain important cult holidays were related to these astronomical events and looked for evidence for this assumption in the recently translated Tantric text named *Yoginihridaya* (*The heart of Yogini*, the English translation of Padoux and Jeanty, 2013) The sacred text was written down in the 10th or 11th century.Because it is a secret teaching, it can be assumed that it was transmitted orally from teachers to students for some time before enrollment. It describes a particular ritual of the 64 Yoginis cult, given in the form of a conversation between Shiva and Parvati: the God explains the secrets of Tantra and the sequence of events in the ritual to his divine consort, constantly insisting that it is a secret teaching. Practically, the majority of the divine beings mentioned by Shiva as the objects of worship are closely connected with astronomical concepts: there are 28 (27 + 1) Nakshatras, the main celestial bodies (Navagraha, i.e. the Sun, the Moon, five known planets and two Lunar nodes named Rahu and Ketu), Yoginis, Matrikas (or major Yoginis, the mythicalmothers, sometimes considered to be the mothers of the main celestial bodies); it is stated that the holiday is held on "certain lunar days". The game of numbers given in the text suggests the duration of different astronomical cycles, with the number 37 (18.6 x 2) being clearly mentioned several times, which is the exact duration (the number of years) of two draconian lunar cycles.

Shiva is usually depicted with the crescent Moon in his hair, he is known as *Candraśekhara* (Sanskrit: चन्द्रशेखर, "Having the Moon as his crest") which in itself could be an indication for the importance of the Moon in his cult.

We are aware that knowledge about the sky and celestial bodies, as well as the way it was built into the understanding of the world (cosmology) is only one of the layers in the multi-layered religious system of Tantra. Our intention was to recognize and label it, without indulging in philosophical and spiritual values.

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CROMLECH OF MEZORA: A NEOLITHIC CONSTRUCTION IN THE NORTH OF MOROCCO. AN ARCHEOASTRONOMICAL UPDATING IN THE SEARCH TO IDENTIFY A SOLAR CULT AND OTHER THEORIES

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The Mezora cromlech, located in northern Morocco, has been the object of our studies for the last three years. It concerns an excavated site studied for almost two centuries in the traditional Archaeology manner. A series of expeditions which took place mention this site since 1829 (Capell Bruke, 1831). It was excavated several times, sometimes in the midst of complicated war-political events, and almost always without the appropriate archaeological elements or the idea of landscape/cultural archaeology or Archaeoastronomy.

Throughout our work and studies, we have come researched by means of abundant bibliography in this regard, and our studies and opinions coincide with the ideas of one of the most prolific writers about Mezora, Enrique Goncalbes Gravioto, who believes that in recent years there have been no new studies, and that there are no complete studies based on history, sociology and geomorphology (Goncalbes Graviotto, 2012).

Our intention is to carry out a multidisciplinary study of the megalithic group, in all aspects that made it functional throughout its history. Not only we will carry out a thorough study of the existing bibliography but our work will expose the first result of our campaign to the North of Morocco, in order to place Mezora geographically, sociologically and historically in the set of Mediterranean megalithic monuments.

The first part of our studies leads us to the presentation of a work concerning various Archeo-Astronomy aspects of the set. Our current work will try to make sense of the succession of functions with which the people of the area used it: Burial site (Belmonte, 1999), temple for solar worship, and the possibilities of its use in the form of other sacred aspects, meeting point, mark of political boundaries and finally part of the prehistoric social mobility and commerce system in North Africa (Koehler, 1932).

Our field investigation in Mezora archaeological site will also try to find astronomical coincidences in its constructions. We have models, drawings and stone constructions to obtain these coincidences. After the measurements we have determined that the circle is, in fact, a complete ellipse consisting of 176 stones, which at first glance looks like a circle (Taradell, 1952, Souville 2000). The amount of stones and their arrangement place them approximately two degrees from each other taken from the center of the ellipse. From the calculations we have made with the measurements in place and processed through the Stellarium program we can indicate coincidences of the location of several stones with the observation of stars and Going back up to 7 centuries before the common era, we will carry out the measurements that indicate that the local inhabitants, in addition to being able to observe the solar and lunar movements, could match their constructions with the observation of common stars in the Mediterranean area and of which they do not match according to their latitude.

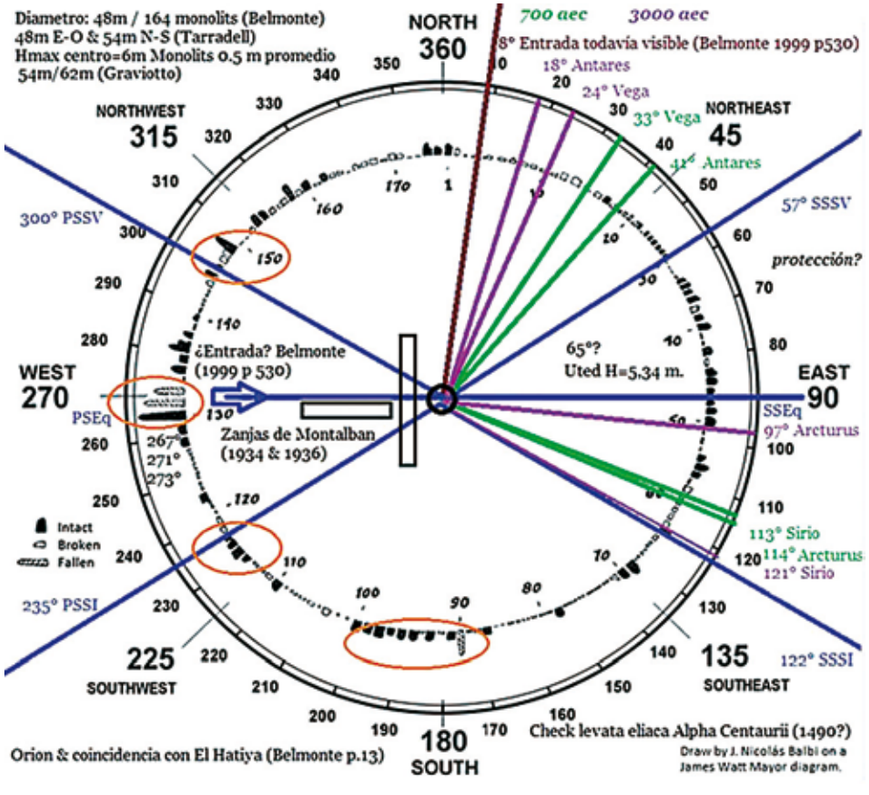

Fig 1. Cromlech and main references. Diagram drawn by J. Nicolas Balbi and James Watt Mayor.

We took a bibliographic tour starting from the first time the site was mentioned by the Roman writers Plutarch and Tanusio Gemino, due to the description of the site by the Roman general Sertorio (year 81 BC) in the context of civil wars and mentions of the Mauritanian King Iuba II. We will see the location of the site in the Peutigerian Tabula and how its privileged location leads to the conclusion that not only does an ancient tomb exist but the complete set exists as well. We will explore the subsequent silence in the writings of Pliny and Solino and of the medieval travellers and arrive to the final explorations.

Finally we will take a field research of the site surroundings and old known routes in order to understand and discover new architectural and functional relationships, in this exciting archaeological and cult site of North Africa.

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BELLA VISTA (BEAUTIFUL VIEW) TO THE COSMOS. CHRONOLOGY OF AN ASTRONOMICAL TEACHING AND SCIENTIFIC DISSEMINATION WORK AND ITS EXPERIENCES

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Our presentation establishes a study of the results schedule of dissertations, workshops and observations in relation to astronomical and related science. They will be held in the city of Bella Vista, San Miguel district, Buenos Aires, Argentina, South America. The general public and students of different levels of school education will be invited to participate by listening, observing and interacting with the various activities that will be developed for that day.

It should be noted that for this purpose, eleven professors have formed a pedagogical group that will develop the different activities to disseminate astronomical and scientific knowledge in their different fields. Our desire is to encourage the general public to make new experiences and internalize in the aspects that this science studies. In the same way it is intended to promote the teaching of astronomy (Gangui, 2009).

The location chosen for this study is a protected urban nature reserve in the city of Buenos Aires, where observation equipment, radio telescopes, etc. were installed. For the event, and where different strategic sectors and tents were installed for small conferences, this will facilitate discussion and observations with instruments in the teaching of astronomy and Archaeoastronomy, mainly in Andean Cultures (Balbi, 2018, Corrado, 2017, Ziolkowski and Sadowsky, 1992).

Our goal is to comment our results to the scientific community of SEAC and bring this experience to the work table in a free public event, which was born as a recreational scientific proposal and that came to convene between 2000 and 3000 people interested in science, with the participation of state entities, educational and private companies, among others.

We will describe different types of events: Presence until 2020 in a Nature Reserve Park and in the San Miguel Astronomical Observatory (which we have begun to restore), research trips such as the Solar Eclipse of December 2020 that we saw in total in Patagonia and compared with the Observations of the Observatory in San Miguel (Mintti et al., 2013), classes on various topics of science and astronomy, given in person at the events and then virtually after the isolation due to Covid-19 and finally the “star parties”, meetings for observation and scientific dissemination held both in the Reserve as from 2020 in the San Miguel Observatory, with certain restrictions and then virtually (Balbi et al., 2021).

Fig 1: Pictures from the event. Author J. Nicolas Balbi and Santiago Maiese.

In all cases we study and communicate the reception by the public, the reception by the press, a study on the type of public attending and our conclusions.

Our experience allows us to improve in the realization of these events and to transmit to the general public the interest in science and Astronomical Observation, and our objective in this conference is to communicate and share our data with the scientific community of the SEAC and obtain their criticisms, suggestions and observations to improve our teaching and scientific dissemination activity.

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THE SOLSTICE DELUSION! CHALLENGING WINTER SOLSTICE ALIGNMENTS IN ANCIENT EGYPT

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Extensive work in Egypt has been carried out during the past decade within the framework of the Archaeoastronomy Mission of ancient Egypt. The orientation of several hundred sacred structures, notably Pharaonic temples, were measured and analysed, discovering a series of patterns that, beside clear topographic orientations related to the Nile, confirmed the presence of astronomically dictated alignments as suggested by ancient texts (Belmonte et al., 2009). One of the most interesting patterns was the one related to the winter solstice, first proposed in the last decades of the past century by pioneering works when analysing the Amun temple at Karnak (see e.g. Krupp, 1984). Our own results seem to confirm that this was as a sort of prototype for later solstital orientations (see Fig. 1). Recent detailed works on the temple has plainly confirmed this idea (Gabolde, 2018).

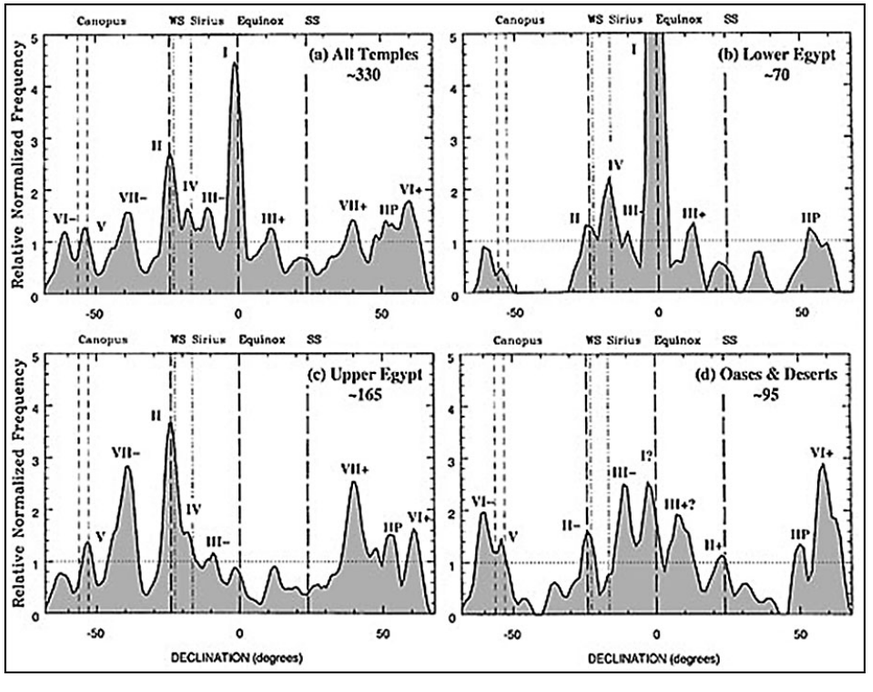

Fig. 1. Declination histograms of ancient Egyptian temples and shrines, organized by geographic areas, including the total sample. Several patterns of orientation were identified, notably one related to winter solstice (II). Notice the concentration in Upper Egypt where Karnak is located. Image of the author, adapted from Belmonte et al. (2009).

Actually, astronomy and landscape did play a most relevant role in the architecture of ancient Egypt (Belmonte, 2012, Magli, 2013). However, the situation was not always so clear.

In particular, the temples of Deir el-Bahari were studied in the earlier campaigns of the Mission in winter 2004 and 2006, notably those of Mentuhotep II and Hatshepsut. Although they seem to belong to the family of temples oriented to sunrise at the winter solstice (#II in Fig. 1), this orientation was not as precise as would be expected for temples of such importance. Therefore, after resuming work in Egypt after the Revolution, it was decided to propose alternative hypotheses that could explain the deviations of these two temples to the south and north of the solstitial line, respectively. It is difficult to imagine that they were mere design errors. In December 2017, further fieldwork was carried out in Thebes, in particular at Deir el-Bahari, and observations and measures were made on site during the winter solstice itself, documenting the phenomenon.

The verifications carried out seem to confirm some new approaches. On the one hand, the burial temple of Mentuhotep II could be diverted *c*. 2º to the south so that there would be a lighting effect during the winter solstice in the chapel closing the complex at the base of the cliff. This would be an astronomical event that could be related to *Wepet Renpet* (New Year Eve, or 1 Akhet I in the civil calendar) at that period (11th Dynasty) and would suggest which kind of structure actually was the controversial 'kernbau' present at this sanctuary (Gabolde, 2015).On the other hand, the Million Year Temple of Hatshepsut could be oriented towards sunrise on another unique date of the civil calendar during the reign of this sovereign, the Feast of Nehebkau celebrated on the first day of the first month of the second calendar season, or 1 Peret I, when royal legitimacy was confirmed. All in all, astronomical orientations at the site of Deir el-Baharicould relate to key dates in the civil calendar at the time when the temples were built, and not merely related to a winter solstice phenomenology.

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PUNITIVE SUPERNATURAL BEINGS OBJECTIFIED IN ASTRONOMICAL AND ARCHITECTURAL REPRESENTATIONS ENCOURAGED THE RISE OF PERUVIAN CIVILIZATION

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A cross-cultural study by Watts and others (2015) showed a linkage between shared beliefs of supernatural beings and trust among non-related peoples. Presented as the "Big God" theory, most extensively documented with psychological and other data by Norenzayan in his book *Big Gods*, and cross-cultural data by Purzycki (2016) and Watts et al. (2015), the theory suggests that trust among people who are not relatives or close friends, created due to sharing a common punitive supernatural being, can initiate civilization.

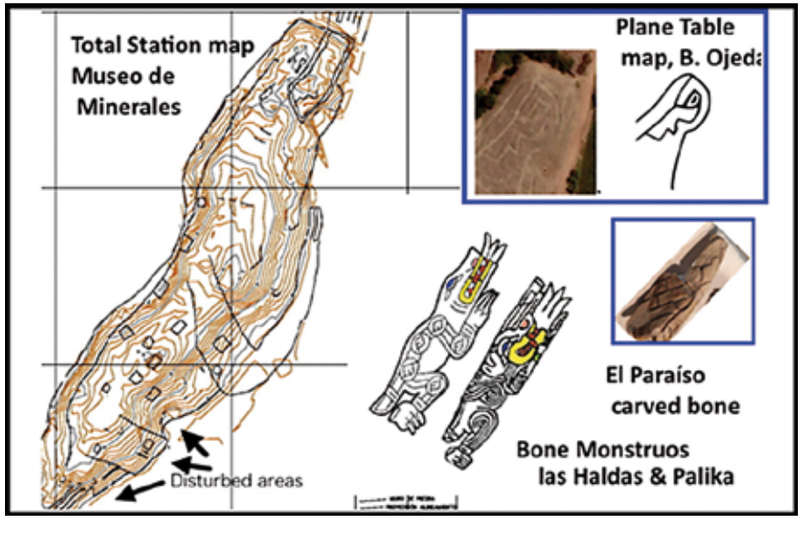

Fig. 1. Monstruo of El Paraíso Total station map on left from Museo de los Minerales, Lima,Perú. Plane table map on right by Bernardino Ojeda, drawings of bone carvings in center by Henning Bischof, photograph on lower right of carved bone from me of Museo Nacional de Antropología, Biodiversidad, Agricultura y Alimentación de la Universidad Nacional Agraria—La Molina.

Whitehouse and others (2019) reported that high gods followed rather than initiated civilization in the archaeological record. Their definition of such a god is the creator of the world (p. 227), and therefore omits other punitive supernatural beings such and as are known for Perú. For the Peruvian area, Whitehouse and others only considered the Inca, overlooking the urban centers of Tiahuanaco and as well as earlier polities discussed here.

We consider the much earlier Late Preceramic coast valley sites as candidates for the supernatural forces of Watts and others influencing the rise of civilization. The hypothesis of Whitehouse, François, Savage and others is that it is routinized, doctrinal rituals that first created common identities across states and empires where a single high god was preeminent. This hypothesis is not inconsistent with the earlier rituals being linked to supernatural forces that later become high gods, so the two theories are not conflict with one another at the beginnings of civilizations earlier than the later Inca.

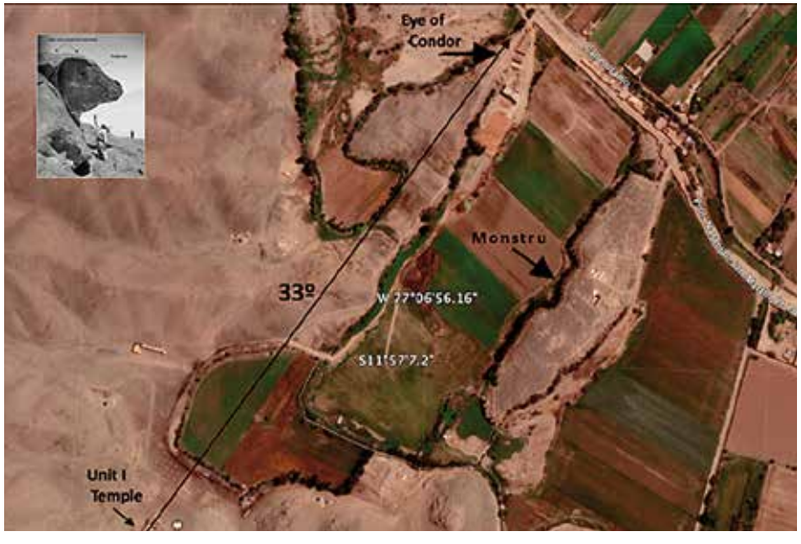

Fig. 2. Two giant animal effigy mounds at the site of El Paraíso, Perú, oriented to the Milky Way extreme, an astronomical direction of importance to the Inca and common at other central coastal early sites; inset, carved condor head from sister site of Buena Vista with equinoctial alignment to temple with incised fox at exit.

In the Peruvian case, the presence of supernatural beings is found embedded in their cosmology as constellations in the dark clouds of the Milky Way as seen in surviving ground drawings and animal effigy mounds and stone sculptures and etched supernatural figures with astronomical associations. Ethnography and ethnohistory also informs this cosmology. In some instances, the cosmology can be linked to *Apus*, animated mountains. The *Apus*are communicated with by foxes on the earth, who observe human behavior, and report to condors who take the news to the *Apus*, who castigate wrong doers. An example from the sites of Buena Vista and El Paraíso in the Chillón valley of central, coastal, Perú, is presented as an archaeological example in support of a very early instance of this system.

We assume that in the Late Preceramic time period when the first large platform mounds were constructed in Perúat around 3,000 BC, tensions among groups would have risen with greater population density and disagreement about rights to productive beaches or farmland expected. The sites discussed here are somewhat later, 2,200 to 1,750 BC, time for the development of shared beliefs in a moralizing, punitive supernatural force, such as an *Apu*. Trust based on punishment of a neighbor who behaved badly would have eased tensions among polities, since trust would be engendered in people otherwise

recognized as untrustworthy enemies rather than relatives. The cosmology of animals in the sky and constructed effigy platform mounds on the earth (see Fig.1 for one example) would have publicly demonstrated shared beliefs among the inhabitants of the central coastal valleys.

This supernatural punitive forces theory is not mutually exclusive with other quite different explanations for the rise of civilizations, but it accords well with Andean belief systems and the architecture of early monumental sites.

In the Chillón Valley of central coastal Perú, the two Late Preceramic monumental sites 29 km apart have indications that support the presence of a punitive god that permitted their economic and spiritual consilience. El Paraíso (Fig. 2) and Buena Vista both have similar radiocarbon dates, from 2,200 to 1750 BC. Both have Mito temples, small, restricted of access chambers where offerings were made. Each has a more open temple with four symmetrical circular offering chambers surrounding a central fire pit, both with the same astronomical orientations. Buena Vista had a large cache of shell fish from the ocean, presumably from El Paraíso, which is located 29 km away.

Buena Vista has an equinoctial sunrise alignment from a fox engraving in the Mito temple to a stone pillar carved in the shape of a condor with an eye looking at a mountain up the valley, at an *Apu*. The shared cosmology of the two sites and linkage with an *Apu*, a punitive supernatural force, may have permitted peaceful trade and pilgrimages.

The entire system of religious beliefs, managed by astronomer priests, would have permitted early polities to grow with trade and pilgrimages rather than warfare. Nonetheless, subsequent warfare showed the system reached its capacity to ameliorate disputes when the population density became too high, although that the continuance of construction of astronomically oriented platform mounds continued. There was a persistence of these beliefs in prehistory. They exist in the Andes and Amazonia today.

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TEACHING CULTURAL ASTRONOMY AT THE UNIVERSITY OF WALES TRINITY SAINT DAVID: AN UPDATE

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The teaching of Cultural Astronomy requires the creation of a syllabus.* This, in turn, requires deep thought about the nature of the discipline, and what a program in Cultural Astronomy should include. Questions arise from such issues as the ways in which we define astronomy, whether Cultural Astronomy is Synonymous with archaeoastronomy, as it is in some definitions, and in this case what we mean by the archaeo part of the term archaeoastronomy. The purpose of this talk is both to expand and clarify our view of what cultural astronomy consists of, and assist the development of a SEAC education policy.

This lecture reports on how we tackle these questions in the teaching programme at the University of Wales Trinity Saint David, now about to enter its fourteenth year (preceded by five years at Bath Spa University). The programme has always been located in the humanities and social sciences: it is currently within the University's Institute of Education and Humanities. It is fundamental to the humanities (as to other areas of academia) that all assumptions must be questioned. It is therefore necessary to begin by defining and critiquing terms such as astronomy and culture and the currwent discussion is strongly influenced by Ruggles (2011). The programme relies on a standard definition of culture from the anthropologist Clifford Geertz (1973, 99), who wrote that it is 'an historically transmitted pattern of meanings embodied in symbols, a system of inherited conceptions expressed in symbolic form'. Mary Le Cron Foster (1994, 366) took this concept further: 'Without symbolism there could be no culture...Culture is not itself formed of symbols, but of the meaning that lies behind and unites symbols. This meaning only exists in the minds of participants in culture, but it is acted out through the manipulation of symbols, which objectify meaning'.

Pursuing an anthropological methodology, the programme raises questions concerning behaviour, artefacts and sites related to Cultural Astronomy and Archaeoastronomy. These questions touch on religion, magic, the arts, the nature of place and space, the internal cosmos, the problematic distinction between astronomy and ethnoastronomy, the new term skyscape archaeology, and what standards are expected of a MA student studying archaeoastronomy. Additional questions arise from the different contexts in which the ways that the term Cultural Astronomy is used: (1) as a discipline or subject area, studying the cultural foundations, contexts and applications of different astronomies; (2) as a form of practice in the sense that a people, community or society has a cultural astronomy (also often known as Ethnoastronomy); for example, is the use of stars for timing significant rituals by Amazonian peoples a form of cultural astronomy as a practice, but not an academic discipline? In order to follow an anthropological methodology it is also necessary to apply qualitative research methods, including reflexive methodology and phenomenology. In this sense, academic Cultural Astronomers themselves have a culture, as do so-called ethnic practitioners of cultural astronomy. Similarly, if culture is universal, do modern astronomers have a culture, in the same sense as sociologists or theologians? If so, then to study this is a legitimate and necessary component of Cultural Astronomy.

The second word in the term Cultural Astronomy is astronomy. As has been noted previously, the use of the term in relation to past cultures can be anachronistic. Astronomy is currently defined as an observational science concerned with the measurements of the movements and material properties of astronomical bodies. However as most studies of cultural astronomy demonstrate, the notion of such observation and measurement did not exist independent of cultural meaning in pre-modern cultures. Neither do most non-western countries employ different words to distinguish traditional astronomy from astrology (defined as the attribution of meaning, significance or indolence to the astronomical bodies). In India both are traditionally *jyotish*, the 'science of light'. In Japan they were *onmyōdō*, the 'yin-yang way'. In China, the observation and measurement of celestial phenomena was inseparable from their application to human knowledge, which, in turn, was divided into two, *li*, or *li fa*, calendar systems, and tian wen, or sky patterns. In the Arab world philosophers used the term *Ahkam al-Nudium*, the decrees of the stars.

As a result of such cultural complexities, when the MA in Cultural Astronomy and Astrology was set up in 2002 it aimed to bring together three separate academic strands. One was the study of Cultural Astronomy as evident in series of conferences such as SEAC and the Oxford conferences, and the resulting publications. The second consisted of a work produced by a network of academics studying the history of astrology with their own series of conferences and publications. The third was the network based around the conferences on the inspiration of astronomical phenomena (INSAP) which prioritises the meaning which people derive from watching the sky, chiefly through the arts. The programme therefore combines all three strands: for example, it has a module on the History of Astrology (which was compulsory until 2020) and a strong component in art history and criticism. From archaeology the programme draws on material which deals with the contemporary world. This can include observatories, modern sacred buildings, the archaeology of the space race, or phenomena such as 'Manhattanhenge'. Throughout, following Geertz and Foster, runs a thread on the nature and understanding of symbol.

The module in Archaeostronomy was launched in 2010 and focused on the study of astronomical alignments with the built and natural environment, featuring, like so much of the material featured at SEAC and Oxford conferences on the ancient and non-western worlds. Strong attention was paid to theory, such as Clifford Geertz's concepts of thick and think description. In 2014 to 15 the module was renamed Skyscapes, Cosmology and Archaeology in order to identify with the new term Skyscape Archaeology, the intention being to further emphasise the need to contextualise alignments or orientations identified in the environment within wider considerations of landscapes and culture. In the year 2020 to 21 the module was redesigned as the result of a change in the credit value of modules (and need to reduce the number of modules) imposed by the University, and Archaeoastronomy and Skyscape Archaeology are now taught within a module known as Sacred skies. This module will further embed the discipline within, for example an understanding of the theory of religion (necessary for understanding sacred buildings) and the phenomenological experience of the sky.

