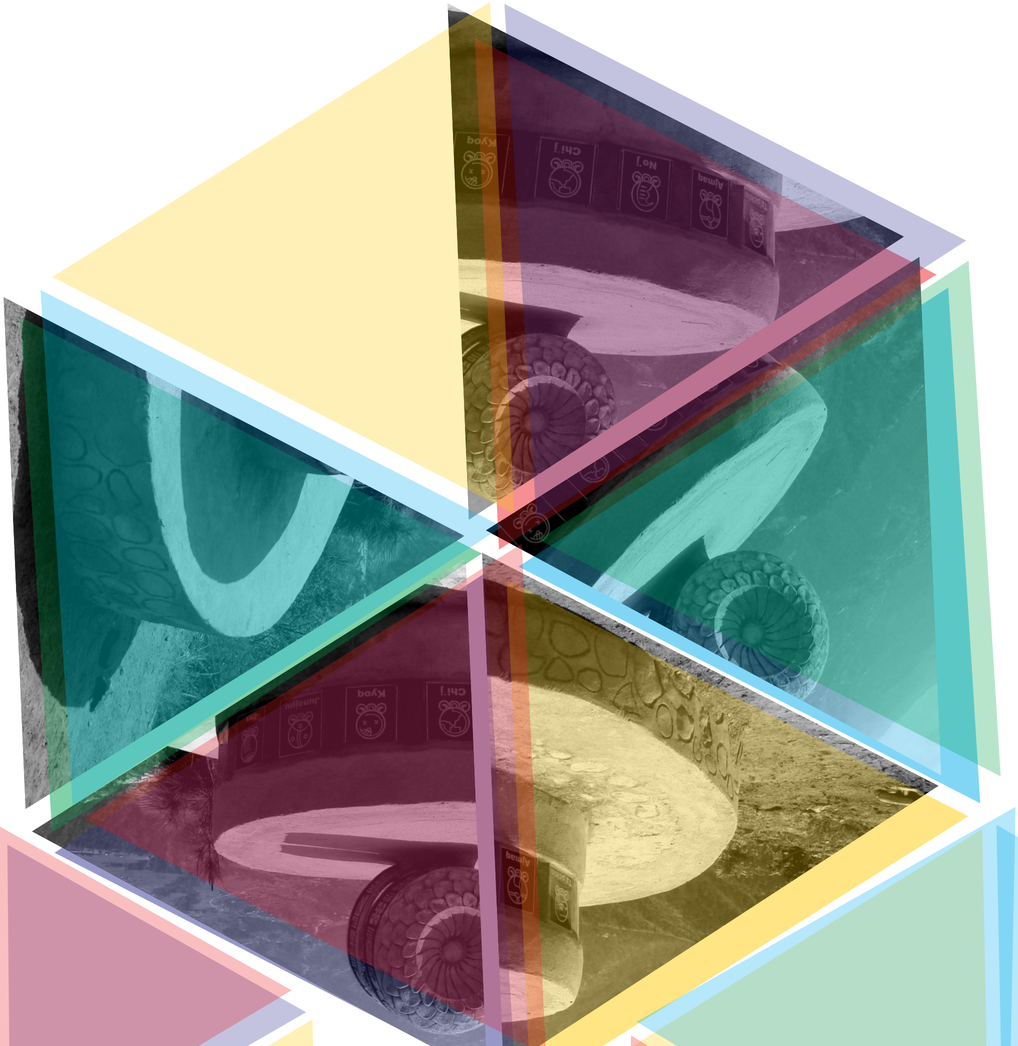
NASE kaleidoscope of experiences in cultural astronomy

Archeoastronomy and Astronomy in the City



KALIDOSCOPE OF EXPERIENCES IN CULTURAL ASTRONOMY

Network for Astronomy School Education

Proceedings of the Second Seminar on NASE Experiences in Cultural Astronomy

Editors: Rosa M. Ros & Juan A. Belmonte

International Astronomical Union

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Introduction

The Network for Astronomy School Education Project (NASE) originated during the International Year of Astronomy in 2009 (IYA 2009), and was developed in response to the International Astronomical Union's (IAU) 10 Year Strategic Plan of 2009 with the objective to increase the efforts of the IAU in primary and secondary schools around the world. NASE's primary mission is to stimulate teaching astronomy in schools, through professional development of primary and secondary school science teachers in developing and emerging countries. The organizational principle is capacity building through workshops in host countries in cooperation with a Local Organising Committee (Local NASE Group), whose members are university professors and education professionals in the host country. Further, the Local NASE Group promotes astronomy activities and organizes additional courses and workshops for teachers in their country. Since the first course in 2009, over 100 NASE workshops have been held worldwide. Instructional materials are currently available in English, Spanish, Chinese, Portuguese, Rumanian, and, Indonesian, with more to come.

NASE's philosophy is to use hands-on activities that explain fundamental concepts like why the Earth has seasons, the phases of the moon, what are planets, how do stars form, the expanding universe, how we learn about the universe from the different wavelengths of light, and how astronomy integrates with culture. NASE emphasizes a accessibility and direct experiences, and therefore provides a wealth of activities that can be carried out with inexpensive, quotidian materials available to every student world wide, that are supported by explanatory texts and ready-made presentations for teachers to use. NASE also encourages workshop participants to share their experiences and lessons through local activities and online.

Respectfully,
Susana Deustua, PhD
Vice-President, Division C (Education, Outreach and Heritage) of the IAU.
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President's Message

Thanks to the NASE members collaborating in the "Second Seminar on "NASE experiences in Cultural Astronomy". After several years, we are beginning to collect the some examples about astronomical visits developed in our courses in different countries.

These proceedings contain the reports of the 23 countries involved in NASE as working in astronomy from an interdisciplinary point of view. During the meeting, we will study some aspects to be improved as well as the strengths of the cultural astronomy included in NASE courses. The desire of NASE's program is to reach many more approaches to Astronomy from a social point of view. Astronomy in the city in the day a day life in our past or currently.

In the about 30 contributions collected we have got examples of archeoastronomy presented by professional astronomers of this area, several papers related to "indigenous" that try to preserve their habitudes in the current situation (gnomons or festivals) and others showing examples of ancient cultures (constellations and orientations) reserved by old people who try to transmit to young ones. Several countries presented studies connected to old observatories, sundials, or meteorites. Of course, all these topics are very connected with Astronomy. Really, they are part of Astronomy, but so integrated in the common life that people feel as part of their city. We love to mention this area as "Astronomy in the city". Certainly, there are many examples of cities founded according cardinal orientations or some examples of religious buildings oriented too. In addition, in a lot of our cities and buildings there are decorations related to Astronomy including astronomical concepts (not only astronomical objects). Finally, but not less interesting, there are examples of astronomical concepts or instruments that evolve to another kind of applications very usual in our life (as periscope or 3D cinemas).

It is possible this activity for NASE because we have the support of several members of IAU Commission C3 of History of Astronomy and in particularly the important help of Juan Antonio Belmonte who acts as referee of this session and his opinions and suggestion give us the opportunity to grow up. We are learning and working with a lot of interest.

It is necessary to thanks to the "Verein Kuffner-Sternwarte" society and the Kuffner-Observatory of Vienna for helping us greatly in the aspects of local organization.

Dr. Rosa M. Ros
NASE President

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América

Second Seminar on NASE

Kalidoscope of experiencies in Cultural Astronomy

Kuffner-Observatory, Vienna

Johann-Staud-Straíe 10, 1160 Wien, Austria

24th August 2018

PROGRAM

9:00 - 9:15 – Delivery of documentation
9:15 - 9:30 – Openning session
9:30 - 12:30 – Oral presentations
12:30- 13:00 – Conclusions

Introduction

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The observation of the sky is probably the earliest 'scientific' activity ever performed by humankind together with some very basic concepts of healthcare. The presence of known predictable patterns in the heavens was fundamental for the control of time and certainly was in the origin of various earliest metaphysics.

Cultural astronomy is the discipline that study and analyze how this phenomenon was produced since the Paleolithic to the structuring of complex societies until present. Any culture around the globe develop a certain capability in sky watching, time keeping and complex mythography that can be disentangled and may help understanding the culture's worldview.

This job is usually performed by a handful of scholars who deals, with ancient (and modern) monuments, arcane manuscripts, and popular traditions in an attempt to identify the patterns and rules each society developed to read and use the sky. On many occasions, to count on local people for this purpose has proven fascinating and even indispensable.

NASE, acronym for "Network for Astronomy School Education", is an IAU initiative created in the GA of Rio de Janeiro in 2009, instructing formative courses in astronomy to middle school teachers worldwide. It has been operating for nearly a decade offering more than a 100 courses to more than 5000 teachers in four continents, using, and this is important, the local language as the lecturing and learning vehicle.

NASE cleverly identified cultural astronomy as a powerful tool for the interaction with the locals, empowering the teachers with tools they were able to perceive as an easy way for dealing with their pupils and students. It is much easier to teach, and to learn, something you feel closer to your heart.

This volume is a preliminary, motivated, intriguing but fascinating approach to a plethora of examples where astronomy did play a role in the formation of local identities. It includes about 30 studies of a same quantity of countries in four continents (actually five if Hawai'i is considered as Oceania). America is strongly represented because with only three languages you could easily cover a whole continent.

The level and typology of contributions is variegated as would be expected from a series of contributors whose first contact with cultural astronomy as a discipline was this essay, precisely. The reader can learn from ancient pre-Hispanic traditions in the Maya heartlands to how traditional or modern astronomical observatories can be perceived as relevant counterparts within the cultural context of a certain country.

The editors have made a huge effort to compile this series of essays. It was not an easy task and we must congratulate that they had the will and energy to bring it to a correct and appropriate end.

Cultural Astronomy in NASE

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Main Objectives of NASE related Cultural Astronomy

NASE is an IAU Working Group focused in teacher's education in astronomy. In general, students are interested in astronomy and it is not difficult to motivate them in our topic. Astronomy is a good open door to science but they do not know the importance of astronomy in the history and culture of humanity.

Astronomy is present in our life and astronomy was part of all of us in some way. It does not matter the country where we work: Astronomy is included in the culture of our grandparents and ancestors. This is the reason why NASE has as part of its objectives to that motivate that teachers with their students discover the astronomy in their own cities, the **cultural astronomy and archeoastronomy** in somewhere. In some cases, it is only necessary to walk in the city with open eyes and observe some aspects that in a normal day we cannot see. We have to use an "Astronomy Hat to find astronomical aspects in our life"!

NASE shows many examples of **Astronomy in the city or Cultural Astronomy** in its website. In this book, we offer a good set of examples. Of course, each one of them it is not possible to apply in other sites, but we only want to show a kaleidoscope of activities and a lot of them can be adapted to other cities and to other cultures. It is a list of suggestions about what to do!

The special topic of "Astronomy in the city" was the result of a proposal of Barcelona Municipality. One astronomer colleague who worked in that institution, mentioned that the countries and the cultures pass, but the cities survive more and more centuries. For instance Barcelona was part of Iberians culture and it was named Laye, Phoenicians and Greeks arrive to the coasts, with the roman invasions and it was founded Barcino, after the Roman Empire falls dawn, arrived Visigoths, Arabs, etc…, but for centuries Barcelona was a place where the people lived. Then we wants to promote the astronomy that we can found in our cities and enjoy them.

On the other hand, NASE also promote a real network of people enjoying astronomy on the Planet. The Program moves people from a NASE country to another one. In figure 1 we show the movement of the NASE members. This exchange offers a real exchange of ideas and different approaches to cultural Astronomy. Different cities have different historical lines and different experiences, all of them contribute to increase knowledge. Different approaches to the universe.

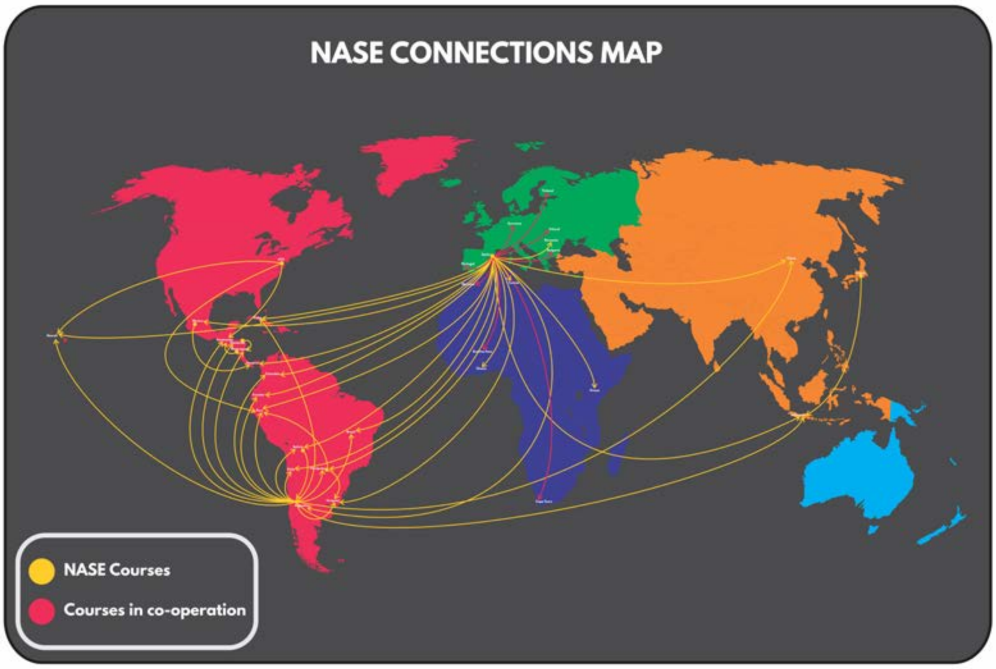

Fig. 1: Relationships between NASE members

The normal courses of NASE began in 2010, (in 2009 we essay a couple of courses during the International Year of Astronomy in cooperation with UNESCO). Since the first course, Cultural Astronomy was present as part of the course and involve teachers moving from the classrooms to outside in order to visit the ancient sites or archaeological vestiges or to discover Astronomy in the city. The first course in 2010 took place in Barranquilla Colombia and we visit in Sabanalarga municipality a simple museum with the “Medallon en Tumbaga” and several “Grabados en Canto Rodado” representing the Sun. We use this excursion also in order to get a better sky quality for night observations too.

Fig. 2: The first NASE excursion on cultural astronomy in Colombia with a typical coach named “La niña Linda” (The beautiful girl).

The second course took place in Managua in Nicaragua with the support of the National Autonomous University of Managua. We visited the historic center of Managua with the streets squared and numbered from a "zero point" the North, South, East and West. The visit was guided by Dr. M. Cristina Pineda de Carias, current Dean of the Faculty of Space Sciences of the National Autonomous University of Honduras and we found the "zero" of this neighborhood (figure 3).

Fig. 3: Participants in the NASE course during the visit to the Historic Centre of Managua.

Of course we cannot make a list of all the astronomical visits developed in the NASE courses but we will finish with the third one in 2010, because this is mentioned in this book. In this course that took place in Lima, Peru, we visit the “Cienaguilla” site with Juan Pablo Villanueva who was working and preparing his PhD thesis in this year. We have the special opportunity to visit a place not open to the general audience and we received his explanations. At first in the Universidad Nacional Mayor de San Marcos and after that in the real excavations. This was a very special luxury to have this opportunity in 2010.

Fig. 4: Participants in the NASE course listening the explanation in “La Cienaguilla”, close to Lima.

Some examples of Astronomy in the city

The cities that we know better are our own: one of them is Barcelona and the other one is Mendoza. They are not similar, but we will use both as examples of different possible activities connected to Astronomy in the City. Barcelona is not a big and is not a small one, but has a long history and we can find a lot of examples walking in the street.

1) One of the main quarters in Barcelona is the “Eixample” that means the “extension”. This quarter was created by Idelfons Cerdà in 1860 and integrated the nucleus of Barcelona with other small towns close to it. When the Barcelona borders where destroyed the main idea was to create a new zone healthier than the old way cities (figure 5). The structure of the “Eixample” was a grid, but their streets are not North-South and East-West oriented, that we can discover in a lot of cites, the structure is a little bit more sophisticated.

Fig. 5: Barcelona, “Eixample” quarter.

The diagonal of each square is oriented North-South (figure 6). If you observe figure 6, you can see that each apartment, included in the square, receive Sun light in both parts of it (interior and exterior). In figure 6 you can see the situation of gray apartment, the part of the apartment with the windows to the interior of square receive the Sun light during the morning and the part with windows to the street receive the Sun Light during the afternoon. Always we have a part of our apartment illuminated by the Sun.

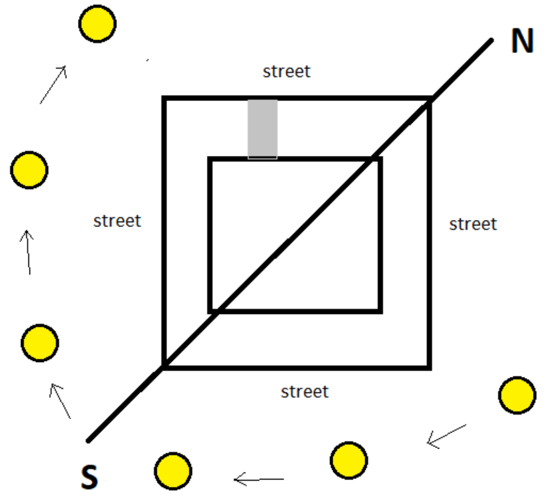

Fig. 6: Always the grey apartment have a part illuminated by the Sun. Fig. 7: The intersection of parallel and meridian is the old lighthouse of 18th century turned into a tower clock.

2) There are many other examples of Astronomy interaction with the city in the street too. In particular there are two street named Parallel and Meridian in the plans of "Eixample". Both of them are in the appropriate direction according with geographical lines mentioned in their names (only the original part because the prolongations were constructed with another criteria). Both of them are not a chance. The intersection of both lines are in the port of Barcelona and correspond to an old lighthouse of 1772 turned into a tower with a clock in 1904 which gives the time to fishers (figure 7).

3) In Barcelona there are many sundials. For instance in the corner of Valencia street and Balmes street in the "Eixample" quarter there is a church with a bel tower (square tower) that include a sundial in each of their four sides (figures 8 and 9). There are four vertical sundials with hour lines and zodiacal lines. One of them has the plane oriented to the South, another to the North (which only can be used in spring and summer) and other to the East and the last one to the West, which projects shadow only some days and close to the Sunrises and Sunsets.

Fig. 8: Sundials to the north and the west.

Fig. 9: Sundials to the South

4) Of course it is possible to organize a tour following the Barcelona Sundials and this is not of our interest, but there is another one very special. In the Ciutadella Park you can see a Parallel Earth used as spherical sundial. This is on the top of a meteorological column that is not possible to use currently (figure 10). The sundial is not useful every day because there are a lot of trees in this area and depending on the season the sundial is in the shadow area.

Fig. 10: Column with spherical sundial. Fig. 11: Colon is not showing the direction to America

5) In the main door of this Park close to the previously mentioned column begins a big Avenue named Passeig Colón parallel to the border of the Mediterranean Sea. In the intersection of this avenue with the Rambla -the much more characteristic street of Barcelona- there is a big column with the sculpture of Cristobal Colon. The admiral make a signal with his finger pointing to the sea, people believe that he indicate the direction of America, but really America is in the opposite way (figure 11).

6) A sundial has part of astronomical concepts, but there are other examples of Astronomy in the city not very common. The Architecture Department of Technical University of Catalonia is a building designed by Antoni Gaudi. Really this construction was originally the estable for horses of the Count Güell. Of course the architects that work now there appreciate this site better than the horses. The main door of this building is one of the best iron works by Gaudi.

The Draco constellation is there with all the stars in the correct place (less one of them that was broken and the new one was put in the bad place). The Draco according mythology was the guardian of Hesperides Garden and the trees in the interior (original from Gaudi time) are orange trees according with mythological mention. In particular, the door is also oriented in the direction of Drago position for a special day for the Count Güell (figure 12). Gaudi was very delicate in all his constructions with the meaning and the symbology of its orientations and decorations.

Fig. 12: The stars of Draco constellation are represented as spheres with spikes

7) If the visitor decide to enjoy a museum in Barcelona, you can discover relationships with Astronomy also. One of the best examples is the Museu Nacional d'Art de Catalunya in the Monjuic mountain. When you visit the Romanesque pictures of Santa Maria de Taüll (figure 10), you can discover on the main figure two stars colored. On the left a red star and on the right a white star, both of them in the sky over the figures of three Magician Kings (Melchior, Gaspar and Balthasar).

Fig. 13: Santa Maria de Taüll with three kings and the stars over them.

In Catalonia, in Christmas period, it is visible the Orion constellation dominating the southern horizon. Normally people in this area named "the three kings" the three stars in the Orion belt. It seems that the painter show us one of the first astrophysical observations. Painted the star on the left red or orange as Betelguese and the star on the right appears white as Bellatrix. We know that this painting was made before 1123, beecause the church was consecrated then.

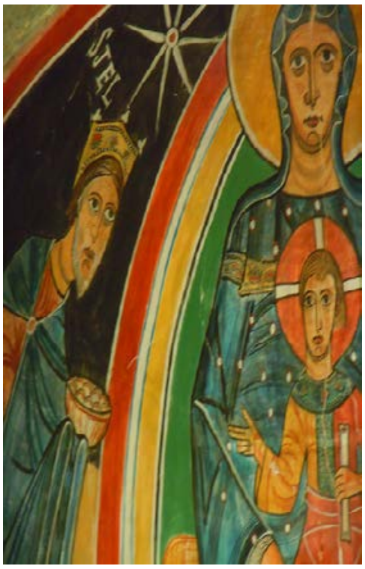

Fig. 14: Red star Fig. 15: Orion constellation. Fig. 16: White star

8) Barcelona was founded by Roman Empire in 1st century BC (It was named Iulia Augusta Faventia Paterna Barcino) on a small hill named "Mons Taber" for strategic reasons in order to facilitate its defense in case of attack. The Augustus Temple (dedicated to Emperor Augustus) was located on the highest point of Mons Taber (figure 17).

Fig. 17: Four columns of August Temple with their respective capitals are still in their original position and we can see them in Paradis street at number 10.

Barcino was crossed by the Decumanus maximus (main street with approximate orientation of east-west), which crossed the city from the Porta Praetoria (Portal del Bisbe now, figure 18), passing through the current streets of Bisbe, Ciutat and Regomir until the Porta Decumana.

Fig. 18: Now one of the three arcades that the Porta Praetoria had is appreciated, and the two towers of circular plant that defended the sides. It is possible to see some rest of the aqueduct, which arrived to Barcino.

The Cardo maximus that connected the Porta Principalis Sinistra (current Pl. De l'Àngel) and Porta Principalis Dextra (which was between Ferran and Call streets), passing through Llibreteria and Call streets (figure 19).

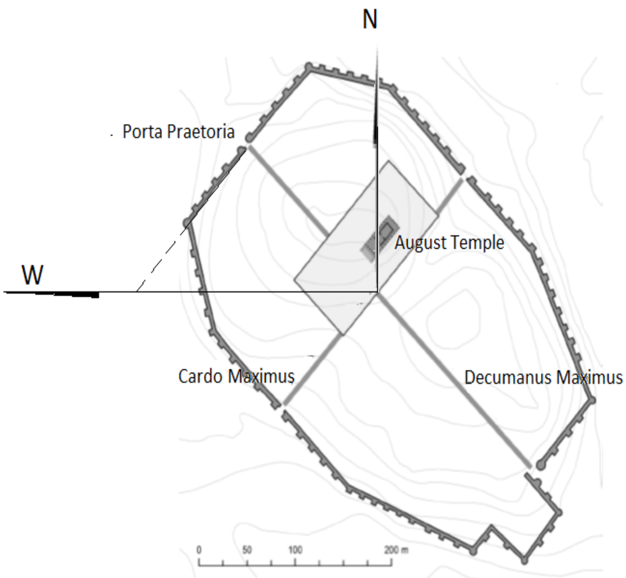

Fig. 19: Cardo (North-South approx.) and Decumanus (East-West approx.)

The Decumanus Maximus is easy to find in the current Barcelona and it is not difficult to calculate its angle to the west and compare the result obtained with the results of professional archeoastronomers. For instance, in table 1 summarize the result of a study carried out about 270 urban structures and military settlements measured

declination	festivity	zone
+15º	May 1st	Celtic origin, Galia
+12º	Sunrise April 21st Roma Foundation	Cartago Nova NW Hispania Galia and Germania
+7 º	Sunrise and Sunset March 1st Mars Festivity	Britania, Limes Arabicus and Limes Germanicus
0º	Equinoxes March 21st September 23th	Iberian origin North of Africa and Near East Berber groups
-15º	November 1st	
-23,5º	Sunset Winter Solstice December 21st Saturnalia	East and West of Rome

Table 1: Summary of Andrea Rodríguez-Antón phD thesis La Laguna University.

Also in Mendoza it is possible to recognize some examples of Astronomy in the City.

9) The foundational area of Mendoza studying is the oldest area of this city and it is oriented. Captain Pedro del Castillo sent by the governor of Chile, García Hurtado de Mendoza, founded the new city in 1561, calling it "Ciudad de Mendoza del Nuevo Valle de La Rioja". The initial location of Mendoza was in what is now known as “La Media Luna” in the Department of Guaymallen on the eastern margin of the channel currently known as “Cacique Guaymallén”. In 1562 it was moved at a distance of two shots of arquebus to the west of the point of the foundation made by Pedro del Castillo, placing the new site about 100 meters west of the Cacique Guaymallén channel, at the current position of the Pedro del Castillo square.

At the time of its founding, the design seems to fit the tradition: a Plaza de Armas (the current Pedro del Castillo), with the town hall (the Cabildo) on one of its margins (in this case the east sidewalk) and the Church in another. Normally, at that time, the church was installed with the door facing west, so that the Sun of the dawn entered the altar. In the first place, with the help of a compass, we check the orientation (figure 20). Ituzango street is in the North-South direction (former la Cañada street, figure 21).

Knowing that in the Fundamental Area the history of Mendoza is narrated through reminder plaques, it is enough to go around the perimeter of the square to discover that in the South-West corner there are plaques that recall that the first church of the city was installed there, the "Iglesia Matrix ", where José de San Martín had the flag, weapons and soldiers blessed before the epic of the crossing of the Andes.

Fig.20: Determining the orientation of the "Área Fundacional" and of Ituzaingo Street. Fig. 21: Ituzango Street is oriented in the North-South direction.

Fig. 22: Building site of the old church, the first church built in the Plaza Pedro del Castillo on the South-East corner, the current corner formed by Ituzango and Alberdi streets. This church had its door in the old Calle de la Cañada, now Ituzaingo Street. Fig. 23: Information plate

10) Much of the colonial buildings in Mendoza was destroyed during the earthquake on March 20, 1861 (as happened to the Iglesia Matriz) which led to the construction of the New City in the area about 1 km Southwest of the Foundational Area that was abandoned. The new model was structured with a central square of large dimensions, satellite squares, avenues of circumvallation, North-South and East-West directives and boulevards with the innovative characteristics of the 19th century under guidelines of Julio Ballofet. The city was reborn as a 64-block checkerboard centered on "Plaza Independencia", a 4-hectare park square. In the diagonals of the main square, and with blocks built in between, four new squares appear that were erected

at the same time as minor squares. They are the current places: Spain, Italy, Chile and San Martin. But this central checkerboard of the new city is not really well oriented.

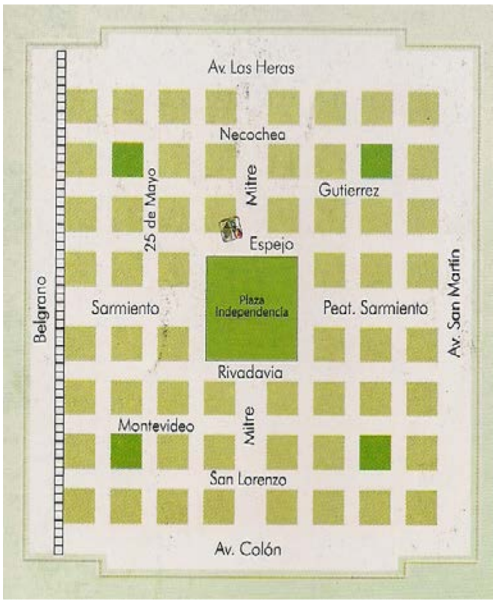

Fig. 24: Plan of the Plaza Independencia and surrounding areas. The four symmetrically arranged squares are: Plaza de Chile (top left), Plaza S. Martin (top right), Plaza Italia (bottom left) and Plaza España (bottom right).

Fig. 25: Determination of the orientation of the North-South direction in the Plaza España. As you can see, the North-South direction forms an angle of about 20 degrees with the line of the tiles.

If we compare the grid aspect of the two zones (Foundational Area and New City) it is observed that the North-South direction in one and in the other are not exactly parallel, the orientation is more correct in the Foundational Area than in the New City (figure 26).

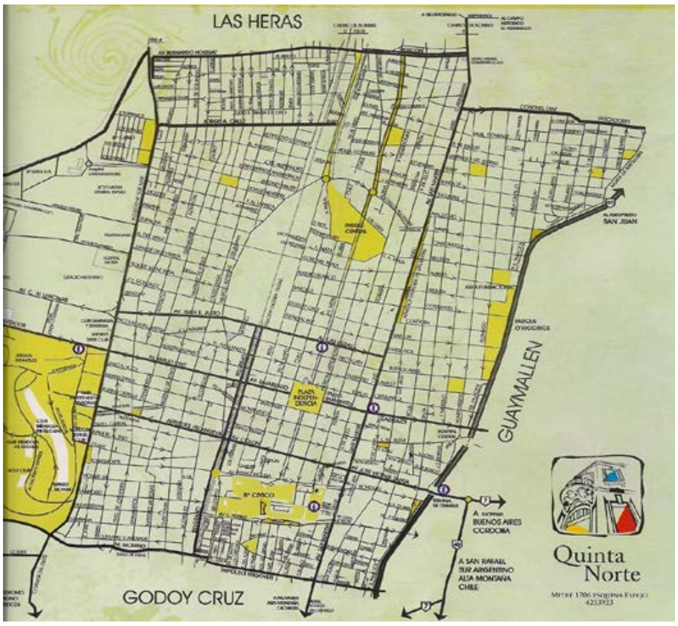

Fig. 26: The North-South direction of the Foundational Area and the Plaza Independencia do not correspond.

Precisely the origin of coordinates of the urban signals that give name to the streets of Mendoza is at the intersection between San Martín and Colón avenues (figure 27): lower right corner of the map of figure 24. It is easy to calculate distances in this grid. This simple way to calculate positions, it is translated into a surprising habit of the people of Mendoza who usually indicate the directions to the taxi driver or to the visitor who asks them with a phrase such as "two blocks north and three blocks to the left". This type of habits can only be given if you live in a grid. Also, it is normal indicate to the West or the East direction: the use of the cardinal points is connected with the visibility of the Cordillera de los Andes, which is not exactly in South-North direction, but near.

Fig. 27: Origin of the Coordinates point in the new city. It can be read in both streets (Av. Colon and Av. San Martin) axis 0 (“Eje 0”). This corresponds to the lower right corner of the square in figure 24.

11) We can visit in Mendoza city two big Sundials. One on them is installed at the University of Cuyo in the San Martin Park (figure 28). The sundial is an armilar sphere and was specially constructed for the Interactive Museum of Sciences (now closed). The sundial was made in a metallurgic workshop with the funds donated by a famous jeweler from Mendoza and the purpose was to make "the biggest armilar Sundial on the Planet", this was a problem, because the clock with several parts of welded iron, needed to be checked using X Rays in order to assure safety. The real big problem with this clock was that the constructor did not interpret the scientific design in the correct way, and the tilt for the gnomon (the latitude of the site) was considered between the rotation axis and the vertical of the site, not with the horizon. For this reason was necessary to change the base inclination (figures 29) to represent in the good way the parallel sphere.

Fig. 28: FCEN-UN Cuyo Armilar Sundial location: -32.88: -68.87

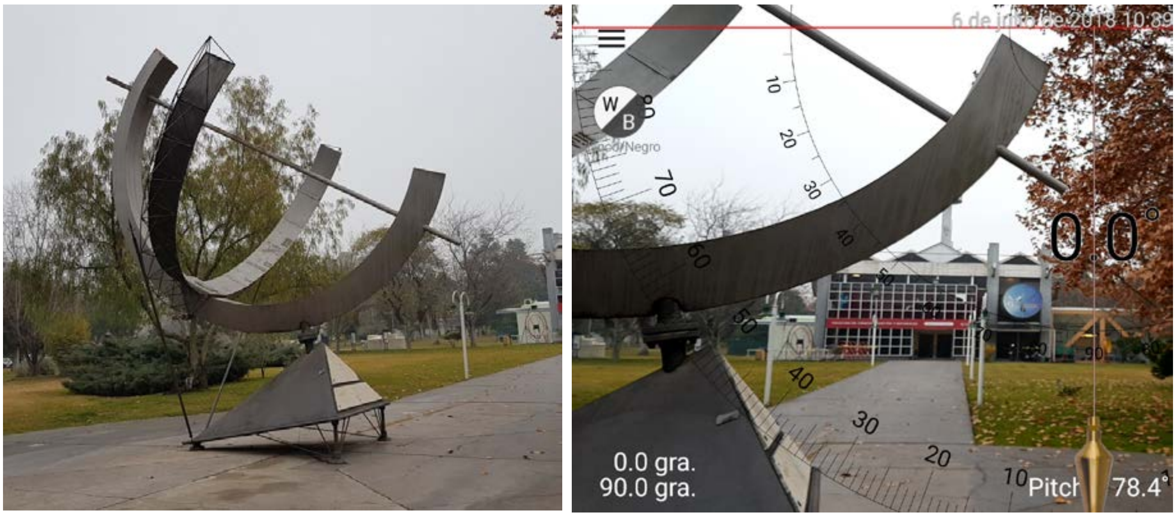

Fig. 29: Armilar Sundial at San Martin Park. Base tilted (left) to obtain the right inclination (34deg) for the gnomon (right)

12) The second interesting case, is the Central Park Sundial (figure 30), an horizontal design which was thinking for the time zone -4 (4 hours to the West of Greenwich), the correct time zone for Argentina, to determine the real solar time and also to now the month in which the hour is measured. The funds for this installation were important, the gnomon is in steel and the square of the clock was prepared with care. The different paths of the Sun on the horizon were well designed and the gnomon must be installed according the Earth rotation axis… but … during the installation "someone" which name is not known, decided that 34 degrees over the horizon could be dangerous for the visitors, runners or walking people and changed the inclination of the steel stick, as it is possible to see in figure 31, with any consultation. The inclination of the gnomon is really far from 34 degrees and the possibility to use the sundial as it was thought was lost.

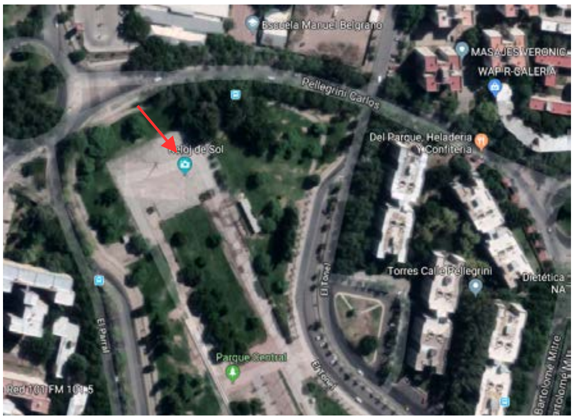

Fig. 30: Central Park Horizontal Sundial location: -32.87: -68.84, Fig. 31: Central Park Horizontal Sundial. The gnomon projects the shadow on the horizon and the path change during the year. Horizontal Sundial gnomon: it has not the latitude tilt (photo by Juan Palacio).

13) When Aristarco de Samos, more than 2200 years ago, recomended the method proposed to measure distances to (nearby) stars, called parallax,had been vident that both eyes have slightly different versions of the same object. If we observe the object with a single eye, we will see it projected on a determined background, if we observe it with the other eye, it will be projected on another background. The human brain integrates the two visions into a single three-dimensional image. If the world is observed with only one eye, the vision will be two-dimensional, if one moved under this premise, it would be unable to estimate distances for nearby objects.

Years ago there was an instrument, called a stereoscope, that had a binocular viewer, through which two images of the same object were seen slightly displaced, each eye perceives one of the images and the brain, when detecting the different points of view, interprets three-dimensionality, although it was a fiction. In the same way, the first version of the so-called three-dimensional cinema functioned: it presented images in blue and red (or green and red), which were filtered with glasses (called anaglyph) of these colors, deceiving the brain.

The 3D cinema has changed over the years and nowadays the images, slightly displaced, are observed through lenses with polarizing filters, which adjust the light allowing the electric field to vibrate in certain directions (figure 33). In some cases the polarization is linear and each eye sees the image associated with the electric field vibrating in perpendicular directions to each other, in other cases the polarization is circular. This type of lens allows to see for each eye a certain number of images, getting a sense of depth or 3D effect of higher quality and we are talking about one of the characteristics of light... its electric field can be polarized and this offers us special information for the brain in the cinema, and for Astrophysics, when we study the electromagnetic radiation that comes from The Cosmos.

Fig. 32: Stereoscope, Fig. 33: The 3D cinema we observe through lenses with polarizing filters.

It is not surprising that we started talking about one of the greatest astronomers of the ancient world, continued with the mesuremt of the distance to the stars and closed talking about the latest technology in the cinema. That's it, also Cultural Astronomy.

Conclusion

Cultural Astronomy is everywhere and is included in our life and in the development of humanity, from the past is projected to the future. We cannot forget it.

References

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Continents and countries

Ethiopia

Introduction to Ethiopian Calendars

Getinet Feleke
Kotebe Metropolitan University, Addis Ababa
Tolu Biressa
Jimma University, Jimma
Mekbeb Tamrat, Dugasa Belay, Etsegenet Getachew, Eyoas Ergetu, Sebhat Tadesse
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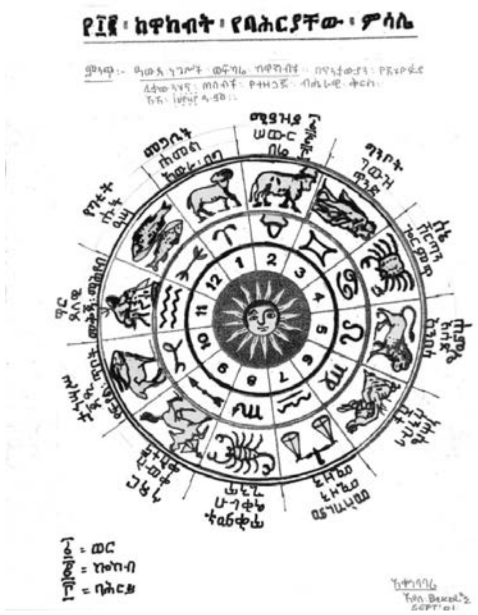
Abstract

Ethiopia preserves an amazing heritage in terms of calendars that are still in use in different parts of country. In the following, we will introduce three calendars, but as mentioned they are not the only ones found in Ethiopia.

Main Ethiopian Calendar

Ethiopian calendar, based on the Ethiopian Orthodox Tewahedo Church, uses a solar calendar which has 365 days divided into 12 months of 30 days, and Pagume, the 13th month. It contains 5 days for a normal year, but this number becomes 6 every leap year and 7 every 600 years [1]. There is evidence to indicate that the Ethiopians have measured the number of hours of daylight using wax candles and have found this number to vary periodically [2]. They knew that there were 182 and 1⁄2 days between the vernal and autumnal equinoxes, and they had names for the signs of the zodiacs (see figure on the right). They divided a 24-hour day into 60 equal parts called the Kaykros, and they divided each Kaykros successively into 60 with a total of 6 such smaller units. [1] [2].

The science of fixing the dates of Easter and related fasts is called the Bahire-Hasab. The calendar has seven main cycles used to calculate these dates. These denote the week, the month, the year, and periods of 19, 28, 76 and 532 years. Each of these cycles have their own meaning. There is a difference of 5 to 11 days, and 7 to 8 years between the Ethiopian and the Gregorian calendar. This difference of 7 or 8 years lies in determining the exact date of the birth of Christ. The Ethiopian Orthodox Church bases its calendar on dates mentioned in the Holy Bible. The story begins from the fifth chapter of Genesis (Gen. 5:3 and Gen 10:11). The calculations are also based on the verse on the Book of Daniel (Dan. 9:24-25). In this verse the coming of the Messiah has been clearly stated as 62 'sevens'. The Church also uses the Bahire-Hasab to compute different ages according to the calendars which Enoch, Noah, Daniel, Jeremiah, Ezekiel, and Ezra have used. All these calendars give consistent dates for the date of Creation and the date of birth of Christ.



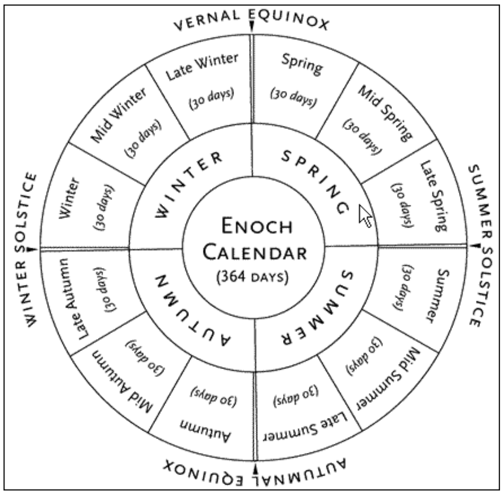


Fig. 1: Ethiopian Astronomy/Zodiac (source: An Ethiopian Journal), Fig. 2: Enoch Calander (Ancient book of Enoch)

The Ethiopic Book of Enoch which is written in Ge'ez and which the Ethiopian Orthodox Church has included in its canon provides the commentary of what Enoch, seventh generation from Adam, saw when Archangels took him to show him the entirety of the known Universe [3]. He describes the motion of the Sun in terms of "windows" in the sky, and also uses these to describe the cycles of the moon and the winds. When Adam was banished from Garden of Eden, he sought to get mercy of God. God told Adam that forgiveness of sin would not be obtained by his effort. He then promised him, "When five and a half days are full, I will be born of your offspring and save you". Note that one-day is one thousand years with God (2Pt.3: 8). When this time (5500 years) had fully come, Jesus was born. This is how Ethiopians started to calculate time, following the pace of Biblical history from Genesis up to the time of Jesus the Christ. Some of the main events are as follows: Adam to the Great flood [3]: 2256 years, Adam to Abraham: 3428 years, Adam to exile of Babylon: 4918 years, Adam to Birth of Jesus Christ: 5500 years. This is the time God gave Adam to come to this World. The Ethiopian Orthodox Tewahedo Church based its calendar (see the above figure) on these calculations [3].

