CHAPTER 8

ASTRONOMY, LANDSCAPE AND SYMBOLISM: A STUDY OF THE ORIENTATION OF ANCIENT EGYPTIAN TEMPLES:

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Summary: For various reasons, Archaeoastronomy has not been one of the favourite disciplines of Egyptologists in the past. Probably because of this, important questions such as the orientation of Egyptian temples and the relevance of astronomy in this respect had never been afforded with the requisite seriousness and depth. The Egyptian-Spanish Mission for the Archaeoastronomy of Ancient Egypt has, among its various priorities, the solution of this problem. In order to achieve this, we have so far measured the orientation of some 330 temples in the Valley, the Delta, the Oases and the Sinai. The aim is to find a correct and almost definitive answer to the question of whether the ancient Egyptian sacred constructions were astronomically aligned or not. Our data seem to answer this question in the affirmative. In addition, they offer a very interesting new perspective both in chronology and in the field of landscape archaeology, a new discipline in which few have engaged so far in Egypt, and in which terrestrial landscape, dominated by the Nile, and celestial landscape, dominated by the sun and the stars, combine in order to permit the establishment of Ma'at, the Cosmic Order, on Earth.

8.1. Introduction

Les architects tenaient compte avant tout du terrain et des commodités d'accès. Nos textes suggèrent au contraire qu'ils se déterminaient par l'état du ciel, sans entrer dans le détail des opérations

P. Montet. 'Le rituel de fondation des temples Égyptiens'. *Kemi* (1960)

Were the temples of the ancient Egyptian civilization astronomically orientated? This is a very important question that, as the above quotation emphasizes, is far from being resolved. Recently, Richard Wilkinson, in his useful *The complete temples of Ancient Egypt*, clearly stated that *most commonly temples built along the Nile were oriented on an east-west axis, according to local cardinal directions as determined by the river*, so local topography would be the determining reason for temple orientation. However, he also pointed out that *on occasions, orientation towards the sun or important stars was definitely the priority, and this principle may be more important than is often recognized*. Indeed, it is the main goal of this chapter to show that the *most commonly* is certainly true (see Figure 8.1.) but that *on occasions* is far too restrictive and that solar (see Figure 8.2) and stellar (see Figure 8.3) orientations were much more common in ancient Egypt than had previously been suspected.

As has been explained in Chapter 7, the ground plan of a temple (or at least its four corners), including the orientation of its main axes, was normally established in a ceremony known as the "stretching of the cord", records of which exist as early as the 1st Dynasty. The first depiction of the ritual dates from the reign of Khasekhemuy, last king of the 2nd Dynasty (c. 2750 B.C.). The ceremony is represented on several occasions throughout Egyptian history but only in the Graeco-Roman period do the associated inscriptions clearly refer to the way in which the axis was placed.

Figure 8.1. Image of the Nile from the necropolis of Beni Hassan. The land of Egypt is organized according to the river. Indeed, this was probably the situation thousands of years ago. Photograph by J.A. Belmonte.

Figure 8.2. Today, as 3350 years ago, the colossi of Mennon still face sunrise at the winter solstice as did the Million year temple of King Amenhotep III behind them. Photograph courtesy of M. A. Molinero and N. Delgado.

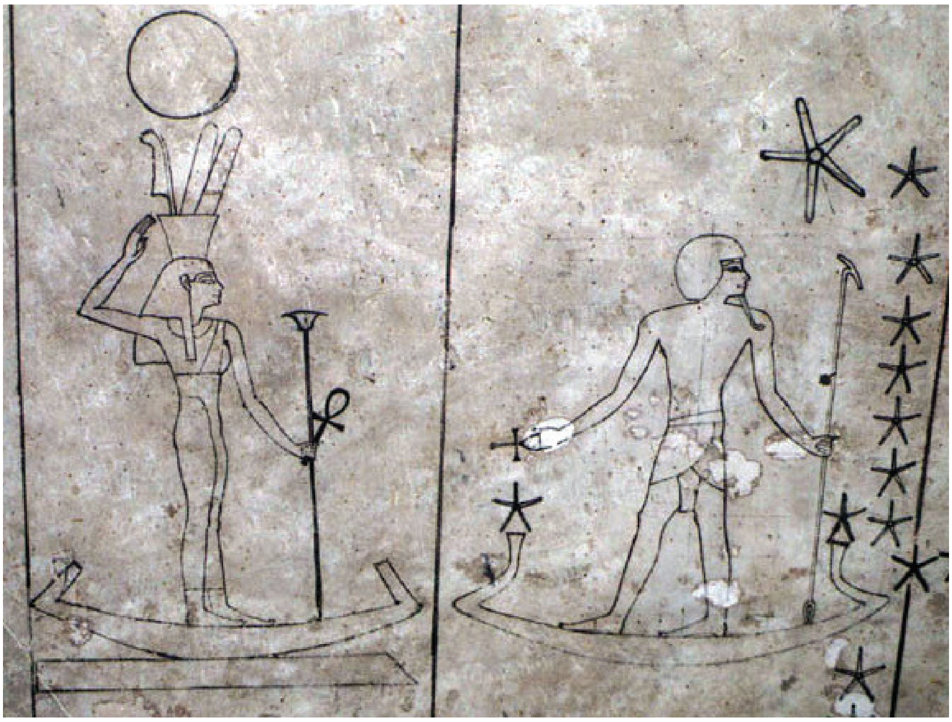

Figure 8.3. The goddess *Sopdet* standing for Sirius, the brightest star of the Egyptian firmament, and the god *Sah* (southern part of Orion), as beautifully depicted in the astronomical ceiling of the tomb of Senenmut in Deir el Bahari. Several ancient monuments were presumably orientated towards Sirius in the geography of Egypt. Photograph by J.A. Belmonte.

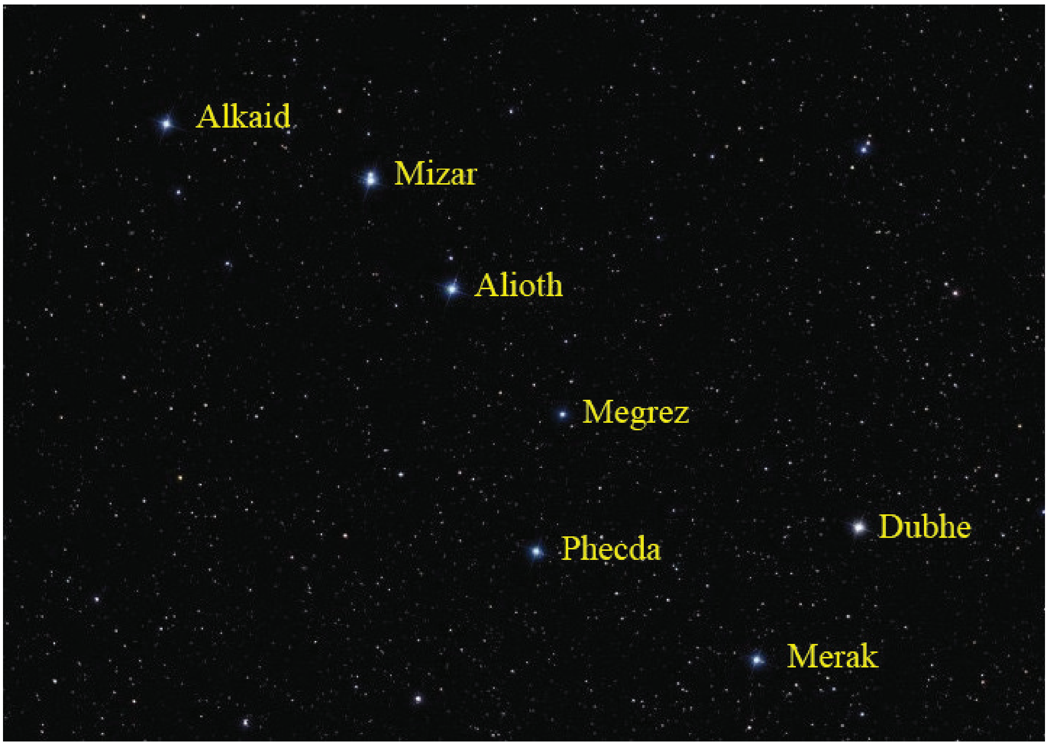

Figure. 8.4. The seven bright stars of the ancient Egyptian constellation of *Meskhetyu*, the Bull´s Foreleg, undoubtedly identified with the asterism of the Plough. We will defend in this chapter the importance of the observation of different configurations of this celestial object in temple orientation. Image adapted from a photograph courtesy of A. López.

The earliest inscriptions are written on the walls of Horus' temple in Edfu, whose foundations were settled in 237 B.C. The texts are unanimous, the King was looking at *Meskhet(yu)*, the Bull's Foreleg, the asterism of the Plough (see Figure 8.4). So for the Egyptians, at least of later periods, the orientation procedure was astronomical, in apparent contradiction of the opinion of most specialists so far.

