"Living skies"/ "Cielos vivos"

Astronomies, cultures and societies / Astronomías, culturas y sociedades

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Oxford XII Conference, ISAAC
&
VIII Jornadas Interamericanas de Astronomía Cultural, SIAC

La Plata, Buenos Aires, Argentina
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EQUIPO DE ANTROPOLOGÍA DE LA RELIGIÓN
SECCIÓN ETNOLOGÍA ICA/FFYL-UBA

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UNIVERSIDAD NACIONAL DE LA PLATA

EAR EQUIPO DE ANTROPOLOGÍA DE LA RELIGIÓN
SECCIÓN ETNOLOGÍA ICA/FFYL-UBA

The present volume includes all the abstracts of the oral and poster presentations accepted to be delivered at the **Oxford XII Conference (ISAAC)** and **VIII Jornadas Interamericanas de Astronomía Cultural (SIAC)**. This is the second Oxford conference held in South America and the first academic event held jointly by the **International Society for Archaeoastronomy and Astronomy in Culture** (ISAAC) and the **Sociedad interamericana de Astronomía en La Cultura** (SIAC).

This five-day symposium, preceded by a five-day school for young researchers -IX Escuela Interamericana de Astronomía en la Cultura and X La Plata International School on Astronomy and Geophysics (LAPIS)- is frame in the context of the radical improvement of studies on cultural astronomy from Latin American in the last twenty years, and its growing dialogue with world research in this interdisciplinary field.

The title of the conference, "Living skies / Cielos vivos", indicates their main interest: to stimulate the study of the role of astronomy as an integral and significant part of the daily life of different human societies, and make people aware of the general relevance of astronomical knowledge. This title also aims to emphasize that astronomical systems and practices are not static: they change over time and are permanently in the process of construction. From this perspective, this conference is concerned with the discussion of theoretical and methodological problems and also addresses issues of primary importance for the professional astronomical community in its relationship with the whole of social life: the world astronomical heritage, astronomical education and the link between astronomy and development.

El presente volumen incluye todos los resúmenes de las presentaciones orales y en póster aceptadas para ser entregadas en la XII Conferencia de Oxford (ISAAC) y las VIII Jornadas Interamericanas de Astronomía Cultural (SIAC). Esta es la segunda conferencia de Oxford que se realiza en América del Sur y el primer evento académico realizado conjuntamente por la Sociedad Internacional de Arqueoastronomía y Astronomía en la Cultura (ISAAC) y la Sociedad interamericana de Astronomía en La Cultura (SIAC).

Este simposio de cinco días, precedido por una escuela de cinco días para jóvenes investigadores -IX Escuela Interamericana de Astronomía en la Cultura y X La Plata International School on Astronomy and Geophysics (LAPIS)- se enmarca en el contexto de la mejora radical de los estudios sobre la astronomía cultural latinoamericana en los últimos veinte años, y su creciente diálogo con la investigación mundial en este campo interdisciplinario.

El título de la conferencia, "Living skies / Cielos vivos", indica su principal interés: estimular el estudio del papel de la astronomía como parte integral y significativa de la vida cotidiana de las diferentes sociedades humanas, y sensibilizar a las personas sobre la relevancia del conocimiento astronómico. Este título también pretende enfatizar que los sistemas y prácticas astronómicas no son estáticos: cambian con el tiempo y están permanentemente en proceso de construcción. Desde esta perspectiva, esta conferencia se preocupa por la discusión de problemas teóricos y metodológicos y también aborda temas de primera importancia para la comunidad astronómica profesional en su relación con el conjunto de la vida social: el patrimonio astronómico mundial, la educación astronómica y el vínculo entre la astronomía y desarrollo.

	Monday/Lunes (31 oct.)	Tuesday/Martes (01 nov.)	Wednesday/Miércoles (02 nov.)	Thursday/Jueves (03 nov.)	Friday/Viernes (04 nov.)	Saturday/Sábado (05 nov.)	Sunday/Domingo (06nov.)
08:00	**Accreditation/Acreditación**		**ISAAC Assembly/Asamblea ISAAC**				
09:00		Graphic Rock Manifestations/Manifestaciones gráficas rupestres		Greco-Roman skies/Cielos greco-romanos	Methods, concepts and tools/Métodos, conceptos y herramientas		
09:30	**Opening/Apertura**						
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11:20							
11:40	Abrahamic Astronomies/Astronomías abrahámicas	European Megaliths/Megalitos europeos		Heritage/Patrimonio	Ethnography and Temporalities/Etnografía y temporalidades		
12:40	**Lunch Time/Tiempo para almuerzo**	**Lunch Time/Tiempo para almuerzo**		**Lunch Time/Tiempo para almuerzo**	**Lunch Time/Tiempo para almuerzo**		
13:40						**Post conference optional excursion / Excursión opcional post-conferencia**	
14:40	Oriented Landscapes/Paisajes orientados	Education/Educación		Cosmic Urbanism/Urbanismo cósmico	Colonial Urbanism/Urbanismo colonial		
15:40			**Trip to Bs. As. / Excursion Bs. As.**				
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16:20	Structures and observation/Estructuras y observación	Education & Art/Educación y arte		Calendars and climate/Calendarios y clima	**Closing/Cierre**		
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17:40	**Mesa redonda**: educación, comunicación y relación con la sociedad	**Mesa redonda**: diversidades y políticas del conocimiento		**Mesa redonda**: patrimonio, "desarrollo" y conflictos			
18:20							
18:30							
19:00					**Public talk/ Charla para todo público**		
19:30	**Cocktail / Cóctel**						
20:00				**Dinner/Cena**			
20:30							
21:00							

	Monday/Lunes (31 oct.)	Tuesday/Martes (01 nov.)	Wednesday/Miércoles (02 nov.)	Thursday/Jueves (03 nov.)	Friday/Viernes (04 nov.)	Saturday/Sábado (05 nov.)	Sunday/Domingo (06nov.)
08:00	Accreditation/Acreditación		ISAAC Assembly/Asamblea ISAAC			Post conference optional excursion / Excursión opcional post-conferencia	
09:00		Mejuto, Villanueva, Izquierdo, Houston		Berio, Boutzikas, Pérez-Enriquez, Rodríguez-Anton	Ruggles, Belmonte, Zotti, García Regna		
09:30	Opening/Apertura						
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10:40	Baratta, Pankenier	Zimbrón, Pino Matos, Quiros-Enis		Aguilera, Edwards	López, Hamacher, Malville		
11:20							
11:40	Mudrik, Adams, Urrutia	Gonzáles García, Higginbotton		Wolfshmith, Rojas	Gómez, Faulhaber, McCluskey		
12:40	Lunch Time/Tiempo para almuerzo	Lunch Time/Tiempo para almuerzo		Lunch Time/Tiempo para almuerzo	Lunch Time/Tiempo para almuerzo		
13:40							
14:40	Gianotti, Munson, Pinasco	Holbrook, Lanciano, Pernicone		Corrado, Shady, Martz	Muratore, Gómez Ruiz, Cobo		
15:40							
16:00							
16:20	Morante López, Salas Delgado	Williams, Williamson, Mott		Patrick, Quijano, Iwaniszewski	Closing/Cierre		
17:00							
17:20							
17:40	Camino, Williamson, García, Thomazi Cardoso	Holbrook, Faulhaber, López, Alves-Britos		Iwaniszewski, Wolfshmith, Ruggles, Gullberg	SIAC Assembly/ Asamblea SIAC		
18:20							
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ORAL PRESENTATIONS

ORAL PRESENTATIONS

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When the Scorpion Rises: Evolutions of Arabic Rhymed Prose for Seasonal Forecasting

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Traditional naked-eye astronomy was a rich element of Arab culture that figured prominently in the daily lives of herdsmen, farmers and fishermen, and indeed much of society (Varisco 2000). These cultural practices were passed down from ancestors to successors for a very long time, and the knowledge was preserved through oral poetry and rhymed prose, an ancient and honored Arab tradition. Abbasid (750-1258 CE) historians were the first to document traditional Arab astronomical knowledge, the most complete extant work being the *Kitab al-Anwā'* (1956) of Ibn Qutayba, who died in 889 CE. His work and the remnants of other works (see Ibn Sīda 1898-1903; al-Marzūqī 1914; Quṭrub 1985; and al-Ṣūfī 1981) reveal the breadth of application of local star knowledge to the prediction of seasonal weather changes which in turn forecast various elements of floral, faunal and social cycles (Henninger 1954; Pellat 1955; Varisco 1991).

Observed in the dawn twilight of the morning, setting and rising stars alike played strong roles in indigenous Arabian cultures. Cosmical settings were predominant and featured strongly in poetry and even the Qur'ān, but heliacal risings were predominant within the particular medium of rhymed prose (*saj'*). Considered by some to have been a precursor to the first forms of classical Arabic poetry, rhymed prose featured a rhyme at the end of each phrase without any internal meter or required number of syllables. Within the context of heliacal risings, the rhymed prose was highly formulaic, beginning with the phrase, "When [star] rises, …" The rhymed phrases that followed this opening connected the seasonal time of the star or asterism's heliacal rising with characteristics of the floral, faunal and social activities undertaken during that time. Thus, the pieces of rhymed prose contained practical lessons that communicated an intimate knowledge of life in the desert among the Arabs, who observed "the blowing of the winds, the rising of the stars, and the changing of the seasons" (al-Marzūqī 1914, 2:179-180). A peculiarity of this set of rhymed prose is that attributions of authorship were never identified within the literature that remains extant, indicating that the these rhymed prose sayings developed organically out of Arabian society. **In this paper, the author examines the development of rhymed prose over time for the celestial complex of the Scorpion *(al-ʿaqrab)* as an example of the ongoing social process of construction of these rhymed prose sayings and their evolving utility for seasonal forecasting.**

Over time, the Scorpion developed rhyme prose for the figure as a whole and for each of its four constituent parts: the Pincer *(az-zubānā)*, the Crown *(al-iklīl)*, the Heart *(al-qalb)*, and the Raised Tail *(ash-shawla)*. An analysis of the Arabic source material shows that the Scorpion had appeared in pre-Islamic poetry by 600 CE, and it was first included in an extant compilation of rhymed prose by Quṭrub (d. 821 CE), who listed the constellation as the first of the rising stars of winter. Outside of his ordered description of the rising star calendar, Quṭrub also included rhymed prose for the Pincer, the Crown, and the Heart, but he did not include rhymed prose for the Raised Tail. Decades later, Ibn Qutayba (d. 889 CE) included rhymed prose for all four parts of the Scorpion, as did his contemporary Abū Ḥanīfa (d. 896 CE). However, both the organization of this content and the content itself were significantly different in these later works.

In the rhymed prose for the Scorpion as a whole, the early of account of Quṭrub contained 4 rhymed phrases that were mostly retained by the later authors, with some variations, one omission by Abū Ḥanīfa, and one added phrase bin Ibn Qutayba's account. However, the rhymed prose for the four parts of the Scorpion saw a great degree of change over time. For example, the Pincer had a simple piece of rhymed prose with just two phrases recorded by Quṭrub, but Ibn Qutayba and Abū Ḥanīfa recorded an entirely different piece of rhymed prose with five phrases. Both of these variations then appeared in the work of al-Marzūqī (d. 1030 CE). In the case of the Crown, the piece of rhymed prose recorded by Quṭrub never reappeared in later works, but in the case of the Heart, the piece of rhymed prose recorded by Quṭrub persisted as the core around which additional rhymed phrases were added.

The examination of these snapshots of rhymed prose for the Scorpion, as recorded by these four authors whose lifetimes spanned a period of two centuries, provides insight into the processes of change in social astronomical systems that continue to evolve over time rather than remaining static. As such, these living skies of Arabia are windows into the integral roles that indigenous astronomies play within a society.

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Identidad, Astronomía y Cosmos Conciencia del Pueblo Diaguita en los Territorios Ancestrales de los Valles de Choapa

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Palabras clave

Cosmos conciencia, territorio, religiosidad popular, trashumancia.

Con esta presentación intentamos conocer, y valorar; el legado cultural, la cosmos- conciencia y el conocimiento astronómico del Pueblo Diaguita", a partir de la reconstrucción simbólica del territorio de la provincia de los valles de Choapa, región de Coquimbo, norte de Chile. El universo representacional del diaguita, tiene singularidades histórico - culturales caracterizado por símbolos y signos representativos de su iconografía, estética y diseños presentes en el arte rupestre, la cerámica, la música y la oralidad. Tomamos como eje fundacional elementos de geografía sagrada terrestre y celeste, además de aspectos bióticos y climáticos cuya significancia calendárica y astronómica esté relacionada con las montañas tutelares, el río, el mar, la religiosidad popular, la trashumancia y el arte rupestre. Este estudio incorporó elementos del concepto de auto-similitud de la geometría fractal de Mandelbrot y el enfoque del paradigma de la complejidad de Luhmann y Madera, así como conceptos de la cosmos-conciencia de los pueblos ancestrales fundados en los principios de la ciencia ancestral del universo representacional diaguita, como son: los cuatro elementos, las cuatro puertas, y los tres mundos. También nos basamos en la astronomía cultural desarrollada por Broda (1991-1993) y Bustamante y Moyano (2011). Nuestra investigación contempla el posicionamiento geográfico, la fotografía y en los lugares con antecedentes culturales, con apoyo de cartografía IGM (escala 1:50.000). Los antecedentes recopilados se analizan y se construye una propuesta interpretativa intersitios. En síntesis, entendidos como parámetros del tiempo social que se configuran a partir de la articulación del arte rupestre, las actividades tradicionales y la cosmos- conciencia de los pueblos de los territorios del Choapa.

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Applying the methods of Archaeoastronomy to the study of feng shui: the case of the three Ming capitals

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With the rise to power of the Ming Dynasty, after Mongol foreign domination, a clear project aimed at the legitimization of power was consolidated, drawing on the one hand from the Chinese urban planning tradition described by *Kao Gong Ji* and, on the other, from the traditional Chinese doctrine of the landscape (the so-called *feng shui*).
In the Chinese imperial system, power resided in the figure of the emperor, the *Son of Heaven*, who, as the holder of the *Divine Mandate*, had the power and rule of understanding the heavenly order and bringing it down to earth (Krupp 1982). The main instrument for achieving this was urban planning (Schinz 1996, Steinhardt 1999). This paper will discuss the potential of adopting the methods of modern Archaeoastronomy (Magli 2018) within an Archaeo-topographic context, as recently applied specifically to the Beijing case (Baratta & Magli 2021). In this sense we will be able to study astronomical relationships as well as topographical and magnetic ones, considering a link between the urban layout and the sacred -scape as Sky-scape and Land-scape. The classical area of interest of Archaeoastronomy (that is indeed the study of astronomical alignments) is much broadened to include the sky as just one of the elements of the built, sacred landscape. In this way, orientations which are due to the traditional Chinese doctrine of the landscape can be individuated and studied as well. Topographical as well as astronomical references can thus be analyzed within a global, scientific framework aimed at a better understanding of the ideas and the religion of their planners.
More specifically, the distinction between the two schools of feng shui is well known: the *form school*, which is more strictly concerned with the morphological aspect of the landscape in which the urban layout is located and therefore considers the presence, reciprocal position, dimension and form of the main natural elements, and the *compass school*, which instead refers to the use of an orientation instrument (of a magnetic type, a *Luopan*) to identify a preferential direction for defining the main axis of the city, the pivot of the sky and the earth, the order of the entire cosmos. For the investigation that refers to the first school the study of historical cartography and the use of remote sensing instruments for the analysis of recent and historical satellite images are proposed (many Chinese cities have been undergoing a great urbanistic increase for some decades now, which may have in some way altered the relationship that the historical layout had with the landscape).
A case study is proposed comparing the three Ming capitals as the highest expression of imperial power and cities built in a relatively short period of time (late 1300s - early 1400s, the first phase of the new dynasty). These are the re-planning of the imperial city of Nanjing (from 1375), the re-construction of the new capital Beijing (1407-1420) and the planning and construction (interrupted almost to completion) of the central capital Mingzhong (1369-75, today Fengyang). For each of them, thanks to remote sensing using Google Earth Pro tools, the orientations of the main axes, the horizon and the relationships with the landscape that hosts the cities, in which (and for which) the urban layout were designed, are investigated. With reference to the second school of feng shui, the deviation of the azimuth of the main axis and the magnetic deviation at the time of the construction of the layout of the cities is compared. These data were collected using the paleomagnetic model CALS10k.2, a global geomagnetic field reconstruction, developed at the German Research Center for Geosciences in Potsdam: it allows us, knowing the specific coordinates of a place, to calculate the value of the magnetic declination in that place over time (Korte et al. 2011; Constable et al. 2016). The correlation of the deviations found in the cases of the three capitals would support the hypothesis of the use of a magnetic orientation tool to define the direction of the principal axis.
These results help in placing the architecture of the Ming capitals within the original perception of the landscape at the time of their planning, also with the aim of contributing to the preservation and fruition of this important

Chinese cultural heritage. At the same time, they show the effectiveness of using the tools and methods of Archaeoastronomy also in the study of the relationships between the built and the landscape.

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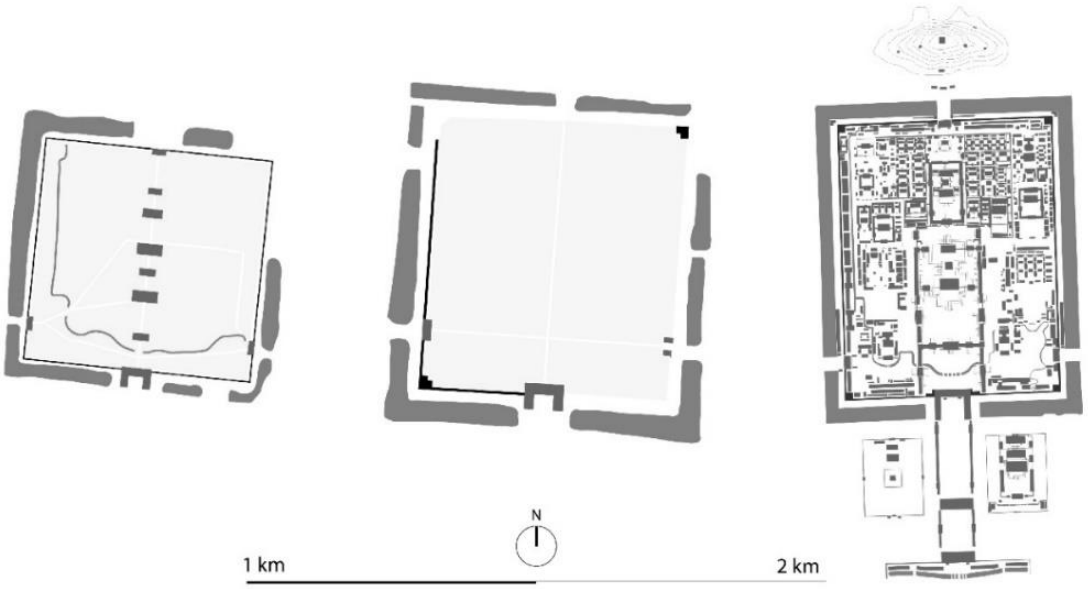
Figure

From left to right: Imperial Palace of Nanjing, Mingzhong and Beijing. (Drawing by the authors)



What Equinox?

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Equinox, what a controversial concept! Since the dawn of archaeoastronomy this has arguably been the most problematic concept – perhaps together with the lunar standstills or lunistices − to be taken into account since it was first used in 'megalithic' astronomy to explain the orientation of certain monuments such as the impressive tumulus of Knowth in Ireland or, more recently, the dolmen of Viera in Spain. The term 'megalithic' equinox has also been polluting the scientific literature since the 1970s. In the mid-1990s, the situation was so harsh that Clive Ruggles thought it could be adequate and useful to ask himself 'Whose equinox?' (Ruggles, 1997). In this work, he stablished the difference between the true astronomical equinox ($\delta=0°$), when the sun crosses the celestial equator, the midday between the solstices, sunrise at due-East, or the mid-horizon sunrise point between solstice sunrises, among other possible definitions. They were close at the horizon to the place of actual equinox sunrise but could represent quite different concepts in the worldview of the builders under scrutiny. A decade later, González-García and Belmonte (2006) asked themselves 'Which equinox?' when the date and concept of the Equinox in ancient Rome at the moment of the Julian reform had to be taken into account. The Romans apparently preferred the midday between the solstices instead of the astronomical equinox itself. This could have obvious consequences when interpreting the archaeoastronomical data of the Roman era. Consequently, it was clear that one needs to be very cautious when studying buildings with an orientation close to due-East and claiming that they are 'equinoctial'. This is especially sensitive when megalithic monuments are considered. The first buildings which are arguably orientated close to the astronomical equinox, whenever the eastern horizon in nearly flat, are the funerary temples and related structures (e.g. the Sphinx) of the pyramid complexes of Egypt during the Old Kingdom (Belmonte et al. 2009). However, interestingly, this pattern of orientation could be the by-product of an actual interest in due-North and the realm of the imperishable stars rather than sunrise itself. Only later this transformed, notably with the solar temples of the Vth Dynasty − and perhaps earlier during the reign of Snefru − into a true solar relationship, this was independent of the fact that the ancient Egyptians had a knowledge of the astronomical equinox or not (see Figure 1). For more than two decades, my research team and collaborators of several nationalities have explored the interest on the sky of different cultures across the world. Indeed, we have encountered 'equinoctial' orientations in many occasions such as the Iberian Culture, pre-Hispanic Canary Islands, cyclopean Easter Island, the Hindu culture, the Nabataean realm, or, more recently, the Christian churches. With such a large and suggestive amount of data, it was the time to ask the question: 'What equinox' were they observing? And perhaps try to answer it. Evidence suggests that 'equinoctial' alignments are as varied as the definitions of 'Equinox' we might imagine.

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Figure
Equinox at Giza. Sunrise in front of the Sphinx (a) and sunset behind it at the corner of Khaefre Pyramid (b). Photograph: Juan Antonio Belmonte.

Rethinking the Orientations of Minoan Palace Central Courts

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The academic debate surrounding the orientation of the Minoan palace central courts has been ongoing for the last few decades. The monumental rectangular central courts, oriented north-south on the long axis, are considered the defining architectural characteristic of the so-called Minoan "palaces". Jan Driessen (2007, 4) argued that "the Central Court was the '*raison de vivre*' of a Minoan 'Palace'". Joseph Shaw (1977, 58) proposed that the Minoans architected the courts not with the long axis in mind, but contemplating the shorter east-west orientation, due to the natural illumination entering the western façades where the ceremonial structures were located. However, Shaw's hypothesis, which focused on sunlight and wind phenomena with unknown religious or cultic significance, did not account comprehensively for the inconsistent variability in orientation azimuths of the various palaces. In 1973, W.E. Belknap proposed that the palaces were oriented toward distant geographical locations, which, however, Shaw heavily critiqued for its faulty methodology. More recently, the Uppsala Project, led by Mary Blomberg and Göran Henriksson, surveyed various Minoan sites around Crete. They hypothesized that the long axis of the central court of Phaistos was oriented, without direct sightline, toward the star Canopus (α Car) behind the mountains south of the palace (2006, 190-191). However, they did not expand further on the possible link between navigational stars and the central court orientations.

The aim of this presentation is to explore if Minoan central courts were aligned to distant trading routes along particular star paths based on a hypothetically reconstructed celestial navigation system. The *in situ* fieldwork surveyed the axes orientations of the Minoan palace central courts of Knossos, Phaistos, Zakros, Malia, Galatas, Gournia, and Petras. The measurements were taken with a professional compass and clinometer, with a stated accuracy of $\pm 1/3°$, and were adjusted for magnetic declination. A novel methodology was devised that included the mapping of long-distant orientations with skyscape simulations (accounting for precession and extinction coefficients), and cross-referencing with palace construction dates, wind patterns, and archaeological evidence of seaborne exchange cycles.

The research also investigated the thoroughly-documented Polynesian and Micronesian sailing traditions, where star paths symbolized interisland direct routes between distances comparable to those sailed in the Mediterranean and the Aegean. When compared to the limited literary references of star steering by ancient Greek and Levantine sailors, the detailed ethnographic reports from the Pacific Islands may augment our understanding of how Bronze Age celestial navigation may have occurred.

The data indicates that Minoan palace courts were oriented toward star paths aimed at distant coastal emporia throughout the Mediterranean, destinations imbued with historical and commercial significance. The study concludes that the intergenerational central courts memorialized directions associated with direct maritime trade sea lanes instead of the commonly asserted circular coastline routes. This indicates that the Minoans may have relied on wayfinding methods analogous to those from the Pacific Islands and relied on star paths for the memorization, practical use, and oral transmission of trade routes, which were enshrined into the orientations of the central courts of their palaces.

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Religious experience at the temple of Epikourean Apollo in Bassae: Virtual Reality technology in the service of archaeoastronomical research

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Reconstructions of ancient religious performances at a specific time and place facilitate better understanding of ways in which natural light, or the night-sky may have been used to enhance religious experience. If combined with the study of spatial movement, such approaches allow us to infer on emotionality and cognitive experience (e.g. Bille and Sørensen 2007, Sundstedt *et al* 2004). Architecture was imbedded in ancient ritual experience. Orientations, lines of sight, spatial movement –in other words, methods based on a space syntax– become particularly important in enriching interpretations on perception.

The fifth century BCE temple of Apollo at Bassae, located on a peak of the sacred Arcadian mountains, has long been suspected to have been constructed with astronomical considerations in mind. Such an aim seems fitting for Apollo who was viewed as the god of light and calendars. If indeed present, these would have greatly influenced religious experience. The temple's current state of preservation is missing key architectural elements and the material used for the temple's foundations has caused considerable movement of the structure above ground level. Furthermore, since 1980, when the temple was completely covered with a canopy to be protected from the elements and rapid deterioration, it has not been possible to either make direct archaeoastronomical observations, or to study the temple within its landscape. Through a Virtual Reality Model of the temple and its surrounding landscape, this paper presents reconstructions of specific moments in the year thought to have been of importance. For the first time since its construction, we are able to appreciate and track the sun's path inside the temple and to determine whether the suspicions of deliberate solar observations, expressed more than forty years ago, can be verified (Cooper 1968).

The aim of this paper is to better discern the conditions which shaped ancient experience of the temple, so that they, in turn, may help us identify ways in which darkness, and illumination may have assisted in intensifying religious experience. A great deal is revealed about the way the sun entered the temple's interior, which leads also to a discussion on the contribution of digital technology in understanding ancient experience and ancient natural light manipulation in enhancing experience of religious architecture.

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The Equatorial Ancient Astronomy of Quito

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According to canonical rules, churches had to be astronomically oriented towards the sunrise. These rules originated from the beginnings of the Christian era in the council of Nicaea (Gonsález, p. 325). It is clear that, throughout history, procedures regarding the selection of sites and construction of churches, including the alignment of their apses or vaults, have obeyed old standards that corresponded to specific astronomical events, especially the sunrise.

The present study reveals findings in the colonial section of the city of Quito, Ecuador, where church design reflects an interesting confluence between the surrounding orography of the region's geography and astronomical alignments, such as relationships with the solstices, equinoxes, and axes, such as the north-south polar axis, and the ecliptic axes, possibly represented by the position of the Milky Way (Urton, 2006).

These findings help us to understand the importance of astronomy not only for administrative purposes and ends, such as agricultural calendars, territorial planning, social organization, and the intelligent use of natural resources, such as water, but also for ceremonial purposes, due to sacred relationships with the sun, stars, and tutelary gods, such as the Apus or gods of the mountains.

The astronomical architecture of the colonial churches in Quito has allowed us to find around 55 light effects, thanks to the development of predictive models, with the application of space programs, satellite technology, and instruments for geodetic and topographic positioning measurements.

In this presentation, we demonstrate the cases of light effects that occur simultaneously (and others with symmetry in pairs), which suggest the intentionality of these light effects or the desired purposes of colonial architects.

These phenomena of light not only demonstrate the astronomy implicit in the architecture of churches, but also a possible relationship with pre-Hispanic astronomy, since, according to the councils of the early colony (Martínez de Codes, 2011), chapels and crosses were to be built on the shrines of natives, considered pagan by the Christian clergy.

