Mediterranean Archaeology and Archaeometry, Vol. 18, No 4 (2018), pp. 89-95

DOI: 10.5281/zenodo.1472277

AN ARCHAEOASTRONOMICAL APPROACH TO ROMAN URBANISM. ORIENTATION OF ROMAN SETTLEMENTS ACROSS THE EMPIRE

A. Rodríguez-Antón[1,2], A. C. González-García[3] and J. A. Belmonte[1,2]

[1]Instituto de Astrofísica de Canarias, 38200, La Laguna, Spain
[2]Universidad de La Laguna, 38200, La Laguna, Spain
[3]Heritage Sciences Institute, Incipit-CSIC, Santiago de Compostela, 15705, Spain

Received: 01/02/2018
Accepted: 04/06/2018
**Corresponding author: A. Rodríguez-Antón (rodriguezantonandrea@gmail.com)*

ABSTRACT

In this work we try to identify if there exist specific patterns in the orientation of Roman towns and military settlements across the Roman Empire, and whether this can be explained by astronomy, as suggested in a number of ancient texts and latter discussed by contemporary scholars. In order to check if cosmology was present in the urban planning at Roman times we have analyzed the orientations of more than 250 Roman sites located in different regions, from the Roman West to the East, and is the largest dataset of this kind obtained so far. Our results present suggestive orientation patterns and point towards an astronomical intentionality, maybe by the integration of important dates of Roman and pre-Roman calendars into the urban layout.

KEYWORDS: Archaeoastronomy, orientations, Roman Empire, Roman architecture, Roman urbanism

1. INTRODUCTION

The incorporation of normativity in the planning of the territory was characteristic of the Roman culture, and it played a key role in the expansionist project conducted through the different lands. This was mainly because of their major role in the land control. Although this planification was subject to empirical guidelines that involved environmental factors, among others, the creation of a new urban space included more symbolic elements, as the performing of a sacred foundational ritual (Ryckwert, 1988). This ritual allegedly recreated the same that Romulus would have executed in the mythical foundation of Rome and is possible that the directions of the streets were determined at some point during this performance.

To undertake the endeavour to form a new *urbs*, an enormous manpower and technicians were necessary to design and mark out the site prior to the development of new infrastructures. Several treatises on land division, rules for the settlement of disputes and land use that include guidelines about how to preceed when starting a design and division of the terrain have survived from some of these technicians: the *agrimensores* or ancient topographers. Orthogonallity is present in a great part of the Roman urbanism, that presents two main axes: *cardo* and *decumanus*, ideally running north-south and east-west respectively. Some ancient authors, as Frontinus (*De Agrimensura*, 27) or Hyginius Gromaticus (*Constitutio*, I) referred that *decumanus* should ideally follow the path of the sun. Moreover, although the surveying treatises described technical steps to proceed to the land division, according to some scholars the planification rules may have suffered a secularization at some point, hiding more cosmological principles (Pikulska, 2004). Nevertheless, surveyors had to cope with a variety of topographical settings that may have limited a primordial idea, and this should be considered at examining a new site.

Taking all of this into account, our aim with the study of the present sample is to elucidate whether the Roman towns were oriented according to specific patterns. If so, we are interested in determining if towns were set incorporating symbology and beliefs in their plans, that could give us information about the worldview of the Romans, as well as that of other local peoples of the different areas studied.

Even if astronomy was the determining factor at orientating the streets, we have explored an alternative method to the direct observation of a celestial phenomena (Rodríguez-Antón et al., 2018b). This is a geometric technique: the *uaratio*, also mentioned by ancient sources and that may have allowed to stablish a chosen orientation without the need to actually observe the sunrise (Roth-Congés, 1996; Orfila et al., 2017).

The orientation of Roman towns was studied in previous works, some of them rejecting the existence of astronomical patterns (Le Gall, 1975). But in the last years successive publications on this topic have claimed that orientations according to astronomical phenomena do arise when restricted samples are analyzed (Magli, 2007; Magli, 2008; González-García and Costa-Ferrer, 2011; González-García and Magli, 2015). All those previous works support the current results obtained in the different studies conducted during the elaboration of this research..