In conclusion, the talk will argue that a broad syllabus in Cultural Astronomy should consider any and all human engagement with the sky, stars and planets regardless of period,

*I use Cultural Astronomy with capital letters to denote the academic discipline, and as cultural astronomy with small letters to denote the practices which are part of astronomy's cultural practice.

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SKYSCAPE ARCHAEOLOGY AT POMPEII BETWEEN THE ARCHAIC AND THE HELLENISTIC PERIOD

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Historical Context

There is no strong agreement on which population founded Pompeii. Strabo recounted the Opici and Ausones, italic people of the Latino-Faliscan group, to bethe first inhabitants of the area of the gulf of Naples; later it was occupied by Oscans, Etruscans, Cumaens, Samnites, and Romans (Strabo *Geography*, V, 4, 3-8). From an archaeological perspective, in the whole area around Pompeii, the Sarno Valley, funerary materials revealed a strong Etruscan characterisation of the social indigenous communities from the 7th to the 6th century BC (Franciosi 2009, 2). Pompei born as result of a cultural, economic, and social transformation which characterised the area starting from around 600 BC, as evinced by new forms of craft specialisations, imported materials, exchange routes, co-presence of different alphabets, and the rising of the nearby urban centres of Nocera and Stabia (Cristofani 2009, 20-24). Mauro Cristofani traced the socio-cultural portrait ofthe area around the river Sarno in the Archaic period (6th–beginning 5th cent. BC), where "a sort of ethnic pluralism of literate classes who were presumable involved in a system of reciprocal of hospitality" is evident (Cristofani 2009, 24). This equilibrium was put in crisis with the Battle of Cumae at the turn to the 5th century BC, with a consequent negative impact on the life at Pompeii. By the end 5thcentury, the "Samnitisation" of Campania invested also the city, and the Classical period (5th–4th cent BC) is characterised by the lack of votive offerings in the main sanctuaries and a probable urban restriction. At the beginning of the 3rd century the city reborn after the submission to RomewithaHellenisingimprint as evident in the architectonic restructuration and urban reorganisation until its crystallisation in AD 79.

The Archaic phase map of Pompeii and the problem of its orientation

The current accepted theory for Archaic Pompeii is that the whole 66 m perimeter was occupied, urbanised, and encircled within a wall. Recently, Alessandra Avagliano (2018) mapped the fragmentary archaeological remains of the Archaic phase of Pompeii. However, the main orientations of the Archaic city remain in incognito. Maria Bonghi Jovino (2011) outlined the current state of research on the topic: the first interpretation suggests a continuity of orientation from the Archaic to the Hellenistic city; the second tends towards a discontinuity. The ambiguity in this result is due to the general lack of accuracy in archaeology when reporting a building orientation. Moreover, the pre-roman town has been excavated only in small portions and most of Archaic findings are not locate on streets, but under houses and buildings, thus reconstructing viability and historicising roads is complicated by the lack of records. Finally, the altimetric differences in altitude of the plateau, with *Via Stabiana* following the contours of a natural canyon, should be considered as a constrain leading the layout to diverge from a geometrical form.

Skyscape Archaeology

In questioning the diachronic layout of Pompei, it may be useful to test astronomical hypothesis of orientation. Indeed, the *Etrusca Disciplina* of setting boundaries was based

on the observation of the sky, at least as far as the Latin legacy can testimony. Heinrich Nissen (1906)first proposed a summer solstice sunrise alignment for *via di Nola*, but mentioning an error evident by the fact that the south side of the street was not illuminated (Nissen 1906, 105-107). The starting hypothesis by Nissen was tested by employing digital reconstruction of the land- and skyscape by using a georeferenced cartography (Morichi 2018), Stellarium (2019), and Horizon (©Andrew Smith), with processed DTM data (SRTM 3"). Moreover, adirect fieldwork has proven the compatibly of direct data with the digital models. The orientations of *Via dell'Abbondanza*, *Via di Nola*, and *Via delle Terme* were compared to the position of the rising sun at summer solstice in the Archaic period above Monte Torrenone and Faitaldo. The best fit result was for *Via delle Terme*, orientated towards the solstitial sun within 0°.5, in respect to *Via dell'Abbondanza* with 1°.2 of error, whereas *Via di Nola* has a divergence error of 1°.3.

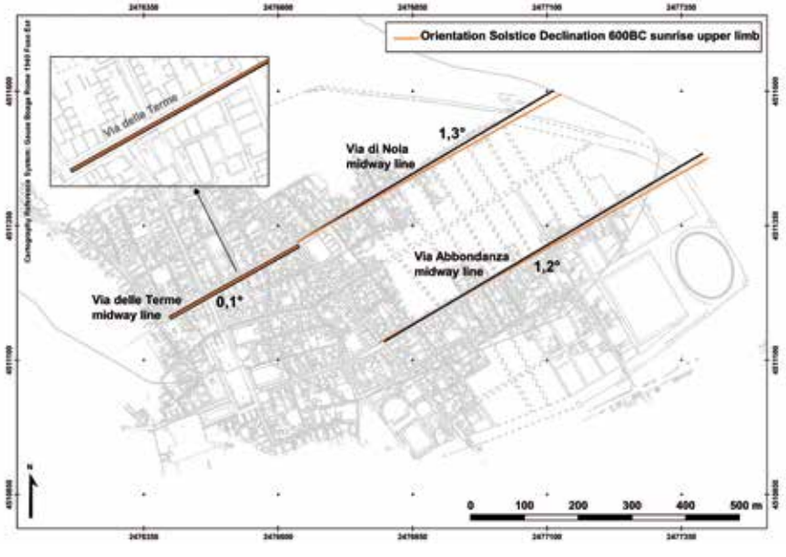

Fig. 1. Comparing the orientation of street centrelines (black) with the direction of the sunrise upper limb rising on summer solstice in 600 BC (orange lines). All orange lines are created parallel to each other's starting from the one at Via dell'Abbondanza, obtained after Total Station fieldwork measurements and data analysis for the sun position. The geometrical translation is possible due to the sun infinite distance in respect to the urban dimensions: the sun has the same azimuth (60°.37) for the whole plateau of Pompei when rising above the local mountains (elaborated by Michele Silani).

Such orientations are valid for the Hellenistic restructuration of the city, also assigned to the entire eastern side of the city and later monumentalised with the construction of Temple of Fortuna in 9 BC. But some hints may suggest that this choice was a perpetuation of the urban orientation already from the Archaic period, especially if considering those structures directed east-west: the *pappamonte* foundations below the *Casa dei Gladiatori* V, 5, 1-3 are approximately parallel to *Via di Nola*, as well as those found at the house VII, 14, 40 (Bonghi Jovino 2011, 9). Furthermore, it not coincidental that the Archaic Doric Temple, situated on a promontory on the southern limit of the city, has its main axis aligned with the summer solstice sunset: with an azimuth of 300°.8, the sun was seen setting behind the city plateau, which was hiding the horizon for 1°.7. Instead, at the opposite direction, the temple is not aligned with the sun rising at winter solstice due to a prominent orographic landscape.

In order to confirm the intentionality of such astronomical alignment, a statistical test was carried out: considering the co-existence on site of two important solar directions, one in the urban grid and the other at the Doric Temple, the probability that this is coincidental is 0.2%. Moreover, archaeological evidence in relation to the cult of Heracles at the Doric Temple and the position of *Via Consolare* proposed by Coarelliwill be further scrutinised with the additional evidence of the alignment to the direction of the summer solstice sunset. The intention of assuring equal solar irradiation all year could be one explanation for the urban grid and this needs further testing.

Conclusion

It seems that the urban solstitial alignment of Pompeii is relative to thereorganisation of the city during the Hellenistic age. However, this datum can be read as a continuationof memory from the Archaic period, already explicit in the preservation of the urbansacred spaces. Indeed, the exact *dies* when the Archaic Doric Temple aligned with the sun, the day of summer solstice, is coincidental with thealignmentof the urban layout at sunrise. At the current state of knowledge, it is not possible to confirm if the city had the same orientation from the Archaic to the Hellenistic period, but it is possible to infer that sacred spaces preserved such temporal memory of foundation. These preliminary results will be contextualised by applying the method of skyscape archaeology to other Campanian cities in order to compare data.

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SUMMER SOLSTICE SUNSET AT THE CAVE OF AYIA TRIADA

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The Cave of Ayia Triada in southern Euboea is a long, only partially explored cave. Archaeological material dates to three main chronological periods: Late Neolithic I; Late Neolithic II / Final Neolithic; Early Bronze Age II (Mavridis & Tankosic, 2009). It has yielded the earliest archaeological material in the greater region.Its studysuggested a symbolic significance connected to rites conducted inside the cave (Mavridis & Tankosic, 2016a), as the narrow corridors, the absent of galleries and the lack of light just a few meters inside, make the cave unsuitable for habitation.

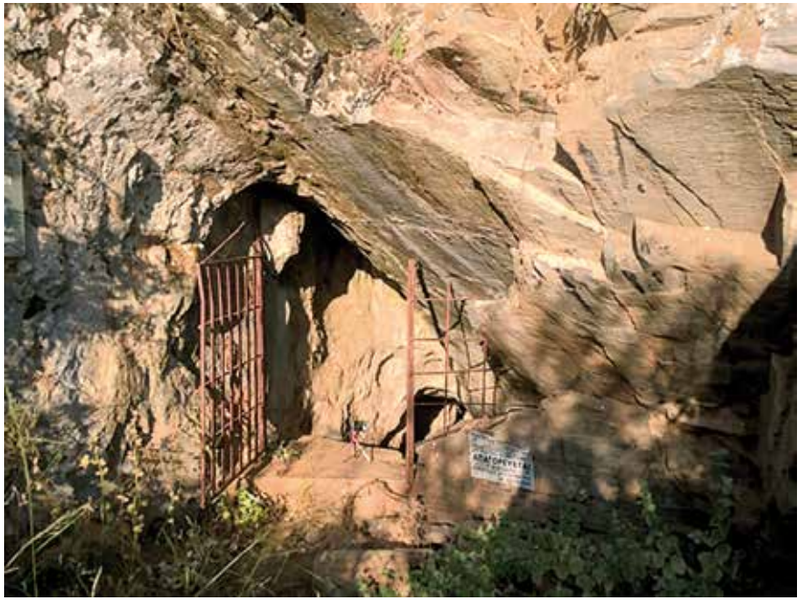

Fig. 1. The entrance to the Ayia Triada cave, lit by the sun rays, just a few minutes before sunset.

Most importantly, it is the place of a unique mortuary ritual from EBA: a secondary deposition of human bones, of possibly nine individuals, together with animal bones and large quantities of broken pottery, over a layer of carbonized figs and cereal sand below a thin layer of stalagmitic crust (Mavridis & Tankosic, 2016b). The use of caves for burials is on its own a very rare phenomenon in the EBA, let alone the elaborate ritual suggested by the archaeological excavation and the osteological analysis (Prevedorou, Mavridis & Tankosic, 2019) which is not found in any other burial sites in Greece.

On our visit to the cave, it became apparent that the cave entrance is oriented towards the summer solstice sunset; this may be the reason that this particular place was selected for the ritual. Thus, the cave of Ayia Triada joins the long list of caves with a solar orientation towards the solstices or equinoxes used for rituals.

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ON THE ORIENTATION OF EARLY SYRIAC CHURHES

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In our continuing saga to find the way early Christian churches are oriented eastwards, we turn our attention to the early Syriac churches. Although a lot of attention is paid on the orientation of medieval churches, not much research is done on the early Christian churches of the Middle East, which due to their location near the birthplace of Christianity may point to the roots of orientation canons. Also, settlements in the area were established in the Hellenistic period and flourished until the end of Byzantine times, enabling us to check temporal shifts in the orientation habits. Finally, unique architectural characteristics of churches in the area may be linked to differences in orientation.

We use the term “Syriac”, instead of “Syrian”, to draw attention that the Syria of late roman era was a much larger geographic and cultural area than the country of the same name that exists today. Thus, our study extends in nowadays Syria, Lebanon, Turkey, Iraq, even the Arabian Gulf. We do not include churches in Jordan, as an in situ survey is already in progress. We also limit ourselves to only a few churches in north Israel as Google Earth coverage of the area is of very low quality.The churches studied date from the earliest churches of the 2nd and 3rd centuries, to the majority dated in the 5th and 6th centuries. Later churches are also included in the data, including the 8th century, with a handful of later ones probably built on pre-existing older structures.

As the current situation in Syria makes it impossible to carry out in situ surveys, we use remote measurement using the *Google Earth Pro* software. Our main sources for locating the churches are the gazetteer of Burns (2009), the surveys of Tchalenko (1953) and –of course– the study of Syriac churches by Butler (1929). A complete list of all the churches, our calculations and references is available as an online map.

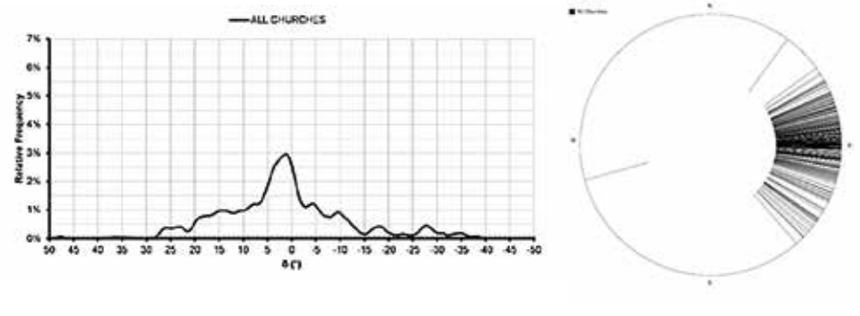

Fig. 1. Provisional declination curvigram and azimuth diagram of early Syriac churches.

We measure the orientation of almost 350 early Christian churches and conclude that vast majority of them point within the solar sunrise arc with a distribution that peaks around the time of equinox and the feast of Annunciation. However, the orientation is not the same in all areas; we do note sets of churches that seem to be oriented extremely south or extremely north and which may be linked to pre-existing orientation customs.

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THE SHARP ROCK SANCTUARY AND THE LEGEND OF KRALI MARKO

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The Sharp Rock sanctuary is also known as Marko's Rock or Vineyard Rock because of the vineyards that once existed around it. It is located to the west of the village of Chokoba, Sliven District, on a small rocky hill at an altitude of about 240 m. It lies in the easternmost parts of the Sredna Gora Mountains and has good visibility of the horizon in all directions. A wide passage divides the rocks into a southern and a northern part (Fig. 1).

Fig. 1. Aerial view of the sanctuary from the east.

An explanation for the name Marko's Rock as well as for the names of some carvings on the rocks is found in a local legend about Krali Marko, the most distinguished protagonist in the Bulgarian heroic epic. For example, the top surface of the southern block is artificially leveled and is called Markova trapeza ('Marko's Dining Table'). A rectangular altar is also carved there. On the northern slope, two small oval cisterns are cut and called Krali Markovi stapki ('Krali Marko's Steps'). After a rain, the water remains in them for a long time. In the enslaved Bulgarian lands, Krali Marko was the beloved patron and protector endowed with superhuman stature and strength. He appears wherever his help is needed. The traces of his footsteps, of his horse's hooves, of the blow of his mace or sword are signs of his presence and feats.

The sanctuary has a special place in the traditional culture of the local people in and around the village of Chokoba (Demirev, 1983). At the beginning of the Great Fast before Easter, boys and bachelors light fires here. After three days of strict fast, the village maidens perform a ritual washing with 'healing water' from Krali Marko's Steps, followed by games, songs and a spring dance called Buenets. The sanctuary is also a scene for certain rituals performed after weddings by the newlyweds especially if the bride is from another village. Washing with the 'healing water' and tying red thread on a nearby rosehip bush are a way to present the new couple at the sacred place of the ancestors and welcome it in the family. The name of the Chokoba village can also be related to the sanctuary. In the Turkic languages, its first part 'chok' means 'many' while the second part 'oba' bears the meaning of sacrificial stones in honor of the spirit of the mountain.

Rocks with 'traces' left by Krali Marko at other sanctuaries in the Sliven region have preserved the memory of rites performed around the Orthodox feast of the Forty Martyrs or Mladentsi (Infants) – March 9th. The documented ethnological and folklore data show that a much older pagan tradition is carried over in time. The places associated with the performance of these rites acquire a special, sacred meaning and status (Demirev, 2014). Behind the written and oral narratives, there are thousands of years of life preceding them. We can make conclusions about the material culture and the spiritual world of the people of that time mainly based on archaeological data.

The sanctuary is located in an area with millennia of history. To the north, the Tundzha River flows, whose southern banks were inhabited as early as the Early Neolithic. In the immediate vicinity, in the area of today's village of Chokoba, there are settlement mounds from the Late Neolithic, the Chalcolithic and the Bronze Age. A mound necropolis and an antique settlement have also been found (Banov and Demirev, 1991). All this testifies to a long and intensive life determined by the favorable natural conditions for both the ancient farmers and cattle breeders, and the first miners.

The astronomical analysis is an integral part of the study of rock sanctuaries. As is well-known, tying an entire site or its elements to the cardinal points or to important markers on the visible horizon is a necessary part of their sacralization. Therefore, astronomical knowledge is commonly found at cult sites, even if no written records exist about them.

Our study revealed structures that, although destroyed by erosion and human activity, mark very well the cardinal points – east, west, north and south. There are also cases where the orientation is towards remarkable details of the horizon that are connected with the Sharp Rock through motifs from the legend of Krali Marko. For example, a deep groove is carved on the central rock in the northern part of the sanctuary, which directs the observer's eye exactly to the north, towards the Sliven Mountain. When viewed from there, the Golyama Chatalka Peak (1100 m) is seen right in the middle of the groove's V-shaped profile. According to the legend, the loom used by Krali Marko's sister to weave is located on this peak.

The long grooves cut on the slopes of the southern block point southeast to the Bakadzhitsite Ridge. From there, the legend says, Krali Marko led the freed slaves all the way to the Sharp Rock to feed them. The long axis of the rectangular altar at the top points northeast to the Zaychi Vrah hill where there is another rock-cut sanctuary. These two directions are symmetrical with respect to the east. They mark the points where the sun rises about a month before and after the equinoxes. The study also pays attention to the important calendar days, which are in line with the solar-chthonic and probably also astral nature of the legendary horseman. It is believed that magical acts performed with fire and water at Marko's Rock can boost the fertility of the earth in the season when the sunshine increases significantly and the recognizable spring stars appear in the sky.

Tracing the various aspects of the folk tradition, both in the worship of the Sharp Rock sanctuary and in the living legend of the immortal horseman, reveals to us the worldview and religious beliefs of the people who inhabited these lands millennia ago.

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AN ARCHAEOASTRONOMICAL PERSPECTIVE ON LBA TUMULUS NECROPOLIS LĂPUŞ – PODANC FROM ROMANIA

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The impressive tumulus necropolis of Lăpuş in northwest Romania is one of the best-known Late Bronze Age sites in the eastern Carpathian Basin. This is not only due to the rich and prolific finds and the detailed information about funerary ritual from the excavated tumuli but also because of the fact that the chronological sequence of the cemetery's use is a keystone in defining the initiation of the Late Bronze Age in the Carpathian basin (Kacsó et al., 2011).

The LBA tumulus necropolis Lăpuş – Podanc of 13th - 12 centuries BC century Transylvania was used for about 200 years. The burial rituals are diverse, not all mounds can be classified as proper graves but rather as barrow shaped ritual monuments. It comprises of 70 tumuli spread over 20 ha. Its barrows have produced a selection of grave goods hitherto unknown from any other contemporary burial site.

This décor also occurs on large high necked vessels which are decorated with, among other things, figurative motifs like animal head protomes and incised friezes with zoomorphic and anthropomorphic décor combined with symbolic motifs such as the **target design** (**solar symbol?**) which only become an integral part of east central European art in the Hallstatt period (Kacsó et al., 2011).

From the Lăpuş – Podanc group 3 barrow shaped ritual monuments (Kacsó et al., 2011) site the summer solstice sunrise aligns with the pyramid shaped Hudin Peak and the sunset aligns with the trapezoidal shaped Șatra Pintii Peak (Fig. 1). Nowadays the events are off due to axis precession but in LBA they would have occurred behind the peaks. The double alignment significantly increases the statistical chances for an intentional placement of the necropolis. It is hence likely that the sunrise and sunset during summer solstice played an important role in the funerary rituals at Lăpuş,

In our study we simulated based on photographic imagery, and compass and clinometer measurements the sunrise and sunset during LBA using the Cartes du Ciel and Stellarium v.0.19 astronomical software. The presented cases add value to the archaeological landscape by attempting to establish the vast context of the solar ritual rite in LBA from an astronomical perspective.

The Lapuş tumulus necropolis at is not located near a large settlement, however it was used repeatedly over a long period of time.

It's probably a place of ceremonies related to a cosmology in which the sun and the mountains are important references.

As in the present, it is likely that in the past rituals related to the worship of ancestors must take place at certain times of the year, on these occasions people who the respective companies emphasize their intra-community relations, and the summer solstice could be a good moment for that.

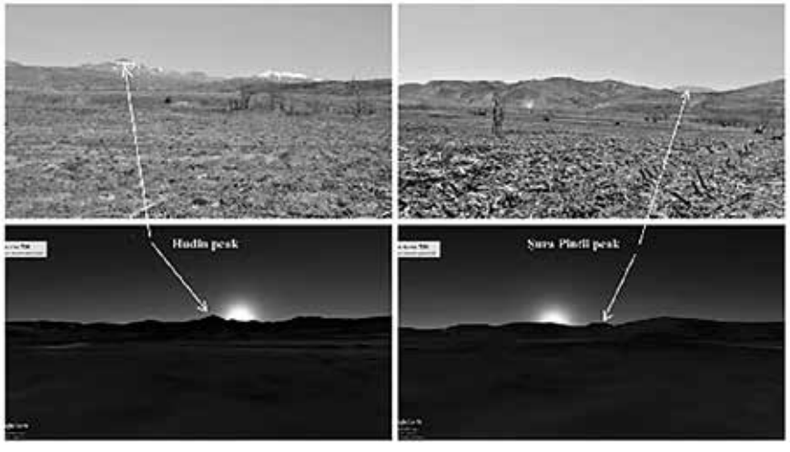

Fig. 1. (top) Actual landscape. (bottom) Sunriseandsunset as simulated in Google Earth for 2020.

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UTILISING THE NATURAL WONDER OF THE SKIES.

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This paper considers the philosophy of awe and wonder as an appropriate theory for cultural astronomical research. The philosophical basis for epistemology stems from Plato’s exploration of the nature of knowledge, where Socrates discussed with Theaetetus his small difficulty. This sparked a debate about how we discover knowledge, concluding that wondering is where philosophy begins. Subsequently, this established the core of Heidegger and Husserl’s transcendental philosophies, which explore sensory-data-input knowledge and subjective states of knowledge. Current theories of wonder within anthropology and archaeology, also stem from this philosophical framework.

As scientists we are familiar with the idea that truth is largely objective. This permits causal explanations and undertaking hypothesis-tested research. For example, the proposition was that by measuring at Clava Cairns, which have a distinctive north-east/south-west orientation, then orientations would be found on the midwinter sunset, and southern moonset limits, with perhaps stellar alignments. To further refine the research, the region’s riverine horizons were included, where the hypothesis was that there would be more significant lunar sky narratives at cairn sites, in comparison with non-cairn sites. This hypothesis-driven research led to undertaking fieldwork which could be replicated and verified by independent researchers in the future. This is familiar, accepted, scientific procedure. With this approach, we usually seek scientifically, replicable, precision measurements, to indicate the likelihood of intentionality within our methodology. However, I will argue that we need to substantiate our methodology with an equally rigorous, broader theoretical approach.

As a discipline it is essential that skyscape archaeology’s ideas and theories continue to evolve. When exploring material of a social nature, human behaviours cannot solely be viewed through the lens of the scientific hypothesis-testing approach. Where human beings are concerned, truth is relative and open to changes in perception and interpretation. Such an awareness leads to research which is data driven rather than hypothesis driven. In exploring ancient monuments, we encounter socially constructed ideas, which require more inductive theorising, if cultural astronomy is to be understood by other disciplines. I recommend that we undertake both kinds of research: that which encompasses scientifically verifiable data gathering, with a broader theoretical framework which explains our findings in ways that fulfil the needs of anthropology and archaeology, as practiced in the twenty first century.

Frequently monuments sit within distinctive landscapes and by adopting a phenomenological approach, we ground mathematically derived alignments into a socially constructed whole. I propose that phenomenology alone is inadequate in explaining human responses in a ritual landscape. The intangible and mysterious cannot be assessed by phenomenology alone. An appreciation of myth is also essential. Myths of a cosmogonic nature enable skyscape archaeologists to encapsulate sky phenomenon within a rich socially nuanced framework (Downes and Thomas, 2013).

Previous research at Clava indicated that access to buildings was by crawling through a tunnel into darkness, where cup-marked stones implied that certain locations

were special. Some of these dark dome-like structures are lit up by the midwinter sunset along the passages. I argue that sky narratives drove both the building of Clava cairns and the positioning of Barnhouse settlement in Orkney. I consider potential usage of social space within the ceremonial buildings at Barnhouse. Plus, how the structures on earth reflect ancestral or celestial connections. Social concepts are integral to the way people understand the sky.

These locations offer two distinct environments, one intrinsically connected with rivers and the other at the centre of an island. This posed questions about river travel, journeys, and understanding centrality. Centrality is exemplified by Colin Richards who stated that 'cosmologies allow a particular cultural understanding and categorization of the lived and experienced world' and that the spatial order within the building reflects the 'natural topography and environment' (Richards, 1996). I explore that inner spatial order and the way people are socially constrained as they enter buildings and move around once inside. The builders of these monuments responded to their environment and selected these locations to embody what they considered significant. They mirror their environment and the changing seasons. These structures, in their shape and form, reflect the sky above and the waters below. In the Central Highlands, the mountains and rivers are dominant features, but in Orkney the sky and sea prevail.

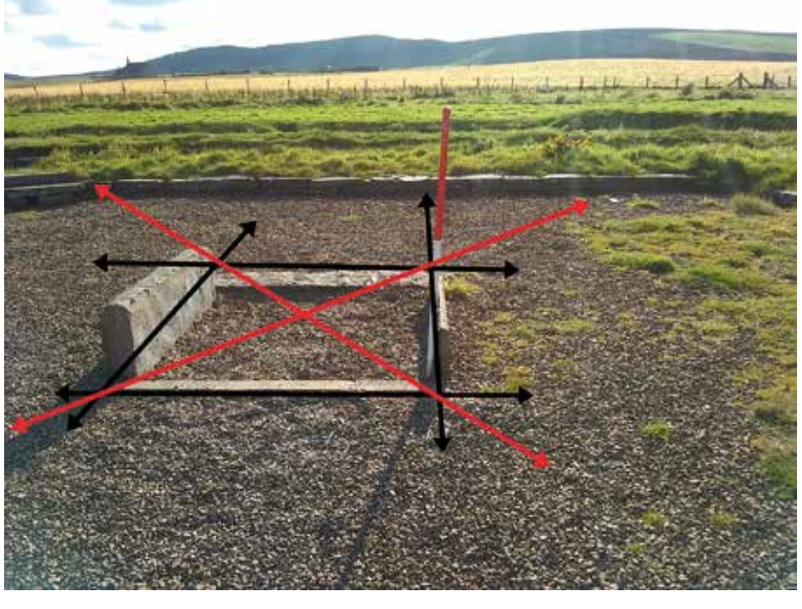

Fig.1. Barnhouse, Orkney, building 8. Hearth measurements.