In short, the mathematics implicit in ancient astronomy and geodesy are implicit in the layout of the streets, which match the alignment of temples, as well as in light effects in churches, providing evidence to understand the astronomy of the pre-Incan past of the region. In turn, we can see how phenomena of lights and shadows reflect the intentions of the main architects of ancient cities and subsequent developments in the religious and cultural environment. That is, they allow us to understand both pre-Hispanic cultural heritage and historical process.

The data in this study have been subjected to various modes of verification. Our hypothesis reveals another interpretation of our heritage, much more reasonable and substantial than conventional. It reveals a story that matches the natural, geographic and astronomical environment. (Ziolkowski, M. and R. Sadowski, 1992)

The study of ancient astronomy cannot be developed, if the most important geographical considerations are not taken into account, such as the latitude of the unit of study and the horizon of the general context. The application of astronomical knowledge and its relationship with the surrounding geography allowed ancestral societies to develop a geodesy that, at the same time, could be applicable to countless needs of ancient peoples.

The investigation of ethno-historic sources, as well as archaeological studies developed in the region and measurements made with rigorous methodologies and procedures for archeo-astronomical explorations, have been applied with the rigor that merits the attention of the archaeological cultural heritage of the equatorial Andes.

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Figure


Cayambe
SSSE
Oyacachi
SSSJ
SSSD
Antisana
Papallacta
QUITO
Eje de confluencia.
Pambamarca
Yanaurco
Quinche
Pifo
Cochasquí
La Merced
Sincholagua
Eje Eclíptica
Catequilla
Ilaló
Tola Pomásqui
Rumiñahui
QUITO
Portalanza
Calacalí
Eje Sur-Norte
Nono
Lloa
Pichincha
Pucará Aloag
Pasochoa
CSSJ
CSE
CSSD
Iliniza
Eje Eclíptica
Sitios Arqueológicos y urbanos
Montañas
SSSJ, SSE Y SSSD: Salidas del Sol en los Solsticios de junio y diciembre y equinoccios de Marzo y septiembre
CSSJ, CSE Y CSSD: Caídas del Sol en los Solsticios de junio y diciembre y equinocciosde marzo y septiembre.

Marcadores solares en el Shincal de Quimivil

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Este trabajo expone una perspectiva arqueoastronómica del sito inka El Shincal de Quimivil en el sur del Tawantinsuyu (Catamarca, Argentina). Una capital provincial Inka, que por su configuración espacial es considerada como un Nuevo Cuzco según varias investigaciones (Farrington 1999).

Arquitectónicamente el Shincal de Quimivil nos muestra evidencias de una importante estructura de alineamientos paisajísticos y astronómicos, conformando una cartografía que relacionaba un paisaje sagrado, los astros y la arquitectura. La diagramación espacial del sitio El Shincal de Quimivil nos muestra que estructuras como el Ushnu y Cerros Aterrazados están alineadas astronómicamente, conformando una cartografía que está fuertemente relacionada con la idea de un paisaje sagrado que tiene una conexión con el movimiento crítico del sol, y el calendárico.

Los estudios arqueoastronómicos en el sitio se vienen desarrollando hace ya más de 5 años, como parte de la una tesis doctoral (Corrado y Giménez Benítez 2018; Co-rrado y Giménez Benítez 2021). Este trabajo expone los resultados obtenidos en dos estructuras importantes en el Shincal: el Cerro Aterrazado Occidental y el Ushnu, desde los cuales se realizaban observaciones y rituales relacionados con el Sol.

El ushnu ubicado casi centralmente en relación a la plaza principal, no solamente se muestra como la representación de un escenario de ritos y ceremonias durante los eventos importantes, sino también, el eje espacial que marca alineamientos hacia puntos que seguramente jugaron un rol fundamental en el paisaje sagrado (Corrado y Giménez Benítez 2018).

La construcción y ubicación del ushnu podría responder a la idea de los incas de resignificar los elementos importantes del paisaje preexistente de los territorios conquistados, reutilizando los elementos potencialmente sagrados de la topografía local. (Corrado y Giménez Benítez 2018). En el caso de El Shincal la alineación del ushnu con los Cerros Aterrazados Oriental y Occidental respondería a esta idea. En la cual vemos que a la orientación hacia los cerros (que encontramos en otros sitios inca) se le superpone la orientación a la salida del sol en una fecha solar importante. Este hecho sería similar a lo que ocurre en Pumpu, donde el eje del ushnu, además de corresponder a la orientación hacia cerros importantes del paisaje local (que son haucas), se superpone con la salida del sol el día del paso cenital en el lugar (Pino Matos y Moreano 2014). Después de analizar la información obtenida en el ushnu de El Shincal, vemos que su orientación no sería al equinoccio astronómico, sino que hay un compromiso entre la orientación al equinoccio medio temporal, y dos huacas en los Cerros Aterrazados Oriental y Occidental (Corrado y Giménez Benítez 2018).

Por otro lado, en la cima del Cerro Aterrazado Occidental se han encontrado dos alineaciones con respecto a la salida del sol, que nos dan fechas importantes dentro del calendario inka. El Cerro Aterrazado Occidental habría sido una huaca local, razón por la cual fue revestida por una muralla con forma de zigzag de factura cusqueña. Debido a estas propiedades mencionadas, el Cerro Aterrazado Occidental habría sido un espacio ceremonial importante del sitio donde, probablemente, se habría llevado a cabo el control calendárico de las fiestas (Corrado y Giménez Benítez 2021)

Ziółkowski sostiene que el calendario imperial convivía con calendarios locales, por lo tanto, que haya una orientación que marca una fecha local (el solsticio) y un marcador de una fecha cusqueña no sería contradictorio (Ziolkowski 2015).

A diferencia de otros sitios inkas donde la búsqueda de alineaciones, con vinculación calendárica, se ajustan a cada territorio particular. En El Shincal de Quimivil las fechas más destacadas tienen que ver, por un lado, con fenómenos solares locales y por el otro, con fechas definidas para el Cusco. Entonces, lo que observamos aquí, no es tanto la búsqueda se marcar en el territorio líneas que definan la conexión con marcadores del paisaje sino la implantación del calendario estatal en esta provincia (Ziolkowski 2015). Con esto no es que desconozcamos las relaciones de algunas construcciones con un paisaje sacralizado. Por ejemplo, la plaza está orientada cardinalmente, con un error de un grado.

La orientación del ushnu y de las dos líneas de piedras del Cerro Aterrazado Occidental son un ejemplo de la implantación que mencionáramos antes. Estas orientaciones que se vinculan al aspecto festivo y calendárico de la organización del culto estatal y la práctica agrícola de esta región del sur del Tawantinsuyu.

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Research on the cultural and astronomic relationships between specific archaeological remains in the area of Ahu Tongariki Easter Island or Rapa Nui, Chile

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Our research consists in determining the relationships and alignments that exist between several astronomically - related archaeological remains located in the neighborhood of Ahu Tongariki - or in its surroundings, such as; outcrops with numerous petroglyphs and cupules, hollow stone towers (tupa) and regular stone towers (pipihoreko). To date, evidence suggests that all of these types of remains which served to mark the heliacal or achronic rising or setting of different stars or constellations as well as the maximum and minimum North-South movement of the Moon during its 18 years 6 month orbit (Belmonte & Edwards ,2008). A previous study (Edwards & Edwards, 2010) of such associations and of their ethnological records indicates that the observations carried out by their astronomer priests from such structures formed the basis upon which they built their annual ritual calendar. The heliacal and achronic rise or set of the Pleiades determined the dry and wet seasons as well as the right times for the planting and harvest of the sweet potato, their principal food crop. Meanwhile others stars and constellations served to predict the time of arrival of their principal 'immigrational' food resources such as; fish, birds, turtles and whales.

Our newest research, and thus our presentation, highlights how in the surrounding these areas there also existed the largest concentration of hollow stone towers or (tupa), which might indicate that there was once a large group of special priests living in its the neighborhood dedicated to the astronomic observation of the sky and to the interpretation of their cosmogonic beliefs. Other regular stone towers are visible against the horizon (pipihoreko) marking different astronomic phenomena like de La Perouse bay (Belmonte & Edwards, 2008). The outcrops with petroglyphs extend towards the interior of the altar in a sacred area located next to a large number of house foundations belonging to the chiefs of the different lineages represented by the 15 large stone statues standing upon this altar. In the background behind this complex rises Rano Raraku, an extinct volcano with volcanic tuff, out of which the great majority of the island statues were carved was known as Maea Matariki, or Pleiades stone. Two of these outcrops with the petroglyphs depict principally mythical tuna fish, turtles and birds, which fall well into this ritual calendar pattern as well as god faces and vulvas which served as fertility signs. Other lines formed by interspaced small cupules belong to a later period, as they superimpose these figures and supposedly indicate the number of persons that were killed and eaten during a long intertribal war in the late 18 early 19th century. A third outcrop in the vicinity has on its periphery the figure of a vulva and a sooty tern and in its center a large space covered by many small cupules that were done with some type of drill and which could depict a representation of the Pleiades. Meanwhile another group of three cupules that form the eyes of three identical fish could represent Orion's belt, which gives the impression that the many cupules spread across this area depicts a sky map. The numerous depictions of the Pleiades are not uncommon, as the Pleiades constitutes in all of Polynesia the most important sky object, which served to establish their yearly calendar which started with the first New or full Moon after its heliacal rise It actually has a declination of 24 degrees; therefore, its heliacal ascent is very close to the winter Solstice and therefore certain structures that are oriented towards its azimuth have been wrongly identified in the past (Edwards, d´Ans & Edwards, 2018).

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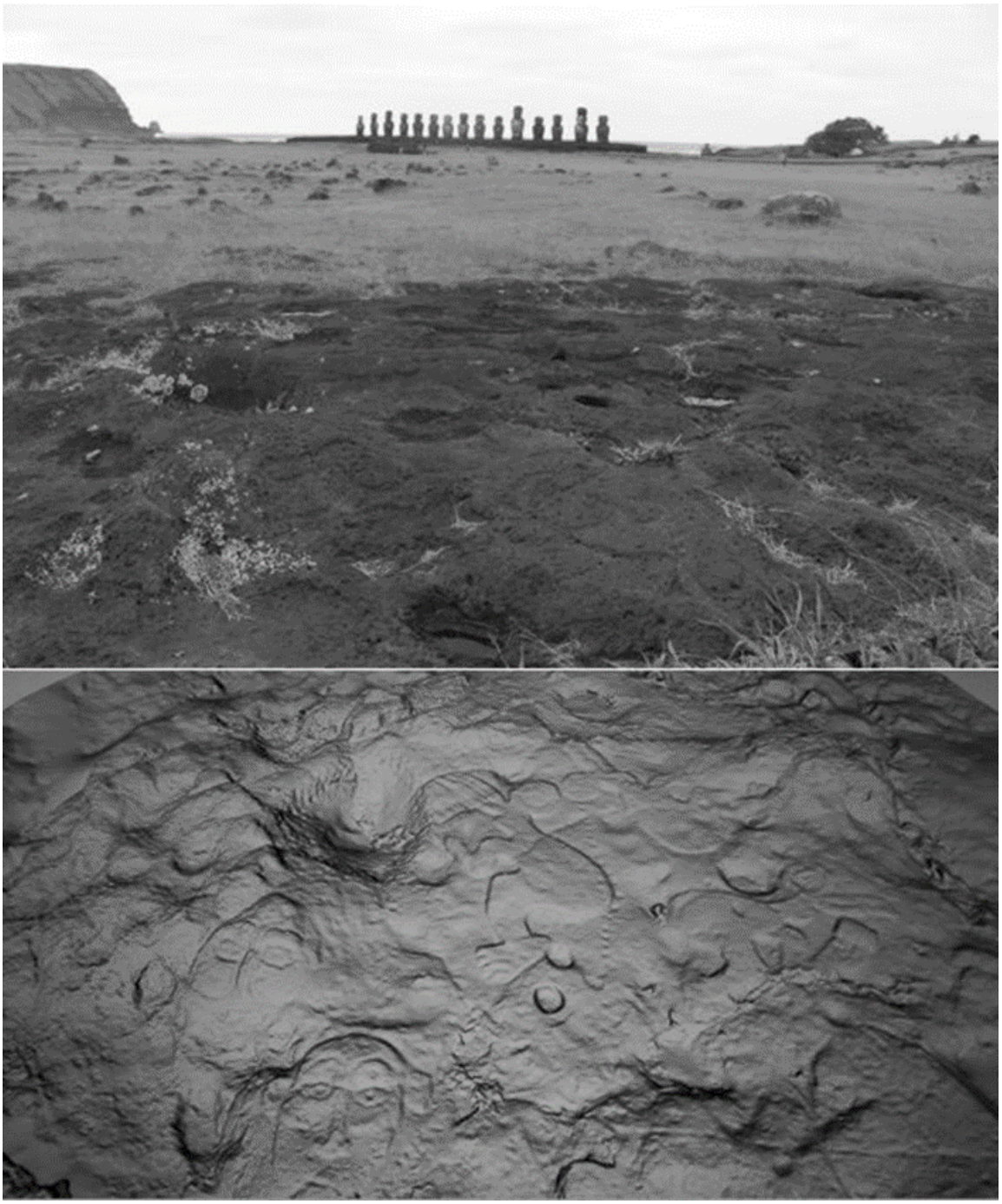
Figure



Rethinking Constellations Based on Two Amazon Experiences

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This work is the result of an analysis of the reinterpretations of astronomical constellations created by peoples that live near the equator: the Tikuna people, living in the Western Amazon on the border between Brazil, Colombia, and Peru, and the Tukano, Tuyuka, and Desana peoples, among others, in the Northwestern Amazon on the border between Brazil, Colombia, and Venezuela. These indigenous cosmovisions are based on forms of knowledge and guidance in the world that are passed down from generation to generation by combining oral narratives and ritual practices.

We compared and contrasted these peoples' constellations based on a puzzle and assembled it considering the difference between the dry season (summer) and the rainy season (winter), variations in river levels, cyclical phenomena involving animals and plants as well as other interactions of these peoples with environmental transformations. Even though this article focuses on constellations, we must take into account that the sky is understood in various dimensions that range from classical descriptions of astronomy to events that we deem to be meteorological and relate material and spiritual aspects. In line with Tim Ingold, considering that "in the perception of the weather-world, earth and sky are not opposed as real to immaterial, but inextricably linked within one indivisible field", it is understood that such accounts associate what is perceived in a given visual field, such as landscape, person, and living beings, and integrated by imagination to the culture and cosmovision of each people.

The figures created by Amazonian communities in the sky are constellations that form representations by considering asterisms, e.g. the alignments between stars or dark regions of the sky, which are identified through diversified processes. The images constructed by these groups differ with regard to the representations themselves. In other words, these cultures represent, for example, animals such as turtles, snakes, anteaters, or jaguars in their constellations, but not necessarily in the same places. For the Tikuna, during the dry season, they see the fight of the Jaguar and the Anteater that lies between the areas of Scorpius (the eyes of the jaguar are in Antares) and the Southern Cross in the sky. Tchatü (Anteater) is located in the Triangulum Australe, Corona Australis, Norma (the Carpenter's Square) and Ara (the Altar). When the two contenders appear on the horizon, they announce the beginning of the rains. The turtle (Baweta) occupies the Pleiades area while the cayman's jaw (Coyatchicura) occupies the Hyades area. Both asterisms of the classic Western culture are in the Taurus constellation. For the Tukano people, these two asterisms correspond to nhorkoatero (group of stars) and Waikhasa ('moquém' or 'jirau' - wood grill used for smoking fish). For the Tuyuka and Desana, two other ethnicities of Alto Rio Negro, these two constellations are virtually the same. If we take into account these differences in the representations that arise from small linguistic variations and from the form they take according to different informants or in different research situations, we can conclude that there is a concept of constellation, but it is neither unique nor homogeneous. The stars very much occupy the same region, but that does not mean that the representations of indigenous experts are conventionally accepted by all members of a particular ethnicity or even of a certain community. The spontaneous representations of many of these contributors usually correspond to drawings where stars fill all the spaces or alignments between the main stars. The justification of a research such as the one we have developed is the mediating role it plays between an exclusive and precise determination of an aligned group of stars and an inclusive determination thereof, which admits variations due to the differences resulting from the different narratives of indigenous experts, contributors, and connoisseurs.

We believe that relativizing the concepts of constellation of these groups is relevant because they refer to figures that are present in their cosmovision, but that they see in dreams and reveries triggered by different territorial situations lived, which generate various descriptions.

The recent history of the constitution of our Western constellations is not entirely different. Until 1930 the Western constellations were not officially determined either. In other words, Western astronomy also functioned according

to local conventions based on ancient cultures. The fact that we have a complete set of 88 constellations was a normative decision and not an action that respected diversity.
The *Stellarium* app allows you to correlate figures from indigenous cosmovisions with star configurations that are considered official constellations by Western astronomy. Such correlation assumes that these are different ways of seeing the world and, seeks points of interdisciplinary understanding in possible correspondences between different languages, even though many statements will probably be completely untranslatable.

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Figure

El Conjunto Tlaloc de la Zona Arqueológica de Calixtlahuaca. Un ejercicio de arqueoastronomía virtual

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Hoy en día las herramientas digitales enfocadas a la investigación en arqueoastronomía nos permiten la recreación virtual de los objetos de estudio y la simulación de los eventos celestes que le conciernen. Son un grupo de herramientas importantes para el investigador ya que le auxilian en la revisión de planteamientos e hipótesis, así como en la generación de imágenes de lectura accesible para el público no especializado en el tema. Por lo tanto, estas imágenes que recrean virtualmente los objetos de estudio y su entorno celeste tienen un gran potencial al momento de divulgar el conocimiento arqueoastronómico.

Bajo esta línea, en el presente trabajo se desarrolla un modelo 3D virtual del sitio arqueológico Calixtlahuaca, ubicado en Toluca, México. En especial de un grupo de edificios conocido como "Conjunto Tlaloc". Sobre el sitio se han generado una serie de trabajos arqueológicos de la mano de José García Payón (1981) y Michael Smith (2006) y dentro del área de arqueoastronomía por parte de Iván Šprajc (2001). Por lo cual, un modelo virtual que integre la arquitectura, el paisaje y los fenómenos celestes del conjunto Tlaloc podrían contribuir tanto en el avance de los estudios, así como en su divulgación.

De esta forma, en el presente trabajo se describe el proceso llevado a cabo para la recreación virtual del Conjunto Tlaloc y la simulación de los fenómenos celestes del sitio.

En un primer paso, se describe el levantamiento fotogramétrico del sitio arqueológico mediante el uso de drones, el procesamiento de las fotografías capturadas para obtener la ortofoto y el modelo 3D del conjunto, desarrollado con Drone2map para ArcGIS. Posteriormente, se explica la edición del objeto 3D, así como la aplicación de texturas y la reconstrucción de los elementos faltantes de la arquitectura mediante el uso del programa libre Blender. En este caso se presta especial atención en una reconstrucción hipotética del sitio apoyándonos en los trabajos de los arqueólogos antes mencionados.

En un segundo paso, se muestra el proceso para la creación de un entorno topográfico 3D haciendo uso de mapas SRTM (Shuttle radar topography misión) integrados en el programa Horizon. Esto con el fin de obtener el horizonte 360° para el sitio arqueológico. La importancia de esta etapa radica en generar un modelo de elevación adecuado para la futura revisión de los posibles calendarios de horizonte.

En un tercer paso, se describe la integración del modelo 3D del conjunto Tlaloc, así como del horizonte generado anteriormente, dentro de la plataforma Stellarium. Conociendo la fecha de ocupación del sitio, se podrán simular los diferentes eventos celestes relacionados con las antiguas prácticas astronómicas del grupo al poder tales como los calendarios de horizonte, las paradas mayores y menores de la luna, el ciclo de venus y el movimiento de las constelaciones.

En un cuarto y último paso se muestra un recorrido virtual dentro del sitio arqueológico donde se refleja su arquitectura y su posible relación con el movimiento de los diferentes objetos celestes. Esta fase resulta clave para la comunicación de los resultados mediante una forma accesible y llamativa tanto para los grupos académicos como para el público en general.

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The sky on earth: first archaeoastronomical approach to the pre-Hispanic mounds of the Uruguayan lowlands (Rocha, Uruguay)

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Archaeoastronomy, Ethnoastronomy and Cultural Astronomy in general have had an impressive development especially in Mesoamerica, the Andes and the US southwest in the last decades. There are several works on hunter-gatherer groups and farmers of the Amazon (Pedroza & Mendonça 2010) or the Argentinian Chaco (*mocoví*, *toba-pilagá*, *wichí* y *qom* groups) among original people and creole (López 2015). Together, these works show two of the most dynamic and prolific regions of research in ethnoastronomy and astronomy of original peoples. However, the Uruguayan lowlands (NE and NW of Uruguay) did not attracted yet significant research on these study areas. This has been so in spite of the rich archaeological remains with several different pre-Hispanic architectural manifestations that may allow exploring the relation between their skylore and the transformation and peopling of the humid ecosystems.

The development of different mound architectures (monumental mounds, earthworks, geometric ditches enclosures, among others) appears in distant ecological regions and with clear ethnic differences. We could highlight the Amazonia, the Moxos lowlands, the Paraná delta, the Uruguay and southern Brazil wetlands and the southern Atlantic coast and sierras. It is generally understood that this phenomenon materialized the establishment of communal ways of organization, the emergence of social complexity and the increase of population. These changes have been interpreted as a part of the domestication process of their environment (Clement 2014; Erickson 2006) that rendered singular archaeological landscapes.

Different social, productive and economic hypothesis have been put forward to explain the complex location, distribution and orientation patterns that these architecture displays. Recently, the recurrent and consistent spatial orientation found at the groups of mounds in Uruguay paved the way to new hypothesis that recognize other knowledge related to their ecologic environment, location and distribution.

The present study shows the result of a number of archaeoastronomical investigations on the orientation and location of the mounds in five sites at the Rocha department (Uruguay). We discuss the coherent orientation of

these groups of mounds in relation with certain asterisms such as the Southern Cross or the Milky Way and celestial bodies such as the full moon after winter solstice. The results allow discussing how the perception and knowledge of celestial phenomena c. 3000 BP could have played a key role in the organization of space and time among these societies. Besides, some results gain particular relevance when contrasted with ethnographic, ethno-historic and archaeological information for other groups in Southern Hemisphere. This preliminary approach prompt us to conclude that the skylore and the particular perception of time and Nature's cycles linked with flood and drought periods were part of a holistic technology that allowed these peoples to live in these wet ecosystems.

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Figure

La orientación astronómica de los templos conventuales franciscanos del siglo XVI en Puebla

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En la segunda mitad del siglo XX, a la par que se desarrollaban las metodologías para el estudio de la alineación astronómica de estructuras prehispánicas, las investigaciones que las aplicaban también incluyeron el caso de templos religiosos novohispanos. Los trabajos del geógrafo Franz Tichy fueron pioneros del estudio en conjunto de ambos tipos de edificaciones (e.j.: Tichy, 1991). Sin embargo, en años posteriores mediciones sistemáticas en campo más precisas de construcciones prehispánicas revelaron las deficiencias en los resultados obtenidos por Tichy. Estas últimas tuvieron que ver sobre todo con la suposición de una altura de horizonte constante al momento de trasladar la medida de la orientación a la alineación hacia fechas de salidas y puestas solares. Esto, aunado a la precisión limitada del proceso de medición angular misma, conduce a una indeterminación del orden de varios días en las fechas de alineación. Los resultados de indagaciones en las últimas décadas han enmendado los defectos de estos estudios iniciales y han demostrado de manera estadísticamente robusta la relación de la orientación de templos precolombinos hacia fechas importantes del calendario agrícola mesoamericano o en consonancia con el sistema calendárico (Sprajc, 2001). No obstante, estos avances en el área de la arqueoastronomía, nuevos estudios sobre la orientación astronómica de edificios religiosos construidos durante el dominio español y la aplicación de nuevas metodologías han sido escasos (ej.: Zimbrón, 2013; Martz de la Vega y González Morales, 2021).

El objetivo de la presente investigación es hacer una reevaluación de las mediciones de la orientación de iglesias novohispanas hechas hace varias décadas, proveer estimaciones más precisas de alineación hacia salidas y puestas solares, para finalmente contestar a la pregunta si las orientaciones de estructuras de la nueva religión heredaron la tradición prehispánica. Para tal objetivo se ha seleccionado en primera instancia un conjunto de iglesias de la muestra de Tichy, en particular templos conventuales franciscanos del siglo XVI y restringidos al área geográfica del actual estado de Puebla.

La metodología empleada hace uso de herramientas de percepción remota disponibles libremente en internet para su descarga, en conjunto con programas astronómicos. Reconociendo las limitaciones de tales herramientas, los resultados teóricos se han comprobado mediante observaciones en campo para cinco de los edificios estudiados, seleccionados por ubicarse en las cercanías de la región Cholula-Puebla.

En esta presentación se mostrarán los resultados generales sobre una muestra de 20 edificios conventuales y se explicarán en detalle los resultados de los cinco en los cuales se pudieron hacer observaciones directas. Estos últimos son el templo y Capilla Real del conjunto conventual de San Gabriel Cholula, Huejotzingo, Cuauhtinchan y Tepeaca. El trabajo de campo confirmó las predicciones obtenidas mediante las herramientas utilizadas, acertando con una precisión de +/- 1 día en la fecha de alineación. En general los resultados de este trabajo difieren hasta por 3 grados del ángulo de orientación medido por Tichy, y en varios casos las fechas de orientación son reportadas por primera vez. La confirmación en campo de la fecha de alineación implica que las mediciones obtenidas con esta metodología son más precisas que las estimadas por Tichy.

El caso más emblemático lo representa el de los edificios del complejo en Cholula, que para la Capilla Real se obtienen resultados similares a Tichy, al relacionarse con la orientación sagrada de Teotihuacan. Sin embargo, en nuestro caso tal relación la encontramos en la orientación temporal y no en la espacial, pues el ángulo acimutal medido difiere por casi 2 grados del ángulo medido por Tichy. Para el caso del templo conventual, que también difiere de las mediadas de Tichy por casi 2 grados, se discuten posibilidades de interpretación de la fecha de alineación, como la coincidencia con la festividad del santo patrono o su relación con una de las definiciones de equinoccio.

Finalmente, los resultados generales se discutirán en conjunto con los trabajos recientes en otras zonas del país (ej.: los resultados de Xochimilco y Milpa Alta por Zimbrón, 2013) y se argumentará sobre las razones de la elección de la orientación de los templos en sus respectivas localidades, basándose en información historiográfica y arqueológica.

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Temporalidad cíclica y materialidad entre los tobas del oeste formoseño y los pilagás

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En el presente trabajo indagaremos sobre la lectura que hacen los tobas del oeste formoseño y los pilagá del Bañado La Estrella sobre dos lapsos temporales cíclicos específicos que se relacionan, de un modo u otro, al espacio celeste. Entre los tobas del oeste formoseño remitiremos al transcurso del día, en tanto que entre los pilagá del bañado la Estrella nos abocaremos a trabajar el ciclo anual. En esta ocasión analizaremos estos períodos temporales atendiendo a las relaciones que se establecen con la cultura material, tanto aquella heredada y relacionada a "los estudios de los antiguos", como aquellos elementos de la cultura material tomados o impuestos por la sociedad occidental. Por un lado, trabajaremos sobre dos asterismos pilagá que serán tomados en conjunto, Dapichí, que mayormente es asociado a las Pléyades, y YaGain'dí, que es trazado en lo que en la astronomía académica se conoce como Cinturón de Orión. Estos dos asterismos son representados por un juego de hilo progresante, esto último significa que se comienza con la ejecución de un motivo y se forma otro sin desarmar el primero. Por otro lado, indagaremos sobre otra vinculación de un objeto celeste con la materialidad: la relación que se establece entre el sol y el reloj entre los tobas del oeste formoseño.

En primer lugar, trabajaremos sobre el juego de hilo asociado al nombrado par de asterismos (Pléyades y Cinturón de Orión), porque representa dos objetos celestes específicos, cuyos cambios y movimientos cíclicos aparentes se asocian con el devenir de un importante ciclo temporal que tradicionalmente ritmaba la vida de los pilagá: el ciclo anual. A su vez, este conocimiento forma parte de aquellos saberes transmitidos por los más ancianos y refiere a una de las pocas formas que tenían los "antiguos" de representar asterismos. En un reciente trabajo de campo etnográfico en la zona del Bañado la Estrella, cercana a la ciudad de las Lomitas (provincia de Formosa, Argentina) los juegos de hilo sobre los que se trabajará fueron reconocidos sin dificultad y se hizo explícito que aún hoy algunos jóvenes pueden ejecutarlos. En esta ponencia remitiremos a sectores de la cultura que se relacionan con el tránsito de los objetos celestes por el cielo y, en particular, con la sucesión de las estaciones del año. Una de las hipótesis que manejamos en este trabajo es que el juego de hilo al que se remitirá aquí da cuenta del lapso temporal cíclico que antiguamente se asociaba con el comienzo del ciclo anual, el período más frío de año y que tiene importantes connotaciones en la vida social de los pilagá.

