Juan Antonio Belmonte*
*Corresponding author

Instituto de Astrofísica de Canarias
La Laguna, Tenerife, SPAIN
Departamento de Astrofísica,
Universidad de La Laguna
Tenerife, SPAIN
jba@iac.es

A. César González-García

Instituto de Ciencias del Patrimonio
Incipit, CSIC,
Santiago de Compostela, SPAIN
cesar.gonzalez-garcia@incipit.csic.es

Andrea Polcaro

Università degli Studi di Perugia
Perugia, ITALY
andrea.polcaro@gmail.com

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Research

Light and Shadows over Petra: Astronomy and Landscape in Nabataean Lands

Abstract. A statistical analysis of the orientation of Nabatean sacred monuments demonstrates that astronomical orientations were often part of an elaborated plan and possibly a trace of the astral nature of the Nabataean religion. Petra and other monuments in the ancient Nabataean kingdom have proven to be marvellous laboratories for the interaction between landscape features and astronomical events, showing impressive hierophanies on particular monuments related to cultic times and worships. Among other findings, the famous Ad Deir has shown a fascinating ensemble of light and shadow effects, perhaps connected with the bulk of Nabataean mythology, while from the impressive Urn Tomb, a series of suggestive solstitial and equinoctial alignments emanate which might have lately helped its selection as the cathedral of the city. This paper demonstrates that the sky was a substantial element in Nabataean religion and reveals new evidence for cultic worship centred on the celestial sphere.

1 Introduction

From the victory of the legendary king Obodas I over Seleucid armies in the early first century B.C. to the annexation of their kingdom to the Roman Empire by Emperor Trajan at the beginning of the second century A.D. and even later, the Nabataeans, a people of presumably Arab lineage, developed a singular and sophisticated culture in the harsh lands of Arabia Petraea (to the southeast of Palestine and Syria in antiquity) at the frontiers of the Hellenistic world [Markoe 2003: Bowersock 2003]. For centuries, they carved hundreds of tombs into the sandstone and built palaces for their kings and temples for their divinities, creating one of the most fascinating places on earth, the legendary city of Petra, Nabataean Reqem. This was the capital of their kingdom for generations and represented the high point of their civilization, although the Nabataean genius was also present in many other sacred buildings scattered across their lands (fig. 1). Among these, the nearly contemporaneous temples at Khirbet et Tannur and Khirbet ed Dharih show a collection of elements of undoubted astral symbolism which might be traced to the nature of Nabataean religion [Gawlikowski 1990]. In particular, Tholbecq [1997] has convincingly suggested that certain busts uncovered at the excavations of Dharih actually represent the seven planets.

There are indications that the Nabataeans had a naturalistic religion, a strange mixture of elements from pre-Islamic Arabs with Hellenistic, Egyptian and other Middle Eastern influences [Healy 2000]. Stone blocks (*baetyles*) often representing the divinities, although human or quasi-human forms were developed lately. The principal male divinity was the god Dushara or Dushares, very probably an astral god with a hypothetical lunar or solar character.

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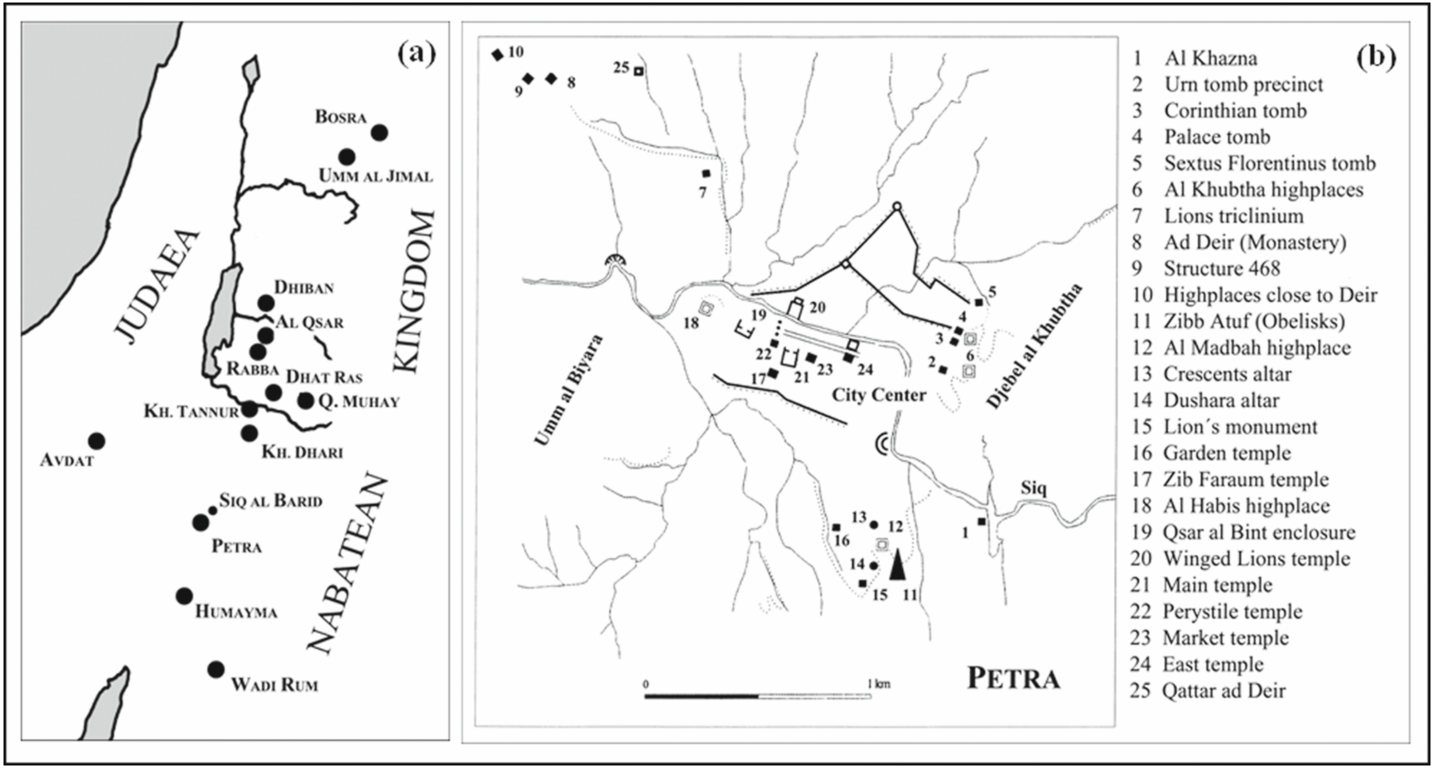