This fact has been well known since the 19th century when the inscriptions at Edfu were first studied and translated by Brugsch and one would have expected that a close collaboration between (archaeo)astronomers and Egyptologists would have been established. However, this potentially productive synergy never took place. We could raise the question of why and the answer, or the blame, can probably be attributed to a book, *The Dawn of Astronomy*, published at the end of the 19th century by an otherwise reputable astronomer. This volume was written by Sir Norman Lockyer, the first editor of the journal *Nature* and is considered today by several archaeoastronomers worldwide as the founding work of their discipline. Throughout the text the author made extensive use of precession in dating temples in Egypt, and basically supported the accepted long chronology of his time, which placed the 1st Dynasty around 4500 B.C. The book also included a high degree of religious speculation which earned it the opprobrium of most Egyptologists of his time (see Chapter 3). When the long chronology lapsed at the beginning of the 20th century, any possibility of archaeoastronomy as an auxiliary science of Egyptology died with it.

For example, the magnificent *Egyptian Astronomical Texts* by Neugebauer and Parker do not mention a single word on orientations and Badawy, in his study on Egyptian architecture, suggested in his analysis of the plans of some 40 temples that their orientation was probably random. It was not until the last quarter of the 20th century that the works of Gerald Hawkins, widely promulgated by the reputed archaeoastronomer and outreach specialist Edwin Krupp, who also carried out his own restricted fieldwork, re-opened the question, but there was still a failure to rouse any sort of enthusiasm about ancient astronomical practices among the Egyptological community. Indeed, it is hard to see the important early work of archaeoastronomers, such as Krupp's "Light in the temples", mentioned in the literature of Egyptology. On the contrary, the old fashioned and out-of-date work of Lockyer is frequently referenced in order to criticize it.

Recently, Clagget's pivotal volume can be considered as a point of inflexion in the discipline. However, yet again, archaeoastronomy and its scholarly possibilities have not been properly explored. As an example of this, we can mention that in the 27 volumes of the former *Archaeoastronomy* supplement of the *Journal for the History of Astronomy*, published between 1979 and 2002, only two papers dealt with astronomical alignments of Egyptian monuments and both were in relation to the pyramids, not to the temples.

This was the situation we found at the beginning of the 21st century when we decided that this situation ought to be rectified. To achieve this, the authors joined efforts and inaugurated a project with the main objective of putting the study of ancient Egyptian archaeoastronomy on the footing it deserves in the context of present-day Egyptology. An Egyptian-Spanish Mission was created under the auspices of the Egyptian Supreme Council of Antiquities with the aim of measuring the orientation of the vast majority of ancient buildings, notably the temples, across Egypt, within a reasonable period of time. The purpose was to obtain sufficient fieldwork data that could prove, or disprove, through statistical studies, all the speculations concerning temple orientation from both the topographical and the astronomical point of view.

Hence, during the last five years, our mission and its collaborators has been performing an ambitious scientific project with the aim of studying the cosmovision of the ancient civilization of the pharaohs. Part of the project has consisted of a re-analysis of the iconographic and historical sources that has allowed, among other things, a reassessment of the calendar theory (see Chapter 4), challenging old-fashioned paradigms, or a new proposal for the sky-maps of ancient Egypt (see Chapter 6).

Indeed, the most expensive part of the project, in time, effort and resources, has been the five campaigns devoted so far to measuring the orientation and studying the spatial location of ancient monuments across the Nile Valley and beyond. More than 500 pyramids, hypogea, chapels, sanctuaries or small and large temples have been measured so far. The fieldwork in successive campaigns was organized geographically but also with the intention of testing previous results with new exercises. Accordingly, the first campaign was devoted to Upper Egypt, the second to Middle Egypt, the third to the Oases of the Western Desert, the fourth to Lower Egypt, and the fifth with the fundamental aim of completing the sample and making some further tests. Four successive papers (Shaltout and Belmonte 2005, Belmonte and Shaltout 2006, Shaltout, Belmonte and Fekri 2007, and Belmonte, Shaltout and Fekri 2008, hereafter Papers 1, 2, 3 and 4, respectively) have been published about the temples in which, stage by stage, we have analysed the relationship of temple orientation and their location within the local landscape, understanding landscape in its broadest meaning of both terrestrial (basically the Nile) and celestial (astronomical orientations) aspects. Our studies demonstrate that both components were necessary and indeed intimately correlated (see Figure 8.5).

Figure 8.5. Astronomy and landscape. The location of two important sacred sites in Upper Egypt may have been determined by the presence of a double astronomical-topographical alignment, combining astronomy and landscape. Karnak would have been located at a particular place in the valley where the winter solstice sunrise was perpendicular to the course of the Nile. Dendara would have been located at a place where the river flow came from the direction where the heliacal rising of Sirius, harbinger of the flooding, was observable. In the Graeco-Roman Period, the perpendicular to this line signalled the *3ḫ* of *Meskhetyu*. The temples erected at these places had their orientations selected accordingly. See the text for further discussion. Adapted from an image courtesy of Google Earth.

Figure 8.6 shows the location of the sites where we have assembled the data of the temples during the five campaigns. We have taken measurements in almost every archaeological location within Egypt, visiting not only extended areas such as Luxor or Memphis but also isolated monuments in the middle of nowhere, such as Serabit el Khadim in Sinai or the lost city of Mons Claudianus. This includes very well preserved temples, such as the one of Horus in Edfu (see Figure 8.7), or monuments where just a few walls of the foundations were visible. The orientation has always been taken from the inside looking outside, from the sanctuary of the temple to the gate, often across several halls, courts and pylons. In a few occasions, the opposite direction has also been considered or even the perpendicular to the main axis.

Figure 8.6. Map of Egypt showing the location of sites, from the Western and Eastern Deserts to the Nile Valley, where the orientation data yielded by our five field campaigns have been assembled. Dots stand for sites with just one or a few (two or three) sanctuaries on site. Ellipses stand for imposing archaeological sites where several temples, sometimes as many as ten, could be measured within a single location.

Figure 8.7. The pylon of the temple of Edfu. This temple was aligned in a stretching of the cord ceremony in August 23rd 253 B.C. during the reign of Ptolemy II, a 6th lunar day, according to the texts inscribed in the temple walls. During the ceremony, the king was looking at *Meskhetyu*, possibly at the lower culmination of a star of this asterism, permitting a temple orientation close to, but not exactly at, the Meridian line. Photograph by J.A. Belmonte.

We wish to stress clearly that we were not seeking for extreme-precision alignments. Our main task was to measure as many sacred buildings as we were able to, giving a similar weight to those exceptionally well preserved as well as to temples where not more than a few walls are visible on site. Bearing this in mind, and considering the large number of monuments to be studied, we obtained our measurements using a high precision compass, correcting for local magnetic declination and a clinometer, both as isolated instruments or enclosed within a single tandem device. Magnetic alterations are not expected in Egypt, where most of the terrain is limestone and sandstone. In any case, the temples were mostly measured along their main axis, from inside the sanctuary to the outermost gate and, on several occasions, in the opposite direction checking for possible alterations of the measurement.

The instruments permit a theoretical ¼° precision for both kinds of measurements. However, owing to various considerations, an error close to ½º in both azimuth and angular height is probably nearer to reality. This would signify a mean error of the order ±¾º in the determination of the corresponding declination, the reference astronomical magnitude. We can affirm without fear of being grossly in error that, for the latitudes of

Egypt, a precision of ½º is perhaps the best we can expect in solar, lunar or very bright star observations near the horizon and, in the case of fainter stars, the errors in estimating the azimuth can range from more than one to several degrees. As a matter of fact, and according to our own experience, we consider our altazimuth data to be of good enough quality to pursue our main quest, i.e. to demonstrate the importance of certain customs of astronomical alignments in ancient Egypt. In the case that any one temple or a certain pyramid complex may deserve further study, in order to test further developed theories in terms of seeking greater precision in the corresponding alignments, theodolite measurements can always be planned if necessary. Besides, on several occasions, in situ observations have been performed in order fully to appreciate the impacting effects of some of the discovered hierophanies. These are frequently illustrated within this chapter.

Two questions that we have frequently been asked in the last few years are on the one hand, why have we not used standard plans to take the measurements? And on the other, why not use the facilities of Google Earth? Both possibilities would have saved effort and indeed a lot of funds. However, neither of the two offers the second necessary datum to perform archaeoastronomical studies, the angular height, nor offers the possibility of in situ analysis of the surrounding landscape. This is absolutely crucial to contextualize the data. Besides, archaeological plans often suffer from deterrent inaccuracies or defects, confusion between magnetic and geographic north being the most frequent, while proxy high resolution Google Earth images (only available in the last two years for some places in Egypt) suffer from parallax and must be treated with extreme caution. As a consequence, fieldwork is indeed necessary to obtain the correct answers to our requirements.

8.2. Discussion

In our five campaigns, we have completed a sample of 330 temples of ancient Egyptian culture in Egypt herself. We have made a revision of most of the relevant archaeological literature and this sample contains data of more than 95% of all the temples to be found nowadays in Egypt. The exceptions are minor temples at faraway sites (such as Sekait or Nugrus) or at some places that were out of the main routes and could not be studied for lack of time (for example the temples at Tihna el Gebel, to the north of El-Minya). However, even with those minor exceptions, we consider our sample to be statistically representative beyond any doubt and we are convinced that new data will only serve to reinforce our results.