En segundo lugar, la otra materialidad con la que trabajaremos fue claramente tomada y, de una forma u otra, impuesta por la sociedad occidental: el reloj, un elemento claramente relacionado a la sociedad envolvente y al que los tobas aprendieron a adaptarse. Sin embargo, según lo trabajado entre los tobas, tomaron al reloj en sus propios términos. Por lo tanto, parte del conocimiento legado por los más ancianos: "los estudios de los antiguos" puede leerse en la forma que leen y entienden al reloj, sobre todo el reloj analógico. Esta amalgama también se observa en el análisis lingüístico de la palabra que utilizan para referirse al reloj en su idioma, cuestión que será analizada oportunamente durante la exposición. Trabajar sobre el reloj nos llevará a desarrollar, como expresamos más arriba, la relación que aún hoy se da con el astro y cómo es entendida ésta, en tanto que el sol es un claro marcador temporal que refiere al transcurso de la jornada. Claramente, con la colonización, se impuso una forma distinta de marcar los momentos del día. Sin embargo, como dijimos, ello propició una confluencia o un intento de entretejer la forma de ritmar la vida diaria que heredaron de sus ancianos, con la estricta forma de dividir el día de la sociedad envolvente.

Tomando en cuenta lo trabajado en ambos grupos indígenas, nuestros objetivos últimos son, continuar en esta ponencia el análisis de lo publicado oportunamente (Gómez y Carpio 2018 y Gómez y Braunstein 2020) para, por un lado, ver cómo las lecturas celestes que remiten al transcurso temporal se relacionan con la materialidad y como esta relación va variando y actualizándose según la situación social que les toca atravesar. Por otro lado, se buscará dejar expuesto cómo se dejan ver varias diferencias en las lecturas celestes de estos dos grupos indígenas que están emparentados y formando parte, también, del mismo grupo lingüístico: el grupo lingüístico Guaycurú.

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Diachrony and the big picture: a way to disentangle a landscape and archaeoastronomic riddle

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Megalithic monuments abound in the northern part of the Iberian Peninsula. They appear in the local late Neolithic period as a complex process of crystallization on the landscape of the social dynamics that appear in this period. In general, most of the megalithic chambers appear as more or less elaborate passage graves under a conspicuous earth mound. Their location has been investigated in the last decades in search for patterns in the framework of Landscape Archaeology. This has allowed us to understand their connection with mountain passes, fords or possible prehistoric routes (Alday Ruiz, Montes Ramírez and Baldellou Martínez 2012). Archaeoastronomy has also highlighted the coherence of their orientation throughout large regions, perhaps pointing at common traits to larger areas than indicated by other material remains found at or near the burial grounds themselves (González-García & Belmonte 2010).

A particularly intriguing group of monuments appears in the southern part of the Basque Country, in close relationship with the river Ebro. This group, formed by a small number of passage graves, displays a coherent but peculiar and troublesome orientation towards the south and southeast, away from the customary orientation towards east or the winter solstice more common in neighbouring areas (Hoskin 2001). The reason for this discrepancy is not clear. One could advocate a connection with the visibility of the Southern Cross, which would be visible on the local sky at this period. However, this presents a number of other problems. Besides, their location, although connected with the main river valley, the Ebro River is not directly visible from any of these sites.

A particularly significant element of this group is the so-called Chabola de la Hechicera (‘*Witch’s shack*’), whose name recalls a local tale that may shed light to its possible association with a particularly significant landscape feature at some moment in the past. But, was this significant at Neolithic times?

In the present talk, I will highlight a number of issues related to how archaeoastronomy may shed light into understanding the orientation of this group of monuments by considering the big picture, both in time and in space. First, I will present how the orientation of this group relates to other groups in their neighbourhood, and how this consideration highlights its difference. However, when we open the scope to other areas a bit farther away, a coherent picture appears that may relate this group with locations closer to the Mediterranean than previously thought. This may appear as a surprise unless we consider the situation in previous epochs and find that these patterns were probably not the exception but rather the norm.

In addition, I will treat the issue of how, on certain occasions, local legends and folklore may shed light upon, but also obscure, the interpretation. Prehistoric monuments today bear a load of interpretation due to their long history. The fact that a given element has been interpreted at some moment in the past in a particular way that it is still kept today by oral tradition does not directly imply that such interpretation was directly valid at first use of such building.

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ISAAC's *Journal of Astronomy in Culture*

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This session is an informative orientation to the updating and expansion of the scope of ISAAC's *Journal of Astronomy in Culture*. New directions for the journal will be highlighted and as well will be collaborations that will take place with *Revista Cosmovisiones / Cosmovisões*, the journal of SIAC. The future is exciting for publication in Cultural Astronomy, and we look forward to the articles you will contribute!

How Indigenous star knowledge can help us understand the longevity of oral tradition

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The astronomical knowledge of Indigenous cultures in the past and present is encoded to oral traditions that are transmitted to successive generations through story/narratives, song, dance, and artistic forms that function as mnemonic devices. But how long can these traditions transmit information over time? How does information get passed down without degradation as the sky gradually changes due to precession, proper motion, and climate change? In this paper, we discuss techniques that can be utilised to date oral traditions and show – rigorously – how they can be passed down for timescales exceeding several millennia.

Techniques for testing this involve scientifically analysing and dating geological or astronomical events described in oral tradition, such as volcanic eruptions, tsunamis, solar eclipses, supernovae, or meteorite impacts (Piccardi and Masse, 2007). Various issues arise when interpreting oral histories as elements of the traditions may not always translate to observed or experienced "natural events" (in a Western scientific sense). Oral traditions often include the use of allegory, symbolism, spirituality, and deduction that make using scientific means impossible (Henige, 2009). However, rigorous scholarship can identify examples where oral histories and scientific research converge to provide solid evidence to date oral traditions.

Research provides strong evidence that Aboriginal oral histories record the meteorite impact that formed the Henbury crater–field, dated to more than 4,000 years ago (Hamacher and Goldsmith 2013). Oral histories from Aboriginal communities around coastal Australia describe sea level inundation at the end of the Holocene Ice Age, demonstrating a longevity of orality exceeding 8,000 years BP (Nunn and Reid 2016). Some of these histories include details about landscape features and riverine pathways that are now submerged by water, providing predictions that can be examined and dated using modern scientific methods. This was then applied to oral histories regarding volcanic eruptions in the Atherton Tablelands of northern Queensland (Hamacher and Norris 2009). Local Aboriginal traditions described heated water erupting from the ground and killing a number of people, noting that the region was covered by eucalypt scrub when the event occurred instead of the current rainforest. Years after this narrative was recorded, pollen samples analysed from the bottom of Lake Eacham revealed that the rainforest is only 7,600 years old; before that the area was covered in eucalypt forest. Analysis of the volcanic lakes provided dates of the eruption exceeding 9,130 years ago (Head et al. 1994).

Emerging frameworks regarding orality and the longevity of oral tradition provide a theoretical foundation for explaining how this can be accomplished, focusing on the *method of loci* as a mechanism for linking memory to place (e.g. Kelly 2017, 2019; Bradley 2010). Evidence of oral traditions exceeding 10,000 years in duration is generally scant, and examples of traditions that describe unrelated concurrent natural events that can each be dated scientifically are almost non–existent. But we identify an example of this from the Aboriginal oral traditions of Tasmania in Australia. Here, we scientifically analyse independent natural occurrences described in Palawa (Tasmanian Aboriginal) oral histories that were first documented in the early 19th century by Robinson (Robinson

and Plomley 2008). These accounts describe witnessed geological and astronomical events with sufficient detail as to enable the use of scientific dating techniques to derive a *terminus post quem* (earliest possible date) of when the tradition *could have* arisen.

The Palawa traditions describe Tasmania being connected to the mainland before being flooded by rising seas, during which time a bright, culturally significant star (Mohinee, identified as Canopus) was described as the "Great South Star" (Gantevoort et al. 2016). By combining studies of sea–level rise at the end of the Last Glacial Maximum, and extrapolating the positions of stars in the southern sky through calculations of stellar proper motion, we conclude that the oral traditions describe conditions that are consistent with a *terminus post quem* in the Late Pleistocene, approximately 13,000 years ago.

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The Art of Topography

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Context
This paper is part of our ongoing reports on the EU funded project SHoW: Shared Worlds (project no 800236: e.g. Higginbottom 2020). The proposed project (SHoW) investigates the roles that landscapes, skylines and astronomy played in past peoples' lives in order to determine the cultural relatedness between people along Europe´s Atlantic Façade. Specifically, it investigates the types of visual-scapes people chose for the erection of their megalithic monuments within and across regions, that clearly seem to have some kind of related megalithic tradition, but which is not yet understood. Focusing on the periods of intensive monument building in prehistoric Iberia (c. 4500-2500 B.C.) and Britain (3100-900 B.C.), the project uses 3D technology, along with interdisciplinary approaches, to assist in the reconstruction of past visual worlds of the megalith builders. By investigating the role of the natural world, this project upholds and extends UNESCO's Astronomy and World Heritage Thematic Initiative, for the project recognises that the way people observed the land and the sky in the past is a repository for people's perception of their world. Ultimately, SHoW reveals the degree to which the people in these regions possessed shared worlds.

Aims
This presentation focuses upon the region, Costa da Morte. The material culture we primarily work with is that of Neolithic dolmens. Costa da Morte is part of NW Galicia, located on the south-eastern side of the Atlantic Façade. Our research here focuses upon all of the exposed *dolmens* within this area. In our most recently accepted paper, Higginbottom et al (2022), we uncovered that the megalithic monuments in this area are visually situated in relation to complex topographical variables, we now reveal our investigations into the connections between the chosen topography of these same sites combined with astronomical phenomena. We will see how the detailed shape of the horizon coincides with specific risings and settings of the Sun and Moon, suggesting further support for the notion that the creators of these monuments selectively drew upon variables found in their natural world that included astronomical bodies.

Data
For this paper (and our 1st paper mention above), we use the 25m LiDAR data made freely available by the Galician Xunta. We employ the software Horizon to build 2D-360º vertical viewsheds or horizon profiles (not map views). We use the ascii data obtained through the same software for creating our own landscape polar plots The ascii data contains three pieces of information sampled at regular intervals (of 0.01º) in azimuth around the full horizon, which gives you 36,000 x (azimuth or direction) and y co-ordinates (angular altitude), along with the distance of each azimuthal point from the observing position to the horizon. We examine 17 of our 32 2D horizon profiles previously created as part of our last investigation and their concomitant ascii data files, where 17 horizons equate to 17 different dolmens (Table 1). The number 17 equals the number of sites from which we could obtain an orientation due to their structural indicators (n=17/32 sites). We also created 17 3D landscape panoramas. All of these profiles and data were created using the software *Horizon* (Smith, A. G. K. 2020. *Horizon user guide and implementation notes*. Documentation Version 0.16 January 1, 2020; http://www.agksmith.net/horizon.). We obtained the list of the directions of the dolmens' corridor or entrance axes (not all tombs are made with corridors),

measured in the field from magnetic north (azimuth) and corrected to True North readings by Vilas-Estévez (2016: 41)

Results

We have several outcomes of this particular section of the project. Whilst we shall offer our statistical results on the likelihood of the orientations of the tombs being linked to astronomical phenomena, in this talk we will focus on the landscape features connected to orientations and cardinal points. A study of the horizon target locations coincident with the 17 orientations for each site on the 3D landscape panoramas within an image viewer (like Irfan View) show that there appear to be distinct horizon markers for the orientation targets, as will be shown on the offered figures. These markers or topographical qualities will be categorised and theories offered as to their significance.

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Building a Cultural Astronomy Curriculum

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Cultural Astronomy researchers have made several efforts to establish an international degree program for cultural astronomy including archaeoastronomy along with history of astronomy with mixed success. Having an internationally recognized academic degree program would benefit the cultural astronomy community by attracting young people keeping the discipline alive and vibrant. A cultural astronomy degree program must familiarize students with theories, case studies, data collection methods, analysis techniques and especially teach how to critically analyse cultural astronomy research. Thus, cultural astronomy degree programs hold the potential to lay a foundation while building and broadening the field. In 2006, I began an initiative focused on undergraduate students interested in earning a minor in cultural astronomy at the University of Arizona. Tucson, Arizona, where the University of Arizona is located has the reputation of having the highest density of astronomers in the world, but it was also home to a handful of researchers that engaged in cultural astronomy research in one form or another mainly in archaeoastronomy. Thus, there were enough professors and researchers available to contribute classes that could be part of the cultural astronomy initiative (Bonine 2008; Doxtater 2003; Oxford International Symposium on Archaeoastronomy, Fountain, and Sinclair 2005; Impey et al. 2004). The undergraduate focus was unique considering that the other existing programs at the time focused on post graduate students (Campion 2008; Holbrook and Campion 2008; Orchiston et al. 2011). For such an interdisciplinary field the curriculum was required to bring together mathematics, astronomy, anthropology, archaeology, and area studies. This presentation focuses on topics and regions included in the curriculum as well as the structure of the classes. Successfully, the classes were always oversubscribed, but the program stagnated when I left the university. I share the cultural astronomy concepts with which the undergraduate students struggled.

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Houston Solar Marker Matrix of Intentionality

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Rock art is ubiquitous around the world. The first known report of a solar interaction with rock art was in 1979 by Ken Hedges (Hudson, et al. 1979). The interplay of sun and shadow on rock art, known as "solar markers" are reported in very few areas of the world, with most being reported in the American Southwest. Preston & Preston (1987) reported 58 solar markers at nineteen different sites. As reported by Fountain (2005) solar markers are the third branch of archaeoastronomy. Since Fountain (2005) and Preston and Preston (2005) presented at the Oxford V conference in Santa Fe, 1996, there has been relatively little follow-up to advance this area of archaeoastronomy. The lack of reports worldwide are due in part to a lack of understanding and how to identify these solar markers. To that end, the Houston Solar Marker Matrix of Intentionality (HSMMI), Figure 1., is offered as a tool for researchers to: 1) Help identify new solar markers, 2) Confirm existing solar markers, 3) Rule out coincidental interactions, and 4) lead to a worldwide database of solar markers. First, a definition of a "solar marker" is presented (Houston 2020):

A "solar marker" is an intentional rock art glyph or panel which records a significant component of the astronomical knowledge of a culture, preserving the interactions of light and shadows on the rock art at specific solar points.

A discussion of the four types of indirect solar markers follows, which are Type 1 pointers, Type 2 moving sun or shadow lines, Type 3 geometric alignments, and Type 4 miscellaneous. Four qualifying restrictions are discussed, that must be met by any reported interaction, before proceeding to evaluate an interaction using the HSMMI. The restrictions are: 1) The solar interaction must touch and interact with the glyph, 2) The interaction must be brief, typically less than 30 minutes, 3) The culmination of the interaction must be unique, both in the design of the sun or shadow shape, and must interact with the focal point or tangent of the glyph, or some very unique part of the glyph, and 4) The solar interaction must interact with one glyph at a time. These are established to help rule out coincidental interactions and help eliminate false positives. The Houston Solar Marker Matrix of Intentionality provides and analytical tool in which four categories are scored. The final score determines the strength of a solar marker. The four categories are 1) Solar Points, 2) Time of Day, 2) Interactive Characteristics, and 4) Supporting evidence. Solar Markers are one of the most objective interpretations of rock art for the following reasons: 1) We can see the sky the same as the ancient cultures, 2) Precession does not affect the travel of the Sun along the horizon, 3) As a result, the operation of solar marker interactions operate the same today as when originally created, and 4) The recorded astronomical knowledge is usually the most closely guarded information, which the solar marker opens that knowledge to us today.

The HSMMI is a tool that will be employed by researchers, who in turn, will bring forward new reports worldwide, so a database can be established. The HSMMI is a tool in constant transition and updating, of which, many changes have already been incorporated to date. It is hoped that the presentation at Oxford XII will help to further constraint the parameters, such that false positives will be eliminated through the use of the HSMMI.

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Figure

Figure 1. THE HOUSTON SOLAR MARKER MATRIX OF INTENTIONALITY (HSMMI)					
PTS.	**1. Solar Points**	**A**	**PTS.**	**3. Interactive Characteristics**	**B**
5	1.1Winter/Summer Solstice (WS, SS)		5	3.1 Confirmed multi solar point marker	
4	1.2 Equinox (VE, AE)		4	3.2 Focal Point(s)	
3	1.3 Cross-quarter days (V, S, A, W)		3	3.3 Geometric Alignments	
2	1.4 Confirmed anticipatory points		2	3.4 Register Mark alignment	
1	1.5 Random days		1	3.5 Tangent alignments	
			0	3.6 Random	
PTS.	**2. Time of Day**		**PTS.**	**4. Supporting Evidence***	
5	2.1 Solar Noon		5	4.1 Horizon Astronomy#	
4	2.2 Sunrise		4	4.2 Temporal Sensitivity/Precision	
3	2.3 Sunset		3	4.3 Informed sources	
2	2.4 Random morning		2	4.4 Formal examination	
1	2.5 Random afternoon		1	4.5 Analogy/Symbolism	
	Point Values Total Column A			**Point Values Total Column B**	

INTENTIONALITY FACTOR	
HIGH PROBABILITY	18-20+
PROBABLE	14-18
LOW PROBABILITY	8-13
NO CHANCE	4-8

COLUMN A & B TOTALS
V-Vernal
S- Summer
A-Autumnal
W-Winter

Notes:

Section 1: Solar Points. The first four items order can be changed, based on the observed operations of a solar marker, with supporting evidence.

Section 2: Time of Day. Categories 2.4, 2.5 can be interchanged based on known observational methods of the local culture.

Section 4: Supporting Evidence. It is highly recommended that an horizon survey be completed at any site, to establish that a culture had the ability to determine the specific solar points. More than one of these five categories may be scored.

Eclipse Prediction and the Length of the Lunar Month in Mayan Astronomy

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One of the most remarkable achievements of Mayan calendrical astronomy was the creation of a lunar theory which combined the triple "Tritos" Eclipse Cycle with the prediction of the mean lunar month, known as the Lunar Series. It is not precisely known when and how the Dresden Codex Eclipse Table was developed, but as the recent paper by Justeson (1987) suggested, eclipses could have been predicted with considerable accuracy using the 88-month eclipse cycle designed to predict 15 eclipse possibilities. His work seems to prove that this method originated with lunar eclipses and was then applied to the prediction of solar eclipses. Following this, while it is probable that the structure of the Dresden Codex Eclipse Table evolved from the intervals used to predict lunar eclipse possibilities, its current design strongly suggests it was used to predict solar eclipse possibilities.

I argue here that it was a triple 135-month interval that was used to predict eclipse possibilities rather than the 88-month cycle. In my opinion, the 405-month scheme could better be synchronized with the sequence of the Moon's phases.

The Mayan Lunar Series embodied a type of a lunar calendar. It provided information about the age of the Moon, the position of the lunar month in a set of 6 and 18 differentiated months and the length of the current month to be either 29 or 30 days.

When the first Lunar Series became recorded on Mayan monuments (4th century CE), they became already arranged in the groups of six and eighteen lunar months. During the 5th century CE, they also were composed of the strings of alternating 30- and 29-day formal lunar months. It means the Mayan daykeepers could have modeled the motions of the Moon based on purely mathematical, calendrical and astronomical schemes. Where the daykeepers mastered these schemes, the so-called uniformity periods appeared (Aldana 2006). These schemes are known as the 2392-day Palenque ratio or the 4784-day Lunar Table from Xultun. They significantly speeded up astronomical computations, but could not be used to predict eclipse possibilities. The revision of lunar computations at Palenque and Coba suggests that the 11960-day cycle was used to perform long-distance lunar calculations, linking current rulers with the mythological events rather than to predict eclipse possibilities. All these cycles determine that one lunar month = 29.5308642 days.

The use of the Dresden Codex Eclipse Table to predict eclipse possibilities changed the arrangement of the lunar months. It still bears some similarity with the structure of the Lunar Series, but the groups of 6 months are mixed with the groups of 5 months. The Table does not represent the ideal triple Tritos cycle, apparently Mayan day keepers moved the Tritos cycle three eclipse possibilities earlier than the corresponding lunar cycle. This rearrangement enabled them to predict solar eclipse possibilities. Finally, the Tritos cycle can be fixed by simply adding the sequences of 88 and 47 months discussed by Justeson (2017).

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Notational production rules in the Muisca Culture iconography, Colombia

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In the context of the study of the calendar traditions of the pre columbian inhabitants of the Western Andes of the current day Colombia (traditionally referred to as the Muisca Culture), the iconography appearing in many expressions pertaining their material culture, such as spindle whorls, goldsmithing, ceramics, textiles, musical instruments and rock art, suggest the presence of symbolic elements that in many cases seem to be related to the representation of numerical quantities. This draws the attention as such numerical representations could be potentially related to narratives where astronomy and calendars could play an important role. Examples of artifacts where this is more evident are the carved stone ican42-viii-3920 of the Museo Nacional de Colombia and the Strombus shell Trumpet of the Sogamoso Museum where their iconography show clear accounts of a native lunisolar calendar originally described by Jose Domingo Duquesne in the late 18th century and more recently studied by the present author in past years.

However, attaining an astronomical-calendrical interpretation of such iconography is not entirely straightforward as we do not fully understand the contexts of their production, contexts related to procedures, social sanctioned styles, and motivations for its performance. Traditionally, these expressions have been studied from a point of view of Art, where by its very essence, the aesthetic dimension predominates in the interpretation of the expressed contents, which could lead to a continuous spectrum of meanings, ranging from the subjective to the objective, as a consequence of one of the most fruitful resources of art: ambiguity.

The numerical contents of artifacts as the Choachi Stone and the Strombus shell Trumpet suggest, however, that the nature of the iconographic representations are not restricted only to the artistic realm, but that on the contrary, a precise, non ambiguous information might be encoded in the artifacts. This work takes a perspective more related to epigraphy and without fully ignoring the artistic dimension of these iconographic expressions, suggest that these representations encode precise contents, of semasiographic nature, following coding rules defined by a grammar, formed by a set of production rules.

This work centres in the analysis and deduction of such grammatical rules, and get theoretical support on Theory of Language's generative grammars, working on the specific case of iconographic corpus of the spindle whorl collection of the Sogamoso Museum. The spindle whorls are used as an entry point for the study of this system as they show in their graphic components, compared to other kinds of Muisca artifacts, a high degree of simplification without sacrificing information loss, which allows us to observe, from a Chomskian point of view, the deep structure showing the syntactic components of the system.

It is important to emphasize that, despite this iconographic system could be governed by grammatical rules, there is no evidence suggesting that this iconographic system is a form of writing, in the conventional view that writing is the representation of the spoken language. Instead, it is suggested that this system is semasiographic, and that it may represent a notational system of information restricted to a specific topic, similar to our mathematical notation or musical scores.

A good understanding of the syntactic structures of this iconographic system, is in my point of view, a mandatory step prior to any further interpretation of meaning, for this reason, a semantic analysis is left to a posterior work. In consequence, the analysis of recognized astronomical-calendrical elements in this iconography, are presented as a preliminary work, build upon the results of the present research, and that it is expected to be expanded in the near future.

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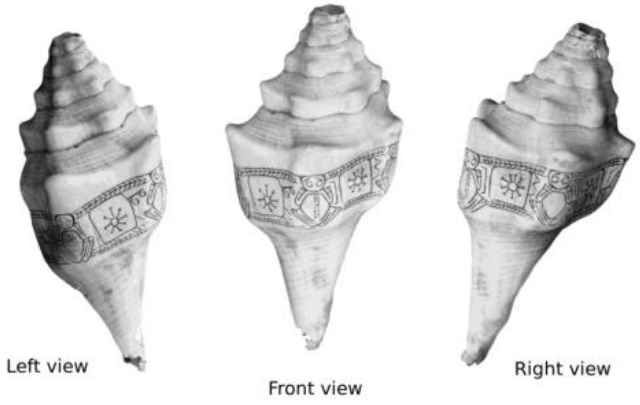
Figure

Stone ican42-viii-3920 of
the Museo Nacional de Colombia



Strombus shell Trumpet of
the Sogamoso Museum

El globo terráqueo paralelo
En la construcción de identidad vinculada al cielo

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La representación tridimensional más común de nuestro planeta Tierra tiene la forma del habitual globo terráqueo, el cual se puede encontrar en cualquier institución educativa y en cualquier comercio del ramo dedicado a insumos educativos, en todas partes del mundo, sin excepción. Este modelo concreto se presenta con un soporte que permite ubicarlo sobre una mesa, fijando el globo por los polos geográficos de modo que el eje de rotación queda formando un ángulo de aproximadamente 23.5° con respecto al plano horizontal de la mesa, con el hemisferio norte hacia arriba, con las palabras que detallan la geografía para ser leídas sólo en esa posición. El globo rota libremente, en ambos sentidos, alrededor del eje que pasa por los polos. Esta representación presenta una única perspectiva: la de un observador en el espacio por encima del plano de la Eclíptica hacia el norte, perspectiva que se ha naturalizado, a veces por convención y a veces por desconocimiento, en todo el mundo, en todas las culturas, en todas las personas, con algunas pocas excepciones. El globo terráqueo tradicional es único, y no tiene ninguna diferenciación temporal ni espacial para los distintos observadores/personas que poblamos el planeta. Es único para todos, no representa a nadie en particular, pero fortalece visiones dominantes aún hoy, de hecho y simbólicas, en especial a través de asociaciones como norte- arriba, sur-abajo, entre muchas otras. El globo terráqueo además no está vinculado con aspectos físicos y astronómicos, como la gravedad y el estado de iluminación y sus cambios; es decir, es un instrumento representativo de una cierta concepción geográfica, muy pobre con relación a la enseñanza de la Astronomía (tanto es así que se utiliza en espacios cerrados), y muy tendencioso desde una mirada antropológica.

Desde hace ya varias décadas los autores y muchos otros colegas estamos trabajando con un modelo concreto que denominamos "Globo Terráqueo Paralelo (GTP)", el cual consiste en tomar un globo terráqueo, quitar el soporte de fábrica, y reposicionarlo para cada lugar de observación, de modo que ambas verticales del lugar, la real y la propia de la representación, sean paralelas, y que los planos fundamentales: horizonte y meridiano, reales y del GTP sean también paralelos, lo que lleva a que ambos ejes de rotación también lo sean. Así, el Globo Terráqueo Paralelo y la Tierra constituyen un par homotético: cada punto real sobre la superficie está vinculado a un único punto sobre el modelo, y todas las direcciones y planos son paralelos respectivamente, con total correspondencia en tiempo real de todos los efectos en cuanto a estado de iluminación (día y noche, estaciones). El GTP no rota, es fijo y presenta una única perspectiva topocéntrica, propia de cada lugar de observación, y por consiguiente no es posible trasladarlo para ser utilizado en otras ubicaciones geográficas. De hecho, el GTP paralelo se utiliza en espacios abiertos, con la iluminación diurna del Sol. Por estas razones, el Globo Terráqueo Paralelo es una herramienta didáctica de gran potencialidad, y a la vez muy simple, que posibilita trabajar en forma muy accesible todos los conceptos de la relación de las personas con el cielo, contribuyendo a la construcción de una visión dual, local y planetaria, al mismo tiempo, de vital importancia para la enseñanza de la Astronomía y para la vida en sociedad. Por esto mismo, es un instrumento no sólo para la educación, sino para la construcción de una visión de la humanidad respetuosa de las singularidades, espaciales y temporales, y por ello mismo culturales, de cada persona/observador terrestre, a través de los tiempos.

Presentaremos en la Comunicación Oral detalles del GTP y mostraremos de qué manera utilizamos desde hace muchos años este modelo didáctico (a través del proyecto internacional Globo Local, http://www.globolocal.net/esp/proyecto.html) para fortalecer la construcción de identidad cultural y social, en todo el mundo, pero en especial en Latinoamérica, y discutiremos su proyección como dispositivo de gran importancia para la Astronomía Cultural.