Oromo Astronomical Calendar

The Oromo is a family of East African Cushitic people (largest group) currently inhabiting most of Ethiopia, and other significant number of them in Kenya and Somalia. Their living style is based on indigenous knowledge of cosmos view where they have developed Gada system as a whole general governing principle of both nature and social affairs.

The calendrical system they use within the Gada system is astronomical, a lunar-stellar system . The system is based on astronomical observations of the moon in conjunction with eight or more particular stars (or star groups). The 8 recognized prominent stars (or star groups) used to derive the calendar are, from the northernmost to the southernmost, 1) Beta Triangulum 2) Pleiades 3) Aldebarran 4) Belletrix 5) Central Orion 6) Saiph 7) Betelgeuse, and finally 8) Sirius (refer to table 1 for the names as provided by the authors in the Oromo language and with their corresponding standard astronomical names) [6], [7], [8], [9]. There are twelve lunar synodic months in a year, but no weeks. Each month is identified with a unique astronomical observation by the Ayyantus who are the specialists in making such observations among the Oromo people. The length of each month is either 29 or 30 days – the time it takes the moon to go through all its phases. There are 27 day names. Since each month is 29 or 30 days long so there is a shortage of two to three days early in the same month. But the Oromo recycle the days name so that the 28th day has the first name, the 29th has the second name, and start the next month using the third day name and so on. Thus each month will start on a different day name. Whether the particular month is to be 29 or 30 days long would depend on the astronomical observations of the stars being in conjunction with the rising of the moon.

The New Year begins with the most important astronomical observation of the year – a new moon in conjunction ("side-by-side") with Beta Triangulum. The next month starts when the new moon is found in conjunction with the Pleiades, and so on until the first six months of the calendar are started by the astronomical observations of the new phase moon found in conjunction with six specific locations in the sky marked by the stars. The method is then switched, and the final six months are identified by six different phases of the moon (from full to crescent) being found in conjunction with only one position in the sky – the one marked by Beta Triangulum. In this way the whole Oromo year is identified astronomically and when the new phase moon is finally seen again in conjunction with Beta Triangulum the next New Year will begin. On the other hand, the calendar also has some complex eventual observations even involving intercalation of months and observation of activity of the solar cycle. This issue remains open to research.

No.	Stars Name by the authors			
	Legesse (1973)	Doyle & Wilcox (1986)	Bassi (1988)	Standard Astronomical name
1	Lami	Bittottessa	Lami	Triangulum
2	Busan	Camsa	Busan	Pleiads
3	Bakkalcha	Bufa	Baqqalcha Sors	Aldebarran
4	Algajima	Wacabajjii	Baqqalcha Algajim Algajima	Belletrix
5	Arb gaddu	Arb gaddu	Baqqalcha Arb gaddu	Central Orion
6	Urji Walla	Obora Gudda	Baqqalcha Walla	Saiph
7	Basa	Obora Dikkaa.	Baqqalcha Basa Guddo	Sirius
8	-	-	Baqqalcha Basa Diqqo	Beteleguse

Table1: Names of Borana Stars [6], [8], [9]

The Sidama Lunar New Year, Fichchee

The Sidama people live in the southern part of Ethiopia. They follow their own lunar calendar system which is different from both the Ethiopian and Western (Gregorian) calendar system. Their calendar is based on investigative findings of the Ayyantto (Sidama astrologist). At midnight, they get out of their houses to assemble outside and observe the Moon's size, shape, color, change of position through time, and related situation of solar system. Moreover, they also observe its spatial relation to other stars in terms of their relative positions, movements, and whether they appear separated or close to the moon and/or to each other. The Ayyantoo conduct their observations for at least six to ten days per month. Most of the time, they perform such tasks collectively, and in some occasions, they carry out their study individually. When undertaking the investigation in groups, each will present the analyzed findings of what he has observed, and a thorough discussion on the observations and findings will be held to arrive at plausible conclusions. If the observations and related investigations are done individually, the findings of the investigation will be presented at the appointed time and place where the general meeting of the group is held.

The declaration of the first day of the New Year, called Fichchee, will be announced when the Ayyantto see close approximation of the moon to five constellations of stars, known in Sidama language as Buusa, with well-defined movements observed in relation to each other and to that of the moon. The Sidama New Year (Fichchee) is therefore unique in that it does not have a fixed date. It rotates every year following the movements of the stars. The Sidama calendar has 13 months in a year; each of the months is divided equally into 28 days while the 13th month has 29 days. This is because the Sidama week has only 4 days, and hence each month has 7 weeks instead of the conventional 4 weeks [10], [11]. The history of Sidama calendar and its relation to the overall socio-economic, political and cultural spheres of life of the Sidama people and related affairs is such a rich and broad subject which cannot be exhausted in such a short description as this one.

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Ghana

An Almost Forgotten “Star Compass” of the Mfantse Fishermen

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Abstract

The Mfantse fishermen of Ghana use the stars and the moon for navigation in fishing since the 13th century. This made the fishermen acquired knowledge of celestial objects. However, this knowledge is getting extinct, as it is not documented and also with the advancement of technology, younger fishermen prefer to use Geographical Positioning System (GPS), Telescope, compass and mobile phone for fishing. Nine old and ten young fishermen were interviewed and the results showed that the unlike the young fishermen, old fishermen still use the celestial objects fishing expedition.

Introduction

An African proverb, which says when an old man dies, a whole library dies, implies that much of the knowledge acquired over time or discoveries are not documented but rests with people and the knowledge is lost when they die. This is also the situation of the traditions and the knowledge that have maintained and regulated the fishing industry among the Fantes in Ghana.

The Fante ethnic group occupies the southwestern part of Ghana, 150 kilometers west of Accra the capital of modern day Ghana. The Fantes are believed to have arrived from the North before the 13th century (Berry, 1994) they are one of the subgroups of the Akan with Cape Coast as their capital city. They speak mfantse and practice matrilineal inheritance (succession from the mother’s lineage).

Their major occupation is fishing among the males and fish mongering for the females for many centuries. Before the advent of modern day technology for navigation on the sea, most fishermen relied on their knowledge of the celestial objects such as the stars, the moon and the sun and their position in the sky for direction, weather forecasting and reckoning of time on the chartless ocean. Many centuries of practice had given them insights into heliacal rise and setting of such celestial objects and had formulated this set of knowledge into rules and customs to enable them to find their way on the ocean. This tradition has been guided and passed on from generation to generation of Mfantse fishermen since they settled along the coast for many centuries until recently.

In recent days, it is becoming customarily for young fishermen to go fishing in the sea and yet have no knowledge of the celestial objects for their navigation, weather forecasting and also to tell the time. This is because of the introduction of and the dependence on technology as modern day state of the art navigational instruments.

This study focuses on documenting the indigenous astronomy knowledge of the Mfantse fishermen and compare the knowledge of the older fishermen to the younger fishermen on celestial bodies.

Method

A separate interaction with nine old fishermen (aged between 50 and 60), including the chief fisherman and ten young fishermen (aged between 20 and 49) in Cape Coast was conducted.

Results

The interactions with the fishermen revealed a worrying development with the possibility of extinction of the traditional knowledge of using the celestial bodies for navigation on the ocean. Out of the eight constellations which were described by the elders as vital for fishing expedition, only three were familiar with the young fishermen, they could only recall *Abrewawuraba* (an old lady star) *Estewuraba* and *Safowuraba*. They were unable to tell if these names were constellation (a recognizable pattern) or individual stars. The younger generation of the Mfantse fishermen is now becoming more comfortable with the use of Global Position System (GPS), Compass, telescope and mobile phone for their fishing expedition.

The older fishermen of Cape Coast like the Este-Fante fishermen of the recent past according to Rogers (2007), still make use of a traditional calendar, where the moon, stars and constellations are linked to their lore, navigation and weather. They also observed that when Antofi (Southern Cross, figure 1) rises with the sun at the beginning of October, there would be rain and thunder storms and when Orion (figure 2) appears on the horizon, after being absent from the night sky for a while, they expected rough weather and do not take their boat to sea (Roger 2007). The modern day younger fishermen depend on whether forecast from the Ghana Meteorological Agency to determine whether there would be rain or thunderstorm.

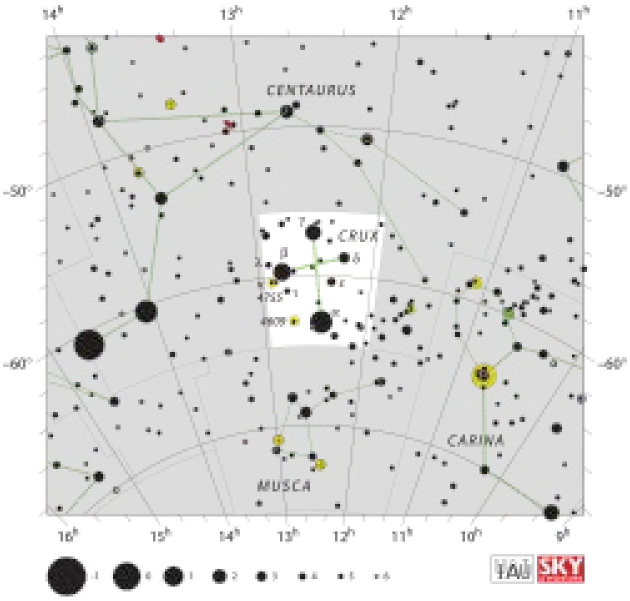

Fig. 1: Southern Cross (Antofi: (Source: Africa skies))….

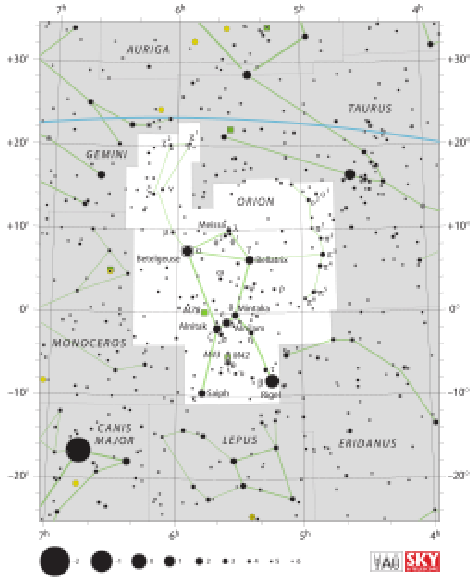

Fig. 2: Orion (Source: Africa skies)

However, beside the knowledge that *Abrewawuraba* is prominent from May to July, the younger fishermen were unable to provide any other useful information on the three stars or constellations *Abrewawraba*, *Saforwuraba* and *Estewuraba* (brings winds) as mentioned by the older fishermen. Except for *Abrewawuraba* and when it rises in the night (between 9 pm and 12 midnight), they use the brightness and their position in a particular area of the sky to identify the stars. The elderly fishermen were very knowledgeable of eight stars/constellations. But here also except for *Boundesun* (a group of seven starts with Pleiades in figure 3) they could not tell whether they were describing individual stars or constellations. Besides *Boundesun*, they mentioned *Estewuraba*, *Abrewawuraba*, *Antofiewuraba*, *Antiwiawuraba*, *Safowuraba*, *Adzekyewuraba, Kokroa* (brings fish from middle of August to middle of September) and *Mprenprenwuraba*. The fishermen indicated that they sometimes come across an unusual and a very bright star they called *Russianwuraba* (Russian star; possibly International Space Station).

Fig. 3: Pleiades - also known as the seven sisters (Source: Africa skies)

The old fishermen explained that, they depended on the *Antofiewuraba* to go fishing expedition, that, upon the heliacal rise of it, they move facing the star with the positon of the star at their left hand relative to the boat or canoe. With this they are able to move to a precise location on the sea and repeated the process when they are returning from fishing, using *Antiwiawuraba* maintaining the position of the star at their right relative to the boat.

During the fishing expedition the rise of *Safowurabe* indicates the night is almost over, that, it could be 3:30 am and when they see *Adekyewuraba* (day break star) it means that it is about 4:00 am. The rise of *Mprenprenwuraba* is an indication that, there would be storm and rain on the sea and usually do not go fishing when they see this star in the sky.

During full moon the sea becomes rough and as a result there are no night fishing expedition. Beside the rough sea, it becomes difficult to have successful night fishing expedition and as a result fishing is restricted to day-time.

Conclusion

When the old fishermen join their ancestors, there would be no succeeding generation who would become the custodians of the time tested tradition of the Mfantse fishermen in the knowledge and usage of the celestial bodies for navigation, weather forecasting and time reckoning. We have an endangered generation of Mfantse fishermen who are becoming extinct as the relevance of this knowledge gradually loses its pride of place to GPS, Telescope, compass and mobile phone. Unless there is a concerted effort to document this knowledge and synchronize them with the standard classification (Johann Bayer Classification) of stars and constellations (Hamacher, 2014), we would soon have no man who is able to navigate the sea without modern technology among the Mfantse fishermen.

On the other hand, the concern cultural astronomers, Ghana Space science and Technology Institute, the Government of Ghana, Astronomy for Development West Africa & Africa and International Astronomy Union working together can rescue the endangered species of cultural astronomy among the Fantes. In Ghana it is not only the Fantes that engage in fishing. The Ga, the Ewe, and the Nzema people also engage in fishing and will have similar knowledge. It is possible that the success in documenting the knowledge would inspire same endeavour in Ivory Coast, Liberia, Gambia, Senegal and Africa as a whole. Cultural astronomy and Astronomy in general stands to gain if these pieces of the puzzle, among the Mfantse people, elsewhere in Ghana and Africa are not allowed to fade.

As Ghana develops its space industry with both the launch of Ghanasat 1 into orbit and the inauguration of the 32-meter dish Radio Telescope Observatory, the ordinary people asked, which part of these investments benefit the socio-economic well-being?

It is possible that this question would get louder with time as the nation continue to pursue space science. The question will easily be answered with our knowledge in cultural astronomy, which has lived with the people. We recommend further and in-depth study to document the indigenous knowledge in astronomy in Ghana to ensure the development of cultural astronomy along the development of space science. The "Star Compass" of the Mfantse fishermen of Ghana is key to start with.

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Kenya

Cultural Astronomy in Kenya

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Abstract

The African perspectives of astronomy are explored from the point of view of using indigenous knowledge of the night sky for purposes of addressing local challenges such as food insecurity and periodic natural weather phenomena such as droughts and floods. The local ethnic groups use stellar positions, and plant and animal behavior changes for purposes of forecasting the weather and climate for the coming seasons.

These traditional indicators give rise to an interdisciplinary discourse that could benefit the community in environmental protection measures and boost the tourism industry in some countries in Africa.

Introduction

We define Cultural Astronomy as the study of the application of beliefs about the stars to all aspects of human culture, from religion and science to the arts and literature. It includes the new discipline of archaeoastronomy: the study of astronomical alignments, orientation and symbolism in ancient and modern architecture.

Most African societies have developed indigenous astronomical knowledge largely for understanding and predicting seasonal weather changes. These communities depend mostly on rain-fed agriculture for subsistence farming, so they use their knowledge of the day and night sky to forecast rainfall and to predict periodic phenomena such as floods and droughts. In this paper we discuss a few traditional tools that are used by some ethnic communities in East Africa to interpret astronomical phenomena for solving their local problems. These traditional methods rely on the interaction of plants and animals with the terrestrial environment. Their scientific value needs to be established and recognized.

Traditional biological and astronomical Indicators African communities combine their knowledge of plant and animal behavioral changes together with their night sky knowledge to predict the weather and climate for the coming season. These communities recognize that some plants and animals are more sensitive to changes in the atmospheric conditions than others. Traditional forecasting complements modern meteorological forecasting and is still the major source of weather and climate information for farm management in the rural areas. In this discussion, we focus on the traditional forecasting methods used by the Luo community who live around Lake

Victoria in Kenya. In this part of Kenya, there are two distinct wet seasons. Short rains occur from October to December and long rains from March to May.

Plant footprints

Certain types of plants are known to shed their leaves to signal the onset of dry conditions, or they flower before a wet season begins. The shedding of leaves is an indication of water stress conditions associated with dry conditions. The trees shed their leaves to reduce evapo-transpiration and grow leaves when the rains approach. These behavioural changes have been used to predict the weather and climate for the coming season. Among the plants with these observed properties are:

- Those plants that shed leaves to indicate an impending dry season are: Terminii browni, Ficus sur & Kigelia africana – trees that shed leaves twice a year to mark distinct dry conditions around Lake Victoria region. The plants grow leaves when a wet season is approaching.
- Those that flower to indicate an impending change of season are: (a) Zephranthus - a field flower that appears a week or two before the onset of rains. The flower appears white during rainy season and pinkish during dry periods. (b) Blue Lotus (or Water Lily) - this plant grows in water but will never blossom during the dry season. Its flowering is normally an indication that a wet season is approaching and that the rains will be adequate. If the coming rains will be poorly distributed this plant does not flower at all.

Animal indicators

The behaviour of certain animals is believed to indicate changes in the weather:

- The bird Robin Chat disappears for several months and only reappears when a rainy season begins. The swallows Hirundo Abyssinia and Hirundo Smithic exhibit circular movements in the sky when the rain is forming. Certain seasonal cries of birds are also believed to communicate changes in the weather.
- The absence of frogs and toads indicates a dry season. When frogs stop croaking during the rainy season, even when it is still raining, it is an indication of the onset of a dry spell. Movements of ants indicate that a wet or rainy season is approaching.
- The appearance of snakes, and other reptiles and wild animals around houses is an indication of the prevalence and continuity of a dry spell.

Astronomical indicators

The movement of stars has also been related by the Luos to the weather and change of seasons.

The constellations

Orion, is classified by the Luos as the “male constellation” and the Pleiades as the “female constellation”. Their appearance in the sky is linked with an impending change of season.

The appearance of the female constellation indicates the cultivation season, while the appearance of the male constellation signals a decline in rains showing the start of dry season or harvesting.

Fig. 1: Orion is clasified by the Luos as the “male constellation”.

Fig. 2: Pleiades, is classified by the Luos as the “female constellation”

The Milky Way

It has been noted that the appearance and positioning of the Milky Way (called Rip- in Luo), especially in April, is normally an indication of the impending dry season.

These traditional indicators are still the most widely used methods for farm management and food production. The changes and astronomy could change peoples' view of astronomy to see it as a practical discipline that can help put food on the table rather than an esoteric science that it is perceived be. Cultural and economic value of astronomy to society In the African perspective it seems that the best way to spread knowledge in astronomy is to begin by appreciating its cultural value.

Conclusion

Indigenous Kenyan astronomical beliefs and uses of astronomical knowledge need to be explored and recognized. Most, if not all, African ethnic groups have their own usage of sky knowledge and it would interesting to find out scientific basis of the traditional indicators that the these groups (such as the Luos of Kenya and Tanzania mentioned in this paper) use to predict the weather, climate and periodic natural phenomena such as droughts and floods. For purposes of spreading astronomy education in Africa, it would be necessary tap into these traditional values of astronomy and incorporate them into the standard astronomy curriculum, so that the role of astronomy in tackling local challenges continues to be recognized. This would in turn lead to the conservation of the environment and a boost in the tourism sector. Once the value of indigenous astronomical knowledge is recognized, and it is seen as an intrinsic part of African culture, it might be possible to use this to secure funding for the development of astronomy from the various African governments.

Tunisia

Sundials and Curves of religious moments

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Abstract

When comparing the medieval Islamic sundial with the antic horlogium solarium, especially the horizontal ones, one can notice the morphological continuity which concerns the curves relative to astronomical and celestial phenomena, the indications of geographical directions and the use of the temporary hour as a unit of time measurement as well as the functioning principles. However, other curves designed for Muslims' religious practices moments were added. This continuity also concerns the Islamic gnomonic treaties and many of these treaties used approaches which were adopted in the similar ones of the antic times or more simply represented translations of these treaties

The measurement of time and its management are considered to be major concerns as Man needs them to organize himself in his everyday life, his movements from one place to another and in his religious practices. After the appearance of monotheistic religions, time becomes an important element for the planning of daily activities and important moments. To ensure a good management of time, Man developed some sciences and invented many instruments like astrolabes, compasses, sundials etc.

The religious moments that figure most of the time in the sundials are mainly the three everyday prayers. Each one is mentioned by a curve representing the *duha (Al Dhouha)* prayer; two hours before midday, the curve of the *zuhr (AL Dhor)*; the first prayer of the afternoon and the prayer of *as*r (Al'Asr); the second one of the afternoon. The latter is sometimes represented by two curves: the first one at the beginning of its time and the second one at its last delay. The prayer of the *isha* (Al Icha) was indirectly mentioned by curves specifying the remaining hours before its time.

The curve of AL'ASR

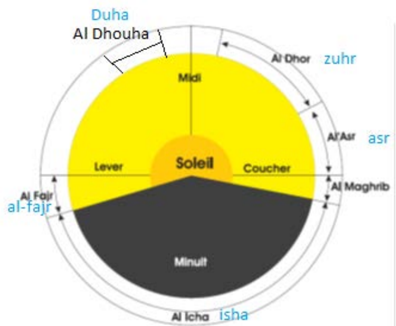

Fig.1: Diagram of the prayers

The most common definition of Salat Al'asr is when the length R of the shadow of a straight style is equal to that of its shadow at noon plus its own length.

This condition (figure 2) results in: R = a (1 + tang (Φ - δ)).

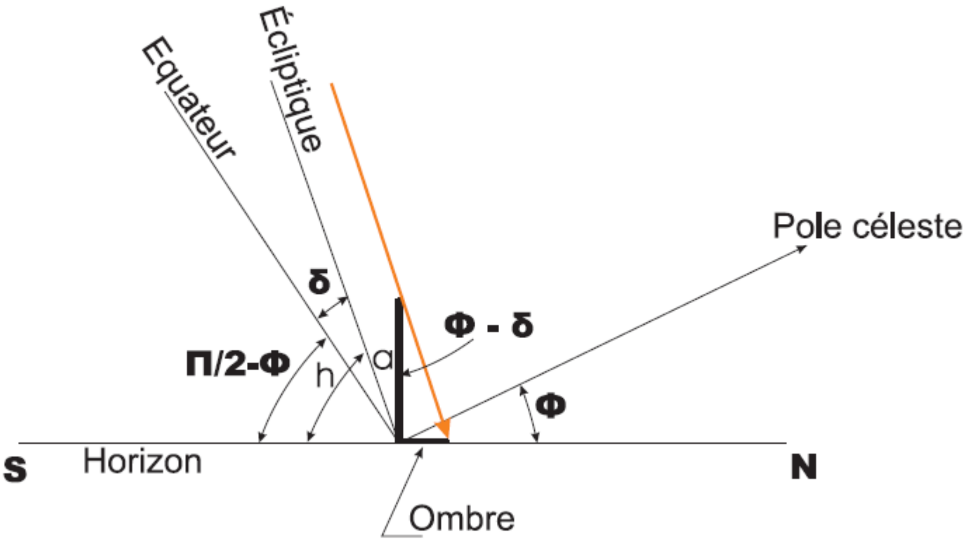

Fig. 2: Geometry of problem

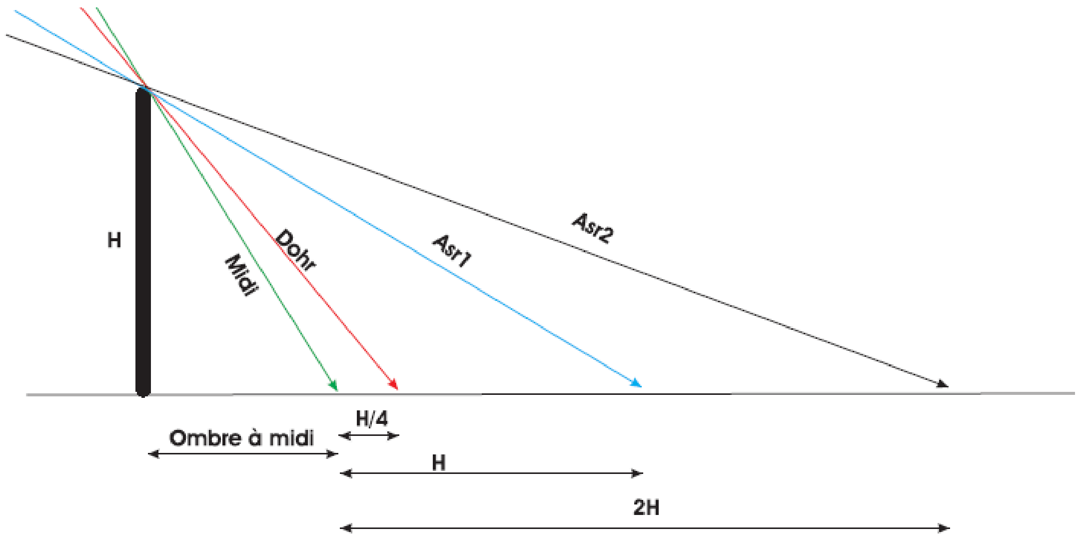

Fig. 3: Beginning and end of the prayer time

To draw the curve of the Asr on a sundial plan of any orientation and inclination, it is sufficient to know for each point of the plot the hour angle H and the declination δ of the Sun, a being the length of the right style .

H is the hour angle of the Sun counting on the celestial equator from the South meridian, positively west from 0 ° to + 180 °, and negatively east from 0 ° to -180 °. The hour angle is zero when the Sun is at the meridian of the place (true noon). As the

Earth performs a complete turn in 24 hours, 360 ° in 24 hours, which amounts to 15 ° every hour.

The hour angle is calculated by:

$$\cos H = (\sin h - \sin\Phi \sin\delta) / (\cos\Phi \cos\delta)$$

h étant la hauteur du Soleil calculée par:

$$\text{tang } h = 1 / (1 + \text{tang}(\Phi-\delta))$$

To obtain the prayer curves, simply inject the values of H into the expressions of the rectangular coordinates x and y of the end of the shadow of the right style.

$$x = a \sin H / (\cos\Phi \cos H + \sin\Phi \text{ tang}\delta)$$
$$y = a (\sin\Phi \cos H - \cos\Phi \text{ tang}\delta) / (\cos\Phi \cos H + \sin\Phi \text{ tang}\delta$$

Example

Either a dial (horizontal or vertical) whose length of the straight style is 100 mm, installed at latitude $\Phi = 36$ °. Let's calculate h and H for three remarkable variations

- At the summer solstice : $\delta = 23{,}44°$ We obtain h = 39°,28 et H = 57°,46
  x = 122,2 mm, y = – 5,0 mm

- At the equinoxes: $\delta = 0°$ We obtain h = 30°,08 et H = 51°,72
  x = 156,6 mm, y = 72,7 mm

- At the solstice of winter: $\delta = -23{,}44°$ We obtain h = 20°,37 et H = 38°,38
  x = 163,7 mm, y = 213,9 mm

Fig. 4: Sundial Dar el Djaziri SIDI-Bou said Tuninisia **1163/1749-50**

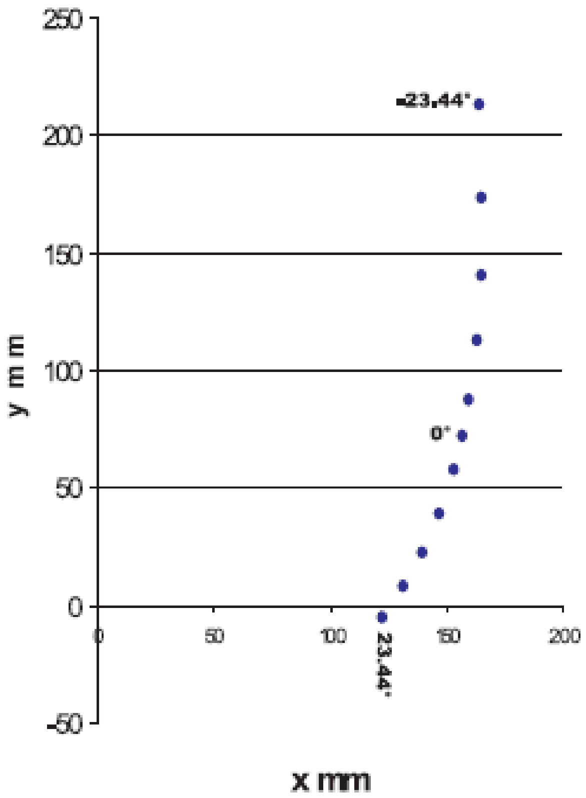

Fig. 5: The annual curve of Al'asr for $\Phi = 36°$ and a= 100 mm

AL' QUIBLA

The Quibla is the direction of Mecca (Saudi Arabia) towards which Muslims must turn to pray. Some horizontal dials indicate this direction: it is simply the azimuth of Mecca, counted from the South. By calling the latitude of the place, λ the longitude of the place expressed in degrees and counted from the meridian of Greenwich, the Azimuth A of the Quibla, is given by (figure 6):

$$\text{tang } A = \sin\Delta / (\sin\Phi \cos\Delta - \cos\Phi \text{ tang}\Phi')$$

Δ being the difference of the longitudes between Mecca and the considered place. $\Phi' = +21° 27'$ and $\lambda' = -39° 49'$, the latitude and longitude of Mecca.

Example:

From the Tunis Science City $\Phi = 36° 50'$ and $\lambda = -10° 11'$

$\Delta = \lambda' - \lambda = -29° 39'$. We find $A = -66° 44'$ from the South.

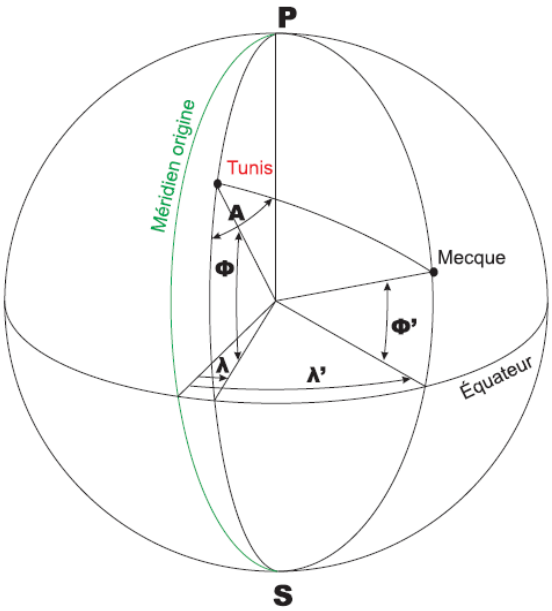

Fig. 6: The Azimuth A of the Quibla from Tunis.

Fig. 7: The sundial of Dougga archeological site

Type of sundials in Tunisia

The sundial of Dougga archeological site

This sundial is presently preserved in the Dougga archeogical site reserves (figure 7). It is made up of an ecru of clay block having the form of the Latin letter L and made up of two parts; one lower part used as backing (support) for the sundial and an upper part carved into a cavity forming a quarter of sphere and bearing line drawings and curves.

The Carthage Museum Sundial

The form of this sundial is alike those of that time. Its assembly is made up of, besides the midday line drawing, twelve temporary hours emanating from the centre, three superposed curves engraved in a perpendicular way to the hours' line drawings: the lower curve pointing out the summer solstice, the median curve pointing out the two equinoxes and the upper one pointing out the winter solstice. This sundial works thanks to a horizontal metallic gnomon, the curves of which are still visible on the upper edge.

This sundial is presently preserved at the *National Museum of Carthage* (figure 8). It is a square form white marble slab (24,5 cm X 24,5 cm) and 7 cm thick. Despite the absence of every sort of indication relative to the origin of its place, the examination of its gnomon shows clearly that it was made according to Tunis latitude and its surroundings.

Fig. 8: The Carthage Museum Sundial 746/1345-46

According to the commemorative inscription text, engraved in Coufic Hafsid characters, this sundial was made in 746/1345-46 by *Ab losim al-yadd*, the name of who figures neither on other sundials nor among the other gnomonic treaties.

The sundial offers an exhaustive and original assembly different from the middle ages ones. Beside the astronomical indications of the solstice curves, the line drawing of the two equinoxes, that of midday and the geographical directions (South, North, East and West), this sundial gathers all the necessary elements for its functioning such as, *Al Zawal* line drawing, that of *Tahib* and the curve of *Duha*, those of the two prayers of *Zuhr* and *Al Asr* and the indication of *Al Qibla* in form of *Mihrab*. In comparison with the similar ones of that epoch, the divergence lies upon the absence of temporary hours line drawings of which the assembly concerns only the period from the *Duha* to *Al Asr* prayer unlike the middle age sundials which cover all the day long from sunrise to sunset.

The first sundial of the great Zaytuna Mosque of Tunis

The sundial is placed upon a support constructed with ocher sandstones of 1, 20 meter high located in the patio of the mosque (figure 9). It is a greyish white rectangular marble block (87cm x 47cm) set up horizontally. Its written surface is strongly eroded the reason why the major part of its cryptograms and its commemorative inscription has disappeared.


Fig. 9: The first sundial of the great Zaytuna Mosque of Tunis 1041/1631-32

The setting up of the sundial was probably realized on the occasion of the arrangement works having taken place at the Zaytuna mosque at the middle of XVIIth century. It constitutes a transitory model of medieval age sundials and modern sundials. In fact, it is composed of a new assembly functioning thanks to a shadow-bearing string and four gnomons.

- The lower right gnomon: it is 6cm high and designed for the remaining hours before sunset and the prayer of Isha
- The lower left gnomon: it is 6cm high and designed for the left hours since sunrise
- The upper right gnomon: it is 5cm high and designed for the temporary hours
- The upper left gnomon: it is a 5cm high and designed for the remaining hours after Al Asr prayer

This sundial is the second after the sundial of Yussef Dey's Mosque which dates back to 1025/1616-17 on which new subdivisions of 4/20/60 minutes figure in association with curves and line drawings related to the religious dues.

In addition, there are other elements which are still visible, like the midday line drawing (Al Zawal), the curve relative to Al Asr prayer, and the hours lines.

The second sundial of the Great mosque of Kairouan

This sundial is placed upon a structure of 2.2m high which is constructed in the middle of the mosque's yard (figure 10). It is a rectangular white marble slab (80cm x 50cm) set up in a horizontal way. It is broken at the level of its four gnomons.

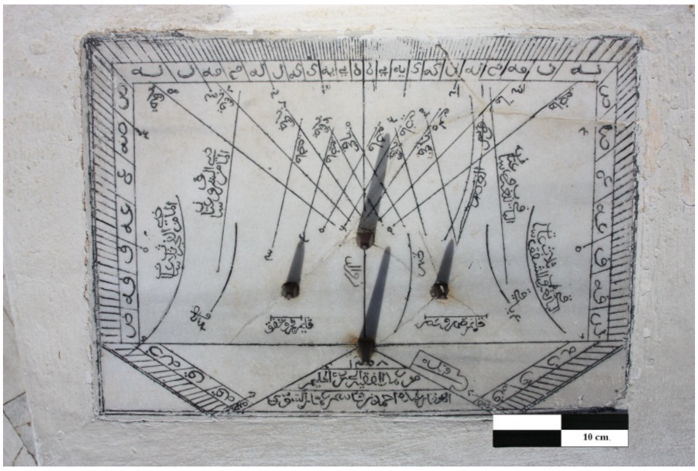

Fig. 10: The second sundial of the Great mosque of Kairouan 1248/1852-53

This instrument dates back to 1258/1842-43 and was the last achievement of *Ahmad al-Susi*. It almost imitates the previous sundials especially the sundial of *Ribat of Sousse* which dates back to 1239/1823-24. In addition to the graduation of the periphery with subdivisions of time measurement units of 4/20/60 minutes, its assembly represents the curves and the ordinary line drawings relative not only to the hours relative to the prayers of the day but also to the precisions related to the moments of dawn (*Al Fagr*), sunset and sunrise, midday (*Al Zawal*) and the disappearance of dusk. Like its counterparts, this sundial works with a shadow-bearing string and four metallic gnomons: two principle gnomons fixed at the level of the midday line drawing of 9cm high and designed for Al Zuhr and *Al Asr* prayers and the two other gnomons are located near the midday line drawing of 4.5cm high and designed for dawn and dusk.

The sundial of the Great mosque of Zaghouan

This sundial is fixed on the Western wall of the prayer room in a 2.10m high (figure 11). It is a white rectangular (22cm x 20cm) marble slab set up in a vertical way.

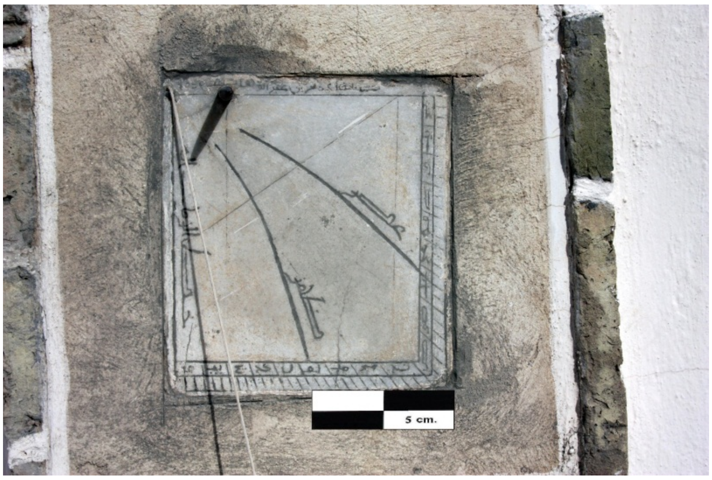

Fig. 11: The sundial of the Great mosque of Zaghouan in 1957

This sundial is likely an imitation of a previous sundial made by *"Umar ben Abdelwahhid"* in the 50's of the XXth century. It is classified among the vertical sundial type. It works with a metallic gnomon of 6.5cm high and a shadow-bearing string. Its assembly shows only the afternoon period. In addition to the midday line drawing and the two curves relative to *Al Zuhr* and a*l Asr* prayers, its periphery is graduated with units of time measurement of 5/15 minutes which appeared in the middle of the XIXth century sundials.

Fig. 12: An astronomical visit of the group NASE Tunisia

Fig. 12: The group NASE Tunisia November 2017

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Argentina

Interculturality and Astronomy Education: Perspectives from the Argentinean Chaco

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Abstract

The sky and their phenomena have been an area of great interest for many cultures throughout the planet over time. In Western culture, since the Copernican revolution, astronomy has become a model for all science. Due to the colonial expansion of the Western society their academic astronomy is taught today in the most diverse places on Earth. In this context, it is often pointed out that in countries in "development" there are high rates of school failure in this area of knowledge. One of the crucial factors for that is the fact that Western academic astronomy assumes a worldview that frequently does not enter into dialogue with the people to whom it is intends to teach. We believe that cultural astronomy (Belmonte Avilés 2006; Iwaniszewski 1994; Ruggles 1994), as interdisciplinary field dedicated to study ideas and practices of different cultures about the sky as an integral part of their social life, has much to contribute in this regard. This work tries to point out some of these possibilities studying the ideas and practices about the sky of the Moqoit aboriginal People of the Argentine Chaco.

Knowledge as a social construction

Our knowledge of the world in which we live is a product of our socio-cultural reality (Bloor 1998). We do not learn by “ourselves”, in simple "direct contact" with the world. Our world is a universe full of senses, schemes of perception and metaphors in which we are introduced by the other members of our society. This process occurs primarily through primary socialization, imitation, and concrete day-to-day experience (Bourdieu 1997). This includes our ideas about the sky. This also implies that the construction of knowledge is traversed fundamentally by the power relations that structure human groups and their mutual links. That is why a true education should always be an intercultural education. An education that establish a real dialogue between cultures, assuming that they have hierarchical relations with each other, linked to political, economic, ethnic, gender, age, religion, etc. inequalities.

Like all astronomy, as every vision of the sky, Western Academic Astronomy assumes certain base metaphors, which even propose a possible repertoire of emotions and attitudes towards the sky. These ideas, obvious for those who grew up socialized in them, for other human groups are profoundly opposed to their own way of experiencing and thinking about the sky. For the teaching process not to be a colonial imposition, it must be based on respect and understanding of the other's ways of seeing. A true intercultural dialogue implies, a true reflexivity on the part of the teacher. He must have a real interest in the dialogue and must be willing to learn as well.

The *Moqoit* People

In this work we are going to address some of the ways of thinking about the sky of the *Moqoit* aboriginal people of the Argentine Chaco. Traditionally they were hunter-gatherers and their language is part of the *Guaycurú* linguistic group. The first testimonies in the Spanish chronicles show us that the "Mocobí", "Mocoví" or "Muscovites" were organized into "bands" formed by several extended families that established more or less stable alliances with other bands, especially through marriage. The arrival of the Spaniards to the Chaco introduced many changes, including horses and cows. Spanish pressure, especially after 1710, made the *Moqoit* People settle in the south of the province of Chaco Argentina and north of Santa Fe province. During the eighteenth century several Jesuit missions were founded among them. Despite these pressures, they managed to maintain an important degree of autonomy until the military campaigns with which the nascent Argentine nation-state effectively occupied the region, between the last decades of the 19th century and the first decades of the 20th century. With this occupation, also started the agricultural exploitation at large scale of the Chaco, especially the extraction of wood and the cultivation of cotton. The *Moqoit* People were incorporated as seasonal labor in these ventures. A series of millenarists protest movements were severely repressed in the first decades of the 20th century. The evangelical presence among the *Moqoit* People began to increase notably in the 1970s, especially aboriginal variants of Pentecostalism.

Fig. 1: Map indicating the area with the greatest *Moqoit* people presence.

