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Astronomy in towns? An archaeoastronomical approach to the Roman urbanism

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Abstract

Although the final definition of Archaeoastronomy is still under debate, what is clear is that this discipline offers a different approach to the knowledge of ancient cultures than traditional archaeology has done so far. Archaeoastronomy considers the sky as an inseparabe part of the environment and thus an element of the transformed landscape with highly symbolic content. In the case of the Roman culture, the great colonizing activity involved continuous spatial transformations and the skyscape should be considered as a piece of the created urbanized spaces. For this reason, a number of fieldwork campaigns were conducted in several Roman cities across different regions of the ancient Roman Empire in order to study the configuration of those landscapes and the possible integration of the sky during the buiding processes. At the present, our group has the largest sample of orientations of Roman settlements so far, and here it is shown the preliminary results of an statistical analysis which may offer new answers to the various still open questions in Roman urbanism, often faced from conservative views.

1 Introduction

The interest in understanding the celestial motions and to unveil the mysteries of the universe has contributed to the emergence of uncountable myths, but also has encouraged time reckoning systems and, of course, astronomy in the modern sense. From a political and religious points of view, the study of the cosmic events helped humans to create time patterns and, consequently, cultural ones. A quote in Ecclesiastes [3:1] may reflect this idea: *'For everything there is a season, and a time for every matter under heaven'*. In the vast Roman Empire, the existence of a common and well-stablished calendar that marked remarkable days in the year, contributed to create a feeling of unity among settled territories. Dates as the day of the traditional foundation of Rome by Romulus, established *'timemarks'* for performing diverse rituals throughout the Empire and, in some sense, remind peoples that the Gods, through the State, ruled time. Moreover, from the beginning of the Roman expansion in the 5th century BC, the cities were the key elements for the colonisation and became centres of Roman cultural transmission [10]. This was just the first step previous to their spread through wide lands, which comprised areas from Britain to Jordan and the whole Mediterranean. Another important role of the cities was the creation of Roman citizens, by which the manpower increased and contributed to ensure the continuity of a national identity. Furthermore, the foundation of a new city was not irrelevant but the most important moment of its history, and was performed in a ritual atmosphere in which their limits and divisions were established [15]. There exist a number of ancient textual evidences, as those of Hyginus Gromaticus [1] and Frontinus [2], that suggest the role of some celestial objects in the layout of a city. In this sense, astronomical events, such as sun risings or settings, could have been involved in the creation of spaces as natural representations of the sacred, as present in monuments from many other ancient cultures such as Egyptian temples.

2 Roman city. Foundation and layout

One might say that the development of the urbanism runs parallel to the history of the Roman spread through the Mediterranean and, in the case of the Iberian Peninsula, they were responsible of much of the growth of the urban culture [10]. Structural and archaeologically, this kind of urbanism can be identified across the settled territories because the existence of common features on their layout. This was based on an orthogonal grid with two main axes, *Cardus Maximus* running roughly north-south and *Decumanus Maximus* running east-west, and a series of parallel streets traditionally named *cardines* and *decumani*. In the intersection of those main streets, the *forum*, main square and political and administrative centre, was located normally equally oriented as the main streets[9]. The design and orientation of the streets were performed by the *agrimensores*, or ancient surveyors, who carried out complex works through their great management of trigonometry. A number of writings of the *agrimensores* have reached us and they are grouped in the so called *Corpus Agrimensorum*, where authors as those mentioned in Section 1 referred the issue of orientation. Moreover, the foundation of a city, as accounted by numerous ancient writers such as Livy [11], was preceded by a ritual to consecrate the space conducted by a priest. Emulating the ritual of the foundation of Rome by Romulus, the sacred boundary of the city and the direction of the main streets were defined by a series of steps with a high symbolic content. Of course the intrinsic pragmatism of Roman culture should not be dismissed –which has an explicit expression in the change of the date for the beginning of the year, from March 1^{st} to January 1^{st}, due to military tactical reasons– but it is as well unquestionable the fact that the design of a city was neither irrelevant nor unplanned.

[1] Constitutio, 1: The limits are set not without a reason, but direct the decumani in accordance to the course of the sun, and the cardines towards the polar axis.

[2] De Agrimensura, 27: The limits and the origin [of the layout], just described by Varro, came from the Etruscan Discipline; the soothsayers [aruspices] divided the world into two parts, the right hand towards the north, which they called Septemtrion, to the left would be the meridian of the earth, from east to west, where you can see the paths of the sun and moon...

