Chapter 9
The Archaeoastronomy and Chronology of the Temple of Jupiter at Baalbek

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Abstract The temple of Jupiter at Baalbek in Lebanon is one of the most complex architectural projects ever conceived. Several issues remain unsolved about this site; in particular, the relative chronology and the dates of construction of the two 'podia' of the temple are unsure, as well as the true nature of the cult of Jupiter practiced there. We present here a new architectural analysis based on the orientation and on other features of the temple, which clearly point to a unified project originally conceived under Herod the Great.

Introduction

The Temple of Jupiter at Baalbek (Heliopolis), Lebanon, is famous worldwide for its megalithic architecture (Segal 2013). Yet an impressive number of problems remain unsolved about this monument, including its precise dating, the phases of construction, and even the true nature of the 'triad' cult involving Jupiter, Venus and Mercury that is known to have been practiced at this place (Kropp 2009, 2010). From the point of view of the history of architecture, one of the problems is the absence of contemporary sources, but another is the uniqueness of the megalithic building technique.

The main features of the temple can be briefly described as follows (Fig. 9.1). The complex develops along a monumental axis comprising a hexagonal court and a huge platform with Propilea, both built by the Romans in the second century AD, together with the nearby temples of Bacchus and Venus. The Jupiter Temple proper is located at the end of the Propilea. Its final phase of construction—with the erection of the enormous columns almost 20 m high—is dated to the Julio-Claudian period (AD 40–60) due to a graffito left by one of the stonemasons, which mentions the date 2 August 60 AD. This was found on top of one of the column shafts, and construction therefore must have been almost finished by that date. The columns rest on a

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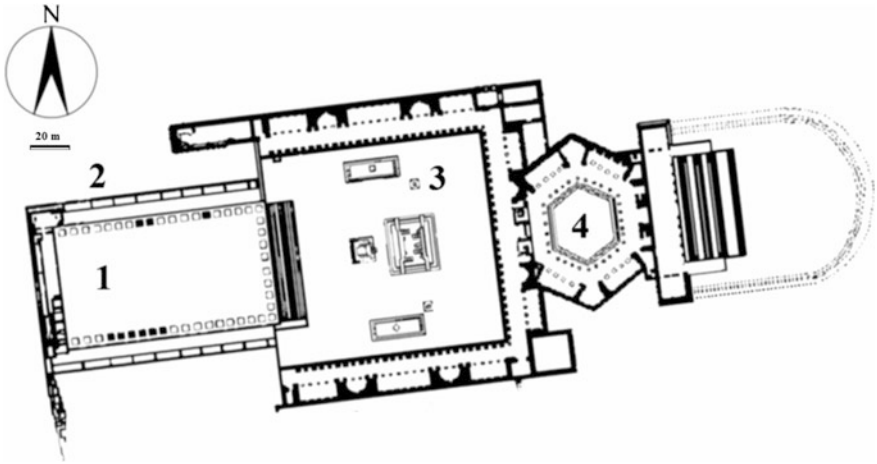

Fig. 9.1 Plan of the Temple of Jupiter at Baalbeck. (1) Podium I, (2) Podium II, (3) Propylea, (4) Hexagonal court

huge basement which, adopting the terminology of Kropp and Lohmann (2011), will be called Podium I.

At a distance of *a few meters* from Podium I runs a huge wall, 'Podium II', which is parallel to Podium I and surrounds it along three sides forming a giant U-shaped structure. This structure was originally built without any connection to Podium I whatsoever, as is apparent upon looking at its north-west side. The design is astonishing: it is constructed through the superposition of increasingly greater stones as the height increases. Big stones are in fact used at the base, but even larger stones are present in the second course, and huge megaliths (about 500 tons each) were used to build the third course. Finally, enormous blocks, each around $4 \times 4 \times 20$ m and not less than 800 tons, were to be placed in the uppermost course, but only the south-west side was completed, where the three famous stones that are usually called (somewhat inappropriately) the 'trilithon', were put in place. At least three other enormous blocks remain at the quarry some hundreds of meters to the south-west, including the largest of all, which has only recently been discovered (Abdul Massih 2015).