Fig. 1. Maps of the sites mentioned in the text and where the data have been collected: a) Sites of the Nabataean Kingdom discussed in the text; b) Sites of the city of Petra. Diagrams by the authors

The god's name means "He of Shara", Shara being the mountain range to the east of Petra where the ancient site of Gaia (presumably the previous capital city) is located. There is evidence of a certain syncretism with the god al-Kutba, meaning the "writer" and, consequently, with the Babylonian god Nabu [Gawlikowski 1990]. In this case, the planet Mercury would have been one of his celestial manifestations [Pettinato 1998]. Dushara has sometimes been identified with the Greek gods Zeus, Dionysus or Ares, although the latter is a less common association. Archaeological evidence suggests that he was a deity related to the cult of the deceased.

However, there has been much discussion regarding the head female divinity of the Nabataean pantheon. In Bosra, the northern Nabataean capital during the crepuscular reign of king Rabel II (71-106 AD), the main goddess was Allat, meaning simply "the Goddess". With a hypothetical solar character (since Sams, the sun, was a female divinity in pre-Islamic Arabia), she has been identified with Athena or Atargatis [Healy 2000]. Her name is also present in Wadi Ramm (ancient Iram). However, in Petra, this name is never found, whilst many inscriptions in Nabataean script have been found mentioning the goddess Al Uzza. Her name means "the Most Powerful" and she was the personification of the evening star, the planet Venus, identified with the Greek Aphrodite and the Cananaean Astarte, and also with the Egyptian goddess Isis. In Nabataean inscriptions found in Petra and Iram, she is mentioned in close relationship with Al Kutba and of course Dushara but we still do not know the exact ties between them. Indeed, in the area of Petra, Dushara and Uzza were undoubtedly at the head of a pantheon with many layers of meaning [Zayadine 2003].

2 Statistical analysis of orientations

In December 2011, deliberately in coincidence with the winter solstice, our team, consisting of two archaeoastronomers, specialists in ancient Mediterranean cultures and statistical analyses of series of data (see, for example, [González-García and Belmonte 2011]), and an archaeologist working in the Levant, notably in Jordan and Syria [see, e.g. Polcaro 2012], travelled to Jordan with the aim of performing a primeval archaeoastronomical analysis of Nabataean monuments in the region. Our goal was to analyse a statistically significant sample of temples and other sacred buildings, which would permit archaeological confirmation of suspected astronomical activities by the Nabataeans relating to religious practice [Belmonte 1999]. Fig. 1 illustrates the sites from which data have been collected (including the city of Petra itself), while Table 1 shows the raw data for the different sites and monuments. The sample includes the datum of the commemorative temple of king Obodas at Avdat obtained during a visit to the Negev region in 2008.

The data sample includes 92% of the temples known, including those in Petra and in other Nabataean settlements of the kingdom such as el Qsar, Dhat Ras, Tannur, Dharih or Wadi Ramm (fig. 2). In Petra, data includes temples plus the majority (~80%) of the accessible highplaces (open-air altars carved on the rock in the top of cliffs and conspicuous mountains), including the best known at Djebel Madbah (fig. 2a), and a few of the most representative monuments excavated and sculpted in the sandstone walls. Although the number of rock-cut chambers present in the last census of the city is quite high [Lehme 2003] not all of them had a marked religious character. Our intention was selecting those architecturally significant for which a religious character behind its mortuary use has been definitely proven such as Ad Deir or Monastery, the Urn Tomb (fig. 2c) or the most controversial of them, Al Khazna or Treasury (fig. 3d) [Stewart 2003].