The image of the hearth at building eight, Barnhouse, Orkney exemplifies the importance of measuring from many angles and the spatial order of the building. Jane Downes and Colin Richards commented that the hearth was a 'primary element of house construction' and its alignments, avoiding cardinal directions, were of 'particular importance'(Downes and Richards, 2005).There is also a hearth at the centre of the Stones of Stenness. Barnhouse is a Neolithic village surrounded by significant structures,

including Maeshowe chambered tomb, the Stones of Stenness and Ring of Brodgar, which comprise the UNESCO World Heritage Centre,Heart of Neolithic Orkney. The award-winning archaeological site of Ness of Brodgar is nearby.

Research conducted while travelling along Scotland's central highland rivers and at Barnhousewill serve as exemplars of applying wonder theory to skyscape archaeological sites. By adopting the theory of awe and wonder, we can express our findings in a way which addresses meaning, just as significantly as facts. Storytelling will be crucial in underpinning the legacy of cultural astronomy for future generations. By their nature wondrous events are fleeting and rare, they engender research questions not encountered by other theoretical frameworks. Skyscape archaeology needs to incorporate both scientific methods and innovative, ontological research.

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3-D LUNAR AND SOLAR ANALYSIS OF STONE ROWS OF COUNTY CORK, IRELAND,

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Following the 3-Dimensional simulations research as to potential astronomical orientations conducted into stones rows within Argyll Scotland (Fisher, 2019) and those surrounding the Presceli Hills of Wales (Fisher, 2017), the same approach is being applied to stone rows situated within the Republic of Ireland's, County Cork. By analysing the O'Nuallain's survey (1988) that indentifies sites that may still have a degree of integrity and sufficient stones still standing to warrant investigation, ten sites were selected comprising of stone arrangements ranging from 2 to 5 in number. Each site was visited and each stone within the site were measured dimensionally, geometrically and photographed.

These sites are:

- Ballyhalwick
- Carrigeen
- Castlenalact
- Cools
- Garrane
- Glandine
- Gurraneleigh
- Lackabaun
- Maughanasilly
- Rossnakilla

The construction of 3 dimensional models of the stones has been completed and placed within their 3-D topography created from Irish Transverse Mercator (ITM) coordinate system for assessing any celestial orientations is currently underway. This research has already exposed some orientations hitherto unknown and will expand on Ruggles (1994) reconnaissance with the intention of presenting the results to the SEAC community.

Fig. 1. Stones of Castlenalact.

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NEW CONSIDERATIONS REGARDING TWO MEGALITHIC SITES IN ARMENIA

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Armenia is home to numerous archaeological sites including megaliths and petroglyphs (Mickaelian and Farmanyan, 2016). Many of these date back to the bronze age and have been poorly investigated from an archaeoastronomical perspective. The research methodology and assumptions has led to debates regarding the astronomical significance of some of the sites (González-Garcia, 2015). In this reseach we revisit two interesting stone rows at **Qarahunj** in the Syunik region and **Hartashen** in Shyrak the province. While the former has caught the attention of researchers due to its complexity and increasing popularity, the latter is less known and studied.

Most theories about **Qarahunj** involve astronomical alignments and representations of constellations (Ayrapetyan, 2018). Ongoing excavations indicate that at least some of the menhirs are placed on a stone structure. We suggest in our study that the shape and placement of the menhirs is in fact related to the horizon, being representations of the distant mountains, similar to other places around the world, e.g., Machu Picchu. Our hypothesis is based on the various shapes, sizes, and apparent random placement of the menhirs. Starting from the northern edge of the complex one has the impression of having each important mountain marked by different menhirs (Figure 1 (c)). The shape of the menhirs is sometimes quite like that of the distant mountains (Figure 1 (a) – left). Some smaller stones are even placed in front of larger ones exactly like the distant features they seem to mimic (Figure 1 (b) and Figure 1 (a) – right). Figure 1 (c) depicts the summer solstice sunrise in 2019 as captured by our expedition team.

Hartashen is a site located in NW Armenia near the border with Georgia. It is a less studied site with a recent team asserting its role as a possible modern military barrier without completely dismissing a possible bronze age dating (Schunke et al., 2011). Magnetometric analysis has outlined some interesting underground features. It comprises of six stone rows divided in two groups. The two groups start at one end and then diverge, one of them crossing a valley (Figure 1 (d)) and the other covering the slope of a small hill (Figure 1 (e)). While the former may indicate it acted as a barrier for entering the valley, the location of the latter is quite strange as it runs parallel with the ridge of the hill. The two groups are in fact diverging towards the declinations 45°55′51.5″ and 44°35′45.38″. The difference in their orientation is of only 1°20′6.18″ (the Suunto Tandem 360Pc compass error is ~19′. The circumpolar circle for Harthasen is located at 48°59′6″ and can be reached by continuing the arc formed by the second group towards its end and the slope of the distant hill (Figure 1 (e)). It must be noted that the second group of does not extend beyond the sightline as viewed from their divergence point. The structure seems to symmetrically frame the north axis. Checking for bright stars rising from the indicated direction only Arcturus in 3000 BCE is found. Two large unexcavated circular cairns can be found between the two groups, one being around 30m in diameter which as indicated by archaeologists is perhaps the largest in Armenia.

Figure 1. Qarahunj and Hartashen.

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THE SALA DELLO ZODIACO IN VILLA GIULIA AND THE HOROSCOPE OF JULIUS III

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The Sala dello Zodiaco in Villa Giulia and the Horoscope of Julius III
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The Sala dello Zodiaco in Villa Giulia, the wonderful "suburbanum" built by Julius III Del Monte on the slopes of Monte Parioli in the north of Rome, is an overlooked mannerist jewel located in front of the famous nymphaeum, only recently restored and opened to the public. Its frescoed vault, attributed to the workshop of Prospero Fontana, represents classical gods alternated to chariots with seasonal symbolisms and an anomalous zodiacal spiral (RIBOUILLAULT, 2012), reflecting the helicoidal staircase devised by Vignola for the main casino. We will discuss the astrological elements of the decoration, showing that CIERI VIA (1996) was right in interpreting it as connected to the horoscope of the Pope, albeit the standard birth date she adopted was fairly wrong. The fresco is not the complete geniture of Julius, as calculated and commented by Luca Gaurico and Francesco Giuntini, but a careful selection of favorable planetary and stellar aspects in his birth theme. Other evidences of astrological propaganda and astronomical interests on the part of the Pontiff and his courtiers are examined, confirming the reading of the vault and revealing once more the extent of the involvement of the Renaissance Popes in the Science of the Stars (AZZOLINI, 2012).

Fig. 1. The zodiacal vault of the Sala dello Zodiaco in Villa Giulia, Rome (photo: G. Masi).

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PAINTING THE ANTIQUE ASTRONOMERS: AN ICONOGRAPHICAL INVESTIGATION OF THE BAROQUE PICTORIAL CYCLE OF THE HISTORY OF ASTRONOMY IN PALAZZO PATRIZI-MONTORO IN ROME

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We present an iconographical study of the largely unpublished pictorial cycle of the History of Astronomy in the roman Palazzo Patrizi-Montoro (PEDROCCHI, 2000), dated about 1700. The work is unprecedented in its range and scopes and constitutes the decoration of the hitherto unknown observatory of the astronomers-artists Mariano and Francesco Felice Patrizi, active during the pontificate of Innocens XII and Clemens XI (MARSHALL, 2015).

The sequence of 18 large-format paintings, complemented by 4 single herms carrying astronomical attributes, is presently preserved in the original Specola-Atelier of the attic of the building and in the first floor where some canvases have been moved, with the exception of a painting and an herm which appear to be missing. A large celestial planisphere painted on a ceiling of the attic and some astronomical instruments are also surviving (GANDOLFI, LEONE and MASI, 2019).

The cycle features 81 surviving historical episodes since the first century BC to the XVII century AD, some explained with a short textual description, but the majority associated only to a year, often imprecise or plainly wrong. We propose interpretations for many of the most puzzling scenes, identifications for a number of antiquarian architectural settings and a general discussion of the large portion of arabic astronomy represented, a very interesting evidence of the "subterranean" transmission of eastern texts and concepts during the western Renaissance and at the beginnings of the Scientific Revolution.

Fig. 1. The IX century AD. Pictorial Cycle of the History of Astronomy. Palazzo Patrizi-Montoro, 1700, Rome.

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TIME MEASURING DEVICES AND THEIR MULTIPLE FUNCTIONS IN EGYPT, GREECE AND THE ROMAN EMPIRE

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Fig. 1. Southern face of the Tower of the Winds in Athens with the wind Notos above the vertical south sundial.

To us, time is a fundamental and very familiar concept. Our calendars are determined by the number of days in the calendar month and the number of months in a year. The day is further subdivided in hours, minutes and seconds. Although these categories are based on regular and periodic astronomical phenomena, there are different ways in which people may conceive time because "time" is related to environmental conditions and socio-economic structures (Rüpke, 2011). Thus, it is not surprising that time measuring devices had multiple functions in antiquity which may be categorised as "scientific/calendrical", "daily use", "religious/cultic" and "symbolic" (Färber& Gautschy, 2020).I will present several objects from ancient Egypt, Greece and the Roman Empire and put them in a socio-economic context to highlight their various functions.

Monuments such as the Tower of the Winds and the Meridian of Augustus can be classified as scientific or calendrical instruments. The ensemble of the nine sundials on the Tower of the Winds is outstanding. It is a major *tour de force*illustrating the capability of Andronikos of Kyrrhos and his understanding of gnomonics and the underlying basic astronomical phenomena. These sundials announced local solar time rather precisely,

thus they deserve being categorised as “scientific”.

The Meridian of Augustus is best understood as a calendrical and cultic tool. It can barely be a coincidence that this large instrument was erected on the Field of Mars only shortly before the calendar reform of Augustus was inaugurated.In 12 BCE Augustus became *pontifex maximus* and thus responsible for the calendar. In the years since Caesar’s calendar reform intercalations had been applied in an improper way. Augustus declared in 12 BCE that the calendar was wrong and that he will adjust it again. The large meridian was the perfect tool to demonstrate to all that this was not only an ideological manoeuvre, but a necessity in order to restore the correct course of the calendar that was originally introduced by his adoptive father Caesar.

Objects such as sundials in Egyptian quarries were instruments of daily use, which only roughly divided the day into equal pieces of time. The lengths of these pieces – most common is a 12-hour-division – vary considerably. However, they seem to having fit the daily needs, namely announcing two daily work shifts and a break in between.

Water clocks from Egyptian temples are as imprecise indicators of local solar time as the sundials in the quarries. But it is known that they were regarded as secondary instruments – inscriptions on water clocks from Ptolemaic and Roman times reveal that they were only used if the stars or the sun were hidden. Without means of comparison a certain ritual was simply due if the water clock announced the corresponding hour. This kind of determination of the hour was backed by the authority of the god Thoth who is mentioned as “master of the hours” in the inscriptions on some water clocks. The god Thoth in form of a baboon sitting above the drain passed water from the vessel as though urinating, thereby serving to depict control over both the flow of the water and the passing of time. These instruments served religious purposes.

Texts such as funerary epigrams or inscriptions connected with the measurement of time (Bonnin, 2015) from ancient Egypt, Greece and the Roman Empire introduce another category, namely “symbolic”. They are especially interesting because the interpretation of the multiple functions of objects and epigrams/inscriptions from the times of the Roman Empire can be backed by literary texts. One such example is the habit to have a skaphe, a spherical sundial, installed at the tomb. Its main functions were to attract people to come close, to read the inscription and the name of the person resting there, as well as to remind passer-by on the limited amount of time of their lives. They functioned as point of attraction and asmemento mori. Showing proper local solar time was less important, if important at all. Although the lines may have simply be painted and be lost today, it deems significant that lots of sundials from secure tomb contexts do not show any declination lines. In the text Satyricon by Petronius (first century CE) the arrogant former slave Trimalchiostates that he wants to have a sundial in the centre of his tomb in order to command the gaze of passer-by because it was functional: anyone who wanted to know the time would then read his name!

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A POSSIBLE INTERPRETATION OF THE ORIENTATION OF THE MAIN STREETS OF STARA ZAGORA, ACCORDING TO THE CONSTRUCTION PLAN MADE BY THE ENGINEER LIBOR BAYER IN 1879

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This scientific report presents data from observations of the sunrise over Stara Zagora, by specialists Pencho Markishki from National Astronomica Observatory “Rozhen” and Georgi Georgiev, PhD student in cultural history at The University of Library Studies and Information Technologies, Sofia. In the process of reviewing and researching the information, the task was initially set to determine the orientation of the main boulevards in the city of Stara Zagora - “Tsar Simeon the Great” and “St. Patriarch Evtimiy” Blvd. Stara Zagora was completely burned down during the Russo-Turkish War of Liberation 1877-1878. In 1879, Libor Bayer - a construction technician from Austria-Hungary (Czech by nationality) was invited and prepared a plan for the regulation of the burned city and a town-planning plan, representing a rectangular chess plan, typical for the big cities in America. This modern act defines the nickname of Stara Zagora as “City of Straight Streets”.

These boulevards are the tentatively called “decumanus maximus” and “cardo maximus” by us from the new plan of the modern city. In the scope of the research it was necessary to determine on which dates in the old style the Sun disk / the Sun / rose, from an azimuth coinciding with the azimuth on “Tsar Simeon the Great” Blvd, at the time when this construction plan was prepared and implemented - in 1879. Specific field observations and measurements were performed.In the context of the historical situation and specifically of the possible justification for the orientation of these main streets, by Libor Bayer, the important historical events after the Liberation are analyzed.

Whether this technician, who laid the foundations of today’s city, had an ingenious idea in his plan, hinting at important dates of his time, remains to be seen. Science offers different opinions about the interpretation of the main azimuth line shifted by a little over 11 degrees, and in this report we will focus on the hypothesis that this is necessarily related to the date of a historical event in Bulgarian history. Of course, other hypotheses are possible, such as the relocation to protect the city from the winds from the north. Astronomical software was used, allowing simulations of celestial phenomena in past epochs, with reported corrections from the calendar of Pope Gregory XIII. The time after the Liberation was filled with hectic and dynamic preparation for the organic structure of the liberated Bulgarian territories, related to the removal of direct damage from the Ottoman rule, but also with the return of large masses of Bulgarians and the construction of homes, public buildings, infrastructure, and basic development activities.

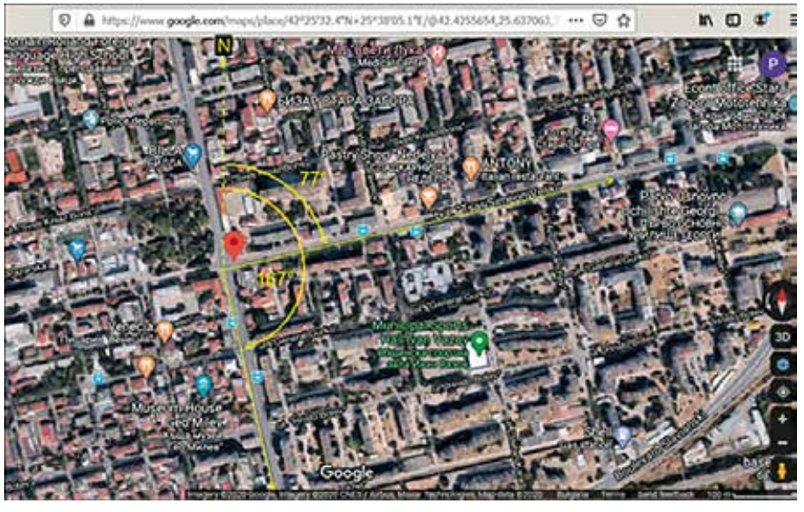

Fig. 1. Streets of the Stara Zagora town as panned by architect Libor Bayer

Thus the incinerated Stara Zagora finds its new leaders during the difficult times of reconstruction, who give strength and energy for the revival of the city. Publicly known and worthy Stara Zagora personalities, such as Dimitar Naumov, Atanas Iliev, Stefan Salabashev, foresightedly decided to seek the help of the Czech genius engineer Libor Bayer, who then resided in the new Bulgarian state. Not long after, the plan was prepared, approved and implemented. Libor Bayer's plan has been criticized, underestimated and praised, but it remains one of the world's examples of the continuity of history, with a visionary approach, in line with public needs and a general urban plan. The designated public territories are not insignificant, given the importance of presenting the Western achievements of civilization and, accordingly, the new Bulgarian government to distinguish itself from the declining Ottoman Empire by placing the nation state as a pillar of prosperity and stability.

The results of this study can help scientists, PhD students and researchers on the way to the search for historical truth, intertwined through the prism of astronomical observations, provided the basis for the creation of ancient Augusta Trayana, and subsequently contribute to the understanding of modern urban environment as a unity of spirit, culture, past and present.

ASTRONOMY AND IMMORTALITY IN THE ROYAL NECROPOLIS OF THE GETAE IN SBORYANOVO.

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The long term archaeological and interdisciplinary investigations of its Hellenistic necropolises of the capital of the Northern Thracians- the Getae in Sboryanovo reveal on several levels the unbreakable connection between their belief in the astral immortality, their enigmatic rites of immortalization and their deep astronomical knowledge. This is demonstrated by the general location of the mounds insinuating the idea of the Milky way – the way of the souls, by the clusters of tumuli that largely coincide with the mirror image of part of the brightest stars in several constellations / Canis Major, Canis Minor, Orion in the Eastern Royal necropolis/ or by the mounds from the Western necropolis – a double mirror image of the constellation Sagittarius.

Fig. 1. Sboryanovo the capital of the Northern Thracians – the Getae.

The egg shaped and covered with white stones constructions of some of the tumular embankments suggest its predetermination by the Orphic idea of the cosmic egg and unique rings of Eros – the progenitor, appearing form the cosmic egg are found only in them. The orientation of the axis of the unique Sveshtari tomb of the Getic ruler Dromichaites from the 1st half of 3rd century BC coincides with the direction of the winter

solstice in the end of 4th century BC and is another example of the binding of the path of the soul with the cosmic cycle.

The results of these investigations confirm the claims of the ancient authors that astronomy was one of the main disciplines in which the Getic priests were teaching their young noble men.

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WHEN LOCATION MATTERS: THE DOLMENS OF THE CENTRAL PYRENEES, A REAPPRAISAL

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The area of the Spanish Central Pyrenees, in the province of Huesca, houses some of the higher altitude dolmens in Western Europe. The agro-pastoral communities that occupied these areas seasonally for around two millennia since the local late Neolithic (Pérez Arrondo & Martínez Bea 2004) erected these monuments. Possibly built along routes to cross the mountain range and at areas used for cattle herding in the summer months, they are mostly located at the ravines close to the alpine river valleys.

The megalithic structure is generally comprised of a small chamber with normally four or five stones defining a square chamber. A small tumulus or cairn surrounds this structure (Narvate Sanz 2005:124-135).

In 2012 a small number of these dolmens were measured and their overall orientation was compared with that of other neighbouring groups of dolmens to find that their orientation was similar to that of the megalithic monuments found in the eastern valleys of the Pyrenees and in Catalonia (Belmonte & González-García 2012). This sample contained dolmens both in the area of high mountains and in areas closer to the river Ebro valley.

We now present a more detailed study on a larger number (30) of the high altitude (up to nearly 2000 m.a.s.l.) megalithic monuments. Their orientation was measured using standard techniqueswith a tandem including a professional compass and clinometer, later corrected for magnetic declination. The error of an individual measurement should be considered of the order of ±½° for both azimuth and angular height. However, the error in the azimuth itself may be larger because of the characteristics of the dolmens and their varied state of preservation

When we consider all of them together, taking into account the high altitude of the mountains defining their local landscape, their orientation is always compatible with a lunar or solar orientation in the horizon, either rising or setting.

To understand and contextualize these results, it isparticularly important the area where the dolmens are located. These high altitude valleys are normally covered in deep snow during late autumn, winter and early spring. Besides, recent ethnographic accounts indicate that the local herders bring their flocks to the highestpastures in coincidence with the start of summer. This information, together with the pattern of orientation of the dolmens, may shed further light to disentangle the possible use of these megalithic monuments at particular times of the year.

Fig. 1. The Acherito dolmen in the central Pyrenees. We can notice here the mound that covers the megalithic structure at the central part of the picture. Located nearly at 2000 m.a.s.l. it presents a small chamber surrounded by a mound of loose stones. The landscape is rather mountainous at this site and it is characteristic of most of the dolmens in the area. It lies on a natural route to cross the mountains that even in midsummer still house permanent snow deposits. The area is completely impractical during late autumn, winter and early spring. Image: Jorge CanosaBetés ©.

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THE RECURRING SEASONS: AN ORAL STORY-ALMANAC PRESERVED IN THE EPIC POEM *BEOWULF*

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My cross-disciplinary project, *The Recurring Seasons*, uses artwork, prose, diagrams and astronomical observations to gaze into the origins and structure of *Beowulf*. Here, I explore the possibility that *Beowulf* grew out of an oral epic that borrowed its shape, structure and rhythms from close observations of the seasons as well as celestial patterns. Those amassed observations were part of an "oral almanac" tradition.

Long before the Beowulf poet preserved it, I believe *Beowulf* took shape as an oral epic poem, arising from a tradition whose practitioners were close observers of nature and celestial patterns. My hypothesis draws from my early life on a farm that relied on an oral almanac; this unique experience left the imprint that led to leaving my training as a painter for travel through the American Southeast and to West Africa, collecting oral traditions that serve as almanacs based on skyscape observations, as well as evidence in early written literature.

Norse calendar. The epic, Anglo-Saxon literature written sometime in the late first millennium CE, is set in a medieval Norse culture so my *Fig. 1* calendar grid references the Norse months and seasons of contemporary Iceland's lunar calendar. Each of the Norse calendar's two seasons—winter and summer—have six of that calendar's twelve 30-day months. To match the length of a solar year the Norse calendar adds a small mid-summer "leap month" called *Sumarauki*, "additional summer," with which to accommodate an extra four or—when an extra "leap week" is needed—eleven days. Little is known about the history of the written *Beowulf* or the spoken versions likely preceding it; I locate *Fig.1's* calendar in the early medieval period (ca. AD 300). Due to precession's effects the solar Julian calendar's Christmas was then in November, its Summer Solstice in May; for this discussion I align the Julian months with the Norse calendar.

Norse seasons	Norse lunar calendar	Julian solar calendar	Astronomical markers	Story's primary themes	*Story's secondary themes*
	Sumarauki	***May/June***			
Waning **SUMMER** months	Heyannir	June	***1a.** First Bread*		***1a.** Situation's conflict*
	Tvimanudur	July			
	Haustmanudur	August	**A1. AUTUMNAL EQUINOX**	**A1. Call to glory**	
WINTER	Gormanudur	September	*2a. All Hallows Eve*		*2a. Hero's honor discounted*
	Ylir	October			
	Morsugur	November	**B1. WINTER SOLSTICE**	**B1. Monster's death**	
	Porri	December	***1b.** Groundhog Day*		***1b.** Situation's resolution*
	Goi	January			
	Einmanudur	February	**A2. VERNAL EQUINOX**	**A2. Glory won**	
Waxing **SUMMER** months	Harpa	March	*2b. May Day*		*2b. Hero's honor redeemed*
	Skerpla	April			
	Solmanudur	May	**B2. SUMMER SOLSTICE**	**B2. Hero's death**	

Figure 1. Seasonal calendar of the Early Medieval period (ca. AD 300)

Beowulf. The epic poem *Beowulf*, written in what is now called Old English, tells of a Norse warrior's quest for honor and renown (Heaney, 2008). My childhood on a

farm that relied on an unwritten almanac, and my knowledge of oral traditions, has given me a particular lens to interpret this work. In one section of the work, a vivid description of Beowulf tearing the arm off Grendel, a man-eating giant, is bracketed inside a calm description of a long dark night, which could be the Winter Solstice. The epic's four primary themes are an expressive fit with seasonal features of the Quarter Days; and the eight secondary themes are a likewise fit with the Cross-Quarter Days. The resulting simple story diagrammed in *Fig. 2* is a summary of the themes in the *Beowulf* epic starting with the cross-quarter day **1a First Bread**, resurrecting an oral story-almanac possibly remembered in the written Beowulf.

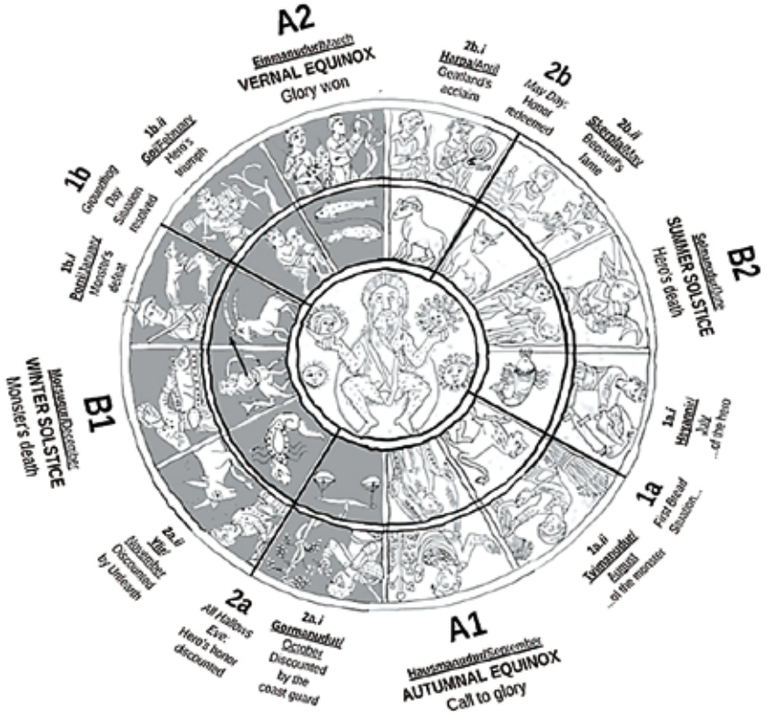

Fig. 2. Beowulf 's repeating themes mapped as a calendar wheel that begins at the Cross-Quarter Day **1a. First Bread.**

Beowulf as a story-almanac; ring compositions in oral-influenced literature. *Fig. 2's* repeating themes are similar to a classic ring composition, the formal device signaling closure which is typical of archaic Greek literature and generally of oral and orally-influenced literatures. Closure is effected formally by repeating at the end a theme announced at the beginning. An example of the device from the *Iliad* is Achilles' **ABCDCBA** speech to Priam:

A 599-601 Your son is free, you will see him tomorrow.
B 601 Now let us think of eating.
C 602 For even Niobe was mindful of food.
D 603-12 The story of slaughter of Niobe's children Apollo and Artemis.

C 613 Niobe ate, when she had tired of weeping.
B 618-19 But come, let us also think of eating.
A 619-20 After that you can mourn your son, when you have him back to Troy (Niles, 1979).

Accordingly then, in *Fig. 3*, *Fig. 2's* primary themes repeat as the Quarter Day pairs **EquinoxA1>A2** and **SolsticeB1>B2**;and the secondary themes repeat as the waxing-month/waning-month book-ends of the Cross-Quarterpairs **1a>1b** and **2a>2b**.