Currently the *Moqoit* People live in rural, urban and peri-urban communities, principally in the provinces of Chaco and Santa Fe. Their present population is about 18,000 people (INDEC 2015).

The social life of sky

For the *Moqoit* People, the world is made up of a set of human and non-human societies that have complex relationships with each other. That is why the management of these links, generally thought of as relationships in which humans get in touch with beings much more powerful than them, is a central theme for *Moqoit* thinking. For this reason, for *Moqoit* people, knowing the cosmos is to know the ways of linking with these different beings, with the sectors of the universe that each one of them dominates and with what can be obtained by contacting them. This contact is essential for the daily life of human beings since any special ability requires a pact with non-human beings (López and Altman 2017).

The beings that inhabit the *Moqoit* celestial space are especially powerful and fecund. The brightness of stars is a sign of that since brightness is one of the bodily manifestations of power. In addition, the celestial space is a fundamentally feminine sphere, since most of the stars are women. Even, the stories that speak of the origin of the human women give account of the celestial origin of the same ones. This links heaven with power and fertility. In fact, the sky is seen as the source of water, which in the arid areas of the western Chaco is a scarce and essential good.

The sky path

Among the *Moqoit* People the concept of *nayic*, or path, is a fundamental structure of their world view. For them, the idea of the path is primarily linked to the experience of the footpaths that go into the forest from the places they inhabit and lead them to the spaces where they obtain resources. The areas that must cross and the goods they contain are under the control of powerful beings called "owners", with whom they understand that they must agree in order to access the resources necessary for survival. The meetings with the "owners" mark the paths and gave rise to the *nayic*, metaphor or model of a journey that leads from the known to the unknown, in which the pacts with the powers that govern the cosmos take place. This structure is used by each *Moqoit* person to elaborate their own history, which is why it is known as "their wanderings". The Milky Way, our galaxy, which is seen in the night sky as an enormous band of diffuse brilliance, is for the *Moqoit* People a gigantic road, the *nayic*, that unites the different layers of the world. Cultural Astronomy uses the term asterism, instead of constellation, to designate those celestial features to which a culture gives meaning, because they do not necessarily take the form of a set of stars joined by imaginary lines. Many of the *Moqoit* asterisms are located along the Milky Way, as landmarks of the *nayic*. The stories that are associated with these asterisms are stories of encounters and pacts with powerful beings. That *nayic* is the path that the *pi'xonaq*, the *Moqoit* shamans, need travel as their initiation, in which they must confront the powerful beings who find there and must make deals with them. In this way, the image of our galaxy constitutes the structuring axis of the *Moqoit's* sky (López and Giménez Benítez 2008).

Fig. 2: The *Nayic*, the Milky Way, as a structuring axis that organizes the main *Moqoit* asterisms. In the image it is possible see some of the asterisms mentioned in the text. From above to the left: *Qaqare*, the little brothers, *coviguiñic* -the pigeons-, *pioxo* -the dogs-. In the center, as a set of dark areas you can see the silhouette of the *Mañic*. Authors: Diego Alterleib and Alejandro López

Moqoit Asterisms

One of the most important *Moqoit* asterisms is formed not by stars, but by dark spots on the bright background of the Milky Way. This is the *Mañic*, the gigantic celestial Greater Rhea -*rhea Americana*- that an ancestor of the *Moqoit* People pursued to the sky. It is a large asterism that goes from the coal sack (that makes up the *Mañic's* head) to a region close to Scorpio.

Alpha and Beta *Centaurii*, the two bright stars near the Southern Cross, are seen by the *Moqoit* People as the *pioxo*, the pair of dogs that intervene in the pursuit of the *Mañic* and that in fact are seen in the sky on their neck.

The ancestor who leads that persecution, *Lapilalaxachi* or the grandfather, is associated with the group of stars known by Western astronomy as the Pleiades (López 2009). The period of invisibility of these stars is associated by the *Moqoit* People to a disease of the grandfather as a result of his struggle with the *Mañic*. His

reappearance at the end of June was related with the June solstice or *rapilra'aasa*, the "return of the sun". These two events marked the beginning of the annual cycle, linked with the first frosts which are considered responsible for the spring buds. It is also linked to the flowering of the air plants (*Tillandsia spp*.), an epiphytic plant that receives the same name: *Lapilalaxachi*.
In the region of the western constellation of Scorpio, the stars λ and υ *Scorpii* are associated with two little brothers protagonists of a story in which they get lost in the forest. The pigeons that help them are linked to another pair of stars ξ_1 and ξ_2 *Scorpii*. The star Antares is linked to *Qaqare*, the Southern Caracara -*carcara plancus*- or *Pohe*, the Turkey vulture -*cathartes aura*-, characters of whom it is said that, in the beginnings of the world, would have achieved fire for humans. But they are not necessarily always associated with that star. In summer, when the Tauro area is clearly visible at dusk, it is Aldebaran the star that is linked to *Qaqare* or *Pohe*. This same dynamic can be seen in the case of *La Virjole*, a powerful being from the Sky fruit of the *Moqoit* resignification of the christian Virgin. She is identified during the summer months with a triangle formed by the stars ε, δ_1, γ, θ_1, θ_2 and α in Taurus. But, in the winter months when in the early hours of the night the area of Capricorn is visible, it is a triangle in that region, formed by the stars δ, ε, γ, ζ, HR 8213, ι, ϕ, χ, η and θ which is identified with *La Virjole*

The sky on the ground

The sky for the *Moqoit* People, begins very close to us, in the treetops. It is very connected to life on earth. In fact, it is present in the ground in several ways.

For example, the *Moqoit* names of the eastern zone and the western zone of the horizon refer to the cycle of lunar phases. The west, *lauashiguim* -rising, shining- is linked to the fact that it is in that area of the horizon that the Moon is seen at the first time, just after sunset, when the crescent Moon phase begins. The east, *lqoidoigue* -term linked to the end or term - is the area of the horizon where the Moon looks "complete", at sunset in the phase of full Moon, when it is understood that it reaches its "maturity" (Giménez Benítez, et al. 2006).

Another way in which the sky is present in the soil for *Moqoit* People is related to the metallic meteorites of the “Campo del Cielo” great dispersion in the provinces of Chaco and Santiago del Estero. This is one of the largest observed on Earth, with a longitude of 175 kilometers and a width of three kilometers. All the fragments of iron you can reach there belong to an unique event occurred about four thousand years ago (Cassidy, et al. 1965).For the *Moqoit* People this objects are part of a whole set of objects of power -*nqolaq*- that a person, if destined for it, can be found in the forest. These objects provide for themselves "luck" to those who find them and are the sign of the presence of a powerful being. In particular, the iron meteorites are understood by the *Moqoit* people as the result of stars that fall from the sky (*huaqajñi najñi*), wich are related with important rains or droughts. Also, the *Moqoit* People traditionally call *huaqajñi la'tec* (lit. 'star excrement') to a variety of small fungi that they relate to the meteorites and that have in the upper part a rust-colored powder that was used by them to heal sharp wounds. For *Moqoit* people, because meteorites are *nqolaq*, they cannot be manipulated in a careless way. The meteorites had play a crucial role in some *Moqoit* People demonstrations claiming territorial and cultural rights (López 2011). Also, the first *Moqoit* medium-length film, is called "La Nación oculta. En el meteorito" ("The Hidden Nation. In the meteorite ") (López 2011). For these reasons, the *Moqoit* people opposed with great strength the attempt of two artists from Buenos Aires to take away, without the free and informed consent of the local communities, the meteorite "El Chaco" to the famous "Documenta 13" art exhibition in Germany (López 2011).

Contributions to education

As we mentioned at the beginning of this article, cultural astronomy has an enormous potential to collaborate in a radical improvement of astronomical education.

Today there is a huge amount of material in circulation about the astronomy of different cultures. Unfortunately, a lot of that material consists of productions without methodological rigor, that is used in the teaching and popularization of astronomy. Also, references to the astronomies of other cultures are often used in an "anecdotal" manner, as a kind of curious introduction to the strange things that were "thought" before the arrival of Western science.

To avoid these dangers, educators can appeal to the knowledge produced by professional such as the members of the Sociedad Interamericana de Astronomía en la Cultura (SIAC), the Société Européenne pour l'Astronomie Dans la Culture (SEAC) or the International Society for Archaeoastronomy and Astronomy in Culture (ISAAC).

A deeper understanding of the astronomies of other cultures, which does not relegate diversity to a distant past, would be crucial to improve the teaching of astronomy in the world. Addressing the different ways of knowing the sky in greater depth, understanding its structure and its raison d'etre, allows us to appreciate the way in which the ideas and models with which humans seek to know the world are generated. This gives rise to a more anthropological view of the history of Western Academic Astronomy, which reveals its character as a historical product. In addition, approaching the logics, metaphors, interests and observations in which they rest can make it easier for educators to design strategies to approach the teaching of Western Academic Astronomy in diverse cultural contexts. This approach can also provide a much wider variety of models, metaphors and approaches to this astronomy.

Finally, due to the prestige associated with astronomical knowledge, the recognition of the astronomical knowledge of oppressed communities has a great relevance to build respect and legitimacy for them. Thus, astronomical education could, from an intercultural perspective, promote greater equity in this Global World.

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Argentina

The Masonic Temple in Entre Ríos and NASE

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Abstract

In the Concordia city, located in the province of Entre Ríos, Argentina, Freemasonry has regained strength from a lodge composed of a group of young professionals, technicians and workers of the city, whose purpose is to contribute to the progress of the community, through the dissemination of the moral values of righteousness and the principles of Freedom, Equality and Fraternity, which inspire all they actions.

This new group has opened the doors to the community, which visits the facilities, especially in the Night of the Museums (https://www.elentrerios.com/actualidad/el-templo-masonico-abrio-sus-puertas.htm). Masonry is not a secret society, its only principle is discretion, each mason can be known because his/her own decision, but will not reveal the belonging to the order of her/his companions. It is interesting to mention, also, that Freemasonry is not something only to men: in Argentina, there are several women's lodges.

Fig 1. Masonic Temple in Concordia: Entrance detail.

Fig 2. Masonic Temple in Conordia: Entrance

The building, the physical structure in which the Freemasons meet to advance on the path to perfection, constitute the temple, they point out that the Masonic Temple is, in turn, a representation of the human body, where the Being dwells.

The Lodge is the congregation of the Brothers, who are nothing but small universes and in the Lodge are symbolized all the manifestations of the physical universe that would reflect the interior of the Human Being. The Temple is full of symbols and allegories that serve to remind the members of the order their origin and that "within their own body there are as many stars or more than those that are scattered in infinite space", a good principle for an special visit, guided by a Master of the Lodge, and organized for the NASE participants at the course 89 ,as part of the activity Cultural Astronomy.

The Masonic Temple: its physical spaces

Just to access the building (Figures 1 and 2), the symbolism present in a Masonic Temple is evident, it is constituted by a series of spaces that the visitor goes through. What is fascinating for the newly initiated, are the astronomical elements present in this symbolism.

The most notable spaces of the Temple are:

The Room of Reflections, which represents the planet Earth and symbolizes in the first place the matter that is the basis of the beings and that, is offered to the senses in different states. It also represents the center of the Earth and the mother's womb, where the new being forms and prepares to be born. There the human being is born to practice virtue, wisdom and good. The second space is the Hall of the banquets, destined for the celebration of meetings of social type. The next space is called Chamber of Teachers, where Master Masons perform their work. The Hall of the Lost Steps is the place where the Brothers are concentrated before entering the Temple or place of work: it is the place where visitors are received before being announced. It is also here that the members of the order wear the characteristic dress. The Atrium, the line or physical space that separates the profane world from the sacred, here the Freemasons concentrate before entering the Temple.

Finally, we access the Temple or Chamber, the space with the greatest number of symbols, that appeal, in some way, to cultural astronomy. The Temple is a closed place where Masonic works are performed in the apprentice degree: it has the form of a parallelogram or rectangle, it is oriented from east to west, in the direction of the light of the rising Sun (figure 3); its smaller side or width is oriented from north to south, representing the distance to the center of the Earth, in this frame of planes, axes and points of astronomical interest, the perpendicular to the horizon, marks the zenith in the vault of the temple. The Temple symbolizes the following premise: Masonry is Universal and the World is a Lodge.

On the other hand, the Temple does not have windows, it should not receive light from outside, but only from inside and only presents a door located at the west side of the main room, symbolizing that the human being enters and leaves this world through a single door (figure 3).

Fig. 3: East wall inside the Temple. The image of the rising Sun is in the center, over it, the wisdom column.

The door of the Temple, from the masonic point of view, is the opening that communicates two worlds, the profane and the sacred worlds, and fixes the right and the left of the Temple, symbolic directions in which the base of the triangle that denotes the hierarchy of the Workshop and represents the aurora is supported.

For the symbolic treatment of the entrance door to the Masonic Temple, we must appeal to what was written in the First Book of Kings, the Old Testament, about the Temple of Solomon in Jerusalem, which shared characteristics of most temples or ancient sanctuaries: "there was a door 20 cubits wide, 10 long and 30 high, in addition to the Holy Place and the Sancta Sanctorum. In front of the door, there were two large bronze (o covered with it) columns, that constituted the Door of the Temple, that had no structural reason and whose intention was strictly symbolic ". It is also claimed that these two columns called B (force) and J (beauty) (figure 4), held the universe and a slightly open pomegranate as a symbol of maturity.

Fig. 4: Access to the Temple. Columns J and B, taken from those at Salomon Temple

The two columns are in Corinthian style and on the capitals there are half-open pomegranates and lilies; on each of them there is a sphere, the first one is the terrestrial (on the column B) to symbolize matter, and the other is the celestial one (on column J), which represents the spirit or the superior order. These columns demarcate the work place of Apprentices, and also correspond to the Ideal Phallus (Creator Principle) and the formal Cteis (Created Principle); the insertion of the vertical Phallus in the horizontal Cteis forms the stasis of the Gnostic and the Philosophical Cross of the Masons. They represent the man and the woman, the beginning and the verb, the active and the passive, the unity (J) and the binary (B) or also the Yin (Unity) and the Yan (Binary) of the Chinese trigrams.

Inside the Temple there are twelve columns called “of the Zodiac”, because on them are located the Zodiac constellations, six on each side of the Temple, at North and South directions (figure 5). These twelve columns symbolize the twelve white stones with which Moses circumscribed the sacred ground at the foot of Mount Sinai, where the Ark of the Covenant was located.

The banks at the north and south of the Temple, where the members of the Lodges are sited when they perform their works, are called Temple Columns. In addition, the Column of Harmony, whose origin corresponds to the time of the reign of Louis XV, is observed to refer to the set of instruments that harmonized the ceremonies, in our days it refers to the device of musical reproduction that is used for the execution of music, especially during the execution of ritual ceremonies.

Fig. 5: Southern wall of the Temple. Six chairs represent six columns and six Zodiac symbols.

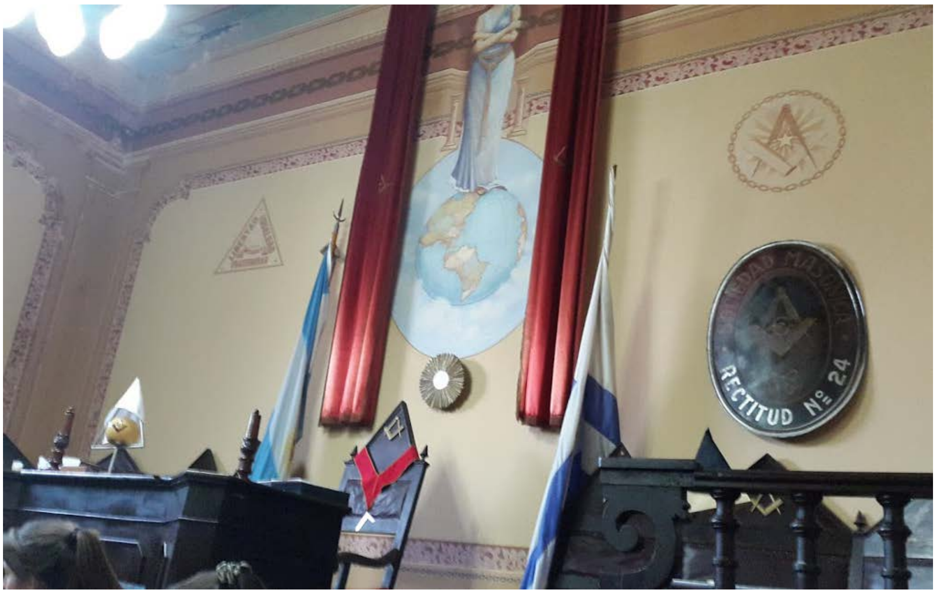

Fig. 6: Columns of the Order: Wisdom (Minerva in the center, stop on the Earth), Strength and Beauty (represented by the banks on both sides of the central position, reserved for the Master of the Lodge).

Finally, it is possible to point out three large columns that support the Masonic Temple, at the east, called columns of Wisdom, Strength and Beauty. These columns are also known collectively as Order Columns (figure 6). The first one, the wisdom, is represented by the goddess Minerva; the force, is represented by Hercules.

Everything we find in the Masonic Temple rests on a mosaic floor, similar to a chessboard, with multiple meanings, among which we can mention the positive and negative aspect that everything has in life and also the diversity of races, classes, religions, nationalities that can be accepted in the Temples. This checkerboard also indicates the contrast of social positions, political ideas and religious beliefs of the Masons, who despite the diversity of criteria of each, can live in the most absolute harmony within the Order.

Fig. 7. The Temple sky. Images of the Sun, the Moon and the stars on a pale blue background, lighter towards the East.

Fig. 8. NASE 2016 participants at the Temple. Concordia, Entre Ríos, Argentina

The Temple is covered by a true celestial sphere, a dome decorated with images of the Sun, the Moon and the stars that represent the constellations on a blue sky, lighter towards the East. This dome indicates that "the Sky (masculine principle) complements the Earth (feminine principle) and from its union arises man (son of Heaven and Earth).

On the other hand, the solstices (from the Latin "Sol" and "sístere": to remain still) have represented throughout the history of humanity a date of great significance for all cultures, nowadays around 40 festivities are recognized associated with the Winter Solstice in different cultures, such as the Inca, Maya, Babylon, Jewess, Roman, Hindu, Celtic. In all these celebrations, part of the ritual was or is associated with the symbols that represent the struggle of man against darkness. The Masons are heirs of these cultures, especially the Roman and the two most important festivals that are celebrated are those connected to the Solstices, Summer and Winter, that correspond respectively to the South and the North, to the Zodiac signs of Cancer and Capricorn and to Noon and at Midnight, within the cosmic order of the Temple.

Conclusions

It was a real discovery for the NASE visitors at the Masonic Temple (figure 8) to know that the astronomical references in the Masonic temples are multiple: the importance of the Sun, the Moon, the constellations and the internal ordering of the temple in function of the celestial vault in relation to the location of the human being on Earth, is a fundamental issue.

Regarding the apparent position of the Sun along the year and the change of its trajectory, associated with the angle between the Equator and the Ecliptic, which determines the seasons, we can conclude that the Winter Solstice reaches a superlative relevance. It is considered a singular moment, more important than any other date, the time of what the Romans called "the Sun Unbeaten": after 6 months of diminishing the sunlight hours, when everything makes presuppose that the Darkness will prevail over the Light, it expires and from the day of the Winter Solstice each day will have one more minute of clarity until the cycle is completed, which undoubtedly has a scientific, astronomical and, of course, a symbolic meaning.

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Bolivia
The Chakana or the True Cross

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Abstract

If we do a quick survey in Bolivia asking about the easiest constellation to identify, the answer would undoubtedly be the Cruz del Sur (Southen Cross). This constellation can be observed from all latitudes of the country and for almost the whole year, therefore it is easy to understand that since time immemorial this constellation necessarily had to be part of the popular culture of our ancestors.

Seven kilometers to the south of the city of Cochabamba, the third in importance in Bolivia, is the town of Valle Hermoso, which until a few years ago was an area populated by farmers of Quechua origin. In this place there is a Catholic chapel of architecture and modern construction in front of a fenced lot where every May 2 hundreds of families gather for three days to celebrate a ritual that marks the syncretism between the pagan and the Catholic, among the beliefs prehispanicas founded on astronomical observation and the tradition brought by the Spanish conquest.

Fig. 1: Southen Cross

The feast of the cross is known in many countries throughout the planet, especially those that have a strong Catholic influence, however in the American continent it has a very strong pre-Columbian involvement, in almost all Latin American countries this celebration is celebrated in the same date and for the same reason: during much of the night, the southern cross can be observed "standing"; the celebration varies from country to country and in Bolivia changes from one region to another.

The Southern Cross has always been a guide for the traveler, his eternal presence in the southern sky has given each of the peoples who have inhabited it a point of reference. That same permanent presence has marked the cultural events of the continent; According to M. Ester Greve, the Aymaras organized their agricultural calendar observing the movement of the Sun, the Moon and the Southern Cross. At one point of the year it was observed that the main axis of this constellation was perpendicular to the horizon when marking midnight, that date coincided with the end of harvest season and therefore in the regions where the cultivation of the land was the main economic activity, this date was very important.

The Andean Cross in the Quechua language Chakana or in Aymara Achakana is not the Western cross but is referred to or inspired by the Southern Cross, the first mention in this respect was made in 1613 by the chronicler Juan de Santa Cruz Pachacuti Yamqui Salcamaygua in his "*Chronicle of Relation of Antiquities of this Kingdom of Pirú*", this representation, nevertheless it is seen in ruins as old as the Tiahuanacotas reason why it is of great importance for the native towns. Chaka means union or bridge and janah, high, top, meaning the Chakana is the bridge on the top.

The Chakana is a stepped cross with twelve points, various interpretations have been attributed to it being used as a calendar and a synthetic symbol of the Andean cosmovision.

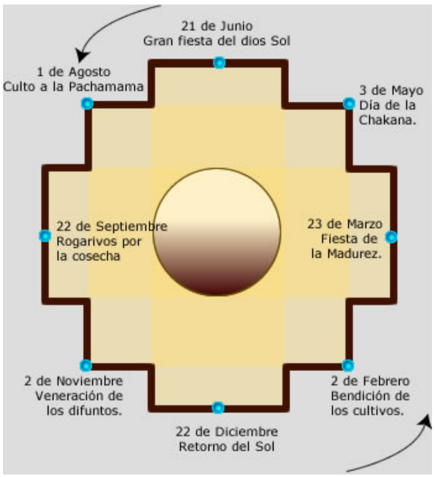

Fig. 2: Chakana in the ruins of Tiahuanacotas. Fig. 3: Four extremes and four intermediate points of the Chakana represent eight ceremonies of the Andean culture, four coinciding with the solstices and equinoxes and four intermediates. The chronicler Juan de Santa Cruz Pachacuti Yamqui Salcamaygua in 1613 when writing his "Chronicle of Relation of Antiquities of this Kingdom of Pirú" drew and inserted an engraving on the Andean cosmovision, which he named Chakana, the bridge or staircase that allowed the Andean man keep dormant its union with the cosmos.

In the Bolivian valley, region that provided food to the populated areas of the highlands dominated by the Inca Empire, the festival acquired its own characteristic elements that are still maintained today, the date coincides with the last potato harvest and the preparation of the land for the new planting, this feast is the Fertility Feast. The custom transmitted from parents to children was based on the family meeting in the place where the Inca priests interpreted by observing said constellation favorable or unfavorable weather conditions for the agricultural year, at that time, taking advantage of contact with the deity, the population towards fertility requests for both land and animals and even people.

Date approx.	Ceremoy	Description
21.06	Great feast of the Sun god	The new solar year Inti Raymi. Maximum distance from the Sun to Earth.
01.08	Cult of the Pachamama	The ceremony is held to ask permission to the Pachamama to start planting. According to the Andean tradition, the Pachamama awakens at this era
22.09	Request for good harvest	Ceremony of good harvest omens
02.11	Veneration of the deceased	Ceremony of respect to the souls and spirits
22.12	Return of the Sun	Half-year. Change of direction of the Sun
02.02	Blessing the crops	Today tied to the carnivals, it is an agricultural festival, a blessing of the fields in full growth. New animals are also marked
23.03	Autumn equinox	The plants reach maturity. It is the feast of maturity and the introduction of girls and boys to adolescence begins
03.05	Feast of fertility	Chakana Day. The constellation of the Southern Cross acquires the astronomical form of the perfect cross, in vertical position with respect to the South Pole. Authorization is requested to the Pachamama to collect the fruits

Table 1: Summary of the Chakana

It is said that in this location was located a "waca", a volcanic rock whose cracks had the shape of a cross, said rock would have been dynamited and replaced by a chapel in an attempt to eliminate the original beliefs and supplant them by faith in the true cross: the True Cross (Vera Cruz), a crucified Christ was placed in said chapel and he was named as The Lord of the True Cross; the inhabitants clinging to their previous faith, did not reject the new image identifying it with that divine being to whom the requests were made and calling it of affection Santa Vera Cruz Tatala whose translation is not that of Lord of the Cross, distant to the human but that of the affectionate meaning of the father "Papito or Abuelito de la Santa Cruz", the one who is affectionately and familiarly asked for a gift with the assurance of receiving it.

Fig. 4: Santa Vera Cruz Tatala

In the ritual performed, various symbolic elements are included: the family gathers a candle with each member, even for the absent, if the family has a good relationship and is united, the candles are placed together; if there are quarrels, the candles can be put away or together in a desire for reconciliation; if the real ones can not be carried, representations of animals are always carried by couples to whom they adorn themselves and paint themselves; they take potatoes, corn or the best fruits produced as an offering. These objects are presented to the Tatala, their blessing is requested and they go out to the canchón where in a circle, each family gathers around the objects, the candles are lit next to dung and hair collected from the combs throughout the year, they are sung couplets with the characteristic that the men only play the instruments and the women sing; they drink chicha, nowadays it is gradually being replaced by drinks like beer, but first they give or offer a jet of drink poured to the ground as an offering to the Pachamama, Mother Earth, once the fire is consumed the ashes are collected to take them home and scatter them in the fields and stables.

Fig. 5 and 6: Families gathered

A very interesting custom is that being a feast for fertility, women who have many children and no longer wish to have a larger family, carry a doll on behalf of a baby and leave it at the feet of the Tatala, while the couples who want children and cannot have them wait to take these dolls, bless them with the faith that this year they will have children. If your wish is fulfilled on May 2, you will return with the child to thank the Tatala.

We do not know for sure what was the original purpose of this place, it could have been an astronomical observatory, it could have been a sacred place due to the presence of a Waca or a temple, what we know is that astronomical observation was so intrinsic to life and the mentality of the Andean man that in spite of the passing of the centuries and the attempts of the colonizer to erase the traces of the ancestral culture this tradition persists and while those four stars can be seen in the firmament, this tradition will not die.

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Brazil

Cultural Astronomy: A model of an Indigenous Solar Observatory

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Abstract

*This work presents the practice of Cultural Astronomy in the Astronomical Pole of the Itaipu Technological Park, Foz do Iguassu, Paraná, Brazil, through the use of a replica of the instrument called the **I**ndigenous **S**olar **O**bservatory (ISO). Its purpose is to reconstruct and pass on daily knowledge of indigenous groups in the triple border region of Brazil, Argentina and Paraguay, in relation to the reading of the sky, astronomical phenomena, cardinal points, the apparent daily and annual movement of the Sun, route the Sun follows in the East-West horizons for a year, the solstices and equinoxes, the height of the Sun in the sky and the solar half-day. It is a didactic activity presented to students, teachers and tourists. It also integrates the content of the Teacher Training Course, Proposal of a University Extension of the Federal University for Latin-American Integration (UNILA) and the Network for Astronomy School Education (NASE) Didactic Course of Astronomy.*

Introduction

It is known that Astronomy is a Science of Nature and has the function of studying and researching the phenomena correlated to the sky. All cultures look at the sky in disparate ways everywhere on the planet. The experience of observation changes context, but usually assumes links with survival, transcendence, and how man relates to the sky, which complements each culture in different places and times. "Every curve of a river has a different sky for different peoples" (unknown author). “Each civilization, people or group has built over time a specific vision of the sky, a relationship, almost always practical and symbolic with astronomical knowledge. ” (Tavares, 2014)

According to Cardoso (2016), two terms are associated with Astronomy in Cultures: Ethnoastronomy that takes care of the existing connections between the sky and the representatives of cultures of social groups, knowing that culture has mobility and multiple bias, before the relations from the natural scene to the cosmological conceptions and ways of seeing and configuring the sky, the accumulated experiences, the coexistence, the non-universal beliefs and myths of some ethnic groups. And Archeoastronomy that investigates the evidence and vestiges of cultures astronomy (man-sky-nature relations) with which there is no direct contact, most of them.

[...] Thus, it does not make sense to look for a first culture that had this or another great idea. Ideas simply appear everywhere and they can take different forms depending on many conjunctural aspects. Hence astronomy in cultures play an important role in understanding the concepts and how they can be understood within a particular culture or how they interact between different cultures when we deal with the relationships between humans and the rest of the natural world. (Cardoso, 2016)

Indigenous Solar Observatory (ISO) - *Kuarahy Jehechana Ava Maba'Eva*

Characterization of the Model

The Tupi-Guarani groups in all parts of Brazil, Argentina, Paraguay and other countries of Latin America have their daily guided by the Sun, named by the Guarani of *Kuarahy.*

The ISO is composed of a crude rock block (monolith) in the center, in pyramidal form, with four faces forming the vertical indigenous gnomon (*Arahy'äjehechaukaha*), about 1.50 meters high. Its apex points to the zenith (highest point in the sky), its major faces define the North-South line and the smaller faces establish the East-West line. They designate the cardinal points.

Around the vertical indigenous gnomon, which forms a circumference, smaller rocks are distributed, whose rocks surround the lines of the cardinal points and the collateral points, resembling the rose-of-the-winds, which also have smaller rocks. The East-West line guides the sunrise and sunset on the spring and autumn equinoxes. Two other lines marked with small rocks are directed towards the horizons East (sunrise) and West (sunset) in the summer and winter solstices.

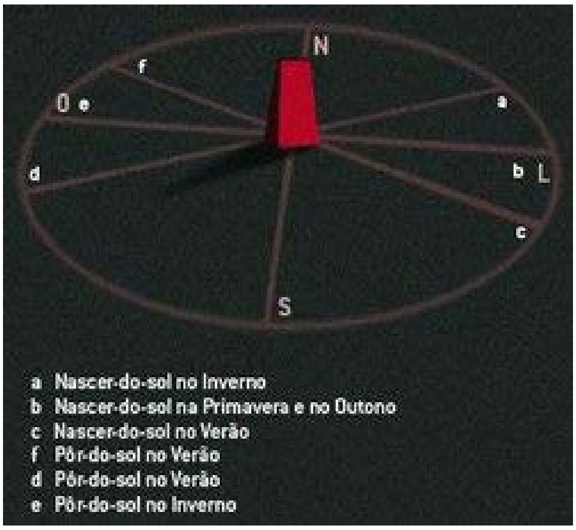

Fig. 1: Indigenous Solar Observatory (Source: Scientific American)

Fig, 2: Indigenous Solar Observatory and Analemmatic Sun Clock. (Source: Astronomical Pole (2018)).
Fig. 3: Indigenous Solar Observatory (Source: Astronomical Pole (2018)).

Goals

It aims to demonstrate that the natives used the solar observatory to organize themselves temporarily; to relate the official astronomical knowledge with that produced by the natives; present the possibility of working on the subject using low cost resources, which can be reproduced in schools of Basic Education.

Dynamics of Service

Visitors (students, teachers and tourists) are arranged around the ISO. The dynamic begins with a brief introduction on astronomy today, the technological research carried out by specialized scientists using advanced equipment, which can be installed on the surface of the planet and beyond its atmosphere. In the imaginary of the people, astronomers develop activities that border on fiction because their discoveries are highly advanced and that astronomical knowledge is only the result of a Western scientific culture, produced through sophisticated instruments. Due to the peculiar format of this artifact, visitors are encouraged to respond to what they see as such. The answers are diverse, from compass to sundial. When the answers are exhausted and it is verified that none of them matches the artifact, a process of deconstruction of the formed ideas begins, but in a didactic way. Every deconstruction of ideas generates a lot of knowledge, since the answers given were emitted on the basis of common sense.

Then the question arises: Where is the sun born and where does the sun go? What do the lines of this artifact mean? In what times of the year is the largest and smallest photoperiod observed? What is the use of knowing the apparent movement of the Sun over the period of one year? What is the function of this monolith at the center of the circumference? Have you followed the apparent movement of the sun and the shadows over the course of a day? The sun is on the pin? After obtaining the most diverse answers, the process of demonstrating how the "technological" artifact of the Indians works begins by giving the correct answers to each of the previous questions, and also to the ones made by the visitors.

Topics addressed to visitors.

Seasons of the year for the Tupi-Guarani nation: "new time" and "old time"

According to Afonso and Silva (2012), the apparent movement of the Sun for a year delimits two seasons of the year for the Guarani Indians: the new time (*ara pyau*), spring and summer e. the old time (*ara ymã*), autumn and winter. *Ara pyau,* occurs from the beginning of the spring equinox to the end of the autumnal equinox, having a higher daily luminosity index and a shorter night.

The maximum of the "new time" occurs in the summer solstice, when this movement reaches the bigest distance to the South, on the Tropic of Capricorn. At this point, the movement of the Sun ceases and it returns to the North. In the region south of the Tropic of Capricorn, for example, in southern Brazil, the "new time" is the season of heat and plenty of food. (Afonso & Silva, 2012, pp. 37-38)

Ara ymã, it happens from the autumn equinox to the spring equinox with the duration of the night biger than the day.

The maximum of "old time" occurs in the winter solstice, when this movement reaches the greatest distance to the North side on the Tropic of Cancer. At this point, the movement of the Sun ceases and it returns to the South. In the region south of the Tropic of Capricorn, for example, Southern Brazil, "old time" is the time of cold and food shortage. When sunrise and sunset occur in intermediate positions (spring and autumn equinoxes), the temperature is mild and the length of day is equal to the night. (Afonso & Silva, 2012, pp. 38).

Seasons of the year with the gnomon (*Kuarahy hã rape jechaukaha*).

In the ISO, from the observation of sunrise and sunset the beginning of each season, it is noticed that the vertical gnomon projects its shadow at the cardinal points and at the collateral points, thus representing the equinoxes and solstices throughout the year. The Sun travels the East-West line (east and west) to reach extreme points (more to the North or more to the South) taking a year for this route. It also explores the Earth's rotation movement, the height of the Sun at equinoxes and solstices (imaginary lines in the celestial vault), Ecuador and Tropics of Cancer and Capricorn, duration of the day in the year (solar radiation index).

Fig. 4: Sunset on the summer solstice (Source: Astronomical Pole (2012)).

Fig. 5: Sunset on the equinox (Source: Astronomical Pole (2012)).

Half solar day with the gnomon (*Asaje mbyte kuarahy'ã jehechaukaha*).

When the sun reaches its maximum daily elevation (culmination) and the shadow of the vertical gnomon reaches a minimum length, in the opposite direction to the Sun, when it crosses the North-South line. It is the mid-point between sunrise and sunset, which can vary up to sixty minutes before or after 12 P.M. of the conventional clock. In Foz do Iguassu, latitude 25º32 '52 "S, it has a range between thirty eight and forty minutes.

The cardinal points with the gnomon (*Kuarahy hã rape jechaukaha*).

It is understood the cardinal points and the collateral points and how to locate them in the horizons East-West, North-South, positioning next to the indigenous vertical gnomon. This model allows to apply the technique of determining the minimum shadow, marking and measuring the length, from the vertical gnomon to the edge of the shadows. It is measured when the sun rises on the eastern horizon (longest shadow), when it reaches midday solar, exactly on the north-south line (shorter shade) and when it sets on the west horizon (longer shade). The distance between the lengths of the two shadows of equal length is measured and the midpoint on the North-South line is marked. For Foz do Iguaçu, the shadow of the solar noon points to the South Cardinal point. However, for residents of other latitudes, it may point to the North Cardinal point.

Final Considerations

In the state of Paraná, according to its State Curricular Guidelines, Astronomy is a structuring and obligatory theme in the content of Sciences, to be worked interdisciplinarily, being able to work the cultural and ethnic diversity of this Brazilian State.

Multiculturalism in Foz do Iguassu, Paraná, allows each ethnic group to understand life, existence and the sky with specificity and originality. They are eighty-one different languages, that is, eighty-one ethnic, cultural and odd ways of observing the sky, which with a cosmological vision or worldview structure knowledge, contextualize, narrate and exchange these knowledge relating them to the situations of life everyday life, traditions, myths, rituals and beliefs, adding values to all societies.

The use of the Indigenous Solar Observatory is configured as a Cultural Astronomy activity, because in addition to being a representation of a structure idealized by specific ethnicity, in this case the Tupi Guarani nation, it is still efficient, revealing deep knowledge of indigenous people on natural issues and Astronomy. From 2012, the year of inauguration, up to the present moment, approximately one hundred and thirty-two thousand people have been familiar with this didactic model of one of the cultures of the southern region of Brazil and three frontiers, adding astronomical knowledge of the Tupi-Guarani civilization.

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Brazil

Valorization of the astronomical knowledge of an indigenous village Terena in the state of São Paulo

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Abstract

Currently with the process of acculturation and the increasing urbanization of the indigenous population in the country, there is evidence of a legitimate concern for the preservation of the cultural identity of these people. We constructed a timer from the sun, and we developed diversified activities of skywatching, culture and indigenous astronomy. The purpose was unlocking the curiosity, grasp concepts of universe and relate them to everyday life. Based on this study it is expected that the teaching of indigenous astronomy will contribute for the reflection and subsequent applications of teaching / learning that can reaffirm ethnic identities, valuing languages and science. Respecting these different ethnical groups that the culture, beliefs and rights will be preserved.

Introduction

Men has been watching the sky for millennuns. The man turned to the sky in order to discover a process as a measure to know the time and, with its own methods, to plan the daily life. Some astronomers are now engaged in researching what was left by the peoples have constructed and recorded about these observations.

Luiz Galdino, a researcher of prehistoric rock art in Brazil, author of "Indigenous Astronomy" (2011), says that the foundation of astronomy lies in the evidence that man realized in prehistoric times that climatic variations – Wind, rain, cold, heat - as well as the production of fruits and the process of reproduction of the animals identified different seasons. He discovered that the cycles observed in nature around him corresponded to demarcated cycles in heaven, mainly by stars and constellations. This observation led them to register the stars whose cycles had proved to be important for the creation of calendars. The author comments that archeoastronomy allows us to better know ancient astronomy, from archaeological research. These evidences can be constructions, sets of constructions, alignments of stones, rock paintings, etc.

Looking in specifically the past, in some of the ancient cities in which those peoples lived, we can find constructions and monuments that resist the time and indicate the knowledge of the sky, with records of certain positions of the stars as the one of the brightest stars, of the Moon and especially the birth and sunset of the Sun on the horizon. Many of the discovered monuments point, for example, to the position where the Sun sets in special dates that mark the beginning of the seasons of the year where the cycle that intersperses solstices and equinoxes is established. This was a way of organizing a calendar for the seasons of planting food or for religious festivals.

One of the most striking indications of prehistoric astronomy in Brazil, among many others throughout the country, is inscribed on the figures of the Pedra do Ingá, located in the municipality of Ingá, in the state of Paraíba. The immense and heavy rocky block, with surface covered with reliefs, serves the communication of significant facts of the quotidian, between the signs representing the elements of nature, appear figures and stars interconnection, simulating the night sky with the constellations. This archaeological monument was the first to be listed as a national patrimony in 1944 by IPHAN (Institute of National Artistic Heritage). Archaeologists classify the Ingá Stone as "Itacoatiara" - which in Tupi means "painted stone".

Based on data allow everyday life and striking events of the prehistoric man who lived in that age, the stone is also known as Germano Bruno Afonso, astronomer and researcher of the astronomical knowledge of the Brazilian Indians. Regarding this monument, Afonso reports that, on the banks of the river Ingá, in Paraíba, there is a very hard gaseous rock monolith whose surface is covered by about 500 low-relief inscriptions, which many researchers claim to be unique in the world. It is the famous Itacoatiara of Ingá, about 23 m wide and 3 m high. There are several hypotheses about the origin of the graphics. Ours is that Itacoatiara do Ingá served as a place for religious rituals related to astronomical elements. We have identified some spirits of Tupi-Guarani mythology there, and we assume that the panel indicates part of the Milky Way.

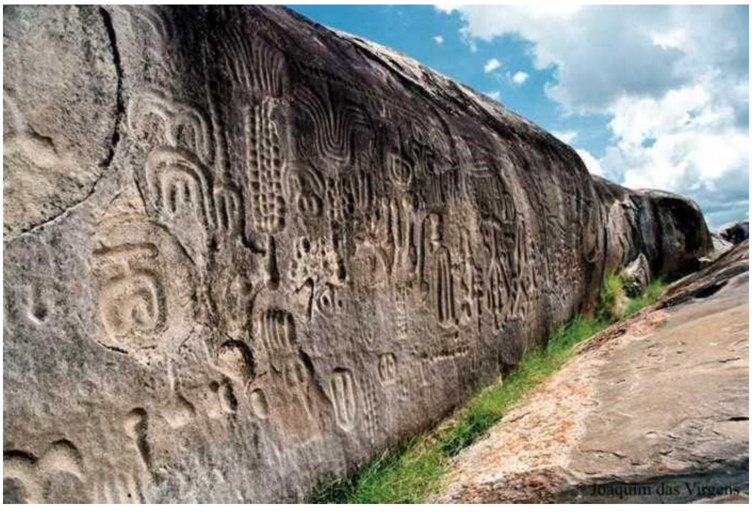


Fig. 1: Ingá Stone. It is supposed to have been recorded in 4134 a.C. (sic) - Source: Secretariat of the Patrimony of the Union.