Table 1. Orientation of 50 Nabataean monuments of a sacred character (temples, shrines, royal tombs and highplaces) as mainly obtained in December 2011. The table shows for each monument the location, the identification of the structure, the latitude and longitude (φ and λ), its azimuth (a) from inside looking out, and the angular height of the horizon (h) in that direction, and the corresponding declination (δ). The last column contains some additional comments or data for alternative orientations (in °)

Place	Monument	φ (°/’)	λ (°/’)	a (°)	h (°)	δ (°)	Comments
Umm al Jimal	Nabataean temple	32/20	36/22	18¼	0B	52¾	
Dhiban	Nabataean temple	31/30	35/46	338	0½	52¼	
El Qsar	Nabataean temple	31/19	35/45	77¼	0b	10½	
Rabba	Roman temple	31/16	35/44	109	0b	16½	Nabataean foundations?
Khir. Dharih	Nabataean temple	30/54	35/42	194	6	–50¼	h~2½ N / δ~58 h~13½ E / δ~–4¾
Khir. Tannur	Nabataean temple	30/58	35/42	92½	2	–1¼	
Dhat Ras	Nabataean temple I	31/00	35/46	359½	–0½	57¼	h~–0½ E / δ~–0¼
	Nabataean temple II			267½	–0½	–2¾	
	Nabataean temple III			182	0½	–58½	Well preserved
Qsar Muhay	Central structure	31/00	35/52	135½	–0½	–38¼	Nabataean podium?
Wadi Ramm	Allat temple	29/35	35/25	112	6½	–15½	
	East temple ?			171¾	5½	–54¼	
Humayma	Nabataean temple	29/57	35/21	90¾	1	–0¼	
Petra	Al Khazne (Treasury)	30/20	35/27	65	17½	30	Towards Siq If h~13½° / δ~28½
	Urn Tomb			264½ 303 241½ 295½	8 3 1½ 4½	–0¾ 29½ –23½ 24	^ ^ at Umm al Biyara To Ad Deir SW-NE diagonal NW-SE diagonal 293^ ^296, see fig. 5
	Corinthian Tomb			277	3½	7¾	
	Palace Tomb			298	3	25½	
	Sextus Florentinus			344	6	61¼	Roman period
	Khubtha H1			61	5	27¼	H = Highplace
	Khubtha H2			259	3	–8	
	Khubtha H3			255	2½	–11¾	
	Khubtha H4			280	1½	9¼	
	Lions’ triclinium			132¼	13 15	–27 –25½	
	Ad Deir (Monastery)			234 237½	8½ 7	–25¼ –23½	Exterior Interior
	Structure 468			73¼	7½	18¼	Deir Urn a~80½ / h~8 / δ~12¼
	Upper highplace			296	2½	23½	Near Deir h~2½E / δ~–21
	Lower highplace			7½	1	59½	Near Deir
	Deir altar			157	5½	–48	
	Zibb Attuf			92½	4¾	0¼	
	Madbah (court)			258	2½	–9¼	
	Madbah (altar)			263	2½	–6	Djebel Harum a~262 / h~3 / δ~–5½
	Crescents’ shrine			252½	2	–14¼	
	Lion Mon. betyl			154½	10	–43	
	Dushara shrine			354½	7½	66½	
	Garden temple			156½	23½	–31½	
	Zib Faraum temple			92¾	17½	6½	
	Habis highplace			270	7½	3¾	
	Qsar al Bint			18½	7½	61¼	
	Qsar el Bint altar			18½	9	62½	
	QB Temenos			289	16	24	h~10½E / δ~–10¾
	Winged Lion temple			197	3	–53¼	
	Great temple (Civil use?)			6½	5½ 7	64¼ 65¾	Upper section Lower section

	Peristyle temple			19	7½	61	
	Market temple			6	7½	66¼	
	Cardus			97½	10	–1¼	
	East temple			16½	B	55¼	
Siq al Barid	"Khazna"	30/22	35/27	147½	26½	–25¼	"Little Petra"
	Temple			338	32>	71	
	Highplace			227	12	–28¼	
Avdat	Nabataean temple	30/48	34/40	62½	0	23	

Fig. 2. Images of different kind of monuments of Petra measured, analyzed and discussed within the text: (a) Madbah highplace; (b) the Obelisks or Zibb Attuf at Djebel Madbah; (c) The Urn Tomb at the cliffs of Djebel Khubtha; and (d) the splendid façade of Al Khazna. Photos: J.A. Belmonte