This construction technique is very strange indeed, because the use of pre-compression in megalithic masonry—namely, putting in place huger stone blocks near the summit instead of the base—is very well attested in antiquity but in polygonal courses, where it was used to 'frieze' stresses and therefore to strengthen the joints between the blocks lying beneath (see e.g. Magli 2006). Clearly such a trick does not work if the stones are placed on horizontal layers, as at Baalbek, so—although it may seem incredible—we have to conclude that only aesthetic reasons inspired the builders.

Who built the two podia, and when? The most accepted archaeological viewpoint was that the building belongs to the Julio-Claudian period, with perhaps two phases of construction. However, a recent architectural analysis of Podium I has shown

striking similarities with Herodian sanctuaries, such as the use of alternating rows of headers and stretchers and the presence of drafted-margin masonry. In particular, obvious similarities exist with the Herodian phase at the Temple Mount at Jerusalem, not only in general appearance, but also in proportions and measures. All in all, this new analysis leads quite naturally to the conclusion that Podium I was originally built by Herodian architects (Kropp and Lohmann 2011; Lohmann 2008, 2010). In this connection it should be noticed that Baalbek was not enclosed in Herod's reign; however, it was enclosed in the Roman colony of Berytus (Beirut), founded in 15 BC. Since this date, Herod is known to have been keen in showing his attention to the Roman possessions in the whole area.

So far so good for the date of the original construction of Podium I. There remains, however, the problem of dating Podium II which, as mentioned, is structurally unrelated to Podium I. According to Kropp and Lohmann (2011), it postdates the Herodian phase and was designed by the Roman architects to 'harmonize' the dimensions to Roman standards. The idea that the Roman builders, for whatever reason, decided to carry on a megalithic enterprise that had no antecedents whatsoever in the whole history of architecture, not to say the Roman one, is however frankly difficult to believe, especially if we take into account the well-known practical mentality of Roman engineers. It is thus the aim of the present paper to re-analyze the problem of the date of construction of the Temple of Jupiter. We will start from the point of view of modern archaeoastronomy (see e.g. Magli 2015), and therefore we will study the building within the sky landscape in which it was immersed, in strict connection with the historical context. As we shall see, our results will finally lead to a completely new hypothesis for the dating of Podium I, that supports the idea that both Podia were originally conceived together, within the context of a single-phase Herodian project.

Archaeoastronomy at Baalbek

Orientations of temples in the cultures of the Mediterranean have been widely investigated (see e.g. Boutsikas 2009; Belmonte et al. 2009) but to the best of our knowledge the orientation of the Baalbek temple has never been studied.

The area is quite well covered by satellite imagery and as a consequence from satellite data (Google Earth and Bing) both the azimuth and the horizon height (from inside looking out) can be determined with good approximation (say to within 0.5° for both). The results are azimuth 75° 30′, horizon height 5°. Using the program getdec (kindly provided by Clive Ruggles) which takes into account refraction, at the latitude of Baalbek these data yield a declination of ~14° 44′. This declination is within the solar range: the Sun therefore rises in alignment with the temple twice a year, around 1 May and 12 August (Gregorian; up to the second century AD the difference with the Julian was negligible). These dates of course are not of special significance for the solar cycle, and this may be seen as a confirmation of already existing doubts (Kropp 2010) about the true solar character of the 'Heliopolitan' (*sic*)

Jupiter. The dates are not close enough to days of special significance in the Roman calendar either. For instance, the foundation of Rome on 21 April is known to be referenced in Roman architecture (Hannah and Magli 2011) but the movement of the rising Sun along the horizon at the end of April is too fast to think this could be an orientational error. Also, these dates do not match anything significant in the Hebrew luni-solar calendar, as the closest important event is Passover which however never extends to the end of April.