Quarter Days/ primary themes	Cross-Quarter Days/secondary themes		
	waxing month	Cross-Quarter Day	waning month
A1. Equinox with **A2. Equinox**	**1a. First Bread** with **1b. Groundhog Day**		
A1. Autumnal CALL: King Hrothgar is ruined by Grendel; heeding this grim call to glory Beowulf sails to Denmark .	**1a.i.** "All warriors know" a discounting must be redeemed; Beowulf honor was stained by his having been discounted as an unprotected orphan child.	**1a. CALL:** Beowulf must redeem his honor/ Grendel must hate and ruin Hrothgar.	**1a.ii.** "All pagans know" Danish king Hrothgar's destruction of the forest to build his high hall would mean hate and ruin from Grendel the forest's ogre.
A2. Vernal RESPONSE: Hrothgar is saved from ruin because Grendel is slain; having achieved a bright glory Beowulf sails back to Geatland.	**1b.i.** Grendel invades Heorot and Beowulf slays him. In gratitude Hrothgar gives a feast for Beowulf that is lavish with praise and extravagant gifts.	**1b. RESPONSE:** Beowulf's honor is redeemed/ Grendel is slain and Hrothgar is saved from ruin.	**1b.ii.** The troll-dam invades Heorot and Beowulf slays her too. At an even bigger feast Hrothgar gives Beowulf treasures that are also tokens of honor.
B1. Solstice with **B2. Solstice**	**2a. All Hallows Eve** with **2b. May Day**		
B1. Winter CALL: Young Beowulf slays dark Grendel on the longest night of the year.	**2a.i.** Beowulf beaches his ship on Denmark's shore; a prideful coast guardsman rudely discounts the hero's right to enter Denmark.	**2a CALL:** Beowulf is twice-discounted: when first entering the call to glory, and then when in the midst of that work.	**2a.i.** Hrothgar welcomes Beowulf's offer to fight Grendel; Unearth a jealous and drunk Danish warrior rudely discounts Beowulf.
B2. Summer RESPONSE: Aged Beowulf and Fire Dragon slay one another on the longest day of the year.	**2b.i.** The Geat king Hygelac welcomes Beowulf, extols the once-discounted orphan as a great hero, grants him treasure and lands.	**2b. RESPONSE:** Beowulf is twice-redeemed; when first entering greatness, and then when in the midst of that work.	**2b.ii.** Time passes, Hygelac dies in battle; for 50 years Beowulf rules the Geats, blessing them with peace and prosperity.

Fig. 3. Diagram of the Beowulf epic's repeating themes, starting with the Cross-Quarter Day **1a. First Bread**.

The Recurring Seasons, an in-progress artist book. The narrative structure of *The Recurring Seasons* comes from a year—late Summer through Summer Solstice—of Norse seasons. The book begins with the leap month *Sumarauki* and then proceeds with the warrior Beowulf's themes (see *Fig. 3*) traveling alongside a medieval Norse farmer's

monthly labors (see *Fig. 2*). The presentation's accompanying poster includes text and images excerpted—late Summer to Winter Solstice—from the book.

My images of Beowulf quote the Bayeux tapestry, and I use the mono-spaced Courier font to recall pre-laptop field notes entered on a small portable typewriter during an expedition to find the earthy poet who first entered the starry sky in a hero story's DNA.

Conclusion

My conclusion—that the written Beowulf's orderly structure comes from an inherited oral story-almanac—is in part conjecture based on past experience with oral almanacs; readings in Anglo-Saxon literature and culture (including Garner, 2016) and in cultural astronomy; and on the material evidence of *Figs 2* and *3*: when Beowulf's four primary and eight secondary themes are mapped as a ring of seasonal markers (*Fig. 2*), then an almanac comprised of four sets of repeating call-and-response pairs appears (*Fig. 3*); I believe that this orderly seasonal almanac gives the written poem its remarkably coherent structure.

In the world of science I am an engaged and occasionally published amateur. The written and oral evidence for my conclusion is limited but I believe the material evidence is compelling. *The Recurring Seasons*, a cross-disciplinary artist book making reference to cultural astronomy in its widest sense, is an experienced artist's view of the Beowulf saga interpreted as a story-almanac.

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COMPLEMENTARY DUALITY OF THE INCA'S COSMOVISION: AN ASTROPHYSICS PERSPECTIVE

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We seek to identify conceptual elements in Inca and pre-Inca cultures that are consonant and exhibit convergence with science, and more specifically with astronomy and astrophysics. Moreover, this procedure may allow, as a consequence of an analysis based on some aspects of epistemology and astrophysics, a deeper discussion within a structuralist/poststructuralist point of view.

Fig. 1. The dark constellations of the Incas in the Milky Way. Right to left: 1) Machacuay, 2) Hanp'atu, 3) Yutu, 4) Yacana, 5) Unallamacha, 6) Atoq, and 7) Michij runa. Western astronomy knows 3) as The Coalsack. Painting by Jessica Gullberg.

We find, albeit in a still preliminary conceptual way, some points of similarity between the Inca's cosmovision and modern views of space time, amenable to Hegel's dialectical and methodological vision, which relies on a contradictory argument process between opposing sides. Hegel's dialectics leads to a linear evolution or development from less sophisticated definitions or views to more sophisticated ones. An important

element of the Inca's cosmovision is the *Yanantin* (complementary opposites), a mode of contemplation based on a dual and complementary view of the Universe, which would represent the supreme commitment of the Inca civilization to harmonize conflicting opposites, seeking harmony as the supreme principle of humanity and realms. For the Incas the past, present, and future are ubiquitous, in the same space and the same time. From a conceptual point of view, in physics space is not objective and is not real, nor is it a substance. It is rather a subjective and idealized concept that originates through a logical mental process.

In this investigation, we endeavor to note epistemological contributions that may serve to broaden views of archaeoastronomy.

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THE SUN GOD OF PUENTE TABLAS (JAÉN, ESPAÑA)

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In the congress of SEAC, celebrated in Ljubljana, in 2012, a cult place was presented. It was associated to a gate in the defensive wall that protected the Iberian *oppidum* of Puente Tablas (Jaén, Spain)(Ruiz Rodríguez2011). During the congress, the idea of the representation of annual cycle was suggested because was grounded in the spectacular play of lights and shadows produced by the illumination of the stela along the corridor before the equinoctial Sunrise.

Three years later, in Rome (SEAC 2015) we presented the set of the urban sanctuary that the excavations had revealed. According to the Attic red-figure ceramics, the sanctuary was dated in the first half of the fourth century BC, but news evidence situates it to sixth century BC (Ruiz Rodríguez 2011, Ruiz et al 2007). The description of the sanctuary can be found in Pérez Gutiérrez (2016), like that all process associated to equinoctial aspects (in spring and autumn equinoxes) and to stela (the goddess).

Despite having found markers in the architectural elements (gate, corridor and stone bench offering beside to the door), it is remarkable that the easterly horizon gives astronomical marks in the Equinoxes, but not in the Solstices. At least until now, as a new finding has shed some light on this issue.

Fig. 1. The *Ara* of the Sun God of Puente Tablas.

We talk about a little *Ara* found in the sanctuary (Fig. 1), that is cut and engrave (in three sides) with a shape of a quadrangular prism of 10 cm lengthby4 cm base. In first side nothing is engraved. In the second one (left in the middle image) we found, in Iberian script, the name of (probably) founder of settlement of Puente Tablas: NOKAKIS. In a third one (right in the middle image) is engrave a rooster, who is associated with a daybreak. And the last side (left in the right image), which is more complex and still have some elements

without interpretation, has some elements that visible and readily identifiable. We can find the symbolic representation of a settlement and the representation of Nokakison the horizon, exactly in the place where the sun rises in winter solstice. The other engraves are still under discussions but is possible associate them to a stellar representation and with some dates along the year, that is heliacal rising of a star/constellation. Some of these dates are reflected in the corridor close the sanctuary. We hope to conclude this research soon.

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RAMESES II AND SUNRISE AT THE GREAT ABU SIMBEL TEMPLE

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The High Dam project was carried out 1960-5 and the water level at Abu Simbel should be raised by 60 m and the Great and Small temples would be drowned. The temples were lifted by 65 m and the original orientation of the main axis of the Great Temple has been preserved. However, the first rays of the rising sun lit the statue of Rameses II, in the uplifted temple, on 22 October instead of on 21 October in its original position. The explanation is that the horizon altitude is 1.13° lower today. I have calculated the sunrise at Abu Simbel for 17-22 October 1961, and the path for the rising sun was compared with the hand drawn solar discs on the photograph by Haagen (1962). The azimuth for the axis of symmetry of the temple is determined as 100.930° ±0.005°. A photo taken on October 21, 1961, shows that the only completely sunlit statue was that of Rameses II. The same phenomenon happened for the first time on 19 October in 1275 BC, during the important ceremony that took place in the morning of the 30th year Jubilee of the reign of Rameses II. The Abu Simbel temple was built by Rameses II to celebrate the day when he became deified and King-God. Bauval (2008) writes: “The calendar criterion 1st Tybi fits only in 1275 BC and the first year of Rameses II 1304 BC.” I can confirm that it was New moon on 19 October 1275. This paper supports the High Egyptian chronology with 1304 BC as the first year of Rameses II, Henriksson (2007).

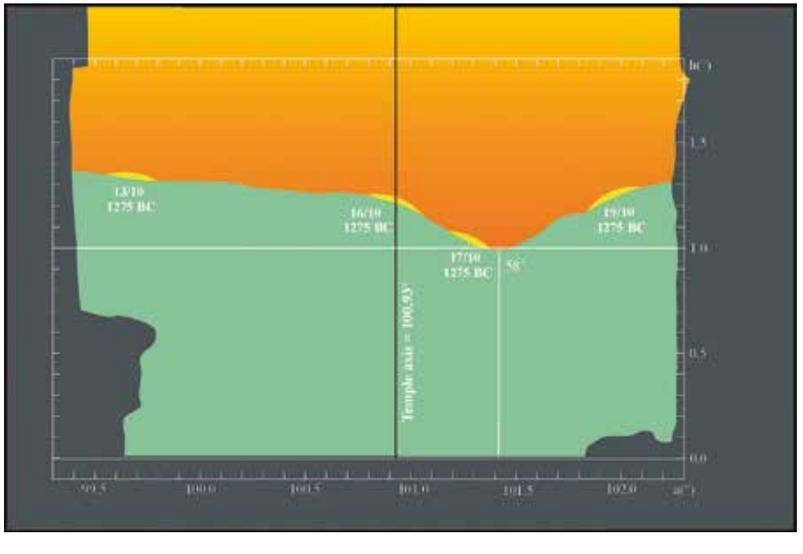

Fig. 1. Sunrise at the Abu Simbel temple on 13-19 October 1275 BC. The statue of Amon alone, Amon and Rameses and Rameses alone were lit by the rising sun’s first rays on 13, 16 and 19 October respectively.

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ORIENTATION OF 73 TOMBS FROM THE LATE MINOAN CEMETERY AT ARMENOI, CRETE

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The late Minoan II-IIIB cemetery at Armenoi (1450-1190 BCE) has a very special location to the west of Mt Vrysinas, a conical shaped mountain 858 m high. These tombs have a chamber and a dromos (a passage, cut into the limestone bedrock). All tombs seem to have an orientation of the dromos towards Mt Vrysinas within the azimuth limits of the rising moon.

Fig. 1
The peak of Mount Vrysinas as seen from the bottom of the dromos of tomb 146. (From Hi8 video 1998.)

Fig. 2.
The dromos of tomb 146 at Armini. The length of the dromos is 8.62 m. It is the third longest dromos at the cemetery. (From Hi8 video 1998.)

Papathanassiou et al. (1992) measured the orientation of 209 of the excavated tombs with magnetic compass corrected for deviation (Tzedakis et al., 2018). The azimuth range of the dromoi is 52.5°-133°. Initially they believed that the tombs were oriented towards the rising sun and only exceptionally towards the rising moon. However, our statistical investigation shows that the tombs were not oriented towards the rising sun or moon on random dates during the year.

We measured the orientation and horizon altitude of 73 of the best preserved tombs with a solar oriented total station. Our methods are described in Henriksson & Blomberg (1996).We tested the more realistic hypothesis that the tombs were oriented towards the rising full moon, and theoretical lines are calculated for the interval between 1450-1200 BCE.

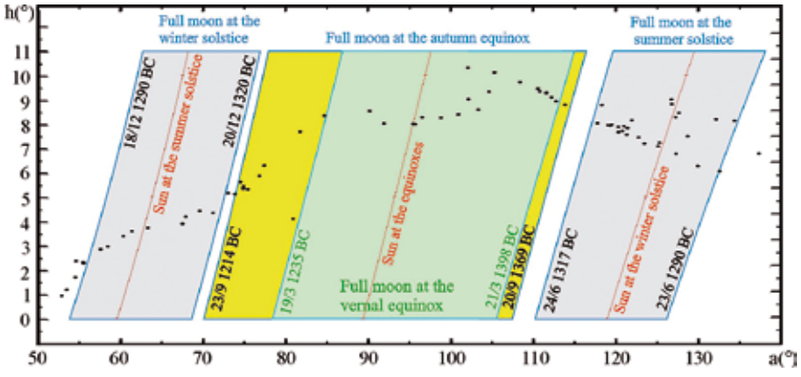

Fig. 3. Orientation of 73 of the more than 230 tombs on the late Minoan cemetery at Armenoi measured by laser theodolite. The altitude of the horizon in the direction of the passages of the tombs have been calculated from the 3-dimensional coordinates of their entrances and a digital model of Mt Vrysinas. The shaded area corresponds to the appearance of the full moon at winter solstice, the equinoxes and the summer solstice. Some of the tombs from different parts of the cemetery seems to have been oriented simultaneously at the rising full moon. In some cases it may be possible to identify when the tombs were oriented and built.

There exist three groups of graves separated by gaps corresponding to the rising full moon at the winter solstice, the equinoxes and the summer solstice. We offer hypotheses to explain this phenomenon in the light of historical events occurring in Crete at the time when the graves were built.

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INTRODUCING ASTROMOVES

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The ASTROMOVES project studies the career moves and the career decision-making of astrophysicists. The astrophysicists participating have to have made at least two career moves after receiving their doctorates, which is usually between 4 and 8 years post PhD. ASTROMOVES is funded via the European Union and thus each participant must have worked or lived in Europe. Gender, ethnicity, nationality, marital status, and if they have children are some of the many factors for analysis. Other studies of the careers of astronomers and astrophysicists have taken survey approaches (Janine Fohlmeister and Helling 2014; J. Fohlmeister and Helling 2012; Ivie et al. 2013; Ivie and White 2015) laying a foundation upon which ASTROMOVES builds. For ASTROMOVES qualitative interviews are combined with publicly available information for the project, rather than surveys. Valuable information about career options and the decisions about where not to apply will be gathered for the first time. Those few studies that have used qualitative interviews often include both physicists and astrophysicists, nonetheless they have revealed issues that are important to ASTROMOVES such as the role of activism and the nuances of having children related to the long work hours culture (Ong 2001; Rolin and Vainio 2011).

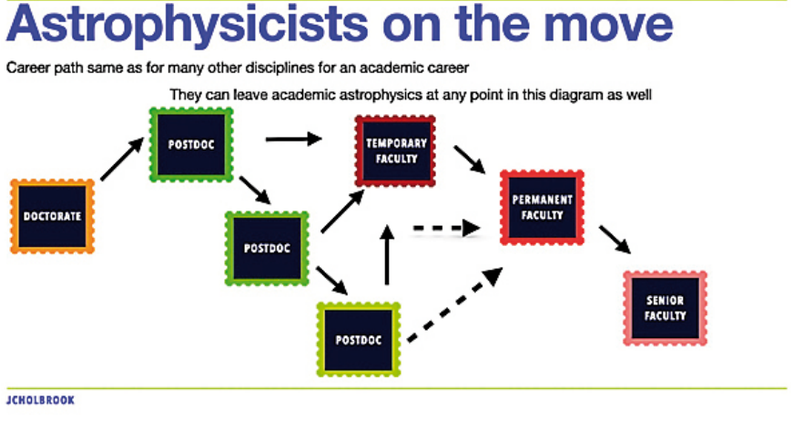

Fig. 1. Career path to an astrophysicist' academic career.

The global COVID-19 pandemic has slowed down the project; however, at the time of this writing 20 interviews have been completed. These interviews support previous research findings on how having a family plays an important role in career decision making, as well as the importance of mobility in building a career in astrophysics. Unexpected preliminary results include imposter syndrome, unemployment, stalking and coping with the global pandemic (Holbrook 2021). Cultural Astronomy spans all aspects

of the relationship between humans and the sky as well as all times ancient to the present; and thus, studying astronomers & astrophysicists who have a professional relationship to the sky is part of cultural astronomy, too.

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CULTURAL ASTRONOMY & MODERN SKYWATCHING

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The relationship between astronomical observatories on indigenous lands and the local people oftentimes is fraught with conflicts and unresolved tensions. The most recent example is the construction of the Thirty Meter Telescope (TMT) on Mauna Kea on the Island of Hawai'i, USA, which has sparked much debate among astronomers (Prescod-Weinstein et al., 2020). Other USA examples include the building of the Daniel K Inouye Solar Telescope on Haleakala, on the Island of Maui, USA (Rimmele and McMullin, 2016), and Mount Graham Observatory in Arizona, USA (Brandt, 1995).

Fig. 1. Teide Observatory, Canary Islands, Spain. An observatory that has not been the focus of recent protests. Credit: J. Davé

Observatories take a variety of approaches to foster better communication and to have more positive connections with local populations with varying results (TMT, 2018; Kneale, 2015). Considering this history and the real possibility of the future expansion of existing observatories, the Royal Astronomical Society (RAS) and International Astronomical Union (IAU) Division C Working Group on Archaeoastronomy and Astronomy in Culture partnered to create a new initiative focused on culturally sensitive sites connected to astronomy. When creating the committee, it was important to include people outside the astronomical community including cultural astronomers, anthropologists and other experts. Once formed, the group includes the current ISAAC

and SIAC presidents, as well as representatives from the American Astronomical Society (AAS). This interdisciplinary group includes people that have been studying these issues (Jarita Holbrook, Alejandro López); and people that have experience collaborating with indigenous communities and advocating for indigenous priorities (Jarita Holbrook, Alejandro López, Annette S. Lee). The group is working to provide social, historical, and cultural context for astrophysicists to better understand the sites they use for astronomical observations; with the goal of fostering better cross cultural and intercultural relations with the local and indigenous people incorporating cultural perspectives. The Culturally Sensitive Sites group is less than a year old, but has been busy! This poster includes descriptions of their activities thus far.

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THE SANCTUARY NEAR THE VILLAGE OF ANGEL VOYVODA – ARCHAEOLOGICAL AND ORIENTATIONAL STUDY

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This work presents new results from the research of the sanctuary near the village of Angel Voyvoda, Haskovo District. It is located on the southeast edge of a rocky hill (610 m) and falls within the boundaries of a fortified complex known as Asara, Hisarya or Kumburlarkalesi ('fortress'). The first archaeological studies reveal traces of life from the Late Bronze Age to the Late Antiquity. In IV-VI century it was permanently inhabited, as evidenced by the remains of solid buildings, furnaces, cisterns and a fortress wall (Petrov, 2003). After the resumption of excavations in 2016, two early Christian churches from the Late Antiquity were discovered.

The subject of our study are the prehistoric structures at the top of the hill, as well as the trapezoidal niches on the southeastern slope. They are made with stone and bone tools, which distinguishes them from later carvings with traces of iron chisels. During our visits from 2007 to 2010, along with numerous ceramic fragments from later ages, we also found Chalcolithic pottery and several stone artifacts (Ivanova, 2016).

The most sacred part of the sanctuary consists of four blocks with almost the same length, but different in shape and purpose. They are arranged along the east-west line (cf. the photo). Various elements shaped as steps, shelves, thrones and grooves are carved on the northern side of the blocks. Depending on the viewing angle and the sunlight, one is left with the impression that the rock blocks are sculptured as large schematic anthropomorphic and zoomorphic figures. These visible forms with ritual functions, which have their analogues in other rock sanctuaries, undoubtedly carry some symbolic meaning characteristic of the spiritual culture of their creators. We believe that archaeo-astronomical studies can reveal important aspects of the worldview of that time. For example, our measurements confirm the orientation of the basic elements towards the cardinal points (Ivanova, Koleva and Kolev, 2013).

Fig.1. Aerial view of the sanctuary from the north. Photo: S. Ivanova.

On top of the easternmost block, an oval trough is cut out, whose longitudinal axis is oriented exactly east-west. It overlooks a remarkable equinox marker on the eastern horizon – Golyam Hisar hill (515 m). Some researchers consider this structure to be a "stone tomb" or an altar. Gifts were probably placed on the narrow steps (shelves) of the second block. Next is the block with the thrones looking north.

The westernmost block has narrow step-like carvings on its north side. Its upper part is oval and a groove runs along the base. There is a slanting conical hollow in the middle of the groove, whose axis points to the north celestial pole. At noon, the shadow of a gnomon placed in it falls onto a small transverse cutting and outlines the projection of the celestial meridian of the observer. An imaginary continuation of the line of this shadow in the opposite direction leads to the south point of the horizon, on each side of which there is a high hill Sadzhak and Kodzhakale, respectively. Above them the sun reaches its upper culmination every day. Our observations have shown that both the shadow cast by a suitable gnomon and the shadow of elements of this structure could be used to measure time.

Some contemporary toponyms preserved from Turkish seem to have carried over the millennia information about the remarkable positions of the sun on its diurnal and annual path as viewed from the sanctuary. For example, south of the sanctuary is Gyunemlik Sart ('sun ridge'), which extends in a north - south direction and reaches a height of 658 m. Behind it is the Sadzhak ('trivet', 'tripod') hill (841 m), which connects three ridges. These two toponyms figuratively remind of the direction in which the sun reaches its maximum height and maximum power at midday. We can consider two other toponyms to be calendar markers. To the northeast is Chaltepe hill ('ring hill') (506 m), around which the sun turns south on the days of the summer solstice. To the southeast is Asmadzha ('vine') hill (587 m), where the sun reverses its movement in the days of the winter solstice.

The Asara sanctuary has close parallels in the Eastern Rhodope Mountains where it has been established that rituals were performed as far back as during the Chalcolithic (Ivanova, 2016). Our study confirms that it is related to worship of the sun and natural cycles and shows the principles of its construction. An important part of the rock complex are tens of trapezoidal niches on the southeast face of the hill that are like road signs for pilgrims on their way to the top. There are numerous hypotheses about their purpose, including that they are elements of a chthonic cult.

The efforts and knowledge invested in the construction of this and similar cult centers speak of the high level of social organization of those who created and used them. In the process of their development in the following epochs cultural continuity took place, which testifies to the closeness and inheritance of religious ideas. The new religious architecture coexists with the earlier prehistoric sanctuaries, preserving or fitting into their structures.

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RECORDS OF THE LUNAR CYCLES IN CLASSIC MAYA COPÁN, HONDURAS

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Though the Moon is the second brightest body in the sky after the Sun, it is unique in being the only celestial object visible in the night and day sky. Its size, changing form, and brightness received considerable attention from timekeepers for all ages and all peoples. The close watch of its synodic phases was essential to the development of the calendars based on the regular recurrences of astronomical bodies.

After gaining basic knowledge of the Moon's changing phases, calendar uses of the Moon consisted of a determination of her synodic cycle commensurate with the Sun. This practice of commensuration – of converting distinct synodic cycles into a single calendrical cycle – was also known by the Maya. They quantified multiples of synodic revolutions along a single scale of the *tzolk'in*, a 260-day divinatory calendar. The Lunar Series that appear in Maya monumental inscriptions consisted of six glyphs, referred to by letters, E, D, C, X, B, and A assigned by epigraphers, represented their attempts to create the cyclical calendrical structure capable of predicting the synodic period of the Moon. The Lunar Series contains three basic components: the moon's age in the current month, the number of days assigned to the lunar month (either 29 or 30), the name of the lunar month and its positions in the bundle (*k'al*) of six and eighteen lunar months.

Fig. 1. Lunar deity with a rabbit. Classic period carved stone bench, Str. 8N-66C, Group 8N-11, Copán, Honduras.

However, dealing with the Maya astronomical record, which is far from being complete, it is tempting to overstate their astronomical achievements. Recent research by Justeson (2017) shows that there is still much evidence that can be recovered, allowing us to propose new but sound hypotheses. In tracking the lunar phases, the Maya timekeepers

used numbers and cycles derived from their tzolk'in. So, examining the Lunar Series, it is possible to infer formulae that made the lunar synodic cycle compatible with this 260-day calendar.

There are over thirty lunar data at Copán scattered between about CE 436 and 773, eight of them being clustered around CE 652, providing thus a unique opportunity for controlled interpretation of the lunar count. These data show that solar eclipses could have affected the regular sequence of the Lunar Series (Brauer, 2013). In general, at Copán several shifts in lunar computing have been detected (Gaida and Tear, 1984; Iwaniszewski, 2007). Changes in the numerological models of the Maya and associations of the lunar count with eclipses will be discussed in the paper.

Accepting the idea that most Late Classic Copán lunar data were computed rather than observed, the purpose of this paper is to show the limited value of the Lunar Series for the correlation problem.

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PROJECTIVE SYSTEM FOR SUN CULMINATIONS IN THE AREA OF MARONIA ROCK SANCTUARY, GREECE

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Ismaros is a mountain in northern Greece, the Rhodopes region, located south of Komotini, centrally located in Maronia. It is a small mountain, at an altitude of 678 meters, full of life and riddled with perfectly maintained forest roads. The mountain rests on the shores of the Aegean Sea (Thracian Archipelago) and preserves the remains of ancient Maronia - one of the richest cities of Ancient Thrace. In addition, numerous rock-cut monuments and sanctuaries have been found in the region. The entire rocky area is extensively carved, leaving no doubt that it was humanly modified with the intention of rendering it sacred (Kiotsekoglou, 2016).

The spatial orientation of a rock cave sanctuary, located at the base of the rocky ridge of the rocky hill, on which the ancient rocky acropolis of Petrota was built, is investigated in detail in the work. Cave sanctuaries are a specific type of cult rock-cut monuments from the Mountainous Thrace, with a specific shape and orientation in space and are part of the characteristic representatives of the archaeoastronomical sites of the Balkan Peninsula of the Eneolithic and Early Bronze Age. Archeological material has been discovered on the territory of the rock-cut monument - mainly pottery from the end of the Eneolithic Age.

The archaeoastronomical study of the Petrota Rock Cave Sanctuary involves determining the geographical location, spatial orientation of the cave and its relationship with other sanctuaries in the area. The exploration of the rock-cut elements and cult structures within it and their situation reveals the boundaries between the sacred and the profane space.

Fig. 1. South-West entrance of the cave sanctuary.

This iconic monument has a central place in the sacred territory of Petrota and a superb view of the line of the local southern horizon and the southern part of the local meridian.

It is searched for geometrical centers of the observation lines, connecting the extreme points of sun culminations and characteristic structures of the autochthonous rock relief of the cave sanctuary. The peculiarities of observing sun culminations from the sacred territory of the cave are discussed in the report. On the basis of geodetic measurements vectors of observation, aiming at characteristic positions of sun culminations related to the 24 hour and annual solar cycle are proposed. The reception marker of the solar projection and the possibility of a calendar creation from regular observations are investigated.