Figure 8.8 presents the orientation histogram of all our data as presented in the corresponding Tables 1 of Papers 1, 2, 3 and 4 (see also Appendix II). The histogram presents relative frequency versus azimuth and clearly shows two peaks which are statistically significant at 91¼º and 117º. The first is connected with east and we will further discuss it extensively. The second is the azimuth for winter solstice sunrise at the time of the pharaohs for latitudes near ancient Thebes (*c*. 26ºN). The following peak at 102½º corresponds to a declination of −11¼º for the average latitude of Egypt. Then two peaks at 134¾º and 45º surely correspond to NE and SE directions of the compass. We will demonstrate in this chapter that all these azimuths have an intrinsic astronomical meaning.

Hence, the simplest analysis of our data, the rough plotting of azimuth versus relative frequency positively answers the question that was the basis of our project, whether the temples of ancient Egypt were astronomically orientated or not. However, the answer is not always as simple as it looks and we will go further in our discussion proposing a series of exercises that will permit us to demonstrate: that the Nile also played a critical role in the orientation of the temples (8.2.1); that certain families of orientations, as first defined in Paper 3, can be confirmed and further developed (8.2.2); that certain customs remain constant in time and space but others either evolved, or appeared and disappeared along Egyptian history (8.2.3); and finally, that ancient Egyptians were probably unaware of the phenomenon of precession, at least until Greco-Roman times, and of the variation of the obliquity of the Ecliptic, but that a few building orientations might reflect these physical realities. This will be analysed in the case studies.

8.2.1. ***Testing Nile orientations; the null hypothesis***

The majority of Egyptologists have traditionally considered ancient Egyptian temples to be orientated in relation to the Nile. On several occasions, this preconceived notion has precluded any serious or systematic attempt on the part of the Egyptological community to study the orientations of the temples, and most efforts up to a few years ago had come from dedicated archaeoastronomers, like Hawkins or Krupp, whose conclusions were not always assimilated. Indeed, during our fieldwork in the last few years we have heard this opinion several times, even being asked by some reputed scholars why we were devoting so much efforts to a question that was crystal-clear. To be fair, we must also mention that Egyptologists on site have received us with open arms on several occasions and have been enchanted with our work, arguing that this was indeed a job that needed to be done. So, from the very beginning of our project, one of our primary objectives has been to test the Nile hypothesis in order to check if so many scholars could be wrong. In Paper 1 we demonstrated that they were indeed correct and that in Upper Egypt the Nile was the main source of "inspiration" for orientating sacred buildings, but that it was not the only one. In Paper 2 we tried to falsify the Nile hypothesis by performing fieldwork in a land with no river, the Oases of the Western Desert, and we found that when the Nile is absent, astronomical orientations certainly dominate the situation. Figures 8.9 and 8.10 repeat those exercises but with a larger amount of additional data obtained in later campaigns.

Fig. 8.9 shows a histogram where the difference between the orientation of the temple and the course of the Nile versus frequency is presented. The histogram has been produced with the data of 170 temples in Upper, Middle and Lower Egypt, with the particularity that in the Delta the difference is with respect to the closest river branch. The plot clearly demonstrates that temple orientation with the main gate located in front of (axis perpendicular to) the Nile is the most common way of orientating the buildings. Furthermore, axes nearly parallel to (at ~0º or 180º) or perpendicular to the river, but facing the other way (~270º), were also common. This demonstrates beyond any reasonable doubt that local topography (the course of the Nile) was very important at the moment of laying the foundations of the temples.

In contrast, Figure 8.10 shows the orientation diagram of 95 temples in the deserts and oases of Egypt, where there is no river to justify the orientation but the Egyptians were able to construct superb monuments (see Figure 8.11). The diagram shows the typical form of a Maltese Cross which is probably related to a certain preference for solar and cardinal orientations that could not be obtained without a celestial reference. As a matter of fact, the answer to the controversy is fascinating: both hypotheses are certainly correct. This is what we have observed during this research and demonstrated in previous works on the topic, notably Papers 1 to 4. Moreover, we are almost convinced that certain places throughout Egypt had an especially sacred character because they presented double (topographic and astronomical) alignments, such as Karnak or Dendara (see Fig. 8.5), and some customs, like the selection of cardinal or quarter-cardinal orientations in certain regions, will follow a similar line of reasoning.

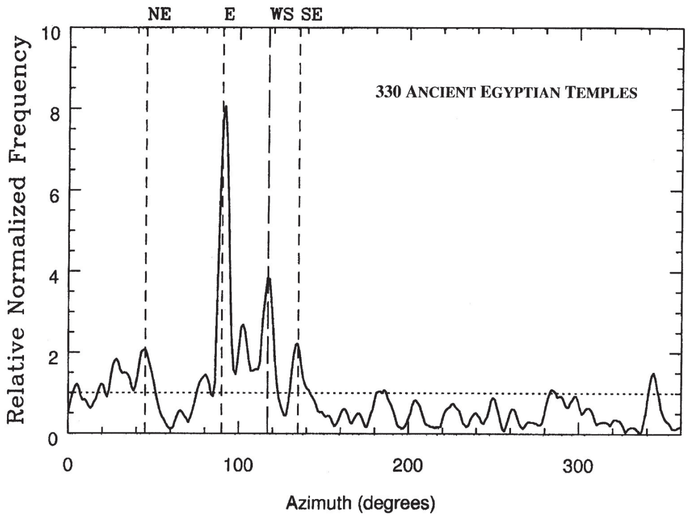

Figure 8.8. First test of the astronomical hypothesis. Orientation (azimuth) histogram of the 330 temples measured during our five campaigns in Egypt between February 2004 and December 2006. Although there are temples orientated to each sector of the horizon, there are obviously clear preferences with statistically significant peaks at near due-East ("equinoctial" sunrise and/or due-north orientations later skewed by 90º) and winter solstice (WS) sunrise. There are also clear peaks at NE and SE. These are indisputable evidences of intentional astronomical orientations. See the text for further discussion.

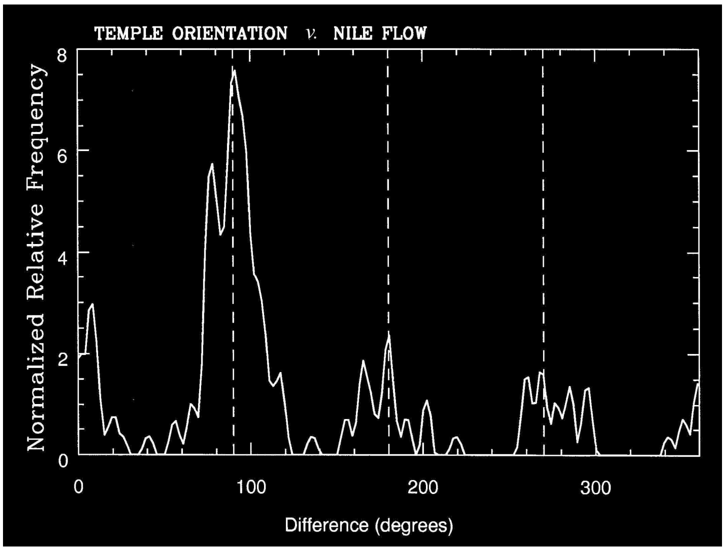

Figure 8.9. Testing the Nile hypothesis. Histogram representing the difference in orientation between the main axes of 170 temples of the Nile Valley and the average course of the river (or river branch in the case of the Delta) at their corresponding locations, for an interval of ±1º, larger than our estimated error of ½º, allowing for probable historical changes in the river flow. Temple orientation with the main gate located in front of (axis perpendicular to) the Nile is the most common way of orientating the buildings. Axes parallel to (at ~0º or 180º) or perpendicular to the river, but facing the other way (~270º) were also common. This demonstrates beyond any reasonable doubt that local topography (the course of the Nile) was very important at the moment of settling the foundations of the temples but was not the only factor to be considered. See text for further discussion.

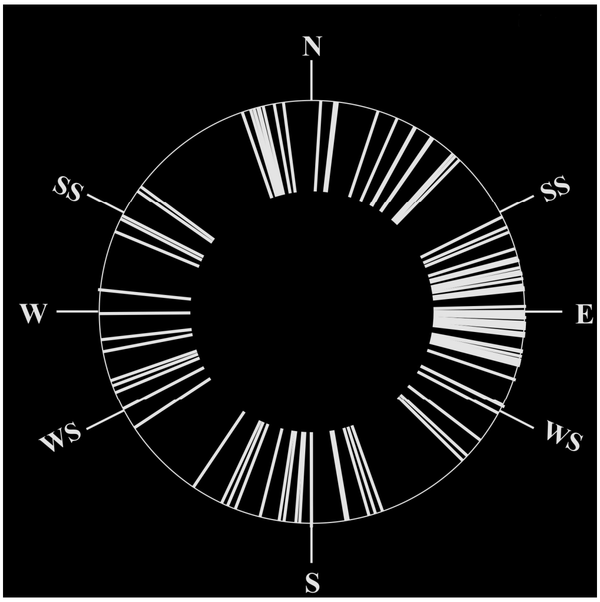

Figure 8.10. Falsifying the Nile hypothesis. Orientation diagram of the data assembled for temples measured outside the Nile Valley, where the river influence would be absent. Notice the Maltese Cross form of the diagram typical of astronomical orientations with a preference for cardinal and solar orientations.