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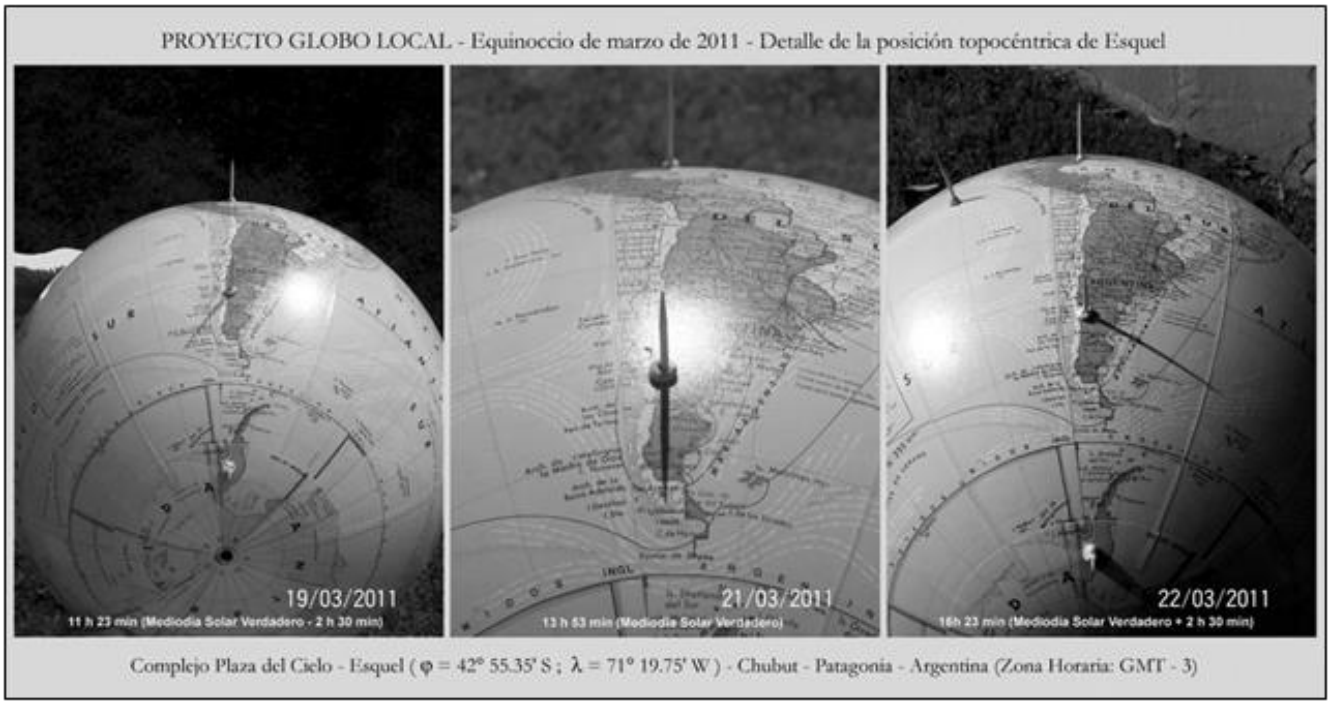
Figura



Sky's Bodies

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Keywords
meteorites, body, Chaco, experience, social construction

Anthropological inquiries in recent decades have shown the relevance of a perspective on and from the bodies (Csordas 1994) to fully understand our experience of the world. This avoids over-emphasizing the rational aspect of social life and not paying attention to the social construction of the perception, that forms the basis of our knowledge systems. In this sense, cultural astronomy, as an anthropological view of knowledge and practices regarding the sky, is at risk of not being aware of these approaches. This is because many times, naturalizing a view of the sky that is typical of Western Modern Science, the celestial space is conceived as distant, far away, the "other" par excellence. An area with which our interactions would be mediated only by the sense of sight and its technical aids.
However, the experiences and narratives of many human groups show that other senses can play an important role in the experience of the sky. The idea of a distant sky is not universal. For many cultures, human beings can approach the sky and touch it, smell it, taste it and even hear it. In this perspective, even the view of Western Modern Science, which emphasizes distance, can be read in another key, analyzing what it sustains and implies as a social construction. One of the most interesting experiences in this regard is that of human encounters with meteoric fragments. In this case, the encounter on Earth with what is typical of the Sky puts us in contact with multiple “bodies of the Sky”, which confront human beings very directly.
The Meteoric Dispersion of Campo del Cielo allows us to address these sensorial explorations of the bodies of the sky in a particularly interesting way. Occurred about 4000 years ago in the SW of the Argentine Chaco, it brings together a large number of iron-nickel fragments from small pieces to huge masses of tens of tons in a 100 km X 3 km strip. The fact that many of these fragments were exposed on the surface of a huge plain caused different human populations to establish a complex web of relationships with these celestial bodies for a long time. The changing inter-ethnic exchanges of the region constitute a dense human network on which intense links with the meteorites of Campo del Cielo are woven.
In this work, continuing a long term research initiated twenty years ago (Giménez Benítez, López and Granada 2004), we will focus on the analysis of the embodied experiences that these diverse human groups have and have had of these celestial bodies. We will analyze a series of ways of experiencing and building diverse "bodies" of the sky. It is about demonstrating how links are established with the celestial mediated by the direct experience of a material presence. We will seek to deepen the way in which these experiences of and from the body construct and are constructed by the different conceptualizations of the meteorites. We will address the richness and variety of perceptions of Creoles, European migrants and aboriginal population. We will attend to the diversity present in the approaches of shamans, community leaders, young bilingual teachers, artists from Buenos Aires, Argentine and foreign scientists, local Creoles, state officials, tourism agents, etc.
We will see how meteorites become true embodiments of the celestial, one of their "body regimes" (Foucault 2002). Sensations such as hardness, resistance, cold, heaviness, brightness, durability or exceptional character will become constitutive of the experience of the encounter of various human groups with these presences. The tension between presence-visibility and absence-invisibility, its location, its links with its surroundings: all this constitutes the substance, the stone like "flesh", of a huge diversity of skies. This "flesh of the sky" can be touched and climbed. From it fragments are taken, inscriptions are painted on it, in front of it some people dance, its manipulation affects the weather or generates fecundity and wealth. These experiences will be constructed and interpreted within the framework of different cosmological schemes and ideas about corporality and the senses. Hence, diverse human groups will build alternative landscapes of Campo del Cielo. Things that for some are fragments of “fallen sky”, trapped down here, debris of the construction of the solar system; for others they are ways in which celestial beings actively seek to be present among humans, seats of powerful entities with desires and intentions. Although it seems paradoxical at first impression, these bodies of the sky are also associated with movement, they are not thought of simply as inert masses. Their past, possible and dreamed displacements are crucial. For some they wandered through the solar system and fell to Earth, for others they came down from the sky and buried themselves in the ground and then slowly ascending to meet those they were destined for.

So in this paper we will analyze these experiences of the sky flesh, including our own field experience, linking both human and non-human bodies and movements.

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Ritual, Pilgrimage and the Ontological Turn in the Chaco Regional System, Southwest United States

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It has been suggested by Lekson (2018) that Chaco Canyon was the capital of a small city-state, known as the Chaco Regional System, with a total population of 50,000. The Canyon contains Great Houses that once may have functioned as palaces, which he suggests were the homes of royals. Mills (2015) criticizes such a viewpoint as inappropriate division of a culture, a 'trichotomization' into religion, economics, and power, whereas these features, she argues, are inextricably intertwined. An alternate interpretation is that the canyon may have been an empty ceremonial center, similar to many pilgrimage centers around the world such as Cahuachi, Peru (Silverman 1994) and Konarak, Varanasi, and Pandharpur in India (Malville and Malville 2001). Thus, Rowe (1963), described ceremonial centers that he found in Peru, which may apply to Chaco Canyon: "Between occasions when a ceremonial center is used it is either closed and empty or houses only small permanent population of caretaker personnel…. ."

Benson (2019) and colleagues have shown that Chaco Canyon was agriculturally unsustainable for large populations. For 2000 people living in the Canyon, 50 porter loads each day would have been required to provide sufficient food. However, as an empty ceremonial center only filled with people during the arrival of pilgrims and traders, Chaco Canyon is understandable. During pilgrimage events visitors may have carried in offerings and contributions, hoping to get bountiful harvests in return for participating in festivals.

It may be that these monumental Great House were more meaningful as structures (and social memories) than any of the residents they may have housed. Great Houses were built to be impressive to outsiders, and appearance may have been more important than livability. The Great House of Chimney Rock, for example, was clearly not a permanent residence of powerful elites from Chaco Canyon. It appears to have been a site for celebrations associated with the major standstill moon which rises between the double rock chimneys as viewed from the Great House. The two sets of construction dates coincide with the last two major standstills of the 11th century. The stacking of metates inside the Great House together with faunal remains suggest periodic festivals. A guard house, constructed by the local community, closed off the upper mesa such that regular access by any residents, especially those from Chaco Canyon, would have been rendered difficult.

Great Houses, as well as earlier pit houses in the Canyon, are grouped into two orientations, either north-south or toward the south-south-east. The persistence of that tradition indicates how meaningful and compelling it was, perhaps related to migration and ethnic traditions. The largest Great House, Pueblo Bonito, started oriented to the south-south-east but around 1100 CE was reoriented north-south. This potentially disruptive reorientation of Pueblo Bonito provides, I believe, a significant clue to its nature. As a home for people for whom orientation was a fundamental aspect of their self-identity, it is very difficult to understand how residents could accept such a change, which may have demanded a change in origin myth as well as in ethnicity. There is no evidence of a forceful takeover of Pueblo Bonito. One explanation is that there were very few people living in the building, and, consequently, the structure could be modified without a major disruption of its residents.

In keeping with the ontological turn, Great Houses may have contained meaning beyond religion, economy, and politics. A reluctance to dishonor or mistreat the structure for fear of something that was nearly impossible to articulate may have been consistent with Descola's ontological classification of analogisim. The Great Houses, at one time, may have been similar to those of house societies described by Levi-Strauss in that were understood to be living entities that were maintained by a series of rituals, linking the structures to ancestors and the powers of the heavens. Andean huacas may be examples of comparable animated features of the landscape.

Great Houses throughout the Chaco Regional System will be analyzed with reference to these suggestions.

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La relación entre las orientaciones arquitectónicas y la cosmovisión en Mesoamérica. Estudios en Tehuacalco, Guerrero, México

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Palabras clave
Montaña sagrada; Xipe Tótec; *Yopico*; *Tlacaxipehualiztli*; equinoccios temporales; siete días.

La Zona Arqueológica de Tehuacalco quedó registrada en el año de 1996 pero fue una década después cuando se comenzó a investigar y habilitar para el público bajo la custodia del Instituto Nacional de Antropología e Historia (INAH), México. Es una de las zonas prehispánicas más grandes con arquitectura expuesta en todo el Estado de Guerrero. Las exploraciones, que iniciaron en el 2006 y finalizaron en el 2008, consistieron en liberar, consolidar y restaurar las once estructuras de las cuales destaca un templo elevado, un palacio y un juego de pelota. La cronología va del Periodo Epiclásico (650-900 dC) hasta principios del Periodo Posclásico Tardío (1200-1521 dC). Tehuacalco quedó circunscrito en la macro área denominada Mesoamérica, específicamente en el área de Occidente, aunque a su vez una parte de Guerrero ha sido propuesta como un área en sí misma. A pesar de lo anterior no se conoce la filiación étnica de Tehuacalco. La cultura que se asentó en la región antes de que existiera fue la usuaria del complejo cerámico Capacha que se remonta cuando menos al año 1200 aC. Durante el Posclásico la región se caracterizó por la presencia de una cerámica rojiza, arenosa y en ocasiones con mica. Su arquitectura destacó por el paramento mixteco, un estilo a base del recubrimiento de muros con lápidas lisas verticales y lajas horizontales. Tehuacalco estuvo en una posición estratégica en una ruta natural norte-sur empleada como una red de intercambio de grandes dimensiones que comunicó la Cuenca de México con la costa del Océano Pacífico o al menos los valles centrales de Guerrero con el océano quizá desde el Periodo Preclásico en el año 600 aC. Todo parece indicar que cuando los españoles llegaron a la región, Tehuacalco ya había sido abandonada y eran los yopes, grupo nómada, quizá con algunas fracciones sedentarias y cuyo dios tutelar era Xipe Tótec, eran quienes se encontraban en ese territorio. Estos fueron extintos poco después hacia mediados del siglo XVI. El Yopitzingo[1] fue un señorío independiente del imperio mexica pues éste nunca logró someterlos (Davies 1968). El nombre de Tehuacalco está en náhuatl y pudo deberse al expansionismo de las alianzas del Centro de México durante el Posclásico o simplemente a las migraciones nahuas.

En los años 2010 y 2014 demostramos que la traza general de Tehuacalco estuvo diseñada y orientada con base en principios calendárico-astronómicos relacionados con el paisaje. Ésta tiene cuatro montañas, una en cada uno de los rumbos cardinales (Figura 1), destacando la del este por sus dimensiones y cercanía, además de que fue lugar de culto desde el Preclásico Medio (1200-400 aC), siendo así una de las más antiguas de Mesoamérica hasta hoy conocidas. Por lo anterior, consideramos que es una montaña sagrada y ancestral. Algunas de las estructuras principales de Tehuacalco están orientadas y armonizadas con esa montaña de una manera que recuerda a la representación del *yopico*, templo de los yopes que se encontraba en la ciudad de México Tenochtitlán, en la cual el gorro del dios Xipe Tótec aparece de forma simbólica encima del recinto (Sahagún 1982). El gorro, denominado *yopitzintli*, tenía una forma cónica con bifurcaciones laterales de la misma manera que la montaña sagrada de Tehuacalco, región donde se sabe fue Xipe el dios tutelar, al menos en el Posclásico Tardío (Figura 2). De hecho, algunos investigadores han propuesto a la región como una de las posibles de donde surgió el culto a esa deidad.

En concordancia con el acomodo mencionado de estructura-montaña (A E-M), figuran fechas que también se pueden asociar a Xipe Tótec. En el calendario del Centro de México la segunda veintena del ciclo de 365 días se llamó *Tlacaxipehualiztli* y sucedía, según Bernardino de Sahagún, entre el 4 y 23 de marzo (gregoriano), ésta última, fecha cercana al equinoccio temporal (22/23 de marzo). El eje de orientación visual del Templo Corona del Palacio de Tehuacalco tiende a 23 de marzo (Figura 3). La otra estructura de Tehuacalco con un acomodo A E-M es el templo principal y está orientado con fechas calendárico-astronómicas ya que por el oeste, tiende al

[1] El territorio de los yopes en Guerrero. Tehuacalco está en su límite norte.

intervalo de 73 días,[2] una de las orientaciones destacables en Mesoamérica, y como se trata de ejes cuyas asociaciones primarias este-oeste nos remiten al ordenamiento espacial mesoamericano fundamentado en los pares de oposiciones, la orientación al este también podría estar vinculada a un intervalo. Efectivamente, el intervalo está compuesto de dos fechas que se repiten en las orientaciones de Tehuacalco pero también en las de Mesoamérica. Se trata del 14 de marzo y 29 de septiembre ±1 día (Figura 4). El intervalo tiende a 84 días, en años específicos, y se caracteriza por tener como base al número siete, número asociado a la tierra de la misma manera que *Tlacaxipehualiztli*, que podía representar el cambio de piel que era la renovación de la naturaleza (González González 2014), el inicio de un ciclo más. El siete era el del plano terrestre, pero también la sustancia dadora de vida de los seres humanos según Beliaev (2012). El siete fue, además de un número básico de la cosmovisión, un número calendárico pues nos remite, por ejemplo, al ciclo computacional de 364 días (7x52), a la distancia ideal entre los solsticios y los equinoccios temporales (7x13), al ciclo sagrado de 819 días (7x9x13, los tres números fundamentales de la cosmovisión), al factor de 63 días (7x9), presente en las orientaciones de la arquitectura como la del Castillo de Chichén Itzá y el Templo del Fuego Nuevo del Cerro de la Estrella, y al ciclo de los siete días y dioses en la Cuenta Larga maya, el Glifo Y.

Después de la emancipación progresiva de Mesoamérica siguen existiendo festividades arraigadas a las tradiciones prehispánicas como las de la región aledaña al Yopitzingo, la de los tlapanecas, grupo sedentario y asociado a los yopes. Ellos siguen utilizando cerros y milpas como escenarios, por ejemplo, el 29 de septiembre (fecha en el eje de orientación visual del templo principal de Tehuacalco) para conmemorar la lucha entre el bien y el mal, entre la abundancia y la hambruna, entre el calor y el frío, en lugares que aún mantienen el nombre de Xipe, como Chiepetlán y Chiepetepec. Octubre es el final de las lluvias y por tanto el momento de mayor madurez del maíz y de la cosecha en estas latitudes, y con ello el fin del ciclo ritual agrícola.

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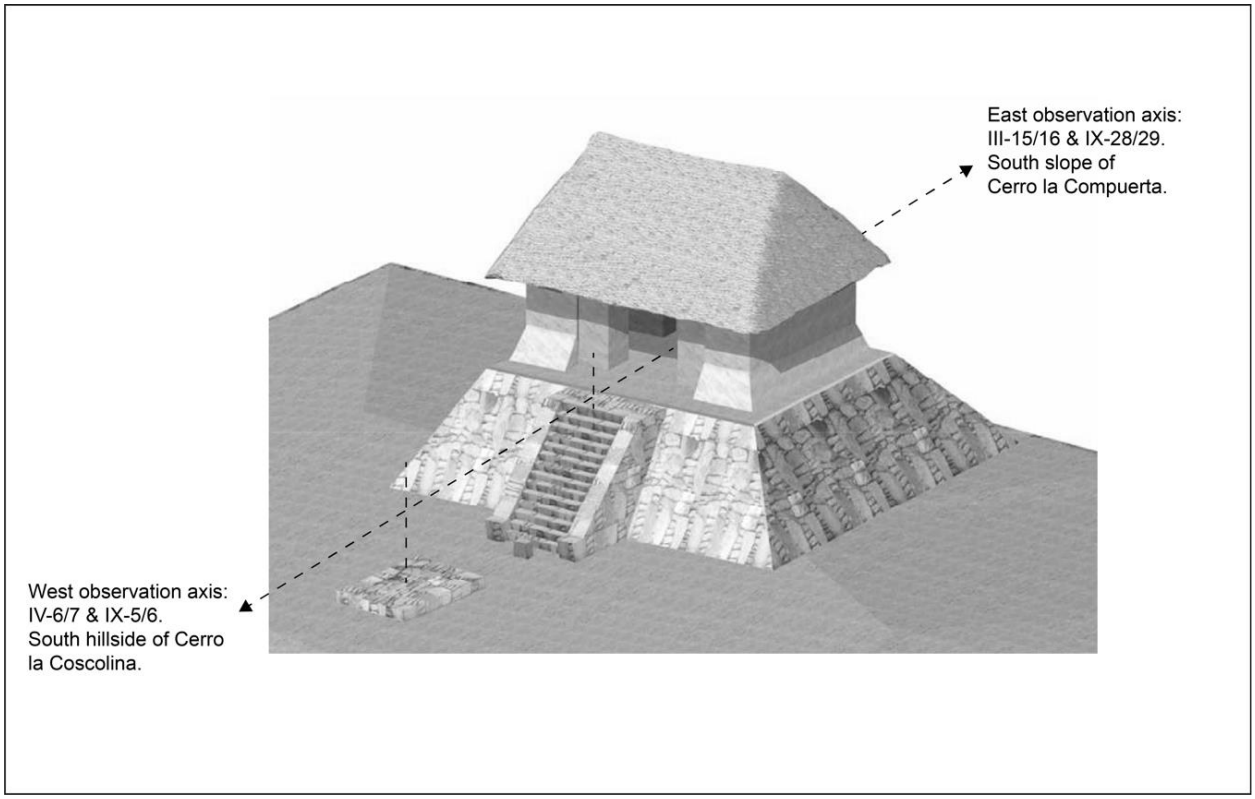
Figura

Templo principal de Tehuacalco (E1B) y el eje de orientación de la escalinata. Reconstrucción hipotética del encierro y techo. Realizado por Hans Martz de la Vega y Miguel Pérez Negrete (2014).

[2] Se trata de un conteo de días entre la fecha y el solsticio más cercano a ella. Todo parece indicar que era una de las formas como contaban días en Mesoamérica.


East observation axis:
III-15/16 & IX-28/29.
South slope of
Cerro la Compuerta.
West observation axis:
IV-6/7 & IX-5/6.
South hillside of Cerro
la Coscolina.

What Did Knowledgeable Hopi Mean When They Called the Moon Chief *Qahopi*?

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> "The Moon Chief is a man-& is so called (*Müʳiyawû Moñwi*) but does not seem to be held in much veneration, in fact they say he is *Ka-ho'-pi* = foolish. He has no house."
> Alexander M. Stephen, Letter to J. Walter Fewkes, Tewa, Jany 18th 1894

We use historical methodology to critically examine an unpublished ethnographic text in the correspondence of Alexander Stephen to Jesse Fewkes in the Smithsonian Institution's National Anthropological Archives (Stephen 1891-84). This study revealed how a knowledgeable group of nineteenth-century First Mesa Hopi understood the Moon Chief's journey as he carried the Moon on his arm from moonrise to moonset.

First, comparison with Stephen's contemporary usages of the term chief or *mongwi*, and particularly of the term Sun Chief (Stephen 1936), indicates that he and his knowledgeable Hopi informants understood the Moon Chief to be a spiritual being who each day carried the Moon on his arm from East to West. Second, drawing on a range of specific examples of behavior that are described in the ethnographic literature as *qahopi*, we examine what a typical Hopi would mean if they said that a man or a woman or the Moon Chief or a kind of behavior was *qahopi* (Brandt 1954, 91; Glowacka and Sekaquaptewa 2009, 176-7). Next, after having clarified the pejorative nature of the term *qahopi*, we returned to Stephen's original text to demonstrate that it was the Moon Chief's lack of a house — that is, of fixed rising or setting points marking the northern and southern extremes of his monthly journeys along the eastern or western horizons, that Stephen's knowledgeable Hopi considered to be *qahopi*. Finally, we compare theoretical models of the lunar standstills to demonstrate that This labeling the Moon Chief's lack of a house as *qahopi* suggests that the Hopi may have been aware of the fluidity of the lunar extremes, and possibly of the existence of intervals when the lunar extremes approached the standstill limits. They judged this wandering to be a deviation from the orderly behavior expected of a Hopi and there is no ethnographic evidence that they tried to find a pattern for this *qahopi* behavior. This makes it extremely unlikely that the Hopi used observations of the Moon's place on the horizon as an element of their calendar.

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Astromorphs and Astronomical Scenes in The Honduran Rock Art: Ayasta Rock Shelter

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Keywords
Rock art, Astromorphs, Astronomical Heritage, Astronomical Heritage in danger

The appearance of astromorphs, figures with a morphological resemblance to an astronomical element such as the sun, the moon or a possible calendrical account or record, in rock art is common in most countries. However, it is not frequent to be able to verify its possible astronomical meaning since the context of rock art usually appears isolated and difficult to interpret, with a high bias of the researcher. This is true because of the lack of cultural context as well as the lack of correlated records that support interpretations by evidence accumulation.
In this work, the archaeological site of Ayasta is presented, located in the department of Francisco Morazán, Honduras (Figueroa, 2006 and Figueroa and Rodríguez, 2006). It is a group of three contiguous rock shelters that contain a complex of different types of astromorphs that are on the list of endangered astronomical heritage sites of Commission C4 of the International Astronomical Union (IAU), due to their delicate situation of conservation. Petroglyphs are classified according to their anthropomorphic, zoomorphic, anthropozoomorphic and geometric character (Rodríguez, 2007), however all reports, articles or records obviate the existence of clear astromorphs on the site. The rock art presented here is interpreted as proto-lenca as this territory was occuppied by this culture in the past (Rodriguez, 2007), however the lack of a proper excavation produces a high degree of uncertainty in this interpretation. Thus, correlation with archaeological materials with the engravings themselves and in relation to ethnographic data must be shown in subsequent investigations.
Despite of this, the relevance of the archeological site, from the archaeoastronomical point of view, is the appearance of astronomical scenes on several of the panels, that is, an astronomical event with the interaction of a person or a group of them as it will be argued in the exposition of this work. These scenes could be probably related to solar observation or worship by an officiant. Also relevant is the appearance of geometric symbols in the form of spirals with possible astronomical significance, in particular linked to solstices and equinoxes. This is supported by several solar astromorphs at the edges of the rock shelter. There is also an "... unusual presence in abundance of holes, also known as domes or cups, of different sizes and in different areas of the shelters…" (Rodríguez, 2007) that has not been interpreted and that could well be seen as certain type of record that could explain the knowledge and use of astronomical events for both religious and civil purposes.
The site is completed with a possible registration of a fireball bolide that could have been registered by other nearby rock art sites. As can be seen, it is an astronomical complex, still under research, but it is clear that it shows a sophisticated and methodical knowledge of the celestial space by the inhabitants of this region.

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El Observatorio de Xochicalco: ¿primer telescopio solar de la humanidad?

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Xochicalco, sitio arqueológico del estado de Morelos, México, datado en el periodo Epiclásico (650-950 d.C.) donde encontramos las más abundantes e importantes inscripciones calendáricas del centro de México, mismas que nos han permitido reconstruir su *tonalpohualli* o cuenta sagrada (Morante 2019b). Las primeras investigaciones acerca del Observatorio de Xochicalco las realizó el geógrafo alemán Franz Tichy (1980) en la década de 1960. Le siguieron los estudios de Johanna Broda (1982). En ambos casos hablamos de trabajos pioneros de las observaciones mesoamericanas al cenit. Tras observar que el brocal del tiro del observatorio de Xochicalco se ampliaba en su extremo exterior mediante una especie de caja, Tichy propuso que ésta se ocupaba para colocar un objeto que redujera el diámetro de entradas solares al interior de la cámara de observación y hablo de un orificio con diámetro de 4.5 cm., Broda realizaría años después este experimento durante el solsticio de verano y obtuvo una imagen redonda que, como Tichy había previsto, resultó ser muy útil para registrar los movimientos solares. Morante en sus estudios entre 1986 y 1993 notó un orificio al borde de la chimenea y supuso que se cubría para regular la primera y última entradas solares en un año, con lo cual resultó mucho más precisa la relación de 105 días con presencia de rayos solares al interior del Observatorio y 260 sin ellas, lo cual nos remitía a los dos calendarios mesoamericanos. Un tercer experimento fue realizado por A. Cornejo Rodríguez (2011: 13) y sus colegas de la especialidad en Física de la Universidad Autónoma Metropolitana Xochimilco, quienes, con base en sus estos trabajos en Xochicalco, proponen la creación de una disciplina a la que llaman arqueo o etno-óptica. Ellos colocaron un diafragma y lo redujeron hasta que proyectó una imagen nítida en el piso de la cámara de observación, lo hizo cuando el diafragma tuvo 4.9 Mme., de diámetro, muy similar al calculado por Tichy de 4.5 Mme. No obstante, las propuestas de estos investigadores quedaban en meras especulaciones que no comprobaban que los xochicalcas hubiesen tenido y usado tales dispositivos.

Durante el Proyecto Especial Xochicalco, entre los años 1994 y 1995, se descubrieron alrededor de 17 discos de cerámica en las cercanías del Observatorio de Xochicalco (al norte de la zona arqueológica). Uno de ellos se exhibió en el Museo de Sitio y los demás se guardaron en las bodegas del INAH en Cuernavaca. Tras casi 25 años desde estos hechos, en el año 2017, se me permitió tener acceso a ellos y experimentar in situ colocándolos en la boca del tiro vertical de este Observatorio cenital que estudié en detalle desde el año 1986 (Morante 1990, 1993, 2001, 2019) con el fin de hacer observaciones directas de las entradas de rayos solares con y sin estos dispositivos. Los experimentos se realizaron entre el 27 de abril y el 15 de agosto de 2017 por parte del suscrito, apoyado por el arqueólogo Mauricio Escalante; en la bodega del INAH contamos con el apoyo de la Mtra. Silvia Garza. Los resultados se publicaron con fines de divulgación (Morante, Garza y Escalante 2018); y el estudio detallado sigue inédito. El objetivo de esta ponencia es presentar datos comparativos especializados y los resultados de estas investigaciones que indican la forma en que estos discos pudieron usarse y la precisión de las observaciones que a través de ellos debieron hacerse. Una comparación con algunos telescopios solares actuales, como los que hemos visitado en Tenerife, España, resulta útil para entender algunas características mutuas y para distinguir objetivos, si bien distintos, comparten un mismo interés por conocer mejor al Sol.