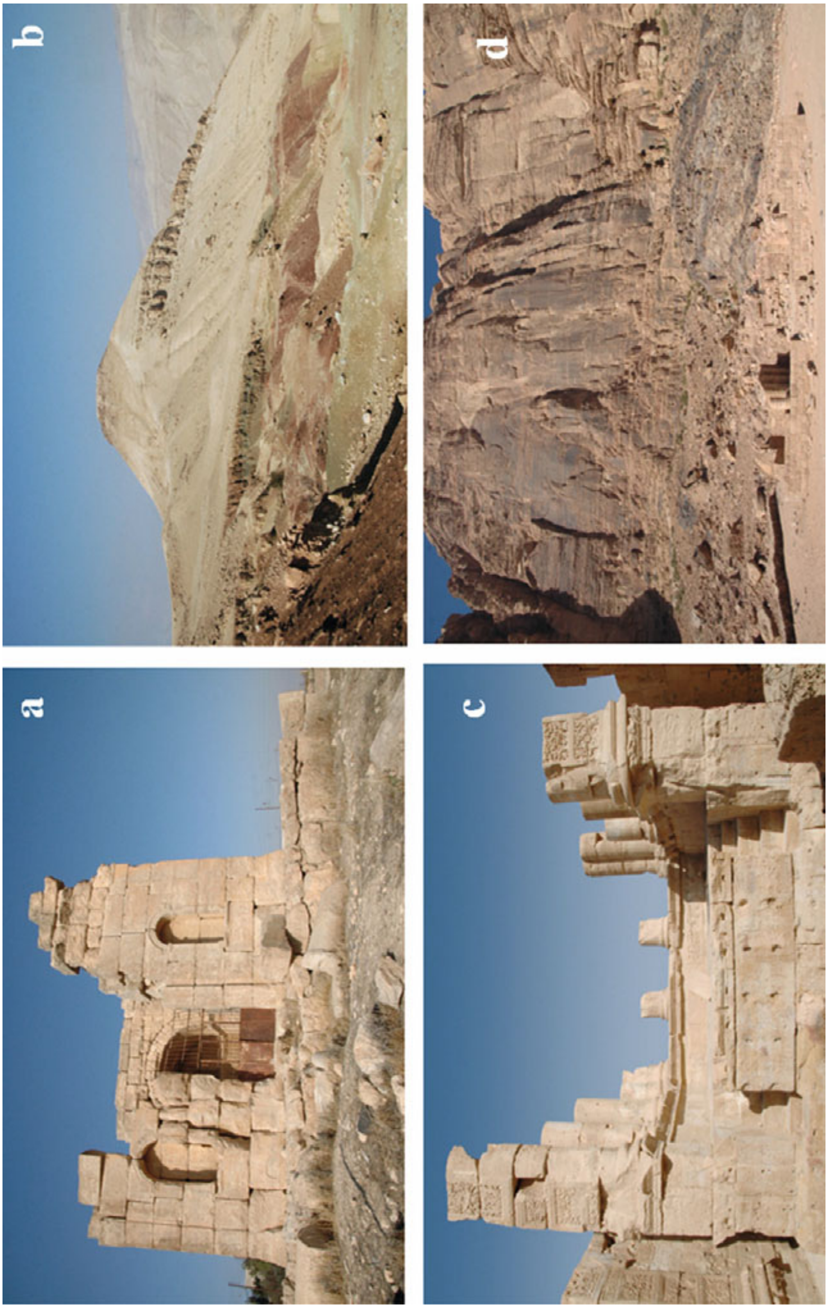

Fig. 3. Nabataean temples outside Petra: (a) Sanctuary at Dhat Ras; (b) Djebel Tannur, the temple is located at its summit; (c) Sancta sanctorum of the temple of Khirbet ed-Dharih; and (d) the temple of Allat dwarfed by the impressive cliffs of Djebel Ramm. Photos: J. A. Belmonte

In total, our data includes fifty temples and other cultic structures from all over the ancient Nabataean kingdom, which we estimate to be a statistically significant sample of all religious structures known up to date.

Data were collected using high precision compasses and clinometers and corrected for magnetic declinations. Magnetic alterations are not expected in the Nabataean territory, where most of the terrain is limestone or sandstone. The measurements included in Table 1 have an average error of ¼° in azimuth and ½° in horizon altitude, which translates into an error ~¾° in declination. Fig. 4 illustrates the results of our work. Fig. 4a shows the orientation diagram of the sample in azimuth where it can be observed that the axes of most structures are concentrated either in the solar arc or in a general orientation towards the meridian. Fig. 4b shows the astronomical declination histogram, a magnitude independent of geographic coordinates and local topography. The declination histogram was calculated using a density distribution with an Epanechnikov kernel with a pass band of 1½°. This histogram is similar to the one discovered for neighbouring cultures with a strong astral component in their religion, such as ancient Egypt [Belmonte, Shaltout and Fekri 2009] and shows a series of significant peaks. Significance is estimated by the following procedure. The mean is first computed and subtracted from the data, then the data are normalized with the standard deviation of the measurements. Any peak rising above the 3σ level could be considered as having a degree of confidence higher than 99% within this particular significance test.

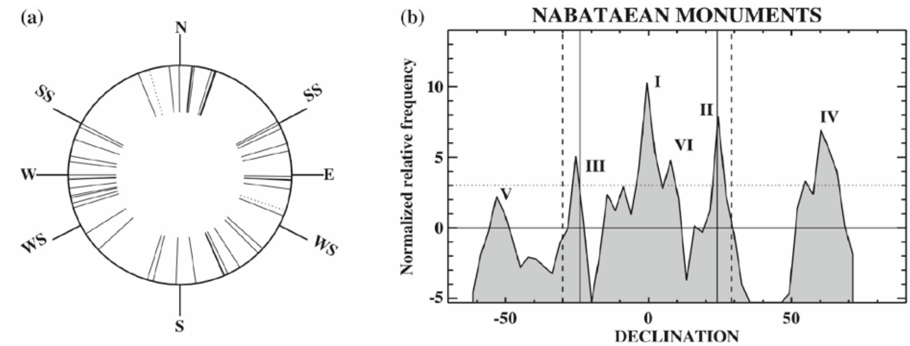

Fig. 4. Main outcomes of the archaeoastronomical analysis of Nabataean monuments. a, left) orientation diagram of the structures (dot-lines for Roman period ones); b, right) declination histogram of the set of monuments. Dashed and continuous vertical lines stand for major lunastices and solstices, respectively. Horizontal dot-line stands for the 3σ confidence level. Roman numbers identify peaks discussed within the text