Figure 8.11. The splendid location of the temple of the Oracle of Amon at the acropolis of Aghurmi, in the middle of the palm-tree forest of the Oasis of Siwa. Photograph by J. A. Belmonte.

8.2.2. *Challenging new hypotheses; astronomy in action*

In Paper 3, we proposed for the first time in the study of ancient Egypt that a number of families or patterns of orientations of ancient temples could be identified. We defined seven families, namely: the "equinoctial" or eastern family (I), the solstitial family (II), the seasonal family (III), the *Sopdet* family (IV), the Canopus family (V), the Meridian family (VI) and the (mid) quarter-cardinal family (VII). These were the result of an analysis performed to the histogram of the absolute value of the declination of only 90 monuments, mostly of Lower Egypt. Indeed, it was worth repeating the exercise with our complete sample of 330 temples.

Figure 8.12 presents the result of the experiment where the histogram of declinations is presented. The declination is an astronomical magnitude which is more useful than the azimuth because it is independent of the location of the observer. Eleven peaks are easily identified in the diagram. It is fascinating that these peaks correspond to the seven families of our preliminary identification using a much smaller sample of monuments (only 28% of the present one). Peak I can be associated with due-east and could be catalogued as “equinoctial”. We have a significant peak at −24º associated to winter solstice afterwards. A peculiar related peak II⊥ will be further discussed later on. Then follow the accumulation peaks (VI+ and VI–), representing the cardinal family, and those of the quarter-cardinal family (VII+ and VII–), respectively. We then have a couple of peaks (III+ and III–) at ~±11¼º, the negative one being the most relevant. It mostly corresponds to temples facing an interval of declination between −10½º and −12º. These are the declinations of the sun at dates in the vicinity of February 20th and October 22nd and would mark the beginning of the actual sowing and harvest seasons, hence the name “seasonal”. Finally, the peaks at −17¾º and −53¾º (for families IV and V) correspond to the value of the declinations of Sirius and Canopus during the New Kingdom (and beyond, if the errors are considered), the two brightest stars of Egyptian skies, respectively.

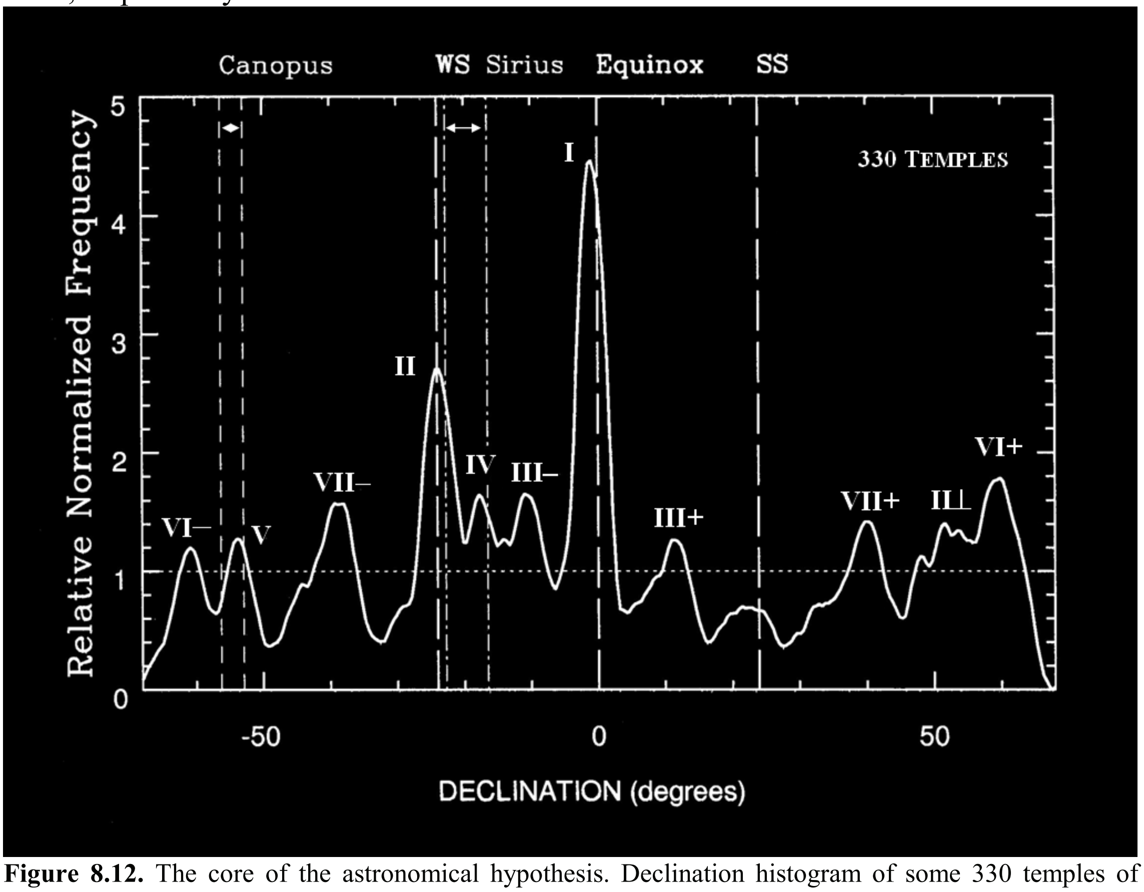

Figure 8.12. The core of the astronomical hypothesis. Declination histogram of some 330 temples of ancient Egypt obtained from the data measured in our five field campaigns across Egypt and their analyses as presented in Papers 1, 2, 3 and 4. Each peak is identified by a Roman numeral referring to each of the seven families of astronomical orientations as defined in Paper 3 and explained in detail in this work. Only peaks with values of the frequency above the average (dot-line) have been taken into account. Long-dashed lines stress the extreme and medium positions of the sun at the solstices and equinoxes, respectively. The lines for Sirius (dot-dashed) and Canopus (short-dashed) straddle the extreme declinations of these stars, the brightest ones of the skies of ancient Egypt, from the beginning to the end of her civilization. See the text for further discussion.

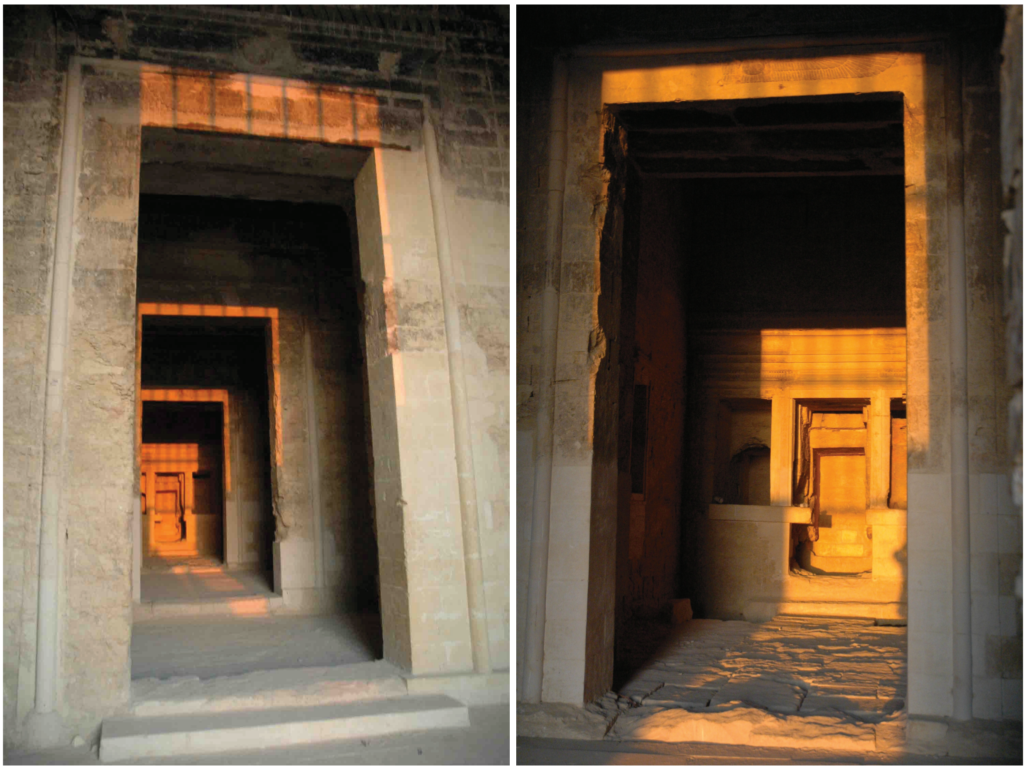

Figure 8.13. A splendid light hierophany at sunrise at the winter solstice (December 21st 2006) at the temple of Sobek-Re in Qsar Qarun (Dionysas) in El-Fayum Oasis. Notice the illumination of the inner sanctuary (left), where the statue of the god would have been located, and of the various successive portals. The winged-disc symbol of Horus Behedety blossoms above the first gate at the pale yellow light of the first rays of his physical counterpart, the solar-disk. As the sun rises, its light moves to the north illuminating the small shrine to the right of the sanctuary while the niche to its left, where the mummy (the underworld aspect) of the god was presumably located, always remains in darkness. Notice the parallelism with the illumination phenomenon at Abu Simbel. Photographs by J. A. Belmonte.