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Neutron Star performance art workshop informed by Indigenous Knowledge, Queer Identity and quantum physics.

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The visual art practice utilises transdisciplinary mixed-method research informed by the intersection of astrophysics, Indigenous knowledge, and neuroscience – to create inclusive, meaningful, and positive social change (Sullivan 2006).

This is accomplished by examining lightning through the lens of sexual difference, Indigenous and scientific philosophical inquiry, and sculpture and performance art. The aim of the creative practice and process is a way to invite audiences to expand upon their perception of identity through the responsibility of learning the teachings of Indigenous Knowledge and non-archival art and the process of making (Cameron 2005). The philosophical position of this practice is based on the artist's departure from binary lexicon by identifying not as a woman or a man but as lightning – building upon their lifelong trans/disciplinary creative practice.

Bon Mott identifying as lightning was sparked by researching Bon Scott, the singer and songwriter of the Australian rock band AC/DC from 1974 until their death in 1980. When asked by a journalist whether they were the 'AC' or the 'DC', Ronald Belford Scott (Bon Scott) replied, "Neither, I'm the lightning flash in the middle." Bon Scott's identification as the lightning flash in the band's logo can have multiple meanings: AC/DC is an abbreviation for an alternating current/direct current electrical power system from which the band takes its name. It also means 'bisexual' in 1970s English slang and is a transgender identity-fluid-crossing description in gender-diverse communities of Indonesia.

A developing model on the origins of lightning within Western science is that lightning originates from cosmic rays generated from supernovae (Binns et al. 2019). Cosmic rays enter the Earth's atmosphere and collide with oxygen and nitrogen to produce another shower of X-rays and subatomic particles. The lighting strikes we see occur from electrons moving between clouds and Earth's surface. Charged storm clouds, connecting with conductive tubular ice and electrically short-circuiting, create a combination of leaders and step leaders of incandescent light, also known as terrestrial plasma (Rodger 2014). According to this model, lightning is intergalactic in origin, taking millions of years to come to reach our ozone layer in the form of cosmic rays. The electrical energy in a thunderstorm splits apart nitrogen molecules, which then combine with oxygen to form nitrates. These nitrates fertilize the soil and mineralise water, known as the nitrogen cycle. Nitrates feed soil and water for plants and animals – becoming the pathway for people to absorb nitrogen through food. Just as cosmic rays are formed in supernovae, the iron in our blood was formed in the cores of dying stars through nuclear fusion, seeded across the cosmos through supernovae. This leads to the preface of identification as lightning, poetically equating these areas as *Wakan* – a Lakota word for a mysterious, powerful, and intangible energetic force in *Lakota/Dakota/Nakota* traditions (Peat 1995).

Lightning research led to the curatorial premise of an intensive three-day trans/disciplinary live-art laboratory *Neutron Star,* curated for radical artists and non-binary, transgender, and/or Indigenous participants from backgrounds in performance art, dance, theory, and activism hosted by Guillermo Gomez-Pena and the international performance troupe 'La Pocha Nostra'. Gomez-Pena is a Chicano academic and performance artist who works with the politics of language, the side effects of globalization, the culture of violence, and new technologies from a Latino perspective to navigate their artistic practice.

Artist and curator Bon Mott will demonstrate their methodology through a video of the high energy process of protons and electrons merging into neutrons, forming the tightly packed neutron stars through sculpture and performance art – informed by Indigenous knowledge – to communicate the urgency of positive social change.

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Figure

Neutron Star, Guillermo and Bon, 2018. Photo: Amanda Fordyce

“Towards East, towards Jerusalem”: a study about orientations in Jewish religious practices

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Through archaeoastronomical and ethnoastronomical techniques I investigate orientation practices in the religious context of *Ashkenazim* Jewish communities present in the south of the Argentinean Chaco region, north of the province of Santa Fe. These communities have their origin in the Jewish agricultural colonies of the area, formed by Jewish immigrants from central and eastern Europe who arrived among waves of immigration occurring in Argentina in the second half of the nineteenth century and the first half of the twentieth century. These Jewish colonists lived in the context of a complex interaction between *criollos*, aboriginals and European colonists from different origins and religions, who settled in the area. As such, it is within the framework of an enterprise being carried out by many researchers to thoroughly investigate cultural astronomy in the Chaco region.

Through ethnographic field research among some of these Jewish immigrants and their descendants in the towns of Monigotes, Las Palmeras, Palacios and Moisés Ville (the first Jewish agricultural colony in Argentina established in 1889 by the Jewish Colonization Association), I recorded some ideas about the orientation when praying, and about the orientation of synagogues and graves present in the region. To these people, when they pray, at specific moments, they turn “towards East,” “towards Jerusalem.” Furthermore, according to them, the wall of the Ark (which contains the Torah scroll) is in the eight synagogues present in the region, faced “towards East,” “towards where the sun rises” or “towards Jerusalem,” as all the graves in the three Jewish Cemeteries in the area. In this case, my interlocutors understand that "all the dead are buried with their feet facing East," "with their feet towards Jerusalem," "like the synagogues." According to them, it reflects the Jewish belief in the fact that “after the arrival of the Messiah the dead will return to life and go directly to the Holy Land, Jerusalem, the Temple."

Fundamentally, in Jewish tradition it is important to pray "towards Jerusalem" or "towards the Temple." This custom is transferred to law in the rabbinic period, being fixed in the *Mishnah* and extended in the *Talmud*. Particularlly, the *Talmud* understands that “Jews in the diaspora should face towards the Holy Land while praying, those in Israel should face towards Jerusalem, those in Jerusalem should face toward the Temple Mount, and those on the Mount should turn toward the Holy of Holies.”

The importance of oriented prayer is reflected in architectural constructions, especially in synagogues. Historically the architectural elements of the synagogues were structured so that the synagogal cult was centered on the Torah, it is the Torah that is clearly faced towards Jerusalem, and the space is arranged so the faithful can enter and pray in front of the Torah, looking in this sacred direction. On the other hand, it is very difficult to find in Jewish tradition the origin of that custom of “buried dead with their feet facing East," but there are some references in *Gesher Hachaim*, a medieval *Ashkenazi* treaty on grieving laws.

But it is in the European Jewish diaspora (where the *Ashkenazi* Jewish tradition arises), and later in American Jewish diaspora, where this concept of sacred direction was reinterpreted, obviously by geographical dispersion, and references appear in which a synonym is established between the direction towards Jerusalem and "the East."

In this context, it is important to highlight that all the immigrants with whom I was able to talk in the fieldwork, when asked about the appreciation of possible differences in the orientation between the synagogues of their settlements in Europe and those of the colonies they arrived at, said that “the orientation was always the same, always towards East”, suggesting that they did not find or observe differences in this regard.

In order to understand what are the directions that the Jewish interlocutors conceptualize as "East, " or "towards Jerusalem," I undertook the measurement of the orientation of main axes of all the synagogues and seven hundred eighty-seven graves present in the area addressed in the investigation. At the same time, I measured the azimuths of the urban or rural layout in which they are immersed.

As a result of these measurements, I see that there is a great dispersion in the orientation of synagogues and graves, so that the direction "towards East," "towards Jerusalem," is something not precise and rather an abstract and flexible concept.

In turn, although graves and synagogues conceptualized as oriented “towards East,” "towards Jerusalem," are facing within the range of sunrise azimuths throughout the year (and therefore, very close to the East cardinal

point), the majority is aligned with the urban or rural layout in which each cemetery or synagogue is inserted, which does not match with the direction to Jerusalem, but which could have been seen as adequate for the purposes of the cult.

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Escalante Pueblo Building and Landscape Orientation Documentation Study

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It is increasingly apparent that the architects of ancient buildings and villages appear to have been quite intentional in deciding where on the landscape to build and how they oriented their structures in the Greater American Southwest. Some structures seem to be deliberately aligned to critical directions such as the summer or winter solstice; others align to prominent natural landscape features. There is no simplified tool currently available to evaluate the possible intentions of the builders in placing their structures on the landscape.

The Society for Cultural Astronomy in the American Southwest, Inc. (SCAAS) is using Escalante and Dominguez Pueblo at Canyons of the Ancients National Monument (CANM) near Dolores, Colorado USA to develop a documentation tool focused on evaluating the orientation of buildings and their components to other adjacent sites, environmental features, and prominent landscape topography. Development of this multidisciplinary documentation system will include creation of a field form modeled after the Mesa Verde National Park ArcDoc system (Nordby et al. 2002) and compatible for use in CANM and other cultural resource management projects. The project intends to build georeferenced 3D photogrammetric models placed into a terrain model. We are developing the capability to integrate virtual building and terrain models with the local skyscape to investigate the interaction of the buildings and their features with other sites, solar and lunar cycles.

Escalante Pueblo is a well-documented, easily accessible, hardened archaeological site that was well-suited for our initial building and landscape orientation documentation study. It is partially excavated, exposing prominent liner exterior walls that appear to have intentional orientations to landscape features and are near cardinal orientation. The project took two fieldwork days in late May 2022 to develop field forms and to complete saturation photography including a small drone for 3D photogrammetric modeling. We consulted with members of related indigenous descendant communities to incorporate their insights in our thinking. The project will rely on legacy documentation in the CANM archives to illuminate the background and architectural history of the site (Munson 2011). The data collected was used in a workshop the Society conducted at Arizona State University – Tempe, AZ USA, School of Earth and Space Exploration in October 2022. There we processed the data into 3D models, modified and edited the documentation process and evaluated the building's orientation and features for culturally meaningful alignments (Munson 2014).

The project provided on-site public outreach and interpretation of its goals during the field documentation process. We delivered digital copies of all photography, photogrammetric models and documentation forms used by the project to CANM and are making a special effort to create a documentation process that is useful to cultural resource managers across the Greater American Southwest. We made a special effort to make the documentation produced by the project available to indigenous descendant communities in a culturally meaningful manner. We are developing this documentation process with the goal of it being used by a variety of avocational and professional researchers and cultural resource managers to document archaeological sites with a focus on those sites with standing architectural elements.

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Figure

Comparing land- and skyscapes in the three main manorial-conquered lands of the Canary Islands

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Keywords

Canary Islands, churches, archeoastronomy, orography

The present work is a study of the relationship between astronomy and landscape focused on the orientation of Christian churches and chapels of the three main Manorial (Señorío) Islands of the Canarian Archipelago (Spain). These relatively wild and isolated island territories were subdued by Franco-Norman knights (Jean de Bethencourt and Gadifer de La Salle, in Lanzarote and Fuerteventura) and, later, by noblemen in the service of the crown of Castile (mainly Hernán Peraza "the Elder", in La Gomera) decades before the conquest of America (Gangui et al. 2016; Di Paolo et al. 2019). As a background to this study of orientations, we have the information provided by the texts of early Christian writers and apologists. These writings imposed that Christian churches should be oriented towards the geographical east, that is, towards the astronomical equinox. It is known that these prescriptions for the orientation of the temples were followed systematically throughout Europe, at least during the Middle Ages (González-García 2015).
In this context, as an extension of previous works and a preliminary application of current developments (Muratore, Work in progress 2019), our motivation is to carry out a comparative study between the three Canary Islands already mentioned and verify if the orientation patterns of the temples keep any relationship with each other, or with those of the churches of continental Europe. We are interested in exploring to what extent the indications of the early texts on Christian architecture were respected and to what degree the temples are eventually oriented following different alignments, for example according to pre-existing aboriginal traditions, ubiquitous on all these islands and very particularly in the region of the Tindaya mountain in Fuerteventura, perhaps due to a syncretism process.

We are also interested in knowing if there exist religious constructions that are oriented towards points of the horizon on which the Sun rises on the day of the patronal feast of each temple, since that custom was found in several previous studies, despite not being backed by an epigraphic endorsement prior to the late Middle Ages.

The analysis of the few cases in which this calendrical coincidence was verified in Lanzarote and La Gomera, is now increased with half a hundred churches that were measured in Fuerteventura.
The fieldwork that supports our comparative study is based on the measurement of the precise location coordinates of most of the churches and chapels of the three islands considered, which amounts to about 120 measurements. In addition, for each church we measured its axis' azimuth and the angular height of the horizon in the direction to which the altar of the temple is pointing. The data thus obtained were then corroborated with digital terrain models often used in archaeoastronomical studies. Finally, for the study of the sample, we have employed various analyses, both statistical, as well as calendric and orographic, trying to find clues that would allow us to understand the different patterns of the orientations.
Our preliminary results show that on all the islands, the pattern of double orientations is repeated, which contemplates the canonical tradition of orienting the altars of Christian temples within the solar range (pointing either eastward or westward). Cases also occur where it is possible to identify constructions whose orientation follows solstitial patterns, perhaps as imitation of aboriginal worship. But this double pattern also includes a high proportion of churches with orientations far from this range. An example is Lanzarote and Fuerteventura, both islands subjected to the same flow of the prevailing trade winds in the region, but each with its own characteristics. Another example is given by the particular orography of deep ravines of La Gomera, which determines the orientation of the temples located in those geographical accidents, a situation that does not seem to be repeated in the characteristic plains of Fuerteventura, that is, far from Tindaya and the Pico de Jandía located towards the south of the island.
In our presentation, we will show how the combination of elements of the land- and sky-scape can, with a high degree of probability, offer a satisfactory explanation to the particular orientation of these insular centres of worship, which were built during the first decades after the European conquest.

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A Legendary Sibling Rivalry and Competing Astral Traditions in Early China

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Etiological myths and legends are traditional narratives that instruct about how certain things came to be as they are or should be. One important category imparts astral lore about the stars and seasons and how certain stars impinge on human activity. Many such stories from around the world such as the myth of Demeter and Persephone are well-known to ethnologists and cultural astronomers. Important aspects of ancient Chinese cultural astronomy surface in just such an etiological myth about feuding brothers. The myth uniquely encodes very early Bronze Age astral lore and calendrical science. As transmitted in Zhou dynasty (1046–256 BCE) texts the story takes the form of a tale of sibling rivalry symbolized by the opposition between the "Fire Star" Alpha Scorpius and "Triaster" or Orion's belt. To put a stop to two elite princes sibling rivalry the Emperor Yao (early 2nd millennium BCE) dispatched them to the far eastern and western borders of the kingdom respectively and charged them with the observation and timely sacrifices to the two asterisms. E Bo and Shi Chen thus became the paradigmatic astral calendar keepers and in time became deified as the spirits of the two vital seasonal asterisms.

Prominent among the state counselors of certain mainstream lowland kingdoms were a number of renowned figures who were expert in astro-calendrical (and astrological) matters. One of them, Guan Zhong (7th c. BCE) is reputed to have been the compiler of a treatise on technical calendrical matters know as the *Lesser Annuary of the Xia* that survives in fragments. Pre-dynastic "Xia" is traditionally recognized as the first of the so-called Three Dynasties, the others being Shang and Zhou, but the true nature of the pre-dynastic polities of the late-Neolithic remains obscure, although we do know that they were avid sky-watchers. Because the *Lesser Annuary* has turned out to be an account of an ancient solar calendar with ten "months" of thirty-six days, misconceived efforts to reconcile its data with the official luni-solar calendar invariably failed. By the late 1st millennium BCE, as the minority peoples interspersed among the Chinese kingdoms became assimilated, the solar calendar fell into obscurity and the 12-month calendar familiar from Chinese canonical works came to dominate. Fortunately, the highland solar calendar survived and is still in use among certain ethno-linguistic minorities of China's southwest, including the Yizu 彝族 and the Naxizu 纳西族. Their calendrical practices are traceable to the ancient Qiang-Rong 羌戎 people, highland neighbors and adversaries of the Shang (1562–1046 BCE) and Zhou kingdoms from the mid-second millennium BCE through the early imperial period (beginning of the Common Era). Research on their calendrical practices made possible the correct "decipherment" of the *Lesser Annuary of Xia*.

It is now apparent that the highland Qiang-Rong heavily influenced the cultural and technological development of the soon to be dominant Hua-Xia 華夏 ("hybrid") polities of North China throughout the Bronze Age. Indeed, they mediated the transmission of bronze technology and horsemanship to North China. Lacking writing the Qiang-Rong left only sketchy second-hand traces of their ancient solar calendar in the ancient texts. The present study reconstructs the astral indications of the *Annuary's* solar calendar and suggests how the theme of sibling rivalry can be read, not merely as a teaching story about the ancient seasonal stars–it is that too–but also as an allegory of the millennia-long political and cultural relations between the Hua-Xia ("Chinese") and their highland neighbors.

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Reconstruction of Ja'ab by Maya Local Researchers and its Application in Current Times of Climate Crisis

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The authors coordinate an interdisciplinary research team comprised of four Yucatec language professors from two universities in the Yucatan Peninsula (Universidad de Oriente and Universidad Intercultural Maya de Quintana Roo). We have designed a methodological framework to determine whether the ja'ab (the Maya 365-day cycle) is synchronized with the solar year cycle and with biocultural activities in both precolonial and contemporary Maya lowlands. The null hypothesis is that the Maya calendar lacks an intercalation system. Because of this, its months cannot be associated to any astronomical or biocultural cycle. The technique requires conducting workshops with university students, local museum curators and school teachers from the Yucatan Peninsula. Participants try to reject the null hypothesis by putting the ja'ab into a year cycle context. They use colonial texts with calendar information, such as *Códice Pérez* and *Libro del Chilam Balam de Kaua*, to test different anchor dates and propose ways in which the last quarter day of the year cycle may have been included. They also recur to their own ethnoecological knowledge and astronomic knowledge about the Sun, Moon, Venus and constellations like Pleiades. They then compare their proposed ja'ab with that calculated by Patrick Encina, who used epigraphic data, archaeoastronomy and colonial information (2013a, 2013b, Ms2019). Out of the ten workshops that we have carried out over the past seven years there is a 100% match between the proposed ja'ab versions and between these and the one obtained by Patrick Encina. Participants associate month Tzek (skull) to November, Keh (deer) to the beginning of spring in March and Sip (deer deity) to the onset of autumnal equinox. In the last two workshops we have added a new topic of discussion, which is the drastic change in weather patterns, where droughts and rainfalls are more intense and unpredictable. They are using the recovered ja'ab to contrast current climate to the standard subtropical climate of Yucatan Peninsula that originally framed the ja'ab. The recovery of the ja'ab using an ethnoecological and cultural astronomy approach generates a sense of empowerment to Maya intellectuals and researchers as they design new educational contents about traditional and contemporary conceptions of time and biocultural adaptation to weather and climate change.

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Astronomical Orientation of Greek Theatres: Gnomonic design criteria

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In ancient Greece, covering great part of east Mediterranean coasts, the role of the Theatre, a greek invention, was of capital importance. There, the people got in touch with the knowledge prevailing at the time but, also, they could learn about human behaviour and other aspects dealing with the citizenship formation.
The term Theatron comes from the verb θεάομαι (I see) two components, thea view and –tron that implies an instrument. It is usually assumed that it is an "instrument" or a construction to observe, but perhaps it implies to observe celestial phenomena too, an astronomical instrument, a type of meteoroscopeion; i.e., a building that serves to observe the cosmos.
The role of the Orchestra, a circular area where the chorus and music players develop, was one of the main parts of the theatre, the most central one. It can be considered that the while designing a theatre the ancient architects used a set of design criteria that could change from one place to another due to the geographical landscapes, the direction of the winds, etc. All these design criteria for this type of buildings has been studied from different disciplinary points of view: architecture, sound, etc. On the other hand, we know that the Sun which's presence in the Greek culture was incorporated throughout the Pantheon with Apollo as the top place, played a role in many aspects of the way of life. In particular, few years ago, we have presented a study that involves the Sun within the design criteria for temples oriented to Apollo's worship.
Now, we introduce the idea of a design criteria stablishing a relation between the dimensions of the orchestra (its radius) and the amplitude of the theatron (angle subtended by the seats), based in an astronomical observation. In particular, a consideration about the definition of the radius by the length of the shadow of a gnomon, located at centre of the orchestra, measured at relevant specific dates of the year (solstices and/or equinoxes) is assumed. This is the main feature of the proposed design criteria.
We report astronomical, solar and at times lunar, orientation of the theatres that enable the use of the theatre to keep a good calendar based on the Sun with orientation towards the equinox sunrise or sunset and winter solstice sunrise and sunsets. Both practices, observation at solar positions and at the Moon minor and major standstills, go back to the prehistoric time in Greece around 6000 BC in Thessaly, when agriculture of cereals is well developed and established.
We have analysed twenty-one Greek and Roman theatres from 450 BC to 100 BC, who's location and blue prints are accessible (or from which good photographs exist), supposing the existence of such a criteria. Using the Latitude and the approximated dates of construction and astronomical and mathematical tools (Stellarium, Excel and GeoGebra), we have found that 57% of the theatres comply with it and gave us confidence on the application of the rule for the rest of them. The design criteria has to do with the definition of the radius of the orchestra as the length of the shadow cast by a gnomon placed at its centre; and, measured at the time when the Sun has an azimuth and an elevation well defined: i) an azimuth in the direction of the extremes of the Theatron; and, ii) an elevation sufficient to cast specific shadows. Twelve of them show that the shadows are integer multiples of the gnomon; the rest gave us integer plus a rational fraction. The days happen to be either an equinox or the winter solstice.
We consider that it is possible that in between others, a design criteria relating the use of a gnomon to estimate the size of the orchestra and the orientation of the theatron, results feasible for the Greek theatres which's description Vitruvius presented in a qualitative form in his "The Ten Books On Architecture".

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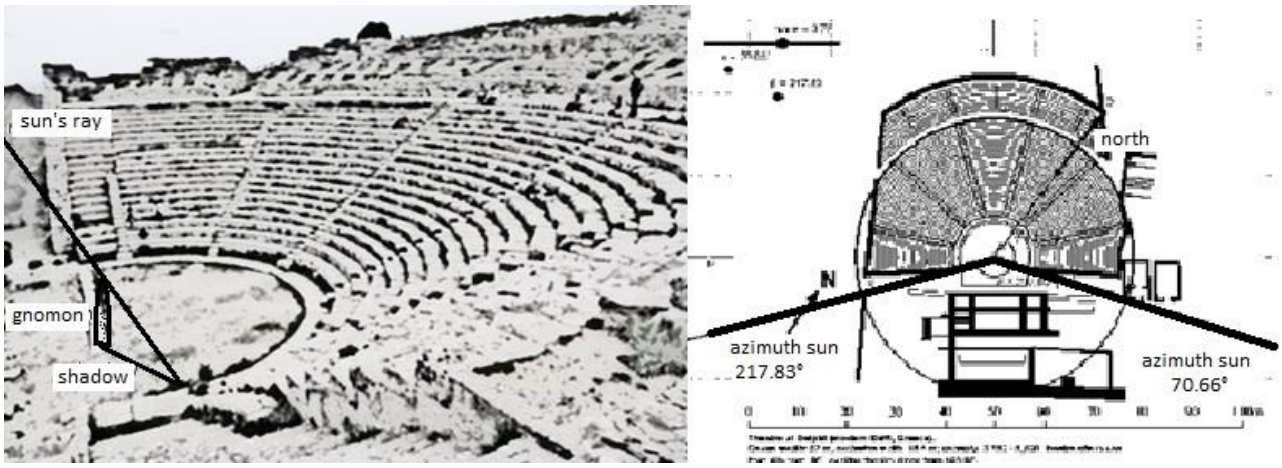
Figure



La importancia de incluir contenidos de arqueoastronomía en la educación intercultural

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Desde mediados de la década de 1980, el sistema educativo argentino, influido por los profundos cambios políticos y sociales acaecidos a nivel global y local, abandonó paulatinamente el propósito de formar sujetos monolíticos identificados con una única cultura de evidentes rasgos europeos, ideal heredado de las últimas décadas del siglo XIX, cuando el objetivo de la educación pública era crear un ciudadano funcional a la nueva nación. En las últimas décadas, los contenidos curriculares han sido analizados por los educadores preocupados por la pertinencia cultural del curriculum, lo que dio origen al diseño de proyectos educativos que promueven el respeto a la diversidad, en reconocimiento al carácter multicultural de nuestro país.

El proceso de globalización trajo consigo una amplia revisión de las historias nacionales y locales, una disminución del impulso dado por los estados-nación para producir identidades nacionales, y el surgimiento de una multiplicidad de historias e identidades "nuevas" y "viejas". En respuesta a ello, la educación intercultural ha propuesto una narración del pasado a cargo de múltiples voces, no sólo la versión legitimada que cuenta la historia del grupo hegemónico, sino también las que relatan un pasado de silencios forzados y de historias olvidadas. De esta forma, los objetos, las fotografías y, principalmente, los testimonios orales, se han consolidado como los principales aliados de los docentes que quieren brindar a sus alumnos el acceso a "otros pasados", en especial el de los pueblos que carecen de historia escrita.

La arqueología es otra manera de conocer esos pasados y, además, tiene la ventaja de superar el límite temporal que se impone sobre la historia oral. Puede obtener información acerca de hechos que ocurrieron miles de años atrás e introducir, tanto en ámbitos educativos formales como no formales, el pasado más remoto de los pueblos originarios. La inclusión de contenidos curriculares que traten la diversidad en el pasado es algo absolutamente indispensable para una educación intercultural que aspire a respetar la diversidad en el presente.

Sin embargo, hasta ahora la arqueología no ha brindado un aporte significativo a la educación. Felizmente, el número de arqueólogos que dedican parte de su tiempo a realizar actividades de arqueología pública crece cada día, pero aún queda mucho por hacer. En este escenario, el papel que juega la arqueoastronomía es casi nulo, seguramente debido a que también son escasas las investigaciones que se llevan a cabo dentro de ese campo científico en nuestro país.

No obstante, la incorporación de temas de arqueoastronomía en la educación formal y no formal se hace cada vez más ineludible para contrarrestar los mensajes equívocos que suelen difundirse en los diversos medios de comunicación acerca del conocimiento astronómico que poseían los antiguos habitantes de América. Desde míticas civilizaciones tecnológicas perdidas hasta visitas de extraterrestres: toda hipótesis es válida, salvo reconocer la capacidad intelectual de nuestros ancestros.

Por estos motivos, he incluido constantemente temas de arqueoastronomía en mi práctica dentro del campo de la arqueología pública, tanto en el Curso de Astronomía Cultural que dicta el Club de Ciencias EnDiAs (Enseñanza y Divulgación de la Astronomía) como en el programa de radio El Eslabón Perdido, que se emite por la FM 88.9 Radio Universidad Nacional de Luján como proyecto de extensión universitaria con la misión de divulgar temas de antropología, arqueología e historia desde una perspectiva intercultural.

En ambas actividades, los principales objetivos perseguidos para los alumnos del curso y los oyentes de la radio son:

Que puedan:

- Discernir entre los verdaderos conocimientos astronómicos que tuvieron las culturas del pasado y las versiones pseudo-científicas y etnocéntricas que suelen difundirse en los medios de comunicación.
- Conocer los sitios arqueológicos que muestran evidencias de actividades astronómicas.
- Reflexionar sobre las prácticas relacionadas con lo celeste que se pueden haber llevado a cabo en esos sitios.
- Conocer las investigaciones arqueoastronómicas que se realizan en la Argentina.

Además, al evaluar el resultado de cada Curso de Astronomía Cultural, se hizo patente que los alumnos previamente desconocían el concepto de arqueoastronomía, tenían ideas confusas acerca de los conocimientos astronómicos que poseían los pueblos originarios en el pasado, y tampoco estaban al tanto de las investigaciones

arqueoastronómicas efectuadas en el país. El contacto con algunos temas de arqueoastronomía les proporcionó una mirada más amplia para considerar el desarrollo de las antiguas culturas americanas, y les brindó una idea más cabal de la cosmovisión y del concepto de paisaje que manejaban esos pueblos.
Este trabajo expone las tareas realizadas y los resultados obtenidos en la difusión de la arqueoastronomía en los mencionados ámbitos educativos no formales.