Fig. 2. South entrance of the cave sanctuary.

The study of the sacred space of the cave sanctuary - different cuttings inside the cave and around it, reception markers of different shape and size, as well as the orientation of the main axis of the cave show that it was created as a projective system of sun culminations and a system for measuring the duration of the seasons within the tropical year. Most probably, the cave sanctuary at Petrota is part of a large-scale cult complex, conceived and used at various social levels in the then society.

Detailed archaeoastronomical studies show that the beginning of the creation of the megalithic monument and the complex as a whole is at the end of the Eneolithic Age (the first half of the third millennium BC). The team suggests that the megalithic monument used later - in the Early Bronze Age - is an expression of worship of the Sun-God. It fully fits to the theory of the belief-ritual of the Thracian ethnicity to the Great Mother-Goddess and her son-Sun, called Thracian (oral) orphism, formed during the Mycenaean antiquity (Popov, 2014). The Megalithic Monument at Petrota is one of the earliest cult monuments of mass mysterious ritual in honor of the Sun-God in the territory of a later spatially formed and architecturally absorbed territory, called “Mountainous Thrace” on both sides of the Rhodope Mountains. The purpose of the study is to define the character

of the object as an “ancient cult and ritual complex - sacred territory” and to show its relation to other similar objects from the same or from other more remote areas that directly correspond and fall together in one and the same contact zone, namely that of the Eastern Mediterranean (Stoev et al., 2001). The mysterious function of these astrometric observations is more certain also in later epochs - up to and from Antiquity - because of written evidence. Measurement of the spatio-temporal parameters of the main daytime celestial luminary - The sun has been considered a complex and magical procedure for attaining divine insight by dedicated priests with special astronomical knowledge.

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VERNACULAR MODELS: HEAVEN AND PARADISE BASED ON BALTIC FINNIC AND EASTERN SLAVIC FOLKLORE

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The presentation gives an overview of the sky and Paradise models of the Estonian and Finno-Ugric peoples and compares them with the closest Scandinavian and Eastern Slavic data. Based on various beliefs and myths, the researchers have determined the imagination of at least three layers of the world: Heaven, Earth, and the underground or other worldly world. However, in the folk imagination, the Earth and the sky often have more layers, such as 3 or 7, 9, 12 layers, and a special journey is attempted to get there. Hell can lie under Earth, on Earth, in the forest, in the sky. Rudolf Põldmäe (1935) mentions the journey, described in the visions of the Estonian prophets of the 18th century, to the mountain of the world wrapped in cold and dark, foggy and grey, to the top of which the deceased must reach – there is the abode of the dead (the same happens in the tradition of other Finno-Ugric peoples). In the Slavic tradition, it may be an iceberg, reaching the top of which requires the nails cut off during the entire life (Vinogradova and Levkievskaya, 2017, Boganeva and Kõiva, 2021), but with the influential folklore of apocryphal stories of Komi (Limerov, 2020: 192). In the Slavic afterlife, Hell and Paradise are close together; they can only be separated by a river, but as otherworldly models also include a garden, an island, a city, a space with limited walls – all of them locate in heaven. In heaven, in addition to the souls of the dead, Old Testament characters can move (Belova and Kabakova, 2012: 400); it can be a blooming garden, which we also meet in a couple of Estonian variants. Belarusians in Polesje have a famous giant celestial fenced garden with ten-verst-high glass walls covered by a glass arch; there are also reports of fenced heavens from Estonians (there may also contain knowledge affected by apocrypha). The special feature of Slavic imagery is its immutable time and space (cf.Jason 1988). The ever-warming sun shines there, the animals are friends with each other, and the humans are about 30 years old and do not age.). Among other beliefs Votians feature an image of heaven and Paradise as a heavenly garden where trees grow (Arukask,1998). The otherworldly imaginations of Estonians are also complex and controversial: heaven has several floors, for example, the souls of pious people living in the third. The sky is known to be both paradise and hell, usually associated with certain stars, the Moon and the Sun. Paradise may also be located underground, somewhere nearby, in the so-called parallel world where man was mistaken, or on a mountain, or on the edge of the world, or in the sky, on the stars. It is possible to expand the comparisons, which I show based on the Berezkin (2004) motif directory. The majority of Estonian and Baltic-Finnic material originates from the data base and analyzing tool Skriptoorium, Together with notes from older publications, it forms a corpus of oral and written information over a lõng period of time (17th - 21st century).

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CAESAR'S COMET GAVE BIRTH TO THE ROMAN EMPIRE

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In *Natural History* (Book II, 23, 93-94), the Roman writer Pliny explains: 'The only place in the whole world where a comet is the object of worship is a temple at Rome. His late Majesty Augustus had deemed this comet very propitious to himself, as it had appeared at the beginning of his rule, at some games which, not long after the decease of his father Caesar... he was celebrating...'

'In fact he made public the joy that it gave him in these words: 'On the very days of my Games a comet was visible for seven days in the northern part of the sky. It was rising about an hour before sunset, and was a bright star, visible from all lands. The common people believed that this signified the soul of Caesar received among the spirits of the immortal gods...' This was his public utterance...' (tr. Rackham, 1938, 237).

Figure 1. Silver denarius of Augustus (Caesaraugusta, c. 18 BCE) shows the bust of Caesar's heir and the comet of Divus Julius (Seaby, 1952, *Roman Silver Coins*, Vol. 1, 97. Photo courtesy Roma Numismatics).

Coins struck by Augustus in 18 BCE show the comet of Divus Julius and the bust of his heir (Fig. 1). The long gap between the purported 44 BCE sighting and the comet on coins of Augustus in 18 BCE has led to questions as to whether such an apparition ever took place (Gurval, 1997).

Might the comet of 44 BCE have been Augustus' invention? Ramsey and Licht (1997) write: 'The answer to this question must be "surely not" for at least three cogent reasons.' One, traces of 'anti-Augustan' interpretations of the event. Two, comets were usually seen as threatening, but Octavian managed to turn this perception around. 'This stroke of genius on Augustus' part has to be regarded as one of the most remarkable examples of "spin" control in the whole of antiquity. Third and lastly, we can be certain that there was a comet in 44 BC because one is attested in our Chinese sources...'

The July cometary outburst reached an apparent magnitude of -4, and the *Sidus Iulium* appeared repeatedly in Roman literature: Virgil (37 BCE), Ovid (8 CE), Pliny (77 CE), Suetonius (121 CE). Modern discussions of ancient texts and coins include works by Scott (1941) and by Pandey (2013) who shows coins that illustrate the evolution of Caesar's Comet.

What would have qualified Julius Caesar for such a spectacular celestial ascent? Caesar had spent a fortune on bread and games in order to be elected Pontifex Maximus, highest priest of the Roman state religion. Any violence against the body of the Pontifex Maximus was taboo. As he amassed power under his own hand, Caesar must have felt invincible.

After Caesar's demise, Augustus eventually appropriated the office of Pontifex Maximus (*Res Gestae*), along with the authority of consul and the veto power of tribune. Church and state became one. Caesar's comet had foretold the birth of the Roman Empire.

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HARMONIC UNIVERSE: PLATO TO KEPLER

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Kepler discovered his Third Law of Planetary Motion in 1618, almost ten years after he published his first two Laws in *Astronomia Nova* (1609). In *Harmonices Mundi* (1619), he writes: '… at first I believed I was dreaming, and assuming my conclusion among my basic premises. But it is absolutely certain and exact that *the proportion between the periodic times of any two planets is precisely the sesquialterate proportion of their mean distances…*' (tr. Aiton et al., 1997: 411).

For all of its importance, we seem to have little understanding of Kepler's thinking. According to Gingerich (1975: 595): 'Kepler's Third or Harmonic Law appears to have sprung up full grown, like Minerva from the brow of Zeus.'

Heeffer asserts (2014: 15): 'Concerning the third law, we do not know exactly how Kepler came to the idea… we may safely state that data-driven induction does not at all fit the process that led to the discovery of Kepler's third law.'

Where might Kepler have found inspiration for his Harmonic Third Law?

Kepler provides a clue, as to his thinking, in a letter to Galileo (Baumgardt, 1951: 41), wherein he points to Plato and Pythagoras as 'our true masters.' And Kepler follows a similar path in Book 4 of *Harmonices Mundi*, when he quotes from Proclus' commentary on Euclid: 'And here we must follow Timaeus… For those seven terms of all numbers pre-existed in it as far as cause is concerned.' (tr. Aiton et al., 1997: 301). What seven numbers was Kepler referring to?

In Plato's *Timaeus* (35b-c), the character Timaeus of Locri (likely a Pythagorean philosopher) presents a numerical and harmonic cosmogony. The Demiurge (cosmic craftsman) mixes together various cosmic essemces (Same, Different, Being) and from this mixture, he takes various portions that yield seven numbers: 1, 2, 3, 4, 9, 8, 27. These intervals are filled by other harmonic intervals: musical fifths (2:3), fourths (3:4) and whole notes (9:8), providing a harmonic world structure (*Timaeus*, 36b).

According to Plutarch, the Academy scholarch Crantor arranged Plato's seven harmonic numbers in the triangular shape of the letter *Lambda* with even numbers down one side (2, 4, 8), odd numbers down the other (3, 9, 27). This arrangement highlights the powers progression of squares (2x2, 3x3) and cubes (2x2x2, 3x3x3).

In *Timaeus* (36d), the powers of two and three are connected to the motion of the Circle of the Different (or Other): 'He split the inner Revolution in six places into seven unequal circles, according to each of the intervals of the double and triple intervals, three double and three triple.' (tr. Bury, 1929: 73).

Plato connects the Circle of the Other to the Wanderers in the heavens (38c-d): '…the sun and moon and five other stars… came into existence… He placed them in the orbits along which the revolution of the Other was moving, seven orbits for the seven bodies.' (tr. Bury, 1929: 79).

The seven harmonic numbers in Plato's *Timaeus*, linking celestial Wanderers to harmonic proportions, laid a course that would be followed for millennia

Plutarch writes (c. 110 CE): 'Yet certain people look for the prescribed proportions in the velocities of the planetary spheres, certain others rather in their distances…' (tr. Cherniss, 1976: 321).

In Plutarch's time, scholars already contended with the ingredients that would come together in Kepler's Third Law: planetary velocities (orbital periods), planetary distances, and powers of squares and cubes.

Calcidius (4th cent.) discusses Plato's numbers and then connects them to the Planets: 'He [Plato] himself testifies to this when he says that god cut the circle derived from the nature of the other six ways and fashioned seven disparate spheres, which in contrary patterns of movement revolve according to the intervals of the double and triple, and in those orbits he places the Sun, Moon, and other wandering luminaries.' (tr. Magee, 2016: 179).

Kepler saw Pythagoras and Plato as his 'true masters,' likely because they both envisioned a harmonic order in the universe.

The music of the planetary spheres was a Pythagorean concept, according to Aristotle. And Plato connected harmony and planetary courses in *Timaeus*, as well as in *Republic*.

Fig. 1. At the Academy, the scholar Crantor arranged Plato's seven cosmic proportions into the triangular form of the letter *Lambda*, illustrating squares and cubes that Plato had connected to planetary motions in *Timaeus*.

Kepler would find inspiration in Plato's work over the course of decades. In *Mysterium Cosmographicum* (1597), Kepler pursued Plato's polyhedra (*Timaeus* 55a-c), as indicating distances between planetary orbits. This scheme was not precise enough, so Kepler turned to Plato's harmonic numbers, invoking, as we've seen, Timaeus and Plato's seven numbers in Book 4 of *Harmonices Mundi*.

Then came a revelatory alignment that Kepler describes in Book 5: '… and if you want the exact moment in time, it was conceived mentally on the 8th March in this year [1618], but submitted to calculation in an unlucky way, and therefore rejected as false, and finally returning on the 15th of May and adopting a new line of attack, stormed the darkness of my mind. So strong was the support from the combination of my labor of seventeen years on the observations of Brahe and the present study, which conspired together, that at first I believed I was dreaming…' (tr. Aiton et al., 1997: 411).

Subsequently, Kepler formulates what would come to be his harmonic Third Law of Planetary Motion.

To explain his sesquialterate proportions, Kepler takes the cube roots of planetary orbits and squares them, to arrive at planetary distances: 'Thus if one takes one third of the proportion from the period, for example, of the Earth, which is one year, and the same from the period of Saturn, thirty years, that is the cube roots, and one doubles that proportion, by squaring the roots, he has in the resulting numbers the exact correct proportion of the mean distances of the Earth and Saturn from the Sun. (tr. Aiton et al., 1997:412).

Then, Kepler uses Plato's harmonic numbers to illustrate his Harmonic Law: 'Let the periodic times of two planets be 27 and 8. Then the proportion of the mean daily motion of the former to the latter is as 8 to 27. Hence the semidiameters of the orbits will be as 9 to 4. For the cube root of 27 is 3; that of 8 is 2; and the squares of these roots are 9 and 4.' (tr. Aiton et al., 1997: 413).

The harmonic numbers in *Timaeus*, and their connection to the Wanderers, traveled from Plato to Plutarch, to Calcidius, to Kepler, over a period of two thousand years. Plato's harmonic universe, with its squares and cubes linked to planetary motion, appears to have inspired Kepler's Third Law in *Harmonices Mundi*.

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THE AGE OF MOSES

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Moses died on the eastern bank of the Jordan, looking at the promised land. He was then very exactly a hundred and twenty years old, day by day *"So Moses went and spoke these words to all Israel. And he said to them, "I am a hundred and twenty years old today; I am no longer able to come and go, and the LORD has said to me, 'You shall not cross this Jordan.' "* (Bible 1955, Deut. 31:1-2) ; *"Moses was 120 years old when he died, yet his eyesight was clear, and he was as strong as ever. "* (Bible 1955, Deut.34:7). In such a way was fulfilled God's decision that a hundred and twenty years would be the limit of human life "Then the LORD said, *"My Spirit will not contend with humans forever, for they are mortal; their days will be a hundred and twenty years "* (Bible, 1955, Genesis 6:3).

We know from various fragments of the Bible that sometimes the year was rounded to 360 days as we also find in Babylonian astronomy (Englund, 1988). Counting this way and considering that Moses was exactly 120 years old, by the day, we see that the number of his days was then 43200. This is of course an interesting number as we find it under different forms in Mesopotamian and Indian cosmologies (Karp, 2001). It is found as well in Scandinavian traditions concerning the last battle, Ragnarök (Campbell, 1962). We find this proportion again as the most sacred figure of PythagoreanTetraktys (Fludd, 1626).

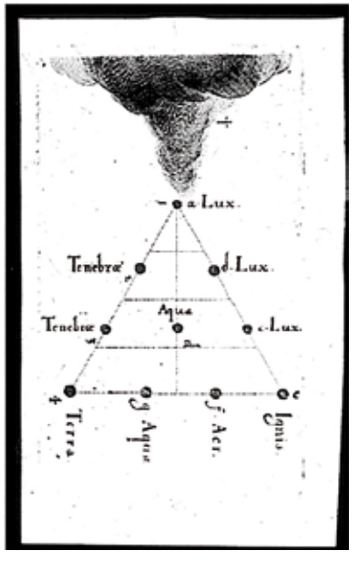

Fig. 1. The proportion 1/2/3/4 shown in the most sacred figure of Pythagorean Tetraktys (Fludd, 1626)

Joseph Cambell (1962) had already noticed some of the cross cultural references to this number used for the calculation of the Great Year in ancient sacred numerology.

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ARCHAEOASTRONOMICAL STUDY OF THE ENEOLITHIC ROCK-CUT MONUMENT BELINTASH NEAR THE VILLAGE OF MOSTOVO, ASENOVGRAD MUNICIPALITY, BULGARIA

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Introduction: The rock-cut monument "Belintash" is situated on a large plateau, high on the Rhodopes mountain, above the villages of Mostovo and Topolovo, Municipality of Asenovgrad. Deep river valleys separate it from the higher mountain ranges located in a circle. The plateau is north-south oriented and has a specific sickle shape. The area is 5-6 acres, the length is about 300 m and the height is 30-40 m. Three stairways of different length, size and number of stairs are cut in the northern part of the vertical rock. A specially delineated staircase ends the ascent and leads to the foundations of the base of a building. There are also traces of a facility at the highest point in the central part of the plateau. Two basins with precision cylindrical shape with diameters of 1.65 and 2.10 meters are cut in the main rock. They are connected with a system of drainage channels and grooves designed to collect rainwater.

Archaeological research: First archaeological investigations of Belintash was conducted by the Assenovgrad Historical Museum in 1975. Large amount of Late Eneolithic ceramics was discovered on the central part of the sanctuary, and especially under the sheer rocks of the plateau and the caves below. On the basis of a comparison with materials found in the eastern parts of the Rhodopes and Lower Struma, the predominant ceramic material is dated back to the 7th-6th century BC (Hristov, 2009).

Regular archaeological excavations of Belintash are resumed in the spring of 2010 by Naitonal Archaeological Institute and Museum - BAS. The discovered artifacts confirm the hypothesis that the sanctuary dates back to the Chalcolithic era, which places the Belintash rock-cut monument among the oldest cult sites on Bulgarian lands. It is supposed that through the Chalcolithic Age the surrounding population came to worship at Belintash, and the site played the role of a central sanctuary for a much larger area - the whole territory of the Rhodopes and even the Upper Thracian Plain (Raduncheva, 2002).

Fig. 1. Panoramic view from the Belintash rock-cut monument.

In 2011, remains of an artificially built wall, located across the Belintash plateau, were found. The wall has probably separated the most sacred part of the sanctuary from the rest of the territory. The place of a massive entrance door was also found. This is evidenced by cut in the rock footholds of supporting columns and grooves for moving at opening. According to recent studies, it can be argued that from the 5th century BC until the end of the Bronze Age (2nd millennium BC) and the whole 1st millennium BC, the sanctuary was operating, but as a result of some conflict at the end of the fourth or third century BC, the sacred site was forcibly destroyed (Borislavov et al., 2014).

The proximity to other ancient sanctuaries gives the reason to consider the Belintash sanctuary region as a large complex of cult places that were more or less active at different times.

Archaeoastronomical research: The existing cult to the Sun in the Eneolithic era and later would require objective knowledge of the movement of this central heavenly body, in addition to the religious-mythological notions. The careful view of the central part of the plateau shows that there is a **precisely leveled two-level ground at its highest point**. The local horizon line (360 degree panorama) is visible from the higher level of the ground.

The position, structure and peculiarities of the Belintash Rock Sanctuary allow the following archeoastronomical hypothesis to be formulated: The **precisely leveled ground at the highest point** of the monument served for observations of sunrises at astronomically significant points on the horizon (solstice and equinox).

In the course of the research, lines of reference were sought to **relief features of the horizon line connected with the distribution of the rock-cut hollows** on the central part of the sanctuary. For the strict scientific examination of this hypothesis geodetic surveying of the rock plateau (relief and microrelief forms) was carried out as well as study of the **main lines of sight to near and distant marks of the landscape**.

A vertical and horizontal plan of the sanctuary was drawn and the height of the visible horizon along the north - east - south line was determined. The slope of the ecliptic ε for the lines of sight was also determined. Its average value is $\varepsilon = 23.87°$, which gives reason to support the thesis that in the period of about 3,000 BC ancient people observed sunrises during the summer solstice and the spring and autumn equinox from special observational site. It should be noted that in the adjacent area of all these places selected for distant marks Late Eeneolithic ceramics was discovered (Stoev et al., 1990).

Conclusion: The rock-cut monument Belintash is unique site for astronomical observations and another site, with the described characteristics does not exist on the whole rock plateau due to the significant horizontal parallax of the existing relief marks on the horizon line. Also, accuracy of the observations was probably enhanced by a developed system of close-up marks, in the form of vertical pillars standing in the holes cut in the rock. The large number of such footholds can be explained by the long-term use of this observational facility, which necessitated corrections of the nearby markers due to the movement of the point of sunrise along the horizon because of the influence of the Earth's axis rotation (precession).

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A NEW POSSIBLE ASTRONOMICAL SIGNIFICANCE OF THE STANDING STONE ROW OF "LE GRAND MENHIR BRISÉ" (LOCMARIAQUER, FRANCE)

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"Le Grand Menhir Brisé" (GMB), the largest menhir in Europe, is also among the oldest. The archaeological excavations of the site during the 90s made it possible to identify and date to the 5th millennium BC, the pits of 19aligned standing stones, among which the GMB occupied the southern end (Cassen, 2009). According to A.Thom (1971), the GMB and other associated megalithic structures formed a set of alignments allowing the observation of the eight extreme positions of moonsets and rises. This hypothesis was refuted due to the high probability of observing such alignments by mere coincidence in a region with the highest density of megaliths in Europe (Ruggles, 1999).

Fig. 1. The19 pits of the standing stone row of "Le Grand Menhir Brisé" (Locmariaquer, France): view from the south at the foot of the large menhir (left) and view from the north at the back of the dolmen of "La Table des Marchands"

However, if we consider only the very limited number of archeologically homogeneous and contemporary structures on the site, an astronomical hypothesis again becomes convincing. The location of the stone row, its length, its orientation and the number of constituent menhirs prove to be remarkably suited to following the progression of the extreme rises of the Moon on the south-eastern horizon, between the tumuli of Tumiac and of Petit Mont, during the 18.6-year cycle of precession of the plane of the Moon's orbit.

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THE CORRIDORS OF THE DOLMENS OF MENGA AND VIERA AND THE MILKY WAY

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The passage tombs of Menga and Viera dating from the 4th millennium BC, located near Antequera in Andalusia, belong to a megalithic complex classified as World Heritage by Unesco (Ruiz Gonzales, 2015). While the passage of the Viera dolmen is oriented towards the sunrise at the equinox (Hoskins, 2001), that of Menga is oriented northwest beyond the azimuth of the sunrise at the summer solstice, which makes it an atypical monument among all the megaliths of southern Spain almost all oriented towards an azimuth between the solstice extremes (Hoskins, 2001). This singularity seems to be explained by the orientation of the corridor towards the Peña de los Enamorados, a mountain with an anthropomorphic profile, which shelters at its foot a Neolithic site linked to the megalithic complex of Antequera.

Fig. 1. Peña de los Enamorados, entrance (left) and view from the entrance (right) of the corridor of Menga Dolmen (Antequera, Province of Malaga).

A detailed archaeoastronomic analysis of the passages of Menga and Viera further reveals that the two monumentsare also oriented towards the Milky Way, respectively towards the rising of the Swan (Deneb and Sadr) and toward the rising of the Scorpion (Antares) at the intersection of the Milky Way and the plane of the ecliptic, and towards the rising of the Pleïades. The intention of this orientation towards the Milky Way, interpreted since the Paleolithic as the path of souls (D'Huy, 2017), is discussed.

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AN ARCHAEOASTRONOMICAL INVESTIGATION ON THE BLACK CHURCH (*BISERICA NEAGRĂ*), IN BRASOV, ROMANIA

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Abstract: In this work we outline the results of an archaeoastronomical investigation dealing with the Black Church (*Biserica Neagră*), in Brasov, Romania, in order to define the criteria of the astronomical orientations and of the geometry used. The name "Black" came in use in 1689 when the church burnt down and left a smoke-blackened ruin. Traces of an earlier smaller church were found during archaeological diggings. The predecessor of the Black Church has been built at the latest in 13th century. The building of the new church, dedicated to the Holy Virgin Mary, began in 1383. During the Turkish invasion it was destroyed and the reconstruction was taken up later by a reduced plan.

The data have been collected *in situ*, in spring 2019 by the authors and they have been analyzed, obtaining notable results.

Several statistical methods have been employed and basic tests have been performed.

The architectural alignments that we measured, applying a rigorous methodology, reveal that the use of astronomical references at the horizon represents the most viable rationale and outlines the existence of orientation patterns that have been used for planning the church, which is connectable with the " Equinoctial Cycle" religious calendar , and the "Solstice Cycle " religious calendar.

The statistical analysis was performed using the most recent techniques belonging to the theory of the Circular Data.

Subsequently an appropriate statistical study was carried out in order to infer the distribution function with the aim to perform an appropriate archaeoastronomical analysis.

Statistical test have been applied to verify the confidence level of the results obtained.

At present the research is still in progress.

Fig. 1. The Black Church in Brasov, Romania.

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TIWANAKU (BOLIVIA), AN ARCHAEOASTRONOMICAL INVESTIGATION ON THE ROLE OF ASTRONOMICAL TARGETS IN THE ORIENTATION OF THE SITE

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Abstract: In this paper we present the results of the archaeoastronomical analysis of the archaeological site of Tiwanaku., UNESCO World Heritage Site, which is located near the southern shores of Lake Titicaca on the Altiplano, at an altitude of 3,850 m., Department of La Paz, Bolivia. Its monumental remains testify to the cultural and political significance of this civilisation.

The public - religious space of this city is shaped by a series of architectural structures that correspond to different periods of cultural accessions. The Akapana Pyramid, the Kantatayita Temple, the Semisubterranean Templete, the "Kalasasaya" Temple of the Sun, the Putuni Palace, the Kheri Kala Palace and the "Puma Punku" Temple of the Moon. The Centre of the Tiwanaku Culture (200 BC. and 900 AD),formerly known like the Taypikala or Piedra del Centro, it contains traces of more than 1200 years of human occupation. It is the most important pre-Inca site of the Andean region of South America and the archaeological remains have maintained to a certain extent their physical integrity.

This report aims to relate the work carried out during the years 2007 - 2008, 2014, 2019, in the area of Tiwanaku. It is a project carried out by AKAKOR to do research in collaboration with UNAR, that will continue over the next few years until the end of the investigations, for a geological, archaeological, astronomical and also cartographic study.

The best evidence for astronomical practice involves a system of pillars, mountains, pyramids and underground conduits connected with the annual cycle of the sun, solstices, equinoxes and passage through the Zenith. Furthermore, the purpose of this work is to highlight the close correlation between the alignments of some structures towards astronomical targets which are stars belonging to the dark constellations of the Milky Way.

The data have been collected in *situ*, by the authors. Moreover an aerial survey was carried out using a drone Phantom Gx and the data have been processed with the software Pix4D. The magnetic measurements have been corrected by the magnetic declination. We analyzed all the records, obtaining notable results. Subsequently an appropriate statistical study was carried out in order to check their astronomical consistency.

The statistical analysis was performed using the most recent techniques belonging to the theory of the Circular Data that is one of the most suitable way in the archaeoastronomical data processing. Statistical test have been applied to verify the confidence level of the results obtained. The archaeoastronomical analysis was carried out with special care trying to find the real or symbolic meaning.

Fig. 1. The stepped entrance to the sacred Kalasasaya precinct at Tiwanaku, Bolivia.

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ARCHAEOASTRONOMY AND THE ORIENTATION OF CHURCHES IN THE JESUIT MISSIONS

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The study of the orientation of Christian churches has been of interest for a long time, having received new impetus in the literature as it was recognized that it represents a key feature of their architecture (González-García and Belmonte, 2015). Based on the texts of the early Christian writers, churches' apses should lie along a particular direction, that is, the priest had to stand facing eastward during services. This is recognized by Clement of Alexandria, Tertullian and Origen, and was ratified by the first Council of Nicaea (AD 325). Also in the fourth century St. Athanasius of Alexandria declared that the priest and participants should face east, where Christ, the Sun of Justice, would shine at the end of time.