2. SAMPLE AND ARCHAEOASTRONOMICAL DATA COLLECTION

The data analyzed consist of a variegated sample of urban structures mainly in the western part of the Roman realm. They include 81 urban structures and military settlements measured in Hispania (Rodríguez-Antón et al., 2018; González-García et al., 2015), 30 in Roman Arabia (Rodríguez-Antón et al., 2016a), 93 in Britannia (Rodríguez-Antón et al., 2016b), 34 in North Africa (Rodríguez-Antón et al., 2017) and 32 in Gaul and Germania (Espinosa Espinosa et al., 2016; González-García and García Quintela, 2014; González-García et al., 2016; García Quintela and González-García, 2016), from which roughly half of them have been measured *in situ*. The general location of these sites is presented in Figure 1. They were founded or refounded during a timeframe of about 500 years; from the end of the 3rd century BCE to the 3rd century CE. The sample includes settlements of diverse status, depending on the terms of foundation and the type of inhabiting people (among others factors). Moreover, the present study encompasses a variety of local traditions spread across the territories before the Roman arrival. A number of results of the specific studies of some of these samples have been already released and the rest (either submitted or in press) will be published proximately. For measurements taken during fieldwork campaigns, we use different compass and clinometer tandems simultaneously (Suunto and Silva), to obtain the azimuth of the streets or other urban structures and the altitude of the horizon in each direction, respectively.

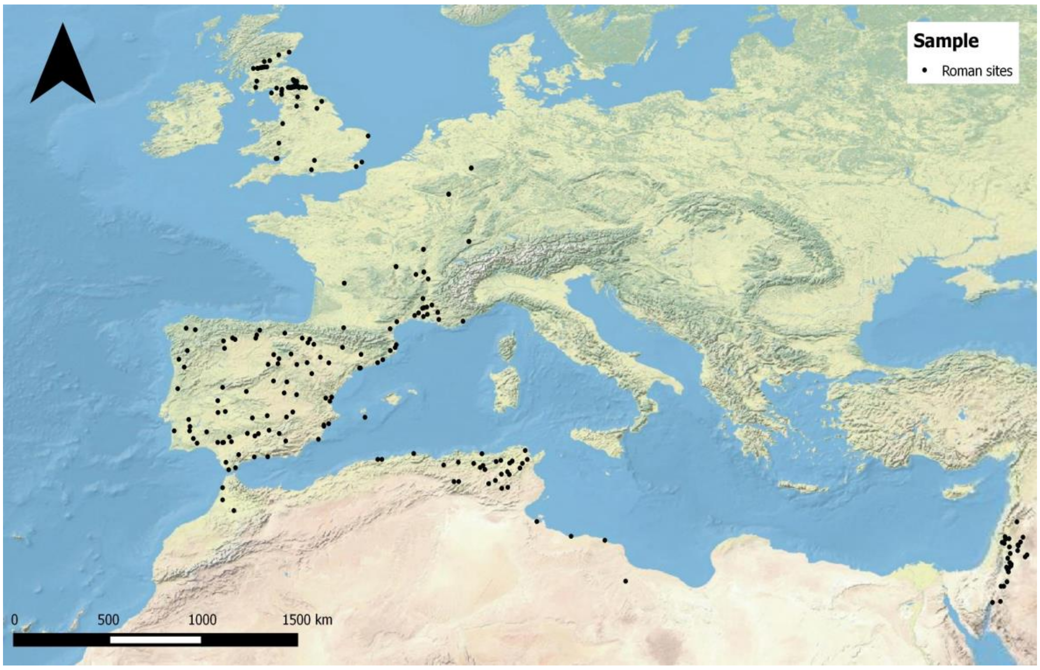

Figure 1: Location of the Roman settlements included in the data sample.

Azimuths are corrected using the WMM magnetic declination model on the NOAA webpage (https://www.ngdc.noaa.gov/geomag-web/). When horizons are blocked, we use a SRTM digital terrain model to reconstruct the horizon.[1] In cases in which fieldwork was not possible, we have made some measurements by using Google Earth and assuming the error margin introduced by this tool (Rodríguez-Antón et al., 2017). In general, we measure the orientation of the main streets of a Roman town (*cardo* and *decumanus*) when possible, or that of the main sides of the forum of the city and other streets or urban features (like capitols, for example) that run parallel to *cardo* and *decumanus*. In military camps and forts the directions are those of their main axes, since they are mostly rectangled or squared.