Some of the peaks of the histogram, of a probable astral – presumably solar – character, might be interpreted in light of Nabataean beliefs, considering, among other sources, that Strabo[1] reported that the Nabataeans worshipped the sun on the roof of their houses. Peak I, centred at –0¼° could indeed be catalogued as equinoctial. Scholars have suspected that the temple of Tannur may be associated with the equinoxes [Villeneuve and Al-Muheisen 2003; McKenzie 2003], presumably a moment for pilgrimages to the top of the mountain where the temple is located (see fig. 3). This fact is hardly surprising considering the abundance of astral symbolism in the sculpture recovered at Tannur and the neighbouring temple of Dharih. This may suggest that the equinoxes were important marks in the Nabataean sacred time and a possible way of controlling time within the framework of a lunisolar calendar. The results of this study confirm this suspicion, since there is a significant general trend in the data to the time frame of the equinoxes (declination 0°). The Urn Tomb (fig. 2c) and the Obelisks at Djebel Madbah (fig. 3b) are also relevant in this context, as we will see below. Peak II at 24¼° is certainly solstitial, while peak III, centred at –25¼° could be related to any of the celestial bodies moving close to the ecliptic and relevant in Nabataean religion: the winter solstice sun (according to Epiphanius's *Panarion*), Venus or Mercury, as stated above. For the additional peak above the 3σ level within the solar range in fig. 4, at a declination of ~8°, there is however no direct or simple astronomical explanation.

To understand peaks IV and V we must take into account that the Nabataeans were a people of presumably Arab lineage. Peak IV, centred at 60¼°, is certainly the accumulation peak to northern directions related to the average latitude of the Nabataean Kingdom: 30°N. This could be connected with the large number of monuments which were oriented towards north, including the main temples at the colonnade avenue in Petra. One of those temples was the singular Qsar el Bint, arguably the main sanctuary of Dushara, situated at the convergence of the main caravan roads leading to the city centre which was possibly founded by King Obodas III (28-9 BC), and completed by Aretas IV. It was severely damaged by an earthquake (perhaps the one that nearly destroyed the city in 363 A.D.) but recent excavations have recovered part of the starry decoration in stucco [Larche and Zayadine 2003]. An additional, although less significant peak (V) is located at a declination –52¾°, very close for the epoch to the declination of the bright star Canopus, which could however be interesting in a most general context.

According to Arabic sources of the early Muslim era, the Ka'aba in Mekka had a main axis orientated to Suhail (the Arabic for Canopus) and the stars of the Handle of the Plough (Alkaid had a declination of 60° ca. 1 A.D.) and a minor axis oriented according to the solstitial line [Hawkins and King 1982]. The black stone was embedded in the SE corner of the monument facing the equinoxes. It is certainly curious that some Nabataean monuments reproduce the same pattern of alignments as those classically reported for a hypothetical pre-Islamic Arabic temple such as Ka'aba. The last surviving inscription in the Nabataean language dates from 356 A.D., a quarter of a millennium earlier than the arrival of Islam but the Nabataean divinities were certainly worshiped in the region; the sanctuary of Al Uzza at Wadi Hurad was destroyed by Khalid Ibn al Walid at the commandment of Mohammed immediately after the capture of Mekka. It is worth noticing that "by Allat, Al Uzza and Manat, the third of the triad" Kuraish performed "tawat" in Ka'aba [Zayadine 2003], although the impossibility of carrying out archaeological excavations in the Holy Mosque disables any further conclusions. However, most of the peaks in the histogram can be interpreted at the light of Nabatean beliefs, reinforcing the astral character of the religion and showing that the equinox and perhaps the solstices were important for their time-keeping.

Peaks IV and V in fig. 4b correspond to the accumulation peaks related to northern and southern azimuths. These correspond to areas where a large number of declinations are available within a certain azimuth interval and consequently some of the peaks towards these directions could have a spurious nature. We have been puzzled by this possibility since our research group started statistical analysis of temple orientation in the Mediterranean region, but it was difficult to prove with samples of a high variability in latitude and horizon angular heights. In order to test this phenomenology in a compact geographical area, we have performed a preliminary test of our Nabataean data by comparing the distribution of declinations of our sample with that arising from a homogeneous set of orientations with the same population. Fig. 5 shows the result of this comparison after subtracting such distribution and normalizing by the standard deviation of the homogeneous sample. We can see that the vast majority of the relevant peaks are still present, including peak IV towards northern declinations which is certainly significant. However, peak V is absent and seems compatible with a homogeneous distribution. Consequently, it must be considered with more caution. This test is still a preliminary trial and must indeed be refined. It does not include the effect of varying horizon altitudes and in its present state may not work well for larger geographical areas such as ancient Egypt. However, it behaves reasonably well for the Nabataean realm and the results seem robust.

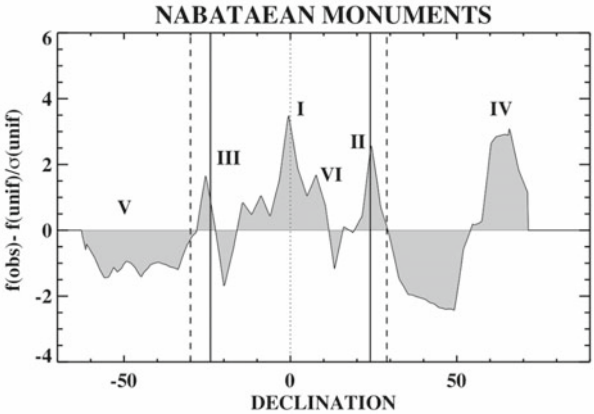

Fig. 5. Results yielded by a new analysis of the data in an attempt to test the significance of the peaks of accumulation. The observed declination histogram f(obs) is compared with the one that would be yielded by a uniform distribution of azimuths with the same number of data f(unif) and expressed in unit of the standard deviation of this second distribution. Peak IV is still significant within the distribution but peak V, which had already a low significance, loses all its weight

3 Light and shadow effects

The aim of our campaign in Nabataea was to observe the effect of the winter solstice phenomena at some of the most impressive monuments of Petra. Belmonte [1999] suggested a phenomenology related to the solstices for some of the most singular monuments in Petra, such as the Monastery or the Treasury. On-site observation would enable us to directly witness light and shadow effects that may have been of significance to the Nabataeans.