There have been many works that have concentrated mainly on studying groups of churches belonging to a particular historical period or to a particular architectural style. In our previous works we have also concentrated on the study of groups of colonial churches distributed over a limited region, such as islands in the Canaries or a certain region of the highlands (altiplano) in northern Chile (Gangui et al., 2016). These studies generally considered churches of various religious orders together and provided a homogeneous and culturally significant case study. But it is also interesting to study the religious constructions of a particular Order in a limited period of time.

In this work we focus mainly on the Jesuit missionary churches in South America, which for almost two centuries were the most representative constructions in the process of Christian evangelization on the continent until the Order's expulsion in 1767. The main objective is to discern possible patterns of orientations in the studied structures and to assess whether these orientations could be related to the location of the Sun or other celestial bodies when crossing the local horizon, which could yield important information pertaining to their construction. Although extensive and detailed historical and cultural studies of missionary peoples and of their most emblematic buildings throughout this region have been carried out, the orientation of churches (or ruins thereof) in these villages had not been the subject of in-depth study until recently. Archaeoastronomical fieldwork that considers the urban characteristics and the writings and chronicles of the missionaries have only recently been undertaken in the Guaraní peoples' territories, which today are distributed over a large region that spreads across three countries – the northeast of Argentina, southern Brazil and Paraguay (Giménez Benítez et al., 2018). Intending to continue and complement this work, which provided a detailed study of Jesuit churches in the Province of Paraquaria, we review our recent archaeoastronomical study of the orientations of Jesuit churches in nearby Chiquitos (today the Chiquitanía region in eastern Bolivia).

The fieldwork we performed consisted of the precise measurements of the orientations of eight churches that still exist in the region and of the ruins of a ninth church, San Juan Bautista de Taperas, of which only the monumental bell tower is still standing. By using satellite maps and the reconstruction of local topography from a digital terrain model, we were able to determine the orientation data of a tenth church, Santo Corazón de Jesús, located in an area of very difficult access. Finally, all the measurements were then corroborated with the same digital terrain models. The landscape surrounding these churches was examined in detail in situ and a thorough cultural and historical study of the characteristics of the villages where the churches are located was also carried out.

Our results have shown that, unlike the churches of the Province of Paraquaria where meridian orientations in the north-south direction were the most numerous, half of the studied Chiquitan Jesuit churches had potential canonical orientations that seemed to be aligned to solar phenomena, with three remarkable churches exhibiting precise equinoctial orientation.

We discuss these findings in the light of our previous works, trying to understand whether it was the new landscape of the South American virgin forest what made the missionaries deviate from the indications of the old Catholic writers (as it happened in part with the colonial churches in Lanzarote and La Gomera, in the Canaries) or, on the contrary, there was an initial intention in the Jesuits' way (their particular mode of constructing, or "modo nostro") of orienting their monumental churches that could justify the data we gathered in our fieldwork.

Apart from the data already collected and analyzed, we consider that the findings of these studies in South America should be interpreted within a larger historical and geographical context. For we know that before the studied churches at Chiquitos, Jesuits built over more than a century a large number of churches on the other side of the equator (e.g., in Baja California and Sonora). Hence, to get the complete picture of the religious architecture in the continent it would require an analysis and comparison of our data with the orientation of seventeenth and eighteenth century Jesuit churches in North America (and in Europe). Our first exploratory steps in this new project are already underway mainly by means of satellite images, which are appropriate enough, and will be shown in the presentation.

Lastly, some comments on possible illumination effects that could have taken place within the churches we already analyzed is in order and will also be briefly discussed.

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NEWEST FINDINGS ON COMETS – FIERY SWORD CONNECTION

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The first attempt to date the Bible with a transient event like a comet was done by Gunnar Norling in (Norling, 1953) who proposed a probable link between the mentioning an angel with a fiery sword and the appearance of the Halley's comet. Based on the iconographic Renaissance material we review all the astronomical, historical and ethnographical evidences that such a connection does really exist. In this report we address the newest developments concerning the possible connection between the depiction of the Archangel Michael with a fiery sword and the passages of bright comets (Hasegawa, 1980). We consider a mural painting in the narthex of the Krusedol monastery, Serbia (see, Fig. 1), revisit Simon Ushakov icon 'Michel the Archangel trampling the devil underfoot' (Nedialkov, 1998) and find some statistical evidences in the Federico Zeri collection at the University of Bologna.

Fig. 1. St. Michael the Archangel and his fiery sword as painted by Jov Vasilijevič in 1750 (inner narthex of the Krushedol monastery, Serbia).

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ONLY THE SKYSCAPE OR THE WHOLE WORLD? REFLECTIONS ON A WELL-SUITED METHODOLOGY AND PHILOSOPHY OF SCIENCE CONCERNING A CULTURAL COSMOLOGY

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Archaeoastronomy, Astro-archaeology, Paleo-astronomy, Ethnoastronomy, Cultural Astronomy ... Since its beginnings in the 16th/17th c. the discipline, which is mostly known and popular today under the term *Archaeoastronomy*, has developed into different disciplines. The research first was based on archaeological findings. Then it became apparent that cultures with oral tradition, either currently documented or historically handed down in written form, have a rich knowledge of the cosmos, especially the phenomena of the sky. Moreover, researchers studied the equipment used by the ancient cultures. It becomes clear that since the Palaeolithic, archaic and pre-modern celestial images and cosmovisions have played a significant role in human life worldwide. They answered fundamental human questions about the what and how, but also about the why and wherefore of human existence and the world as a whole. Thus, it is obvious that the subject matter is not exhausted in archaic versions of astronomy alone, but must be grasped far more with cosmological and cosmopractical models of the embedding of man in the world (the cosmos). It is thus a *Cultural Cosmology* as an interdisciplinary, transdisciplinary and integral science that explores and reconstructs cosmologies and cosmopractical life of archaic, historical, and even contemporary cultures. The presentation will first deal with the previous positions of the scientific discipline in terms of content and methodology. Then the concept of *Cultural Cosmology* is discussed and justified. Finally, a methodology that may be appropriate for the subject is presented, which helps to overcome the confusion currently existing in the subject with regard to research content as well as methodologies and also allows a clear positioning vis-à-vis pseudoscience, para-science and proto-science. A multidisciplinary, interdisciplinary, and transdisciplinary methodology is suggested. It is based on a system-theoretical modeland follows the coherence principle. It thus reflects the world view of cultures that existed before modern times, which was characterized by a holistic and ecomorphic perception and interpretation of the world.

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THEATRES OF LIGHT AND SHADOW: THE ROLE OF ASTRONOMICAL ORIENTATIONS IN THE MINOAN PALATIAL CENTRE OF MALLIA

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It has become clear since the1990s that astronomy had a central role in Minoan ritual and culture in general. Especially the studies by Mary Blomberg and Göran Henriksson (see e.g., Blomberg & Henriksson 2014, and references therein) have established that the Minoans had an advanced calendric system, which utilised not only solar and lunar, but also stellar observations performed with great accuracy. Minoan buildings, such as the palaces, the villas, the peak sanctuaries and other shrines, as well as tombs have been shown to be oriented towards astronomical events. Some of these orientations seem to have had a primarily calendric motivation, while some were also used for illumination effects, presumably in religious rituals. A famous example of the latter type are the solar orientations in the Throne Room of Knossos and their related ’theatrical’ illumination effects (Goodison 2007).

Fig. 1. 3D model created to evaluate the solar and lunar illumination effects in the likely Mallian equivalent of the Knossian Throne Room.

The Throne Room of Knossos is an example of a uniquely Minoan, Neopalatial (ca. 1700–1500 BCE) type of architectural construction, the so-called ‘Minoan Hall’ room system, which usually includes two large rooms or halls with polythyron doors, a light-well, and a partly sub-terranean room called a lustral basin (or adyton). All of the largest Minoan palaces had at least one Minoan Hall room complex, and most of the Minoan villas had one, too. The Minoan Hall has been shown by Joseph W. Shaw (2011)

to have its forerunners already in the Protopalatial (ca. 1900–1700 BCE) buildings of the town of Mallia, the earliest example being the Middle Minoan I period Crypte Hypostyle near the NW side of the palace of Mallia.

In the present study, the orientations of the aforementioned structures in Mallia were chosen as primary research subjects for the investigation of the role of the astronomical orientations in the Minoan Hall systems other than the Knossian Throne Room. In addition to the Minoan Hall complex of the palace, also the astronomical orientations of other important ritual spaces of the Mallia palace and its surrounding palatial centre were investigated. A 3D model was created to evaluate the solar and lunar illumination effects in the likely Mallian equivalent of the Knossian Throne Room (Fig. 1). The results obtained using the modelling were then compared with the orientations of the other related ritual spaces of Mallia, as well as the orientations from similar spaces in other Minoan palaces and villas. The results obtained in this study strengthen the conclusions of the previous studies on the role of astronomical orientations in Minoan culture, namely that 1) the most important Minoan ritual spaces were oriented towards astronomical events and that 2)the illumination effects created by these events were utilised in Minoan rituals.

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ORIENTATION OF ROMAN CENTURIATIONS IN ITALY. PRELIMINARY RESULTS

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The centuriations were public lands delimited and divided in regular lots (*centuriae*) by a procedure called *limitatio* that was applied by the Roman state as a result of the conquest. But the centuriations were also a kind of conceptual appropriation of the landscape, that gradually transformed the nature according to a religious background and particular conceptions of the space.

Despite previous works refused the astronomical hypothesis for the orientation of Roman centuriations, recent publications support the presence of astronomical patterns in the design of the Roman landscape (Magli et al., 2014) and urbanism in Italy (González-García and Magli, 2012; Bertarione and Magli, 2015). Furthermore, ancient surveyors like Frontinus (De limit. p. 14.14-16 Th.) and Hyginus Gromaticus (Const. p. 131.8-132.5, 135.1-12 Th.) stated that the main axes of a land division should be oriented according to the path of the sun, suggesting that technology and religion might be in the same sphere of activity.

In this work we present a project for the statistical study of the orientation of Roman centuriations and the preliminary results extracted from more than 40 sites in Italy, by now the biggest sample of this type ever studied in this territory. The data acquisition was made on Google Earth images by archaeomorphological recognition and all the structures identified have been corroborated with specialized bibliography to ensure that the observed traces of land division are Roman.

Fig. 1. Satellite image of the North-East centuriation in Padova (Italy).

Our aim is to determine whether the orientations of the centuriations follow a pattern, if astronomy was present in the creation of the Roman landscape and urbanism and if ancient surveyors followed purely practical guidelines to layout the territory or if both symbolic and topographic rules were present in these vast programs of land reorganization.

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ASTRONOMY FROM THE EXILE: A STUDY OF THE SAHRAWI ASTRONOMICAL KNOWLEDGE WITH PROJECT 'AMANAR: UNDER THE SAME SKY'

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The Sahrawis (original inhabitants of Western Sahara) are a traditional bedouin society descendant of the Arab tribe of Beni Hassan, that migrated from Arabia to the Maghreb and expanded throughout the Sahara desert and Mauritania in the early Middle Ages (Awah, 2015). Because of their nomadic lifestyle, the Hassania Sahrawis developed a deep knowledge of the sky that is seriously threatened due to the mostly oral transmission of the culture and the break with the traditional lifestyle, started with the Spanish colonization and later withdrawal of the territory in 1975, followed by the attack of Morocco and Mauritania that forced thousand of people to exile and settle in refugee camps around Tindouf (Algeria), causing a situation defined as 'one of the most protracted refugee situations worldwide'.

Fig.1. Amanar team interviewing Alhaizza Aldih Alnah at his home in the Wilaya of Ausserd, in the Sahrawi refugee camps in Tindouf (Algeria).

This work is part of the project 'AMANAR: Under the same sky' by the non-profit science education initiative Galileo Mobile (GM) and the Canary Association of Friendship with the Sahrawi People (ACAPS) in collaboration with the Instituto de Astrofísica de Canarias (IAC), and its aim is inspiring children and teachers from the

Sahrawi refugee camps through astronomy and the preservation of the intangible cultural heritage that is the traditional astronomical knowledge of the Sahrawi society.

Here we present the previous results derived from a series of interviews conducted by the GM team in October 2019 in the refugee camps of Tindouf (Algeria) with people who used the stars for weather prediction, orientation or religion in a nomadic lifestyle or to avoid attacks during the war in the desert. That is, for survival.

Great part of this knowledge has parallels with an older Arab tradition of time reckoning based on the visibility of some stars (Forcada Nogués, 1993), which is present with local variations in other Saharian societies (Oxby, 1999) and have survived to the colonial period co-existing with other calendars such as the lunar Islamic and the solar Gregorian.

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THE INFLUENCE OF THE MOON ON HUMANS, THE EXAMPLE OF MENSTRUAL CYCLE SINCE PREHISTORY

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In recent time it is often rejected that the lunar cycle has influence on humans or over the female cycle of menstruation. This statement may be true, because since the invention of birth control pills, medicine imitates with pills (hormones) the female cycle in a different pattern from the moon, and taking the pill imposes no or an artificial day rhythm.

Yet, a current study in Argentina found the peak in sleep onset time and trough of sleep duration with two hours sleep less takes place 3 to 5 days before the night of full moon (Casiraghi, 2021). A research from China shows similar effects (Law, 1986).

From etymology, myths and anthropology we have hints that in former times the moon had a major influence. E.g. the word menstruation derives from the Latin word menses, which means the lunar month of the Roman lunar calendar. The myth of Callisto tells about Ursa major, that pregnant women must not follow the moon goddess Artemis/ Diana (Rothwangl, 1998).

Fig. 1. The banishment of Callisto and its transfiguration as Greater Bear (Ursa Major) to the northern sky.

And the sex-strike theory claims that in prehistoric times matrilineal coalitions in particular would have acquired substantial evolutionary benefits by phase-locking their

economic and ritual routines to the rhythms of the moon (Knight, 1991). More specifically, this 'sex strike' model predicts that the time of maximum ritual potency and sacred observance would have been at dark Moon (Sims, 2007). When the moon had left the night sky would be the time for women-as-wives to withdraw from temporary marriage and seclude themselves. This would signal to men-as-husbands to prepare and deliver collective hunting services. Collective hunting became very effective and provided these tribes with more protein, which promoted brain growth. These women could have called upon their brothers, if necessary, to assist them in this seclusion strategy (Watts, 2005). Significant provisioning advantages would be gained by such late-Pleistocene mothers of highly dependent offspring over those females following more competitive strategies.

These facts could be confirmed like an echo by lists of female cycles found in the work of the Austrian gynecologist Hermann Knaus, who is considered to have discovered the fertile days (MUVS, 2021). These lists were compiled in the years 1930-1950 and a statistical test shows the significance of the correspondence between menstruation and the phase of the moon from the time before the introduction of the birth control pill (Krejsa MacManus, 2016).

Is this a confirmation that the power of women and their orientation to the moon was at the beginning of human evolution (Marshak, 1972)?

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THE EFFECTS OF PRECESSION IN CULTURE AND TEMPORAL ORIENTATION.

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The precession has its cause in the gyroscopic movement of Earth's axis, which has an enormous influence on human temporal orientation since ancient times. This very slow movement is noticeable by several essential effects: The change of the star at the celestial pole due to the gyration of Earth's axis and the shift of the constellations at the equinoxes and solstices, caused by the difference between the tropical and sidereal year (Dechend 1977).

Usually the discovery of precession is attributed to Hipparchus, who, like Ptolemy (Manitius 1912), misjudged its rate, although both had much more accurate data available (Hartner, 1979).

Fig. 1. Early Christian petroglyphs of the vernal equinox constellation Pisces in Roman catacomb S. Calixtus.

In addition, there is strong evidence that another effect of the precession, namely the difference between the tropical and sidereal year, was recognized by the Babylonian astronomer Kidinnu even before Hipparchus (Rawlins, 1999).

Numerous descriptions of the earlier functions of polar stars and constellations as seasonal vertices have been handed down to us in myths and religious symbols.

The lecture also deals with the ages and in particular with the difference between the ages caused by precession and the Platonic year (Bennedik, 2007. Le Gentil de La Galaisière, 1789), which is actually based on the Great Year (De Callataÿ, 1996) of which Plato wrote and which is triggered by the course of the planets (Bennedik, 2007. Le Gentil de La Galaisière, 1789. Krojer, 2003, Pingree, 1972). Finally, the influence of the spring constellations on the year count is explained in more detail(Rothwangl, 2009).

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REMOTE LOCATION OF UNKNOWN CAVES AND DEEP-SEATED ROCKSLIDES IN SVESHTARI WORLD HERITAGE SITE BY UNMANNED AIR SYSTEMS (UAS).

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The aim of the work is to apply a new innovative technology for remote detection of unknown caves, deep-seated rockslides and shallow buried archeological structures for survey of the area of the World Heritage Sveshtari tomb. To achieve this goal, we used a thermal camera integrated in unmanned aerial system (UAS).Development of this innovative technique is subject of the International Programme on Remote Location of Caves (RLC) of the Commission on Physical Chemistry and Hydrogeology of Karst of the International Union of speleology (UIS) and this work is a part of it.

We made 7 flights over 4 different polygons located in the "Sboryanovo" National Historical-Archaeological Reserve - the territory of the World Heritage Sveshtari tomb by simultaneous capturing of the same part of the terrain in the visible and the thermal infrared area of the spectrum from a UAS. On 10th and 11th April 2021, we captured 3436 orthogonal images of the studied sites from a UAS. Half of them are in the visible and half in the thermal infrared area of the spectrum. So far, we processed only images from the most problematic and with great concentration of caves polygon 1 "Demir baba teke" along the Krapinets river valley, which has been subject of detailed systematic ground survey by Bulgarian Speleological Society for several years.

Almost all previous studies of the possibilities of remote location of caves with thermal infrared cameras are made on previously known caves and are aimed on demonstration of the potential to locate caves, rather than to make thermal infrared survey for location of new caves(Baroň, et al., 2013). The aim of our study is to develop a technology for remote location of new caves by thermal infrared camera mounted on a UAS and to make survey for location of new unknown caves by this technique (Shopov, 2013, 2017). For this purpose, we used:

Terrain mapping from drone in visual band for 3D reconstruction

Small pixel size (of 2.91 centimeters) gave us very detailed reconstruction. With such model we can find even smallest positive and negative land forms (cave entrances). Detailed visual ortophoto produced from this mapping is valuable information source to check suspicious thermal images against detailed visual image for potential cave entrances.

For maximum precision of digital models, we made a series of images of the nadir

with a high degree of overlap in the horizontal (80%) and in vertical (70%) directions, covering the entire area surveyed.Acquired images serve as inputs to “computer vision” software and generate a point cloud of x, y, z coordinate to further generate Digital Surface Model (DSM), digital orthophoto and 3-D surface models.

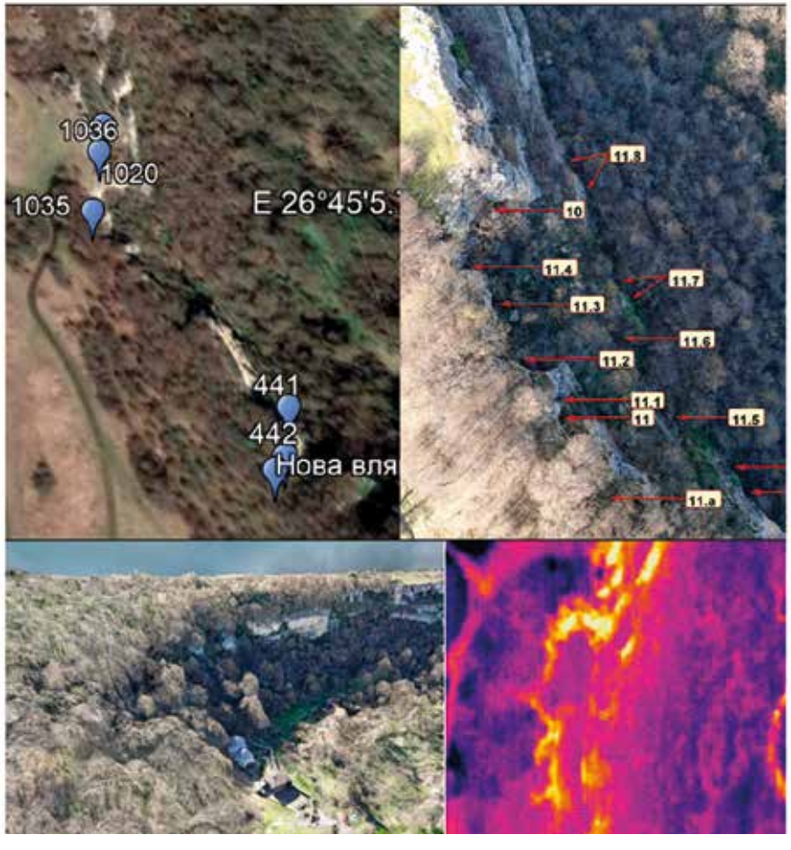

Fig.1.a.(up left) Entrances of the known caves in polygon 1located on the Google map from March 2019 using GPS coordinates of the cave entrances taken by Alexey Jalov. Uncertainty of measurement of these GPS coordinates is bigger than 20 m. In fact, all these cave entrances are under the escarpment and are shifted with over 20 m to the left on the image;1.b. (up right)A small part of the entrances of underground cavities and deep-seated rockslides located by thermal camera from UASon 10th April 2021. Fig.1.a and1.b represent the same terrain. In the frames of the instrumental error of the used GPS device cave entrances of 6 caves: 1036, 1020, 1035, 441, “нова вляво” and 442 coincide with the corresponding remotely located entrances 11.8, 10, 11.4, 11.2, 11 and 11.1. (down left); 1.c. 3D model of the region; 1.d. (down right) Thermal image of caves and rockslides entrances.

Thermal imaging from drone

Thermal images from drone are primary source of information for remote cave location (Baroň et al. 2013, Shopov 2013, 2017). Main benefit from drone usage is ability to move onto strict programmed trajectory and make pictures with equal intervals and programmed camera orientation. These options are most important requirements for processing with photogrametry software. Used ground resolution allow us to distinguish objects only several tens’ centimeters in size from altitude of 95m. Temperature difference of target from surrounding landscape is visualized on obtained thermal images. In addition, our UAS with thermal camera is equipped with GPS, so every picture store coordinates in the file. Cave location was done by manual detection and comparison of hot spots on the thermal images with the corresponding ground futures on the visible orthophoto images of the same part of the ground. Used drone has two coaxial cameras with the same field of view. One of them is thermal, while the other is high resolution Hasselblad visible camera build-in a common housing. This ensures simultaneous capturing of equivalent thermal and visible images. But during the thermal survey of the terrain (6:01- 6:11 a.m.) it was too dark to allow obtaining of sharp visible photos. So, we had to make second authentic survey of the same terrain from the same height latter on the same day in order to obtain good visible images for preparation of Digital Surface Model (DSM), digital orthophoto and 3-D surface models. Hopefully during both flights we had excellent flight conditions, which allow us to produce fine sets of thermal and visible orthophotos like this on fig.1.b.

From 13 entrances remotely located with the thermal camera in the orthophoto on fig.1.b only 6 correspond to known caves (fig.1.a). Only 8 caves are known so far in the studied polygon 1 “Demir baba teke” territory. Our thermal survey located 57 entrances of underground cavities and deep-seated rockslides (fig.1.a,.b) in the same terrain. We expect that some of them are entrances of deep-seated rockslides because their shape is prolonged and very narrow unlike this of cave entrances, which are always more or less round and do not extend to a significant length on the ground. Indeed, several large fractures have openings on the ground of the studied terrain. Obtained results require further extensive ground survey to locate thermal anomalies on the ground and to check their character: - are they cave entrances or are just outlets of the air coming from large, closed underground cavities. In both cases it is necessary to measure their precise GPS coordinates on the ground to locate them precisely on topographic maps.

The presence of archaeological artefacts from Prehistoric, Thracian and Mediaeval periods in some of the caves underlines the importance of these investigations for the exhaustive knowledge of the different forms of settlement and religious life in the area of the Sboryanovo National Archaeological Reserve.

Conclusions:

Here we first demonstrated that aerial survey for remote location of caves with coaxial pair of thermal and visible cameras mounted on a UAS can detect much greater number of entrances of underground cavities and deep-seated rockslides than detailed systematic ground survey by experienced personnel. Obtained results are a significant step forward in the-state-of-the art.

Acknowledgements:

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We thank to Alexey Jalov for providing GPS coordinates of the cave entrances and useful discussions.

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A SEMIOTIC SYSTEM WITH A CALENDAR CONTENT IN THE PREHISTORIC PAINTINGS OF THE MAGURA CAVE, BULGARIA

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Introduction: During the Neolithic, and especially the Chalcolithic, real written systems of signs are formed in different places on the Balkan Peninsula, along with the mixed system of meaning formation. More likely, they are composed by ideograms rather than letters and they are more difficult to understand because they could also contain conditional signs (Todorova H., 1986). The Chalcolithic semiotic system is composed of images, symbols, signs and meaningful forms, combined in a variety of ways in "texts" of an artistic type. These "texts" do not consist of well-defined concepts that can be reduced to words, but of ideas that make up worldviews. The analysis of the image language of the Neolithic and Chalcolithic cultures requires finding the meaning and interrelation between its various components.

One of the most original finds of an Eneolithic letter of definite content (including astronomical images) on the territory of Bulgaria is located in the Magura Cave near the village of Rabisha, Belogradchik Municipality. Prehistoric monochrome drawings on the walls and ceiling of one of the galleries are discovered in 1928.

They are a unique creation of man from prehistoric times, and are original to Southeastern Europe. The drawings were made during different historical periods, the maximum amount being made during the Eneolithic period, some were painted by the end of the Bronze Age, the rest by the end of the Iron Age.

The scenes are dedicated to the cult of fertility, and the signs are symbols related to the magical rites that the cave inhabitants performed to ask for help from the deities. In the semantic analysis of the actions described through the drawings, we have assumed that they are read from right to left. This makes it possible to compare symbols and arrange celestial objects and phenomena, human cultic acts, objects and instruments, logically linked in a common narrative. The analysis shows that more than 95% of the drawings are symbolic and sometimes one or more of them has double meaning.

In this sense, the art of the Eneolithic differs from that of the Paleolithic in its more abstract characteristics. It is not as vital as its predecessor, the forms are not so naturalistic but rather conditional. However, it is characterized by its abstract and conditional beauty and is extremely diverse. The images in it acquire a symbolic meaning and are read as signs. Sometimes, some of the drawn characters can be read in several ways. Some symbols are often used in different combinations with one another, changing their expressive power and direction (Janson, J., 2011).

Eneolithic solar calendar: Our studies so far have shown that the drawings reflect fertility-related rituals, cult practices at precisely certain times of the year, which are fixed during a well-structured solar calendar. In this study, the analysis of the so-called 'solar group' of drawings, with a series of astronomical and calendar symbols, has been continued. The composition group is painted in the so-called Sun Hall of the cave, one of the largest by volume and area of the walls. Using the proposed scheme

to separate the common group of drawings in layers, a calendar is structured within the limits of the tropical (solar) year (Maglova et al., 2018). Their gradual reading and the accumulation of data in the calendar, associates them with the extreme positions of the sun during sunrise, sunset and culminations. The relationship between the number of radial rays in the anthropomorphic "Sun" and the unfolded and segmented band located in the adjacent, left-facing composition group is also interpreted (Fig. 1). The geometric feature of the band is that it is closed at the right end and open at the left end. This allows us to repeat the readings from the "solar scene" in the direction from right to left. It has been suggested that the duration of one segment is one sidereal month (27 days). Thus, we have a recurrence again with the length of the year of 13.5 sidereal months interrupted during the winter solstice. The band of the months within the tropical year is open to the left, which can be interpreted as a link to the symbolic signs below in the composition.