To compare the orientations in such a vast geographic area, we compute the geocentric declination since it is independent of the geographic coordinates and the local topography. Besides, by considering the shape of the terrain, and thus the landscape, it is possible to identify which astronomical events take place in the horizon observed. For the interested reader, the specific data of the orientations of the diversity of Roman towns and camps obtained so far can be found in the publications previously referred.

3. MAIN RESULTS

In order to observe the orientation patterns present in the various samples we have conducted independent statistical analysis over groups of sites differenciated geographically or by the type of settlement (towns, camps, forts, etc.). In this way, we have studied separatedly a dataset of Roman camps and forts in Britannia (Rodríguez-Antón et al., 2016b) and in the *Limes Arabicus* (Rodríguez-Antón et al., 2016a), as well as sets of Roman settlements in the Near East (Rodríguez-Antón et al., 2016a), Hispania (González-García et al., 2014; González-García et al., 2015; Rodríguez-Antón, 2017) and North Africa (Rodríguez-Antón et al., 2017); the last two samples include towns and forts. By the statistic, our aim was to observe whether some orientations are significant and to determine if they agree with relevant astronomical events that might be important in a region or during a particular period (Figure 2).

[1] See the online panorama generator at HeyWhatsThat website. For an estimation of the precission of this and other digital methods for data acquisition in archaeoastronomy see Rodríguez-Antón et al., 2017.