The most impressive light and shadow effect at winter solstice occurs at Ad Deir (the Monastery). It is unclear whether this is the temple of one of the most important Nabataean divinities, Dushara or Uzza, a *heroon* for one of their deified kings such as Obodas I, or the unfinished burial place or cenotaph of one of their last kings, such as Rabel II. Its use as a church in the Byzantine era and its internal distribution suggests that this was originally a sort of monumental cella or biclinium with a cultic podium (a *môtab*) at its rear [Wenning 2003]. Indeed, Ad Deir would have been a prominent festival venue, with an elaborated staged ascent from the centre of the city, a vast court in front of it and a series of related monuments such as a stone circle, an altar and the temple-like building known as structure 468 situated in front of it. The orientation of the structure, shown in Table 1, and especially in fig. 6, strongly suggests a winter solstice relationship.

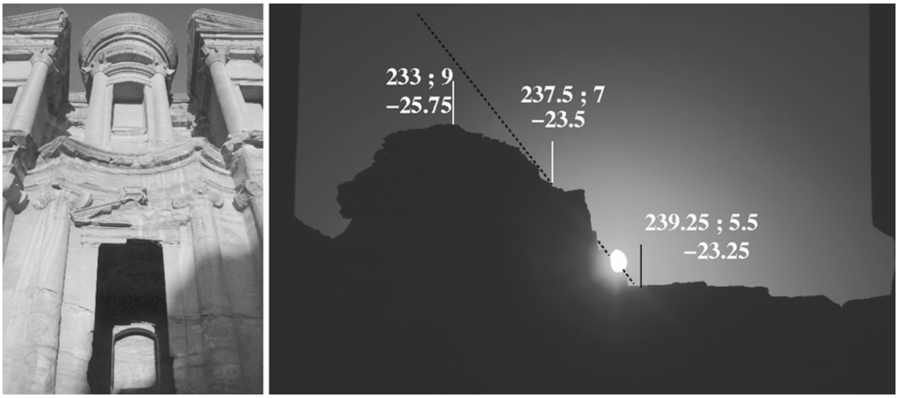

Fig. 6. Winter solstice sunset at Ad Deir: a, left) the light and shadow effect in the innermost sacred area of the structure, the *môtab*; b, right) the accurate solstitial phenomenology associated with the site. Dotted line corresponds to the path followed during winter solstice sunset by the upper limb of the sun for the first century B.C. Photos: J. A. Belmonte and A.C. González-García, respectively

On the one hand, fig. 6a shows the light and shadow effect produced at the interior of the monument at the moment of winter solstice sunset. The light of the setting sun entering through the gate of the monument perfectly illuminates the sacred area of the deep interior of the building where the *môtab* for the installation of the sacred *baetyls* is located. The effect is spectacular, and would have been observable only a week or so before and after the winter solstice. On the other hand, winter solstice sunset, as observed from the môtab itself, is produced in a most peculiar way on a rock with the aspect of the head of a lion – the sacred animal of Al Uzza – as shown in fig. 6b. At the present time, the sun sets at least twice, first on the axis of the monument, then re-appearing in the northernmost corner of the rock before setting the second time and disappearing. The phenomenon would have been still more impressive two thousand years ago, when the northern rim of the disk of the sun had a declination close to 23½°. We believe that this extraordinary ensemble of solar hierophanies, perhaps in combination with the visibility after sunset of other celestial bodies such as the Evening Star, clearly reinforces the idea that the Monastery was one of the most important sacred enclosures of the Nabataean realm. Ad Deir would have been the ideal place to celebrate, on dates close to the winter solstice, the birth of Dushara from his own mother-cum-consort Al Uzza, the goddess of fertility.

As mentioned above, the knowledge of the equinoxes was of particular importance to the Nabataeans, and may have been a key element for the control of a lunisolar calendar [Villeneuve and Al-Muheisen 2003]. Interestingly, our new data confirm the equinoctial alignment of the impressive Zibb Attuf, the "Pillars of Merciful" (fig. 2b), popularly known as the Obelisks. These giant carved markers could have been used to control time through the use of shadow casts at sunrise. However, in the mid-1990s [Belmonte 1999], the most inspiring equinoctial relationship was suggested for the Urn Tomb, the most impressive and better preserved of the so-called royal tombs at the western cliffs of Djebel Khubtha (fig. 2c) and the impressive mountain of Umm al Biyara (see fig. 1). This sacred mountain was very important for the Nabataeans, not only due to its unassailability, but also because it was the main source of water for the city (the Siyagh Spring, the only large permanent water supply in Petra, was located at its base).