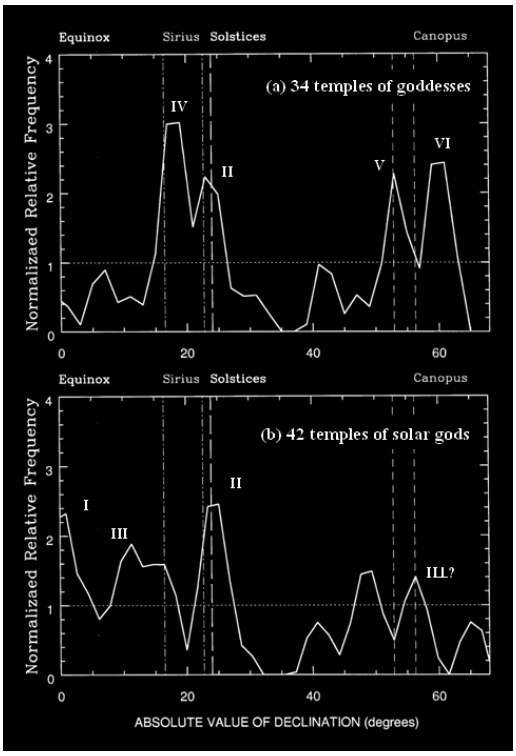

Figure 8.14. Absolute declination histograms of two independent series of temples. (a) 34 temples of goddesses of all periods. (b) 42 temples of divinities with a solar character. Notice the most significant peak corresponding to *Sopdet* family for series (a) and the "equinoctial" and solstitial peaks associated with solar gods. See text for further discussion. Plot lines as in Fig. 8.12.

One important question that may arise from the existence of these families would be if they could actually be identified with any cultural aspect of ancient Egyptian civilization; i.e. we have the facts, the orientations, but how do we explain them? In Papers 1, 2, 3 and 4 we analysed certain case studies (see also sections 8.3) where these aspects were taken into account and we also justified the intrinsic importance of certain celestial bodies, such as for example Sirius, or *Sopdet*, the harbinger of the Flooding. Here we take the advantage offered by our larger sample of monuments to select two independent groups of them for a new experiment. One is formed by all the temples that were unmistakably dedicated to a goddess (34 in total of which 12 belonged to Isis). Here we will take advantage of Egyptian henotheism as defended by Hartung, which identifies different goddesses (or gods) as diverse manifestations of a single deity. The other group is formed by temples devoted to gods of solar character, or that undergo a process of solarisation (as Sobek-Ra in Qasar Qarum, see Figure 8.13). We have 42 of these, of which 20 belonged to Amon-Re.

The results of the experiment are presented in Figure 8.14, where the corresponding histograms of the absolute value of the declination are presented. The upper panel stands for the goddesses and it is fascinating to note that the highest peak of the distribution is for a declination of ~18º. The answer could be *Sopdet*! So the most important celestial hypostasis of Isis, at least from the New Kingdom onwards, is the most important reference for the orientation of her temples (and other deities identified with her). Curiously, other important peaks are found at the solstitial family, the accumulation peak and the family of Canopus. So the temples of the goddesses clearly follow standard patterns, including families II, IV, V and VI. Regarding the "solar" temples, the result is also astonishing (see lower panel). The three highest peaks, nearly centred at 24¼º, 0½º and 11¼º have indeed a solar character (families II, I and III, respectively) beyond any doubt. So solar temples are mostly facing the sun at critical moments of the annual cycle! An obvious conclusion of these experiments would be that we might find profound metaphysical reasons beyond the orientations of a majority of the monuments of our sample.

However, it is interesting to perform a more detailed analysis of the different families (same Roman numbers as in Fig. 8.12):

I. The eastern (or "equinoctial") family, a part of the Meridian family

The peak corresponds to a declination of –1º±¾º. This suggests an orientation to the equinoctial sun when the disk has completely risen above the horizon. This might imply that the ancient Egyptian were able to determine the day of the equinoxes with reasonable precision. In our writings, we have frequently used the term "equinoctial" for any alignment with declination near 0º and "equinox" for the corresponding time point, associated with orientations close to due-east. However, this does not mean that we are attributing knowledge of the astronomical equinox (i.e. the moment when the sun crosses the celestial equator) to the ancient Egyptians but rather that we believe that such orientation would be a proof of a certain interest in the four cardinal directions. How this interest converted into actual construction planning is discussed later at several points in this paper.

Actually, it is our contention that cardinal orientations would have been obtained by the observation of certain configuration of stars and constellations in the northern skies, notably *Meskhetyu*. Among these, we may count: the simultaneous transit of two stars across the celestial meridian, the maximum east or west polar distance (maximum digression), upper culmination or lower culmination of a relevant star or, for Upper Egypt, the rising or setting of some stars. Actually, any sight of a conspicuous star near due-north could have been also relevant. Any of these particular configurations would establish a near-north, but not necessary true-north, reference line. A perfect N-S orientation could be gained only by a handful of these procedures, notably, for example, simultaneous meridian transit of a pair of stars. An example of this is illustrated in Figure 8.15. The idea of the simultaneous transit of stars as possible targets for ancient Egyptian pyramid orientations was resurrected by K. Spence in her most controversial "Ancient Egyptian chronology and the astronomical orientation of pyramids", a work published in the last volume of *Nature* of the 20th Century.

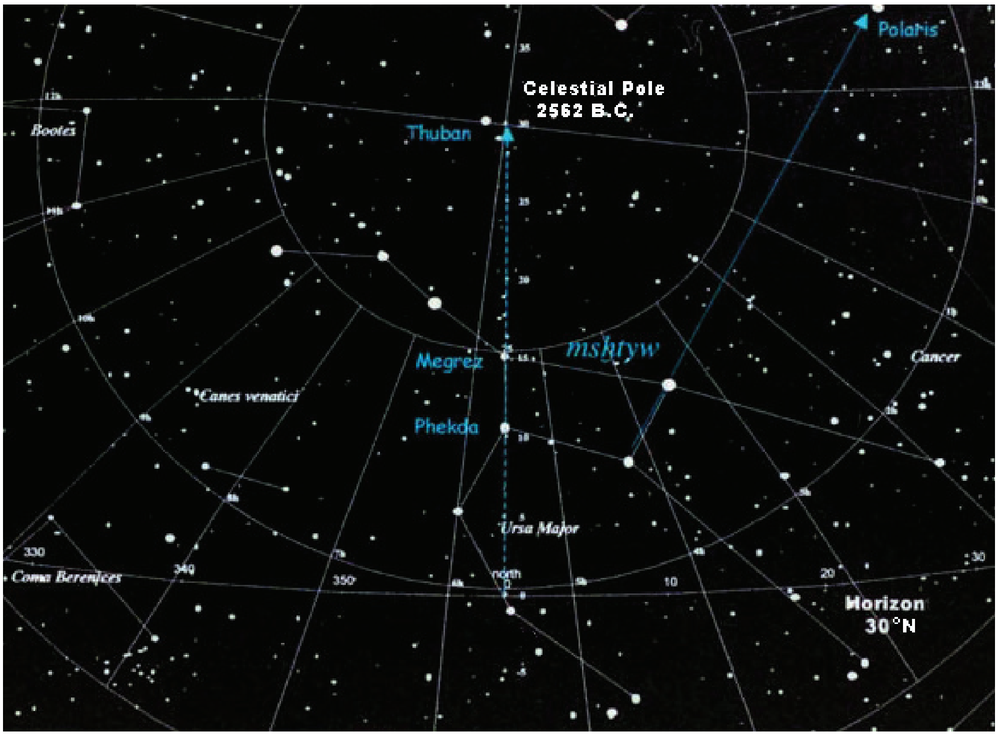

Figure 8.15. The ancient Egyptian Bull's Foreleg constellation, *Meskhetyu* (*msẖtyu*), at lower culmination in the year 2562 B.C., when the line connecting the stars Phecda (γUMa) and Megrez (δUMa) accurately marked the position of the Pole in one direction and, in the opposite direction, the location of due north above the horizon. Today, a similar configuration, but with other two stars of the asterism, Dubhe and Merak, connects Polaris, the Pole Star, and modern due north, because of precession.

As a matter of fact, we suggest that family I could be the result of an orientation in the Meridian line (probably to due-north) and later the gate of the temple would have been open by establishing the perpendicular through standard topographic techniques. The pyramid complexes could be the paradigmatic example of such a procedure, where the N-S axis of the pyramid would have been the first element of the construction obtained in the foundation ceremonies, a fact accepted by most scholars. We can find arguments in favour of one or other alternative and the probable solution is that both kinds of monuments ought to be included within the group. These would include "equinoctially" orientated monuments, such as the Sphinx or the solar temples of the 5th Dynasty at Abu Ghurob, and 90º-rotated axis temples such as those of the pyramid complexes of the Old and Middle Kingdoms. These monuments will be further analyzed in much more detail in our selected case studies (see Section 8.3).