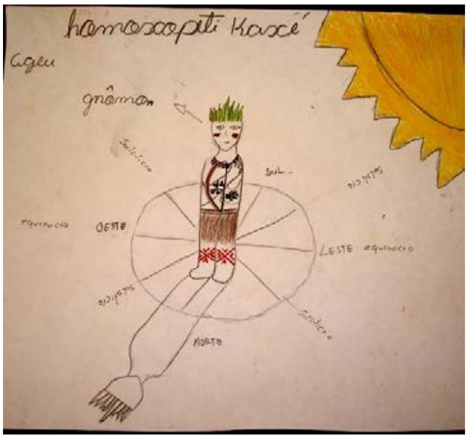
The rescue of Brazilian indigenous knowledge of the sky has been a cause for great concern, as the older Indians, who are holders of this knowledge, are dying and, for lack of registration, this knowledge is dying with them. Afonso (2012), an in loco researcher of indigenous astronomy in the villages, writes that a good part of the Brazilian Indians, through their own astronomy, still define the time of planting and harvesting, the count of days, months and years, the duration of tides, the arrival of rains. They throw their myths and moral codes in heaven, making the firmament a mainstay of their daily life. Much of this knowledge is still found among farmers, hunters and fishermen, who use them in their daily lives. One of the most well-known indigenous constellations among the Indians from north to south of Brazil is the constellation Ema (below). When it appears in the sky at dusk, on the southeast side (southern hemisphere), announces the arrival of winter solstice, on June 21, a very cold season. The Ema constellation is located in a region of the sky bounded by the western constellations of the Southern Cross and Scorpio. Its head is formed by the Nebula of the Coal Sack. Alpha and beta Centauri are inside the neck, representing two large eggs that have just swallowed. The light and dark patches of the Milky Way form their plumage. According to the Tupi Indians, the constellation Cruzeiro do Sul holds the head of Ema, because if released, will drink all the water of the planet. This has been passed from generation to generation by the legend of Ema.

Fig. 2: Brazilian indigenous constellation of Ema. Source: Internet

With the intention of participating in the valorization of the Brazilian indigenous astronomical culture, it was developed in the Ekeruá Village, indigenous land of Araribá / Avai / SP, by researchers from Unesp de Bauru / SP, a collaborating plastic artist and Terena Indians, where has constructed a Sun Time Marker which, like many of the astronomical connotations found in archeological sites in Brazil, has the function of recording solstices, equinoxes, and seasons through the passage of the Sun.

The development of the academic project linked to the Astronomy Didactic Observatory "Lionel Jose Andriatto" Unesp / Bauru, contemplated the experience of sky observation by the Indians of the village through astronomical equipment, software as well as interactive material. The meaning of the function of the Solar Time Marker was given through conversations with the indigenous community, Sun Time Marker modeling workshops was done with children, throw introductory classroom astronomy clarifications by the village teachers, research and storytelling, related to the astronomical knowledge of the ancestors.

In the visits to the village to verify the astronomical knowledge of the indigenous community Terena of Ekeruá some points were revealed and revealing the observation and application of their knowledge of the sky in their daily life. For them, as for the Brazilian indigenous peoples in general (AFONSO, 2012), time is a sacred deity. The cycles of nature are mirrored in the sky. Indians indirectly use the Sun and Moon references to measure the passage of time, which is based on the apparent motion of the Sun. They adopt the Earth standing still and let the whole sky move in front of it, including the Sun and the Moon. The Ekeruá Indians note the different durations of the clear day and the events that relate to this phenomenon. They recognize that there are repetitions and concomitances in the phenomena that help them regulate social life. The day and the north are associated with the passage of time. During the night, the count begins with the position of the stars, or constellations that are emerging. During the day, by the position of the Sun. Thus are formed stations of the Earth that can be measured by the Sun or the Moon. For the Indians, the division and the counting of the time are based on the times of planting and harvest, having direct relation with the phenomena of nature. Considering these knowledges, the construction of the Solar Time Marker also generated the elaboration of an instructional notebook, as a paradidical material about the astronomical aspects involved, such as producing a solar time marker model to simulate its function and use, the construction phases and the cultural values emphasized by the indigenous community involved.



Fig, 3: Drawing made in classroom Time marker of the Sun. Fig. 4: Solar marker built in the village in the development of the project

Figure 3, the drawing was made by a 13 years old child in one of the educational workshops held and, on figure 4, the *Yétore* Sunshine Time marker (*Yétore*, name of the village chief) built in the village with the participation of the entire indigenous community, using the drawing of the child as inspiration. The photo shows the moment of visitation of schools in the village in order to get in touch with its own indigenous culture of the region.

The professor of the indigenous school of Ekeruá, Davi Pereira (*AWA TXERAPÓ*), comments that the Time Marker of the *Yétore* Sun more than rescuing the knowledge of his ancestors also add values of the culture, as the work with the clay (ceramic material used for the modeling of the Indian who is placed in the position of the *gnomon*). The techniques of braiding were also employed in clothing and body painting and in the base of the solar time marker.

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Chile

Cultural Astronomy in the Central Valley of Chile

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Abstract

Vestiges dating back to 11,000 years ago have been found in the central valley of Chile. It is in the intermediate potter period where relevant information is found to determine cultural astronomy, diversity of cultures that inhabited the valley. This article will show us positional astronomy and settlements of religious constructions around the main square.

Introduction

In the central valley of Chile we have evidence of the archaic period for 11.000 years of human evidence, regarding the late intermediate potter period that is between 900 and 1500 AC. We find the vestiges of the settlement of cultures that were coexisting in the valley through different pacific as well as violent invasions, creating alliances between the local world, Aconcagua, Promaucaes, Mapochoes, Incas and Spanish cultures.

In the writings of Villar, it appears: *"Cacique Quilicanta came from peace and the other cacique that we said above is said to be Atepudo. These caciques made war against the cacique Michimalongo. Before we entered the earth they had a great difference between these four masters".*

"There came another eleven caciques of the region, the closest ones who were friends and close friends of those two caciques mostly of the Quilicanta. For being courageous and being one of the Incas of Pirú, was placed by the Inca in this land as governor, and this Inca being in this land when the advanced Don Diego de Almagro came and he served him and was given as a friend. It was this friendship that was part of the enmity of the caciques and Indians, as often happens", he says (Vivar, 1558).

In the writings of Father Rosales, it is mentioned that the cacique Loncomilla, which means head of gold. Loncomilla, Lord of the Valley of Maipo, came to give peace to Pedro de Valdivia and said: *"not to populate in the Chimba, that better site had the other side of the river, the southern part, where the 'Ingas' had made a population,* *which is the place where today is the city of Santiago "*. "…where the Ingas had made a population"(Rosales, 1878).

Pedro de Valdivia settles in the valley of the Mapocho *" ... with all his people was going to populate a town like Cuzco on the banks of the river named Mapocho"* (Vivar 1558).

Fig.1: Map of Santiago in 1540

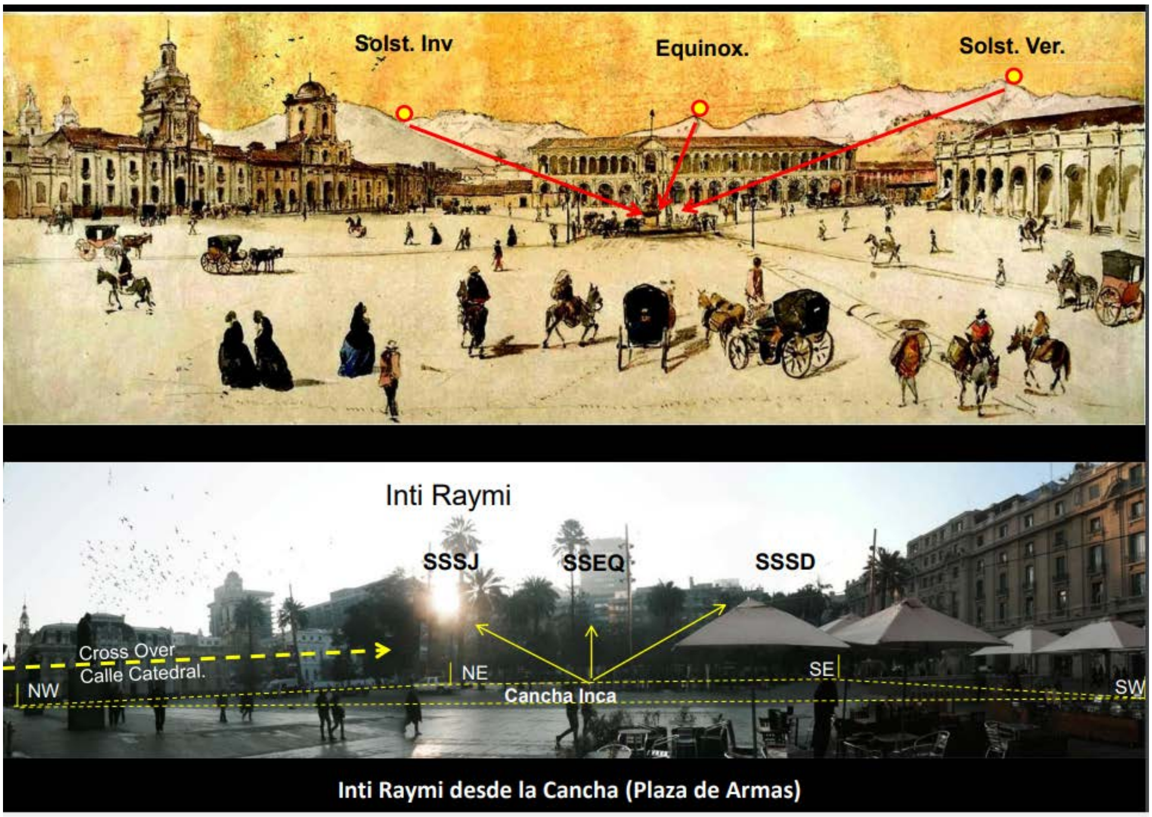

Fig.2: Inti Raymi from the Inca Court (Plaza de Armas).

Fig. 3: Positions of sunrise and sunset

According to investigators like P. Bustamante the main square, today the square of arms of Santiago where Quilicanta lived and Pedro de Valdivia, was aligned in relation to the Inca four partition identified by its "capac ñam" or way of the Inka and described by the Spaniards as Caminol Real. They were going north, south, and east, west. In addition, this square was positioned with the solstices (Bustamante, 2012)

The relationship of the positions of the Churches in relation to the Plaza Mayor.

We can find that the first sacral constructions began to be built with the arrival of Pedro de Valdivia in 1541. The cathedral was the first church, this modest construction was burned by the cacique Michimalonko on September 11, 1541.

Currently the Church of San Francisco that is located on the East - West axis. For the current mall Bernardo Ohiggins ex "Cañada".

The basilica de la Merced built in 1566 can also be found from east to west approximately five hundred meters from the main square.

Fig. 4: Church of S. Francisco in the “Cañada”. Fig. 5: Basilica de la Merced

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Colombia
The Santa Rosa meteorite

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Abstract

In Colombia, the most famous visitor of outer space is the so-called Santa Rosa meteorite, found east of the small town of Santa Rosa de Viterbo in 1810, the day after his spectacular entry observed at night by several people. The main piece, of at least seven known, rests in the National Museum in Bogotá, a metallic piece of 411 kilograms essentially composed of iron with a nickel content. The interesting story of the Santa Rosa meteorite and how it is finally rescued for the museum is narrated in this article.

Few metallic meteorites were known to science in the early nineteenth century. By 1823 about 13 of these bodies have been reported, mostly small specimens. For this reason it was very interesting for the European scientific community the news provided by the German naturalist and explorer Alexander von Humboldt in 1823 to the French Academy through a letter sent by the French naturalist Jean Baptiste Boussingault. It announces the discovery and analysis of metal meteorites in New Granada, nowadays known as Colombia. Boussingault and the Peruvian naturalist Mariano Eduardo de Rivero y Ustariz carried out the research mission and related their discovery:
"They assured us that in Santa Rosa, Boyacá, there were a excessively heavy iron ore. When asking for reports they took us to the blacksmith to show us a large piece of that ore, which served as an anvil. What would be our surprise to recognize in the said anvil, a mass of metallic iron quite irregularly with numerous vacuoles on its surface and covered with a carmelite varnish and had, in a word, all the appearance of a mass of meteoric iron"

This mass of iron had been found by a young woman named Cecilia Corredor on the hill of Tocavita east of Santa Rosa de Viterbo, on Holy Saturday in 1810. Apparently the meteor was seen the day before as it reads in the report:
"We could still see, when the place was indicated, a cavity not very deep, from where the block had been removed. We could still see, when indicating the site, a cavity not very deep, from where the block had been removed; this object evidently fell on the night that preceded the Holy Saturday, because nobody had seen it before ... what supports this opinion is that, that same night they had seen a balloon of fire that was advancing at high speed, at ground level towards the SW."

The story of how this rock was found was referred orally as follows:
"I was referring to my grandmother Cecilia Corredor who was after a broody (hen) that

appeared next to her ranch; she followed the hen and seeing it entering a cave she leaned on a stone ... which seemed very cold: she looked and thought that it was iron ... neighbors go with grills, picks, tools and oxen and bring the stone to the town .. distance 10 kilometers ... ".

The exact location of the discovery is unknown today. The description of Rivero and Boussingault says that the inhabitants met to lower the meteorite and that it was deposited for seven years in front of the Cabildo, and later *"they took it to Manuel Corredor's smithy but could not serve as an anvil because it did not have a flat part".*

The young scientists bought the meteorite for the Museum of Bogotá from Cecilia Corredor and they paid the price they asked for: 20 piastras (100 francs).
"As soon as the news of our purchase spread out, people came to offer us pieces of iron from which we bought a dozen samples. All the inhabitants of Santa Rosa owned minerals. The numerous pieces of iron established, without a doubt, the cosmic origin of the metal because most of them had been collected after the discovery of the main mass, on cultivated fields where before the Holy Saturday they did not exist".

Following the fashion of the time of melting white arms from metal meteorites, a sword blade was forged with one of the pieces, which was offered to the Liberator Simón Bolívar; the dedication said: *"This sword has been made with iron fallen from the sky to defend freedom".* Since then there is no news about the fate of such a weapon.

The main mass of the meteorite was initially calculated at about 750 kg., which caused difficulties for its transport, and in spite of all the recommendations made by the naturalists for this beautiful sample of cosmic iron to be placed in the Museum of Bogotá, it was forgotten for more than eighty years in the Plaza de Santa Rosa. In 1875 the meteorite was placed on a column made by the citizens proud of its treasure.

Fig. 1: Henry Ward in Santa Rosa de Viterbo, 1906.

At the beginning of 1906 and after having sent more than 18,000 communications to various countries of the world requesting information about meteorite fall and having received only four positive responses, Henry Augustus Ward, professor of natural history, adventurer and collector of pieces for museums, originally from Rochester, New York, decided to visit Colombia with the aim of *"rescuing the great Santa Rosa meteorite for science".* Ward found the meteorite on a fluted column next to the fountain that supplied the water for the villa. He checked his weight and saw that it was 612 kilograms. According to Ward's words, the inhabitants highly appreciated the object, so he knew that it was difficult to acquire it; therefore he forged a plan by which he proposed to the authorities to make a statue of General Rafael Reyes, president of Colombia at the time and who had been born in that town, in exchange for the meteorite in the plaza. The governor of the region liked the idea and in a stormy meeting with the mayor and other officials forced the approval of the plan with a contract.

Fig. 2: Main mass of the Santa Rosa meteorite exhibited at the National Museum in Bogotá.

Late in the evening Ward invited the inhabitants of Santa Rosa to a large dinner at the hotel where he was staying and while they ate and drank, a picket line of 50 soldiers silently and quickly lowered the meteorite and placed it in an ox cart towards Bogotá. When they arrived at La Caro station 30 km north of Bogotá, a journalist reported what had happened and General Reyes himself ordered the police to retain the car and its cargo. Ward then filed a lawsuit to enforce the rights he had by doing a legal business with the Santa Rosa authorities. Apparently an agreement was reached quickly because a few days later he told the Director of the National Museum, that the Ministry had agreed to give Professor Ward one of the meteorites that existed in the Museum and also give him a part of the one he brought from Santa Rose of Viterbo. The rock was taken to the ironworks of La Pradera where after several days of cutting work Professor Ward finally achieved part of his goal, a piece of 150 kilograms of the thinnest part of the meteorite, and a part of the mass of the Rasgata meteorite that weighed five and a half kilograms and that was in the Museum. Nowadays, the Field Museum of Natural History in Chicago has a block of 99.34 kilograms of the meteorite cut for Ward.

Subsequently, the Santa Rosa meteorite has been exposed in several places. The National Museum ceded it in 1943 to the National University where it was abandoned in the Materials Resistance Laboratory. In 1949 the Museum requested it again to the University. In 1951 the museum estimated its mass at 411 kilograms. Later he was exhibited in the Bogotá Planetarium between 1969 and 1992 and returned again to the National Museum where he is currently exhibited on the first floor.

In the Meteoritical Society database (2010), the Santa Rosa meteorite is classified as one of the nine Type IC found on the planet, essentially composed of iron with a nickel content of less than 6.1% by weight. The composition is Fe 92.30%, Ni 6.52%, Co 0.78%, P 0.36%, C 0.18%, Cu 0.02%, S 0.04% and traces of Cr.

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Cuba

Neighbors in a square

Taymi García Marichal
Director of the Planetarium of Havana

Abstract

Telescopes are astronomical instruments. In this case we are going to see an application within the terrestrial scope of an instrument, the camera obscura, which is essentially related to telescopes.

Since ancient times man has always tried to interpret the nature of light and use it for his own benefit. First it was the camera obscura, then the telescope and finally the photograph. Optical machines and instruments evolved over time but always based on physical phenomena related to the propagation of Light. Today this task is much more rewarding, when it is possible to enjoy these gadgets to observe from the top of a tower an ancient city, photographs that refer to astronomical subjects, stars and planets.

Camera Obscura

In the tallest building in the Old Square, is the Camera Obscura (figure 1). It is a special place, from where it is possible to observe the city in a different way.

Fig. 1: Old Square where the building with the camera obscura is observed.

It is based on the interpretation of the optical phenomenon that occurs when capturing what happens in the environment of the building thanks to the effect of which is reflected through a periscope and a set of mirrors that project on a concave screen everything that happens at that time in the city.

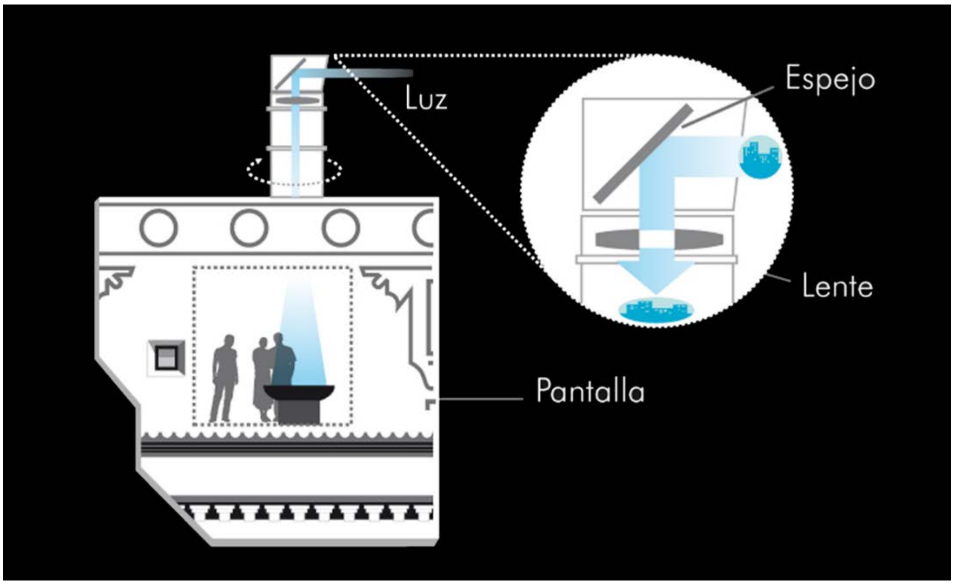

Fig. 2: Outline of the camera obscura

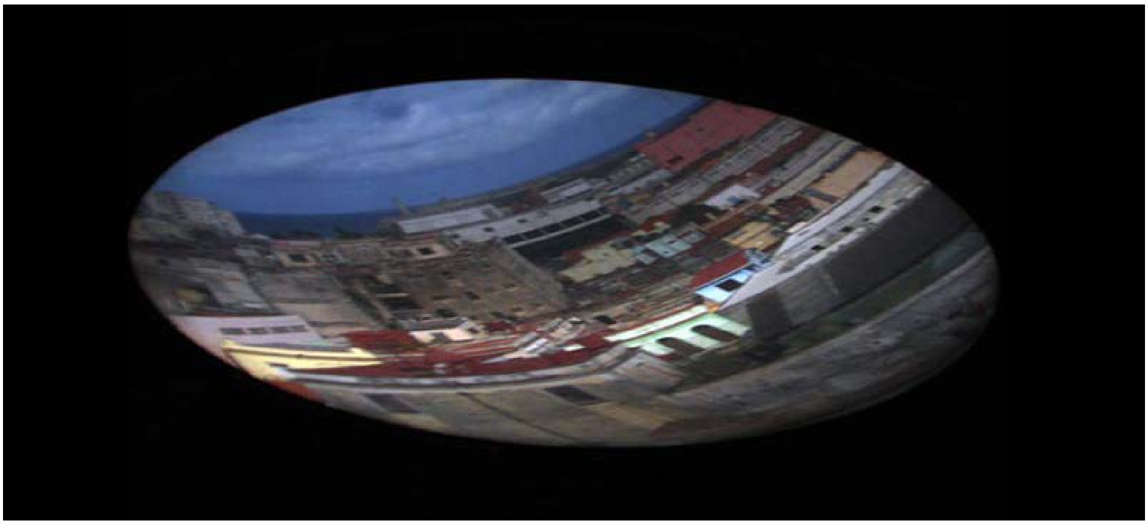

Fig. 3: Image of Havana observed thanks to the camera obscura

The Camera Obscura of Havana is located in the tower of 35m of height in a building constructed in 1909. A camera obscura is a device with mirrors that projects in a totally darkened room, painted of black, inverted images of the outside on a concave screen of 180 cm in diameter. On the screen, everything that happens around the building is reflected in a clear and colorful way through a periscope equipped with lenses and mirrors that is at a higher level and that is responsible for reflecting the environment through light. (figures 2 and 3). The projected image is in color, very bright and also reflects what is taking place, on the outside of the room, in that same moment (real and moving images). Because of the long focal length of the main lenses, the result is a magnificent optical effect that makes objects far away seem very close. The screen goes up and down to focus the different distances. The images in the Camera Obscura can rotate back and forth to visualize the different parts of the landscape. You can see over the horizon at some distance or below it to examine details.

Although this optical phenomenon is known since the time of Aristotle, it was not until the fifteenth century that Leonardo Da Vinci came to make a sketch quite similar to the current structure.

The camera obscura of Havana was inaugurated in 2001 (manufactured by the British company Sinden Optical Co. Ltd) being a donation from the Diputación Provincial de Cádiz through the intermediary of the Office of the Historian of Havana. Currently there are more than seventy dark cameras distributed in different cities of the United Kingdom, Portugal, Spain and the United States. Habanera is unique throughout Latin America and the Caribbean.

Periscope

The American inventor Sarah Mather was the inventor of the underwater telescope that would end up being the precursor of the periscope and the registration of her first patent dates from 1845. Initially it was used from a boat on the surface to examine the seabed. Actually today, as is well known, the periscope is used to the contrary in submarines.

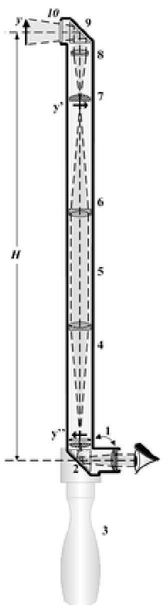

Fig. 4: Periscope scheme. Fig, 5: Soldier of the first world war using a periscope

In simplified form (figure 4) consists of a tube with a set of mirrors at the ends, parallel and at an angle of 45 ° with respect to the line that joins them. A scheme similar to reflectors or newton telescopes. It can be used to observe from a hidden position. This form of periscope, with the addition of simple lenses, was used in the trenches during the First World War (figure 5). These simple periscopes with mirrors are the basis of the camera obscura. Other more complex ones are used, for example, in submarines, and instead of mirrors they include prisms, so that the visualization takes place increased or diminished.

In the same Old Plaza of Havana, a few steps further from the Camera Obscura, there is the Fototeca de Cuba, an institution that treasures important images from daguerreotypes and ferrotypes, to the most modern photographic prints of the nation. Currently this is an art practiced by many, the only requirement is to possess these three things: patience, patience and ... patience. Although it is interesting to have certain instruments if we want to reach with our lenses beyond the visible horizon until reaching the stars.

Fig, 6 and 7: Planetarium of Havana

To complete this visit to the Plaza Vieja you will arrive at the doors of the Planetarium of Havana (figure 6 and 7). Faithful exponent of the close relationship that exists between man and the celestial vault, which goes from science to art, from philosophy to literature. Place that transmits to its visitors the fascinating attraction of man through the moon, the stars, the fire, the rainbow or the aurora borealis and of course the Sun, the primal source of light for our planet, from where it is possible to know our origins. And where they are an essential part of reaching astronomical knowing of the telescopes, which simplifying are not more than small dark cameras.

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Ecuador

Monkeys after Death in Andean Sky

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Abstract

Archaeoastronomy focuses on past astronomical knowledge, in which the practice of astronomy in ancient societies has been interpreted from the orientation of structures, rock art and megaliths in some cases without context. This paper analyses the location of stellar constellation depiction in the environment and its relation to religious systems and symbolism. Archaeological petroglyphs of the pre-Columbian Pastos, between southern Colombia and northern Ecuador highlands, refer to the cosmological myth of the Tutamonos constellation (Osiris for Egyptians, Orion for Westerns). The Pastos iconography depicts pairs of monkeys, a star and a warrior, all of them recurrently appearing on ceramic, metal and stone artifacts buried with death as well as carved on petroglyphs in open-air locations. Tutamonos constellation, represented in dead companion artifacts and in mountain altars, might be interpreted as portraying the religious belief that after death, people would join nocturnal monkeys and other divinities in the sky.

Introduction

A powerful desire of sky gazing developed complex human abstractions such as beliefs and sciences. Astrophysics is an elder science from which the knowledge of cyclic movement of stars was applied to rule human ways of life such as hunting-fishing-gathering-foraging, domestication, farming, voyage orientation, time recording, technology sophistication, and for legitimate religions. Non-Western cosmographers recognized patterns of stars or asterisms, named them in their own languages, depicted and recorded them in the form of engravings in rock and metal, and paintings in mud artifacts, as well as in oral histories, that later transformed into myths and beliefs (Kelley & Milone 2005:475). The stories that occur in the sky have to do with protagonists that are both human and animal, sometimes they are warriors, thieves, gods or demons who remain perpetually engaged in war and love affairs in the sky. Significant for present work is the idea that the sky has become one of the preferred destiny to go after death. As known in Judeo-Christian tradition, supernatural beings inhabit the sky and are able to go up and back after death. This paper focuses on the cosmological myth of the *Tutamonos*[1] constellation (*Osiris* for Egyptians, *Orion* for Westerns) associated to the idea of death in Andean societies, and analyses the location of its ancient depictions in open-air altars and tombs, straight referring to religious systems.

Monkeys and Stars of Andean Sky

Previous ethno-archaeological research performed for more than a decade in the Upper Caquetá River in Amazonian Colombia by Dimitri Karadimas (2000, 2005 & 2014) was inspirational to continue studying Pre-Columbian petroglyphs and funerary artifacts in Northern Andes of Ecuador and Southern Colombia. This ethnographer was the one who recorded the myth of *Tutamonos* from the Miraña society in the Upper Caquetá (2005), and made the connection with Pre-Columbian iconography of archaeological Pastos of Northern Ecuador and Southern Colombia (2000), and later with the Moche culture in the Northern coast of Peru (Karadimas 2014).

The myth in which nocturnal monkeys appear as protagonists under both Andean and Amazonian skies, takes place within the Miraña oral tradition. The Miraña people believe that once upon a time, Star married a woman called Kinkajou (Moon) but her four brothers, the *Tutamonos*, did not like him and planned to kill him in secret. The *Tutamonos* hided inside of the Araracuara waterfall located in the Caquetá river watercourse, and cut his head, which magically transformed into a bunch of chontaduro (Karadimas 2014:205). Chontaduro (*Bactris gasipaes*) is a peach-palm fruit, native of Amazonian tropical forest that fructifies once a year. After Star died, his son recovered his father flesh from the chontaduro bunch, became a warrior and decided to take revenge trying to kill his four night monkey uncles. Every night, the *Tutamonos* myth can be read from the sky in the form of the constellation of the four night monkeys, flying above our heads escaping towards east, and forever being chased by a warrior that wants revenge for his father death (Karadimas 2000:165).

In a similar way, today's Karajá people from the Brazilian Mato Grosso believes in a cosmological myth in which Tainá-Kan (Venus), the great star, came down from the sky in a human shape for marrying a Karajá woman. He carried from the sky the seeds of corn, bean, and watermelon to the earth, and became the father or the origin of agriculture. He stood in the earth teaching the Karajá people how to farm, and in a couple of years, he went back to the sky but this time with his wife and sons, giving birth to a new constellation in the sky, the Pleiades (Figuereido 2006). Contemporary Karajá men wear circular back-dresses made of multi-color feathers in ceremonies to look like Tainá-Kan shining in the sky. In both the Miraña and the Karajá myths, the primary notion is that the sky is the dwelling of ancient and supernatural beings turned into stars after death.

[1] Means monkeys of the night in Kichwa

Tutamonos: The Four Monkeys Constellation

The *Tutamonos* constellation is the local name for Orion in Northern Andes (Karadimas 2000). Orion constellation, a region of star formation, is observable during all nights over the year in the Equatorial region (Figure 1). The principal stars in the northern direction are Betelgeuse (red giant star) and Bellatrix (blue giant star), in the southern direction Saiph (blue giant star) and Rigel (blue giant star). Inside the trapezoid formed by the four star mentioned above, the stars Mintaka, Alnilam and Alnitak (Orion belt) are easily recognizable when the sun goes down. During March equinox, the constellation appears at the beginning of the night in the zenith, and moves towards West during the night. In the June solstice, the Tutamonos are only visible after the sunset and disappear when the sun raises. In the December solstice the Tutamonos constellation appears in the beginning of the night at East and moves all night to ends its occultation in the morning at West. Finally in the September equinox, the constellation raises from East at night and travels along the sky until the zenith when the sun make it disappear in the daylight. The annual cycle of the Tutamonos constellation could be seen by the ancient inhabitants and make them to understand the stars obeys a cycle connected with their live and death.

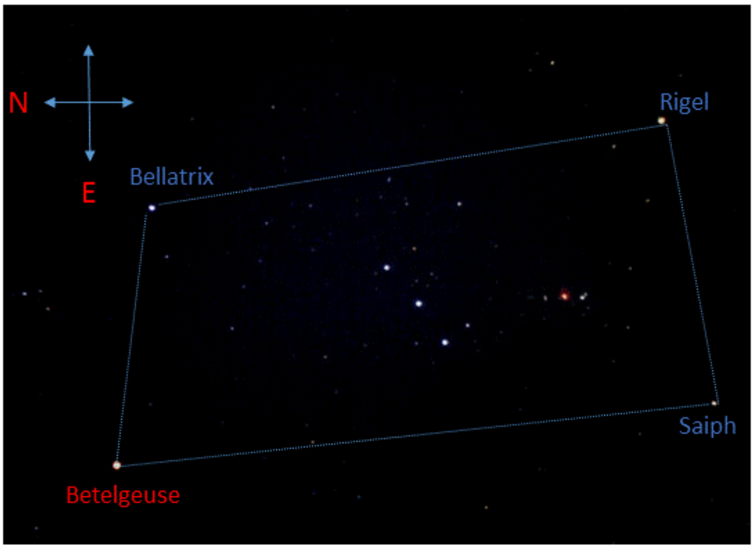

Fig. 1. Tutamonos Constellation. Source: Based on SDSS, Bernd Mienert, Astronomical Image Data Archive

Monkeys depicted for dead companion artifacts

Mythological characters of *Tutamonos* constellation of the Miraña have been recognized in iconographic depictions of archaeological Pasto material culture (300 B.C. - 1600 A.C.). Past Pasto people and their descendants inhabited the Carchi province of Ecuador and the Nariño department of Colombia (Landázuri 1995). A vast collection of metal and ceramic artifacts are kept in museums, whose provenience is not always known. Nevertheless, artifacts associated to dead individuals have been collected from Pasto tombs during systematic excavations (Uribe 1977-1978), providing context to interpret iconography and discuss symbolism. Pasto funerary tombs consist of cylindrical chambers from 1 to 15 meters depth, filled with sandy soil after burial episodes. More than one individual appear in shaft-tombs, ritually dressed for death, with red bi-valve *Spondylus* shell-bead necklaces and charms, and often with gold, silver and *tumbaga* nose rings, earrings, head-dresses, masks or pectoral plaques. Some burials have bracelets and rings manufactured in metal and shell. These artifacts are recurrently decorated with motifs representing pairs of monkeys, a star of 8 angles (Venus?), a warrior with a spear in his hand and other images identified as deer, bird, reptile and geometric compositions (Echeverría 2004). Pasto metal smiths produced laminated earrings, showing pairs of monkeys and chontaduro bunches, which also are depicted in solid pendants for charms. In addition, between 200 and 300 artifacts manufactured in clay have been usually found deposited as death companions in individual interments (Uribe 1977-1978). From museum exhibitions in both Ecuador and Colombia, we can tell that such funerary offerings comprise recipients such as bowls, cups, jars, plates and tri-dimensional representations of houses, female and male effigies, and sea-shells ocarinas. A particular design of a monkey laying on the roof of a clay house has been published in Echeverría (2005) but another monkey appears in a clay sea-shell found near Tulcán (Figure 2). Decorative motifs in burial companion artifacts remind the Tutamonos constellation, which appears in association to funerary rituals to support dead in their way to meet divinities in the sky like do Catholics, who symbolically are buried under a cross that means Jesus Christ in the sky after death.

Fig. 2: Clay artifacts with *Tutamonos* constellation depictions. Photo source: Josefina Vásquez, and central photo by Beatriz Saura.

Monkeys in petroglyphs located open-air locations

Another line of inquiry is the exploration of open-air petroglyphs located in highland mountains with carvings representing the *Tutamonos* constellation. The species *Aotus vociferans* are the *tutamonos*, native tropical forest primates with large frontal eyes and prehensile tail, and therefore cannot be emblematic animals from the Andean mountains because they do not live in cold and high altitude and non-arboreal environments. Its nocturnal behavior and its shiny eyes looking down from the top of the forest trees at night might potentially encourage people to conjure stars. Nonetheless, the Pastos depicted two pairs of monkeys, a star and a warrior, all of them recurrently carved in panels of petroglyphs in open-air locations, one is the well-known Machines petroglyph, reported in Cumbal (Nariño) by Granda Paz in 2010. The Machines petroglyph combines the main characters of the Miraña mythical narration in only one panel: four monkeys, Star, and warriors. During our 2011 exploration season, two archaeological sites with Pasto petroglyphs carved in large rocks have been identified in San Isidro (Carchi) and the other in Los Monos near Guachucal (Nariño, Colombia). Rock art panels occur in open spaces above 2800 m.a.s.l. and in both sites, petroglyphs display pair of monkeys in high and bas-relief. It is noticeable that in one of Los Monos petroglyphs, monkeys are playing together a sea-shell ocarina and in another panel, they play flutes independently (figure 3). Petroglyphs illustrating mythic monkeys and other stars like the 8 angles star, probably Venus were built to serve as public altars or shrines along the Pasto territory in Andean highlands.

Fig. 3: Petroglyphs illustrating mythic monkeys in high Andes. Photo source: Josefina Vásquez

Andean sky and religion

Andean archaeoastronomy is committed fundamentally to the study of Inka religion in Central Andes, in which elites believed themselves as the children of the sun (Dearborn 2000:197). By combining ethnohistorical written chronicles related by European priests and voyagers with archaeological features, a vast knowledge about Inka mythology and rites associated to astronomical events has been produced (Kelley & Milone 2005: 444, Zuidema 2007:270). Critical to our iconographic centered perspective is Urton's work. (2007). Urton interpreted a tapestry mantle with *tukapu*[2] depictions as a multi-year calendar based on astronomical observations (2007:247-265). This woven artifact

[2] Complex geometrical designs depicted in Imperial Inka clothes (Urton 2007:247)

was part of a funerary burial like the kind of artifacts we are presenting in this paper, it was associated with death and after-death thoughts. The *Tutamonos* constellation, represented in dead companion artifacts and in mountain altars, might be interpreted as portraying the religious belief that after death, people would join the four monkeys and other divinities in the nocturnal sky. During first decades of 20^{th} Century, a Spanish priest named Bazares was chatting with a native family of the Aponte ethnic group in El Tablón (Nariño), as he tried to call their attention towards the delights of the sky, Bazares told them in detail about the beauty of Christian paradise. However, he did not observe a positive impression on the faces of his interlocutors until the chief of the family asked him if there are or not monkeys in the sky (Ortíz 1934 cited in Karadimas 2000:167). With this citation in early Karadimas' work, the connection between Miraña myth of Tutamonos and Pasto region cosmology got linked.

Nocturnal monkeys of the stellar Pasto iconography maybe portray a universal illusion that after death we may go to the sky. Plenty of monkeys or not, the untouchable space which we call sky, read from an ancient Pasto perspective could be the dwelling of mythic characters that through time have transformed into ancestors and gods. Terrestrial and celestial landscapes are constructions of human mind, domesticated by humanity (Erickson 2008) in their will of articulating the origin of universe, plants, animals, and human ancestors through the perpetuation of cosmogony myths.

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Guatemala
The Solar Eye

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Abstract

Astronomy has played an important role in the development of civilization, both for its practical applications in agriculture, social organization trough the invention of calendars, and the technical developments associated with it, not only in ancient civilizations, but even now, when the technical challenges solved by scientists end up as gadgets in daily life. In Guatemala the subject of Mayan Astronomy has served as a bridge between cultures providing an introduction to science for the general public, and Mayan groups in particular, but also helping the Guatemalan society to appreciate and value the cultural legacy of Mesoamerican civilizations.

Visualizing the path of the Sun around the year

The connection to the sky has been eroded over time because people arrange their affairs around calendars and clocks, and in many industrialized societies the sky is no longer transparent enough. However, almost any human being when presented with a clear night sky shares the awe and inspiration running trough all ages of human kind.

Astronomy has played a major role in the development of human civilization, and it is importance in culture cannot be underestimated. Not only in ancient civilizations, but in the modern technical society represents a major drive in political, scientific, military and social agendas.

In recent years the study of cultural Astronomy, specially Archaeo Astronomy has proven to be a very effective bridge between ancient and modern cultures motivating the interest of a wider audience in both subjects, science, and culture, presenting an holistic view that in many cases it is relevant to everyday life, sometimes connecting with a forgotten collective memory.

Fig. 1: The Solar Eye sculpture is part of an introduction to Maya Astronomy, tied with the ritual activity at the Tzunen mountain in the Guatemalan Highlands.

This has been used successfully in many places as a way to introduce science in a non conventional way to very diverse groups of people. For example: The Solar Eye sculpture was designed by David Marín at the request from the School of Political Action for Mayan Women, in Guatemala, they wanted a course in astronomy as part of their project to better understand the rich cultural heritage of the Maya civilization in this subject. But not only for scientific or academic interest, but precisely because they recognize the importance of Astronomy in the organization of political life, and technological achievements of the ancient civilization.

However, they required an Astronomy course based on direct experience, tied to social and ritual activities in Mayan tradition, an approach that will promote the transmission of knowledge between elders and children using the traditional vectors of Mayan culture, native languages, textiles, oral tradition and the use of the ritual calendars.

With these ideas in mind the first sculpture was placed at an ancient observatory in the Guatemalan Highlands, where many traditional activities take place, thus presenting several opportunities a year to gather and talk about Mayan Astronomy.

The Solar Eye sculpture is a solar calendar, the play of light and shadows trace the motions of the sun over the year, and it marks eight important dates for the Mayan calendars: solstices, equinoxes and the passages of the sun trough the zenith and nadir.

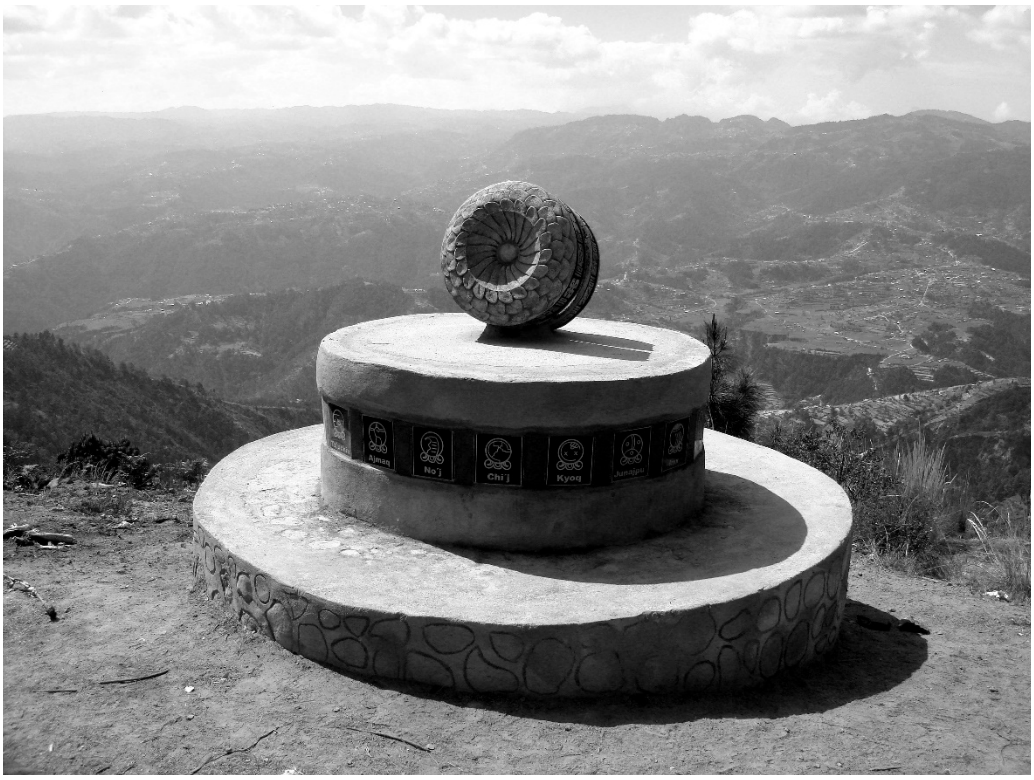

Fig. 2 The Solar calendar during the equinox. The path of the sun lies on a plane bisecting the sculpture producing a beam of light in the shadow.