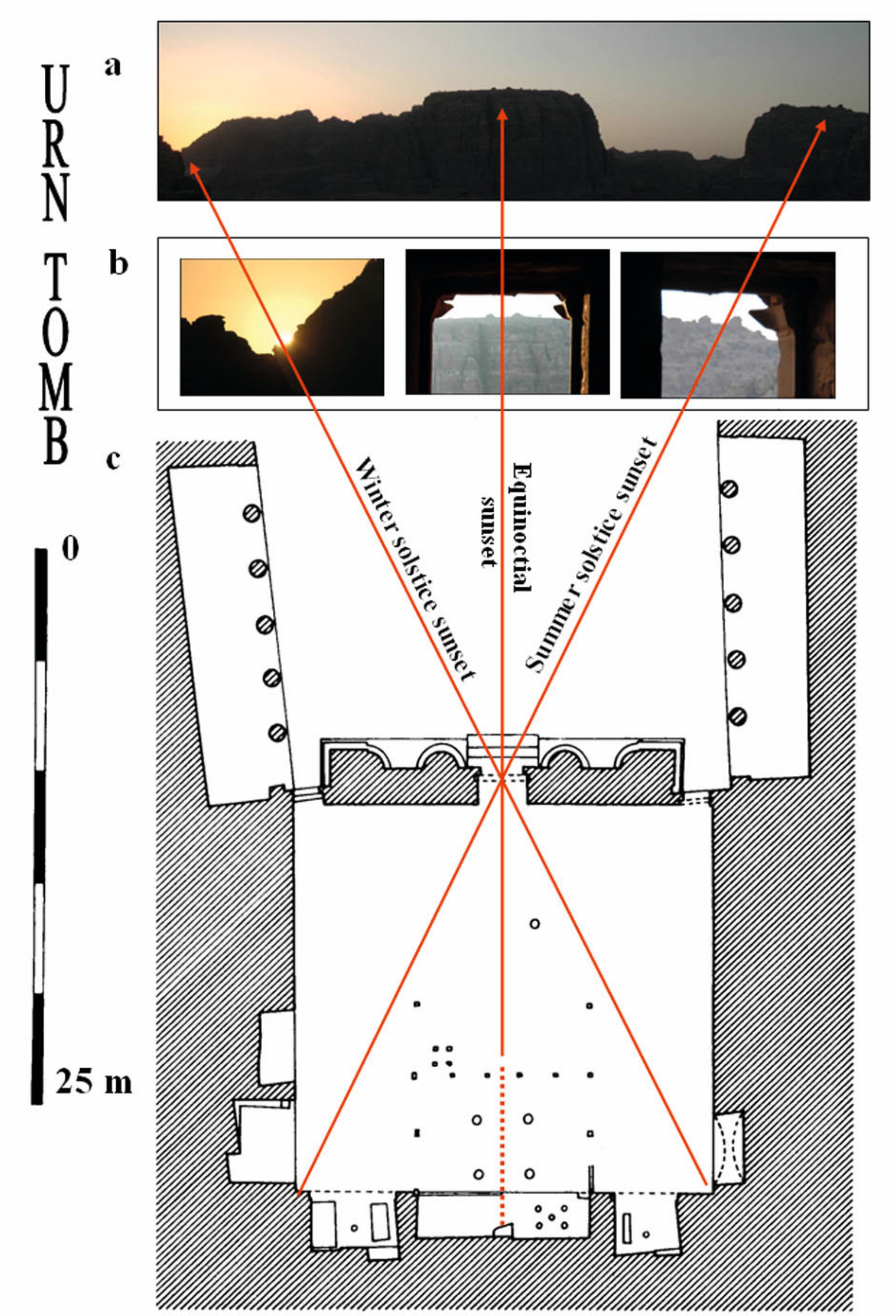

Fig. 7. Sunset phenomenology in the western horizon (a) related to the solstices and the equinoxes as seen from the Urn Tomb enclosure (b). Our data suggests that the site and the internal distribution of the monument were deliberately chosen with an astronomical objective in mind. Photographs by J. A. Belmonte; Urn Tomb plan (c) adapted from [Guzzo and Schneider 1997]

The royal tombs seem to have been built in that sector of Djebel al Khubtha where sunset at the equinoxes was visible over the top of Umm al Biyara. For example, the well-preserved gate of the Urn Tomb was centred at equinox sunset over the central part of that particular mountain. Our new data (see Table 1) plainly confirm this earlier result but to a much higher degree of sophistication.

This is demonstrated in Table 1 and fig. 7. The Urn Tomb has a quite elaborate design, with a large court in front of the structure and a big hall excavated into the sandstone of the cliff, suggesting that it was used not only as a tomb (perhaps of King Malichus II) but also as a place for other religious activities or festivals, possibly related to the cult of the dead, in apparent connection to the autumnal equinox. On 21 December 2011, sunset at the winter solstice was observed from the court in front of the Urn Tomb. During the sunset, the sun passed behind a conspicuous landmark in the distant western horizon. Most important, the last rays of the sun illuminated the northeast corner of the inner hall after crossing the main gate of the tomb. The phenomenon, in combination with the confirmed equinoctial alignment (see fig. 7), proved quite astonishing.

Sunset at the equinox took place between two distinct features on the summit of Umm al Biyara.[2] Surprisingly, our measurements (see Table 1) also indicate that sunset at the summer solstice occurs in between another couple of this kind of "natural" features further to the north in the distant western horizon and that this new alignment completes the symmetry of the main hall of the tomb (see fig. 7). This impressive set of three alignments within the plan of the tomb in combination with significant features in the distant horizon can hardly be ascribed to chance. We argue here in favour of a deliberate attempt to convert the hall of the Urn Tomb, whatever its actual purpose – certainly religious – into a kind of time-keeping device that would have been very useful in controlling time and the calendar, be it sacred or profane. We may conclude that this is the result of an original Nabataean design, considering the findings in other buildings commented on throughout the present paper.