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Alpha and Beta Centauri and the annual water cycle at the Inca Sanctuary of Pachacamac

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The desert coast in the central Andes is irrigated solely by rivers which are formed from rains in the highlands. This vast territory features: to the East, high and rough mountains from where celestial bodies emerge and rivers descend, and to the West is the sea, endless, where all water flows towards and the sun, moon and stars come to settle. These spatial and temporal cycles of the beginning and the end of days, seasons and years, in which mountains, celestial bodies, rivers and the sea take part, was expressed during the Inca period in the form of calendars (Cieza 1550, Betanzos 1551, Ondegardo 1585) of cultural feasts and agricultural labours, and myths such as the dark constellation of the Llama, the *Yacana* (Ávila 1608 in [Taylor, 2011]), associated to the annual water cycle and visible in the coast by its 'Eyes', Alpha and Beta Centauri.

In 1500 AC rain season in the highlands took place mainly between mid-October and mid-March. Alpha and Beta Centauri or the 'Eyes of the Llama' (Llamañawi) arose over the horizon before dawn in mid-October and at dusk in mid-March, to indicate, respectively, the rain season's beginning and end. When the rains should end, the 'Eyes of the Llama' would be seen making their way across the sky towards the sea and sink into it to drink. The Inca ceremonial calendar in Guaman Poma's work (1615) depicts the pleads for the arrival of the rains in October and the end of the rains in March; only in these two months is a llama present in his calendar drawings.

The Sanctuary of Pachacamac (Lat. South -12º15'34", Long. 076º54'05") located in the central coast of current Peru reached its peak during the Inca occupation and, around 1500 AC, it was the most important oracular-administrative centre in the coast, second in all the Tawantinsuyo. Early chroniclers are brief in their description of its urban and ceremonial aspects. The building settlement (mainly related to the Inca period) has four temples, fourteen structures with ramps, several courts, and twenty-one edifices. The order in the urban tracing presents axes, three main and four secondary: the long axis of the main entrance pointed by the 'North Portal' and the 'North-South' street with azimuth ±150º and ±330º, the axis of the 'Pilgrim's Plaza' with azimuth ±62º and ±242º, and the axis of the 'East-West' street with azimuth ±66º and ±246º. These three axes establish basic directions for the tracing of nearly all the structures in the north-central area, the inner and most extensive in the Sanctuary. The four secondary axes are located mainly in the outskirts.

Archaeoastronomical studies on the Sanctuary (Pinasco 2007, 2010, 2017, 2019-2022), with records taken in situ (1991-2009), and studies (2014-2018) on aerial photographs, satellite images and panorama outlines using GIS software confirm urban and geographical alignments directed to the rise and setting of: solstices, zenith, lunar major extremes, Pleiades, and Alpha and Beta Centauri. The oracular Sanctuary of Pachacamac is also a huge astronomical pointer. (Graph 1)

Among the built axes, the 'North Portal's axis with the main entrance path to the Sanctuary is outstanding. This large axis (1,200 metres) points directly to the rise of Alpha and Beta Centauri, which is also pointed by the Pucusana promontory. The buildings aligned to this axis would be associated to the rising dates of Alpha and Beta Centauri on the horizon, and related to its observation, register and worship.

A 3° horizon angular height was considered to establish the azimuth of Alpha and Beta Centaurii. This measure was taken over the Pucusana promontory, located nearby. Precession was also taken into account. The astronomical study was carried out using Stellarium 0.15.0, set geographically at the Sanctuary (latitude: -12º15'34", longitude: 076º54'05") and chronologically in the year 1500 A.D., during the Incaic occupation. This showed that 500 years ago, the alignment of the longer axis of the Sanctuary's main entrance coincided with the rising of Alpha and Beta Centaurii. Currently, at this same location, Alpha and Beta Centaurii rise at an azimuth of ±152º and ±151.50º respectively and do not coincide as well with the mentioned axis.

Inca work in the outline of the Sanctuary would have allowed tracking the passing of time, (as the great annual clock established by *Pachacuteq* in Cusco with the towers or *Sucancas* in the horizon stated by Betanzos 1551), and comparing it with the climatic and hydric variations, organise propitiatory and preventive measures in

agricultural and ceremonial activities. Thus, it is revealing that the axis of the main entrance to the Sanctuary, the 'North Portal' with the 'North-South' street, directed towards the 'Eyes of the Llama', turns out to be a wake-up call about the essential element by which all life flows: water.

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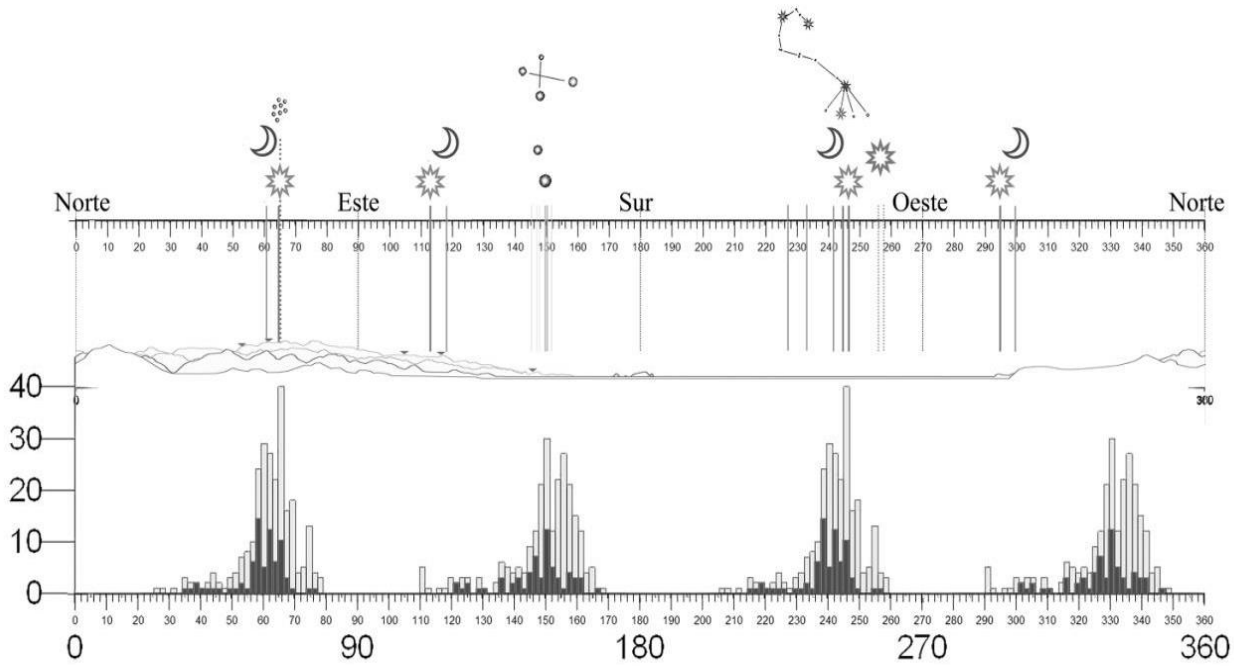
Figure

Comparison between the azimuths of buildings, geographical and astronomical panorama. – Below: orientations of 497 architectural axes ≥ 6 metres (light gray) and 135 architectural axes ≥ 50 metres (black). Centre: Geographical outline. Above: Recorded celestial bodies.



Microverticality as a Quillacingas Strategy to Adapt to Climate Change Based on their Cosmovision

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The Quillacingas have inhabited the Andes of south-western Colombia since 9th century C.E.), near the border with Ecuador, in a territory that in the time of the Incas marked the northern limit of *Tawantinsuyu*. At present, this ethnic group has been affected by climate change through the following phenomena: first, the presence of unusually hot days in areas that had always been characterized as cold; secondly, the time of the year when winter traditionally began has shifted and the expected rains do not fertilize the fields or in the summer season unexpected rains occur; thirdly, the torrential downpours that last a short time; and, fourthly, the summer winds, typical in the area from the end of June until the beginning of September, have begun to diminish their frequency and intensity, even disappearing completely or coming at unusual times in the form of a sudden gale and with great strength. Thus, the Quillacingas have difficulties in making weather forecasts and must carry out agricultural activities knowing that environmental conditions may differ from those expefcted. This affects social practices and rituals that have to do with the calendar, and influences one of the aspects on which their cosmovision is based: an orderly vision of the universe.

This paper presents the results of ethnoecological research (Conklin, 1954; Patton, 1993), applying *doubly reflexive ethnography* (Dietz, 2011), to look into the strategies that indigenous people are implementing to adapt to climate change, especially *microverticality*, which is based on the principles of: complementarity, reciprocity and the sacred and communal aspects of life (Afanador, 2007).

The concept of *microverticality* has its origins in the research carried out by Murra (1972), who for several years studied the way the Incas exercised economic and political power over their vast territory. They established production colonies at different elevations above sea level, calling this mode of production in the Andes *verticality*, which allowed them to have resources from different altitudinal climate zones.

In northern Ecuador and southern Colombia, *verticality was* also implemented, with a distinctive feature. The Incas had to travel great distances between each colony established at a particular level, but in this territory, given the topographic conditions, it was possible to have access to products from different climates on the same day. This gave rise to the concept of *microverticality*, which, according to Oberem (1978) and Brush (1976), refers to the idea that the inhabitants of each town have fields located in different altitudinal climate zones which can be reached in a single day, with the possibility of returning home at night.

The existence of *microverticality* in southern Colombia is based on ethnohistorical evidence (Salomon, 1988; Pinzón & Garay, 2007), as archeological evidence (Rodríguez, 2005) and ethnographic evidence (Rappaport, 1988).

The main results of the study show that *microverticality* has the advantage that traditional agricultural production is not based on a single product, with a single agricultural cycle, which may be vulnerable to climate variations (Joaqui & Figueroa, 2014), but, takes advantage of the different altitude levels within the territory, to ensure that the community is supplied with products from different climate zones.

Similarly, the Quillacingas practice a system of *bartering*, which allows people from different climate zones to have access to products from different crops, especially on important dates of the agricultural cycle and ritual calendar, such as the *Feast of the Guaguas de Pan*, a holiday associated with the June solstice.

The barter system is based on the pre-Hispanic social system of *ayllu*, which is based on a unit of economic production, where family members share land (*markas*), which must be worked together (*minga*) to ensure their livelihood, work being a reciprocal activity (*ayni*) for the benefit of the community.

It is precisely this indigenous solidarity economy that has allowed the Quillacingas to mitigate the effects of climate change and contribute effectively to the capacity of ecosystems to adapt or recover.

In conclusion, based on the use of productive areas located in different altitudinal climate zones at short distances from each other and managed by different members of the same community, the Quillacingas have been able to preserve an economic and social system that has guaranteed food security and has maintained the emotional ties of its members, turning *microverticality* into an important adaptive response to the effects of climate change, precisely because it stimulates biological diversity and allows the community to share in an equitable way the benefits that the earth goddess *Pachamama* gives them.

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Figure

Feast of the Guaguas de Pan in the summer solstice

Direct observation as an archaeoastronomical method: addressing the observer position

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Cañada de la Virgen is a ceremonial pilgrimage prehispanic center located at the central part of the Rio Laja, in a region considered part of the limit of the Mesoamerican frontier before the IX century AD, a temporal period also known as the Epiclasic, marking the transition between the Clasic and Postclasic timeline of Mesoamerica. Cultural regions and traditions related to Cañada de la Virgen are the ones assigned as El Bajío, Western and North cultural areas of Mesoamerica, as well as the chichimeca tolteca background and Guanajuato´s local architectonic pattern known as the patio hundido tradition. Cañada de la Virgen is one of more than 80 archaeological sites located by Luis Felipe Nieto Gamiño (1984) along the basin, streams and canyons that feed the central section of the Laja River at what is today the Municipality of San Miguel de Allende, State of Guanajuato, Mexico.

The cultural astronomical research made in Cañada de la Virgen through the Permanent Program of Celestial Observation stablished by Gabriela Zepeda García Moreno since 2005, emphasized the position of the prehispanic astronomer as an observer that used specific locations to follow different sky objects and their cycles in contrast with the architectonic landscape. Thus, it emphasized the use of such an architectonic landscape over the geographical one, addressing the pilgrim's point of view instead of the hierarchy observational space of the main temple, recovering in this way the calendar landscape of the site in relation to the architectonic design of the main building.

Through this approach, the research was able to document and explain how the different layers of the so called Complex A pyramid, were planed, designed, constructed and used to follow the sun, moon and Venus cycles in day patterns that are extremely congruent with the Mesoamerican day count systems, such as the 20, 52 and 13 days count. In this sense, the building functions as an artificial horizon calendar and as an astronomical calendar instrument that captures the positions of the sun, moon and Venus, through each vertex conformed by the staggered bodies of the pyramid.

Direct observation and it's systematic documentation, through photographic records, as well as the complementary measurements made by the use of theodolite, has allowed the recreation of a model that reveals the count of days in congruent groups for the so called "mesoamerican families". These sequences include counts of 105, 73, 63 and 65, 52, 40, 20, 13, 10 and 5 days.

In terms of methodology, the research started by addressing the locomotion factor of the architectonic design. This is, how the builder is asking the pilgrims to walk, transit and move to, through and among the buildings. Addressing locomotion allows us to focus on the cosmic directions that the architectonic features are emphasizing. It also helps to recognize particular points of view that are locked in terms of the presence of entrances, paths or staircases. Once those points of observation are recognized, direct and systematic observation is needed to document the real visual phenomena that displays along the architectonic lines. Systematic photographic documentation, though time consuming and sometimes expensive for nocturnal events, allows to understand the point of view of the prehispanic observer and astronomer, allowing the researcher to explain, not only the visual metaphors displayed as part of the architectonic spaces, but the mechanic by which they were able to maintain the count of their calendar systems, follow the astronomical cycles that were relevant to them and keep track of the movement of the planets, while passing the information from one generation to the other.

This proposal will present the function of the main building of Cañada de la Virgen as a calendar astronomical device, able to keep track of the 18 blocks of twenty days, including the 5 days ending of the solar 365 days count. It will also show how the 260 days count is included in the main temple, through a 52 days lapse and a 13 days count that runs through the northern vertexes of the architectonic structure. The internal congruence of such count systems will be used to explain the importance of the summer minor and mayor lunar standstills, as well as the importance of the extreme positions of the planet Venus as an evening star.

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Figure

Astronomy and religion in the Roman temples of *Qsar Naous* (Ain Akrine, Lebanon)

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About 30 kilometres north of Byblos, the two Roman temples of *Qsar Naous* (Ain Akrine, Lebanon) are situated on a hilltop 700 meters above the sea level along the ridge of Mount Lebanon, overlooking the Al-Koura Valley to the east and the sea to the west. Probably developed over a previous cultic site, they were in use until Byzantine times in the 4th century CE and their monumentalization and location at relatively high altitude should have made them visible from a great distance.

The temples of *Qsar Naous* share architectonical features with those in *Bekaa* valley as well as with other monuments relatively close to Ain Akrine, such as those of Faqra and Yanouh (Yasmine, 2009) which are also surrounded by a similar sacred enclosure or *temenos*.

Furthermore, astral symbology is present in the lintels of the *propylaea* (entrance gate) of both temples of *Qsar Naous*, decorated with reliefs of Sun disks which are present in further Roman temples in Lebanon like the one at *Chhim* (Aliquot, 2006) and could support the idea of a solar cult present at *Qsar Naous*.

Altough the mountain location and visibility are key factors, for the creation of this sacred landscape, an archaeoastronomical analysis suggests interesting results. Such might relate the sacred complex to astronomical phenomena that may have been relevant for the religious and agricultural calendars in the region in Antiquity. This presentation shows a study on the orientations of the two Roman temples of *Qsar Naous* and their relation to the surrounding landscape. The data were taken on site in the spring of 2018 and they present interesting connections between the design and location of these temples with conspicuous topographic features and relevant moments of the solar cycle, the religious calendar and the productive activities.

In particular, the temples follow the general pattern of orientations of Greek and Roman temples towards east and face important astronomical events such as the sunrise in the summer solstice and tentatively the first visibility of the Pleiades. References to the Pleiades appear in the Greek religion as well as in other Middle East references and the summer solstice was a general moment of renewal across the Mediterranean. Interestingly, these results are in agreement to the orientations previously found in ancient temples in the Lebanese *Bekaa* valley (Magli, 2021) such as the temple of Bacchus and Jupiter Heliopolitanus in *Baalbek* and the great temple in *Niha*, south of Ain Akrine.

Previous surveys in Mount Lebanon reveal various forms of cultic continuity from the Hellenistic to the Roman periods and that the Roman monuments may have been built on previous layers (Kaizer, 2017). In this sense, these evidences provide hints about the origin of the religious practices and the cults performed in *Qsar Naous*, the differences among the divinities worshipped in each temple (if any), the process of Romanization of the previous traditions and the role of these Roman temples in the complex religious context of Lebanon in Antiquity and in the Roman Near East.

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Protection of the Archeological Astronomical Heritage in Chile

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Keywords
Cultural Heritage, Archaeoastronomy, Landscape.

The following work aims to contribute to the discussion about archaeological and astronomical sites in Chile, focusing on its importance for archeology and for today's communities. For this, a comparison is mainly made between two fortresses or pucaras located at the southern end of the Inca empire or Tawantinsuyu, these concepts are used to respect the unique Andean reality (Rostworowsky 1988).
The first of these sites is the Pucara de Chena, located in the Santiago basin, south of the city of the same name, corresponds to nine enclosures around which two perimeter walls were erected (Stehberg 1972). It was a ceremonial center from where astronomical observations were made (Boccas and Bustamante 1998, Boccas 2004, Bustamante 2006) and is currently used for Quechua ceremonies, Mapuches and other cultural activities (Silva et al. 2017), that have included from boy scout to a piano concert on the site.
On the other hand, the pucara de Chada is located 30 km south of Chena, between the Cachapoal and Maipo rivers, located on an elevation composed of two twin summits at low altitude, their structures would also be aligned with geographical sectors and astronomical events (Planella and Stehberg 1997; Boccas 2004; Ruano 2012). The observation of ritual and religious phenomena are of special interest for the understanding of the processes of socio-economic influence with which the Tawantinsuyu would have tried to enter territory under the political control of the Mapuche (Dillehay and Gordon 1998; Dillehay 2011). In this way, it is tried to address its importance along with the sense that these sites have for the current local communities, being observed in the light of national laws and international conventions that protect this type of cultural heritage (González 2004; ICOMOS 2005).

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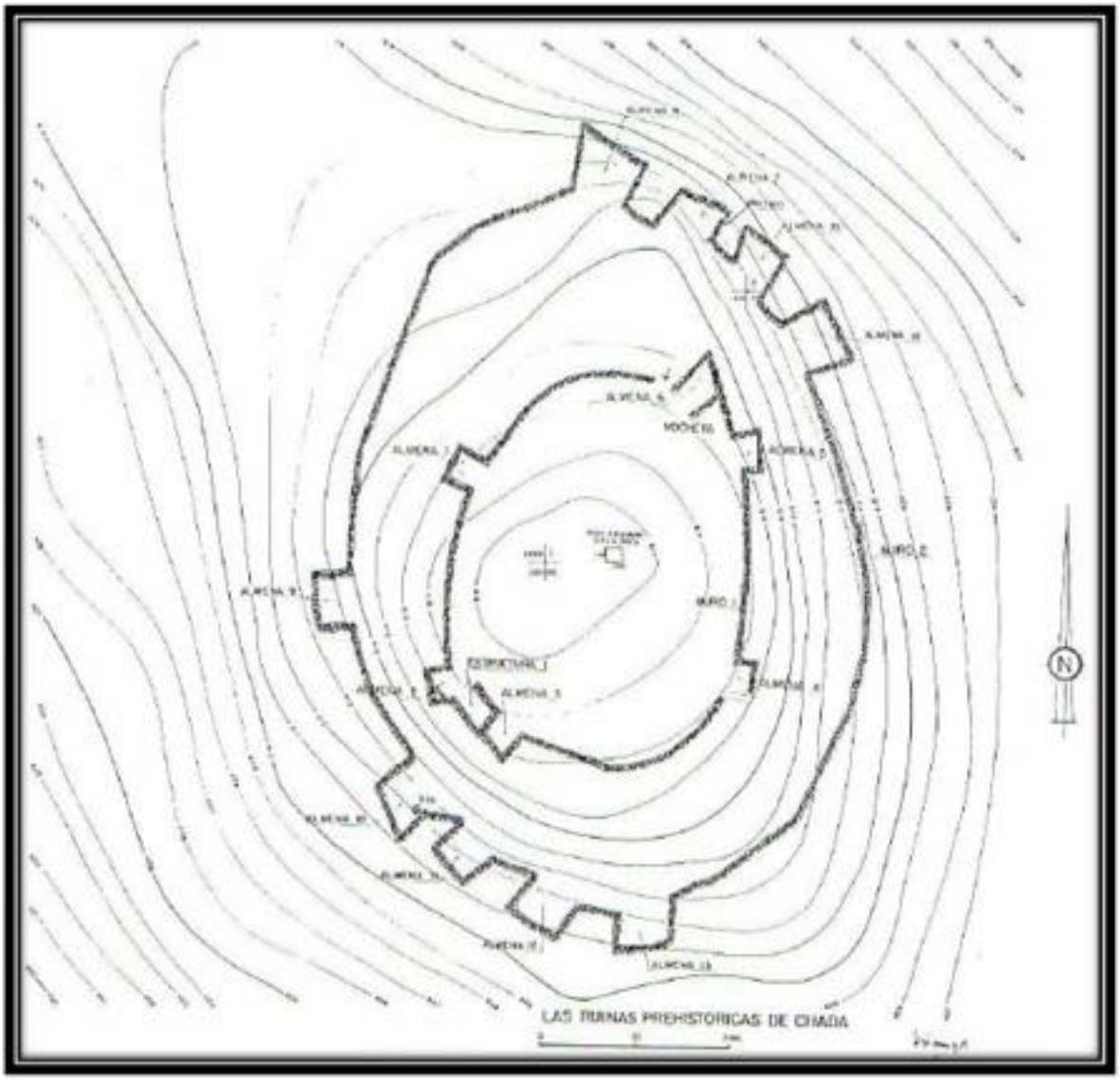
Figure



Plano topográfico Ruinas de Chada (Planella et al. 1997)

Missing Data

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This talk will focus on an extremely well known case study — monuments in the Stonehenge landscape, including Stonehenge itself — presenting a "modern" picture of these monuments and their astronomy, ahead of the publication of our book "Stonehenge—Sighting the Sun". We will discuss the development over time of the practice of sighting the sun at the solstices, together with its possible purposes and social implications, and how this fits with more tentative evidence for an interest in marking motions of the moon. We will eschew most of the complex and largely speculative theories that have preoccupied many archaeoastronomers for generations.
We will be using this case study to illustrate broader methodological issues that have been highlighted by a number of recent papers published by well respected archaeologists. The papers in question present ideas extrapolating well beyond the available evidence and which fall foul of basic methodological considerations (e.g. regarding data selection) that have been well known to archaeoastronomers since the 1980s. In doing so, we will extend a conversation that has been ongoing between CR and Anthony Aveni ever since the first Oxford conference back in 1981, about appropriate methodologies and the ways in which archaeoastronomy in particular, and cultural astronomy in general, is best integrated into culture-based disciplines.

El observatorio astronómico circular de Urqo

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El centro sagrado de Urqo está localizado en la jurisdicción de la cooperativa cristo salvador de Urqo, provincia y distrito de calca – departamento de cusco – Perú.
Pachakuteq, el Inka que transformo el reino Inka, determino que en todos los sitios urbanos Inkas, los Astrónomos arquitectos edificaran estructuras con diseños cósmicos que alinearan al movimiento cíclico estacional de los astros, sus divinidades. el objetivo fue organizar perfectos calendarios para organizar sus actividades agro astronómicas y agradecer a sus dioses por los beneficios alcanzados.
Décadas de investigación Arqueoastronómica en toda la región del cusco, nos permitió definir y caracterizar aspectos de los conocimientos arquitectónicos y su relación agro astronómico ritual desarrollados en las sociedades andinas. la observación y seguimiento de los astros por los cielos del mundo andino, nos permitieron determinar que existen muchas similitudes en los diseños de toda la región, porque en todas las puertas existen orientaciones precisas a los diferentes eventos cíclicos estacionales.
La investigación estuvo complementada con aportes interdisciplinarios, antropológicos, arqueológicos, astronómicos, etnoastronómicos, arquitectónicos, entre otros que apoyaron a reforzar los aspectos teóricos y metodológicos para resolver la función cósmica, como también aspectos de su cosmovisión.
El trabajo de campo realizado en el centro ceremonial de Urqo, el reconocimiento sistemático de la zona, los experimentos repetitivos realizando observaciones, mediciones y análisis Arqueoastronómicos, nos permitió familiarizarnos con los componentes espaciales arquitectónicos y su relación astronómica fundamental en el análisis e interpretación Arqueoastronómica plasmada en los sectores del centro ceremonial.

Características
Todo el conjunto fue considerado como un oráculo en el periodo Inka. El sitio arqueológico en su totalidad está rodeado por un sistema de andenerías, a primera vista es una pirámide trunca.
En la parte del medio del diseño se encuentra la figura de un batracio en un afloramiento natural, la inmensa roca labrada de 25 metros de circunferencia aproximadamente, con una altura de 6.30 metros de altura. la representación del batracio que forma la silueta del cerro Qan Qan, es un homenaje por ser el anunciador de la lluvia. la figura está orientada al este, sus dos ojos labrados en la parte alta orientan perfectamente a la salida del sol en el solsticio de verano, como también a la salida de la luna en el solsticio de invierno. en la parte derecha que es la extremidad anatómica existe una fuente ceremonial que tiene forma de serpiente y su cabeza es el vertedero final del agua que viene de las lagunas que están encima del cerro Qan Qan, donde también se producen la sombras del Inka y el puma en los días del equinoccio.
Las divisiones adyacentes de las plantas rectangulares al sector central también tienen orientación solilunar solsticial.

Al oeste sur del centro ceremonial se encuentra un recinto circular, que tiene todas las características de un observatorio astronómico, el recinto tiene una puerta orientada al ocaso de la cruz del sur y sus dos ventanas tienen orientación a la salida y ocaso del sol y de la luna en los solsticios, tanto en los amaneceres como en los ocasos.
El centro ceremonial de Urqo – Calca, tiene varios sectores y en uno de ellos está el observatorio astronómico circular cuya puerta de ingreso tiene orientación (203.5°) al ocaso de la trayectoria circumpolar de la Cruz del Sur.
Este Observatorio cuenta con 2 ventanas, una de ellas orientada al este (113.5°), a la salida del sol del amanecer del 21 de diciembre, Solsticio de Verano. En esa misma ventana la luna llena hace su aparición en los días del Solsticio de Invierno.
La otra está direccionada al oeste (246.5°), orienta con la puesta del sol el 21 de junio, Solsticio de Invierno y también al ocaso de la luna llena en los días del Solsticio de Verano.
Todas estas características hacen del sitio de Urqo un sofisticado calendario agro astronómico ritual de homenaje al agua y a sus deidades celestes.

Objetivos
Recuperar el conocimiento ancestral que aún están vigentes en las prácticas andinas.
Concientizar a los pueblos del ande y el planeta a proteger el medio ambiente.
Incentivar la práctica de la sabiduría ancestral en beneficio de las futuras generaciones y del planeta.

Resultados
Las conferencias y exposiciones fotográficas Arqueoastronómicas en los pueblos y comunidades del valle sagrado de los Inkas, están familiarizando a los pobladores para realizar turismo vivencial de las estrellas y creando clubes en defensa de la protección del rio sagrado y del medio ambiente.
Los artesanos andinos están plasmando en sus artesanías motivos relacionados a su cosmovisión astronómica. Pronto editaremos el libro de Urqo “Observatorio Astronómico Inka”.

Datos
Todas las estructuras y sus respectivas puertas tienen registros fotográficos y sus respectivas mediciones astronómicas. Amanecer en el solsticio de verano 113.5° y ocaso 246.5°. Amanecer en el solsticio de invierno 66.5° y ocaso 293.5°.