At the latitudes near 15 degrees north, the passages of the sun trough the zenith and nadir divide the year in periods of roughly 260 and 105 days. And 260 days is precisely the length of the ritual period called Tzolkin in Mayan languages, meaning the "count of suns", and it is related to agricultural cycles like the more obvious 365 days Haab. In Guatemala the zenith passages of the sun occur April 30 and August 13, and the Nadir passages of the sun happen around November 1 and February 10. There are precolumbian celebrations that survive to this day in May first, the day of the cross and November first the day of the dead.

The Solar Eye and NASE

The NASE course is taught with the same content in all the countries where it takes place, except for a local part, "Astronomy in the city", where the idea is to visit a site that has some astronomical and cultural relevance to the country. However, in Guatemala City, despite being settled on the ancient Maya city of Kaminal Juyú, there is no surviving construction related to astronomy. And the subject of Maya astronomy has received little attention in Guatemala over the past years. However there has been a renewed interest in ancient Maya culture in general, partly due to the ending of the 13 Baktun cycle of the Maya calendar and there is a demand from the population to know more about this cultural heritage.

For this reason, the School of Physics and Mathematics (founded in 2015) as part of the San Carlos national university is contributing to bring this knowledge to wider audiences using the culturally relevant subjects of Maya astronomy, calendars and arithmetics as an introduction to science and astronomy aimed to diverse populations.

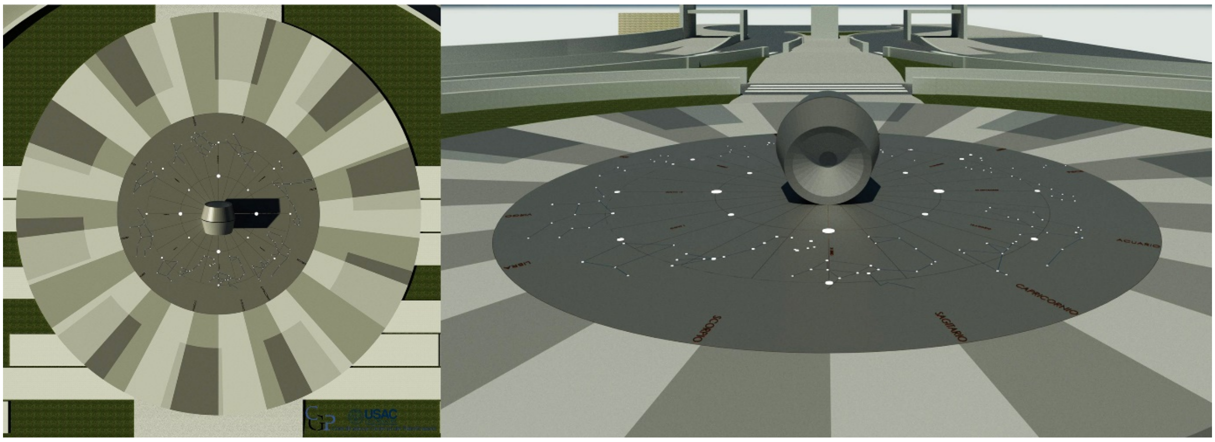

Fig. 3: The Solar Eye project at San Carlos University. This version is designed to mark eight important dates in the motion of the sun in the sky: equinoxes, solstices, and the days of zenith and nadir passage of the sun.

Placing the Solar Eye on the San Carlos national University campus is of particular importance because it represents a new attitude towards ancient knowledge, and connection with the ancient civilizations and a recognition that contemporary Maya culture is alive and evolving.

The solar calendar can be used as an introduction to naked eye astronomy, the motions of the sun trough the year, Maya calendars and their relationship to agriculture and social organization of the indigenous populations.

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Honduras

Copan Ruinas: Maya astronomy in the classic period a vision from the southernmost city of the Maya area

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Abstract

The Mayan history of the archaeological site of Copan covers almost four centuries of settlement (426-822 CE), during this period of time it became one of the most important cities in Maya area and, doubtless, one of the cultural and astronomically most relevant sites. Together with this and its peculiar geographical situation within the Mayan zone, it makes of Copan a confluence place of diverse and long cosmological and observation of the celestial space traditions of the Mayan culture. Through a brief coverage of the main examples that account for this tradition and methodical observation we will focus on the relevance that Copan had within the Mayan world as well as on the importance hat Cultural Astronomy has for a culturally trascendental teaching of Astronomy.

Introduction

The Classic period for the Maya culture -typically between 250 CE and 900 CE- marks the maximum development of major public and ritual monumental architecture, art, writing and calendar systems and of Astronomy that shows a systematic observation of the sky, carried out by an elite in benefit of the highest political and social hierarchy of the Maya.

Mayan astronomical knowledge and its cosmovision are reflected in numerous aspects of culture, architecture, sculpture, decoration of buildings, structures and codex. These are only some of the aspects in which we can observe the degree of specialization and sophistication transforming its environment according to their culture.

Copan Ruinas is the southernmost Maya city located in the Copan river's valley in the western part of Honduras. Its relations with different city-states of the Mayan world are well known, so the bidirectional flow of information, technology, products and knowledge was shared among the different Mayan populations. We have inscriptions that tell us about Copan's relations with Calakmul, Palenque and Tikal, among others. Therefore, it is not surprising that, despite not forming a single political (Marken et al., 2015) or ethnic entity (Beyyette and LeCount, 2017), we can identify a common preponderant cosmovision and shared astronomical knowledge. Copan is one of the most and continuously studied Maya sites, giving us a good framework as a case study for Maya Astronomy. Turning our gaze towards some of the main structures and elements of Copan, we can know and exemplify some of the main concepts of the Mayan worldview and astronomical knowledge.

Underworld and celestial worlds

The contact between the Maya cosmovision and astronomy is clear but perhaps the passage that appears most in the archaeological contexts is the creation of the celestial bodies themselves, particularly the Sun and the Moon. According to the Popol Vuh, the K'iche' Maya people's sacred book: *"Then they arose as the central lights. They arose straight into the sky. One of them arose as the sun, and the other as the moon. Thus the womb of the sky was illuminated over the face of the earth, for they came to dwell in the sky" (Christenson, 2003).* It refers to the history of the twin heroes Hunahpu and Xbalanque who overcame great number of tests and they defeated the gods of the Xibalbá (underworld) after being challenged to play Mesoamerican ball game in the underworld. At the end of these challenges and after defeating these gods, the twins rose to the surface but did not stop there, thus reaching the sky transforming Hunahpu in the Sun and Xbalanque in the Moon.

Fig. 1: Macaw figures in the Copan's main Ballcourt (Courtesy of Eduardo Rodas).

This story allows us to interpret the mesoamerican ball game as a ritual that reflects the creation of the main stars of the day and night sky and their daily movement through the sky. Therefore, the ballcourt is transformed into the universe where everything happens and through the course of the game, it ratifies the order of the cosmos. That is why usually during this period, it was the Ahaw -the ruler- who fought with captured rulers against those who always played with a directed victory that perpetuated and ensured the cosmic order having the ruler as a means to do so and therefore his power. This explanation is reinforced in Copan through the macaws that are in the upper part of the ballcourt and in the structures that served as markers (figure 1).

The Macaw is one of the animals with more symbolic baggage in the Mayan ideology, it is a sacred animal that lives in the upperworld, and therefore, connected with everything that is in the sky including the stars, the sun and the moon. It is not strange, certainly, to find it in a symbolic context in which the celestial space is connected with the underworld, giving an idea of continuity to the different layers of the world in the Mayan vision.

The presence of the Sun represented -in the G God form in codices and called Kinich Ahaw in 16th century yucatec- in the classic period as a man with large square eyes, crossed-eyed, t-shaped upper tooth and frequently three freckles on each side of the face sometimes interpreted as possible indication that the Maya were able to observe sunspots with other examples in the painting from Mayapan archaeological site. The presence of this sun god is well documented in Copan but it is specially impressive in the Rosalila temple, which is fully covered by stucco panels in the form of the Sun God, the divine patron of the maya kings. We have two other examples of the relevance of the sun in Copan that deserve to be commented. The first one is the representation in the so called "courtyard of the jaguars", a sun god figure flanked by two 'Ek glyphs, generally used to name stars or Venus, the star par excellence. It is a very visible representation that dominates the entire archaeological structure from on high. The astronomical interpretation is that it could make reference to a moment of joint visibility between the Sun and Venus but, nevertheless, it is more possible that the 'Ek glyph is used in this context as an emphatic of the lordly power of the Sun God which would also explain its dominating position in the courtyard.

Fig. 2: Skyband bench from Copan (Courtesy of Eduardo Rodas)

The second example of the Sun God representation is its presence in the skyband bench, a profuse artistic work located in the palace of the scribe, in the sector of the

Sepultures in Copan (figure 2). The band represents the firmament, associated with a celestial bird that appears at the beginning and end of the band. After this first image, the following divinities are represented sequentially anthropomorphically: the Moon, the Sun at dawn (as a young man), the Sun at dusk -as an elder- and Venus with its representative glyph and a scorpion tail, also strongly associated with the planet in iconography. Among all these divinities appears the image of the Kinich Ahaw, already commented previously. All this band is formed, therefore, a total of nine reasons that is held by four characters known in Yucatan Maya as Bacabs. These characters inhabited the four cardinal points: Hobnil (South), Cantzicnal (East), Zac-cimi (North) and Hosan-ek (West), inside the earth in water tanks and their task was to hold the firmament.

Time and astronomy

The Bacabs are also related to Pawahtuns, the N God. As “cosmos holder”, it is one of the oldest gods and, therefore, appears represented as a toothless old man with his face wrinkled and his hair wrapped in a net. He was also represented with a turtle shell on his back, and his name in the codices, in addition to number 4 - since it was believed to be one and four at a time - includes a sign representing a shell. Holding the cosmos by its four corners, he maintained its order thanks to the fact that he lived at the same time in the underworld, in the world and in the sky.

As it is well known, Mayan calendrical cycles -as in most Mesoamerican towns- are mainly one of a 260-day ritual nature, the so-called Tzolkin (adaptation of the Quiche ch'ol q'iij voice) and the 365-day civil one, called Haab '. This last calendar has a final period of 5 days called Wayeb, it is an ill-fated period that finishes at the end of the cycle. The Pawahtun presided over the Wayeb, leaving the last four days of the Mayan solar temporal cycle to each of the Bacabs. With that, the cycle ended and another started immediately.

Time conception and its division is inextricably linked to the systematic and continued observation of the sky and its main cultural expressions, the calendars and the different periods of time, such as the long count, are profusely represented in the stelae -directly associated to the course of time- of Copan. The immovable art of Copan is considered as the highest levels reached by the Mayan Culture, and within it we have hundreds of examples of dates and time periods of various kinds. Perhaps the most relevant and unique of Copan-except for Quirigua and Palenque-is the personification of the numbers, called full-body numbers of the D-stela of the main square (figure 3). It is a conceptualization and abstraction typical of the classical period where zoomorphic and anthropomorphic shapes shape the numbers and time periods of the long count. This is totally different from the usual representations in other Mayan cities where the numbers are represented in the form of points and bars or in their variant of head and each period of time by a specific glyph.

Fig. 3: D-Stela from Copan (Maudslay and Goodman (1974))

We can not finish this brief walk through the main examples of astronomy of Copan without talking about horizontal observatories. In Mesoamerica, three types of celestial observatories have been identified: the hemispherical ones, the zeniths and the horizontal ones, present in Copan.

The existence of a zenith observatory in the main square of Copan (Pineda de Carias et al., 2009) tells us of an elaborate urban concept that made the public space both an element of observation and a celebration of the Mayan worldview. This same intentionality, can be seen in other structures of Copan, such as temple 22, where the celestial arch supported by Bacabs (Ahlfeldt, 2004) is represented again and the western plaza, with its different levels that separate the underworld from the world that we inhabit. Currently in Copan is still working on this type of observatories through the 3D Model of Northern sector of the Copan Ruins Main Plaza and whose conclusions expand the published on this square (Mejuto J., in press).

Cultural astronomy in the astronomy school education

Cultural Astronomy and the understanding of astronomical knowledge and its use within a cultural context such as the Maya that is presented here is of great value for a culturally relevant education in Astronomy. The teaching of this type of knowledge in ancient and contemporary cultures different from ours not only complements the teaching of classical astronomical concepts but also exemplifies and expands them with a series of values that escape the classical education of Astronomy and the Natural Sciences.

Development of cultural identity, equity and inclusion from an economic, ethnic and gender perspective Cultural Astronomy allows us to represent groups that have traditionally and historically been relegated. In this way we can work on cultural identity by choosing a culture that roots with the group which we are going to work with and we can make reference to other peoples of any cultural region of the world that allows us to understand the human being as a whole, making the observation of the celestial space the framework that represents us as humans, without distinctions of gender, ethnicity or social stratum. The cultural concretion of astronomical concepts humanizes Astronomy and its study identifies us as humans.

The importance of teachers go beyond teaching about the astronomical knowledge that cultures such as the Maya developed, they should motivate their students to become aware of the relevance of the preservation of archaeological sites and their scientific study to strengthen the national identity.

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Mexico

Astronomy in the city: from history to heritage, Guadalajara's, México case

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Abstract

The case study is presented in Guadalajara, Jalisco, Mexico of the astronomical observatories in different centers and educational institutions that were established in the transfer from the XIX to the XX Century, with a manifest scientific legacy through key characters -of civil or religious order- who contributed to the consolidation of the history of science in Jalisco.

The astronomical practices that lead us to the institutionalization of the discipline and to conformation of scientific communities was born at the city downtown, from where astronomical knowledge spread to curricular and extracurricular way, through publications in bulletins, newspapers and weeklies; in addition to the literary evenings that served as scenarios for popularization of research findings; here such story is recovered in order to perform awareness of astronomical heritage to the students.

As part of Guadalajara's modernization in the second half of the Twentieth century several buildings devoted to the Astronomy was lost, this contributed to the deterioration of the collective memory relative to the knowledge of the nature of the stars and the Universe; a consequence was the loss of astronomical observatories as cultural spaces, today only one survives by fulfilling its task with society by continuing its divulgation talks.

It is through the rescue of knowledge of practices associated with astronomical activity along history, its characters, instruments and publications, when we teach Astronomy that it has been possible to arrive to the Cultural Heritage concept and rethink its importance from our time.

Introduction

When we listen about professional astronomical practices immediately we thought on far and isolated observatories, and will be difficult to think that in the second largest city from México, modern professional Astronomy practically was born at downtown; in this work we recover such history and linked it with Cultural Heritage concept in an approach that will be useful in the sense that Fraknoi (1996) calls “interdisciplinary”, but making awareness of the values both material and immaterial of the astronomical knowledge that remain and those lost in the city.

The Cultural Heritage as an area of study has allowed to build a favorable field to debate about social values and socio-cultural processes, the premises about the meanings of actions and collective memory. One challenge is to explain how cultural practices construct "significant values" for a group of people in a given space, which then integrate a shared knowledge as a collective memory that identifies them as a community; and what's more, how can a similar process happen in the configuration of the academic communities? The objective was to establish the characteristics of the academic community on shared values in the production of astronomical, curricular or extracurricular knowledge.

We thought that to address this issue we should establish intangible heritage from "knowledge". That is why the rescue of documents and academic texts are of special interest, not as material supports, but as a testimony and product of scientific practices. The aim is to revalue the knowledge derived from the astronomical work gestated in Guadalajara, México, from the last quarter of 19th Century and the beginning of the 20th Century as part of the cultural relations in the academic scientific communities in this context: their characters, their scientific production, the instruments, and above all of its facilities, as a resource to go meet our own memory.

Analytical framework for the Astronomical Heritage

The Astronomical Heritage is a concept built from the World Heritage Convention (1972) that highlights the material aspects, however, it is from the Convention of Intangible Cultural Heritage (2003), that the definition manages to provide values of meaning for its study and comprehensive analysis.

a) Intangible Cultural Heritage (ICH)

As defined in Article 2, such as uses, representations, expressions, knowledge and techniques -together with the instruments, objects, artifacts and cultural spaces that are inherent to them- that communities, groups and in some cases individuals recognize as an integral part of their cultural heritage. This intangible cultural heritage, which is transmitted from generation to generation, is constantly recreated by communities and groups according to their environment, their interaction with nature and their history, instilling a sense of identity and continuity and thus contributing to promote respect of cultural diversity and human creativity. For the purposes of this Convention, only intangible cultural heritage that is compatible with existing international human rights instruments and the imperatives of mutual respect among communities, groups and individuals and sustainable development will be taken into account. (Intangible Cultural Heritage Convention, UNESCO 2003).

> *... the uses ... knowledge and techniques -together with the instruments, objects, artifacts and cultural spaces that are inherent to them-” being thus, the*

*academic community the bearers of this knowledge. In the indicators of the field, the one listed in subsection **d** focuses on "knowledge and uses related to the conception of the Universe" as elements that constitute the analytical framework of the astronomical heritage proposal. For conceptualization, the international community in construction has been important as a new axis of work for UNESCO itself.*

b) Conceptualization of the Astronomical Heritage

The International Astronomical Union (IAU), a worldwide institution that represents the academic community dedicated to research and dissemination of scientific knowledge in this discipline, proposed this category of Heritage since 2003 before UNESCO; however, it was not until 2010 that the 34th meeting of the World Committee was held in Brazil, where the thematic study was approved as part of the heritage of humanity, as well as the activities of International Year of Astronomy in 2009.

The concern to preserve "sites" related to astronomical observation established the precedent as an integration to the World Heritage List; Astronomy as a cultural and natural heritage. "The initiative aims to achieve recognition ... through the nomination of the world heritage of those places, landscapes or architectural structures related to the observation of the sky or any other type of connection with Astronomy" (UNESCO, 2009a). Although the astronomical heritage initiative was launched to be considered part of the World Heritage, studies have shown that the complexity of the topic is such that it has developed categories that consider integral perspectives of heritage, but without detaching from the material vision:

> *Such material testimonies of astronomy, which are found in all geographical regions, cover all periods from prehistory to the present day. This close and continuous interaction between astronomical knowledge and its role within human culture is a fundamental element of the value of these properties (UNESCO, 2009b).*

We propose for its conceptualization, to recognize the uses, practices and knowledge as an intangible foundation and not as mere indicators. Thus, the categories in the cultural context: The material, as the set of buildings, (the monuments and sites); furniture, (instruments, artifacts and documents); the natural, such as environments (such as landscapes and observation skies); and the immaterial, which refers to ideas and the impact of knowledge on humanity.

> *The scientific corpus that represents this basic heritage of astronomy comprises the material sources of the history of astronomy: Obviously, most of the evidence for the development of the ideas of astronomy exists in the form of mobile documentation contained in archives, collections and bibliographies. This documentation provides support material for recording the results of observation, prediction, calculation, theory, the use of astronomy. These*

> *documents are the product of scientific activities in their cultural context. The basis of scientific knowledge is essentially immaterial. It is an intellectual framework of the human spirit using specialized languages (as mathematics) and images (drawings, maps, photographs, physical information, like spectra, and so on) (UNESCO, 2009b).*

In the documentation on Astronomy and Archaeoastronomy we emphasize mainly, "the social uses of astronomy, whether or not rational in modern scientific terms (calendars, navigation, agricultural practices related to the Moon, Astrology)" (UNESCO, 2009b). The astronomical practice from material supports constructs in the use from its own explanation, in the representation and in the meanings the cultural frame with which impacts the knowledge that fits our proposal as part of the ICH; since it is through *knowledge* that the value and meaning of the material testimonies are understood and not the object itself.

Fig. 1: The Seven Liberal Arts from Reisch's *Margaritha Philosophica.* (Mathematical Association of America, http//:www.maa.org)

Astronomy in institutional spaces

Although the practice of astronomy is located in institutional spaces in terms of teaching in the first medieval universities, as Cohen mentions: "Since astronomy was one of the first sciences, it is logical to assume that it was also one of the first subjects included in the educational curriculum" (Cohen, 1993). Thus, the oldest reference that we have found about it in the case of Guadalajara are the instructions that revolve in a small office dated July 13, 1804, the bishop of the diocese of Guadalajara, Juan Cruz Ruiz de Cabañas y Crespo, in order to that the course of Arts be opened at the *Seminario Conciliar Tridentino del señor San José* (Cruz, 1804); We can now mention that, according to the medieval university tradition, the so-called seven liberal arts included in the *Trivium* (Logic, Grammar and Dialectics) and the *Quadrivium* (figure 1) (Arithmetic, Geometry, Music and Astronomy) were the preparation for the so-called faculties and chairs majors, which are those of philosophy and theology; says Guy Beaujouan: "Inside the universities, the Faculty of Arts, receptive as it was to new ideas, was at loggerheads with the Faculty of Theology, the guardian of orthodoxy" (Beaujouan, 1963: 488), then in Guadalajara nineteenth-century this may well be the beginning in an institutional space of the cultivation of astronomy, although for some copies that are preserved in the Reserve Funds of the Biblioteca Pública del Estado de Jalisco "Juan José Arreola", we know that advanced astronomical knowledge arrived the novogalaic metropolis in the seventeenth century as already discussed in our work (de Alba, 2010) presented at the *I Congreso Iberoamericano sobre Patrimonio Cultural* (San José, Costa Rica) and in (Galindo, 2012).

Fig. 2: Postcard of the *Seminario del señor San José* devoted in 1903. (Part coll.)

Various reports of the rectors and persons in charge of the *Seminario Conciliar Tridentino del señor San José*, (figure 2) established on a site adjacent to the Cathedral[3], the southeast corner of the block "that today occupies the Rotonda de los Hombres Ilustres" (Peregrina, 1993), they give us an account of the exams given in the chair of Astronomy, Physics and Mathematics, in addition to the *expositio* where the

[3] The inauguration, without having finished the building, was on December 19, 1699, the ceremony was headed by Bishop Felipe Galindo Chávez, as well as the president of the *Audiencia*, Alonso Ceballos Villagutiérrez and the ecclesiastical and municipal councils.

subjects on which the seminarians were examined are specified, for which we can infer that to be priests it was necessary to know the astronomy of the time. Two sundials are silent witnesses, remnants of astronomical knowledge cultivated and exercised within those walls covered with quarry. Of that building, that today occupies the *Museo Regional de Guadalajara* that is part of the *Instituto Nacional de Antropología e Historia* (INAH), they had to move in 1902 to the one that began its construction in 1890 in the lot that occupied the Convento de Santa Mónica, and where it worked until September 1914, the year in which the Constitutionalist troops occupied Guadalajara.

Another important moment was until 1882, when Venus transit on the solar disk reported observations made in the capital of Jalisco, which came to be called the Observatorio Astronómico de Guadalajara, which was on the roof of the private home of engineer Gabriel Castaños, who was the sponsor of the Escuela Libre de Ingenieros and of the Sociedad de Ingenieros de Jalisco. From this same observatory the length of Guadalajara would be determined (figure 3)

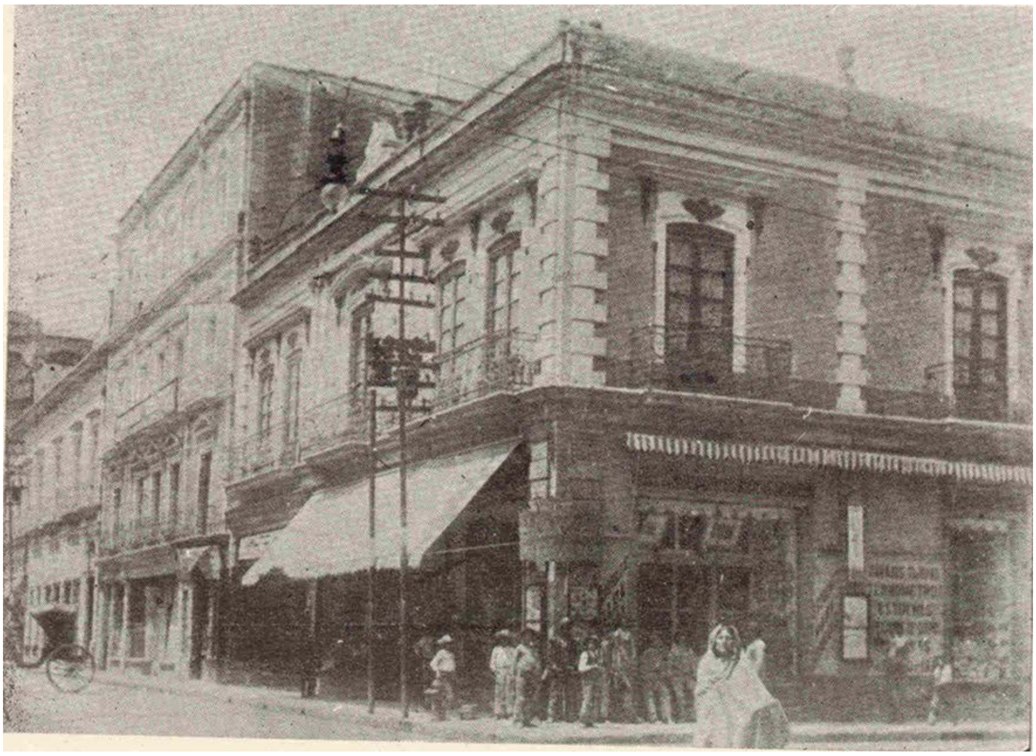
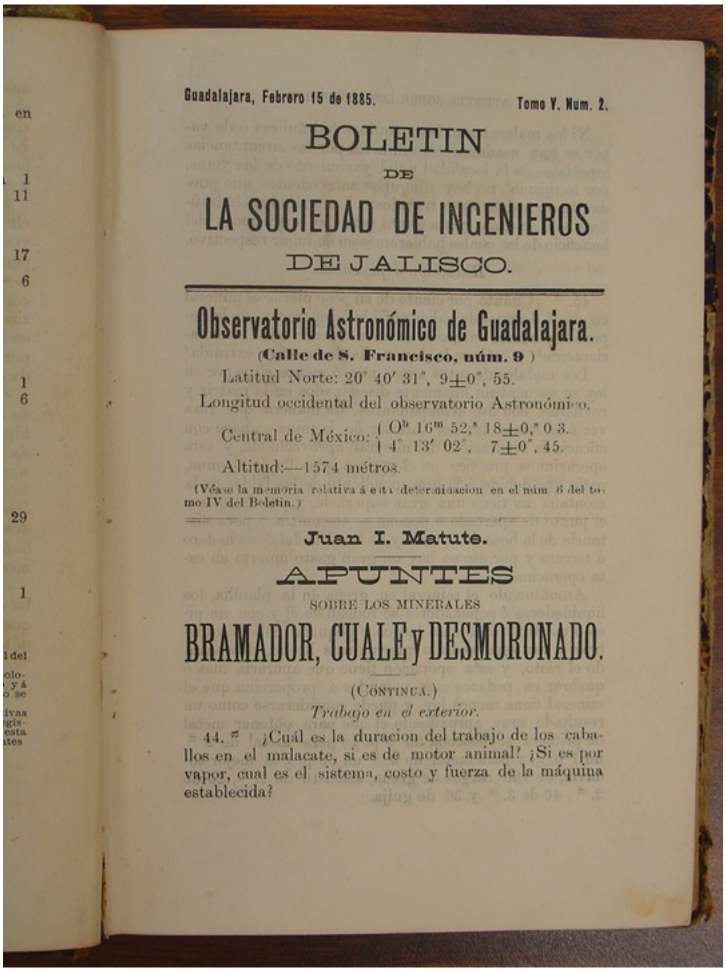


Fig. 3: Gabriel Castaños' house where upstairs was located *Observatorio Astronómico de Guadalajara.* (José Cornejo Franco, *La calle de san Francisco*, Edición Banco Industrial de Jalisco, Guadalajara (1945))

The Governor of the State of Jalisco, Francisco Tolentino, gave an account in the Report presented to the Eleventh Legislature of the State of Jalisco: In the School of Engineers the construction and equipping of an Observatory was begun, and although this company has not been able to take it to auction, very advanced remains, and easy task is already its termination (Tolentino, 1887: 37).

In the annex of the Report presented by Tolentino we read: As it is well known, the building that is being built and that has to serve for the astronomical and meteorological observatories, was designed by the Engineer Gabriel Castaños, having himself been in charge from the beginning of the direction of the work by the Board of the School (Tolentino, 1887: 142) (figure 4)


Guadalajara, Febrero 15 de 1885. Tomo V. Num. 2.

BOLETIN

DE

LA SOCIEDAD DE INGENIEROS

DE JALISCO.

Observatorio Astronómico de Guadalajara.

(Calle de S. Francisco, núm. 9)

Latitud Norte: 20° 40′ 31″, 9±0″, 55.

Longitud occidental del observatorio Astronómico.

Central de México: { 0h 16m 52,s 18±0,s 0 3. / 4° 13′ 02″, 7±0″, 45.

Altitud:—1574 métros.

(Véase la memoria relativa á esta determinacion en el núm 6 del tomo IV del Boletin.)

Juan I. Matute.

APUNTES

SOBRE LOS MINERALES

BRAMADOR, CUALE y DESMORONADO.

(Continua.)

Trabajo en el exterior.

44. ¿Cuál es la duracion del trabajo de los caballos en el malacate, si es de motor animal? ¡Si es por vapor, cual es el sistema, costo y fuerza de la máquina establecida?

Fig. 4: *Boletín de la Sociedad de Ingenieros de Jalisco* (Biblioteca del Instituto de Astronomía y Meteorología de la UdeG)

As part of the Escuela de Ingenieros that worked in the city of Guadalajara, on April 2, 1889, the Observatorio Astronómico y Meteorológico del Estado was to be inaugurated, according to Governor Mariano Bárcena, also an illustrious scientist: On the 2nd of April, the Observatorio Astronómico y Meteorológico del Estado was inaugurated, which has continued to function regularly, contributing with its data, not only to the advancement of the students, but also to the applications that Hygiene and Agriculture demand of those physical studies. (Bárcena, 1890) (figure 5)

We have documentary evidence that at least by 1894 the observatory had already been moved from its original location on the Street Cerrada de la Compañia in the center of Guadalajara to a farm in the West End neighborhood (now Arcos Vallarta, next to the arches built in the 1940s); In 1925, with the inauguration of the Universidad de Guadalajara, it became part of its first dependency, essentially devoted to scientific research. By 1947, it changed its name to the Instituto de Astronomía y Meteorología.

Fig. 5: Facilities of Observatorio Astronómico y Meteorológico del Estado towards the end of the 19th Century (Reserved Funds, library of Instituto de Astronomía y Meteorología -UdeG)

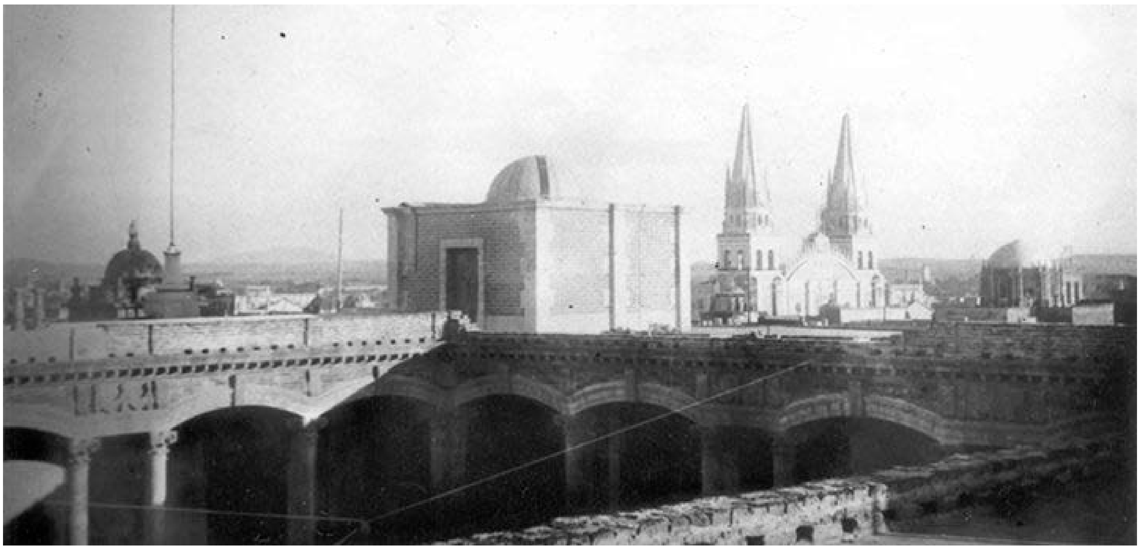


Fig.1: *Observatorio Astronómico at Seminario del señor San José* de Guadalajara (Reserved Funds, library of Instituto de Astronomía y Meteorología -UdeG)

It would have to be until the dawn of the 20th Century when in the new building of the Seminary (for a time abandoned headquarters of the 5th Military Region in 2011) a specific space was established for the practical teaching of astronomy, thus, on March 7, 1904, in Guadalajara the specially dedicated place "to observe the sky and encourage astronomical improvements" was blessed (Faith of the Blessing, 1904), at the Seminary of Sr. José, the blessings[4] were in charge of the archbishop of Guadalajara Lic. José de Jesús Ortiz (figure 6).

Actors and scientific production

“Wise and benefactor”, with these succinct words, which fail to describe his prolific activity throughout his long life, is remembered in the bronze that represents it in the Rotonda de los Hombres Ilustres to José Silvestre Juan Nepomuceno Agustín de la Rosa y Serrano, born in the city of Guadalajara on December 30, 1824, and who began his “apostolate of teaching” in October 1847 (figure 7). According to the renowned bibliographer Juan Bautista Iguíniz: “Almost a child entered the Conciliar Seminary, where after a continuous series of literary triumphs he finished his ecclesiastical wagon” (figure 7) (“Canonical Doctor ...” , 1949: 404), an institution from which he would also become rector. From his prolific pen went, among others, the books *Lecciones de Astronomía* (1853, 1859), *Adiciones a las Lecciones de Astronomía* (1882), *Elementos de Trigonometria plana y esferica con aplicaciones a la astronomía* (1868) in addition to the series of articles in which he discussed with different correspondents the question of Galileo.

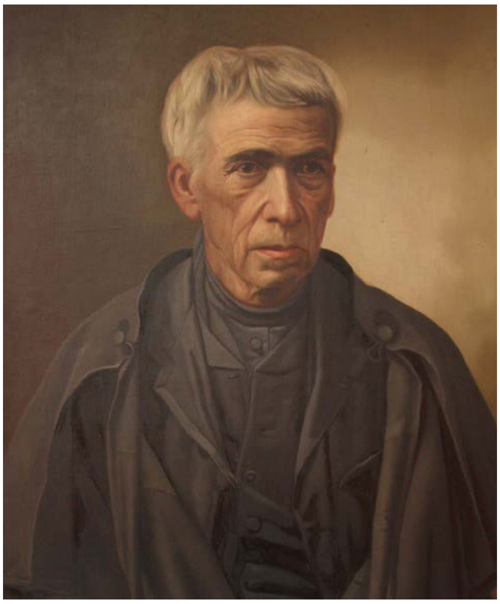
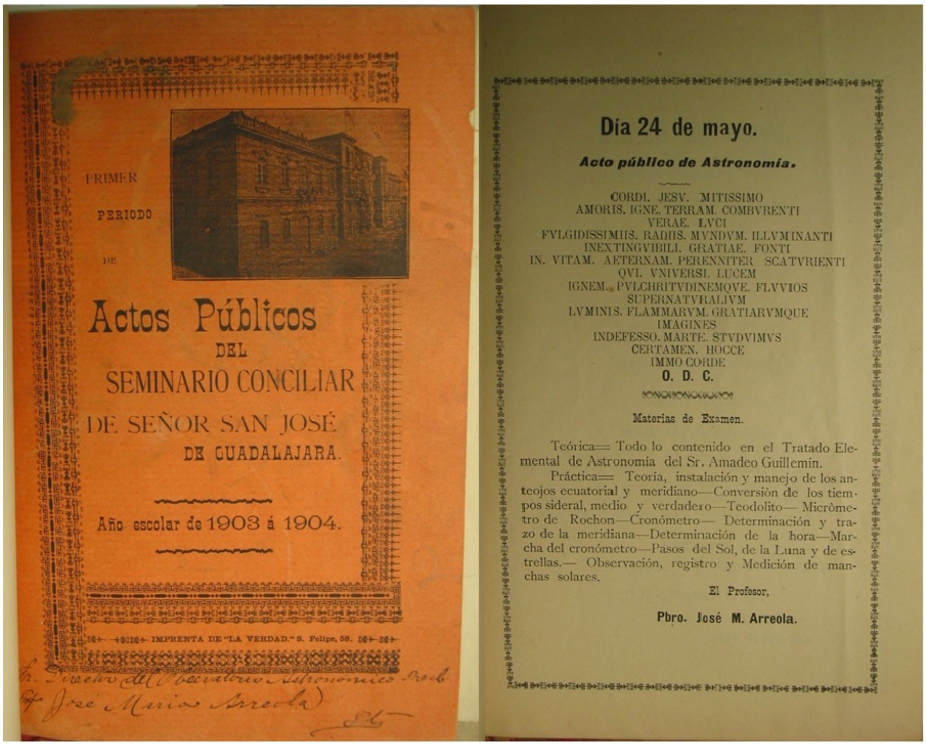


Fig. 7: Agustín de la Rosa y Serrano canvas (Biblioteca Pública del Estado de Jalisco “Juan José Arreola”)

[4] We thank Dr. J. Jesús Gómez Fregoso S.J. the paleography and translation of the Latin of the original document.


PRIMER PERIODO DE

Actos Públicos DEL SEMINARIO CONCILIAR DE SEÑOR SAN JOSÉ DE GUADALAJARA.

Año escolar de 1903 á 1904.

IMPRENTA DE "LA VERDAD." S. Felipe, 38.

Día 24 de mayo.

Acto público de Astronomía.

CORDI. JESV. MITISSIMO
AMORIS. IGNE. TERRAM. COMBVRENTI
VERAE. LVCI
FVLGIDISSIMIIS. RADIIS. MVNDVM. ILLVMINANTI
INEXTINGVIBILI. GRATIAE. FONTI
IN. VITAM. AETERNAM. PERENNITER SCATVRIENTI
QVI. VNIVERSI. LUCEM
IGNEM. PVLCHRITVDINEMQVE. FLVVIOS
SUPERNATVRALIVM
LVMINIS. FLAMMARVM. GRATIARVMQUE
IMAGINES
INDEFESSO. MARTE. STVDVIMVS
CERTAMEN. HOCCE
IMMO CORDE
O. D. C.

Materias de Examen.

Teórica— Todo lo contenido en el Tratado Elemental de Astronomía del Sr. Amadeo Guillemín.

Práctica— Teoría, instalación y manejo de los anteojos ecuatorial y meridiano—Conversiòn de los tiempos sideral, medio y verdadero—Teodolito— Micròmetro de Rochon—Cronómetro— Determinación y trazo de la meridiana—Determinación de la hora—Marcha del cronómetro—Pasos del Sol, de la Luna y de estrellas.— Observación, registro y Medición de manchas solares.

El Profesor,

Pbro. José M. Arreola.

Fig. 8: Booklet of the *Acto público del Seminario del Señor San José* (Coll. "José María Arreola", Special Funds, Biblioteca "Manuel Rodríguez Lapuente", CUCSH-UdeG).

Also in the nineteenth century we have to discuss the participation of two characters so far not well publicized in terms of their contributions to the development of education and science in the state of Jalisco, we refer to the engineers Gabriel Castaños (1839-1905) and Carlos Fernando de Landero y Castaños (1858-1930), uncle and nephew respectively, who in addition to observing the transit of Venus corresponding to 1882 (December 6), published their results in the edition of December 15 of the same year in the Bulletin of the Society of Engineers of Jalisco ("Observation of the passage of Venus through the disk of the Sun, December 6, 1882", Volume II, No. 12, pp. 387-407), together with a reproduction of the text by Francisco Díaz Covarrubias entitled "The transit of Venus through the disc of the Sun, popular exhibition of the object and utility of the observations of this phenomenon" dated April 11, 1874 (Bol. Soc. Ings. Jal., pp. 369 -386).

In addition to Landero comes to determine the geographical position of what was known as the Observatorio Astronómico de Guadalajara (the house of Castaños, located on the then street of S. Francisco No. 9 –actual, September 16), having as witness the director of the Central Astronomical Observatory (sic) Leandro Fernández (Fernández, 1884: 162-165).

The *jalisciense* scientist by antonomasia was also a priest of the Catholic Church: Severo Díaz Galindo, that in addition to the own works of his clerical condition was professor of scientific disciplines (Astronomy, Chemistry, Mathematics) in different educational institutions of Jalisco, as the Escuela Preparatoria de Jalisco, Normal de

Señoritas and Libre de Ingenieros, besides being director of the Observatorio Astronómico y Meteorológico del Estado. To him must the books *Elementos de Astronomía y Meteorología* (1928, 1947), *Tratado de algebra y complementos de aritmética* (1911), as well as the articles *Manchas solares y su influencia en el Vulcanismo* (1904), *La habitabilidad de los astros* (1909), (figure 9) *La vida científica de Galileo* (1909), *El centro del universo* (1910), Marte y las comunicaciones interplanetarias (1920) among others.


OBSERVATORIO METEOROLÓGICO Y ASTRONÓMICO DEL SEMINARIO.