Fig. 1. Stamping of the monochrome paintings from the Magura cave, Solar hall - cult scenes and calendar signs.

It is supposed that time periods less than a month (five and ten-day periods) as well as a chronological sequence of historical for the community astronomical events (solstices and equinoxes, phases of the moon) are marked in the groups of graphical signs. Detailed analysis shows the indisputable interchangeability of Earth and Moon, the symbols of which are often the same. At a logical sign of second reading the other celestial body appears. At this approach, the Earth-Moon system manifests itself in its entirety and a complete lunar-solar calendar can be constructed, used by the eneolithic society mainly for cult purposes.

Conclusion. Our assumption is that the symbols of the Earth and the Moon indicate different degrees of stylization of the image of the Great Mother - Goddess participating in cult ceremonies. It has also been argued that some symbols in the Eneolithic solar calendar have a further use in folklore and folk rite in later epochs. The autochthonous by territory and ethnicity character of the solar calendar are also commented.

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LUNAR ALIGNMENTS AND SYMBOLISM IN MEDIEVAL SACRED BUILDINGS

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The author presents lunisticial (the farthest point of the moon's northing and southing, in its monthly revolution) alignments of eight medieval churches situated in northern Italy and Switzerland (4th-12th centuries). The year of construction date of these churches could be deduced from written sources. Because a lunisticial full moon occurred in those years, the church's corresponding lunar orientations may be interpreted as intentional rather than coincidental.

The author also discusses the symbolism of the full moon in medieval Christianity and the significance of church axes being oriented to the full moon on the local horizon at the major lunistices.

All results have been obtained with the same methodology: by ground surveys with GPS (Theodolite Geodimeter 'System 500'; GPS Garmin 'GPSMAP 62') during fieldwork together with trigonometric and astronomical calculations cross-checked with primary and secondary written sources.

Fig. 1. Fragment with Madonna of the Apocalypse and John the Evangelist, around 1312. Zürich, Schweizerisches National museum, LM 29329.2, *recto, Gradual* of St. Katharinental (Thurgau).

In medieval architectures, a lunisticial alignment (SIMS, 2006; ŠPRAJC, 2016) is much less frequent than a solar alignment e.g. on one of the four Marian feasts (Purification; Annunciation; Assumption; and Nativity) or on the Patron Saint's day (Fig. 1). While 94% of 230 Early Christian and medieval churches exhibit solar alignments, only 5% are aligned toward the moon, and 1% to the Christological constellation *Crux Major* (Northern Cross or *Cygnus*. SPINAZZÈ 2017).

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ASTRONOMICAL USES OF E-GROUPS IN THE MAYA ARCHITECTURE: FROM FICTION TO FACT

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In the 1920s, during the first archaeological excavations at Uaxactún, Guatemala, Group E of this site was interpreted as an astronomical observatory intended to record the equinoctial and solstitial positions of the Sun. Since then, many other architectural complexes of this type, commonly referred to as E Groups, have been found, mostly in the central Yucatán peninsula, typically consisting of a pyramid on the west side of a plaza and an elongated platform, occasionally topped by three temple-like structures, on the east side. Multiple hypotheses have been proposed about the function of these compounds, ranging from those that attribute them a paramount role in astronomical observations to those considering them as merely allegorical or commemorative allusions to celestial cycles, without any observational use (e.g.: Aylesworth, 2015; Freidel et al., 2017).Since these interpretations have been largely based on inaccurate alignment data and, to some extent, on ethnocentric prejudices, field measurements have recently been carried out in a number of E Groups in the central Maya Lowlands. The results of this study, based on both quantitative analyses of the alignment data and the contextual evidence, show that most of the previous hypotheses cannot be sustained. While the alignments connecting the western pyramid with the extremes of the eastern platform in each E Group do not seem to have been astronomically motivated,the orientations of these compounds indicated by their central axes belong to widespread alignment groups in the Maya Lowlands, materialized mostly in other types of buildings (Šprajc, 2018). It is thus evident that E Groups, although built primarily for ritual and mortuary purposes, were observationally functional, but also that their astronomical use was not essentially different from that of other buildings with similar orientations.

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ASTRONOMICAL ASPECTS OF THE ROCK SANCTUARY NEAR POPOVO LAKE, PIRIN MOUNTAIN AND POTENTIAL VECTORS FOR AZIMUTHAL OBSERVATIONS OF THE SUN IN PREHISTORY

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The Popovo Lake is one of the eleven lakes located at the bottom of the largest circus in the Pirin Mountain (6x3 km in size). The lake is enclosed by the peaks of Sivria, Chengelchal, Jano, Kralev Dvor, Momin Dvor and Jangal. Popovo Lake is the largest in area and volume, and the deepest one in the Pirin Mountains. The lake has an area of nearly 123.6 hectares and its length and width are 480 and 336 m respectively. Its water volume is estimated at 1 270 000 cubic meters. It is located at an altitude of 2234 m. The lake collects water from surface precipitation, as well as from two small streams that flow into its southern part. The largest amount of water in Popovo Lake is collected in late spring. This is mainly due to the melting of the snow, which lingered until then on the slopes of the peaks surrounding the lake. Popovo Lake looks like an irregular pentagon. There is a small rocky, circular island (35-30 m) in the lake, covered with a Pinus mugo, called Kalimyavka (Fig. 1).

Fig. 1. General view of the Popovo Lake.

Until 1942, the lake was named Papazgöl, which is a literal translation of its present name (the lake of the priest - "поп" in Bulgarian) from Turkish. At least two legends are associated with it. According to the more popular one, it is called after a priest who has thrown himself into the water because of grief. The reason was that the Turks raped his daughter. When the priest sank, his hat floated to form the islet in the middle of the lake, bearing the same name (Popova kapa - the priest's hat). According to another legend, after the Bulgarians were baptized in the ninth century, a priest went up to Pirin mountain to banish the reigning there Perun – the Slavic pagan God. He has found it, but Perun God became so angry with his audacity that he threw him into the lake to drown. And again the hat floated to the surface and became an islet. Another legend has to do with the sacred area of the Popovo Lake Circus: The God of Storms and Lightning had a daughter who lived in the Fairy gardens near the lake. In the neighborhood lived the Bess god, who liked the girl and abducted her. The beauty's brother, named Jangal, learned what the Bess god had done and collected the evil spirits with the help of which he catched up the kidnapper and, after defeating him, piled him up with stones. The large pile of stones on Mount Bezbog reminds of this ancient legend (Markov, 2019).

An imposing megalithic altar with the shape of an inverted truncated pyramid is discovered and explored on the eastern shore of the Popovo Lake. Two chutes lead the sacred liquid to a lower platform, marked by several different concavities. The ceramics discovered in its adjacent territory are handmade and date from the second half of the 1st millennium BC. Numerous excavations and cuttings are discovered on the northern shore of the lake, on two rock terraces, forming a territory with a great view to the eastern and southern part of the local horizon. Due to the short distance to the high peaks, the sunrise of the solar disk is about 15 - 30° above the mathematical horizon. We assume that a horizontally leveled 3x2 m site that dominates the territory was the main observational point of the rock-cut monument. On the site are clearly distinguished four grooves oriented along the meridian, two rock thrones (eastern and western) in the north, oriented to the south and numerous cup marks. The geodetic survey of the monument shows that the orientation of the long side of the site coincides with the line of the local meridian (north - south). The line of sight of an observer standing on the rock platform to the south direction intersects the local horizon in the rocky saddle between the peaks Chengelchal and Demircapiyski chuki (Fig. 2). Due to the great height of the local horizon, we assume that the ancient observer used the reflection of the culminating sun in the waters of the lake. Such reflection during winter solstice can be observed from the western throne. This allows us to determine the onset of the winter solstice.

Sunrise during the equinoxes can be observed from the pass between the peaks of Sivria and Bezbog (height above the mathematical horizon is 0°). The Retige River valley (the largest tributary of the Mesta River), which flows from the Popovo Lake, also begins from this pass.

Fig. 2. Local horizon - South is in the saddle between the peaks Chengelchal and Demircapiyski chuki.

The report also examines the space-time organization of the architectural and symbolic elements of the Popovo Lake rock sanctuary (Maglova et al., 2010). The morphometric features of the monument and its adjacent sacred territory are noted. Within the general evidence, an archeoastronomical hypothesis related to observations of sunrises and culminations during equinoxes and solstices has been defined. A model of a projective system of solar culminations observed through optical reflections in the lake surface of Popovo Lake and using the screen function on the rock island of Kalimyavka is discussed. The report also discusses the problems of observational practices in the space of the sacred territory and their calendar meaning within the tropical year (Stoev et al., 2018). On the basis of the measurements made so far, observational vectors have been determined. They are directed to characteristic points of the horizon, related to the day-and-night and annual solar cycle.

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UPPER PALEOLITHIC CONSTELLATIONS

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There is a record of inherited constellations and recognized stars with similar animal, human and mythical characteristics from ancient Mesopotamia among ancient Greek astronomers as well as star patterns independently introduced by the latter. This research explores earlier sources of ancient Mesopotamian and Greek constellations, recognized stars, and their associated characters as depicted on the *Gallery of Discs* in the Spanish Cave of El Castillo, dating to approximately 35,000 years ago, to better understand the origins of astronomy in the ancient world. The Upper Paleolithic constellations and stars recognized among the ancient Greeks and Mesopotamians and pictured in this presentation are listed below.

A Hercules –Kneeling man (Kneeling man in ancient Greece).

B Aquila–Eagle (Eagle in ancient Greece and Mesopotamia).

C Pegasus –Horse (Horse in ancient Greece).

D Pisces – Dolphin and whale (Fish in ancient Greece and Mesopotamia).

E Cetus – Seal (Sea monster in ancient Greece).

F Perseus –Man (Man in ancient Greece and Mesopotamia).

G Auriga – Head of elephant.

H Taurus – Trunk and tusks of elephant (Tusked elephant converted to horned bull in ancient Greece and Mesopotamia).

I Orion – Man with club (Man in ancient Greece and Mesopotamia).

J Canis Major/Sirius – Dog (Dog and star in ancient Greece. Star in ancient Mesopotamia).

K Cygnus – Ostrich (Swan in ancient Greece).

L Draco – Crocodile (Dragon in ancient Greece and Mesopotamia).

M Ursa Major – Mother and juvenile bears (She-Bear in ancient Greece).

N Leo – Lion (Lion in ancient Greece and Mesopotamia).

O Gemini – Lioness and Barbary macaque (Pair of eyes for the rectangular-shaped Barbary macaque are Castor and Pollux. Twin stars in ancient Greece and Mesopotamia).

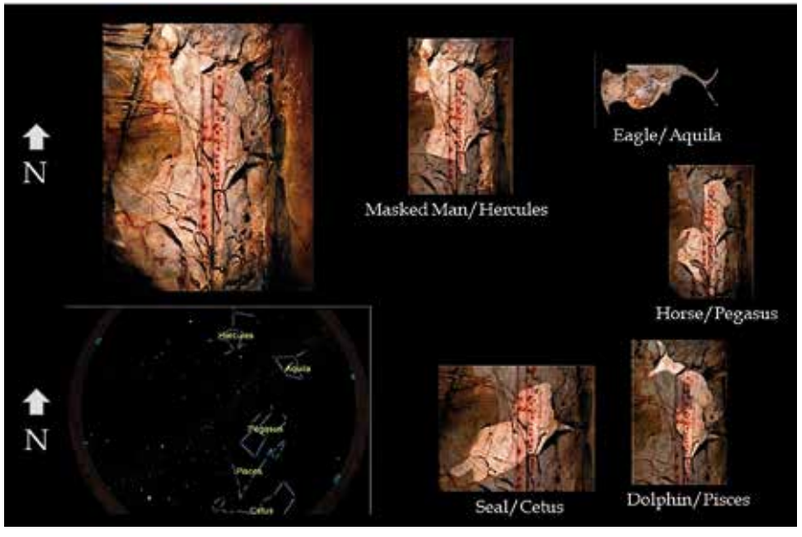

Fig.1. Mid-summer 33k BCE North to South depicted constellations as viewed from Strait of Gibraltar. Depicted characters on the *Gallery of Discs* in the Spanish Cave of El Castillo are directionally oriented to the pictured cave panel.

The night sky during mid-summer in the year 33,000 BCE is pictured in this presentation using Starry Night Pro7 with a visual location from the Strait of Gibraltar. The time of year in Starry Night Pro7 was converted by this researcher to the Gregorian calendar using the equinoxes and solstices in the software program. The life history stage of the fledging eagle depictedon the *Gallery of Discsis* consistent with a mid to late June time period, the constellation Aquila and other presented constellations and recognized stars in the night sky, as viewed from the Strait of Gibraltar during the same time of year 33,000 BCE. This epoch is also consistent with archaeological Uranium-series dating of the panel (Pike, 2012).

This interpretation suggests that some Upper Paleolithic constellations had two representative characters, such as the dolphin and whale for Pisces, which were determined by the traveling direction of the skywatchers and with respect to an epic journey myth. Dual constellations may have been difficult to interpret for ancient Greek astronomers who found one character per constellation with some stars overlapping into other constellations.The ancient Greeks also had other established constellations inherited from earlier times, such as Pisces, representing fish. Ancient Greek astronomers appear to have added smaller constellations for these ancient world and Upper Paleolithic duplicates, such as Delphinus for the dolphin.

The pictured constellations and their representative characters overlap on the *Gallery of Discs* (Taylor, 2020). The overlapping of some constellations may have been later interpreted as wings of the eagle (Aquila) for the horse (Pegasus). Sagittarius may have been developed from the overlapping of the man (Hercules) and the horse (Pegasus). Additionally, there are common spatial elementsbetween the Upper Paleolithic and the ancient Mesopotamian and Greek records, such as the astronomical Sea where we find marine animals for both Pisces and Cetus as well as the Greek Pegasus which was created by Poseidon and arose from a sea.

The archaeological and astronomical record indicates that ancient Mesopotamian and Greek astronomers shared some, but not all of their constellations, and that there are at least fourteen constellations and recognized stars borrowed from the Upper Paleolithic. This suggests that multiple sources of the ancient Greeks and Mesopotamians had either visited the El Castillo Cave and/or there are other Upper Paleolithic caves thatalso depict theseastronomical images (Taylor, 2017).

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TEMPLES OF EGYPT'S EASTERN DESERT AND NUBIA: AN ASTRO-ARCHAEOLOGICAL ANALYSIS

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Background

The present study examines Ptolemaic-Roman temples in Egypt's Eastern Desert and a Nubian temple at Musawwarates-Sufra, Sudan, ca. 100 BC—AD 100 (Sidebotham et al. 1999-2012; Lassányi 2012; https://www.zamaniproject.org). By identifying culturally diagnostic "numerical artifacts" in ancient architecture, astro-archaeology may inform archaeological interpretations in otherwise artifact/feature-poor or looted sites.

Research Objectives

Our primary goal is to determine if a smallrandom sample oftemples in Egypt's Eastern Desert and Nubiawere oriented toa coherent pattern of rise/set pointson the local horizon of astronomical bodiesrepresented in ancient religions, e.g.: Sun (Horus/Rā/Atmu/Osiris), Moon (Toth-Lunus), or selectedStars (Sesheta) (Lockyer 1894, 26-29; Belmonte and Shaltout 2010b). A second goal is to determine if templerectangular floorplanswerebased onintegerancient linearunits in commensurate ratios.

Methodology

Five temples were digitized from site plans as Tiff files and inserted as geo-rectified layers over Google Earth Pro (GEP) satellite imagery. True azimuths of major axes were traced to the local horizons (GEP's Viewshed and Elevation Profile tools) to derive local horizon declinations (δ) from Program Stonehenge (Hawkins 1983, 328-330) (Fig. 1).The resulting horizon declinations were matched to the respective astronomical declinations modeled in Starry Night Pro Plus-6 digital planetarium for an archaeologically appropriate date.Goodness-of-Fit differences (Δ) in horizon vs. astro-target declinationsgreater than 0.5° (i.e., the angular width of the sun or moon) were rejected (Table 1).

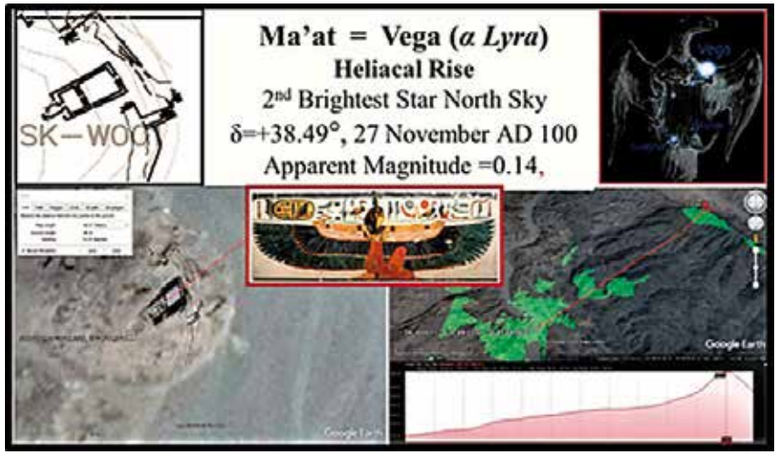

Fig. 1. Astro-Orientation of Administration Building (SK-W001), West Sikait, Egypt Viewshed& Elevation Profile for True Azimuth = 51° (Sidebotham 2004, 2007).

Metrological analysis of *in situ* measurements, site plans and overhead imagery revealed *integer* ancient units of linear measurement as even multiples of *integer* Length-to-Width ratios; e.g., **3x4** (or 6x8, 9x12,…) Roman *pe sin* a **3:4**:5 Pythagorean Triple ratio floor plan (Table 2).

Results

The Administration Building of Wadi Sikait/SK-W001 (24° 37' 49.11" N, 34° 47' 44.72" E, 334m ASL, Table 1), has its northeast major axis aligned with the star Vega (*α Lyra*, +38.55°δ, 0.03 apparent magnitude), rising heliacally in the northeast doorwayat the Winter Solstice, ca. 100 AD.Vega is the second brightest star in the northern celestial hemisphere. In the ancient Egyptian religion, Vega "is said to be Ma'at," the Egyptian goddess of Justice/Law/Morality and is one of the stars "used by Egyptian astronomers at different epochs" (Lockyer 1894, 307) (Allen 1899, 286). On the southwest major axis, the Midsummer Major Standstill Full Moonset in the opening in a cycle of 18-19-19 years (Hawkins 1967;cf. Schaeffer 2007). The moon as the Egyptian god Thoth-Lunus is known as mediator among the gods (Černák 2015, 1). Therefore, the Administration Building may have been oriented to honor the astral deities for justice and mediation; both essential for maintaining good commercial relations.

The Serapis-Isis-ApolloTemple/SK-E002 (24° 37' 43.09" N, 34° 47' 47.06" E, 335m ASL) of East Sikait has a single doorway on the major axiswhich framed the setting Full Moon at the Midsummer Minor Lunar Standstill every 18-19-19 years (Sidebotham 2007, 331-333).

The "Serapis" Temple (23° 54' 37.72"N, 35° 28' 28.30" E, 6.5m ASL) overlooks the Red Sea's ancient harbor of Berenike Troglodytica (Sidebotham 1995,107)."Inscriptions…included 18 Greek dedicatory inscriptions…, six of which were addressed to Isis…. The combination of Isis and Serapis worshipped in one temple was common in Roman Egypt…." (Sidebotham et al. 2019, 15).The temple's major axis is oriented to theMidwinter Major Standstill Fullmoon risingframed in the temple's main entrance at intervals of 18-19-19 years; e.g.,at sunset, 17 December AD 126. The major axis of theTemple of Isis at Pompeii (Regio VIII, Insula vii, 28; TAQ AD 79)is also aligned northeast to the same *rising* Midwinter Major Standstill Full Moon on the local horizon (Tiede 2014, Table 2).

The Nugrus temple (24° 37' 8.34"N, 34° 46' 23.00" E, 315m ASL)has its major axis oriented to Gacrux ((γ Crucis, -46.06°δ, apparent magnitude 1.6), the top star of the Southern Cross as it rose heliacally (e.g., 5 October AD 1) in the south-southeast and framed by the temple entrance. Coincidentally, the Southern Cross is the constellation most resembling a celestial *ankh* or "life" symbol often depicted in the hand of Isis (cf. Gordon &Schwabe 2004, 102-3).

The Apedemakor LionTemple at Musawwarates-Sufra, Sudan (16° 16' 7.92" N, 33° 16' 21.42" E, 417m ASL) has its major axis oriented to the Midsummer Major Standstill Moon rise (-28.8°δ).The diagonal from the west interior corner to the north edge of the main entrance is aligned with the rising moon at the Equinox Southern Lunar Standstill (-5°δ) every 18-19-19 years. The diagonal from the north interior to south edge of the main entrance is also aligned to the heliacal rise (10 October 100 BC) of Gacrux (*γ rucis*, -45.5°δ) in the Southern Cross.

Table1. Temple Orientation & Astro-Target Interpretation, 100 BC—AD 100

Site	Horizon	Astro-Target	Δ	Orientation	Astro-Target Interpretation
Location	°δ	°δ	°δ	(True Azimuth)	
Administration West Sikait, Egypt	38.25	38.55	0.30	NE (51°)	Vega (*α Lyra*) Heliacal Rise at Winter Solstice
	-29.34	-28.85	0.49	SW (231°)	Midsummer Major Lunar Standstill Moon Set
Serapis-Isis-Apollo East Sikait, Egypt	-18.00	-18.55	-0.55	SW (246°)	Midsummer Minor Lunar Standstill Set
	-	-	-	NE Blocked	-
Serapis Temple Berenike, Egypt	27.63	28.12	0.49	NE (59°)	Midwinter Major Lunar Standstill Moon Rise
	-	-	-	SW Blocked	-
Temple Nugrus, Egypt	-46.17	-46.06	0.11	SSE (143°)	Gacrux (*γCrucis*) AD 1, Heliacal Rise 5 October
	-	-	-	NNW Blocked	-
Apedemak Temple Musawwa-rates-Sufra Sudan	-28.82	-28.79	0.03	SE (120.5°)	Midsummer Major Lunar Standstill Moon Rise
	-5.78	-5.30	0.48	E (96.52 °)	Equinox Southern Lunar Standstill Rise
	-45.80	-45.37	0.43	SSE (140°)	Gacrux (*γ Crucis*) 100 BC, Heliacal Rise 10 October

Table 2 presents preliminary *hypothetical* results of the metrology and geometry of four rectangular temples regarding the Best Fit *integer* ancient unit of linear measurement (Brough, 1992) as a multiple of the respective integer length-to-width ratio. (The temple of Serapis-Isis-Apollo (SK-E002) is omitted as its exterior walls are not rectangular.) The Best Fit combination of ancient units of linear measurement of the NE Room 01 of West Sika it'sAdministration Building (SK-W001) are **18x24** Roman pes and/or **12x16** Roman cubitus, i.e., integer multiples of the floor's**3:4**:5 Pythagorean Tripleratio. The rectangular floor of Room 02 has a Best Fit of **2x3** Greek *bema* (*βῆμα*) in a ratio of **2:3**. The Best Fit integer linear unit for the exterior wall of the Serapis Temple at Berenike Troglodytica appears to be **3x4** Egyptian *kassaba* arranged as a **3:4**:5 Pythagorean Triple, i.e.,the same ratio at Room 01 of West Sikait's Administration Building. The Best Fit integer linear unit for the exterior wall of the Nugrus Temple is **39x80** Greek *hemipodium* arranged asa **39:80**:89 Pythagorean Triple.The southeast and adjoining middle room floors at Nugus measure **5x12** Indian *gaz* conforming to a shared floor plan based on a **5:12**:13 Pythagorean Triple. The Best Fit integer linear unit for Nubia's Apedemak Temple interior wall is **18x27** Mesopotamian Cubits in a **2:3** floor plan ratio.

Table 2. Hypothetical Best Fit Metrology with Length-to-Width Ratio

Temple/Building *In situ*/Hypothetical/Local Dimensions Integer Length/Width Ratio	Width	Length	Diagonal	Perim.	Area (Unit sq.)	*In situ* L/W Ratio	Hypoth. L/W Ratio	Δ L/W Ratio
Administration Building (SK-W001), W. Sikait								
**In situ*: NE Room 01 Floor (meters)	5.30	6.80	8.6	24.2	36.0	1.3	1.3	-0.05
Hypothetical: NE Room 01 Floor (meters)	5.32	7.10	8.9	24.8	37.7	1.3	1.3	0.00
Best Fit: Roman *pes* = 0.2956m	18.00	24.00	30.0	84.0	432.0	1.3	1.3	0.00
Best Fit: Roman *cubitus* = 0.4434m	12.00	16.00	20.0	56.0	192.0	1.3	1.3	0.00
W/L/D Ratio = 3:4:5 Pythagorean Triple	3	4	5	14	12	1.3	1.3	0
Administration Building (SK-W001), W. Sikait								
**In situ*: Middle Room 02 Floor (meters)	3.20	4.80	5.8	16.0	15.4	1.5	1.5	0.00
Hypothetical: Middle Room 02 Floor (meters)	3.08	4.62	5.6	15.4	14.2	1.5	1.5	0.00
Best Fit: Greek *bema* βῆμα = 1.54m	2.00	3.00	3.6	10.0	6.0	1.5	1.5	0.00
W/L Ratio = 2:3	2	3	4	10	6	1.5	1.5	0
Administration Building (SK-W001), W. Sikait								
**In situ*: SW Room 03 Floor (meters)	2.00	3.50	4.0	11.0	7.0	1.8	1.7	0.05
Hypothetical: SW Room 03 Floor (meters)	2.03	3.38	3.9	10.8	6.9	1.7	1.7	-0.03
(?) Greek Stambuli Cubit = 0.676	3.00	5.00	5.8	16.0	15.0	1.7	1.7	-0.03
W/L Ratio = 33:56:65	33	56	65	178	1848	1.7	1.7	0
Best Fit: Egyptian *Heseb* (25 cubits sq.)=6.9 m sq.					1			
Serapis Temple, Benrenike Troglodytica								
***In situ*: Exterior Wall (meters)	10.49	14.63	17.7	50.2	153.5	1.4	1.3	0.06
Hypothetical: Exterior Wall (meters)	10.49	14.01	17.7	49.0	147.0	1.3	1.3	0.00
Best Fit: Egyptian *kassaba* = 3.5m	3.00	4.00	5.0	14.0	12.0	1.3	1.3	0.00
***W/L/D Ratio = 3:4:5 Pythagorean Triple**	3	4	5	14	12	1.3	1.3	0
Nugrus Temple (Building 20)								
****In situ*: Exterior Wall (meters)	6.52	13.47	15.0	40.0	87.8	2.1	2.1	0.00
Hypothetical t: Exterior Wall (meters)	6.01	12.32	13.7	36.7	74.0	2.1	2.1	0.00
Best Fit: Greek *Hemipodium* = 0.154m	39.00	80.00	89.0	238.0	3120.0	2.1	2.1	0.00
****W/L/D Ratio = 39:80:89 Pythagorean Triple**	39	80	89	238	3120	2.1	2.1	0
Nugrus Temple (Building 20)								
****In situ*: SE & Mid Room Interiors (meters)	4.86	11.67	12.64	33.1	56.7	2.4	2.4	0.00
Hypothetical: Interior Wall (meters)	4.57	10.97	11.88	31.1	50.1	2.4	2.4	0.00
Best Fit: Indian *gaz* = 0.914m	5.00	12.00	13.0	34.0	60.0	2.4	2.4	0.00
****W/L/D Ratio = 5:12:13 Pythagorean Triple**	5	12	13	30	30	2.4	2.4	0
Best Fit: Ancient Hebrew *garmida* = 0.3 m sq.					200.0			
Best Fit: Sumerian *gin* = 0.25 m sq.					240.0			
Apedemak (Lion) Temple								
*****In situ*: Exterior Wall (meters)	9.07	13.42	16.2	45.0	121.7	1.5	1.5	0.00
Hypothetical: Exterior Wall (meters)	8.91	13.37	16.1	44.6	119.1	1.5	1.5	0.00
Best Fit: Mesopotamian Reed (6 cubits) = 2.97m	3.00	4.50	5.4	15.0	13.5	1.5	1.5	0.00
Best Fit: Mesopotamian Cubit = 0.495m	18.00	27.00	32.4	90.0	486.0	1.5	1.5	0.00
W/L Ratio = 2:3	2	3	4	10	6	1.5	1.5	0

*Sidebotham 2007. 320-321 **BOLD** = Accept. error < n.0 of the Hypothetical value.
**After Hense 2015. Fig. 1C
***After Sidebotham 2004. Fig.54
****After University of Cape Town 2009. www.zamaniproject.org

Conclusion

Two major findings are that: four of the five temples major axes examined were oriented to lunar standstills, an orientation convention shared with the Isis Temple at Pompeii; and the temples' hypothetical Best Fit ancient linear units of measurement match the respective cultures found at the termini of the trade routes linking the Nile-Indus-Tigris/Euphrates valleys.