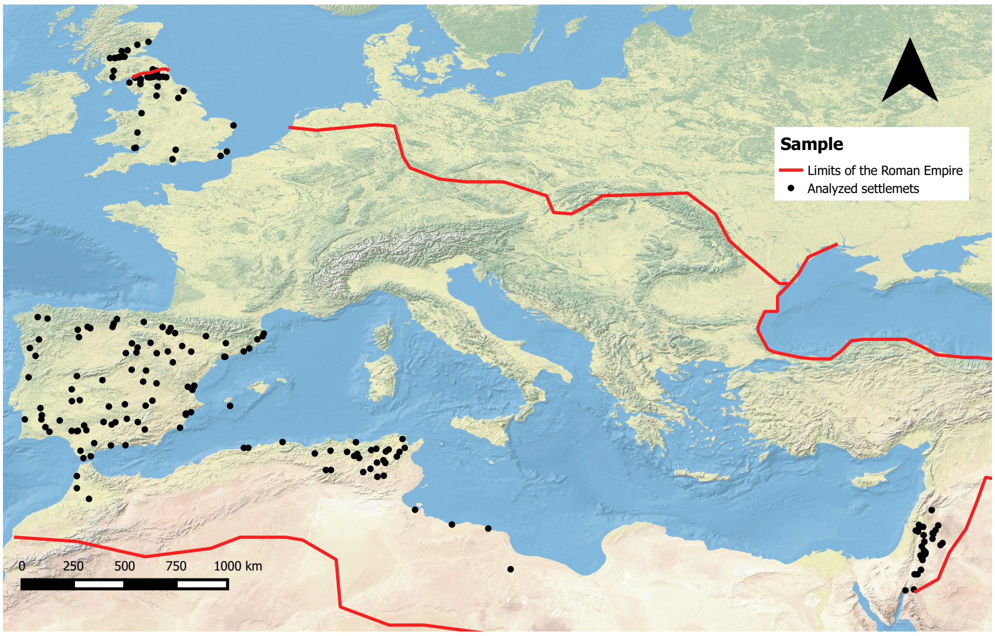

Figure 1: Roman sites analysed so far. The red lines approximately define the limits of the Roman Empire at its greatest extent.

3 Data and methodology

At the moment, the orientations of more than 200 Roman cities and military settlements dispersed throughout different regions of the Roman Empire have been measured as it is shown in Fig. 1. It becomes the greatest sample of Roman orientations studied so far. In order to define the orientations of the *cardines* and *decumani* the horizon has been divided into 4 equal azimuth sectors of 90° each, in the way that the eastern one is defined from 45° to 135°, and so on. To get these data a number of fieldwork campaigns have been conducted by members of our group. The instruments used are a precission compass and a clinometer (Silva Survey Master) to measure the azimuth of the selected structure and the altitude of the horizon for that azimuth, respectively. The error is $\pm\frac{1}{4}^{\circ}$ for the azimuth, although it may be larger due to the state of preservation of the remains, and $\pm\frac{1}{2}^{\circ}$ for the altitude. The azimuth data is corrected for magnetic declination, whose value is calculated from the model WMM2010 available at (http://www.ngdc.noaa.gov/geomag-web/#declination). When the horizon is blocked, tools based on Digital Terrain Models, such as HeyWhatsThat (available for free at http://www.heywhatsthat.com/) are quite helpful. In cases in which fieldwork was not possible, digital tools as Geographic Information Sytems (GIS) and various geographic data have been used. Through these two measurements and the latitude it is possible to calculate the declination, by which the local topography is taken into account. The estimated error for this value is $\pm\frac{3}{4}^{\circ}$. By this procedure, the orientation of a structure can be directly related with an astronomical coordinate and, consequently, with the position of a celestial object.

4 Previous results

The results obtained in Eastern and Western Roman Empire show similarities but, maybe as expected, differences between the distint territories [6] [13]. In this case, the main focus is on the Iberian Peninsula (Roman Hispania) where there are 81 measurements, the largest sample so far. Figure 2 shows an orientation histogram of the sample in Hispania which, at first sight, suggests a random distribution of the azimuths. As stated above, the next step was to measure the declination, in order to test the astronomical hypothesis and to obtain values that consider the local topography.

Figure 3 includes the declination distributions towards the eastern and western horizons in Hispania, that is, the declinations of the cities' decumanus. Attending to these histograms one may infer that the distributions are not smooth but there exist few maximums. In general, the most remarkable ones are around $\delta = \pm 23.5°$, therefore solstitial peaks, $\delta = \pm 14°$ and one peak out of the solar but within the lunar range. In the case of Roman Arabia, in modern-day Jordan and Syria, some orientations match but new ones appear. Two examples are an equinoctial peak and another one towards the direction of the rising of Canopus at the ages studied ($\delta = -53\frac{3}{4}°$), a remarkable celestial body in the region for many cultures since ancient times.

In Roman North Africa, which comprises the area of the present-day Maghreb, there appear again solstitial and equinoctial orientations and others that may be related with stages of the agricultural season, but this is still being studied. In both cases, the assimilation of the Roman culture, and hence its urban tradition, were different from the processes occured in Hispania so it is not striking to find divergences amongst territories.