OBSERVACIONES Y ESTUDIOS

POR EL

Pbro. SEVERO DIAZ.

OBSERVACIONES:

RESUMEN POR CADA MES DEL AÑO DE 1908.

ESTUDIO:

LA HABITABILIDAD DE LOS ASTROS.

GUADALAJARA.

Imprenta, Litografía y Enc. de J. M. Yguiniz.—Donato Guerra No. 235.

1910.

Fig. 9: *Boletín del Observatorio Meteorológico del Seminario* with the study titled "*La habitabilidad de los astros"* (Archivo Histórico de la Arquidiócesis de Guadalajara (1909))

Conclusions

The Astronomy as Heritage initiative helped us to question, what is the astronomical heritage that Jalisco has in general and Guadalajara, in particular, In Guadalajara astronomical observatories as cultural spaces, were lost either by processes of a political nature such as the armed movement of the revolution that had its impact on the occupation of the then *Seminario Conciliar Tridentino del señor San José*. A premise that we highlight in the disappearance of the astronomical observatories where the scientific community came together, is precisely, of lack of social value as spaces of memory; partly due to the constant movement of venues that over time were lost sight of as places of "importance". The singular case where the establishment was incorporated as part of the academic institution, was the *Observatorio Astronómico y Meteorológico del Estado*, after 1925, which was incorporated to the University of Guadalajara, and until today is the only one that remains with its original use in the site according to evidence of observations recorded at least since 1894.

The characters and scientific communities of the *Tapatías* instituted academic practices present in the uses and customs for the dissemination of knowledge with publications in bulletins, newspapers and weeklies. To this end, literary evenings and conferences were organized, which served as scenarios for research findings aimed at all audiences as a heritage legacy and for memory. This practice was diluted with the continuous abandonment of the establishments, the headquarters were changed, leaving the buildings as a shell without any vocation. A similar fate ran the instruments, which were also private belongings.

The scientific production, was established as an academic practice of astronomical work; and it was through knowledge that he was able to link with his peers in other states and even outside the country, mediated by his publications. These academic networks managed to consolidate a scientific movement that is now possible to trace and link again with that collective memory.

The astronomical knowledge product of the scientific and cultural practice, in Guadalajara, witnessed its best moments in the center of the city, in the transition from the XIX to the XX century; with scientific productions, above the City of Mexico itself as the capital of the country; knowledge that today is a fundamental part of the inheritance, as a testimony that astronomical knowledge in itself is the foundation of our Cultural Heritage and today few are the bearers of this knowledge.

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Mexico

Mesoamerican Astronomy: a still recognizable ancient tradition

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Abstract

From ancestral times the observation of the sky played a fundamental role in the cultural evolution of Mesoamerica. Thanks to this practice, one of the most important civilizing elements that characterized the prehispanic culture was generated: its calendar. The record of time had not only a practical use to organize all activity in society, but also reached an exceptional ideological-religious meaning that was manifested in various cultural expressions, today still recognizable. Time and its organization in a calendric system would have been the work of the gods. In particular, the presence of representations of the celestial sphere in material vestiges such as mural painting, ceramics, sculpture and pictographic documents, known as codices, is remarkable. Inspiration in the celestial vault for artistic representation was accompanied by the skill developed by pre-Hispanic observers for the recording of various astronomical phenomena, such as eclipses, comets, and even unusual events, such as transits of Venus and supernova explosions. In addition, for the determination of synodic periods of some planets.

Systematic observation of the sky allowed Mesoamericans not only to develop calendar systems, but also to align their main architectural structures. The practice of recording time was conceived as the stuff of the gods, for the gods had invented the calendar and then bestowed it to the common man so he could organize all societal undertakings. Thus, the pre-Hispanic priest-astronomers conceived of a way to align their iconic structures with the sunrise and sunset on equinoxes and solstices, which astronomically speaking are of little import. These dates, however, serve to divide the solar year into periods that are expressible in counts of 52, 260, 73 and 65 days, numbers that define the Mesoamerican calendric system. Moreover, these number counts start on the summer and winter solstice. A building aligned with sunset or sunrise on the solstices is imbued with ritual symbolism with deep calendric meaning, because it is thereby in harmony with the sacred principles of the calendric system. A ruler ordering the alignment of a temple was able to demonstrate to his subjects that his works and his rule enjoyed the favour of the gods. These aligned structures enhanced the ruler's prestige and legitimacy before the people, justifying his position at the summit of the social pyramid. Across the great expanse of Mesoamerica and over the course of three millennia, we find countless examples of the practice of architectural alignment performed on the basis of calendric and astronomical patterns. This paper shall examine several of these cases, which constitute an outstanding

cultural feature of Mesoamerica. Having inherited the practice from Olmec predecessors, who established the foundations of Mesoamerican calendric systems, the Maya region is especially rich in this regard, boasting numerous aligned temples as far back as the Preclassic Period. To this day, the echoes of this ancient cultural practice are still perceptible in the layout of several modern Mexican cities built on the ruins of a pre-Hispanic urban substratum. Several of these modern cites have central districts laid out in line with Mesoamerican calendric principles, which act as cosmic watches that are still ticking though their builders have long since departed; their descendants, however, can still recognize and admire the genius of the skywatchers of the past.

This paper provides a brief exposition of the operating principles of astronomical practice in Mesoamerica.

Introduction

The age-old predisposition for star gazing has over the course of history been a powerful stimulant for the intellect. In this way, humanity has been graced with food for the senses and challenges for the mind as mankind strives to make sense of what he sees in the faraway reaches of space. The sky has always been a strong force for generating knowledge and inspiring ideas that touch the spirit, because it is the realm that best reveals the interdependent nature of time and space. Observation of the sky requires the development of rational systems for recording time. The knowledge obtained in this way served the ruling elite as an instrument of social control, because subjects were convinced their rulers enjoyed open lines of communications with gods inhabiting the sky. This situation is clearly evident in Mesoamerican cultures. Throughout this discussion, we will examine several tangible architectural manifestations of this religious feeling and how priest-astronomers exploited their astronomical knowledge to prop up their social and political prestige.

Fig. 1: The Pyramid of the Sun in Teotihuacán is a remarkable example of calendric-astronomical

alignment. The western alignment dates of 29 April and 13 August divide the solar year into a ratio of 104/260. The summer solstice is used as a natural pivot from which to follow the Sun over the course of the year. The pyramid also aligns with the Sun in the east on 12 February and 29 October, yielding the same proportion in the division of the year. In this case, the winter solstice serves as the natural pivot for following the Sun.

As far back as 1500 BC, the practice of observing the sky led to the creation of a unique calendric system that would prevail in general use until the arrival of the Spaniards, an astonishing period of three thousand years. Early Olmec art and the orientation of Olmec ruins provides evidence of this system (Pohl et al., 2002; Galindo Trejo, 2011). The Mesoamerican calendric system existed throughout the entire pre-Hispanic period and survived well after first contact with the Spaniards. In fact, there are several sites in Guatemala where this system is still used in rituals (Craveri, 2013).

Fig. 2: At the time of the arrival of the Spanish, the Templo Mayor of Tenochtitlan in Mexico City symbolised the power of the Mexica. The sanctuary served to revere the gods Tlaloc and Huitzilopochtli. On 9 April and 2 September, the setting Sun aligns with this temple. Both of these dates divide the solar year into multiples of 73 days, a number that is common to the Mesoamerican calendars of 365 and 260 days. On 4 March and 9 October, the rising Sun aligns with this important Mexica temple. In both cases, the historic centre of the modern city also aligns with the Sun.

Even though the basic structure of the Mesoamerican calendar was fixed for several millennia, there were important regional variants with regard to the names of days and periods observed. The Mesoamerican calendar possessed two counts: the solar count known as Xiuhpohualli in Nahuatl or Haab in Mayan, consisting of 365 days divided into 18 periods (‘months’) of 20 days plus five additional days; and the ritual count known as Tonalpohualli or Tzolkin, respectively, consisting of 260 days counted in 20 periods of 13 days ('trecenas') each. These counts started on the same date, but after the first 260 days, of course, each marched on independently for a period of fifty-two solar years (365 days) when they would again coincide and begin the march anew.

Over the course of 52 years, the ritual count cycled 73 times, satisfying the basic equation: 52x365 = 73x260. The dates marking the close and start of these 52-year cycles were solemnised in the New Fire ceremonies. In Oaxaca, the Zapotec calendar variant divides the ritual count, known as Piye, into four 65 day periods, each of which was called a Cocijo, in itself a deity and originator of all things on Earth (Córdoba, 1886: 115). This is undoubtedly a deification of time. Often the key numbers underpinning this system were deemed particularly transcendent and therefore used to define architectural elements, such as the number of stairs, panels, merlons and tiers in a pyramid. The numbers of offerings made in religious ceremonies also seems to reflect such belief. During the Classic Period (approximately 100 to 800 AD), the Maya developed a very accurate variant of the basic calendric system (Rice, 2007). Very like the Western calendar that starts with the birth of Christ, the Maya established their starting date as the long ago, mythical moment of 13 August 3114 BC. As such, all social events, wars or natural phenomena were dated on the basis of the number of days that had passed from this ancestral date. Under this scheme, the Maya used a vigesimal base system to express dates, written using a system of positional notation. With respect to the first five powers of twenty (from 0 to 4), the Maya calendar substitutes 360 for 400 in the third position, which is closer to the 365 day year. The five coefficients multiplied by each unit of time serve to determine the exact number of days that have elapsed since the start of the calendar, and in this way specific dates are obtained. In several inscriptions, the Maya raised 20 to even higher powers, thereby expressing dates far into the future. In addition to this 'Long Count' system of expressing dates, the Maya also expressed the date in terms of the Haab and Tzolkin. They also added information regarding the Moon's age and lunation counts. In some cities, the Maya included a coefficient of a factor associated with the 819 day count, whose functional or ritual significance is still the subject of debate (Thompson, 1943). Among the Maya before the conquest, the calendar belonged to the realm of the gods and was worthy of the highest religious reverence: the gods were the makers of the calendar and saw fit to make a gift of it to mankind. The matter of alignment of Mesoamerican architectural structures requires careful analysis in order to grasp the motivating impetus of these pre-Hispanic builders. No doubt they could have used the local landscape, prominent mountains or a bend in a river. For placement and alignment of their structures, they may even have used a mountain associated with origin myths or a topographical feature believed to be the abode of a god. Another guideline could be the position of the rise and set of a heavenly body. One must also pay heed to the fact that the apparent movement of the night sky provided the only basis upon which define directions with a universal significance within the landscape. For example, when the stars are hidden on a cloudy night, one direction is as good as another. On a clear night, however, the alert observer will soon notice that some stars seem to revolve around a fixed imaginary point. In this way, one established a cardinal direction in the sky, that is, the celestial north. At 90^0 from the celestial north one arrives at astronomical east and west, and at 180^0 one comes upon astronomical south, which at Mesoamerican latitudes lies below the horizon. Moreover, the arcs travelled by the stars are shorter in this direction. Within this splendid celestial framework, moving with sublime order, the observer comes to understand that the regular movement of bright stars can be used to align architectural structures. In this way, buildings devoted to a given deity would be aligned with that deity's heavenly manifestation.

Mesoamerican Architectural Alignment

An aspect that shows the importance of the firmament in pre-Hispanic culture is the practice of orienting architectural structures such as pyramids and palaces. Mesoamerica being a region located mostly in the intertropical region, the Sun played a fundamental role in this practice. Certainly, great temples have been identified oriented to the sunrise and sunset at astronomically important moments, such as solstices, equinoxes and in the days of the solar zenith passage. A striking example is the Great Pyramid of Cholula in Puebla, for its volume the largest pyramid in the world. At the time of the sunset of the summer solstice and the sunrise of the winter solstice the Sun is aligned with this pyramid.

Fig. 3: The Jewelled Building or Embassy of Teotihuacán in Monte Albán, Oaxaca, faces the mountain range that surrounds the state capital. The Zapotec divided the 260-day ritual year into four 65-day segments. On 25 February and 17 October, the rising Sun aligns with this building. These dates stand 65 days before and after the winter solstice, respectively.

The earliest architectural structures dating to the Preclassic period exhibit a careful planning within the surrounding landscape and in astronomical orientation. The Circular Pyramid of Cuicuilco in the southern region of the Valley of Mexico is a fine example of this. Built around 600 BC, this structure consists of four circular tiers and two collinear access ways built on an east-west axis. Towards the east, the pyramid's axial line points to Cerro Papayo, a lone summit exhibiting a nearly hemispherical shape. Twice a year, on 23 March and 20 September, the Sun rises from behind this summit. Since these dates are only two days removed from the respective equinoxes, the alignment suggests an attempt to divide the year into two halves. In fact, a count of the days between the solstices divided by two results in the two dates coinciding with the alignment of the Circular Pyramid of Cuicuilco with the sunrise over Cerro Papayo. These dates may be thought of as 'temporal equinoxes', rather than 'spatial or astronomical equinoxes' occurring when the Sun rises at the midpoint between the two solstitial extremes.Towards the dawn of the Christian era, the nearby Xitle volcano erupted and buried the city of Cuicuilco. Some researchers conjecture that this disaster drove the inhabitants into the northern region of the Valley of Mexico, where they founded Teotihuacán, the City of the Gods, one of the largest settlements in Mesoamerica in terms of area and population. Teotihuacán features two main axes: the so-called 'Avenue of the Dead', running north to south and a perpendicular avenue corresponding to the axial orientation of the Pyramid of the Sun, the city's largest structure. All other structures in the city are either parallel or perpendicular to these axes, which lends the city a very ordered aspect. The urban grid, however, is rotated and does not align with cardinal points. The clockwise deviation of the axial line of the Pyramid of the Sun from true east-west is 15.5 degrees. As such, the pyramid and the entire city are aligned with the sunset on 29 April and 13 August, but observation of the sunrises from the top of the pyramid over the course of a year serves to reveal the relevance of these dates. From the first alignment of the Sun on 29 April, it will take 52 days for the Sun to reach the northernmost point on the horizon, which is of course the summer solstice. From this date, another 52 days transpires until 13 August, the pyramid's second instance of solar alignment. From this date, sunset after sunset, the Sun will travel along the horizon southwards until it reaches its position on the winter solstice, from which point it will slowly travel back until sunset number 260, which falls on 29 April of the following year. These alignment dates in effect reveal the canonical division of the year into periods of 104 and 260 days. The axial line running east of the pyramid will point to sunrise of 12 February and 29 October. These dates divide the solar year as already described and use the winter solstice as the natural pivot from which to launch the count of days. For this division of the solar year to work on the western and eastern horizons from the vantage point of the building in question, these opposite horizons must have very similar altitudes. It is clear that these early builders took great pains to select sites offering such features.

All of the architecture of the Teotihuacanos served to manifest the sacred numbers used in the measurement of time. The pyramid was afforded the most holy symbolic and ritual significance and therefore had to be designed in concert with calendric principles. The Sun provides the great stage on which to proclaim the advent of these essential dates. Architectural alignments occurring on these same dates spread across Mesoamerica; but the practice probably did not originate in Teotihuacán. Such alignments were recently confirmed in the Preclassic period of El Mirador, Guatemala, which flourished several centuries before the founding of Teotihuacán (Šprajc et al., 2009: 84). Other noteworthy examples of this solar-calendric alignment include the pyramid of the Five Floors in Edzná in Campeche (Malmström, 1991); House E of the Palace of Palenque in Chiapas (Galindo Trejo, 2001: 295-298); the Upper Temple of the Jaguars of the Great Ball Court of Chichén Itzá (Galindo Trejo et al., 2001) and the El Caracol observatory also in Chichén Itzá (Galindo Trejo, 1994: 140). Sites in other

Mesoamerican regions also exhibit this practice, including: El Templo Mayor in Tula (Šprajc, 2001: 280-284); Structure A of El Consuelo Tamuín in the Huaxteca region (Galindo Trejo, 1999); the habitational compound of Tomb 105 of Monte Albán in Oaxaca (Galindo Trejo, 2008: 316); and Building 1 of Las Higueras in Veracruz, which is a sacred sanctuary containing a variety of splendid ritual murals (Galindo Trejo, 2004: 456-459; Morante, 2005). The zenith observatory in Xochicalco was designed in such a way that the extreme dates of the incidence of solar rays inside are the same as those of the solar alignment of the Pyramid of the Sun in Teotihuacán (Morante, 1995; Galindo Trejo, 2003). The 13 August alignment date is particularly significant, because according studies of the Maya Long Count the count actually began on this date in 3114 BC.

Fig. 4: The majestic Temple I of Tikal, Guatemala, stands across from Temple II, which is nearly as high and slim. On 18 April and August 25, the observer standing on Temple I will see the Sun set behind Temple II. This calendric-astronomical alignment is evident in that these dates stand 65 days before and after the summer solstice, respectively.

Another family of architectural orientation based on the Mesoamerican count of time is seen in the Templo Mayor (Main Temple) in Tenochtitlan. This structure was one of the largest in existence when the Spaniards arrived in the New World. The pyramid is aligned with a major artery crossing the city in both pre-Hispanic and colonial times. Thus, the twin upper sanctuary shown in depictions of the war god Huitzilopochtli is aligned with the setting Sun on 9 April and 2 September, which are key dates in the Maya calendric system. From the first alignment on 9 April, there are exactly 73 days until the summer solstice. After another 73 days the Sun arrives at the second alignment point on 2 September. In subsequent days the Sun will set farther and farther south until it touches the winter solstice, from which it gradually moves northwards to complete the cycle on 9 April of the following year. From 2 September to 9 April, 3 times 73 days will have passed, leaving no doubt that the number 73 is key this scheme; 73 is the number of cycles of the Tonalpohualli or Tzolkin needed to complete the 52 Xiuhpohualli or Haab. With regard to the winter solstice, we also know that the same counting scheme applies to the alignment of the Templo Mayor with the sunrise on 4 March and 9 October. Today, the alignment of the Templo Mayor still offers an astounding spectacle. On either alignment date, one can observe the Sun touch the horizon by gazing down the length of the street running behind the Metropolitan Cathedral. This street, lined with colonial buildings, lampposts and sidewalks, runs along what was once the axial line of the Templo Mayor. It would seem that the heart of Mexico City still beats to the rhythm of the Mesoamerican calendar, which is like a great cosmic watch that keeps on ticking, though the watchmakers are long deceased. There are several places in Mesoamerica with the remains of buildings aligned on the same calendar dates used as those of the Templo Mayor of Tenochtitlan. It is interesting to note that the difference in days between the corresponding pairs of dates from each alignment family are exactly 20, which accords perfectly with the Mesoamerican vigesimal numeric system. Long before this alignment system was used in Tenochtitlan, it had a long history in the Maya region. Examples of this include the great solar mask in the east patio of Copán in Honduras (Galindo Trejo, 2003: 56); the substructure of Building 38 of Dzibilchaltún (Casares, 2002); Arch CA-9a at the entryway to the Ah Canul group of Oxkintok (Casares, 2002) and the Hall of Frescos in Mayapán (Ruiz Gallut et al., 2001), the latter three in Yucatan. In Mayapán, the last major Maya city before the arrival of the Spaniards, the Sun's rays strike a polychrome mural from a grazing lateral angle. This mural contains representations of the Sun that are illuminated on the aforementioned dates. On the other hand, this family of solar alignments has an exceptional property that allowed the priests to calculate the synodic period of Venus, which is also recorded in the Dresden Codex as 584 days (Thompson, 1988: 159-164). This period can be reconstructed by recording a sequence of eight sunsets on the dates given by this alignment family, since 8 x 73 = 584. In the region of central Mexico, there are other noteworthy examples of structural alignment with the Sun on these same dates generated by the 73 day count, including the upper sanctuary of the Pyramid of the Niches of El Tajin in Veracruz (Galindo Trejo, 2004: 459); and the habitation groups containing painted tombs 103, 104 and 112 in the Zapotec city of Monte Albán in Oaxaca (Galindo Trejo, 2008: 328, 331, 340). The polychrome designs in these tombs mostly depict ritual processions of richly festooned dignitaries. These scenes are surrounded by numerous glyphs that have not yet been completely deciphered (Lombardo de Ruiz, 2008). At the same time, the so-called Calendar Temple in the city of Tlatelolco, an ally of the Mexicas (Šprajc, 2001: 374), contains the carved names of the twenty days of the Mesoamerican 'veintena' and a mural depicting Oxomoco and Cipactonal, the divine creators of the calendar.

Fig. 5: The Pyramid of El Castillo at Chichén Itzá represents, through its architectural elements, the fundamental concepts of the Mesoamerican calendrical system. Furthermore, at days near to the equinox, it displays a spectacular hierophany: a serpent of light on the balustrade of the northern stairway.

A third family of architectural alignments was first found in the Zapotec region of Oaxaca in the so-called 'Bejewelled Building' standing on the north platform of Monte Albán. This building displays the talud-tablero style that is characteristic of Teotihuacán and is aligned with the sunrise on 25 February and 17 October (Galindo Trejo, 2008: 310). According to a sixteenth century source, the Zapotec divided the ritual 260 day year into four 65 day periods, calling each of these portions Cocijo, the god of rain (Córdoba, 1886: 115). Both of these solar alignment dates fall exactly one Cocijo before and after the winter solstice. On these same dates, in the north room of El Arroyo at Mitla Complex, the room's lintel is illuminated from the side by the grazing rays of the Sun. This room houses a mural depicting the Sun framed by two buildings and held aloft by two personages hanging from the sky (Galindo Trejo, 2008: 303). Building J at Monte Albán, built on a peculiar pentagonal plan similar to the pan-Mesoamerican solar year glyph, is aligned with a point where Capela, the sixth brightest star and the brightest in the Auriga constellation, once rose above the north-east horizon (Aveni, 1991: 287). Because of the precession of the Earth's rotational axis, the star no longer rises at that point on the horizon. The line of symmetry of Building J passes through a hole in the stairway of Building P, located in the same plaza at Monte Albán. This orifice is the entryway to a chamber below the stairs measuring approximately one metre in width by 4.4 metres in depth. In the deepest part of the chamber there is what seems to be a bench, above which there is a hole that comes out at a point higher along the stairs. This chamber allowed the Sun's passage through zenith to be observed on 8 May and 5 August. Rubén Morante (1995: 52-57) analysed this chamber and reported that on 17 April and 25 August, respectively, which are exactly one Cocijo before and after the summer solstice, the first and last rays of sunlight penetrate into the zenith observatory of Building P. In the ritual 260 day calendar, both pairs of dates, moreover, provide a balanced intercalation of the 260 day ritual count into the solar calendar, as each stands exactly 52 days away from its corresponding contiguous date. Zapotec texts, addressing time counts and associated celebrations, seized by the Holy Inquisition in the seventeenth century, contain interesting supporting information in this regard. These texts record the date of the New Year as 25 February (Alcina Franch, 1993: 185). Although this alignment family was first detected in the Zapotec region, it was also used in the Maya area. After all, the 65 day count made up of five 13 day periods clearly implies a calendric structure. Some examples of this in Maya architecture include: the great Temple I of Tikal (Aveni and Hartung, 1988: 12); from the massive measurements of Šprajc and Nava Sánchez (2012: Tables 4, 5, 6 and 9): the north structure of the north-east Group of Calakmul; Structure I of Chacchoben; Structure E-III-2 of Chen Ho; Structure T1 of Dzibanché; Structure 2 of El Rey; Structure IV-B of Calakmul: Structure 3 of Tabasqueño; the Pyramid of Monkeys of El Mirador; the north structure of the north-east Group of Calakmul; Structure VIII of Becán; Structure XIII of Calakmul; Structure I of Chicaná; Structure 37 of Dzibilchaltún; Structures 5 and 6 of Hochob; Structure VI of El Rey of Kohunlich; the Castle of Oxkintok; Structure I of Pomoná; and the House of Birds of Xelhá.

Evidence of this alignment family in the Classic Period was recently discovered far beyond the Zapotec region in Complex A of Cañada de la Virgen at Guanajuato in Central Mexico. This site consists of a massive pyramid standing before a large sunken square, whose axis of symmetry points to the sunrise on the same dates established by the Building P zenith observatory at Monte Albán (Granados, 2008).

In addition to direct orientations to the Sun, it has been possible to identify several hierophanies, light and shadow events that were designed to increase the symbolic-ritual value of certain important astronomical moments. A spectacular example is the so-called Descent of Kukulcán in the El Castillo pyramid at Chichén Itzá, Yucatán. It is a structure with architectural elements that indicate the importance of the calendar. For example, its four stairways have 91 steps each, which together with the common platform at its top, one has the number of days of the year. On the day of the equinox, one hour before sunset, the nine bodies of the pyramid cast their shadow on the north balustrade of the pyramid. In this way a succession of triangles of light are formed there and resemble the body of a luminous serpent whose stony head is at the beginning of the stairway. Kukulcán is the Maya advocation of Quetzalcoatl, the Feathered Snake, deity that according to Pre-hispanic mythology would have given the calendar to mankind.

Another hierophany can be recognized in a monolithic temple found in Malinalco. The Mexicas carved it by conquering that region of southern Mexico. It is a structure facing celestial south, the upper sanctuary shows an entrance in the form of snake jaws, the interior is formed by a circular bench. In the middle point of the floor an eagle was carved, on the sidewalk there are two other eagles and in the center a jaguar was carved. The direction of the south was linked to the principal god of the Mexicas, Huitzilopochtli, of solar nature. At the winter solstice, the day on which according to the chronicles this god was born, when the solar disk crosses the local meridian, the Sun's rays penetrate the fauces of the entrance and hit the head of the central eagle. The Mexica ruler wanted to highlight the transcendence of the mythical moment of his god by associating it with an astronomical event of special importance.

Architectural Orientation and Ideological

Gazing at the orderly motion of the celestial vault, the observer of nature in Mesoamerica used the knowledge accumulated over many generations to establish the orientation of major architectural structures. The endeavour involved associating aspects of religious doctrine with the unapproachable realm of the firmament. The deities would thereby be the objects of worship in a religious system where the ruler, who had stipulated the orientation of temples and palaces, would also gain prestige and renown. This brief outline provides the barest notion of what occurred over several thousand years and of what was to become a fundamental element in the definition of Mesoamerica.

Of course, there is much still to do in this field; and the archaeological periods of other Mesoamerican regions must be examined. We still do not know if there were other families of architectural orientation; and we know even less, of course, about the appearance of these alleged families or their succession. Since the two families examined in this paper are defined by making counts in multiples of 13, i.e., 52 and 65, one could easily suspect the existence of count schemes arising from other multiples of 13. For example, we could choose a starting point in time from which to divide the year into intervals of thirteen days and, in this way, eventually come across the missing families. Let us take the winter solstice as a pivot point from which to start our division. Thus, we obtain 28 'trecenas' or periods of 13 days each that add up to 364 days. The missing day to complete the year, perceptible to the naked eye and occurring at regular intervals, poses no real difficulty. Even today, the way in which we track the Sun day to day is subject to correction through the use of a leap year. Table 1 (at the end of this article) shows this division. The calendrical dates determined by two orientation families cited previously are immediately evident and also those for the so-called 'temporal equinox' (the mid-point in days between the solstices). To confirm such a complete pattern for Mesoamerican architectural orientation as proposed would require identification of actual structures aligned with the Sun on the dates described by these intervals. In this regard, it is important to remember that one of oldest pyramids in the Valley of Mexico, the Circular Pyramid of Cuicuilco, is precisely oriented with the Sun at dawn on the 'temporal equinox'. In order to validate the Mesoamerican canonical division of the solar year into units of 13 days, the existence of well-preserved Mesoamerican structures is required, and both the ravages of time and poorly executed reconstructions could pose considerable difficulties. We must not forget that the other family presented in this paper, which is based on dividing the year into intervals of 73 days, cannot be reconciled with any multiple of 13. Even though the number 73 is an integral part of the relation between Tzolkin and Haab, its real significance seems to lie in the synodic period of the planet Venus (i.e., 584 days = 8 x 73 days). After all, the brightest object of stellar appearance in the night sky is Venus. As mentioned earlier, this planet was observed with meticulous precision by the Maya. Since it is visually associated with the Sun, appearing just before sunrise or just after sunset, its motion across the sky is easily tracked and readily predicable.

The question of architectural alignment with the Sun has often been associated only with important astronomical events such as solstices and equinoxes, or with the days of the zenith passage of the Sun. While no doubt important, in Mesoamerica these events were complemented by other calendrical features serving as the basis for alternate architectural orientations that appear to obey questions of moments rather than directions. Such a situation might suggest that Mesoamericans were not so much interested in spatial orientation, but rather in that associated with time; since the concept of time is united with the worship of deities who created and control time. If architectural structures stand in harmony with such features, they are imbued thereby with a sacred symbolic value, reinforcing the transcendence that the ruling class wished to express by undertaking their construction. Doubtless, such endeavours were also expressions of political power in a society ruled over by an elite believed to be conduits between man and the gods. Consequently, this practice served as an extraordinarily effective means for cementing the moral authority of the sovereign and his ruling circle.

Moon Worship

Although most of the architectural orientations in Mesoamerica correspond to solar moments, there are few orientations inspired by lunar positions. Here we will show a remarkable example of a lunar orientation associated with an important sanctuary dedicated to a lunar deity. As the brightest object in the sky after the Sun, the Moon was worshipped by Mesoamericans as a fertility deity that was associated with weaving, medicine and childbirth, as well as closely associated with water. Its complex motion in the sky contrasts with that of the Sun. The Maya called this deity Ixchel, or the rainbow goddess. According to Thompson (1939:161-162), Ixchel encompassed two aspects, that of a young women and an elderly female, both of whom exist in the Maya codices, appearing as the ‘mother of the gods’ and as ‘our grandmother’. According to several chroniclers, the Island of Cozumel in the Caribbean Sea was the site of the most important shrine to Ixchel, the goddess of the Moon and wife of the Sun, where there was also an oracle attended by an elderly priest named Ah K’in, who posed the pilgrims’ questions to an idol of the goddess. In exchange for his answers, he received plentiful gifts from the pilgrims’ harvests (Contreras, 1983: 187). The Franciscan monk Diego de Landa (1982:48,58) reported:

> *And Cozmil and the well of Chichenizá were held in such high veneration as our own pilgrimages to Jerusalem and Rome and the people visited these places, especially Cozumel to offer gifts, just as we visit our holy shrines; and even when they did not make pilgrimage, they sent offerings…For childbirth they would go*

> *to a sorceress who made them believe their lies and place an idol of the demon called Ixchel beneath the bed, telling women that she was the goddess of childbirth.*

Hernán Cortés' chaplain, Francisco López de Gómara (1985:32), discovered what could be a shrine to Ixchel, describing it as follows:

> *The temple is a square tower, wide at the base and stepped all around. The upper half is erect and at the top a hollow with a thatched roof with four doorways or windows with parapets like tables. Inside this hollow space reminiscent of a chapel are seated or painted their idols. The temple on the coast was like this and it housed a strange idol, very distinct from the others, though there are many such idols all very different. That great idol was a statue large, hollow, made of kiln-fired clay and stuck to the wall with lime, behind which was sort sacristy where services to the idol were held by its priests. The priests had a small secret doorway in the wall behind the idol, where one of them entered, sheltered by the statue, and he would speak and answer the questions of the pilgrims who came in devotion and those making petitions. This trick made simple men believe that the gods were speaking and they would honour this god above others with fine copal, which is a kind of incense, and also bread and fruit, sacrifices of quail and other fowl, dogs and sometimes even men.*

The most important city on Cozumel during the pre-Hispanic period is known today as San Gervasio. This ancient settlement consisted of three complexes, each comprised of five groups of buildings. These complexes were interconnected by sacbe, or 'white roads'. This city contains the ruins of the structure know as Ka'na Nah, or 'High House', which archaeologists have designated NO(AI)4 (Sierra Sosa, 1994: 102). It is rather a small pyramid only five metres in height with a square plan, consisting of four tiers and a main stairway bordered by a railing on the east. The red and blue paint of the walls of the two-room sanctuary at the top is still perceptible. Referring to the layout of the sanctuary's interior and reports of chroniclers, Freidel and Sabloff (1984: 64-65) have suggested that Ka'na Nah is in fact the sanctuary of the oracle of Ixchel. The pyramid faces north-east. With this proposal in mind, we have made archaeoastronomical measurements of the pyramid's alignment (Galindo Trejo, 2002). In this regard, we have measured from both jambs of the west opening of the sanctuary, because some of the stucco and paint are still intact. Likewise, we measured the angular height of the horizon all along the sightline, thereby obtaining an azimuth of 300° 21' and a horizon height of 1° 10', which in fact lines up with the faraway treetops. As such, we can see that the sanctuary is not aligned with the Sun in any meaningful way. The resulting declination of 28° 33', however, reveals a particularly significant alignment with the Major Lunar Standstill in the north-west, when the Moon sets at its extreme point on this horizon. This phenomenon is analogous to a solstice, though the moonset actually touches a point farther north than the solstitial Sun. The Moon reaches these extreme positions on the horizon only once every 18.61 years. Šprajc (2009) performed measurements of the upper sanctuary of Ka'na Nah and found that the building is aligned with the setting Sun on the summer solstice. Recently, we endeavoured to verify this apparent contradiction in situ, finding that the deteriorated condition of the sanctuary makes any such determination very difficult. It bears mentioning that the door jambs were not parallel. Moreover, the stucco, such as it is, yields an azimuth that diverges from that of the underlying stone jambs by 5º. In view of these uncertainties, the supposition that Ka'na Nah was devoted to the mood goddess Ixchel cannot yet be discarded.

Fig. 6: The eastern side of the Ka'na Nah Pyramid of San Gervasio, Cozumel, exhibits a part of the upper sanctuary comprised of two rooms that very likely once housed a statue of the goddess Ixchel and the oracle sought out by pilgrims from across the Maya region. This small pyramid is aligned on the northwest horizon to the position of the Moon at its Major Standstill.

Final Comments

Our research suggests that the practice of aligning major architectural structures in Mesoamerica became highly specialized and was intimately associated with the sacralisation of space and religious ritual in general. This specialization came about through the selection of certain dates, as determined by the structure of the calendric system, whose sunrises or sunsets provide alignment points for religious or government edifices. The alignment served to imbue these structures with transcendental significance in perfect harmony with the sacred calendar, something sure to attract the favour of the gods. It is clear that directional orientation, expressed as an azimuth angle with respect to the celestial north, of an architectural structure is not sufficient to determine the alignment with a given star. One must also know the angular height of the horizon along the sightline leading to the point where the celestial body rises or sets. This is because in Mesoamerican latitudes these heavenly bodies rise and set on oblique trajectories with a vertical angle equal to the geographic latitude of the observer. Because the Mesoamerican landscape is largely mountainous, the constriction of a fixed date for the alignment event causes a dispersion of azimuths for other buildings on this same day. This is why this dispersion was first identified as an 'alignment family', as intervals of angular deviation against a given cardinal direction: what Aveni, for example, called the 15^0-17^0 family. Therefore, we can reiterate that Mesoamericans aligned their structures in relation to time, not exclusively inspace. Of course, the act of choosing a calendric-astronomical orientation contributed only in a small proportion to the symbolic-religious discourse of political power that the sovereign wanted to transmit through mural painting, steles, sculpture and the solemnity of rituals carried out in the building so aligned.

We have focused out attention on solar alignment of Mesoamerican architectural structures, which we believe was widespread and generally preferred. The rising and setting Moon, however, was also used as a signpost for laying out important structures. Documentary information from contemporary European chroniclers tells us that Moon worship thrived at the shrine of Ixchel on the Island of Cozumel at the time of the conquest of Mexico. These reports reinforce our proposal that the pyramid of Ka'na Nah, which is aligned with a major lunar standstill, is very likely the shrine to this goddess.

In conclusion, we may observe that because of the complexity of society and human nature itself, any attempt to explain the actions of past peoples requires a multifaceted approach. In order to more fully understand the question of calendric alignment of architecture, astronomers need to engage in creative dialogue with the humanities in order to posit plausible hypotheses. After all, it is our human nature that ties us to our ancestors and elicits within us the same sense of awe when contemplating the infinite firmament.

Today, archaeoastronomers and ethnoastronomers (cultural astronomers) combine archaeology and anthropology with astronomy to provide a coherent view of the long road that mankind has followed from the first glimpse of the sky with naked eye to the development of the Big Bang theory and the construction of spaceships. Thanks to their work, hundreds of monuments and architectural buildings exhibiting astronomical alignments and innumerable panels and rock shelters containing representations of heaven or celestial events have been discovered on every continent. In conclusion, the sky has been, and always will be, a constant source of inspiration. Additionally, it will continue to pose an intellectual challenge to any man who accepts it with full awareness of its role as a spectacular universal frame of reference that contributed culturally to the development of mankind.

Winter Solstice: 22 December

1x13=13 4 January
2x13=26 17 January
3x13=39 30 January
4x13=52 12 February
5x13=65 25 February
6x13=78 10 March
7x13=91 23 March
____
8x13=104 5 April
9x13=117 18 April
10x13=130 1 May
11x13=143 14 May
12x13=156 27 May
13x13=169 9 June
14x13=182 22 June
____
15x13=195 5 July
16x13=208 18 July
17x13=221 31 July
18x13=234 13 August
19x13=247 26 August
20x13=260 8 September
21x13=273 21 September
____
22x13=286 4 October
23x13=299 17 October
24x13=312 30 October
25x13=325 12 November
26x13=338 25 November
27x13=351 8 December
28x13=364 21 December
____
+1d 22 December
____
365d

Table 1. The Solar Year divided in trecenas.

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Nicaragua

Central point and zero mileage in the urban plan of the historic center of Managua

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Abstract

This article consists of a bibliographic investigation of the historical antecedents of the population of Managua from its origins until the earthquake of 1972 addressing the urbanization of the city. With the required information, an analysis is made of the relationship that exists between the plane of the city with respect to the apparent movement of the Sun.

Introduction

Managua is the capital city of Nicaragua and head of the municipality. It is located in western Nicaragua, on the southwest coast of Lake Xolotlán or Lake Managua. The city originated in a historic pre-Columbian village for small fishing settlements that inhabited the shore of Lake Xolotlán. In the pre-Columbian era Fernández de Oviedo described it as a beautiful indigenous settlement that lived on the south coast of the lake. In 1819 the King of Spain, Don Fernando VII, decreed a Royal Charter granting the town of Managua the title of Leal Villa of Santiago de Managua as a reward for having remained loyal to Spain before the rise of other cities such as León and Granada seeking the independence of Spain; in 1821 it became independent from the Spanish crown, in 1846 it was elevated to a city with the name of "Santiago de Managua" and in 1852 declared the capital of the Republic of Nicaragua.

From the Colonial Period to the 18th century

"In the 16th century, when the Spanish conquerors arrived, the towns of Mateare, Managua and Tipitapa were located on the outskirts of Lake Xolotlán. Managua was densely populated by people of Chorotega origin and organized under the lordship of the cacique of Tipitapa as the highest authority. Due to its geographical position, the area that today occupies the ancient cathedral of Managua was the center of the region. That is to say, that in the west, their territory began in front of the plaza that for many years the conquerors called Plaza Mayor and that after independence the natives named it Plaza de la Republica; from there it continued to the east until it ended in Tipitapa. " (Romero Arrechavala, 2009, p.64 and 65).

Cuadra (1939) expresses: “In the year of 1760, the Villa de Managua had as urban limits, the following: to the East, the Avenue that passes behind the sacristy of the church of Candelaria, before San Mateo; to the West the Avenue that passes in front of the temple of San Sebastián; to the North, the shore of the lake; and to the South the Street of Santo Domingo, whose church did not exist at that time. Beyond the mentioned limits, they were thick mountains” p. 26 and 27.

Construction of the urban plan of the Historic Center of Managua

During the administration of José Santos Zelaya, from 1893 to 1909, Managua made a qualitative leap in terms of municipal terms: from the construction of the General Estrada Park (now Parque Central) and the Obelisco Park (now Rubén Darío Park), to the construction from the operating room of the General Hospital through the installation of public lighting, inaugurated on the occasion of Christmas 1902, and the first nomenclature attempt of the city, (Traña Galeano, 2000. p.78).

Norori Gutiérrez (2013) expresses "the mayor's office would renew in 1911 the terms of what is known as the "central radio" of the capital as a neurological nucleus of the vital political-administrative functions that were carried out in the city. It was established…

- From the North, 5th and 6th Street from 6th East Avenue to 7th West Avenue.
- To the South, 4th Street South, from 1st Avenue East to 1st Avenue West, to 1st Street South.
- On the East, 4th Avenue, on 1st South Street.
- On the West, 4th Avenue, on 1st South Street" p. 60.

The Managua have always had their own directions, the lake to the north, and mountain to the south, up and down instead of east and west. According to the inhabitants of Managua, the east is "up", because it is where the sun "rises" and brings the dawn; while the west is "below", where the sun is hidden. The north or "lake" is towards the Xolotlán lake and the "mountain" marks the south, towards the Sierras de Managua that are the border of the city, the latter term is currently little used.

The urban center of the city was made up of a large number of buildings built after the earthquake of 1931 and especially at the end of the 50s. From 1950 on, inhabitants exploded demanding the paving of the city, that until then had only three avenues and five paved streets, respectively: the Central Avenue or Roosevelt Avenue, the First Avenue West or Avenue Bolivar, and the First Avenue East or Avenue the Centennial, and the streets the Triunfo (that continued with the one of Candelaria towards the East of the City), Momotombo, Central, September 15 and Colon". (Traña Galeano, 2000, p.97 and 98). See figure 4

1.Ave. Bolivar, 2.Hotel Balmoral, 3.Teatro González, 4.Club Internacional 5.Edificio Palazio, 6.Gran Hotel, 7.Palacio Nacional, 8.Palacio Arzobispal, 9.Catedral, 10. Club Managua

Fig. 4: Panorama of the city of Managua before the 1972 earthquake

Fig. 5: Plane of the central radius of Managua. It illustrates the central point of the city that make up the intersection of the central avenue directed from north to south and the central street oriented from east to west.