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ON THE ORIENTATION OF ROMANESQUE CHURCHES ALONG THE WAY OF ST JAMES: PRELIMINARY RESULTS

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One of the main characteristics of the construction of Christian churches is definitely their eastwards orientation (McCluskey, 20015), which ideally would follow the astronomical equinox. Over the last decades, several works have been carried out in this regard within the framework of cultural astronomy (González-García, 2015). Among them, a study of the pre-Romanesque churches in the Iberian Peninsula and the Balearic Islands (González-García and Belmonte, 2015) demonstrates that there is, in fact, a clear orientation pattern towards the eastern quadrant of the horizon, following the canonical equinox of March 25 Julian.

After the discovery of the tomb of the Apostle Saint James in the ninth Century, the pilgrimage to Santiago de Compostela was significantly intensified in the following centuries. This was the main route of spread of the Romanesque architecture in the Iberian Peninsula,especially during the twelfth and first half of thirteenth centuries. Taking advantage of this building fever, we are conducting a systematic analysis of the orientation of a considerable quantity of Romanesque churches along the French Way, the oldest pilgrimage route along the way of Saint James (aka Camino de Santiago or simply "El Camino", per excellence).

Thus far we have measured the orientation (azimuth and horizon angular height) of a statistically significant number of these monuments spread over the areas of the ancient kingdoms of Castile and Leon.In both samples, two different sectors were chosen, one close to the French Way itself, and the other a little further away, in order to compare independent patterns. This separation has taken into account local topography and a 20km distance to the north and south of the French Way in order to include alternative routes used in the Middle Ages.In case of regional variation, cultural aspects that may influence the orientation, or the place and age of construction are also examined. In Leon we collected the data for 102 churches, from which 73 correspond to The Way and 29 to the Ribeira Sacra, the 'contrast' sample. In Castile, meanwhile, we measured a total of 91 churches, 36 properly on The Way, and the resting 55 placed in the Montaña Palentina.

Most of the orientations fit within the solar arc, facing the direction of sunrise at some time in the year (see attached Figure), but with several peculiarities amid the kingdoms that stand out the exceptional nature of the Camino and the different traditions that were followed.This suggests the necessity to continue the analysis in the area of the ancient Kingdom of Navarra and its surroundings, as this was the gate of the French Way into the Iberian Peninsula. Preliminary results of all these campaigns will be presented together with the open questions that make the Camino an outstanding study case for Christian church orientations.

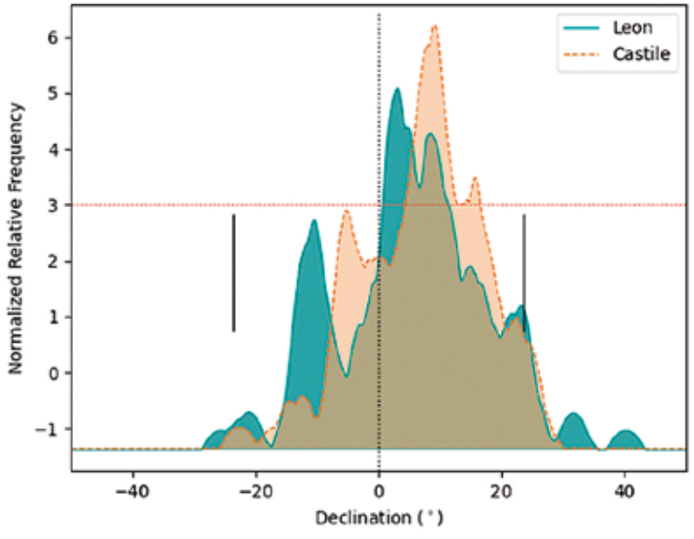

Fig. 1. Declination histogram of Romanesque churches in the ancient kingdoms of Castile (orange, dashed line) and Leon (blue, solid line). The vertical dotted line indicates the astronomical equinox, whilst the solstices are noted with solid vertical lines. The horizontal dotted line represents the 3σ level, above which any peak is statistically significant. Both distributions have a clear tendency to orientate the churches within the solar arc, close to the equinoxes. However, it seems that the two kingdoms have slightly different preferences, which could indicate cultural discrepancies among them. A more traditional approach, similar to the one found in Mozarabic churches, is followed in Leon, with its monuments facing the ecclesiastical equinox. In Castile, Easter plays the main role on the orientation of the churches, rather than the equinox, perhaps due to a stronger influence of the Roman pontificate and the Order of Cluny. This scene could be representative of the struggle held by the Christian kingdoms in the Iberian Peninsula, seeking for a unique Metropolitan See in Toledo or in Santiago de Compostela.

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TEHUACALCO SPATIAL ARRANGEMENT AS A PATTERN FOR SOME GUERRERO REGION'S SITES, MEXICO: THE ORIENTATIONS AND LANDSCAPE

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Tehuacalco is a pre-Hispanic archaeological site in the Central region of the State of Guerrero, in southern Mexico. It is located on a natural corridor that served as a commercial route for a large-scale exchange network that connects Central Mexico (geographic area where power was mostly concentrated) with the coast of the Ocean Pacific or, at least, with the central valleys of Guerrero. Even Christine Niederberger (2002) proposed a route that deviates through the Olmecoid archaeological site, Teopantecuanitlán, around 600 BC (Martz de la Vega, 2010).

To the date, Tehuacalco had no precedents other than those we had reported on its general layout, its orientations and the landscape as well as some details of its architecture and chronology (Martz de la Vega, 2010; Martz de la Vega and Pérez Negrete, 2014). In principle, all these aspects have been identified as integral elements of the so-called macro area of Mesoamerica. It can be said that it is a typical pre-Hispaniccivic-ceremonial center of the Epiclassic (650-900 AD) and Early Postclassic (900-1250 AD) periods, which includes structures such as a ballcourt, a large central square, a main temple, a great palace and some more of the residential type. On the other hand, it shows a distinctive, regional accommodation, which excels a long ramp that replaces the typical staircase, which ascends to the elevated temple. We also know that its architecture is represented in codices of the neighboring regions as well as its relationship with the landscape in the documents of the Center of Mexico.

Tehuacalco represents the *axis mundi* of a quadripartite arrangement. It has, in each of the four directions, a mountain. To the north is Cerro el Capulín (1120 masl) and to the south, Cerro Tlacotepeque (880 masl), which means in the native language, "in the middle of the hill". If we draw an imaginary line from one peak to another; that is, from north to south, we will see that it passes through the center of Tehuacalco and, approximately, through the middle of both mountains; and if from the same ceremonial center we project a perpendicular to the same line heading east, it will also pass over the top of that mountain and on its approximate center. On the other hand, the western mountain, Cerro el Gavilán (800 masl), the least high of the four, we will see that it is not located on the perpendicular to the north-south axis, but slightly out of phase to the south, in a position that relates it, only, with the main temple, which in turn, is oriented to the west, since its staircase is in its western part. This means that this mountain is consecrated to the temple.

Cerro la Compuerta (1325 masl), has been considered, by us, the main mountain, due to two essential reasons. The first aspect is astronomical, and can be conceived from the skyscape concept, because it deals with the relationship between the cyclical and regular movement of a celestial body as a function of the physiognomic properties of the landscape (Martz de la Vega et al., 2016). From architectural elements, on notable points of the mountain, solar phenomena were observed. At the top, they favored the temporal

equinoxes or quarter-days of the year (March 22/23 and September 20/21). On one of its depressions, in the one to the north of its summit, the Sun emerges on the days of the zenith passages of that latitude, around May 8 and August 5 (which in Mesoamerica have a strong presence, in places where power was concentrated such as Monte Albán and Tikal). On the southern depression of the mountain, the builders of Tehuacalco, oriented the axis of the stairway of the main temple, to a couple of recurring dates in Mesoamerican architecture and that pivot; that is, from a count of days with respect to the nearest solstice, at intervals of sevenths; seven being one of the fundamental numbers of the Mesoamerican worldview. That pair makes a numerical game with the pair of dates west of the orientation axis, now at intervals of thirtheens, thirteen being another of the mantic numbers. This las tcouple of dates is listed as one of the most prominent and persistent. It is known as the dates of the calendrical-astronomical family of 73 days, also due to the pivoting, and it is observed from one of the first urban settlements; that is, La Venta (900 BC), Tabasco, until the last great pre-Hispaniccity, México-Tenochtitlan (1325-1521 AD).

Fig. 1. Isometric of Tehuacalco. Elaborated by Hans Martz de la Vega and Miguel Pérez Negrete, 2009.

The second aspect is that, in addition to being, of the four directional mountains the highest and the closest toTehuacalco, Cerro la Compuerta set the standard for the construction project of the settlement, since it was a model for its planning and architecture, because by following its form extended to the sides and of a moderate height, it makesTehuacalco see more horizontal than vertical and also makes it look like a settlement nestled in the bowels of the mountain. Thus, we have identified Cerro la Compuerta as the sacred mountain of Tehuacalco, a mountain that also shows evidence of having been sacred, at least 3,200 years ago, being, to date, one of the oldest documented with these characteristics. We have also identified it with the regional deity called Xipe-Tótec. Rather than looking for great heights, as the Mayans did in the great city of Tikal (c. 500 AD), with its temples raised to the zenith, or stretching for kilometers, parallel along different natural elevations, as Teotihuacán did (c. 150 BC), through the Calzada de los Muertos (the principal causeway), Tehuacalco sought an identity, a symmetry, with Cerro la Compuerta.

In addition to briefly presenting the advances of the aforementioned, what stands out for this work is that recently we found a couple of settlements, relatively close, that are similar, which has led us to study the alignments and their landscape. It is important to know how these two places are, new to the Mexican Archeology and of course to the Archeoastronomy of Mesoamerica. With this we can begin to know more about the relationship of a specific distribution such as Tehuacalco's regarding the needs of the regions in terms of the Mesoamerican calendrical system and the agricultural ritual cycle as well as its worldview. Find out what the repetitions are and what are the changes that exist between the three settlements in terms of skyscape theory such as, for example, the dates of the tropicyeartowhichthey are oriented, theimportance of local horizons and some manifestations of the landscape such as mountains, paths, etcetera.

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THE WARRIOR MENELAUS AND ANCIENT GREEK ARCHAEOASTRONOMY

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'There are very few classical scholars who understand astronomy.
And vice versa.' (A. Belenkiy, 2020)

Readings of the pre-literate Homeric epics as extended metaphor indicate a considerable body of cultural, astronomical and cosmological knowledge (Wood, 1999).

Study of the Greek warrior Menelaus in the *Iliad* and the *Odyssey* illustrates how pre-literate Greek sky-watchersdescribedthe celestial sphere, stars and constellations, the Milky Way, and meteor showers. It also indicates an awareness of Precession and the calculation of time.

From the Catalogue of Ships (*Il.2.485ff*) 45 constellations are identified with 45 homelands of Greek and Trojan contingents and stars associated with named commanders. Red- haired Menelaus is allocated to Antares.

Ensuing combat creates a memorable catalogue of stars and constellations, a prime requirement at the heart of pre-literate Homeric cosmology (Wood, 1999). Identifying Greek and Trojan regiments with constellations and their prominent stars, was a task which required many years of study (Wood, 1999).

Homer sets the scene for half of the celestial sphere in the duel between Menelaus (Scorpius) and Paris (Orion); for as Scorpius rises Orion is setting (*Il.3.340ff*). The Milky Way, the backdrop to Scorpius, reflects Homer's dazzling description of Menelaus' palace (*Od.4.40-5*), a myth known from earliest times (Allen, 1899). The constellation of Scorpius is projected as the tall, narrow-waisted, broad-shouldered Menelaus (*Il.3.210*) and echoes the topology of Menelaus' homeland of Lacedaemon within the narrow Eurotas Valley.

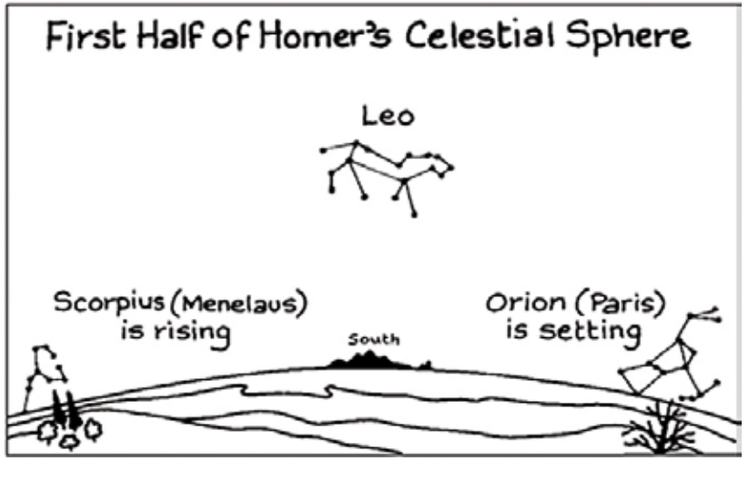

Fig. 1. First half of Homer's Celestial sphere.

There can be little dispute that Odysseus's absence from Ithaca spanned a 19-year luni-solar cycle (Murray, 1907). However, episodes from narrative concerning Menelaus and his family also record 8-year luni-solar cycles of 99 months, such as Menelaus' stay in Egypt, Aegisthus' rule in Mycenae and Orestes' banishment. (Wood, Odyssey, 2011)

Astronomy is known as the oldest of the sciences (Flammarion, 1880). The modern scholar Fara states: "Thales …is often said to be the first true scientist - but choosing him would result in leaving out all his important predecessors, such as the Egyptians and the Babylonians." We suggest the predecessor of Thales' astronomy is Homer.

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THE PERENNIAL CYCLES OF THE UNIVERSE AS SYMBOLIZED IN HITTITE YAZILIKAYA

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In 2019 it was proposed that the rock sanctuary of Yazılıkaya, considered one of the holiest places in the Hittite kingdom, had a calendrical function (Zangger & Gautschy 2019). The 64preserved rock-cut reliefs of deities in Chamber A can be arranged in groups to mark the days, synodic months and solar years. This arrangement was made in order to keep track of synodic months and solar years and/or to display an accurate date during monthly and annually recurring festivals (Demirel 2017).

Here we aim to elaborate on three questions not addressed at the outset: First, why do the figures used for counting the days (Reliefs 13–41) differ in character, whereas those for counting months (Reliefs 1–12) and years (Relief 46a–63) are virtually identical with each other? Second, what is the meaning (technically or metaphorically) of the main panel (Reliefs 42–46)? Third, how can the symbolism of Chamber B be interpreted?

The 30 relief figures that indicate the days of the month on the western wall of the sanctuary's Chamber A differ in attitude, attribute and dress. In our model, winged (celestial) deities correspond to the days of the waxing moon, and mountain (terrestrial) gods with fountains flowing from their robes are the waning days of the moon. We interpret the centre of the sequence, clearly emphasised with the depiction of the bull-men (Reliefs 28–29), as the day of the full moon.The original model for the Yazılıkaya lunar month procession may have associated the days with different distinctive deities, each a personification of a day of the lunar month. A similar panel with 14 gods depicting the 14 days of the waxing moon is found in Egypt in the ceiling of the hypostyle hall of the Temple of Hathor at Dendera (Fig.1). Although the ceiling relief is from the later Ptolemaic era, lists of days of the lunar month are well documented from earlier times, and most of these texts mention days from the waxing half of the month. The sequence at Dendera proceeds from left to right. The sequence at Yazılıkaya runs in the opposite direction, but the full-moon day is highlighted in both instances. At Dendera, it is symbolised with a disk bearing the eye of Horus on a sickle-shaped support stand attended by the god Thoth; at Yazılıkaya, it is marked by two bull-men, who carry a similarly sickle-shaped vessel which represents the Luwian hieroglyphic sign for "sky".

Fig. 1. *Waxing days of the lunar month depicted as Hittite deities in Yazılıkaya's Chamber A (above; Reliefs 28–41) and as Egyptian deities in the Temple of Hathor at Dendera (below). The version in Yazılıkaya,more than 1,000years older,reflects the movement of the Moon astronomically correct from right to left. In both cases the full Moon coincided with the sickle-shaped vessel highlighted in red* (©Luwian Studies).

The principal deities at Yazılıkaya are the Hurrian storm god Teššub,his wife, the Hurrian goddess Ḫebat,and their son Šarruma.Although the links between them are controversial, these gods were associated, respectively, with the Storm God, the Sun Goddess of Arinna and the Storm God of Zippalandain the Hittite pantheon.Their names were written with Luwian hieroglyphic signs but in the Hurrian language. Evidently, parts of the system were introduced from somewhere else and overlaid upon local Anatolian belief systems thousands of years old. It is clear the Hittite state pantheon emerged from the most diverse local pantheons in Anatolian and Syrian cities.

These central gods residing on the chamber's north face rule over the entire pantheon, which is symbolised by the rest of the figures. This zone in the chamber, given its position to the north and at the focus of an assembly of celestial and cosmic gods, can reasonably be assumed to reference the northern celestial realm, centred on the north celestial pole and hosting the circumpolar constellations. The north celestial pole is the unmoving spot around which the sky, and thusthe entire universe, seems to turn. In traditional cosmology, the north celestial polestabilises the cosmos and governs its behaviour. Chamber A as a whole can thus be viewed as symbolising everything existing on Earth plus the sky – as hinted in the symbols above and below the two bull-men (Relief 28 and 29).

Chamber B was designed to reflect the remainder of the cosmos, the netherworld. The 3.4-metre-tall relief of Nergal (Relief 82), the sword god of the underworld, the additional twelve gods of the underworld (Reliefs 69–80), and the narrow passageway covered with water – all these elements fall into the appropriate iconography. Theysymbolise the southern sky and the ocean and thus reflect a transient death – the

dying of the sun at night, the time the sun spends in the south during the winter, and the temporary vanishing of the Pleiades and other stars after their heliacal setting. It is a death that is overcome throughto the perennial celestial cycles.

All things considered, the Yazılıkaya rock sanctuary transmits images rooted in the earliest historical civilisation (Krupp 2005). It depicts the whole habitable world extending around the *axis mundi* – earth, heaven, underworld – the system created by the paradigmatic work of the gods when they organised space into the three cosmic levels. Yazılıkaya even permits passage from one cosmic region to another – from heaven to earth and from earth to the underworld. The religious calendar commemorated in the space of a year all the cosmogonic phases, thereby repeating the act of the creation; Yazılıkaya demonstrates that the timing was accurate. The system works in perpetuity – and could be reactivated today.

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REVISITING STAR NAMES: STELLARIUM AND THE ANCIENT SKIES DATABASE

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Since ancient times most human cultures have formed mythical figures (constellations) out of star patterns and named particular bright stars. The scientific tradition established in Europe since antiquity has developed from the well-known canon of 48 constellations described in Ptolemy's 'Syntaxis', better known in its Arab translation 'Almagest', adding more constellations over the centuries. Finally, the International Astronomical Union (IAU) canonized 88 named constellations filling the sky in well-defined areas (Delporte, 1930). The aim of this work was mostly to avoid ambiguities in the location of variable stars. However, neither the constellation patterns, nowadays usually depicted as stick figures connecting the brighter stars, nor the names or even the spelling of the star names, were standardized.

One of the most popular outreach tools for astronomy is the free and open-source desktop planetarium Stellarium (Zotti et al., 2020). Already quite early in its history, before the UNESCO International Year of Astronomy (IYA2009), the small group of original developers had included the option to show the constellations of various cultures. By version 0.20.4 (December 2020) no less than 40 sky cultures can be presented. These sky cultures usually have been external contributions which over the years have been included in mixed levels of completeness and quality. Some of the latest additions fulfill research-grade standards (Hoffmann, 2017 and Hoffmann, SEAC 2018 in press). However, some concepts which are important in non-European cultures, e.g. Lunar Stations or Dark Constellations (Gullberg et al., 2020), are currently missing. Some ideas for further developments that should happen over the course of the next several years have been given earlier (Zotti and Wolf, submitted).

In a similar time around the IYA2009, the online web service 'Ancient Skies' has been started (Schultz and Vickers, 2011). Ancient Skies is a web based database which aims to collect available information about the astronomical knowledge of various human cultures and their representation in the sky. The main target is to rely on primary sources that are scientifically verified to guarantee that the data collected is valuable to scientists and the general public alike. Data verification and entry was, however, slow, since not enough information about the various cultures could be verified and the project came to a halt in 2013.

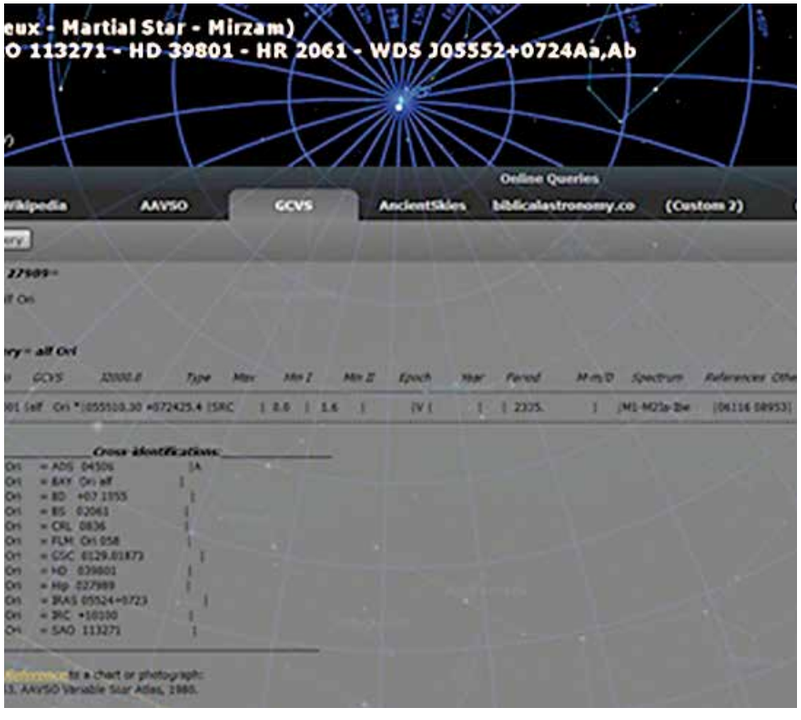

Fig. 1. Preview of a new Stellarium plugin enabling online queries of additional information.

In recent years, the value of traditional constellation knowledge as part of the immaterial cultural heritage has gained increasing attention in cultural astronomy, and in general, cultural matters concerning astronomy has become a research topic in itself, be it the conservation of historical observatories (https://www3.astronomicalheritage.net/) or even the protection of the subject of astronomical research itself, the natural sky free from artificial light (Ruggles and Cotte, 2010, 2017).

A few years ago the IAU created a Working Group for naming stars started to publish official lists of traditional star names (https://www.iau.org/public/themes/naming_stars/, we do not discuss the IAU's Exoplanet naming campaigns in this context). Apart from enforcing one spelling and selection of only one well-used name per star, in these officially sanctioned lists also a few names from non-western traditions have been added, which have however been given to bright stars in constellations formed in the western tradition. The sudden appearance of such names will probably confuse observers, researchers or curious laypeople well-acquainted with the usual names and will evoke more questions about the origin of those names.

These interested people may turn to a lexicon of star names, or may use software like Stellarium, or use some web search engine to find more information. Often, if successful at all, the only information will be the confirmation that the star in question has that name, but may not give further information about the name's cultural background. While Stellarium's sky culture capabilities are in a phase of discussion before actual development of more functionality could start, Stellarium and the Ancient Skies Database have joined forces and allow a lookup of star names and their cultural background information from inside of Stellarium. We have started developing a new plugin that can access the information stored in the Ancient Skies database and display names of the selected star, its constellation, some cultural and etymological information, as well asqualified references. In addition to Ancient Skies, also other web services can be queried for additional cultural and astrophysical information.

The plugin and required changes in the Ancient Skies web services will be presented at the conference (at least as preview).

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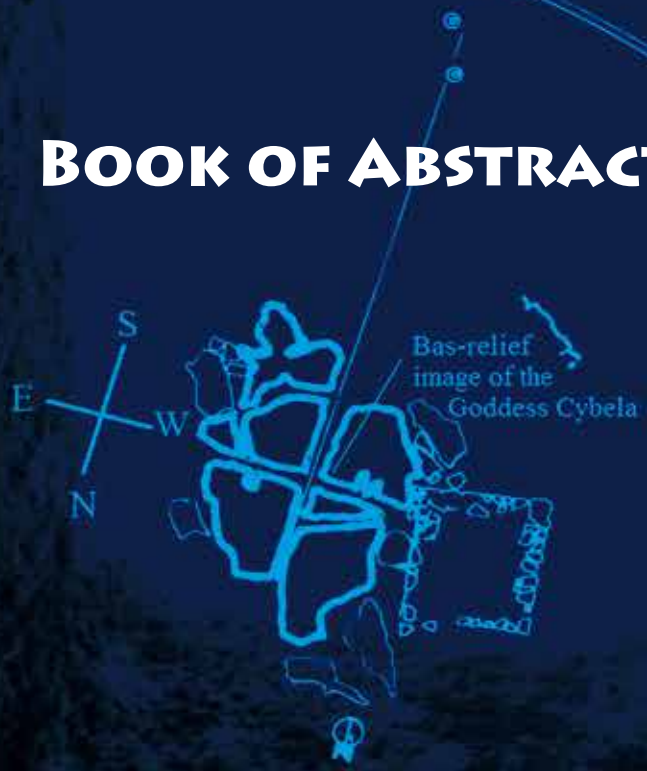

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