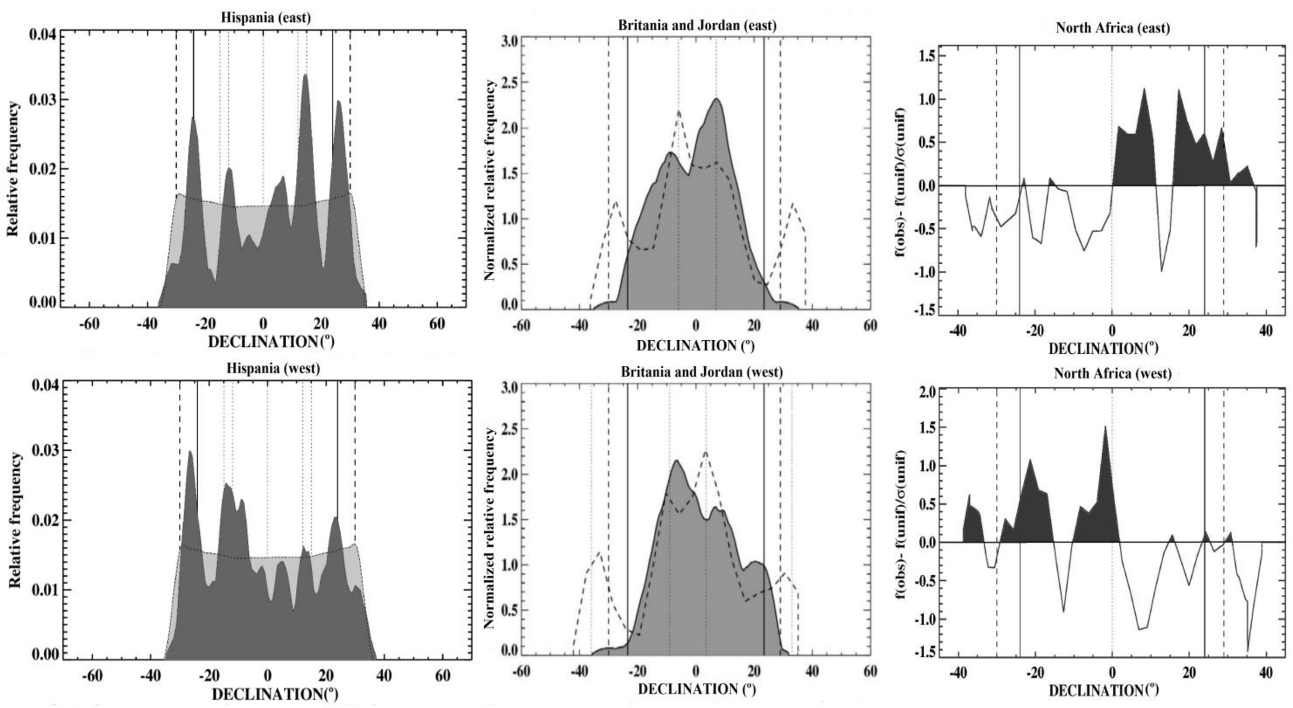

Figure 2: Declination curvigrams at some of the studied areas. Left: declination of Roman towns in the Iberian Peninsula (dark grey area) compared to a homogeneous distribution of declinations in the decumanus sector. Center: declination of military settlements in Britain (grey area) and in the Limes Arabicus (dashed line). Right: declination of settlements in North Africa (Rodríguez-Antón et al., 2017). In all the curvigrams, vertical solid lines indicate the declination of the sun at the solstices and the dashed lines next to these, that of the extreme positions of the moon.

The resultant orientations obtained for each sample do not follow random distributions but present particular patterns when we attend to declination values, as can be observed in Figure 2 for some sets of data. Various of the most significant orientations in the different datasets agree with solar positions in relevant days of the Roman calendar, mainly at dawn but in some cases we could identify some preference for sun setting. One of the remarkable maxima in declination is that which fits to the Winter Solstice sunrise, which is present both in the Roman East and West (see e.g. Figure 2), as well as in several remains from previous cultures across the Mediterranean (Belmonte et al., 2010; González-García and Belmonte, 2011).

Another interesting and significant orientation found in regions of the Roman West is that of $\delta \approx \pm 15^{\circ}$ (Figure 2). It is remarkable as well that cardinal orientations are not the majority in the present sample, neither in the West nor in the East. Finally, in studies of samples of orientations of military settlements we have found a tendency of the axes of the sites to cluster around the position of the sun at March 1st towards the west in Britannia (Rodríguez-Antón et al., 2016b), and towards the east in the forts of *Limes Arabicus* (Rodríguez-Antón et al., 2016a). The same orientation seems to be present in towns near the *Limes Germanicus* (Espinosa Espinosa et al., 2016).

4. ARE ROMAN TOWNS ASTRONOMICALLY ORIENTED?

In Figure 2 it can be observed how the declination do not follow the same pattern neither in the different areas studied nor in the towns and military settlements, but there exist particularities. Nevertheless, the current results evoke the presence of religious traditions and political elements in the various created spaces in the relationship to the skyscape. Winter solstice is relevant from an astronomical perspective, since the sun is at one of its extreme positions in the horizon and the solstice has been considered as a temporal tipping point in most cultures throughout history. A few days before this date the Saturnalia was held, being one of the best known Roman festivals (Scullard, 1981). Furthermore, at Augustan times Capricorn and the winter solstice were incorporated to the Imperial propaganda as a metaphorical representation of Octavian rise to power, symbolizing the transition to a flourishing era ruled by himself as a *Princeps* (González-García et al., 2018).

An orientation of $\delta \approx 15^{\circ}$ is also present when restricted areas are observed. One possible explanation to some of these orientations is that streets look towards the sunrise on April 21st, the mythical day of the foundation of Rome. Although the declination of the sun that day is 11½° approximately, the intrinsic error of the data and the relevance of the foundational date of the *Urbs* make reasonable not to discard this scenario for some orientations. This has been also identified in the Republican temple at *Carthago Nova* (González-García et al., 2015) and in light effects that occurred in the Pantheon in Rome this very same day (Hannah and Magli, 2011). Concretely, it has been identified in a group of towns in the northwest of Hispania, in Gaul and Germania (see e. g. González-García and García Quintela, 2014; Espinosa Espinosa et al., 2016; Rodríguez-Antón, 2017), where Celtic peoples inhabited prior to the Roman arrival. Interestingly, a declination of 15º agrees roughly with the position of the sun around May 1st, traditionally regarded as a Celtic mid-season feast. It has been suggested in a recent paper that mid-season feasts were locally integrated into the Julian calendar in Gaul at some point during the Julio-Claudian Dynasty (González-García et al., 2016). In addition, the same orientation has been found in towns and buildings from that period and it has been proposed that a horizon calendar may have been used in Celtic-speaking areas in order to coordinate events among distant regions (García Quintela and González-García, 2017). In this sense, considering such orientation we argue that local practices prevailed or merged with the Roman ones in several cases.