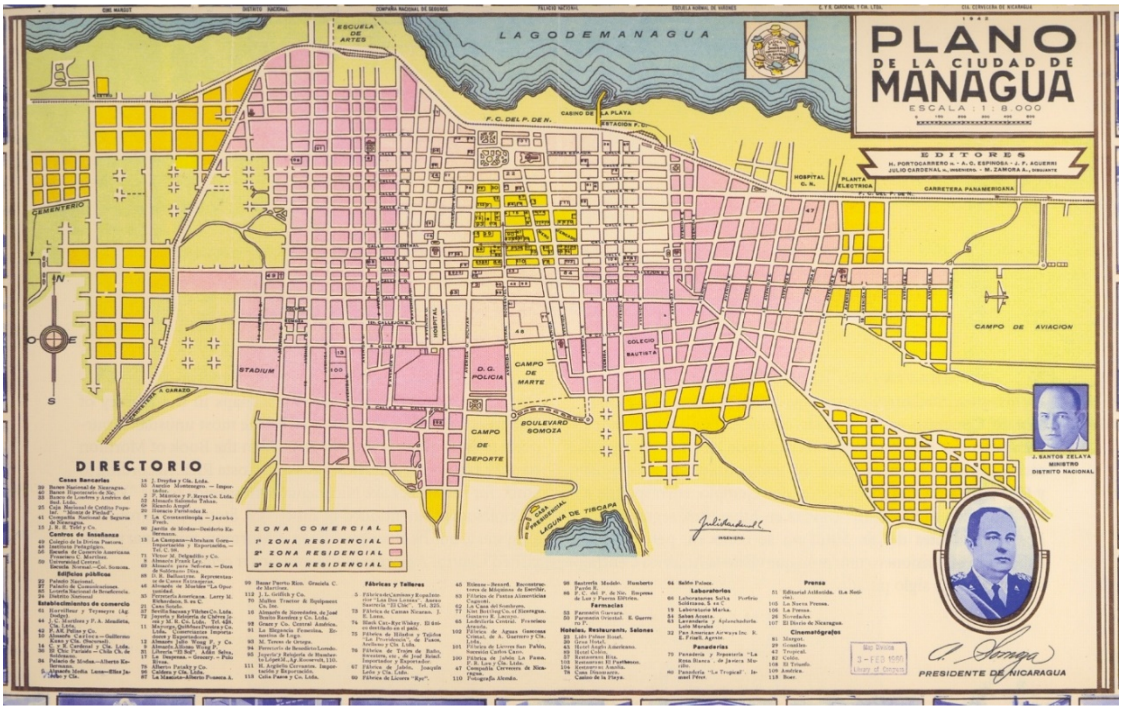

Fig. 6: Urban plan of the Historic Center of Managua in the sixties.

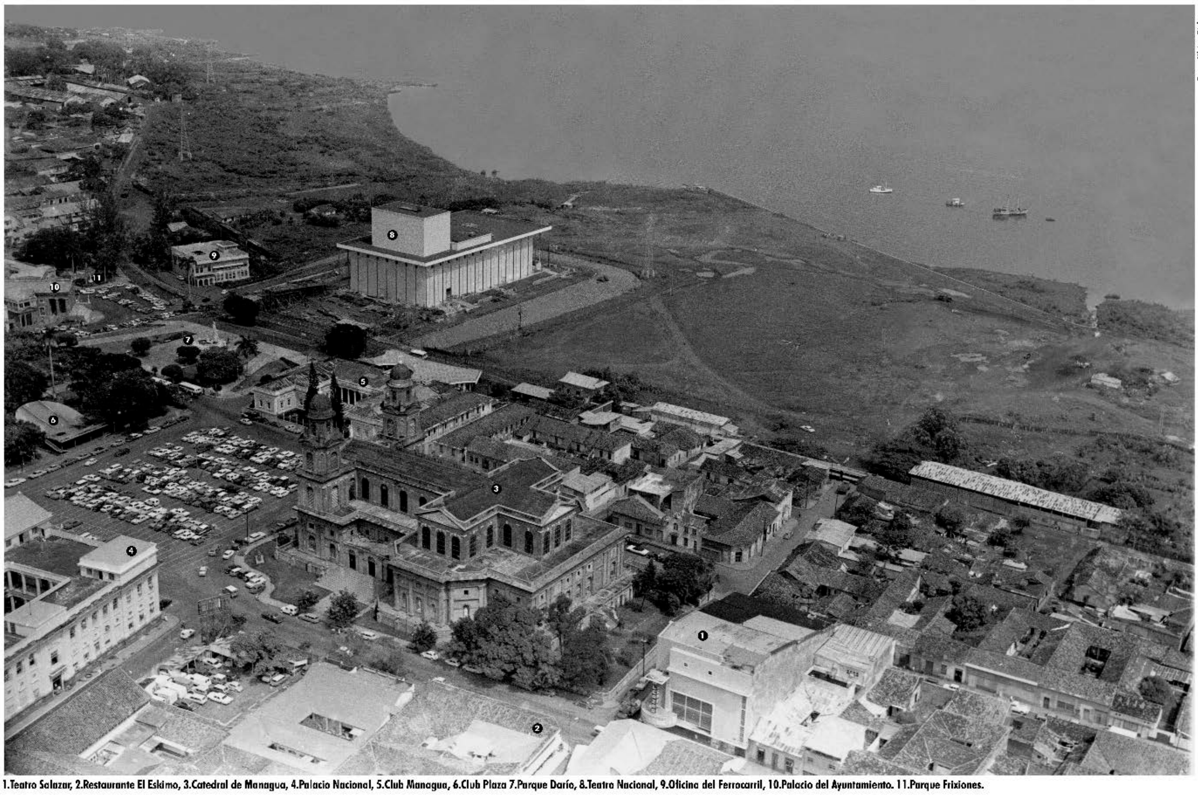

Fig. 7: In the lower right part you can see the National Palace, the Cathedral and the Plaza de la República, where the kilometer zero is located.

"The urban nomenclature of Managua divided the city into four quadrants whose axes were: the central avenue (later the Roosevelt avenue) as axis North South that ran from the lake Xolotlán to the hill of Tiscapa (the same axis from the time of the Colonia), and Calle Central (which never had its own name) as east-west axis located halfway between the lake and Calle Colon, this last one acquiring a special relevance as an exit to the south of the country, particularly to the Department of Carazo. From both axes, the avenues and the streets wer listed as first, second, third, etc., both North and South, as well as East and West" (Traña Galeano, 2000, p.96). The streets (oriented from east to west) were called from their location with respect to the four squares of that plane: northeast, southeast, southwest and northwest and the avenues (oriented from north to south) named from east to west according to the quadrant. The intersection of the central avenue with the plaza of the republic is located at kilometer zero and is located between the old metropolitan cathedral, the national palace and the house of the people (presidential house of Nicaragua). See figures 5, 6 and 7.

The night of December 23, 1972 changed everything. An earthquake of 6.2 degrees on the Richter scale destroyed the city of Spanish grid, with defined avenues and streets. In the old pictures and maps of the pre-earthquake Managua can be seen the grid and the nomenclature that the capital possessed: the avenues arranged from north to south, the streets from east to west.

Conclusions

When reviewing the specialized literature it is concluded that astronomy is of great influence in the nomenclatures of the cities because the sunrise and the sunset are always present.

Nobody calls “Calle 2” to” Calle 15 de Septiembre”, which is the longest street in Managua; o “Avenida 1 Este” to the “Centenario”. But the old nomenclature of Managua has not been totally lost. In Google Maps, for example, "18 Avenida Sur Oeste" and "9 Avenida Norte Este" appear.

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Panamá

Rock Art in Panamá

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Abstract

Petroglyph or rock art are evidence of the human civilizations living in particular places all around the world. The Ngöbe culture has been appointed as the authors of Panamanian Isthmus´ petroglyphs; but the local writer Argelis Bonilla had made some researches and had pointed out that the Doraces culture would be the author.

Most of petroglyphs are representations of animals, plants, and scenes of daily life; but a particular one found in Panama Oeste´s area had been studied by Roberto Perez and with Astronomical´s simulation software, he related this petroglyphs with lunar cycles, solstices, and equinoxes; summing up that a rainy calendar had been drawed to be used for sowing times according to whether the time was rainy or dry.

Introduction

Rock art (from Latin ***rupestris*** = rock) is any type of ancient drawing or sketch that usually exists inside caves, but also in some large rocks (more than 3.0 meters in diameter). This type of art is an evidence of the passage of human civilizations in certain geographical environments.

The drawings or sketches can be representations of animals, plants, scenes of daily life, geometric figures which are considered as manifestation of the skills and thoughts of civilization.

These representations are located in all corners of the planet, and Panama as a forced site of passage among the original civilizations of America is not exempt from these art manifestations.

A very specific art within the rock art are the petroglyphs, (whose etymological meaning is workshop in stone: ***petros*** = stone, ***glyphe*** = carving), used to keep track of events maybe climatological, or astronomical. Generally geometric figures are used in their description. Historically, the Ngöbe culture has been mentioned as the authors of petroglyphs.

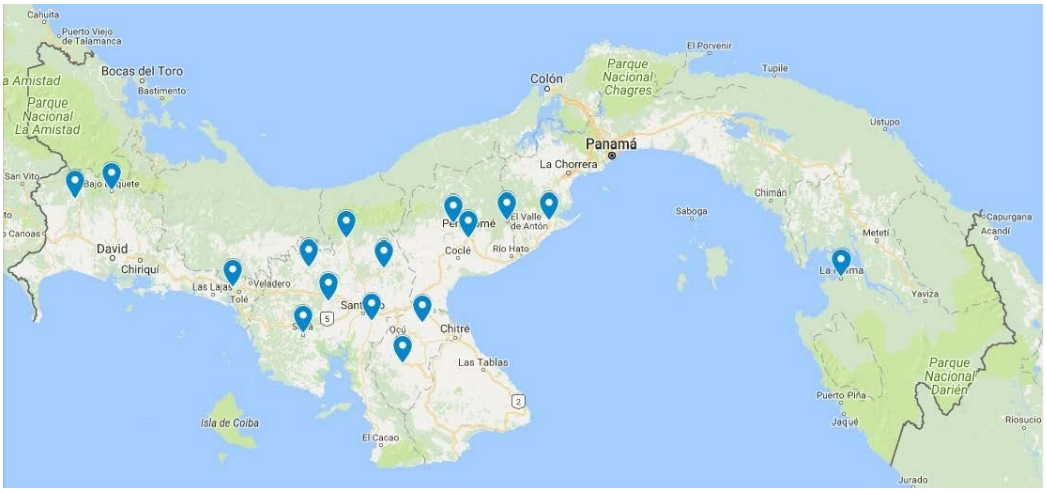

Fig. 1: Places where there are reports of petroglyphs.

Etelvina Medina has reported that this type of demonstration is found along the Panamanian Isthmus, as in the provinces of Panama Oeste (Bejuco and Cabuya), Coclé (El Valle, La Pintada, and Río Grande), Veraguas (Santa Fe, Atalaya , Cañazas, La Mesa, Soná, and Piedra del Sol), Chiriquí (El Nancito, Boquete, and Volcán), Herrera (Las Minas and Ocú), and Darién (Las Palmas).

So far, there are extensive photographic documentation of petroglyphs from some places, but few scientific studies of most of them.

Province of Chiriqui

Liza Hume points out that there are 17 petroglyphs located in El Nancito, the ones that have been documented and taken photographs. She also reports that in different nearby areas such as Tole, San Felix, and Sitio Barriles there is more evidence of more petroglyphs.

The blogger Virginia has documented with photos of petroglyphs from other places such as Sitio Barriles, El Nancito and Piedra Pintada.

Alvaro Brizuela Casimir, with the support of the Science National Secretary's, Technology and Innovation of Panama (SENACYT) conducted a small research in the area of Volcán, in 2007 that could be part of a larger project of the conformation of an Atlas of Petroglyphs in Panama. In his research, he found that at the arrival of the original Ngöbes people, there were already petroglyphs, to the ones Ngöbes assigned a mythological origin. He explains that the petroglyphs found so far consist mostly of geometric figures of curves that include lines, spirals, circles, and points. Lines include straight lines, curves, and zigzag lines. In the spirals he makes the distinction between the simple volute (left and right), the double spirals, those that have less than two turns and those that have more than two turns. In the circles he classifies them completely without filling, complete with filling, and semicircles.

The local writer Argelis Bonilla Morales has reflected in her book **Petroglifos de Nancito: arte y cultura Doraces** that after investigating in the different libraries chroniclers, historians, and anthropologists; and also, the pre-Columbian history of Panama, Colombia, and Costa Rica comes to the conclusion in 2017 that the authors of the petroglyphs were the tribe of the doraces, a tribe of tall stature, their body of slender waist, nose profiled, beautiful face, and had beard like the Spaniards. Denying in some way that the authors of the petroglyphs were the Ngöbes for not finding a relationship between their life or customs with the petroglyphs. Which agrees with the investigation by Brizuela.

Province of Coclé

Cecilia Rodríguez indicates, without greater details that the original towns used petroglyphs to tell the history of El Valle de Antón.

Province of Panamá Oeste

The only study that has presented a technical explanation of the utility of petroglyphs was done by Roberto Pérez Franco, carried out on the so-called Polanco site, located in Capira, Province of Panamá Oeste.

Fig. 2: Adjustment of Pérez Franco with the solstices, equinoxes, Lunar cycle and the occurrence of rainfall for the town of Capira. (Image courtesy by Roberto Pérez Franco)

There is a single stone with more than ten petroglyphic representations. There are drawings where he has proposed hypotheses related to astronomy, but there are others that he has not been able to propose a coherent hypothesis.

But one of the drawings, identified by Pérez Franco as drawing No. 4, relates it to the lunar cycles, the solstices and the equinoxes. With a part of the drawing, and using a STARY NIGHT BASIC stellar simulation program on the 21st of each month, it achieves a good fit for what it supposes to be a rainy calendar. For the place where the stone is, it could have been used to know the sowing times according to whether the time was rainy or dry.

Conclusions

Panama, because it is a transit country, has a good number of places where petroglyphs are observed out in the open. There is the idea that the Ngöbe people were the authors of this type of art, however due to the little information that is available, it is difficult to really know the real meaning of the engravings. There is a recent investigation that denies that the Ngöbe people were the authors of the petroglyphs, grant the intellectual authorship to the tribe of the doraces. One of the possible explanations is that one of the engravings is a rain calendar, so we can assume that the original population recorded meteorological events and astronomical events in stones with the intention of knowing the best dates for sowing.

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Paraguay

Brief highlight of historical and cultural aspects of the Jesuit Reductions of Paraguay

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Abstract

In this work we highlight the main aspects related to the work of the Jesuits in the so-called Missions or Jesuit reductions of Paraguay occurred in the current territories of Paraguay, North of Argentina, Uruguay, South of Bolivia and Northwest of Brazil. Topics such as the formation process of the missionary works, the difficulties encountered during the same and the achievements made will be treated, many of which continue to the present contributing to the educational, economic and cultural life of the country.

The beginning

In the first decades of the sixteenth century, the newly discovered American lands in the process of being completely conquered, began to be systematically evangelized by various religious orders, among which the Society of Jesus, known simply as the Jesuits, stood out. They had many difficulties to establish themselves due to factors such as the siege of the *Mamelucos Paulistas* of Brazil who attacked the newly formed reductions in order to take the indians as slaves and to take possession of the assets of the establishments built with much effort. Another obstacle encountered by the evangelizers was the presence of the *Encomenderos* who were people with legal powers to have at their service and protection to the natives in a kind of American feudalism, with the exception of in most cases the second aspect was ignored in favor of the first, thus generating a situation of great human precariousness in that community of savages.

Even so, the Jesuit work continued with the foundation of dozens of small reductions such that at the end of 1641 of the 48 reductions 26 were destroyed by the *Mamelucos* with about 300,000 natives taken to slaves to São Paulo from which they survived the journey so only about 20,000 people(Pérez A.,F.,1920). The permanent siege was stopped in the battle of *Mbororé* current province of Misiones-Argentina, this could be done among other things thanks to the efforts of Father Montoya who had obtained the Royal Cédulas that would allow the Indians to carry arms for the defense of the Jesuit reductions. This would give the missions a relative calm for more than a century until the expulsion of the Jesuits by the King of Spain Carlos III in 1768.

Life within the Reductions

The life of the natives of this part of the continent was at a stage of evolution that could be framed within the savagery, unlike the Incas and Mayas who had a much more advanced structure with complex organizations of various kinds, even forming large empires. The Guarani natives lived in large common huts, engaged in hunting and fishing. They had good knowledge of medicinal herbs and the natural environment in which they lived, which was vital for their survival.

However, within the Jesuit establishments they had rooms for each family, they carried out specific activities learned from the religious such as carpentry, blacksmithing, manufacture of musical instruments, painting and other crafts. The REDUCTIONS had a church oriented in the north-south direction with the facade facing north (in some cases they used magnetic north and not geographic one (Busaniche, H.,1955) for being considered better from the climatological point of view (better lighting and heating in winter when the sun makes its path more to the north and more shadow in the intense summer when the sun moves more to the south) like those of Jesus, Trinidad and San Cosme San Damián, although there were churches with east-west orientation according to the Christian tradition like those of San Carlos Boromeo (present Argentina) (Giuria,J.,1950).

Fig. 1: Reductions of Santísima Trinidad, Itapúa-Paraguay. Jesuit mission founded on the banks of the Paraná River in 1706, declared a cultural heritage by UNESCO in 1993. (Photos: Courtesy of Rosa M. Ros)

The streets and other dependencies were also parallel or perpendicular to the temples which were surrounded by a park (front), missionaries houses, the school, craft workshops (one side) and a big house (Koty guazú) that worked as a hospital, asylum (other side) and even a cemetery, in the rest of the place were built the indian houses with long roofs connected each other (Brugada G., A., 1975).

The streets were 13 to 20 m wide with 60 m long blocks (mostly they used the unit of length called *Vara, 1Vara=0,836 m,* an old Castilian units). At the end of 1707, 30 reductions known as *Misiones del Paraguay* with a population of about 144.252 had been established and consolidated (Pérez Acosta, F.,1920).

Missionary legacy

The Jesuit reductions were centers of evangelization, but they have also left a rich architectural and cultural legacy. Even as it stands out in recent works such as that of De Asúa, there was also an important scientific legacy in the areas of botany, cartography, astronomy and physics (De Asúa, M.,2014).

Considering that among the missionaries there were educators and scientists of international level, it is worth mentioning among them the astronomers Buenaventura Suárez, Alonso Frías.

The first of which has built its own telescope with local materials, sundial (which is still standing today), pendulum clock and other instruments which led him to produce many works like determining the longitude of San Cosme and Damian where he worked and of other 29 Jesuit reductions in addition to writing *Lunario de un siglo*. His observations of the eclipses of the Jovian satellites were made with an accuracy of 50 arc seconds in light of the current algorithms according to the work of Galindo and Rodriguez-Meza (considered very good for the time) with the purpose of helping calculate longitude by the eclipses method. In his mentioned book, Suárez calculates the ephemerides of the different lunar phases, eclipses of sun and moon for the period from 1740 to 1841, which in turn were successfully predicted.

In the case of the lunar phases also according to the authors mentioned was for the purpose of helping medical practices, thinking that our satellite would influence the health of people. In any case this would imply a similarity between the celestial matter and the terrestrial something revolutionary to think at that time and even more so in his religious condition.

On the other hand, Frías is an example of the type of people who were deprived of Paraguay with the expulsion of the Jesuits and who went to carry out their research work in the astronomical Observatory of Brera in Milan-Italy.In 1972 makes a work where determines the true position of the city of Cádiz, in addition to collaborating with other scientific publications in the area of astronomy. Asúa (La Plata, 2009) mentions the existence of a work on fixed stars of 70 pages in different versions, in addition of his participation in the *Observaciones astronómicas hechas en Cádiz* de Tofiño y Varela (Cádiz, 1776-1777).

Without pretending to be definitive and in a personal trial I consider, like many others, that the expulsion of the Jesuits in the 18th century has cut with an example of coexistence between two very different cultures and this has deprived Paraguay of having better organized cities, with an educational system that would have allowed to improve over the years the present of the country with better prepared people, a gap to our days.

Fig. 2: Sundial of Father Buenaventura Suárez in San Cosme y Damián, Itapúa-Paraguay (Photos: Courtesy of Rosa M. Ros).

Fig.3: View of the Astronomical Interpretation Center *Father Buenaventura Suárez*, Itapúa-Paraguay (Photos: Courtesy of the National Secretariat of Tourism SENATUR, Presidency of the Republic).

The center *Father Buenaventura Suárez* has an astronomical observatory, planetarium with many other educational resources like an armillary sphere and it take place in San Cosme y Damián city. Takes that name in honor of the first South American astronomer.

Suarez built his own telescope with the help of his Guarani assistants. His first telescope, installed in the bell tower of the church of San Cosme, with which he made the first observations, especially solar and lunar eclipses.

Then he developed bigger telescopes, with which he studied the Jupiter's satellites, Mars, the trajectory of Venus, the lunar surface and the rings of Saturn taking meticulous inscription of everything he saw.

Fruit of these observations were his calendars, his celestial maps and his famous “Lunario Centenar” of more than 200 pages, written from 1720, whose five editions date from 1740 (Reduction of La Candelaria), 1743 (Lisbon), 1748 (Lisbon) , 1752 (Barcelona) and 1762 (Quito). That study determined the exact date of the eclipses that could be observed from missionary land between 1740 and 1840, detailing Moon-Sun conjunctions, oppositions and quarters. He also published astronomical tables and yearbooks.

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Peru

Inca archaeoastronomy and patrimonial education in Huaycán of Cieneguilla.

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In memoriam Astronomer María Luisa Aguilar Hurtado

Abstract

Huaycán of Cieneguilla is an Inca site satellite to the Sanctuary of Pachacámac, on the outskirts of Lima-Peru, where ancient amautas-specialists astronomer priests lived who recorded on the walls of the courtyards, where they made their astronomical observations, Calendric and Astral Friezes that represented his systems of computing time and the stars that were associated with those. Today this particular and unique archeoastronomic heritage of mural art is used as a heritage educational tool in the teaching of the local History of Science through knowledge of the Inca Astronomy, of the coastal towns of the region that were subdued by the Inca Empire and of the Andean Astronomy in general.

Introduction

Astronomy and the Inca Calendar are known in Cuzco through early Hispanic chronicles and archaeo-astronomical research (eg Zuidema 2010, Bauer and Dearbon 1995) although very few visual traces have been preserved. The Incas implanted this knowledge in several specialized sites of the *Tawantinsuyu*, some in the important Inca Province of Pachacámac, whose territory comprised approximately the current Metropolitan Lima. The Sanctuary of Pachacámac, famous *huaca*-deity oracular pan-Andean, needed a series of astronomical-calendrical knowledge to guarantee the reliability of its predictions. To obtain them, a group of specialists in these matters was settled in Huaycán de Cieneguilla, a particular settlement located in the northeastern periphery of Lima, where they reflected in their architecture, as friezes, symbolic representations of their astronomical and calendrical practices, revealed to through an archaeoastronomical, semiotic and holistic research.

Huaycán of Cieneguilla. An Inca site specialized in astronomy

Huaycán is a planned Inca administrative settlement located 27 km northeast - upstream - of the Pachacámac Sanctuary, in the district of Cieneguilla. The site is located at 12°05'00'' L. S. and 76 ° 45'58''L. W. The central sector of this settlement shows a series of architectural complexes delimited and intercommunicated by streets, in whose courtyards and main platforms have been shaped at least 24 mud friezes of different designs: circular, stepped, zoomorphic and anthropomorphic; They were painted with red and yellow colors. Huaycán is the site that presents the largest amount and diversity of designs in the region. These friezes correspond to Calendric and Astral Friezes, that is to say to calendrical and astral representations associated with the observation of particular astronomical phenomena (departures and sets) of the deified stars: the Sun, the Moon and particular Inca constellations. For these evidences, Huaycán is constituted in a settlement of specialists in astronomy, calendars and Inca religion in this coastal region of Chinchaysuyu (Villanueva 2014, 2015, 2017). From these Calendric Friezes, we will describe the two most complex and important of the settlement.

The “Patio de las Doce Lunas” (Yard of the Twelve Moons) and the December Solstice

The "Patio de las Doce Lunas" (Yard of the twelve Moons) is named for the presence, on the west wall, of the Friso HC 1, a border composed of 12 lunar signs, circular with an upper appendix, which faces a platform that has a span in its back-east wall. The central and visual axis of the span is oriented to the southeast, in an azimuth of 247° 34' 46'', visually towards a low platform, which functions as an artificial horizon marker - which the Incas called Sucanca -, built on the cusp of Cerro Chavilca (National Letter IGN Hoja Lurín 25-i), at a horizon height of 9° 25'. This platform marks the place where the sunset occurs on the solstice day of December 21, (hereinafter PSSD) to a decline of -23°42'51.12'', observed - together and above the frieze - from the center of the span (figure 2). The intentional orientation of the PSSD is ratified by the toponym of Chavilca hill which means "where the Sun (Vilca) arrives (Chay / Chaya)".

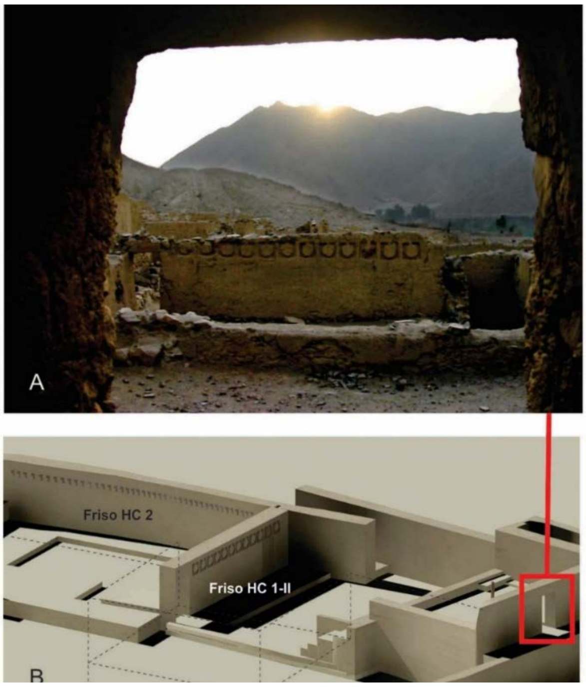

Fig. 2: (A) Observation of the Sunset on the day of the December solstice on the platform on the Chavilca hill "Where the Sun comes", in association with the Friso HC 1, from (B) the central span of the East Platform facing the Friso. Photo: Juan Pablo Villanueva, December 21, 2007.

The “Patio de las Trece Lunas” (Yard of the Thirteen Moons) and the constellation of *atoq*-fox

The "Patio de las Trece Lunas" (Yard of the Thirdteen Moons) is located in another architectural complex, south of the previous one. It is named for presenting, on its south wall, the HC 8 frieze composed of a sequence of 13 circular lunar signs (figure 3) similar to the previous ones, together with two other signs: (1) one of geometric shape - two semicircles joined by a vertical line - located at its western end and (2) another zoomorphic located in the middle of the frieze, identified as the "lunar Animal" present in the Andean iconography from very early periods (figure 3-left) and that would correspond to the representation of a fox that was reflected in the lunar spots (eg Garcilaso de la Vega 1973, t. I: 121 [1609, Bk. Second, Chapter XXIII]) and is also a fox the image of the Pachacámac huaca according to a series of early chroniclers.

From a stool or from the center of the courtyard, a visual axis perpendicular to the Frieze presents an orientation to the south-southeast -144°47'38"of azimuth- towards the top of a hill (height of horizon: 13°43') while the visual towards the "Moon Animal" is aligned with the top of another hill 4° north of the previous one. Both hills, delimit an area on the horizon where around 1500 A.D. it was observed next to the frieze, the sequential heliacal exit -between the beginning of October to December- of a series of Inca constellations near the celestial south pole: *Huchuy Chacana*-South Cross followed by the *Yana puyu*- dark cloud constellations formed of stellar dust in the Milky Way: *yutu*-the partridge, *Yacana*-FLame next to α and β *Centauri* (*llamañawin*-Eyes of the Flame) and *atuq*-fox (cfr Urton 1981: Figs 33 and 65). This last constellation is what was also captured as the "Lunar Animal": fox-Pacahcámac in the frieze. His reappearance occurred just days before, announcing his arrival, from the December solstice that was observed in the previous courtyard.

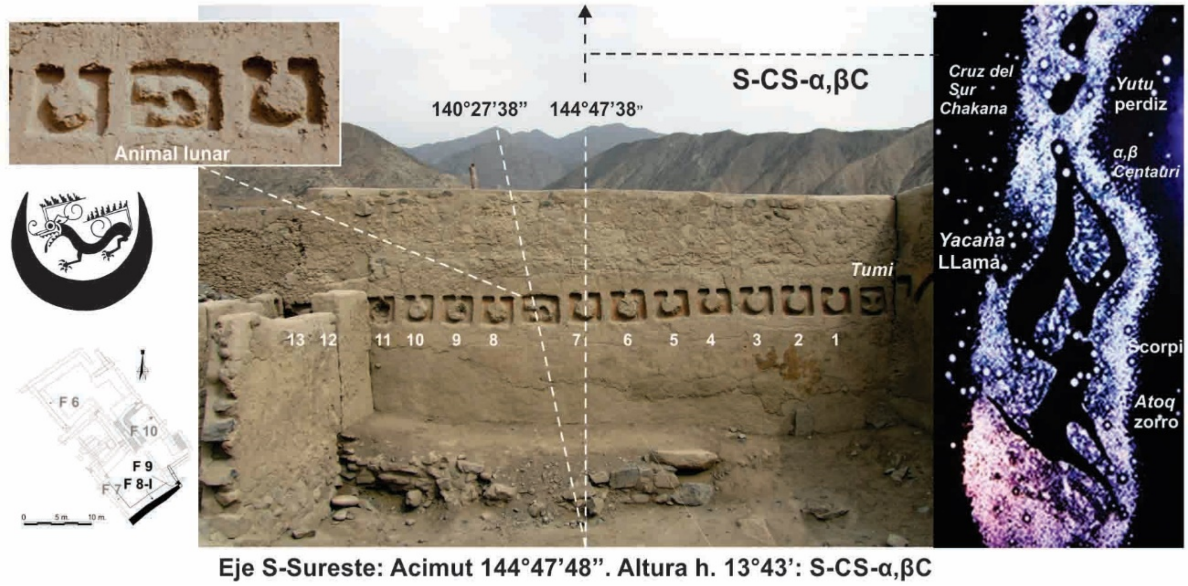

Figure 3. Frieze HC 8 of the "Patio de las Trece lunas" (Yard of the Twelve Moons) oriented to the exit of the Cruz del Sur (South Cross), of α and β Centauri (S-CS-α, βC) and associated dark constellations.

https://www.taringa.net/posts/ciencia-educacion/19359081/Conoce-las-Yana-phuyu-nubes-negras-constelaciones-Incas.html (right). Detail of the lunar Animal and comparison with the Moche Culture sign, taken from G. Kustcher (left).

The moon sign in Cuzco

The lunar sign of Huaycán is also present in Cuzco, in the manner of stone lithosculptures, which today find the atrium of the Church of San Cristóbal, in the Collcampata Palace that was the residence of the Colla-woman of the Inca Huayna Capac and priestess of the Moon (Villanueva 2017). This lunar sign is also represented in the drawings of the twelve months of the Inca ceremonial calendar (3D figure), in the form of a breastplate that is carried by an Inca warrior (figure 3C), only in the *Situa* ceremony performed in the month of September called Coya Raymi Quilla or Quilla Raymi "... the great feast of the moon ... here was the feast and Easter of the moon ..." (Guamán Poma 2002 [1615]: 253-4), which supports its identification as a lunar sign , since it is not present in solar raymis (festival). These silver and copper pectorals (figure 3B) have been found in different funerary contexts of Sacsaywaman, Ollantaytambo and Macchu Picchu, in Cuzco.

Figure 3. Moon Sign: (A) Frieze HC 8, detail. (B) Pectoral Inca found in Macchu Picchu. (C) **Coya Raymi or Raymi Quilla** "Fiesta de la Luna y la Coya" (Festival of the Monn and the Coya) (Guaman Poma 2002 [1615]: 254v, detail). (D) Inka Ceremonial Calendar (Op. Cit.).

Archaeoastronomy and patrimonial education in Huaycán.

Since 2007, the Huaycán de Cieneguilla Comprehensive Project of the Qhapaq Ñan Program-Ministry of Culture of Peru has been developed, within the framework of which I carried out this research. For a couple of years, this project organizes and develops, in cooperation with the District Municipality of Cieneguilla and educational institutions, a series of educational events and cultural dissemination within the archaeological site such as night visits, conferences, workshops and staging whose theme is the Archaeastronomy of the site and the Andean Cultural Astronomy in general. These activities were:

Workshop of Arqueoastronomía directed to schoolchildren of the district of Cieneguilla. 6 November 2015.
https://web.facebook.com/pg/QhapaqNanPeru/photos/?tab=album&album_id=990950590946900

"Night of Stars" - Qhapaq Ñan Week, November 24, 2015. School and public.
https://web.facebook.com/pg/QhapaqNanPeru/photos/?tab=album&album_id=999337800108179

Killawa Tupanapaq "Encounter with the Moon". November 12, 2016 - 7.00: p.m.
Interpretive night visit and archaeoastronomy conference in Huaycán de Cieneguilla by the author
http://qhapaqnan.cultura.pe/noticias/visita-nocturna-interpretativa-y-conferencia-de-arqueoastronom%C3%ADa-en-huayc%C3%A1n-de-cieneguilla

The Hanan Pacha "Sky." VI week of cultural heritage. June 22, 2017. Staging in Huaycán de Cieneguilla recreating the Inti Raymi, the Inca ceremony of the June solstice.

"The Daughters of the Moon and the Children of the Sun". March 2018. First theater workshop and staging held in the main square of Huaycán de Cieneguilla. http://www.portaldeturismo.pe/noticia/recrean-milenario-encuentro-de-culturas-ychsma-e-inca-en-sitio-arqueologico-de-huaycan

These initiatives have achieved important impacts on the local student and teacher community and constitute a seed for the development of an archaeoastronomic cultural tourism in this part of Lima that has a particular local tourism movement that can be inserted into the Sanctuary of Pachacámac.

Conclusions

The archaeoastronomic research in Huaycán provided a series of data that allow us to discuss a series of problems related to Astronomy and the Inca Calendar and pre-Inca coastal societies. Mud sculptures related to the same astronomical observations are present in the first Andean temples, 5 millennia ago, as in Buena Vista on the northern outskirts of Lima (Benfer Et al., 2010) demonstrating a millennial development of the Andean Astronomy. The location of these and other sites in the urban area of Lima and other localities allows these archaeological sites to be used as tools for educational, tourism and cultural sustainable development; as well as in the strengthening of local and citizen identities in favor of the conservation and appreciation of this particular archaeological, architectural, artistic and astronomical cultural heritage. In Huaycán, a seed has been planted that we hope will germinate and spread its spores to the Andean sky.

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Uruguay

Sundials: Resignification and memory recovery

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Abstract

In order to respond to NASE's proposal of looking for elements of archaeoastronomy or astronomy in the street, a bibliographic and images survey was made. By this, the following information was extracted: we have no legacy registered in plastic, written or architectural form, but there is a strong astronomical influence in the construction of sundials and the streets nomenclature of many the cities. We decided to systematize the survey information by registering sundials' data, locate them on a map and reconstruct or improve those that were not in condition. The task was an excellent introduction to develop survey, digital, communicational and scientific competences, as well as apparent sun movement conceptualization.

Introduction

Our country has a great astronomical culture, but not ancient, as in other Latin American countries. In consultation with archaeologists and anthropologists (Renzo Pi, Daniel Vidart, Leonel Cabrera) of our Faculty of Humanities and Education Sciences, no construction or other type of production has been found that evidences an astronomical development on the part of our natives. Although it is difficult to think that our natives, "Indios" did not handle some knowledge related to Astronomy given their agricultural activity, the presence of native animals and plants that could well be projected in the skies, in addition of having a sky without pollution and very rich in brilliant stars, as the southern kies are, we do not have material or documented evidence. There is the importance of registration of the production and maintenance of material goods, beyond the kinetic and psychic aspects that a culture implies, in a society of which Man participates, perpetuates and modifies. Also the fact of living in an intermediate latitude, brings with it important differences in the duration of day and night, not to mention that every organization projects its myths, legends, events and beliefs in relation to a socio-historical-cultural-political in a time and geographic space. However, there is a marked imprint from education, perhaps preceded by some expeditions such as the arrival of the French naturalist Louis Feuillée to the bay of Montevideo as a stopover for a scientific expedition through South America. With his observations of the meridian height of the Sun it was able to determine for the first time the latitude of Montevideo. Alos the scientific expedition under the command of Captain Alejandro Malaspina by 1789, where the first provisional astronomical observatory was installed in Montevideo to observe the transit of Mercury in front of the Sun disk on the 5th November (Etchecopar 1989).

Already in 1816, during the inauguration of the National Library in Montevideo, its Director, Presbyter. Dámaso Antonio Larrañaga, in the inaugural speech said: "Astronomy! This is the country, in my opinion, of astronomers. Here you do not have that sky covered with clouds that hid the stars to Kepler, nor those huge mountains that by their attraction disturb the pendulum of La Condamine and Jorge Juan.

In 1874, José Pedro Varela, leader of the Reformation in Primary School, spoke about the importance of the teaching of science, among them Astronomy, for the progress of the country (The Education of the People , Vol.II, Collection of Uruguayan Classics, Montevideo, 1964). Thus, in 1889 Astronomy was already included in our Secondary School curricula, in 1896 a refractor telescope was incorporated to the Pío College Observatory and in 1922 began the construction of the Montevideo Observatory, which was inaugurated in 1927.

The later history has milestones that shows one of humanity's first wishes: the measure of time. Sundials are creative sculptures that man constructed based on science.

The history of time measure, is the history of Man

Although it was possible to mark intervals of day- time marked by phenomena such as the sunrise, its passage through the meridian and the sunset, for a better appreciation, emerged sundials. The most primitive known was that of a stick, stuck in the ground, known as gnomon, which generates a shadow when illuminated by the Sun. Today this observation may be very obvious, but time must have led Man to realize that the length and position of this shadow varied throughout the day and during the year, with some periodicity.

The measure of time has not only been a concern for Man, but also a necessity. Today digital-screen clocks only show the snapshot of time, a number, without letting us appreciate that time has a becoming and a periodicity closely linked to our circadian rhythms. Sundials do not lie: by the beginning of the day a long shadow shows the moment of the first sunlight, the midday is effectively the moment when the Sun is higher in sky, we see the shorter shadow, which divides the day-time into exactly two equal halves and the end of day period corresponds to sunset.

Today we are tyrannized by those gadgets more or less ornamented that we wear on the wrist, or keep hanging from the wall or leaning on a table, we measure a civil time imposed by the forces of administrative times and uniformity, neglecting the biological and geographical clock. We recognize as noon a moment of the day when the Sun is almost two hours away from crossing the meridian in summer and one hour in winter.

The sundial not only has the virtue of being in tune with nature, but it places us in a historical time and a geographical place. This instrument responds to the historical moment we live, but it is adapted to a certain latitude and longitude of the place, it does not assume the time of another city located in another meridian. Besides it marks the creativity of Man in his construction, in the materials that he uses and even in the legends that he places, generally in Latin. Time is a human construction motivated by that desire to dominate nature, but Sundials resist and respond faithfully to the place and time, where the individual can be the bearer of their own geography of time.

What does the sundial measure?

True Solar Time records the position of the Sun at every moment due to its constant apparent motion. Movement that is not uniform, does not always move angularly at the same speed. Mechanical or electronic watches do not perceive it, the human clock, yes. Only the shadow of an indicator element allows us to know the value of the True Solar Time of the astronomical moment and geographical place in which we find ourselves.

Those responsible for this lack of uniformity, so human, so natural, so idiosyncratic, are the eccentricity of the Earth's orbit and the inclination of the Earth's orbit.

Clocks force us to invent a Sun, a fictitious Sun, which we force to move at a constant angular velocity (does not suffer from depressions and human passions that slow and accelerate our pace) throughout the day and every day of the year: Average Solar Time is equal to what our clocks indicate, with a fixed difference, between different places of the world, related to the length in which we are. Throughout the year, nature also takes on its identity: there is a variable difference between what a Sundial indicates and the Average Solar Time, and it is called Equation of Time, and is equivalent to about 14 minutes of delay for mid February, up to almost 16 and a half minutes in advance at the beginning of November, with another maximum and minimum of about 5 minutes in mid-May and end of July respectively, passing by a zero difference in mid-April and June and at the end of August and December: (http://www.sundials.co.uk/ecuasp.htm)

For this reason we wanted to rescue the sundials from forgetfulness, recognize them from neglected spaces, promote the care and recycling of them, practice the reading of real time, make a survey of existence, their history, encourage the construction of new ones, reed their writings.