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Figura

Astronomical knowledge of 4200 B.P. applied by specialists from the Caral Civilization, north-central coast of Peru

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An archaeoastronomical study is presented based on the analysis of the orientations of 41 buildings that belonged to the penultimate subperiod of occupation of the Ciudad Sagrada de Caral. The analysis was performed with the objective of identify the main orientation patterns of the city and inquire about its possible relationship with astronomical and topographic orientations.
The data acquisition stage was carried out between 2014 and 2016; total station equipment and georeferenced archaeological plans were used to obtain the measurements of the elevation of the horizon and azimuth of each building. Subsequently, the data were analyzed using histograms with probability density functions, which when compared with random distributions, allowed to identify the main orientation patterns of the city.
When comparing these orientation patterns with the distribution of the celestial vault for the study date (2200 - 2000 years BC), a clear astronomical orientation was identified towards the sunrise and sunset during the solstices (SNR ~ 4$\boldsymbol{\sigma}$ with the summer solstice and SNR ~ 10$\boldsymbol{\sigma}$ with the winter solstice); as well as towards the rising of the Moon during the southern major lunastice (SNR ~ 5$\boldsymbol{\sigma}$). In addition, a topographic orientation was identified towards the actual Supe riverbed, which shows that most of the main facades are oriented perpendicular to the course of the river (SNR ~ 8$\boldsymbol{\sigma}$), while a second group is oriented in a parallel direction (SNR ~ 7$\boldsymbol{\sigma}$). On the other hand, when analyzing the orientation of the

main buildings of the city, it was found that these are also oriented towards the solstices and major lunastices, showing a discrepancy less than 1° in declination.

In the case of the astronomical orientation patterns, their interpretation seems to be related to the type of productive system of this society, which was characterized as being an agricultural-fishery type. Being relatively close to the coast, the Ciudad Sagrada de Caral was characterized by having a desert climate, where the main sources of water depended on the variations of the Supe river flow and the water table. The summer solstice marked the beginning of the rainy season in the Andes, and consequently the increase in river flow and the replenishment of the water table. Undoubtedly, a favorable time for planting cotton and food species such as beans, sweet potatoes, calabash, etc. On the other hand, when the winter solstice arrived, the decrease in rainfall in the Andes implied a drastic decrease in the flow of the river, and consequently the beginning of the dry season on the coast, a time when agricultural production it was reduced due to the scarce water sources.

Archaeological research shows that the Ciudad Sagrada de Caral maintained an important exchange of products with the fishing city of Áspero [2]. The large amount of anchovy and sardine remains found in the settlement, shows an important relationship with fishing activity. We can assume that the experience accumulated by fishermen has led them to empirically discover the relationship between the lunar phases and the level of activity of the fish (effect of the tides). In this way, lunar observation would have also become a priority activity for their livelihood, leading them to determine not only periodic changes in their appearance (phases), but also their most extreme positions on the horizon.

It is important to mention that the global statistics of the city find its counterpart in the orientation of the main buildings of the city. These buildings appear to have been constructed in a planned manner and with precise rules, due to the low level of discrepancy that their orientations have with the position of the associated astronomical objects (less than 1° in declination). This level of planning allows us to affirm that it was necessary to have people specialized in the observation of the sky and at the same time in the design of monumental architecture.

If it is assumed that the actual Supe riverbed was the same for the study period, the topographic orientation found towards the river could suggest that the city would have been planned maintaining a harmony between the earth's deities (the river) and the deities of the sky (Sun and Moon). This hypothesis finds support in similar cases such as that found in Upper Egypt and Lower Nubia [3], where astronomical orientations associated with solstices have been identified; and topographic orientations, associated with the Nile River. A geological study on the temporal evolution of the Supe riverbed will confirm or reject this hypothesis.

From these results it can be concluded that during the penultimate stage of occupation of one of the first civilizations of humanity, the observation of the sky played a decisive role in the architectural design of the city; and if it is considered that the actual Supe riverbed was the same for the study period, it is possible that the topographic factor also influenced this design.

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Astronomy and Culture on the Way of St James

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The Way of Saint James is one of the most important pilgrimage roads in the World since the Early Middle Ages, converting Santiago de Compostela into one of the cradles of Christian civilization. Our objective is to explore how this relates to astronomy (Vilas-Estévez and González-García, 2016).

The orientation of Christian churches, which should satisfy the need to lead priests and faithful to the east during prayer, is reflected in various textual sources. Honorius of Autun, in his *Gemma animae*, gives several reasons for churches to be oriented eastward (McCluskey, 2015). First, that Paradise is in the East, and we pray to return there. Second, that the light of day rises in the East, and therefore we pray in that direction to worship Christ, who is the East [Oriens] and the True Light. Finally, that the Sun rising in the East carries the rising of Christ, the Sun of Justice. However, these statements offer a wide variety of interpretations, especially when establishing the concept of East.

In order to verify the ecclesiastical canons on the orientations of the churches, several works have been carried out in this regard within the framework of cultural astronomy. Among them, a study of the pre-Romanesque churches in the Iberian Peninsula and the Balearic Islands (González-García and Belmonte, 2015) shows, in fact, an orientation pattern with a clear tendency to face eastward, following the canonical equinox of 25 of March. This date is very important liturgically, because it sets the date of the Christian Easter. However, other types of possible orientations are suggested, such as the sunrise on the day of Saint James, which appears for churches built shortly after the discovery of the Apostle's tomb in the IXth Century.

The natural continuation of this study would come through a project composed of three main objectives. First, a systematic analysis of the orientation of the Romanesque churches of the French Way is being conducted. In those cases where there is a regional variation, cultural aspects that may influence the choice of the place of construction and the orientation of the church are also being explored. So far, this first objective has been carried out, with the measurement of the orientations of more than 200 Romanesque churches spread over the areas of Galicia and Castile and León. In both samples, two areas have been chosen, one closer or directly on the French Way, and another area a little further away, in order to establish a comprehensive comparison between them and test the results.

Another factor to be examined is the possible light and shadow effects within certain monuments of the Way, on concrete dates such as close to the equinoxes and solstices or feasts of patron saints, to see how these can relate to popular traditions and the liturgical calendar. To achieve this, a 3D model of some of these monuments ought to be made, and there are plans to introduce them in Stellarium or a similar program, to study the lighting events throughout the year.

Finally, the analysis would be complemented by conducting an ethnographic field study, in order to understand the associated astronomical traditions, placing them in a cultural, practical and historical context. The Basque-speaking region of the Way is a primary target.

The outcomes of the project will create (are already creating) a comprehensive image of the uses and customs of the astronomical traditions of the Jacobean Route, its survival in the present, and the importance of recognizing its value at a patrimonial level. This communication will present preliminary results of the project and future prospects.

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Solsticios y equinoccios en los petroglifos del Sector X de Toro Muerto, Perú. Estudios preliminares

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Palabras clave
Toro Muerto, Petroglifos, astronomía, solsticios, equinoccio.

Toro Muerto es uno de los sitios con petroglifos más emblemáticos del Perú y América, no solo por la gran cantidad y complejidad de escenas grabadas en grandes rocas de origen volcánico denominadas ignimbritas (más de 2500 registradas) que se encuentran distribuidas en agrupamientos en un área de 10 km^2 que corresponde al cauce de una árida quebrada que asciende de sureste a noroeste; a una altitud promedio de 700 a m.s.n.m. y a 40 Km del litoral. La quebrada es adyacente al valle medio del Majes en la región de Arequipa, al sur del Perú. El estilo de los diseños de los petroglifos permite ubicar cronológimente este sitio entre los periodos Intermedio Temprano y Horizonte Medio, es decir, en la primera mitad del primer milenio de nuestra era (Wołoszyn et al. 2019). Entre estos diseños, destacan la presencia de diseños circulares y "radiantes", es decir una serie de círculos concéntricos rodeados de una serie de haces, asociados a una serie compleja de signos (antropomorfos, zoomorfos, etc.) (Op. cit.).
Estudios generales de petroglifos en el área Andina, incluyendo Toro Muerto, han llamado la atención acerca de estos diseños "circulares radiantes" y su posible relación como representaciones astrales (cfr. Guffroy 1999). Sin embargo, hasta el momento ningún estudio arqueoastronómico se ha realizado en estos particulares asentamientos, los cuales tendrían importantes resultados si tenemos en cuenta que recientes investigaciones han mostrado que la práctica astronómica y la representación de astros, asociada a las deidades, es una tradición milenaria en las sociedades andinas (cfr. Villanueva et al. eds. 2019, Iwaniszevski et al. eds 2021) y por otro lado, se ha reconocido que prácticas de talla de petroglifos están asociados a representar particulares fenómenos astronómicos en las antiguas sociedades del sureste norteamericano, Mesoamérica y los Andes (cfr. Murray 2015, Cuartas et al. 2021, Ianiszewski 2016).
Es en ese sentido, en Toro Muerto, destaca el Sector X, ubicado en el extremo noreste y superior del sitio, por la presencia de una serie de rocas, grabadas con petroglifos, distribuidas en torno a una gran "roca central" (Gonzales et al. 2020 Wołoszyn et al. 2019). Estas rocas presentan una importante cantidad y variedad de signos "circulares radiantes" asociados a otros particulares signos. A través, de un preliminar análisis estilístico, iconográfico y arqueoastronómico, hemos determinado que muchos de estos "signos radiantes" fueron grabados en particulares rocas que eran observadas alineadas a la salida del sol el día de los solsticios y equinoccios, desde particulares puntos de visión. Además, de esta asociación fenomenológica, las particularidades de los diseños "radiantes" y sus asociaciones a otros signos antropomorfos, zoomorfos y de notación temporal-calendárico, nos permite proponer que estos particulares signos "círculos radiantes" podrían corresponder a las representaciones del Sol, mientras que otros muy probablemente a otros astros (Luna, particulares estrellas y/o constelaciones andinas) lo cual debe ser discutido en próximas investigaciones.

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Figura

Roca central del Sector X de Toro muerto con dos diseños circulares radiantes que representan al Sol en los dos solsticios. ©PIA Toro Muerto.

Honouring Our Bundles: Resources and Programming at the Interface of Indigenous and Western Astronomy

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The ongoing impacts of colonization have led to the destruction and fragmentation of Indigenous education institutions, methodologies, pedagogies, and epistemologies (Cajete 1999, Battiste 2014, Matamura 2017). As a result, we have reached out across the globe and created a strong network called Honoring our Bundles of Indigenous educators, Elders, academics, and scientists from New Zealand, Canada, and the United States, which now includes a partnership with NASA (National Aeronautics and Space Administration).

Building on the work of the Indigenous Knowledge and Mathematics Community of Practice in the province of Ontario, Canada, Honoring our Bundles is working toward revitalizing our Indigenous Knowledge systems which in turn will advance all of society in the fields of STEAM (Science, Technology, Engineering, Arts and Mathematics). Honoring our Bundles works from the understanding that Indigenous Knowledge Systems and Western science reflect, resonate with, and reinforce one another, affirming each other as valid, valuable, and vital. Equally important in this endeavour is the empowerment of our Indigenous youth to embrace their significance and value as strong, intelligent, and vibrant contributing members to society.

In 2015, as a result of a national inquiry into the horrific atrocities committed at Indian Residential Schools across Canada, the Truth and Reconciliation Commission released its report and 94 Calls to Action (TRC 2015). Two Calls to Action specifically require that all students in the education system learn about the histories, perspectives, and contributions of Indigenous Peoples in what is now known as Canada. The process of curriculum revision to include this mandatory learning began in Ontario in the Fall of 2018. This has led to a huge need to provide adequate resources and training for educators.

Through this collaboration we have co-created resources and programs based on Indigenous Knowledge, astronomy, and cosmology with connections to mathematics and other sciences. There is a strong focus on advanced mathematics learning for Indigenous students, building on ways that have been identified through Indigenous technologies and design, as well as supporting educators to deepen their understanding of the benefits of integrating Indigenous knowledge and ways of knowing into their practice. These resources demonstrate how Indigenous Knowledge can and should be viewed as a valuable contributor to supporting our understanding of our world and our ability to engage students in learning, and positively impacting the teaching and learning of mathematics.

In the Spring of 2019, a camp was help for 30 Indigenous youth from 5 school boards across Ontario, Canada which brought Indigenous Elders, Knowledge Holders, scientists, and educators together from the Navajo Nation, Maori of New Zealand, and the Anishinaabek and Onkwehonwe Nations, as well as NASA, the University of Western Ontario, Trent University, and the University of Toronto. Together they shared Western and Indigenous STEAM in workshops and hands-on activities featuring star knowledge and astrobiology, robotics and computer

programming, a portable planetarium show, carving, and design. Building on prior camps focused exclusively on cultural knowledge, the goal of this camp was to immerse students in Western STEAM education from an Indigenous perspective.

Student impacts were assessed, and qualitative data show that they were able to find resonance between their cultural knowledge and practices and those of Western STEAM. Students drew pedagogical connections between story and learning, and identified how life and culture are in relationship with knowledge and learning. Here we present results from the camp, as well as share progress in the development of new, custom learning materials and resources from the interface of Indigenous and Western STEAM.

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Recent Advances in Cultural Astronomy in the American Southwest

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In 2011, the Society for Cultural Astronomy in the American Southwest (SCAAS) was formed to "promote public understanding of the cultural significance of astronomical knowledge among cultures of the American Greater Southwest, past and present, by supporting research, education and its public dissemination." (Society 2019). Since then, the society, a U.S. Non-Profit organization, has worked to bring the results of cultural astronomy research to a wider audience through regional conferences, publications, and the media.

The society has also invested resources and considerable time in working with Native American tribes to bring their perspectives to the conversation about cultural astronomy. Contrary to researchers in many other parts of the United States, researchers in the Southwest U.S. have the opportunity to work directly with the tribes, and to engage them in helping non-Native individuals understand how Native peoples, living traditionally, incorporate their sky knowledge into daily cultural practices. Our 2016 conference, hosted by the Crow Canyon Archaeological Center, entitled Before Borders: Revealing the Greater Southwest's Ancestral Cultural Landscape (Before 2016), specifically included Native speakers from the Hopi, Navajo and Zuni Nations.

Over the years, the archaeological communities of the United States and of Mexico have tended to operate quite separately, seldom crossing the border to collaborate on research. Yet, prior to the establishment of the national border, Native peoples freely passed back and forth over what is now a highly protected border, sharing trade goods, commodities, and ideas. In the view of the society, it is important to reach across our southern border and bring Mexican researchers into the conversation. During our 2016 conference we were able to attract one Mexican researcher, an M.A. candidate from Chihuahua, and hope to increase such cross border cooperation in the future. This outcome highlights an important educational goal of the Society. We are working very hard to mentor researchers, young and old, who have an interest in cultural astronomy. Those efforts include providing some financial assistance to attend conferences and help in writing and revising conference papers. The society considers the development of new researchers, who can approach the field with new eyes and new methods, essential to the continued development of the field of cultural astronomy. The Dr. Carol Ambruster Memorial fund, dedicated to the memory of a dear friend of cultural astronomy, who contributed to an understanding of both Ancestral Pueblo astronomical practices and Navajo practices over more than two decades, was set up and specifically designed to help with this effort, providing travel funding and other assistance to those who need it.

Another educational goal of the society involves self-education by incorporating methods developed over the years in other fields into cultural astronomy research and exposition. We attempt to hold workshops dedicated to this effort, between conference years. For example, in 2017, we held a workshop hosted by Arizona State University, in which we demonstrated the use of mostly free, open source software to create 3-D models of a rock art site and place it into the local landscape using GIS (Spatial 2019). In 2020, we plan to hold a workshop in conjunction with the Hopi Tribe dedicated to documenting an ancestral Hopi rock site, now located on Navajo Nation land, that contains hundreds of Hopi clan symbols on a dozen or so large boulders. Our goal is to produce a set of 3-D models that would enable the Hopi to monitor the condition of this site over time.

Our 2019 conference, held in partnership with the Native American Cultural Center of Northern Arizona University, was entitled Land and Sky in the Cultural Sciences of the Greater Southwest (Land 2019). This four day conference featured Native American speakers from nine Native American nations and attracted school teachers in a day focused on education. Most presentations were captured on video and will be made available in edited form to Native groups for free and to others for a slight fee (to cover the costs of editing). We plan to publish abstracts of all presentations, which will be available on the SCAAS website.

This paper will present highlights and commonalities of presentations from both the 2016 and 2019 conferences and how they relate to previous research in the Greater American Southwest.

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Cultural Heritage of Observatories - Changing Structures over Time

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Astronomical heritage represents scientific heritage in its cultural context, as it is said by Unesco: *"Properties relating to astronomy stand as a tribute to the complexity and diversity of ways in which people rationalised the cosmos and framed their actions in accordance with that understanding. This includes ... the development of modern scientific astronomy. This close and perpetual interaction between astronomical knowledge and its role within human culture is a vital element of the outstanding universal value of these properties."* (https://whc.unesco.org/en/astronomy/).

In this sense I would like to present the development of architecture and instruments of observatories by showing examples like baroque or neo-classical observatories. In the baroque time astronomy is linked very often to other sciences, not only celestial, but also terrestrial and meteorological observations were made. Especially the "Mathematical Tower" of Kremsmünster, Austria, offers a lot of cultural implications like baroque paintings and sculptures but also a baroque museum of science; this collection intends to present the large variety of the world, a microscopic image of the macrocosm. In summary one can see very well the relevance of baroque observatories to the cultural heritage of mankind.

I will discuss what has been achieved for modern observatories around 1900 like La Plata and Hamburg (Wolfschmidt 2009) where the transition from classical astronomy to modern astrophysics will be presented in a serial transnational Unesco application; this transition is visible in the architecture, the choice of instruments, and the arrangement of the observatory buildings in an "astronomy park". This corresponds to the main categories according to which the Unesco "outstanding universal value" has been evaluated (Ruggles & Cotte 2010). This proposal is based on the criteria of a comparability of the observatories in terms of the urbanistic complex and the architecture, the scientific orientation, equipment of instruments, authenticity and integrity of the preserved state, as well as in terms of historic scientific relations and scientific contributions.

The recent observatories around 2000 (e.g. ESO Very Large Telescope (VLT), Thirty Meter Telescope (TMT) or ESO Extremely Large Telescope (ELT) or radio astronomy observatories like Jodrell Bank or Effelsberg or underground neutrino observatories like Gran Sasso, Italy, and Kamiokande, Japan) changed their appearance completely; these are impressive metallic structures which no longer remind of the typical shape of observatories with domes.

In the 18th and 19th century, the main building or the main campus of the university was sometimes connected with an observatory like in Vilnius/Lithuania, Kazan/Russia, or women colleagues like Vassar College, Poughkeepsie, USA. Astronomy was the leading topic in the context of the development of science with their early chemical (Wetzlar, Lisbon), physical, seismological or geomagnetic laboratories (Göttingen University, Potsdam Telegraphenberg, La Plata) - in context to the new Unesco initiative to broaden “Astronomy and World Heritage” (AWH) to include the "Heritage of Astronomy, Science and Technology" in general.

Cultural heritage of astronomy, science and technology plays also an important role in the first institutions devoted to education and popularization of science for the general public and especially young people - and astronomy was the leading science. Examples are (Wolfschmidt 2017):

- Large walkable globes like the Gottorf Globe in Schleswig (1664) and in St. Petersburg Academy,
- Popular observatories for star gazing like the "Urania" in Berlin (1888), in Vienna (1897), starting point for the public understanding of science, in addition with a physical cabinet for hands-on experiments, and a scientific theatre for popular lectures in an understandable and inspiring form and in an entertaining manner, that promoted a Humboldtian view of the "cosmos",
- "Physikalischer Verein" (Physical Society) in Frankfurt am Main (1824) with physics, chemistry, astronomy, meteorology and technology and an observatory (1907), in addition the natural history museum "Senckenberg Museum" (1821, 1907),

- Planetariums like Eise Eisinga Planetarium in Franeker (1781) of the of the Enlightenment Era or an improved version of this idea, a more sophisticated device, was the projection planetarium, the "wonder of Jena", invented by Zeiss of Jena and inaugurated in 1925 in the "Deutsches Museum" in Munich,
- Astronomical museums in former observatories like Sydney or Rio de Janeiro,
- Science and technology museums with observatories and a planetarium like the "Deutsches Museum" in Munich (1903/1925, the layout of the building is even inspired by Pulkovo, St. Petersburg, the most important observatory of the 19th century).

I have discussed the changing architecture and instruments of observatories during the last centuries, then examples for the new Unesco initiative "Heritage of Astronomy, Science and Technology" and in addition early institutions devoted to popularization of astronomy, science and technology as an integral part of daily life.

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Figure
Reflecting Telescope Building, La Plata Observatory (copyright Gudrun Wolfschmidt)

El registro diario de los ocasos solares desde las cruces teotihuacanas de Santa Cruz Acalpixca y de la montaña de San Gregorio Atlapulco

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Palabras clave
Cruces Punteadas, Pirámides, Ocaso, Ajusco, San Miguel.

Mediante una publicación en el año de 1992, se dio a conocer las características físicas de las cruces punteadas, el número de puntos que contenían sus diseños formados por líneas y círculos y las orientaciones magnéticas de los ejes punteados de los 2 petroglifos de origen teotihuacano. Una de estas cruces la reporta Anthony Aveni está localizada en el sitio arqueológico del cerro Cuahilama en Santa Cruz Acalpixca, en los límites orientales del monte sobre un soporte pétreo que ocupa una posición original, es decir no se puede mover de lugar, se tallaron relieves en miniatura de templos, terrazas agrícolas, pocitas que funciona con el líquido que se les vierta y todo esto sobre el diseño cruciforme nombrado por el investigador americano "ACA", a este conjunto se le conoce como "piedra Mapa". La otra cruz "ACA 2", se labró sobre una roca aislada que alguna vez formó parte de una terraza agrícola, que por sus dimensiones puede ser movida con dificultad y está situada en la montaña que limita Acalpixca con San Gregorio Atlapulco, pueblos de la Alcaldía de Xochimilco, al sur de la Ciudad de México.
Entre 2019 y 2022 se han descubierto cerca de los primeros grabados punteados, 2 nuevas cruces de este tipo talladas en pequeñas rocas, uno de estos diseños está en la cima del cerro la Palma "ACA 3" y no es posible moverla del lugar, el otro petroglifo cruciforme "ACA 4" es cuadrado, está en una pequeña piedra alargada que tiene la posibilidad de ser transportada con dificultad relativa y se encuentra cerca de los relieves existentes en el cerro Xilotepec, que es una representación de la diosa Cihuacóatl y del dios Xipe Tótec y una gran pocita que sirve como recipiente para ofrendar, todo esto ubicado en la zona cerril del pueblo de San Gregorio Atlapulco, Xochimilco, que vienen a confirmar la antigua existencia en el lugar de un asentamiento indígena esporádico durante la época teotihuacana y de este reciente estudio; de estos diseños se amplía el panorama sobre su posible función de herramientas para la planeación urbana y calendárica de los ahí existentes emplazamientos prehispánicos.
Por lo tanto, el objetivo de esta ponencia es dar a conocer las fechas que marcan las puestas solares en los horizontes calendáricos de las 4 cruces punteadas que se midieron sus líneas con brújula y los días que registran las orientación de los ejes de las pirámides medidas con teodolito del cerro el Huacal y Tenezcalco, y el paso del Sol visto desde cada uno de estos sitios, que pasa detrás de los picos destacados al oeste como son el Pico del Águila del Ajusco y el cerro San Miguel localizado en la Sierra de las Cruces en los límites de la ciudad de México y el Estado de México, complementando con los registros al este de los ejes de los montículos escalonados de Santa Cruz Acalpixca. Las observaciones solares se hicieron desde el centro de las cruces como punto fijo y en el caso de las estructuras piramidales desde sus lados medidos.
De los resultados de los ocasos solares vistos desde la cruz punteada cuadrada, "ACA 4" tenemos que el Sol se pone en la peña más alta del Ajusco, llamada Pico de Águila, el 25 de febrero; en la cruz "ACA 3" del cerro La Palma, en el mismo Pico, el 26 de Febrero y en la cruz punteada "ACA 2" en el mismo lugar del volcán el 27 de febrero, Es importante mencionar que el 28 de febrero se presenta un alineamiento regional hacia la plataforma prehispánica que existe en el peñasco alejados entre ellos, como son el sitio de petroglifos de los Olivos en Tulyehualco, la estructura piramidal de Hueyimic en San Gregorio Atlapulco, la estructura piramidal de Nativitas Zacapan y en cuarto lugar la Capilla del Calvario en San Mateo Xalpa.
En el día 6 de abril el Sol en su ocaso, visto desde la pirámide del cerro Tenezcalco, desciende sobre la cima más alta del cerro San Miguel, fecha relacionada a la orientación del Templo Mayor de Tenochtitlán según Tichy (1983:84) si bien hay otras propuestas de fechas, tomamos la del geógrafo alemán pues se registra en un punto importante del Horizonte de Acalpixca. Por otra parte, se buscó que se repitiera el mismo lugar de puesta para cada una de las cruces punteadas y las pirámides existentes en el territorio. En este mismo sitio se pone el Sol desde el 31 de marzo hasta el 6 de abril, marcando un día de diferencia entre los lugares, por lo que se puede decir que existe una relación calendárica, además de una correspondencia espacial entre ellas, porque conociendo el territorio se les pueden ubicar a estos elementos a simple vista.

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Figura

Foto tomada desde la estructura piramidal del cerro Tenezcalco la fecha del 6 de abril día de alineamiento del eje del emplazamiento hacia el poniente, con el ocaso del Sol en la cumbre del cerro San Miguel. Fecha que corresponde a la orientación oeste del Templo mayor de Tenochtitlan.

Advanced Virtual Archaeoastronomy

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Orientation studies of prehistorical or historical buildings and monuments which are one focus of classical archaeoastronomy usually provide survey results in the abstract terms of azimuths and altitudes of the intersection of building axes and the landscape horizon, or of potential "observing windows" into arbitrary directions, which are then converted into astronomical declinations in the attempt to find celestial objects that may have acted as orientation targets for these presumably important view directions. The mathematical process and abstractions included therein are often difficult to follow for researchers trained only in the humanities or for a wider public audience when scientists want to disseminate research results. For a better understanding of processes and phenomena visible in the sky, desktop planetarium programs have already been used for many years to visualize and simulate the daily rising and setting of the sun, moon, planets and the starry sky. Some of them allow the inclusion of a photographic or artificially computed horizon panorama to estimate horizon obstructions or experience the potential role of conspicuous mountain peaks on the skyscape at the point of observation. For more advanced studies, a 3D renderer has been introduced into the popular open-source planetarium program Stellarium (Zotti et al., 2021), which allows the user to interactively walk through georeferenced 3D scenery consisting of an architectural reconstruction in its surrounding landscape and investigate and demonstrate the possible connections between architecture, landscape and the sky beyond (Frischer et al., 2016). The astronomical computing engine also has been considerably improved in the last years (Zotti et al., 2021) to finally allow the accurate simulation of celestial processes and phenomena over many millennia. On the other hand, the temporal development of a landscape and monuments can be controlled in Stellarium's scenery3D plug-in simply using the same date control panel which usually just changes the sky (Zotti, Schaukowitsch and Wimmer 2018).

The realism in the 3D scenery plugin in Stellarium is however somewhat limited: First, the scenery is static, so that e.g. vegetation does not look very realistic. This is not the aim of orientation studies with a tool created mostly for non-experts of 3D modelling, where the creation and integration of at least simple virtual reconstructions should not be overly complicated. More important for some applications in historical astronomy seems to be the shortcoming that we cannot interact with 3D objects like medieval observation instruments.

Larger landscape visualizations and simulations of virtual archaeology are nowadays often shown with the help of computer game engines (Zotti and Neubauer, 2019). These at least remedy the mentioned shortcomings: game engines provide the basic framework for interaction and vivid, naturally looking scenes. On the other hand, the sky background and astronomical-celestial details have to be programmed from scratch. For applications where both interaction and a complete sky simulation are required, recent development (Zotti et al., 2020) allows the direct combination of Stellarium (as sky rendering program) with applications based on the Unity game engine which provides the full spectrum of features a typical game engine has to offer: wind-animated and seasonally changing vegetation, machinery which can be both animated or even react to user interaction, reflections on water bodies (even with moving waves!), or also time-controlled changes in architecture and landscape. Such scenes, although requiring a considerably higher effort for development than the static models explorable in Stellarium, can bring an even deeper feeling of immersion into the simulation. We want to provide a few application examples and discuss some highlights, but also still existing shortcomings.