Results in which orientations seem to follow pre-Roman patterns appear also in a diachronic study developed in *Carthago Nova*, present-day Cartagena (Spain), where urban features from its foundation by Hasdrubal in 228 BCE to the Roman period were studied from an archaeoastronomical perspective (González-García et al., 2015). The results manifest an integration of ritual and political elements from the different historical stages in the topography and the urbanism of the city.

Another outcome of this research is that cardinal orientations are rather seldom in our current sample, against what would be expected (Chevallier, 1967; Castillo Pascual, 1993). In the Iberian Peninsula these patterns are rare but there are three exceptions: Basti, Gerunda and Libisosa. Curiously, all of them are located in former Iberian areas, where cardinal and equinoctial patterns have been identified in Iberian settlements and sacred places (Esteban, 2002; Esteban and Escacena, 2013). The same patterns have been observed in towns in North Africa (Rodríguez-Antón et al., 2017) and the Near East (Rodríguez-Antón et al., 2016a), where equinoctial orientations were detected in former remains from the local peoples like the Nabataeans, the Punics and Proto-Berber groups (see for example Belmonte et al., 2013, Belmonte et al., 2007, González-García et al., 2017).

Finally and regarding to the resulting orientations towards sunrises and sunsets in March 1st in military settlements (Rodríguez-Antón et al., 2016ab), we should consider that during March a number of festivities in honour of Mars, the Roman god of war, were celebrated. This was so at least in earlier Roman times according to Ovid's Fasti (*Fasti*, Book 3) and in the *Feriale Duranum* (see Espinosa Espinosa et al., 2016).

Since towns represented the symbolic presence of the power of Rome in the new provinces, the incorporation of specific orientations might act as a cultural element that lasted over time. In this sense, astronomy would have contributed to create a Roman geography differentiated form the previous one. Furtermore, the sky in the past should not be considered as a mere physical space but a place where astronomical objects embodied spiritual agents like gods, provided organizing principles and defined structures for people´s activities. If this was so, the present results suggest that beliefs and political ideologies were inserted in the Roman city plans during their spatial configuration through the observation of the sky.

At this point, it is possible to put aside the oximoron "astronomical orientations-Roman towns" and to keep on this kind of studies in other provinces of the Roman domain, such as the Illyricum, in order to elucidate what is behind the observed orientation patterns.

ACKNOWLEDGEMENTS

We wish to express our sincere gratitude to all those who joined us and participated in the various fieldwork campaigns and share fruitful opinions and ideas to enrich this work. We particularly acknowledge Javier Alegre, Dionisia Antón Correas, José R. Belmonte Avilés, Lourdes Costa Ferrer, M. Esther Chávez Álvarez, Cristina Díaz, David Espinosa Espinosa, César Esteban, Alberto García Aparicio, Marco V. García Quintela, Sixto Giménez Benítez, Margarita Orfila, Manuel Pérez Gutiérrez, Jaime Rodríguez Álvarez, Elena H. Sánchez and Margarita Sanz de Lara. We would like to thank those specialists who kindly offered to guide us and opened the doors of archaeological sites, making our labour easier by their clarifications. This work is partially financed within the framework of the projects *Orientatio ad sidera* III (AYA2011-26759) and *Orientatio ad sidera* IV (AYA2011-66787-P) of Spain MINECO. A. C. González-García is a Ramon y Cajal Fellow of MINECO.

REFERENCES

Belmonte, J.A. and González-García, A.C. (2010) Antiocho's *hierothesion* at Nemrud Dag revisited: adjusting the date in the light of astronomical evidence, *Journal for the History of Astronomy* Vol.41, pp. 469-81.

Belmonte, J.A., Tejera, A., Betancort, M.A.P. and Marrero, R. (2007) On the Orientation of Pre-Islamic Temples of North-west Africa: A Re-appraisal (New Data in Africa Proconsularis), *Mediterranean Archaeology and Archaeometry,* Vol.6 (3), pp. 73–81.

Belmonte, J.A., González-García, A.C. and Polcaro, A. (2013) Light and Shadows over Petra: astronomy and landscape in Nabatean lands. *Nexus Network Journal*, Vol. 15, pp. 487-501.

Belmonte, J.A., Tejera, A., Betancort, M.A.P. and Marrero, R. (2007) On the Orientation of Pre-Islamic Temples of North-west Africa: A Re-appraisal (New Data in Africa Proconsularis), *Mediterranean Archaeology and Archaeometry,* Vol.6 (3), pp. 73–81.