Interestingly, Bishop Jason converted the Urn Tomb into the cathedral church of Petra on 24 June 446 A.D. [Fiema 2003]. We may thus suggest that this formidable enclosure, indeed a place with a sacred character, was selected as the new cathedral of the city because it included such notable grouping of alignments, so useful for Christian worship. The three alignments would have offered markers, of an excellent and precise nature, for the determination of Christmas Eve, on 24 December, Easter (through the observation of the spring equinox), and Saint John, on 24 June, precisely the date of consecration of the new cathedral.

Finally, Al Khazna, or Treasury (fig. 2d), is possibly the finest monument ever erected by the Nabataean kings. Located at a breath-taking position at the exit of As Siq, the narrow canyon that approaches the city from the east, it is the first large building that a visitor to Petra faces when entering the city through Siq. The discovery in recent excavations of what seems to be a couple of traditional burial chambers cut into the rock just below the impressive façade of the Treasury[3] has reinforced the idea that this magnificent monument was something more than a simple royal tomb. This fact suggests that, even if it was the tomb of an important king, such as Aretas IV, or the *heroon* of King Obodas – both alternatives are the most popular – it might have acted as a sort of sanctuary where the genius protector of the city, a manifestation of Tyche represented in the façade of the building, would have been venerated. In the well-known zodiac-stone found at the temple of Tannur, Tyche is represented dominating the scene and associated with a crescent of the moon (fig. 8). It is worth mentioning that the large cliff enclosing the Siq only makes it possible to see a very small section of sky at ~18° of angular height from the *sancta sanctorum* of the monument, thus breaking any solar alignment (see Table 1). However, bearing these considerations in mind, it is possible that lunar events could be compatible with the orientation and layout of the internal structure and the external decoration of the monument. This fact, provided it could be proven in the future, would reinforce the sanctuary nature of the building.

Fig. 8. A reconstructed plaster copy of the portrait of Tyche discovered at the temple of Tannur surrounded by the zodiacal signs. This is just one of the examples of astral symbolism in Nabataean relics. Original fragments at the Museums of Cincinnati and Amman. Photo: J. A. Belmonte, courtesy of the Amman Archaeological Museum

4 Conclusion

The statistical analysis of our sample of data, together with the analysis of the light and shadow effects confirmed in several monuments of the city related to the consistent use of the equinoxes, the solstices and perhaps other conspicuous astronomical features, undoubtedly points towards the importance of astral elements in Nabataean religion. These events could have been used to mark times of worship and, most important, to control a calendar, and certainly convert the city of Petra, "a place of awe-inspiring crystallization of natural beauty and the unique artistic creation of the Nabataean will" into "a gift from their gods, shaped by the supernatural and holding a holy meaning" [Jowkowski 2003: 214], as our work has started to unveil.

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Notes

1. Strabo, *Geographia* XVI, 4, 26.
2. It is not easy to ascertain if these two elements are purely natural, artificial, or natural but re-elaborated. A closer inspection of the mountain summit would be needed.
3. These excavations in the Khazna Courtyard were carried out by the Petra Archaeological Park (PAP) in the years 2003, 2004, 2005, and 2007. However, to our knowledge, no report of these findings has been published yet.

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About the authors

Juan Antonio Belmonte is a staff astronomer at the Instituto de Astrofísica de Canarias in Tenerife, Spain, where he has lectured on history of astronomy and archaeoastronomy and investigates in exoplanets, stellar physics and cultural astronomy. He has published or edited a dozen books and authored nearly 200 publications on those subjects. He was the Director of the Science and Cosmos Museum of Tenerife from 1995 to 2000 and President of the European Society for Astronomy in Culture (SEAC) from 2005 to 2011. He is advisory editor of the *Journal for the History of Astronomy*. In the last years he has been performing extensive research on the astronomical traditions of ancient civilizations, concentrating in the ancient Mediterranean cultures. Born in Murcia (Spain) in 1962, he studied physics and received his master's in 1986 at Barcelona University and his Ph.D. in astrophysics at La Laguna University in 1989.

A. César González García (Valladolid, 1973), Ph.D. in astrophysics (Groningen, The Netherlands) has held postdoctoral fellowships at the IAC (2003-2006 and 2010-2011) and the Theoretical Physics Department – UAM (2006-2010), where he has investigated the evolution of galaxies and archaeoastronomy (working on the possible astronomical orientation of megalithic monuments in central Europe). Since 2010 he is the holder of a *Ramón y Cajal* fellowship to work on cultural astronomy of Mediterranean cultures. He is now based at the Instituto de Ciencias del Patrimonio (Incipit-CSIC) at Santiago de Compostela (Galicia, Spain). He has been vice-president of the European Society for Astronomy in Culture since 2011. His main research lines are centred in three issues: modelling of the possible astronomical orientation of classical cultures; possible astronomical and landscape relations of Iron Age sanctuaries; the study of the orientation of ancient Roman cities.

Andrea Polcaro is contract professor of archaeology of the Ancient Near East at the Università di Perugia, Italy. In 2007 he defended his Ph.D. thesis on Oriental archaeology at the Università degli Studi di Roma "La Sapienza". His main research activities are archaeological excavations and surveys in the Near East and studies on ancient Near Eastern religions, with an extensive interest in archaeoastronomy. He has been member of the Italian Archaeological Mission at Tell Mardikh-Ebla, Syria, under the direction of Prof. P. Matthiae, since 1998. From 2004 to 2007 he was also a member of the expedition to Khirbet al Batrawy (Jordan) and of the archaeological surveys on the Bronze Age monuments at Wadi az-Zarqa, directed by the Prof. L. Nigro.