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POSTER PRESENTATIONS
(in alphabetical order according to the surname of the first author)

Astronomy in Culture: a didactic sequence to promote intercultural science education

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Brazil is a socially complex country, with a historical trajectory marked by over 400 years of a severe transatlantic traffic of captives. The Afro-Brazilian, African and Indigenous populations have historically been oppressed and disenfranchised, especially from the right of accessing science education that takes into account their own histories and epistemologies. In this sense, one of the greatest challenges of Brazil's basic education system in the 21st Century is the implementation of Laws 10.639/03 and 11.645/08, which make compulsory to include, respectively, the teaching of History of Africa, Afro-Brazilian and Indigenous Culture in the curricula of Brazil's educational institutions, in the fight for a more egalitarian society. These two fundamental laws represent the historical opportunity that the country has to decolonize the curricula of the eurocentric's view of the world and to understand the diversity of Brazilian society translated into differences of race, class, gender, beliefs, culture, among other social markers. However, from the practical point of view, the current debate around the cited Laws as well as the pedagogical and didactic practices developed in the schools are almost exclusively restricted to the initiatives made within the disciplines of the Human and Social Sciences. In the case of disciplines focused on the so-called exact sciences (physics, chemistry, mathematics, engineering, technology) this discussion becomes even more crucial since these fields of knowledge have been historically dominated by white, heterosex, middle-class men in Brazil (although this is also a world's reality). Although the underrepresentation of women in the exact sciences and physics has been a chronic case, it is noteworthy that the underrepresentation of black and indigenous people in the exact sciences is even more dramatic when one considers the fact that blacks represent about 54% of the Brazilian population, as shown by the Brazilian Institute of Geography and Statistics in 2018. Consequently, anchored in theoretical references of Astronomy in Culture, the present work presents a diversified Didactic Sequence with the objective of allowing, in the classes of Sciences and Physics of basic education --- even though the Didactic Sequence can also be applied in higher education ---, a large discussion about the historical, cultural, and scientific assumptions of the African, Indigenous and so-called Western sky. Having constellations in various cultures as a starting point, the present work joins initiatives that seek to articulate the guarantee of human and social rights and respect for ethnic-racial diversity. It is, therefore, a simple example, through a virtual object of learning (Stellarium) and a didactic material constructed in class (Planisphere, Games, Google Map), of how Science and Physics classes can contribute in the basic education, with a more critical, antiracist, emancipatory and diverse education, taking into account the different alterities, that is, the "other". In the present didactic sequence, science is designed as an inseparable human construction of historical and social dimensions and, therefore, it needs to be diverse; cultural astronomy is presented as an intercultural educational practice that present new pedagogies, strategies and procedures of diversified teaching and learning and meanings, running through the entire school curriculum.

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Archival Ethnography and Astronomy in Native American Education

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The late Nineteenth and early Twentieth centuries saw an influx of classically educated ethnographers, anthropologists and archaeologists into the Greater American Southwest. Expeditions led by Augustus Hemenway, Jesse Walter Fewkes, Richard Wetherill, George Pepper, Frank Cushing, John Harrington and others investigated not only the archaeological remains of lost Ancestral Pueblo cultures but their living descendants and the other indigenous cultures then occupying these vast lands. Each of these excursions accumulated immense collections of artifacts, maps, notebooks and photographs which then formed the basis for reports in government publications often written months or even years after they were recorded. These collections exist today in the archives of universities and the US Government such as the Smithsonian Institution. The data was often collected and published in a way that, through today's lenses, may appear to be misappropriated or misinterpreted. While the information contained in those records may be highly sensitive today, it is probable that they contain lost information that could be recovered through a detailed examination. Much of the information contained in the field notes has never before been seen. The publications are their interpretation of direct field observations. The recorded field notes likely contain ethnographic information that was never published. These field notes and photograph collections are absolutely invaluable for the accurate assessment of architecture that is alleged to be associated with recording the astronomical cycles of the sun and moon (Munson 2011).

A case in point is that of Dr. Jesse Walter Fewkes. He was Director of the Bureau of American Ethnology and a prominent ethnographer, anthropologist and archaeologist in the American Southwest from the 1880's until his death in 1930. His ethnographic studies while residing among the Hopi and Navajo people and during his travels are recorded in his field notes and photographs from that period. He interpreted his data and published the results of his investigations in the reports of the Bureau of American Ethnology and the Smithsonian Institution. In June 1891, Dr. Fewkes visited the Hopi mesas in Arizona to witness and record the summer ceremonies held in the villages. While there, he had the good fortune to witness preparations for the Summer Solstice celebrations. Fewkes was offered the opportunity to accompany one of the Tewa "chiefs," Ka'lacai, as he visited a sun shrine during the summer solstice to observe sunrise and to offer prayers to Sun asking the deity to bless the people (Fewkes 1892). His methods and activities while studying these peoples is not without controversy. From today's perspective, he may have been too intrusive, recorded information without permission or even published misinterpretations as he never asked for review or input from these tribes. This being the case, we cannot judge the methods of over 100 years ago when looking toward the education of Native American peoples today and into the future (Masayesva 2019).

Dr. Fewkes' manuscript and photograph collection is principally housed at the National Anthropological Archives of the Smithsonian Institute in Suitland, Maryland and at various archival institutions throughout the nation. These records had a significant impact on our research on the architecture and astronomical uses of Sun Temple and Cliff Palace at Mesa Verde National Park. We reviewed previously asserted architectural configurations of Sun Temple and later, pictographs in Cliff Palace that were purported to establish a connection of these sites to cultural astronomy research. At Sun Temple, we learned from historic records that it was unlikely that the central circular structures extended above the outside perimeter wall when completed and did not form a sighting device for observation of solar and lunar alignments. We also learned that modern reconstruction of a pictograph in the four story tower of Cliff Palace led to an incorrect association with lunar cycles (Munson 2014).

These records are vital to the correct interpretation of architecture, features and ethnography in subsequent archaeological and cultural astronomy research projects. The raw ethnographic data recorded in the notebooks and photographs of these early ethnographers and explorers is an invaluable resource in the education of today's Native American peoples. We found numerous drawings and notes about cultural activities and ethnoastronomy that may no longer be in the collective memory of these Native American tribes. A digitizing project to recover that raw data would require a program of preservation, interpretation and education. Such a program would

digitally preserve the records, make the records available to researchers, with restrictions on access to culturally sensitive information, and primarily be used as a tool to educate the societies they studied. As researchers using these records, it is our shared responsibility to make sure that they are used to benefit and educate the indigenous peoples they studied before the records turn to dust.

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Avances preliminares de estudio arqueoastronómico en asentamientos del Formativo Inicial y Formativo Temprano de la costa norcentral del Perú

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En este trabajo se presentan algunos avances sobre los recientes estudios que se vienen realizando en el campo de la arqueoastronomía en los diferentes asentamientos arqueológicos que formaron parte de la civilización Caral. Los objetivos de este estudio son comprender cómo la civilización Caral entendió los fenómenos del cielo, cómo usaron este conocimiento y qué repercusiones tuvo en la sociedad.

La civilización Caral se desarrolló en la costa norcentral del Perú en los periodos Formativo Inicial y Formativo Temprano (Shady 2006: 60-61; Shady *et al*. 2015). Se han identificado un total de 25 asentamientos arqueológicos con arquitectura monumental, siendo 12 de ellos los asentamientos donde actualmente se vienen realizando trabajos de excavación (Shady 2017).

Estudios previos sugieren posibles relaciones astronómicas y topográficas a partir de diferentes metodologías, algunas desde el enfoque de la arquitectura como disciplina y otras desde la astronomía cultural con base en la astronomía de posición y la estadística aplicados a una pequeña muestra exploratoria (González-García *et al*. 2021: 158).

Recientemente se ha iniciado una intensa campaña para medir la orientación de edificios públicos, edificios residenciales y componentes arquitectónicos tales como altares, plazas circulares y plataformas ceremoniales. A la fecha, se han obtenido datos de un total de 127 edificios y 23 componentes arquitectónicos pertenecientes a los asentamientos arqueológicos de Caral, Áspero, Piedra Parada, El Molino, Era de Pando, Miraya y Lurihuasi. Por la amplitud de la muestra, este trabajo constituye el mayor estudio arqueoastronómico hecho hasta el momento en asentamientos tempranos en la costa norcentral del Perú.

La metodología empleada utiliza como materia prima medidas de acimut y altura de horizonte obtenidos en cada una de las fachadas de los edificios o componentes arquitectónicos a analizar (frontal, posterior o laterales). Para esto, se emplearon equipos de estación total ubicados en puntos georreferenciados en el sistema UTM WGS84 con GPS diferencial. Posteriormente, las medidas fueron corregidas por refracción y extinción atmosférica, para luego ser llevadas al sistema de coordenadas horizontal con norte geográfico mediante el cálculo del ángulo de convergencia de meridianos.

Las medidas en coordenadas horizontales permitieron identificar posibles orientaciones topográficas, mientras que, para identificar posibles relaciones astronómicas, fue necesario expresar las coordenadas horizontales en coordenadas ecuatoriales.

Debido a la gran cantidad de datos, el mejor enfoque de análisis fue aplicar una metodología basada en la estadística y en pruebas de confiabilidad. Para esto, se utilizaron funciones de densidad de probabilidad para lograr identificar de una manera más clara los patrones de orientación asociados a las posiciones particulares de algunos objetos astronómicos de relevancia. Por otro lado, se utilizó el test de confiabilidad de los 3σ para identificar aquellos patrones que presentaran un nivel de confiabilidad superior al 99%. Para lograr esto, se realizaron más de 230 simulaciones para generar distribuciones aleatorias con la misma cantidad de datos. Todo el proceso de simulación fue realizado en el entorno IRAF mediante el uso de scripts escritos en lenguaje CL. Finalmente, la

posición precisa de objetos astronómicos más importantes para la época de ocupación de cada asentamiento fue calculada empleando los modelos astrométricos más recientes.
A la fecha, se han obtenido algunos histogramas y test de confiabilidad que han permitido identificar, preliminarmente, posibles relaciones con el paisaje, así como con el Sol, la Luna, las constelaciones y estrellas más relevantes del firmamento.

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Correlations of the Mayan Long Count through the light of the lunar series of Copán's inscriptions

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The Maya recorded event dates, real or mythological, through a series of glyphs that represented documented dates with various cycles or calendars, which include the Long Count, the Tzolkin (260-day cycle), the Haab (365 cycle days) and other cycles. The supplementary series, usually located between the calendar record of the 260-day account and the calendar record of the Haab, consists of a group of six or seven glyphs. The lunar series is part of the supplementary series. And it was Sylvanus Morley, who concluded that part of the supplementary series provided some form of lunar account. This series includes glyphs that represent the lunar age (number of days since the new moon), the position of a particular lunar month (lunar) in a cycle of six (6) lunar and the duration of the lunar month, whether 29 or 30 days (Coe & Van Stone, 2005). Particularly, glyphs E and D represent the number of days that have passed since the last new moon, where the combination of both glyphs will not exceed twenty-nine (29) days. Aveni (2005) performs an analysis of the lunar ages of a series of inscriptions on stelae and altars of Copán regarding the GMT correlation.

This study analyzes 27 records related to the moon in inscriptions on stelae and altars of Copan, specifically of the lunar series, glyphs D and E. The lunar ages described in glyphs D and E of different inscriptions of Copan are analyzed and compared with the lunar ages calculated for the dates (Long Count) and their corresponding Gregorian date from eight different correlations (Bowditch 394483, Makeson 489138, Spinden 489384, Martinez Hernando 584281, GMT 584283, Astronomical 584285, Martin Skidmore 584286, Wells 660208).

As a result, it establishes the differences (in days) between what is described in the glyphs and the calculation of the lunar age according to each correlation. Likewise, the centrality or dispersion of the data generated by each correlation is calculated. The dates and lunar ages from the correlations of Bowditch, Spinden and Martinez Hernando do not fit in the inscriptions analyzed. For the correlations of Makeson, GMT, Astronomical, Martin Skidmore and Wells, values closer to the lunar age described in the inscriptions are presented, but with clear discrepancies in the lunar age in the values close to the lunar age of 0 or the lunar ages maximum, close to 29. This could indicate that the beginning or end of the lunar cycle should be assessed differently, given that these major differences are in the minimum and maximum values of the lunar age. And, on the other hand, consider the duration of the lunar month, of 29 or 30 days, which corresponds to glyph A of the series. Likewise, it is noted that the greatest differences between the lunar age of the inscriptions and the calculated lunar ages occur in Stela I, Altar k, hieroglyphic staircase date 10 and the altar of stela 5.

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MachuPicchu. Arquitectura cósmica inka

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Machupicchu el más grande logro de la Civilización Inka, obra maestra del genio creativo humano. El templo Inka fue coronado en la cumbre más inaccesible de la fractura de la montaña, y al borde de abismos y profundas caídas verticales.

Tiene como diseño arquitectónico a un ave en pleno vuelo empotrada en la montaña. "El Cóndor", la mayor deidad de las alturas esta edificado en altitudes que desafían al genio humano.

La investigación diurna y nocturna realizada por cerca de 40 años en el santuario Inka y plasmada en los libros "Machupicchu tour Arqueostronómico" y "Machupicchu arquitectura cósmica", demuestran que su trazo arquitectónico está ubicado en posición a exactos instantes de la división del tiempo, los registros fotográficos determinados en cada puerta nos detallan que el orden cósmico esta manifestado en todos los sectores del templo Inka.

Sin excepción, todas las puertas y ventanas de templos, plazas, adoratorios y recintos sagrados de la totalidad de los sectores del diseño, tienen precisas orientaciones a todos los eventos cósmicos soli-lunares, estelares y puntos geográficos importantes de los 360° de su horizonte cósmico. Los solsticios, equinoccios, los cenits, nadires, los puntos cardinales, los intermedios de estos, la trayectoria circumpolar de la cruz del sur, los movimientos de la vía láctea, las fases de la luna, estrellas y constelaciones de su cosmovisión, y las apariciones temporales de los 5 planetas visibles eran conocidos por los expertos entendidos de los cielos del santuario.

Las orientaciones plasmadas en la totalidad del diseño determinan perfectos calendarios de su organización social agro astronómica. El calendario fue perfectamente determinado por el conocimiento de las orbitas cíclicas de la trayectoria de los cuerpos celestes.

Los exactos vaticinios sirvieron de marcadores de tiempo que les indicaban la realización de sus actividades sociales agro astronómicas ceremoniales y festivas.

Ellos entendían que este conocimiento traía grandes beneficios a su organización astro agrícola fundamental en su estrategia de supervivencia y bienestar.

El diseño del santuario de Machupicchu es un verdadero calendario pétreo, sus estructuras unen exactamente al tiempo y al espacio.

Machupicchu es quizás el único lugar en el planeta donde se manifiestan orientaciones con todos los eventos de los 360°. Las posiciones de los sectores representan el orden cósmico. El templo Inka es un mapa estelar.

La investigación y comparación con el conocimiento arquitectónico cósmico de culturas como Egipto, Druidas, Mayas, Aztecas, entre otras confirman que la arquitectura Inka es cósmica. En Machupicchu sin excepción su diseño orienta a todos los eventos cósmicos de los 360°. Por los vestigios demostrados en puertas de todos los sectores, registros de instantes de veracidad científica, es quizás la más relevante expresión arquitectónica cósmica del planeta.

Objetivos

La investigación nos devuelve los valores científicos logrados por los ancestros del antiguo Perú

Recuperar las técnicas agroastronómicas y los saberes perdidos para devolverlos al patrimonio de la humanidad

En ese entender las culturas actuales deberían tomar como ejemplo las sabias prácticas de vida ancestral, y de esa manera conectarnos más con la naturaleza, respetar el medio ambiente y proteger la contaminación lumínica en respeto por la luz de las estrellas a beneficio de preservarla a las generaciones futuras.

Resultados

Las observaciones y mediciones de prácticas repetitivas diurnas y nocturnas en el santuario con permisos del ministerio de cultura desde el año 2000, y el apoyo desde el 2007 del IAC – Instituto de Astrofísica de las Islas Canarias – España, con instrumentos de medición, mapas virtuales, clinómetros, bibliografía y reiteradas prácticas de campo con los investigadores astrofísicos, Miquel Serra Ricart y José Antonio Belmonte jefe del departamento de investigaciones Arqueoastronómicas, confirman las evidencias precisas de la actividad científica en el esplendor Inka.

Cerca de 4 décadas de investigaciones en toda la región del cusco, cuna de los Inkas, y en las principales culturas de Sudamérica, demuestran que todos los diseños urbanos del antiguo Perú tienen fundamentos cósmicos.
Las mediciones de las concepciones antiguas están sustentadas con actuales mediciones científicas.
Los libros editados demuestran registros fotográficos de la veracidad de las investigaciones.

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Arte rupestre y el registro arqueoastronómico. Construcción del paisaje en poblaciones humanas del extremo sur de la provincia de Mendoza, departamento de Malargüe

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En el departamento de Malargüe, al sur de la Provincia de Mendoza, en el Centro Oeste Argentino, se encuentran más de 40 sitios con arte rupestre, muchos de los cuales no cuentan con relevamientos sistemáticos previos. Los antecedentes de investigaciones arqueológicas en la región no aportan datos concretos de cómo estas poblaciones, medían el tiempo y cómo manejaban su conocimiento astronómico en sus prácticas sociales. Sin embargo, la movilidad de estos grupos y su subsistencia en ambientes áridos y semiáridos, con recursos críticos localizados y estacionales, están ampliamente asociados. Esto sugiere un conocimiento de las estaciones y una planificación y predicción eficiente de estrategias de subsistencia. El arte rupestre entendido como un sistema de información visual a nivel regional podría haber servido para la organización y ejecución de estas prácticas. Los sitios con arte podrían haber funcionado como marcadores de caminos, áreas territoriales, marcadores de recursos críticos y/o estratégicos, usados por grupos humanos cazadores-recolectores que habitaron la región.

Para contrastar y discutir esta hipótesis se puso en marcha un programa de estudio que incorporó el relevamiento de los sitios con arte, teniendo en cuenta variables referidas a la relación, tipo de motivo, ubicación en el panel y orientación sobre horizonte del panel. También se midieron la orientación de los paneles sobre horizonte del lugar con utilizando un clinómetro. En el caso de los relevamientos de morteros, cúpulas o piedras tacitas, se tuvieron en cuenta sólo aquellos que estuvieran directamente relacionados con el soporte del sitio con arte rupestre, generalmente se encuentra en la parte superior horizontal de los bloques con representaciones rupestres, representadas en grupos alineados de dos o más morteros. De esa forma se toman las alineaciones que forman dos o más morteros, proyectadas sobre el horizonte; se miden con clinómetro: el ángulo de azimut y los grados de altura sobre el horizonte del lugar.

Los relevamientos llevados a cabo en los sitios de Agua Botada I y II y Chenqueco III, durante el equinoccio de otoño del año 2017, permitieron ampliar la discusión sobre la funcionalidad del arte rupestre como marcadores astronómicos. Particularmente en los sitios no se han realizado hasta el momento excavaciones arqueológicas, si muestreos sistemáticos superficiales, que arrojaron datos de materiales líticos y restos de cerámica en las cercanías de los mismos, a una distancia de 2 a 3 km. Estos sitios superficiales como los sitios con arte rupestre se

contextualizan regionalmente en la problemática arqueológica de la cuenca media de rio Grande donde se desarrollan distintos proyectos de investigación arqueológica.
En el sitio Agua Botada I se ajustó la metodología a la observación de los paneles teniendo en cuenta sus alineaciones y motivos, junto con los datos anteriormente obtenidos en relevamientos anteriores. De la misma forma, se identificaron alineaciones de morteros en correspondencia con el paisaje y a un contexto astronómico.
En el sitio Agua Botada II se relevaron nuevos motivos en paneles cercanos, no identificados previamente. En todos los casos se estudian alineaciones, tipo y agrupaciones de motivos y su posible relación con el paisaje y el horizonte astronómico.
El sitio Chenqueco presenta más de diez paneles con grabados rupestres, ubicados en la margen este del arroyo homónimo. Los grabados se encuentran en paneles verticales. Sobre ellos se identifican grupos de morteros. Se miden alineaciones de paneles y morteros en relación con el paisaje y el horizonte astronómico. Cabe destacar que el nombre del arroyo proviene de un toponimio mapuche que significa “Agua de los muertos”. En el margen oeste del arroyo se destaca un cerro, hacia donde apuntan los paneles. Allí se han encontrado restos humanos por pobladores del lugar.
La comparación de los resultados obtenidos, posibilitó generar nueva información y discutir el rol que habría jugado el conocimiento y la contemplación de los fenómenos astronómicos en la localización y uso del entorno por parte de las poblaciones pasadas. Los resultados permiten observar recurrencia y cubierta sistematización en la ubicación de los grabados y morteros, presenten en paisajes con características similares, lo mismo que en los motivos y su contexto astronómico calendárico de horizonte. Se sugieren algunas fechas de realización de los grabados de acuerdo a su posición con respecto al movimiento del Sol en el cielo y a ciertos asterismos. Poniendo a consideración posibles metodologías para determinar fechas de ocupaciones basadas en las alineaciones de morteros y su relación con el paisaje.

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NASE: Astronomy in anywhere

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NASE (Network for Astronomy School Education) is a program of the Commission 1 of IAU which aims to train mainly secondary teachers in:

1) how to teach astronomy
2) to observe not only the sky but also the presence of the astronomy in the city,
3) trying to discover astronomical records. that encourage us to observe and study some astronomical aspects in our culture and historical heritage.

NASE website includes all the materials for the basic course and a repository of teaching materials for astronomy with activities, animations, articles, photos, games, simulations, interactive programs and videos. Until October 2019, NASE has taught 150 courses in America, Africa, Asia and Europe.

In this poster we will show three examples of *Astronomy in the City* :

1. The Courtyard of the Infanta (Zaragoza, Spain)
2. The Dragon of Dalí (Barcelona, Spain)
3. The Foundational Area (Mendoza, Argentina)

The astronomical significance of each one of this examples are:

1. The Courtyard of the Infanta is a plateresque courtyard of great beauty is a jewel carved in stone and alabaster by expert goldsmiths. It was part of the palace that Gabriel Zaporta, a rich Jewish merchant, built in 1546.
   All the decoration of the patio is loaded with symbology: the planets, love, religion, empire, philosophy, the values of the time, are represented in it.
   One of the best known representations is a marriage horoscope made on the occasion of the wedding of Gabriel Zaporta with his second wife, Sabina Santángel held on June 3, 1549.
   Once the zodiac is established, the patio is considered as an ideal place to represent the couple's horoscope on their wedding day. The planets are represented by columns, but obviously their distribution in the horoscope will not be able to coincide with the support points necessary to support the building. For this reason, some are in the corresponding zodiac sign and others in another place and the decoration will have to be interpreted to deduce its correct situation within the representation of the horoscope.
2. In 1884 Gaudí projected the entrance pavilions and gardens of the estate that Eusebi Güell has in Barcelona as a posthumous tribute to Mr. Antonio López, his father-in-law.
   In Greek mythology the Garden of the Hesperides is the garden of Hera (sky), whose trees gave golden apples that provided immortality. These trees were gifts from Gea (the Earth) to Hera as a gift from her wedding with Zeus. The Hesperides were the nymphs who took care of that garden with a fierce dragon.
   We present here the version that Gaudí represented. When Hercules arrived at the Garden he killed the dragon, while the Hesperides cried inconsolably. Hera turns the Hesperides into the constellation of the Ursa Minor (formerly not a bear) and the Dragon in the constellation of the Draco. In ancient times, the Ursa Mayor was considered an apple tree being its three brightest stars (those of the tail) its three apples.

The position of the Dragon and the two groups of “spiked balls” that represent the Bears at the door coincide with the situation of Draco, the Ursa Minor and Ursa Mayor in Barcelona in the months of April or May. For this reason the door is not according to the street, it is oriented to the North and the constellations of the door correspond to those of the sky, at its zenith, during the month of April, (to the birth of Antonio López) or the month of May (when Antonio López, founded his shipping company).

3. In America it is also possible to recognize similar examples. One of them is at the foundational area of Mendoza, where the oldest record in the city is located. Pedro del Castillo founded the new city in 1561. Initially located in the so-called "Media Luna" in the Department of Guaymallen on the east bank of the channel known as "Cacique Guaymallén", it moved in 1562 at a distance of "two arcabuz shots" west of the foundation point. The new site, about 100 meters west of the Cacique Guaymallén canal, is the current position of Pedro del Castillo square. At the time of its foundation, the design seems to fit the tradition: a Plaza de Armas, with the town hall (the Cabildo) in one of itsmargins (the east sidewalk) and the church in another. Normally, at that time, the church was installed with the door to the West, so that the dawn Sun entered the altar. In the Foundational Area the history of Mendoza is told through reminder plates, it is enough to go around the perimeter of the square to discover that in the South-West corner the first church of the city was installed, and it is possible to verify that the Area fits the canons of the time.

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Figure

Three examples of Astronomy in the city: Courtyard of the Infanta in Zaragoza, Spain (left), Dragon of Dalí, Barcelona, Spain (center), Foundational Area, Mendoza, Argentina (right)

Las fechas que marcan los ejes de las iglesias de Milpa Alta

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En este trabajo se pretende mostrar los últimos resultados de las investigaciones recientes en torno a las mediciones de las fechas en las cuales el Sol sale o se pone sobre los ejes de los templos cristianos en Milpa Alta, los cuales fueron construidos por los franciscanos en los primeros momentos de la invasión europea en nuestro continente y particularmente los localizados en la parte sur de la Cuenca de México, que tuvieron un mismo plan de evangelización para las comunidades ahí establecidas, contando con mano de obra homogénea, materiales y técnicas de construcción parecidas. En nuestros estudios previos hemos encontrado que el eje de las iglesias están orientados hacia cerros importantes que con el paso del Sol atrás de ellos marcan fechas significativas del año, ocupando los templos cristianos los horizontes como las pirámides mesoamericanas para registrar fechas que les permitían a los indígenas programar sus actividades rituales y productivas, en el caso de los edificios católicos se ha visto que en algunos casos marca la fecha de la fiesta del santo a que ésta dedicada, los solsticios, los tránsitos cenitales y otras fechas no necesariamente católicas sino provenientes del mundo antiguo, como un fenómeno de síntesis. En el caso de la iglesia principal de Milpa Alta, la Asunción de María hemos comprobado con el sobrevuelo del Dron que su altar se dirige al cuerpo del volcán Iztaccíhuatl que en el mundo náhuatl fue la representación de la diosa Cihualcoatl patrona de los xochimilcas, grupo que habita la zona y que el paso del Sol a tras de este volcán con forma de una mujer dormida, marca el equinoccio astronómico con la salida del astro el 20 de marzo en el cuello, formado por grandes peñascos que dibujan la silueta femenina. En otro pueblo de la región estudiada llamado San Lorenzo Tlacotenco hay un templo muy antiguo construido en el siglo XVI en la loma donde se han encontrado muchos vestigios arqueológicos, pero su eje se dirige de norte a sur, hacia el cerro principal de la localidad, el volcán Teutli, pero no registra una fecha solar, pero está provisto de unas escaleras externas que permiten ver desde su azotea las montañas y los volcanes como el Popocatépetl que asoma su chimenea por la falda del Tlaloc, prominencia de la región. Así, que, si bien su eje no nos da una fecha solar su construcción norte sur, permite observar desde el, las salidas solares en cerros importantes que forman el calendario de horizonte del lugar. Pues bien restan algunos templos por describir sus propiedades calendáricas que podríamos hacerlo en el momento de la exposición ampliando la información y comparando con los datos con que contamos de las iglesias de Xochimilco, localidad contigua a Milpa Alta.

En cuanto a la metodología seguida: se utilizó una brújula para la medición de los azimut magnéticos, los cuales se ajustaron para convertirlos en astronómicos. Las alturas de los horizontes se midieron mediante un clisímetro y con una calculadora en línea se determinó la declinación magnética. En algunos casos se ocupó un Dron para encontrar los alineamientos de los templos. Y se consultó el programa Google Earth, para rectificar mediciones en campo. En el análisis de los resultados se pudo identificar que las fechas del Santo Patrono de las iglesias están dentro de las temporadas agrícolas del año. Por lo tanto, se puede concluir que las fechas registradas siguen una lógica constructiva similar a la reportada en las iglesias de Xochimilco.

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