Belmonte, J.A. And González-García, A.C. (2010) Antiocho's *hierothesion* at Nemrud Dag revisited: adjusting the date in the light of astronomical evidence, *Journal for the History of Astronomy* Vol.41, pp. 469-81.

Bertarione, S. and Magli, G. (2015) Augustus' Power form the Stars and the Foundation of *Augusta Praetoria Salassorum*, *Cambridge Archaeological Journal*, Vol.25, pp.1-15.

Castillo Pascual, M. J. (1996) *El espacio en orden: el modelo gromático romano de ordenación del territorio*, Logroño, Universidad de La Rioja.

Chevallier, R. (1967) Sur les traces des arpenteurs romains, *Caesarodunum*, Vol.2, Orleans-Tours

Espinosa Espinosa, D., González-García, A.C. and García Quintela, M.V. (2016) On the orientation of Roman towns in the Rhine Area, *Mediterranean Archaeology and Archaeometry* Vol.16 (4), pp. 233-240.

Esteban, C. (2002) Elementos astronómicos en el mundo religioso y funerario ibérico, Trabajos de Prehistoria, Vol. 59(2), pp.81-100.

Esteban, C. and Escacena Carrasco, J.L. (2013) Arqueología del cielo. Orientaciones astronómicas en edificios protohistóricos del sur de la Península Ibérica, *Trabajos de Prehistoria,*Vol.70 (1), pp. 114-39.

García Quintela, M.V. and González-García, A.C. (2016) De Bibracte à Augustodunum: observations archéoastronomiques, *Revue Archeologique de l'Est*, Vol.65, pp. 283-297.

García Quintela, M.V. and González-García, A.C. (2017) Archaeological footprints of the "Celtic calendar"?, *Journal of Skyscape Archaeology*, Vol.3(1), pp. 49-78.

González-García, A.C. and Belmonte, J. A. (2011) Thinking Hattusha: Astronomy and landscape in the Hitite lands, *Journal for the History of Astronomy,*Vol. 42 (4), pp. 461-94.

González-García, A.C. and Costa Ferrer, L. (2011) The diachronic study of orientations: Mérida a case study. C.L.N. Ruggles (ed.) *Archaeoastronomy and Ethnoastronomy: Building bridges between Cultures,* Cambridge University Press, Cambridge, pp. 374-381.

González-García, A.C. and García Quintela, M.V. (2014) The 1st of August at Lugdunum: astronomy and Imperial cult in Galia, *Mediterranean Archaeology and Archaeometry,*Vol. 14(3), pp. 83-91.

González-García, A.C., Rodríguez-Antón, A. and Belmonte, J.A. (2014) The orientation of Roman towns in Hispania: preliminary results, *Mediterranean Archaeology and Archaeometry*, Vol. 14 (3), pp. 107-119.

González-García. A.C. and Magli, G. (2015) Roman city planning and spatial organization. C.L.N. Ruggles (ed.), *Handbook of Archaeoastronomy and Ethnoastronomy: Building bridges Between Cultures*, Cambridge University Press, Cambridge, U.K., 374-381.

González-García, A.C., Noguera Celdrán, J.M., Belmonte Avilés, J.A., Rodríguez-Antón, A., Ruiz Valderas, E., Madrid Balanza, M.J., Zamora, E. and Bonnet Casciaro, J. (2015) Orientatio ad sidera: Astronomía y paisaje urbano en Qart Hadašt/Carthago Nova, *Zephyrus* lv (2015), 141-62.

González-García, A.C., García Quintela, M.V. and Rodríguez-Antón, A. (2016) The orientation of *Lugdunum Conuerarum* and the Celtic feasts marking the start of the seasons in ancient Gaul, *Mediterranean Archaeology and Archaeometry,* Vol.15 (4), pp. 241-47.

González-García, A.C., García Quintela, M. V. and Belmonte, J.A. (2016) Landscape construction and time reckoning in Iron Age Celtic Iberia, *Documenta Praehistoria*, pp. 479-97.