Convinced of a humanistic culture, which integrates the arts, sciences and humanities, we believe that sundials are also important as a gateway to other knowledge, which allows collaborative work between representatives of different areas of knowledge , and that ultimately allows us to integrate and share languages that integrate us and reduce the effect of the Tower of Babel and take scientific knowledge as a way of talking about the natural world, the world within our reach: that of children, young people , adults, seniors, undergraduates, graduates and postgraduates. Science education, science literacy, converted into a social tool to generate new representational capacities in individuals (Pozo and Rodrigo, 2001), and Astronomy is an ideal gateway:

Fig. 1: Plotting sundials by google Earth in Uruguay

Description of Activities:

Objectives:

1) Understand the apparent daily and annual movement of the Sun: astronomical causes and local and absolute coordinates.
2) Understand the impact of these movements from the social, economic, psychic and geographic point of view in different places.
3) Build the social, human and astronomical meaning of Time.
4) Rescue from memory the constructions related to orientation and average of time in the whole country: its geographical location and history.
5) Promote the construction of solar watches with contributions from the different fields of training and knowledge.
6) Recognize different types of sundials.
7) Generate an awareness of conservation, maintenance, updating, oral and written disclosure of these socio-astronomical monuments

Fig. 2: Experimental Primary School of Malvín (Montevideo). Built in 1935. Missing gnomon and cleaning, in process (Prof. Esmeralda Mallada). Fig. 3: Montevideo´s Observatory, IAVA, Secondary School Institute Built in 1911 (Prof. Alberto Reyes Thevenet)

Fig. 4: Nueva Palmira, Colonia. Reconstruction of a sundial by students of Secondary School (by Prof. Heriberto Banchero)

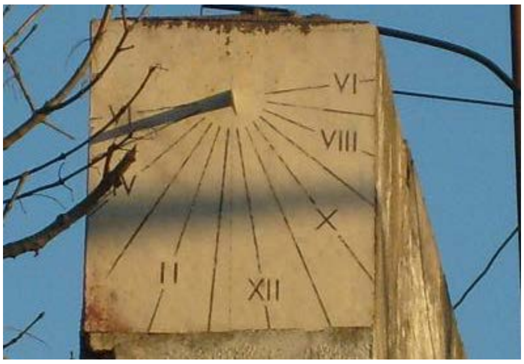

Fig. 5: Melo, Cerro Largo. Built in XIX Century, remade in 1973 (by Prof. Carlos Gereda). Fig. 6: Progreso, Canelones. Built in 1952 (by Ing. Agrim. Adolfo Lista, in an adventist School)

Fig. 7: San Gregorio de Polanco, Tacuarembó.

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US

NASE: Cultural Astronomy in Hawai

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Abstract

In conjunction with the 2015 IAU General Assembly NASE held a workshop in August 2015 at the Bishop Museum in Honololu, Hawai'i. As part of the Cultural Astronomy program, participants visited the Native Hawaiian site of Kukaniloko. This is a brief report of what we learned.

As part of the Cultural Astronomy program, participants visited the Native Hawaiian site of Kukaniloko, guided by Martha Noyes, Cultural Astronomer Researcher.

Today, we modern humans travel to Honolulu on Oahu, Hawai'i by airplane. And if we wish to visit the observatories on Mauna Kea on the Big Island, or another island, we take another airplane. Some transport still relies on ships. However, commercial navigation is now based on the global satellite system and largely computer controlled.

While it is not known when exactly people first arrived on the Hawaiian Islands, Native Hawaiians, the descendants of Polynesian wayfarers, have certainly been living in the Hawaiian Archipelago since the 14th century of the common era. And because they were seafaring people, the Polynesians, and their Hawaiian descendants were acutely interested in and knowledgeable of navigation through observations of astronomical phenomena as well as ocean current, winds, weather, and geography. Naturally, these skills were necessarily taught by one generation to the next

Fig.2: View from above of Kukaniloko (Google Maps). The entrance is on the lower right, and the main complex of stones is seen as the brownish red region in the middle left

Fig. 2: Two stones at the entrance into the site, The large stone on the right is carved.

Kukaniloko Birth Stones (figure 1 and figure 2) is an ancient archaeological site (and now a state park) situated in the center of Oahu on the Waianae Range where, according to history, royal women came to give birth. Up to 36 persons (male chiefs) were witnesses to the event, which occurred at the birthing stone. Figure 3 shows the birthing stone, and Martha Noyes models the position in which the women birthed their babies. Attendants who were present would undoubtedly have caught the baby.

Fig. 3: Demonstrating how a woman may have been positioned during birthing

However, Kukaniloko is a complex of many large stones (pohaku) that obviously have been purposely shaped, as can be seen in Figure 4. As sea-faring people, it was important for Hawaiians to transmit knowledge of navigation, ocean currents, climate, and geography.

Fig. 4. Ground view of Kukaniloko complex

Fig. 5: A demonstration using a pohaku for astronomy

Kukaniloko is believed to also have been a university, and the pohaku were used as instructional tools. Geography and astronomy were certainly part of the curriculum. In figure 5, Martha Noyes demonstrates how one of the pohaku might have been used for observing celestial objects along a line of sight aligned with a geographical landmark.

Fig. 6: An island-shaped stone, likely represents Oahu. The undulated ridges along the edge are worked.
Fig. 7: Modern topographical map of Oahu (Google Maps).

Figure 6 is a pohaku that looks like Oahu seen from above. The carved ridges are likely astronomical – dividing the sky into 20 or so sections. A modern topographical map of Oahu is shown in figure 7, in a similar orientation to figure 6. It is likely that the stone's purpose was to illustrate the general geography or layout of the island, and the ridges mark landmarks as well as positions of important celestial objects at specific times of the year.

Fig. 8: A diamond shaped stone for teaching celestial navigation

Navigation was likely taught with the aid of a diamond-shaped rock. (See Figure 8). This rock was deliberately selected and shaped by the ancient Hawaiians and has 36 ridges distributed around its edge, which align with geographical features around the site. Several concentric circles are carved on the top to teach how to track stars as they move across the local sky during the night and throughout the seasons.

Some of the stones at the site suggest that Hawaiians used landscape features and their relationships as a means of marking time through observations of the annual motion of celestial objects (the Sun, the Moon, planets, and stars) and recurring phenomena like the equinoxes and solstices, and likely eclipses.

Unless otherwise noted, all photographs are by S. Deustua

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China

Rediscover the cultural relics of Beijing Ancient Observatory

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Abstract

Beijing Ancient Observatory had the project to collect the data of the cultural relics in this Observatory.

Beijing Ancient Observatory

The Beijing Ancient Observatory lies beside the Jian Guo Men cloverleaf junction and was first built in 1442 in the Ming Dynasty (1368 - 1644). It has 568 years of history and was the national observatory in the Ming and Qing Dynasty. It is one of the oldest astronomical observatories in the world and was the national observatory of its time.

The Beijing Ancient Observatory consists of a platform, several astronomical instruments and a beautiful courtyard. It is about 14 meters high with 8 astronomical instruments made in the Qing Dynasty. It is also famous for its intact and integrated instruments. The 8 instruments incorporate aspects of western technology and local Chinese art design which demonstrate the exchange between western and eastern cultures. The instruments are designed with symbols depicting Chinese civilization as now seen in books and movies.

The courtyard of the Beijing Ancient Observatory is a local Chinese “Si He Yuan” with a purple hall at the north end. Inside this building there is a tablet written by emperor “Qian Long” from the Qing dynasty which is inscribed with the words: “Guan Xiang Shou Shi”, meaning observe the movement of the stars and planets and then create a calendar. When visiting the observatory, you will feel the conviviality of this place.

The building and the courtyard of the Beijing Ancient Observatory were built in the Ming dynasty. After the Qing Dynasty moved its capital to Beijing in 1644, the observatory continued with astronomical observations. Following western missionary Johann Adam Schall von Bell’s advice, the Chinese began to use western computation standards and measurement systems. Then during 1669-1674, following the orders of Emperor Kang Xi, Ferdinand Verbiest designed 6 new astronomical instruments: the Equatorial Armilla, the Ecliptic Armilla, the Altazimuth, the Quadrant, the Celestial Globe and the Sextant. Later in 1715, Kilian Stumpf designed another instrument--- the

Azimuth Theodolite. In 1744, Emperor Qian Long ordered another instrument to be built--- the New Armilla. Thus all instruments came into being.
In 1900, invading troops from eight different countries came to Beijing. The German and French robbed all the instruments in the Observatory. The French took five instruments to their embassy and returned them the next year, while the Germans took the other five back to their country for display in the Potsdam Hall. In 1921, the Germans returned all five instruments to the observatory.

Fig. 1: Beijing ancient observatory

In 1911, the name of Observatory was changed to “Central Observatory”, and ended its observation life in 1921 because of the establishment of the Purple Mountain Observatory in Nanjing. In 1929, it became the first astronomical museum in China--- “the National Astronomical Museum”. After 1949, the observatory changed its name to “Beijing Ancient Observatory “. It opened to public in May, 1956 and reopened to the world in 1983.

There are three exhibitions on display in the observatory:” Chinese sky”, “History of the observatory” and “European astronomy spreading to China”. These show us the achievements of Chinese ancient astronomy, the history of Chinese ancient astronomy and Chinese culture, and the syncretism between heaven and mankind. Multimedia exhibition methods are used to make a visit to the observatory most memorable.

The Beijing Ancient Observatory holds the world record for continuous astronomical observation: 487 years (from 1442 to 1929) .In 1982 it became a key National Heritage site. The Beijing Ancient Observatory enjoys a high reputation in foreign countries. Many foreign presidents, foreign key government officials and famous scientists have visited the Beijing Ancient Observatory such as Tony Blair (as British Prime Minister), Guy Verhofstadt (as Belgium Prime Minister), etc.

Fig. 2: The platform with several astronomical instruments

Cultural relics

Last year we have a project to collect the data of the cultural relics in Beijing Ancient Observatory. This project consists of three parts: three-dimensional scanning modeling, traditional rubbing (Stone Rubbing) and two-dimensional high-definition heritage photography, which classifies the overall shape, components, astronomical information, decorative details and other elements of the cultural relics, targeted for three-dimensional data acquisition processing, rubbing and two-dimensional high-precision and multi-angle data collection and processing.

In this Project, all the ancient instruments are 2 meters higher and too large to High precision 3D scan. Hand-held scanners & High-Precision Structured-light scanners were applied to acquire geometry information to fulfill relics document requirement.

Meanwhile, for the requirement of High-fidelity color information preservation, this Project have also used IBMR (Image-Based Modeling and Rendering) technology to acquire textures. Color information from Single Lens Reflex camera, geometry information from structured-light scanner, the 3D scanner have assured the precision of geometry, color information are transferred with baking technology. The digital document is focused on high-fidelity, high-precision from beginning to end.

Five months, eight main instrument & more than twenty relics have been successfully scanned and digitalized with advanced computer graphic technologies. Models are finally processed as Unity 3D scenes to display and basic interaction.

Based on the results of the data collections of Ancient Observatory cultural relics by Beijing's municipal financial projects, we could rediscover the cultural meaning of astronomy instruments in ancient observatory, and understand the Chinese traditional concept of harmony between human and nature deeply. Our Chinese medicine is from astronomy, the sky the earth and the people is one system. So you could to see the astronomical instrument like Armillary was include sky earth and living things. This will strengthen the depth and breadth of management, research, and scientific popularization of the collections in Beijing Ancient Observatory.

Fig. 3: Armillary sphere in the ancient observatory

In order to arrive to the Ancient Observatory, visitants can take the underground to Jainguomen Metro Station. This is an interchange station on line 1 and line 2 in Beijing. The walls at Jianguomen Station give us a good idea of the famous Ancient Observatory which are close by mosaics that decorate the platforms. In common with many other subway stations in Beijing, in this occasion the decoration is an example of cultural astronomy in the metro.

Fig. 4 and 5: Platform in the Jainguomen Metro Station with mosaics

Fig. 6: Jainguomen Station is a good example of cultural astronomy in Beijing

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Indonesia

Lontong Cap Go Meh. A celebration at the night of Full Moon

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Abstract

Lontong Cap Go Meh celebration is a special phenomenon of the Indonesian Chinese in Java. This celebration was held on the night of the first full moon after Chinese New Year. Cap Go Meh comes from Hokkian dialect which means the fifteenth night. On that day, the Indonesian Chinese people eat lontong with richly-flavoured dishes such as: opor ayam, sayur lodeh, pindang egg, koya powder, chili paste, and prawn cracker. It is believed that lontong conceived good fortune symbols and the elongated form of lontong also symbolizes longevity. People also watch dragon/lion dance called barongsai during the Cap Go Meh celebration, which is the Chinese lion symbolizes happiness and joy.

Lontong Cap Go Meh

Chinese New Year is calculated based on the lunar calendar. In the Gregorian calendar, the lunar Chinese New Year falls on different dates each year, between January 21 to February 20. In the Chinese calendar, the solstice of winter must occur in month 11, which means Chinese New Year usually falls on the second new moon after the solstice of winter (and sometimes a third if there is the month of a leap year).

On the night of the first full moon after the Chinese New Year, the Chinese ancestry in Indonesia (mostly referred as '*Tionghoa*') are celebrating "*Cap Go Meh*" Festival. The word *Cap Go Meh* Hokkian dialect, "*Cap Go*", which means "fifteenth" and "*Meh*" means night. As the name states, the celebration literally means "the fifteenth night" since Chinese New Year. Typically, Chinese people celebrate New Year for a whole 2 weeks, begins on the first day of the first month in the Chinese calendar system and ends with *Cap Go Meh* in the fifteenth day. Scientifically proven, the full moon always hangs upon the sky of Cap Go Meh. Interesting, isn't it?

Lontong Cap Go Meh celebration is a special phenomenon of the Indonesian Chinese in Java, to be exact in Central Java. Lontong Cap Go Meh is an adaptation of the Chinese cuisine and Indonesian cuisine, especially Javanese cuisine. On that day, the Indonesian Chinese people eat the special food called *lontong* (a dish made of steamed rice in banana leaf). Lontong was eating with richly-flavored dishes which includes *opor ayam* (chicken in coconut milk), *sayur lodeh* vegetables soup (typically made from bamboo tree shoots), hot and spicy liver, hard boiled *pindang egg*, *koya* powder made of soy and dried shrimp or *beef floss, chili paste* and *prawn cracker*. Today, Lontong Cap Go Meh has become so popular food that it is being served anywhere and anytime, with nothing to do with the celebration of Cap Go Meh.

Fig. 1: Lontong Cap Go Meh cuisine

Early Chinese immigrants in Indonesia settled in northern coastal cities of Java, as early as Majapahit period. During that time, only male Chinese settled in Java and they intermarried with local Javanese women and create a Javanese-Chinese culture. These early Chinese immigrants have become accustomed to the cooking of their Javanese wives. To celebrate Chinese New Year, during Cap Go Meh, the descendant of Chinese people in Java replaced the traditional *yuanxiao* (riceball) with local *lontong* accompanied with array of Javanese dishes such as *opor ayam* and *sambal goreng ati* (spicy beef liver). It is believed that the dish reflects the assimilation among Chinese immigrants and local Javanese community. It is believed that *lontong* conceived good fortune symbols; the thick rice cake is considered richer compared to thin rice *congee* that is often associated as food of the poor. The elongated form of *lontong* also symbolizes longevity, while eggs symbolize good fortune.

Generally, during the Cap Go Meh night, people are watching the dragon/lion dance (Indonesians called it as *barongsai/liong*). The name "barongsai" is a combination of the words Barong in Javanese and Sai = Lion in a language dialect of Hokkian. Barongsai in the form of the great human body with the lion-headed. According to this Chinese lion symbolizes happiness and joy. Dancing dragon *Cap Go Meh* (liong) called "Nong Long". Dragon in China is considered as a guardian, who can give you good fortune, power, fertility. In some part of Indonesia with a dense Chinese population, such as Singkawang, Medan, and Palembang, the night is even made more the merrier with the presence of fireworks and firecrackers.

 

Fig. 2: Barongsai dance (left) and Liang-liong dance (right)

The *Cap Go Meh* celebration is not only celebrated in Indonesia alone, though other countries may name it differently. Some Indonesia's neighboring countries, such as Malaysia and Singapore, are celebrating Cap Go Meh exactly the same name, the same way, but in Vietnam, the festival is called *Tết Thượng Nguyên*.

Fig. 3: Chinese lantern

In the origin land China, Cap Go Meh is called *Yuanxiao* or *Shangyuan* and *Yuen Siu* in Hong Kong. According to East Asian tradition, at the very beginning of a new year, when there is a bright full moon hanging in the sky, there should be thousands of colorful lanterns hung out for people to appreciate. At this time, people eat glutinous rice balls and enjoy a family reunion. As to its deep wisdom of gratefulness and family reunion, Cap Go Meh is considered as important as the first day of the New Year itself.

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Japan
Tanabata Star Festival

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Abstract

Every year on 7 July, the seventh day of the seventh month, many people in Japan celebrate the Tanabata star festival. The festival features two bright stars in the July sky, Vega and Altair. Vega stands for a beautiful young woman, Orihime, and Altair stands for a handsome young man, Hikoboshi. People from all generations search for the two bright stars. This star watching is based on the story from ancient China.

Weaving Princess, daughter of Sky King and a hard worker of weaving, got married to a hard worker, Cowman Star, by the arrangement of the Sky King. However, once married, the young couple became lazy. In anger, the Sky King separated the two lovers across the Milky Way River and allowed the two to meet once a year, on the 7th day of the 7th month. On the day, a flock of magpies came and make a bridge with their wings over the Milky Way River so that they could cross the river to meet. This story already appeared in the description of holidays in central China during the 6th and 7th centuries. The story was conveyed to Japan probably in the 8th century. The Weaving Princess became *Orihime* in Japanese, the Cowman became *Hikoboshi* in Japanese.

Fig. 1: In the atrium of a Buddhist temple, Eng-An-Kiong, in Malang, Indonesia where the 82nd NASE course took place, statues of *Orihime* (right) and *Hikoboshi* (left) of the *Tanabata* festival looking at each other over the Milky Way River, are enshrined. Angry King appears on the right edge of the photo. The photo was taken on 23 July 2016 by Tomita.

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People search for the two stars in the evening on the day wondering if the two loving each other, *Orihime* and *Hikoboshi*, surely meet over the Milky Way River.

The star festival is also celebrated in not only Japan but also many countries in East Asia including China, the place of origin. The way of the festival is different from country to country based on each country's cultural background.

As well as that love story, in Japan people celebrate this day by writing wishes, sometimes in the form of poetry, on *tanzaku*, small pieces of paper, and hanging them on bamboo, sometimes with other decorations. At nurseries, kindergartens, and schools, in the daytime, children enjoy making the decoration and writing the wishes, sometimes singing the *Tanabata* song. In night time, children search for the two stars with friends and parents.

Fig. 2: The Tanabata decoration at Hikari Nursery, Osaka, Japan. Young children have many wishes. The photo was taken on 7 July 2012 by Tomita.

The celebration of writing wishes may originate from another traditional custom. In the 8th century in Japan, the *Kikkouden* ceremony at the palace imported from China was held. In the 17th century of the Edo era, the Edo Shogun government established the five seasonal festivals; 7 January, 3 March, 5 May, 7 July, and 9 September. One of them is *Tanabata* on the 7th day of the 7th month, growing as a daily-life festival together with other ancient events and customs [2].

On 7 July of the Gregorian calendar which Japan officially uses, it often rains because Japan experiences rainy season in June and early July which marks the boundary between spring and summer. Therefore, many people cannot see the two stars on the day. Traditionally, Japan used the lunisolar calendar which marked the dates almost a month earlier than the present-day solar calendar; though it is different from year to year, the traditional 7 July corresponds to around present-day 7 August, when Japan clears the rainy season and prepares the clear evening sky for the two bright and beautiful stars. Therefore, in some area in Japan, people celebrate the festival on 7 August of the present-day calendar or on 7 July of the traditional lunisolar calendar.

Fig. 3: The Summer Triangle standing across the Milky Way. Vega, in the center bottom of the photo, representing *Orihime*, and Altair, in the upper left of the photo, representing *Hikoboshi*, shine looking at each other across the Milky Way River. The photo was taken at Wakayama, Japan, on 16 August 2010 by Tomita.

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Romania

The Orthodox Churches' Orientation toward East-West direction in Cluj/Napoca

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Can we orientate after the church's direction if we have no compass?

Abstract

How to find the cardinal points in a new place without compass? It's very simple: you can use the orthodox churches' orientation. Or ... it's not so simple and you need to learn something more.

"Ad orientem" (in Latin - toward east) position is an important recommendation for the apse of the Orthodox Church. In the same time during the mass the priest has to pray to the east. So then many of Romanian Orthodox churches respect this. The article contains a study upon the orientation toward east-west direction for some orthodox churches in Cluj Napoca. The chosen churches are the oldest and very important or new ones. For all of them, at the first sight, one can think that the location is right and the church could be well oriented. The found deviations are between 0^0 and 330^0.

To be sure you correctly identified the cardinal points in a new place it is advised to ask an astronomer.

Introduction

The Nicaean Council in 325 and then Saint Athanasius from Alexandria established that the church has to be oriented with the sanctuary (with apse and sacristies) at the east.

The oldest writings (The Teaching of the Twelve Apostles – written in 1056**,** Constitutions of the Holy Apostles - written in 380) stipulated that the Christian churches have to be built upon higher places, and with the altar to the east. Setting a church high is a symbol of the spiritual church, of the "citadel standing above the mountain".

The position of the altar (apse) toward the east [1], the light or the "light of light" are closely related to the Christianity and its purpose in the world. Often, Christ, the founder, is named „Light of the World" or "The Rising One". As established in the Orthodox Christian faith, at the second coming, the Saviour will also appear from the east. This is why every prayer and the divine service deployed in the church can only be conceived in a place orientated with the apse to the east. Orthodox Christians place their icons at home only on an east wall. To stay with the face to east during the liturgical prayer is part of the Byzantine, Syrian, Armenian, Coptic and Ethiopian traditions.

In our days, it is very easy to build a church with a certain orientation, but some centuries ago, even if the compass was known, people were very good "astronomers". They were staring at the stars with much attention and they were guided by them.

Our purpose was to verify if we can find the cardinal points in a new place only after the church's direction.

What and how have we done to reach our purpose? We checked the orientation of some old and new orthodox churches using compass applications on iPad or iPhone .

What is the orientation of some orthodox churches from Cluj/Napoca?

Cluj-Napoca, the capital of Cluj County is the biggest town from Transylvania and known as Napocensis municipium during the Roman Empire in the first century. Now Cluj-Napoca has about 450.000 inhabitants and is a city with seven universities (about 80.000 students). It is the capital of IT in Romania.

The confessional structure in the city looks like this: Orthodox – 65.6 %, Protestants – 9.7 %, Roman-Catholics – 4.6 %, Greek-Catholics – 4.3 %, Unitarians – 0.9 %, Pentecostals – 2.4 % and Baptists – 1.1 %. In Cluj County, there are 832 churches but in the town there are75 churches, from which 44 are orthodox.

EXAMPLES OF OLD ORTHODOX CHURCHES

The Holy Trinity Church (figure 1)[2] is the first Orthodox Church from the city. It was built in 1796 in baroque style and on the direction east - west but with a deviation of 4^0.

Fig. 1: The Holy Trinity Church

The best found orientations belong to the next three old wooden churches which are located now in the National Ethnographic Park "Romulus Vuia" Cluj-Napoca, the first open-air ethnographic museum in Romania (1929). These churches were moved in the museum in the period 1965 – 1968 but they were built in seventeen or eighteen century. It's very interesting that in a communist period the curator of the museum took care to settle these churches in the right position.

The Cizer Church (figure 2) [3], Petrindu Church (figure 3) [4], and Chiraleș Church (figure 4) [5] are oriented in the right direction east-west with the very small deviations: 1^0, 0^0 and respectively 3^0.

Fig. 2: The wooden Cizer Church

The wooden Cizer Church was built in 1773 by Vasile Nicula Ursu, the well known "Horea" in Romanian history. Horea was a leader of a peasant uprising in 1784 in Transylvania. The church is important not only because it is the only one that bears the signature of Horea, but also because it is emblematic of the stage of maturity in wooden structure building in Romania.

Fig. 3: The wooden Petrindu Church

Fig, 4: The wooden Chiraleș Church

The Petrindu Church was built in the 18th century. Inside it is preserved a valuable wall painting from 1835, signed by Dimitrie Ispas of Gilău, one of the most famous church painters of Transylvania

EXAMPLES OF NEW ORTHODOX CHURCHES

The next checked churches are new ones, they were built after 1989 (Table 1). There are many others churches which are not at all oriented in the good direction because they were built in tight places or they respect the town systematization plan (i.e. The Orthodox Cathedral [6] although was erected in a large square, during 1923-1933 has the direction north-south).

	The church's name	**Deviation from the east-west direction**	**Position**
1	Descent of the Holy Spirit [7]	5^0	along the street
2	St. New Dmitry [8]	8^0	in a square
3	Nativity [9]	22^0	in a corner

Table 1: New Orthodox Churches

It was expected that the oldest Orthodox Church (figure 5) located very close the city (in Feleacu village), to be well oriented. Usually called The Ștefan's the Great (Moldavian voivode) Church, The Saint Paraschiva Church [10] was finished in 1516 and has a deviation of 23^0 from the right direction. The reason can be the very tight place where the church is settled: on a hill in a cemetery.

Fig. 5 The Ștefan's Church

Near this church is a new monastery [11], where the Holy Crucifix Church (figure 6) has a deviation of 11^0. You can see that the church's position is along the street.

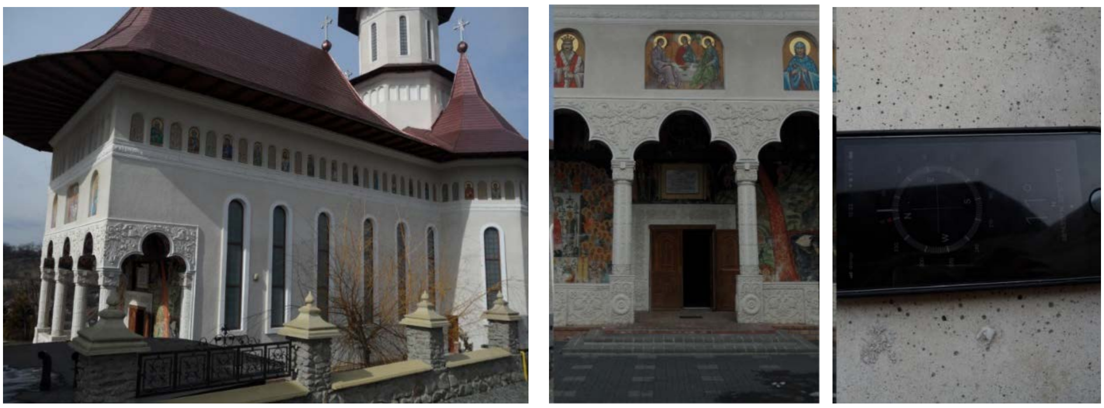

Fig. 6: The Holy Crucifix Church

We checked also the three churches, one of wood (figure 6) and two of stone (figure 7) from the Nicula Monastery [12] which is at distance of 52 km from the city Cluj-Napoca.

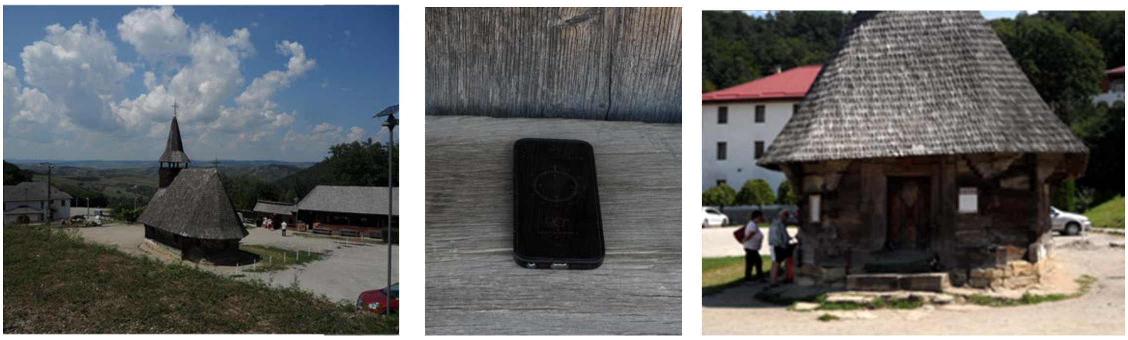

Fig. 6 The wooden church from the Nicula Monastery

Here we found the best oriented churches because all three have no deviation from the east-west direction.

Nicula Monastery is an important pilgrimage centre from Transylvania especially in the 15th of August – the Assumption of the Blessed Virgin Mary. The technique of glass painting was brought at first in Romania in this monastery. According to a minute made by Austrian officers, he famous icon painted on wood in 1681 by the priest Luca from Iclod shed tears between the 15th of February and the 12th of March 1699.

Fig. 7: The stone churches from the Nicula Monastery

The old stone church was built in the period 1875-1879 and the new Orthodox Church is not yet ready.

Conclusion

There were found some orthodox churches well settled in the east-west direction (generally built before 1900). The new ones are usually built after the city systematization plan.

So at the initial question "*Can we navigate just by looking at the position of churches?*" without a regular compass, a Smartphone, an iPad or another new device ...
the answer is ...

It's preferably to learn more astronomy to be sure you know the cardinal points in a new place, or to ask an astronome**r.**

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Spain

Orientation in Roman cities. Zaragoza, the Roman "caesaraugusta"

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Abstract

Since immemorial time and in all ancient cultures, Man has been looking at the sky. Astronomy, mythology, religion and beliefs, all mixed together were the base of his life. What happened in heaven determined completely his life. About that, movements of the Sun and the Moon, something that he can see and observer every day, were very important.

The orientation, in some way, was present in the mayority of the arqueologycal buildings that we can find arround the world. The concept of orientation was transmitted from civilization to civilization and was added to their respective cultures and reached the Roman times. In this paper, we want to present the importance of orientation in the founding of any Roman city. In our case this city is Saragossa.

Architecture or urbanism of the Roman Cities

Cities conformed the civil and social structure of Roman living: trade was centralized, the different conquered peoples were related to each other, and in general the population was controlled. The urban design of the Roman cities follows a guide model necessary for the right functioning of the public and military services.

Basically, the Roman city is composed of a series of *equal modules*, arranged in an orderly manner -parallel and equidistant- and separated by streets. Together they form a set of *rectangular* design that is surrounded by a *perimeter wall* with watchtowers.

All streets are equal except two, the one that goes from the north to the south -*Cardo Maximus*- and the other from the east to the west –*Decumanus Maximus*-, which are wider and end in the only *four doors* that the wall has. Where these two streets intersect are located the Forum of the city and the market.

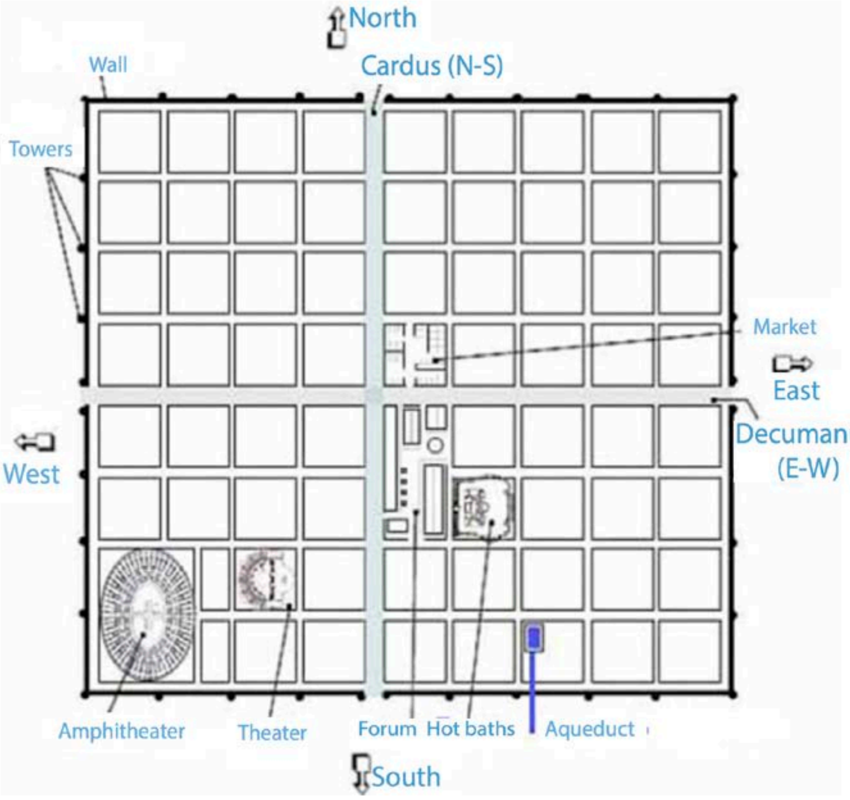

Fig. 1: The Roman city planning.

With modules are designed public buildings, the *amphitheater* -two modules long and one and a half wide-, the *theater* -one module-, the *market* -one module-, the whole *forum* -two modules-, etc. Forums or socio-cultural centers of the cities, usually were located at the intersection of *the cardo maximus and decumanus*. A large porticoed square was the center of a series of buildings that surrounded it, communicating thus through it. *Temples of imperial worship, schools, markets* and even the *hot springs* had direct access from it. In some cases, even the entertainment buildings -*circuits, theaters or amphitheatres*- were communicated with the forums, these being the access of the great personages to their stands. These urban rules are developed for almost 10 centuries creating different cities.

The Roman city Caesar Augusta

Caesar Augusta was founded in the year 14 BC as an immune colony. Soldiers from the legions who fought with Caesar Augustus in Hispania between 29 and 26 BC were integrated in the Iberian Salduie, forming a new Roman colonial city of mixed character as Estrabon reflects in its Geography.

Caesar Augustus who lived between the 63 BC and 14 AC, was not friend of great trips but he did two to the Occident provinces that needed a reordering. Both Galias and Hispania were territories of their direct jurisdiction and not of the Senate. In both trips he was in Hispania and in both trips he founded numerous cities.

Fig. 2: Ancient Roman city within current Zaragoza.

The standard norm has two objection at the time of using it as criterion to find out if the foundational ritual was applied with rigor. The first, it was not strictly obligatory and the concrete topographical circumstances were determinants; the second, as it has been proven, the city experienced notable changes in its layout in the Tiberius times. These two circumstances were probably the ones that the most influenced to orienting (*or disorienting?)* the new city.

To these circumstances a third one is added that Pliny the Elder gathered in his work *Natural History* in which he described, country important by country, the peculiarities of territories and their populations. Of the Roman Saragossa says that *it was built in a place where before there was a indigenous city called Salduvia*. (*Salduie*, the preexistent Celtiberian city, was perfectly aligned with the course of the Ebro river).

The *cardus* and *decumanus maximus* were two central streets of the city, oriented the first in the North-South direction and in the East-West the other. *Cardinal points* come from the word cardo. The cardo and decumanus maximus can be seen in figure 2, as well as the structure of the entire Roman city.

In Caesar Augusta *decumani* were parallel to the Ebro, natural vertebrador of the valley, to favor the irrigation of ample extensions. The city had a *maximum decumanus parallel to the Ebro that coincided with the current streets Mayor and Espoz y Mina*. Cut to the *maximum cardo* in the Plaza Ariño, which *would go*, more or less, *under the street D. Jaime I*, *but something more to the West*, as suggested by the sewer discovered at the confluence of this street with Plaza del Pilar.

The limits of the colony are given by Coso Street (cursus, exterior route), the old street Cerdán, the Central Market, the church San Juan de los Panetes, the Ebro riverside and the Monastery of the Holy Sepulcher.

Fig. 3: The cardo and the decumanus through the current streets D. Jaime I and Espoz and Mina - Mayor streets. The current north direction has also been marked.

Caesar Augusta is another example of a city born next to a bridge, the river acting as an authentic *genitor urbis*, as in Mérida, Lutetia (Paris), Vienne, etc.

The doors of the city were located in the expected location, those of Toledo and Valencia at the ends of the decumanus, and those of the Angel and Cinegio Arch in those of the cardus. It is insecure the southern section of it, because the current initial section of Jaime I with the Coso is from the early eighteenth century, which distorts, imprecisely, the original tracing of the cardo. In figure 3 the cardo has been traced along the Jaime I street.

The decumanus mayor seems to be more reliable in Espoz y Mina and Mayor streets. It is also interesting to take into account the tracing of the aqueduct-bridge over the Ebro river coinciding with the prolongation of the cardo maximus. Of stone, at least in good part, mainly for reasons of urban range and prestige.

During the last 5 years the studies in Spain related to the orientation of the Roman cities have been carried out exhaustively by various researchers. It is necessary to mention here the works of Andrea Rodríguez Antón under the direction of Juan Antonio Belmonte. After studying the orientations of more than 250 Roman sites located in different regions of the empire, both east and west of Rome present patterns that suggest orientation according to an astronomical intentionality, perhaps due to the integration of important dates for Roman calendars or the pre-Roman peoples. According to Rodríguez Antón (2018) there is a preference for adjusting the decumanus towards the sunrise of the Winter Solstice, with a Sun declination of -23.5º in enclaves both east and west of Rome. The winter solstice is relevant from the astronomical point of view because it corresponds to one of the extreme positions of the sun on the horizon phenomenon observed in most cultures and a few days before Saturnalia was celebrated, one of the best-known Roman festivals in all the Empire.

Just as Salduie went with the Romans Caesar Augusta, with the Arabs Saraqusta (also Medina Albaida) and later Zaragoza, it happened with many other cities that were modernized and adapted to each era.

Conclusions

Although following the canons that required the foundation of a Roman city in the final morphology of this city, the concrete topographic conditions of the terrain undoubtedly influenced.

First, the Roman city is founded on the ancient Celtiberian Salduvia, which had a traced parallel to the Ebro river, as can be seen in figure 2 which represents the Roman town, and in figure 3 where it is easy to distinguish without difficulty the area of the ancient Roman city in the current Zaragoza.

In second place, because of what has been found in excavations, the cardo did not follow exactly Don Jaime I street where today we draw the cardus maximum, due no doubt, to the transformations of the city for centuries.

If the East direction of the new Roman cities was marked according to the direction of the sunrise at the winter solstice (Rodriguéz Antón 2018), as the N-S direction is perpendicular to the E-W one, the North direction of the city should be displaced towards the East those same degrees, that is close to 32º. If we see in figure 3 the angle formed by the geographical north with the direction of the maximum cardo passing through Don Jaime street, we obtain an angle slightly greater than 32º.

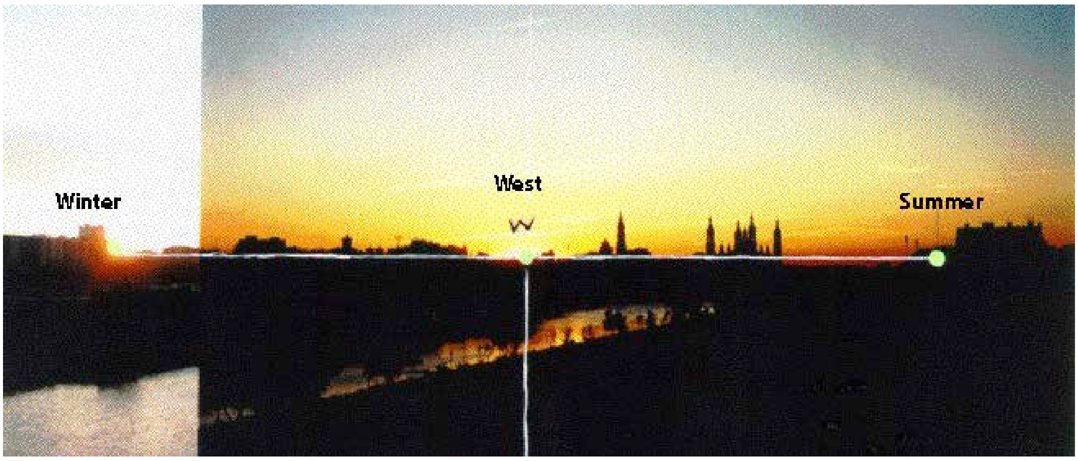

Fig. 5: Sunsets in Zaragoza at dates close to the solstices and equinoxes.

We present the pictures of the sunsets (figure 5) but the angular distances between summer and autumn and autumn and winter are the same as those of the sunrises in that place. Therefore, considering figure 6, we can calculate the declination of the Sun for the winter solstice in Zaragoza.

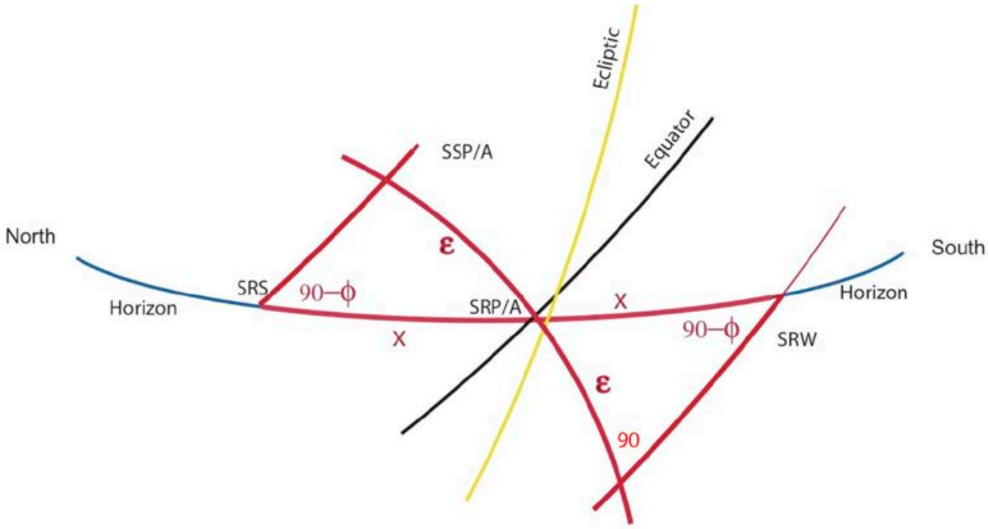

Fig. 6: Sunsets for calculating the Sun declination at the solstices and equinoxes.

If we consider that figure 6 represents the sunrises in Zaragoza, x = 32, ϕ = 42 and 90 - ϕ =48, and callind D la declination of the Sun (that has to be close 23 degrees) using the sines theorem, we have,

$$\sin x / \sin 90º = \sin D / \sin (90 - \phi)$$

substituting,

$$\sin 32º = \sin D / \cos 48º \quad \rightarrow \quad D = 23{,}2 \text{ degrees}$$

Then D = 23.2 degrees is quite close to the value corresponding to the declination of the sun on the winter solstice day, which is D = - 23.5 degrees. This means that x = 32, is the angular distance from the cardinal point east to the point on the horizon toward which the maximum decumanus pointed. The same angle that we have found between the cardus and the north direction because cardus and decumanus are perpendicular.

This allows us to conclude that the Roman city Caesar Augusta (Zaragoza) was founded according to the standard canons of the entire empire.

That small difference may well be due to precision errors in the measurement and to the commented lines above about the real deviation of the Roman cardus with respect to the present Don Jaime street.

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