II. The solstitial family, observing of the solar extremes

With a peak at –24º±¾º, this group is dominated by a series of temples orientated to sunrise at the winter solstice, although other solstitial orientations have also been documented. This is the dominating astronomical custom in the temples of Upper Egypt and was also found at many other locations within Egyptian geography. Hence, we would catalogue it as universal within ancient Egyptian culture (see, for example, Figs. 8.2 and 8.13). On the one hand, there has been discussion relating to the importance of the winter solstice with respect to the extended Mediterranean idea that the Birth of the Sun happened exactly as this solar time-mark. On the other hand, the summer solstice could have been important in ancient Egypt as a date close to the average arrival of the Inundation. Besides, the first author has argued that this time marker could be closely related to the origin of the 365 day civil calendar (see Chapter 4). Associated with this family, we have the peculiar II⊥ (perpendicular) peak (see Fig. 8.12). We are convinced that this group of temples, orientated to an interval of declinations centred at nearly 54º, includes monuments whose axis was obtained by rotating 90º anticlockwise a previous orientation determined by winter solstice sunrise.

The temple of Karnak is the paradigm of the family and we shall devote a special section to it in the case studies. However, the discovery of the solstitial family and overall the demonstration of its intrinsic importance, has permitted the reinterpretation of some controversial monuments whose previous analysis had offered somewhat clever but controversial theories.

On the one hand, perched on the summit of the highest peak in the Hills of Thebes, the Djebel Thoth, there is a fascinating temple dedicated to the falcon god Horus by the 11th Dynasty king Mentuhotep III (*c.* 2000 B.C.). This is presented in Figure 8.16. Djebel Thoth would have been an important landmark in the sacred landscape of Luxor area; the Montu temple at Medamud, for example, was evidently facing it. Being off the beaten track, the temple was not studied in detail until the 1990s when it was excavated by a Hungarian mission conducted by Gyözö Vörös.

One of the most interesting results of the excavations was the discovery that below the Middle Kingdom structure lay the foundations of an older temple that was attributed to the archaic (*c.* 3000 B.C.) period by the excavators and, most fascinatingly, that the axes of the two temples differed by ~2½° in azimuth (see Appendix 2). The Hungarian team, in collaboration with astronomers from Konkoly Observatory, cleverly associated this change of axis with the possibility of stellar alignments and a change in a star's rising position due to precession from 3000 to 2000 B.C. The equinox precession is a astronomical phenomenon caused by perturbations in the Earth orbit which alters the star positions in a cyclic way over a very long period of some 260 centuries.

Their astronomical calculations suggested that the target could be Sirius (actually, the star at the moment of its heliacal rising) and they related the star to Horus, the divinity to whom the temple was dedicated. It is true that the summit of Djebel Thoth would have been a marvellous spot to observe the heliacal rising of the star, well above the haze of the river banks, and we would tend to agree with this hypothesis since, nearby, in the scarps of Djebel Tjauti, a report of the observation of the heliacal rising of *Sopdet* was inscribed on the rocks during the 17th Dynasty, as recently discovered by the Darnells.

In an attempt to confirm all these hypotheses, we climbed the difficult path to the top of Djebel Thoth. The temple was restored by the Hungarian mission and most of the archaic structures have been covered again and were thus impossible to measure. The preserved walls of the Middle Kingdom structure offered a plan that actually gave us several possible azimuths with an average value of 117º. If the temple had not been excavated, our suggestion would have been that we were simply faced with a case of the winter solstice family of orientations. Actually, there are two questions that do not accord with the Sirius hypothesis. On the one hand, Horus, the temple owner, has been mostly associated, according to Krauss, with the planet Venus in the Old and Middle Kingdoms (and Sirius is always related to the goddess *Sopdet*). So the mythological case is not strong. On the other hand, our data force the observation of Sirius heliacal rising at an angular height of nearly 9º, both in 3000 and 2000 B.C. However, according to our experience, this is highly overestimated since Sirius is perfectly visible at a height of 4º to 5º, or even less, at the moment of its heliacal rising.

So, in our opinion, and in spite of the original wishes of the astronomers of our mission, the precession hypothesis is far from being proven, and, taking Ockam's Razor into account, we feel obliged to choose the possibility of the winter solstice alignment, perpendicular to the course of the Nile, as being the most reliable. Actually, this would be almost parallel to the alignment of the nearby temple of Mentuhotep II, father of Mentuhotep III, at Deir el Bahari, and to the unfinished burial monument of the latter king behind the hill of Qurna.

However, bearing these facts in mind, we must also argue against the Sothic alignment proposed by Wells for the Satet temple at Elephantine, erected by "King" Hatshepsut, which we believe was also aligned to the winter solstice rise of "her father Amon", following the same political project that motivated the construction of her other "solstitial" temples in Thebes (see Section 8.3.4). Actually, it is difficult to know the precise orientation of earlier Satet temples at the same location (particularly those of Mentuhotep II and Senuseret I, dated in the Middle Kingdom) or the original archaic shrine enclosed by three large granite boulders. However, when the first sanctuary was erected (*c*. 3200 B.C.), Sirius was rising almost at the same position as the winter solstice sun and thus it is possible and even probable that, for earlier periods, a double alignment was in operation at this particular spot of Elephantine.

Figure 8.16. The Middle Kingdom Horus temple at the summit of Djebel Thoth, the highest peak of the Theban Hills. It is built above the foundations of an archaic period temple with a slightly different orientation. This is an early example of a winter solstice rising temple in the area of Thebes. Photograph by J.A. Belmonte.

III. The seasonal sun family, dealing with the wandering year

This group of temples corresponds to monuments orientated to a peculiar interval of positive and negative declinations of 11½±¾º and −11º±¾º, peaks III+ and III−, respectively. We play with the idea that this family also had a solar origin. One of the most interesting cases in this family is that of the temples of Aton at Tell el Amarna. One of these temples is clearly orientated to a distinctive notch on the eastern horizon similar to an *akhet* sign. Actually, it has been suggested that this geographical accident gave its name to the city, *Akhetaten*, the Horizon of Aton (see Figure 8.17). Since the main gate of the temple is, at the same time, perpendicular to the Nile, the orientation and location of the temple of Aton could have simply been dictated by topographic features. However, there is a striking additional possibility. Sunrise at the *akhet* would have occurred on dates close to October 22nd and February 20th.

Surprisingly, or not, these dates are similar to those when the famous sun illuminating phenomenon occurs at the great temple of Abu Simbel. For Abu Simbel (see below), we have proposed a link to the beginning of two of the seasons of the Egyptian calendar, *Peret* and *Shemu*, "Going Forth" and "Drought", respectively. In the reign of Akhenaten (*c.* 1352-1336 B.C.), the seasons of the calendar did not exactly correspond to the climate seasons (although this was true for Ramses II). However, these dates still divide the year into two periods, one of 120 days (exactly four Egyptian months of 30 days, or one calendar season) and another of 245 days, and they might have acted as harbingers of the real sowing and harvest seasons, respectively. Another temple complex of this family would be the sanctuary of the sun-god Re at Heliopolis and, as a matter of fact, it would be logical to expect it to have a solar-related orientation. Hence, we have finally proposed the hypothesis that this group of temples would actually integrate a so-called seasonal sun family of orientations, with possible members all around Egypt. In fact, the "solstitial family" could be interpreted as a more specialized subgroup of this.

Due to the wandering nature of the Egyptian calendar, the seasons of the tropical year (and the associated climatic phenomena and agricultural activities) did not usually follow the seasons of the civil calendar. Hence, economic activities, although completely under the control of the civil calendar, would be carried out according to the tropical (thus Gregorian) seasons. This is probably the reason why these dates were so important as to be reflected in the orientation of the temples.

Indeed, the most interesting example of the seasonal family is undoubtedly that represented by the phenomenon famed throughout the world of the illumination of the innermost sanctuary of the main temple of Ramses II at Abu Simbel. At dawn on 22 February 2004 we were among the privileged few to observe the complete phenomenon from the interior of the sanctuary while numerous Japanese tourists passed behind us completely astonished, as we were, by the spectacular hierophany that was being represented in front of our eyes, as shown in Figure 8.18.

Much has been written about the phenomenon, and we have little to add to the papers already published by the authors of this essay. We do agree that the illumination phenomenon must be somehow associated with the calendar and with its social, political and religious consequences. The presence within the temple complex of a chapel devoted to Thoth, the god of wisdom and "inventor" of the calendar, supports this view.

Figure 8.17. The axis of the small temple of the sun-disc god Aton at Tell el Amarna. It is orientated to a particular cleft at the horizon (actually the valley where the royal tomb was excavated) where the sun rises in late February and October, perhaps representing the ancient name of the city, *Akhetaton*, the Horizon of Aton. Photograph by courtesy of M. Gabolde.