González-García, A.C., Costa-Ferrer, L., Zedda, M. and Belmonte, J. A. (2017) La Orientación de los santuarios de Ibiza y los hipogeos púnicos del Mediterráneo occidental, A.C. González-García and B. Costa (eds.) *Entre el Cielo y la Tierra: Arqueoastronomía del Mundo* Fenicio-Púnico. *XXX Jornadas de Arqueología Fenicio-Púnica*, Ibiza, Treballs del Museu de Eivissa, in press.

González-García, A.C., Rodríguez-Antón, A., Espinosa Espinosa, D., García Quintela, M.V. and Belmonte, J. A. (2018) Under Augustus Sign: the orientation of Roman cities built in the Age of Augustus, G. Magli (ed.) *Archaeoastronomy in the Roman World*, Spinger, in press.

Hannah, R. and Magli, G. (2011) The role of the Sun in the Pantheon´s design and meaning, *Numen,*Vol.58, pp. 486-513.

Le Gall, J. (1975) Les romains et l'orientation solaire, *MEFRA,* Vol. 87(1), pp. 287–320.M

Magli, G. (2007) Non-orthogonal features in the planning of four ancient towns of Central Italy, *Nexus Network Journal- Architecture and Mathematics*, Vol.9, pp.71-92.

Magli, G. (2008) On the orientation of Roman towns in Italy, *Oxford Journal of Archaeology*, Vol. 27(1), pp.63-71.

Orfila Pons, M., Chávez-Álvarez, M.E. and E.H. Sánchez (2017) Urbanizar en época romana: ritualidad y practicidad. Propuesta de un procedimiento homologado de ejecución. *SPAL,* Vol.26, pp. 113-134.

Pikulska, A. (2004) Les arpenteurs romains et leur formation intellectuelle, *Revue internationale des droits de l'antiquite,* Vol.51, pp. 207–8.

Rodríguez-Antón, A. (2017) *Cosmovisión y urbanismo en la Roma Antigua: Orientación de ciudades y campamentos romanos.* Unpublished Ph.D. Dissertation, Universidad de La Laguna, Spain.

Rodríguez-Antón, A., Belmonte, J.A. and González-García, A.C. (2016a) Romans in the Near East: the orientation of Roman settlements in present-day Jordan, *Mediterranean Archaeology and Archaeometry,* Vol.41 (4), pp. 153-60.

Rodríguez-Antón, A., González-García, A.C. and Belmonte, J.A. (2016b) Orientation of Roman camps and forts in Britannia: reconsidering Alan Richardson's work, F. Silva, K. Malville, T. Lomsdales and F. Ventura (eds.), *The materiality of the sky*, Sophia Centre Press, pp. 135-144. UK, Sophia Centre Press.

Rodríguez-Antón, A. (2017) *Cosmovisión y urbanismo en la Roma Antigua: Orientación de ciudades y campamentos romanos.* Unpublished Ph.D. Dissertation, Universidad de La Laguna, Spain.

Rodríguez-Antón, A., González-García, A.C. and Belmonte, J.A. (2017) Estimating the reliability of digital data acquisition in Cultural Astronomy. Its use in the case of Roman North Africa, *Journal of Skyscape Archaeoloy,* Vol.3(2), pp. 191-206.

Rodríguez-Antón, A., González-García, A. C. and Belmonte, J.A. (2018) Astronomy in Roman Urbanism: A Statistical Analysis of the Orientation of Roman Towns in the Iberian Peninsula, *Journal for the History of Astronomy*, Vol.49(3), pp. 363-387

Rodríguez-Antón, A., Orfila, M., González-García, A.C. and Belmonte, J.A. (2018b) The *uaratio* and its possible use in the Roman urban planning to obtain astronomical orientations, G. Magli (ed.) *Archaeoastronomy in the Roman world,* Springer, in press.

Roth-Congés, A. (1996) Modalités pratiques d'implantation des cadastres romains: quelques aspects (Quintarios claudere. Perpendere. Cultellare. Varare: la construction des cadastres sur une diagonale et ses traces dans le Corpus Agrimensorum). *Mélanges de l'Ecole Française de Rome, Antiquité* Vol.108(1), pp. 299-422.

Rykwert, J. (1988) *The Idea of a Town. The Anthropology of Urban Form in Rome, Italy and the Ancient World.* Princeton, Princeton University Press.

Scullard, H. H. (1981) *Festivals and ceremonies of the Roman Republic* , Suffolk, Thames and Hudson.