5 Astronomy in Roman urbanism?

The results obtained show that homogeneity does not exist at the time to orientate a Roman city. There are solstitial orientations in all the regions, which is not surprising since solstices have been significant events for most cultures throughout history. In the particular case of Rome, winter solstice became especially relevant with the beginning of the Empire, in the 1^{st} century BC, since first emperor of Rome, Cesar Augustus, adopted Capricorn as his symbol and an Imperial emblem[1], which might be reflected in some urban features[7]. From this moment, winter solstice became a metaphor of his rise to power by associating the transition of the darkest part of the year to the beginning of longer days, with the end of the Republic and the start of the prosperous and brighter times of the Empire. In the Iberian Peninsula there is a peak around 14° above 2σ which corresponds with the position of the sun at the end of April or the beginning of May. There are two possible interpretations for this. One is that the selected direction was the sunrise the day of the anniversary of the foundation of Rome by Romulus which, according to the legend, was on April 21^{st} of 753 BC. But there are a number of cities whose orientation coincides with the sunrise on May 1^{st}. This was a date of seasonal change according to the Gaulish calendar of Coligny found in France in the 19^{th} century [14]. The cities in which these orientation appears are mostly located in the north-west of the Iberian Peninsula, historically considered a Celtic area, and in others whose name has

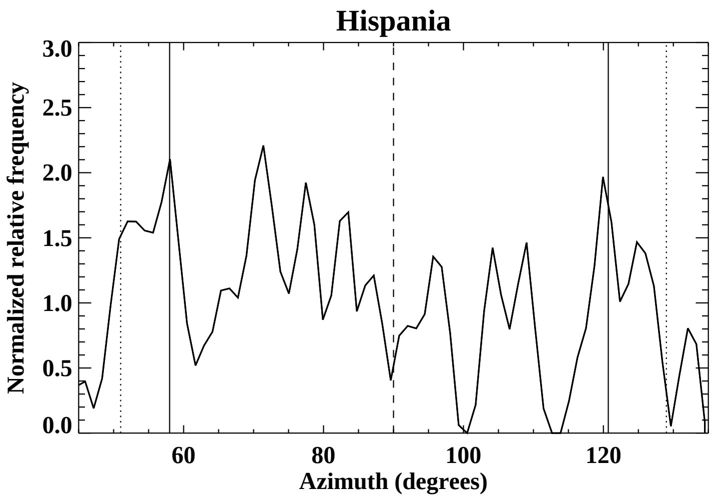

Figure 2: Orientation diagram of the data sample in the Iberian Peninsula. Short lines indicate the azimuth of the town grid or the forum. Each site is represented four times considering orthogonal directions. Dotted lines give the division of the four azimuth sectors. SS and WS for sunrise and sunset at the solstices at latitude 40°. NML and SML stand for the northern and southern major lunar standstills for the same latitude. The term *alkaid* marks the maximus digression of this star.

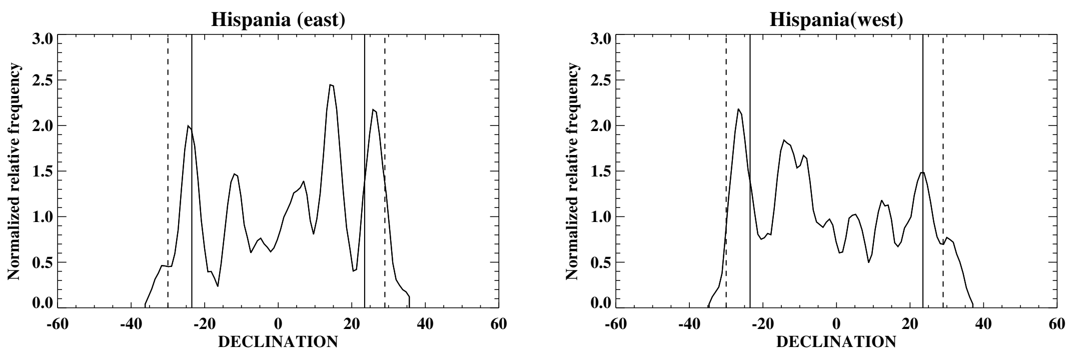

Figure 3: Declination histogram towards east (right) and west (left) horizons for the data sample in the Iberian Peninsula. Vertical solid lines indicate the extreme declinations of the sun and vertical dashed lines indicate the extreme lunar declinations.

Celtic toponyms as *–briga* (e.g. Segobriga). It invites to consider some kind of pre-Roman influence in the urban layout, which is now been compared with a series of cities in other Roman areas also traditionally considered as Celtic lands, such as Gaul. Equinoctial peaks in Near East and North Africa also make us think of the interaction between conquerors and the conquered, since this orientation has been found in pre-Roman sites in both regions. In the case of Roman Arabia, the peak towards the rising of Canopus, as well as the equinoctial one, are present in Nabataean (pre-Roman culture which habited the area) settlements previously studied by our group[3]. This might leave behind the conservative belief sustained by many scholars of a strict cultural imposition by the Romans over the settled peoples. It also suggests that the observation, knowledge and interpretation of the sky by a society, as its behaviour, may be reflected in its material culture. Being the urbanized space part of it, and from all the discussed above, we cannot dismiss the existence of astronomy in the Roman urbanism.

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