The time of Ramses II was very important in the history of the calendar of ancient Egypt since during most of his reign the seasons were in rough agreement with nature (see Chapter 4). This concordance between calendar and nature was especially dramatic at Abu Simbel. At the latitude of the temple, the helical rising of *Sopdet* took place in I *ꜣḫt* 1, the feast of *Wepet Renpet*, the Opening of the (Civil) Year, in the quatriennium around 1270 B.C., around the 10th regnal year of Ramses II. This happened for the first time after the beginning of the Pyramid Age, 1460 years earlier, when perhaps the heliacal rising of Sothis was not yet observed in a systematic way (see Chapter 4).

Also, in Ramses' time, the illumination phenomena happened twice: in I *Peret* 1 and I *Shemu* 1, the beginning of the other two seasons of the Egyptian year, during a period of nearly 48 years centred on 1269 B.C. for the late October illumination (I *Peret* 1), and 1253 B.C. for late February (I *Shemu* 1), i.e. during most of the king's reign (1279-1216 B.C.). Similarly, some local informants and a few old photographs suggest that sunrise occurred at a cleft in the eastern horizon in the form of an *akhet* sign, before the saving of the temple from the waters of Lake Nasser. However, we have tried without success to confirm this information with local people in an attempt to identify the cleft.

To complete the calendrical aspect of the temple, we must refer to the sun chapel located just to the north of the colossi. According to Hawkins' studies, this was orientated towards the sunrise at the winter solstice, and our data confirm that suspicion within tolerance. We are again confronted with a shrine contributing to the well established winter solstice family. However, a calendrical note can be added. In 1260 B.C., the winter solstice fell in III *Peret* 1, the date of an extremely important festival dedicated to Amon-Re. Because of the slow movement of the sun at the solstice (hence the name), which practically does not move for nearly an (Egyptian) decade, the solstitial alignment could have been observed at III *Peret* 1 for a period of some 40 years, again during most of the reign of Ramses II. This might have had a series of religious and/or political implications that, associated with the spectacular hierophany inside the sanctuary, we can hardly imagine today.

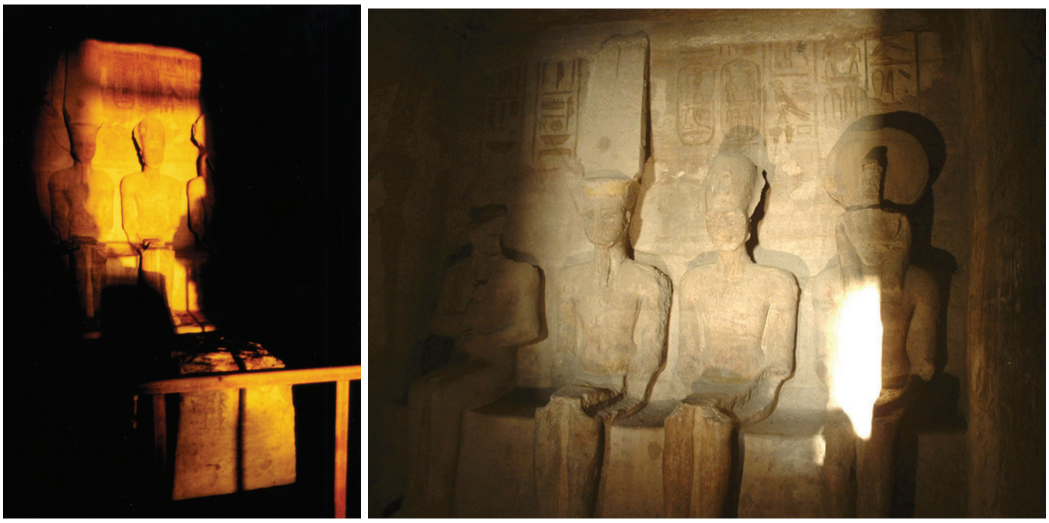

Figure 8.18. At dawn on 22 February 2004, the light of the rising sun enters the sancta sanctorum of the main temple of Abu Simbel. The first rays illuminate the figures of Amon-Re, the divinised king and the shoulder of Re-Horakhty, all of them gods of solar character, while the figure of Ptah, god of the netherworld, stays in darkness. When the light progresses, the figure of Re-Horakhty receives first the full and afterwards the last rays of the sun. This marvellous hierophany may have occurred at the beginning of the Peret and Shemu seasons of the ancient Egyptian calendar, during the first decades of the reign of Ramses II, the temple builder. See text for further discussion. Photographs by J.A. Belmonte.

IV. The *Sopdet* (Sothic) family

The main peak of this family in Figure 8.12 would correspond to a value of the declination of $-17\frac{3}{4}^{\circ}\pm\frac{3}{4}^{\circ}$, covering most of the declination of Sirius for the period of the Middle and New Kingdoms. The star *Sopdet*, our Sirius, the brightest star of the ancient Egyptian skies, was very important as the Harbinger of the actual Flooding at least from the Middle Kingdom onwards, when the phenomenon of its heliacal rising (*Peret Sopdet*) is mentioned in the hieroglyphic texts on several occasions (see Chapter 4), although its name is also largely cited in the Pyramid Texts within the context of the stellar eschatology of the Old Kingdom. Actually, we believe that the relative importance of *Sopdet* was increasing during the Old Kingdom, once it was clear that the wandering calendar and the climatic seasons were diverging. Significantly, it is possible that the first monument ever orientated to the star was the minor step pyramid presumably erected by King Sneferu in Naqada, in agreement with the ideas of A. Cwiek, as the authors has recently shown in a work specially devoted to these seven enigmatic monuments dispersed along the Nile Valley (see Chapter 11).

This Sothic family of orientations would have representatives all over Egypt but there is a place where most of the scientific community has agreed that Sirius would have played a most dominant role. In the early 1990s, the team of the French scholar Sylvie Cauville made a detailed study of the temple complex of the goddess Hathor at Dendara. From textual evidence, Cauville proposed that the axes of the main temple, that devoted to Hathor, was laid down on 16 July 54 B.C., during the reign of Ptolemy Auletes, the father of Cleopatra VII. However, for the temple of Isis, located behind the main temple, the situation was different. This temple shows no less that three main axes: an older one, formed by earlier foundations from the reign of Nectanebus (30th Dynasty) and later constructions of Ptolemy VI and Ptolemy X; a processional axis leading to a monumental gate at the temenos wall of the complex (see Figure 8.19), and the axis of a high room devoted to the birth of Isis and erected at the time of Augustus. The first two (see Figure 8.20) varied by 4º from one another, whilst the 3rd represented a turn of 90º to make the axis of the high room parallel to the axis of the temple of Hathor.

Figure 8.19. The isolated eastern monumental gate in the *temenos* of the temple of Hathor in Dendara, opening the processional way to the small temple of Isis located within the complex. The rising of Sothis (Sirius) would have been visible in this area of the horizon during most of ancient Egyptian history. Photograph by J.A. Belmonte.

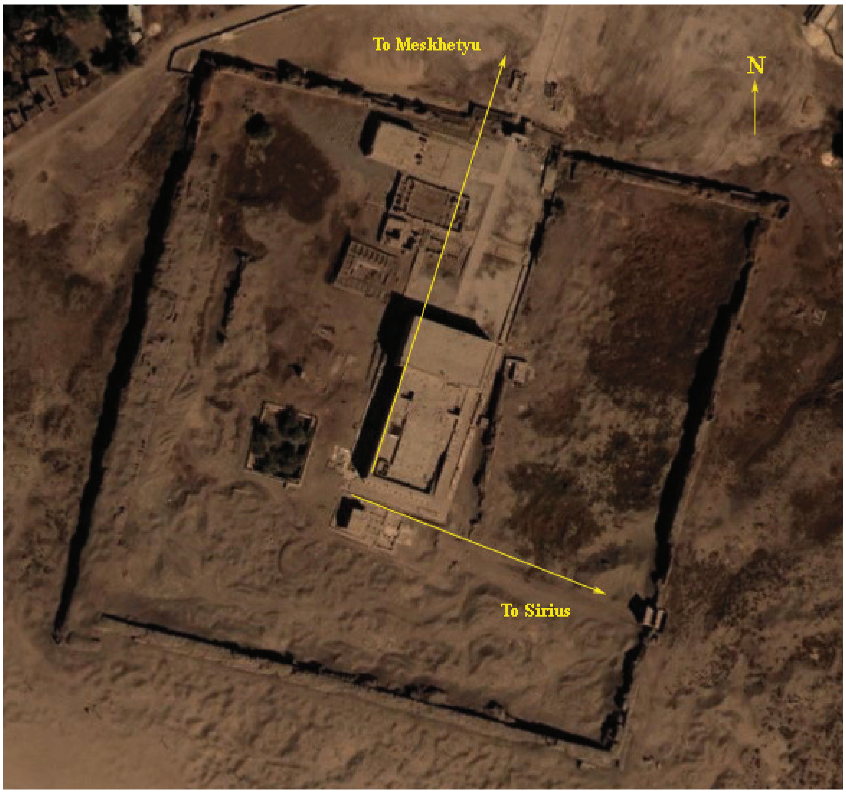

Figure 8.20. The complex of the temple of Hathor at Dendara. The main building is orientated close to north and possibly to the rising of *Meshketyu* in the late Ptolemaic period. However, the hypostyle hall of the small Isis temple located behind it is not exactly perpendicular and could have been orientated to the rising of Sothis as many other buildings on site before it. Notice the different alignment of the major temple and the surrounding *temenos*. See the text for further discussion. Adapted from an image courtesy of Google Earth.