The orientation does not match any recognizable pattern for comparable temples either. In fact, the orientations of the other three main temples of Zeus in the region, namely Kanawat, Damascus, and Gerash, are as follows. The Kanawat temple points almost to true north (azimuth 4°, horizon flat or nearly flat). Interestingly, the building is very clearly directed to the center of Philippopolis, which lies some 10 km to the north and was probably planned a few decades later, using the temple as a landmark. The temple of Damascus (azimuth 85°, horizon nearly flat) has a generic solar orientation which however conforms to the orthogonal grid of the town. Finally, the huge sanctuary of Zeus at Gerash has been measured on site by González-García et al. (2016). According to their data (azimuth 54°, horizon height 3° 30′, declination +31° 30′) the temple is out of the solar range and not far from the maximal northern standstill of the Moon, a possibility that certainly deserves further research but which in any case does not match Baalbek. Last but not least, the Baalbek azimuth is not governed by the topography either—the huge platform was oriented exactly where the builders wanted it to be, without any geological constraints.

If we exclude chance, the only remaining possibility is a stellar alignment. To investigate this possibility we start by analyzing the sky at Herod's time. It is then seen that a rather important celestial object was rising in alignment with the temple: the Pleiades. Of course the Pleiades are an asterism, not a single star (seven stars can be distinguished with the naked eye); however, they can be considered (and were considered in antiquity, since the time of Hesiod in the Greek world) as a single entity spanning ~0.5° in declination. Their declination in Herod times was between 15° 30′ and 16° (for instance, the star Alcyone in 15 BC had a declination of 15° 50′). The agreement with the temple declination is therefore good, and the horizon height which corresponds to the temple front assures that the asterism was really visible (stars are not visible until they are at a height at least comparable to their magnitude in degrees).

Interest for the Pleiades is well documented in Greek religion; for instance, the role of this asterism has been shown to be fundamental to the rites at the Artemis Orthia sanctuary in Sparta (Boutsikas and Ruggles 2011; see also Boutsikas and Hannah 2012 for the role of the Hyades at Athens' Acropolis). Is it possible to associate the Pleiades with the Heliopolitan Jupiter? The pre-Roman history of the God is uncertain, but the iconography is well attested from the Roman period and from the unique written source we have about Baalbek, the Saturnalia dialogues of the fifth-century author Macrobius. The cult image of Jupiter represented a young, unbearded God, bringing a huge vase-shaped top hat (Kalathos). The God usually brings also grain ears and a whip, and is accompanied by two walking bulls. The

Heliopolitan Jupiter thus had the clear attributes of a God of fertility. In this connection, the orientation to the Pleiades becomes more understandable. Indeed already in the Hesiod calendar (eighth century BC) the harvest time of the cereals was indicated by the heliacal rising of Pleiades which occurred in the first week of May. Taking into account the shift in time but also that in latitude, this date does not change substantially in Baalbek. Indeed, we can estimate the date of the heliacal rising at the end of the first century BC in Baalbek using planetarium software (here we use Starry Night Pro 8) and considering that a star of magnitude M starts to be visible when it is separated from the Sun by about 4 M°, that is, the star is at M degrees when the Sun is under the horizon at least 3 M°. Assuming the magnitude of the Pleiades—considered as a single object—to be around 1.6, we can see that these conditions are satisfied around 5 May. Interestingly enough, therefore, the alignment of the temple approximates the direction of the heliacal rising of the Pleiades, and that of the rising Sun a few minutes later, on the same days: a quite peculiar coincidence.[1] In this connection it may further be noted that beforehand on the same nights, one could see in the very same direction the rising of the constellation Aries (the declination of the star Hamal was ~13°) a constellation associated with spring and renewal as well (a direct association of Aries with Zeus also probably existed at those times, but it is securely documented only in the case of Zeus-Ammon, the horned God of Egyptian origin which is not present at Baalbek).

Discussion and Concluding Remarks

As a matter of fact, the Pleiades appears to be the unique feasible explanation for the orientation of Baalbek's Temple of Jupiter. Due to the precession of the Earth's axis however, the declination of each star slowly and continuously changes. In the case of the Pleiades, the alignment at Baalbek worsened slight with time: for instance in AD 60 Alcyone had a declination of 16° 15′. A corresponding slight deviation of the axes of Podium II with respect to Podium I might thus have provided a clue to its dating, but this is not the case. Thus, we are led to think either that the builders of Podium II were interested only in the solar alignment for reasons we do not know, or a new possibility: contemporaneity of construction of the two Podia. To show the feasibility of this latter hypothesis we will proceed *ab absurdo* by showing the weakness of the other two possibilities.

The first hypothesis (which prevails in non-scholarly publications) is that Podium II predates Podium I. It is easy to see, however, that any sensible architect willing to build Podium I after Podium II would have used it. Only a fool would construct

[1] It should, however, be noted that the dates of Heliacal phenomena are always difficult to identify in a precise way. In particular, a more prudential estimate (by increasing the distance in height from the Sun, or by decreasing the assumed magnitude of the asterism, or both) would lead to shift the date later in May.

ex-novo a huge basement, oriented in the same way and accurately placed just a few meters inside the existing wall, without taking advantage of it as a ready-to-go, tremendously stable and affordable structure.

This observation, at least in the author's view, clearly dispatches the "Podium II predates Podium I" theory. Also the second possibility, that Podium I predates Podium II, is quite problematic. As mentioned, it implies that the style of Podium I was not acceptable to the Roman standards and therefore in Julio-Claudian times the Romans opted for the enlargement of the building (Kropp and Lohmann 2011). However, again, any sensible architect willing—for 'stylistic' reasons that, at least to the present author, seem quite weak on their own—to enlarge Podium I up to the dimensions of Podium II, would have used the pre-existing structure and expanded the basement up to the desired dimensions. Constructing ex-novo a self-standing, gargantuan megalithic wall is almost as illogical as the one implied by the inverse chronology.[2] Accordingly, I propose here that the absence of structural connection, and simultaneously the strict parallelism, between the two Podia can be explained much better if the structures were planned together (but a possible explanation for the fact that they were not constructed as a connected building will be given below).

In accordance with the Herodian dating proposed by Kropp and Lohmann for Podium I, I propose that the whole project was conceived under Herod the Great. In this respect it should be noted that strict architectural analogies with the Herodian architecture at the Temple Mount do hold also for Podium II. In fact a wall made of gigantic stone blocks has been unearthed in the tunnels along the western side of the Mount (Bahat 1994; Ritmeyer 1992). These blocks show beyond any reasonable doubt that megalithic masonry was in the minds, and within the abilities, of Herodian stonemasons: the largest known of the Herodian blocks in Jerusalem is indeed $13.7 \times 3.2 \times$ (probably)3 m, and weighs about 570 tons. Furthermore, the wall in itself is very similar to that of Baalbek's Podium II; for instance, the hugest stones are set over courses of smaller blocks.

Why did Herod's architects built Podium II as a disconnected unit? A possibility is that they wanted to form a U-shaped gallery encircling the sides of the temple. The function of the back gallery might have been related to the cult, perhaps to exploit oracular rites. The gargantuan project remained unfinished and, in particular, the builders did not succeed in completing the exterior side walls transporting the missing megaliths, so the construction of the vaults did not begin. As a consequence, the megalithic wall remained as a sort of (at this point really anti-esthetic) curtain and this explains why at the Julio-Claudian stage it was decided to fill it with blocks of

[2]The presence of Roman sketch engravings of the temple pediment on one of the blocks of the Trilithon has been claimed as a proof of contemporaneity. Of course it is not: the Roman architects used to sketch their projects on pre-existing monuments, for instance on the paved floor in front of Augustus mausoleum a precise drawing of Hadrian's Pantheon pediment can be seen. Another proof should be that in the lower course of Podium II a piece of a column drum was used instead of a block; however—if it was not a Arab repair—the small piece does not appear to belong to the huge columns of the Julio-Claudian phase and may come from the Herodian temple.

stone. The temple we can see today is the final result of the Arab conversion of the building in a fortress, with walls built with second-use blocks.

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