According to Cauville and her colleagues, the change of axis can be interpreted as a change in orientation towards Sirius rising caused by precession. The older one (at 111º 11' according to their precise measurements), that of Nectanebus' original building, should keep, according to their interpretation, the earlier orientation of a previous building, of which some fragments are preserved, erected in the same location during the reign of Ramses II (*c.* 1270 B.C.). The new one, at ~108º, was that of the rising of Sirius in 54 B.C., when the axis of the new complex was established. This means that the axis of the complex was not determined according to the orientation of the main axis of the Hathor temple, as one might have expected, but rather in the perpendicular direction. From the mythological and social point of view this solution looks reasonable, given that Isis had been largely identified with *Sopdet*, and thus with Sirius, since early times.

However, as shown in Chapter 7, the inscriptions in the Hathor temple are crystal clear and, according to them, the astronomical target observed to lay down its main axis, and thus presumably the plan of the whole complex, including the Isis processional way and the birth of Isis high room, was the constellation of the Bull's Foreleg, *Meskhet(yu)*. In the text accompanying one of the stretching of the cord ceremony scenes, we can read:

> *The king stretches the rope in joy. With his glance toward the ꜣḫ of msḫt, he establishes the temple of the Lady of Dendera, as took place there before.*

Here the text mentions the *ꜣḫ* of the Plough. The term *ꜣḫ*, plural *ꜣḫw*, is mentioned in the *Pyramid Texts* and, as it was discussed in Chapter 7, it can be translated as "spirit", or "brilliant". Hence, we might translate the text as "the brilliant (star) of the Plough". However, bearing in mind that the seven stars of the Plough are almost of the same brightness (only Megrez, δ UMa, is slightly fainter), Krupp had suggested that *ꜣḫ most likely refers to a particular position and orientation of the Plough in its circular course around the Pole*. However, another hypothesis would be a different version of the same idea. In 54 B.C., at an azimuth of 18º, Alkaid (η UMa), the conspicuous star at the end of the handle of the Plough, was first visible when rising at an angular height of ~2°. It is worth noting that on the astronomical ceiling of the tomb of Senenmut at Deir el Bahari, the constellation of *Meskhetyu* is represented in such a way that the last star of what might be the handle of the Plough is signalled with a red ⊙ symbol. This perhaps indicated that Alkaid played a preferential role within the stars of this important constellation.

Consequently, we must agree with the Egyptians that the temple of Dendera was orientated towards a rising conspicuous star of *Meskhetyu*, one that would make visible the complete asterism above the horizon, and not towards *Sopdet*. This idea is further supported by the enigmatic orientation of the *temenos* (see Fig. 8.20). The aerial photographs clearly show that the axes of the enclosure and the main temple were not parallel, suggesting that both were orientated at different times. In this respect, the *temenos* orientation can only be explained if the rising of Alkaid c. 180 B.C. is contemplated.

Hence, it looks obvious that at Dendara we have a combination of stellar orientations where both *Sopdet* and *Meskhetyu* might be involved for different buildings and different periods. To these, we must add the opinion of those scholars proposing the idea that the temple of Dendara is simply perpendicular to the Nile, which has a very peculiar course in that region. We actually believe that in this case we have one of those marvellous examples of the combination of astronomy and landscape that we mentioned at the beginning of the chapter (see Fig. 8.5). Our contention is that Dendara might have been chosen as a highly important cultic place for Isis-Hathor because the river runs nearly parallel to the direction where Sothis was rising. We could even speculate about the metaphor of the flooding waters being brought by the stellar goddess at the moment of her heliacal rising. Later on, in the Ptolemaic period, the Sirius displacement caused by precession introduced some doubts about the credibility of the star as an accurate reference for orientation and another ancient and well-known procedure was selected, aligning the new temple with the stars of *Meskhetyu*.

V. The Canopus family

With a peak at −53¾º±¾º in Figure 8.12, the stellar interpretation of this family is far more complicated because we cannot prove the importance of Canopus for the ancient Egyptians, notwithstanding the fact that it was their second brightest star in the sky. Canopus changed its declination from –56¼º to –52½º during the course of Egyptian history (–54½º, –54º and –53º for the beginning of the Middle Kingdom, of New Kingdom and of the Late Period, respectively) and would adequately fit the data.

Unfortunately, it is not yet clear whether the ancient Egyptians recognized this individual star or not. In our opinion, they probably did but we have been unable to clearly identify its name, astronomical correlations or possible religious connections (see below), except the very late reference by M. Capella who called it *Ptolemaeus* in honour of King Ptolemy Lagos, as reported by Allen in his old but still most useful book on *Star names.* This is also true for the most recent mapping of the Egyptian skies, as presented in Chapter 6. Curiously, a possible relation between Canopus and Osiris (hence to the mythology of Isis) is mentioned in Plutarch, although it is not clear if the text refers to the star itself or to the pilot of the vessel Argo. However, *Argo Navis*, clearly the constellation now, is related to the boat of Osiris in the same paragraph. The traditional Coptic name of the star, **ⲡⲥⲟⲩ ⲛϩⲱⲣ**, may also relate it to sailing. Besides, this correlation could also be inferred from a controversial passage of the *Book of Day and Night* mentioning *Osiris, who is "behind" Sah*. So the star Canopus may be related in some way or the other with the Osirian Triad.

In this respect, a very interesting case of Family V could be that of the Isis temple complex at Philae (see Figure 8.21). The main axis of the temple of Isis was diverted to a declination of −53½º±¾º and could have been orientated to the setting of Canopus. However, the perpendicular axis (and that of the temple of Hathor), gave a declination of −16½º±¾º, if a reconstruction of the ancient horizon of Philae is attempted. This perfectly agrees with the declination of *Sopdet*, the celestial manifestation of Isis (and of Hathor in that period) and so, perhaps, this could have been the predominant orientation. Which therefore is the correct solution? Either the complex was orientated to Sirius rising and after the main temple axis was rotated by 90º clockwise or, and most interestingly according to the astronomy and landscape interaction we are defending in this work, we could speculate that Philae was located at a place with a very peculiar phenomenology: a singular place in Egypt where Sirius rising and Canopus setting were nearly perpendicular. Unfortunately, the displacement of the island monuments prevents any further testing of this hypothesis.

Family V is the least common of the families of astronomical orientations and sometimes can be confused with II⊥ (see Section 8.3.4). However, we trust in its existence and some singular temples were probably members of this peculiar group.

Figure 8.21. The formidable temple complex at the island of Philae. This complex may have included several astronomical orientations, including those of the main temple of Isis (back) to the setting of Canopus and of the shrine of Hathor (close up) to the rising of Sirius, the two brightest stars of the ancient (and modern) skies on site. Photograph by J.A. Belmonte.

VI. The Meridian (or northern) family, seeking for stars in the north

With two major peaks, VI+ and VI–, located at declinations of 60º±¾º and −61º±¾º, respectively; these "peaks of accumulation" clearly speak of the great importance of near-Meridian, not to say precise N-S, orientations in ancient Egypt. In fact, it is highly probable that families I and VI are two sides of the same coin. Indeed, both are representative of the predominance of cardinal orientations according to the manner in which the ancient Egyptians organized the Cosmos.

As we have mentioned above, we support the idea that this northern custom was effectively achieved through orientations to certain configurations of stars near the celestial pole, and that the circumpolar constellation of *Meskhetyu* would be the most appropriate target for this purpose, as shown in Fig. 8.15. *Meskhetyu* undoubtedly was one of the most important asterisms of Egyptian religion from the Old Kingdom, if not earlier, where it appears in the Pyramid Texts as the "imperishable star" par excellence, to the Ptolemaic Period when it is profusely mentioned in connection with temple orientation (see Chapter 7).

There are a pair of monuments which could be considered as real paradigms of the group, the temple of Horus in Edfu (see Fig. 8.7) and the sanctuary of Amon in Qsar Zaiyan (see Figure 8.22). Their axes are very near to the Meridian line although, in both cases, the temple gate is open to the south. However, we are convinced that this Meridian orientation was achieved by the observations of northern stars. Actually, in the case of Edfu, the inscriptions repeatedly and obsessively mention the observation of *Meskhet(yu)* by the king, in the presence of Thoth, on a certain night when the moon was in its 6th day. This can be easily verified by modern calculations, suggesting that the temple of Horus was aligned to the lower culmination of either Merak or Phecda at nearly mid-night on August 23rd 253 B.C., when the tiny light of the setting crescent moon offered a perfect atmosphere for the celebration of the stretching of the cord ceremony.

Figure 8.22. (left) The Amon temple at Qsar Zaiyan (ancient Tchonemyris), in Kharga Oasis. With an azimuth of 180º, this temple was perfectly orientated within the meridian line and open to the south. However, we play with the idea that the original alignment of the temple was instead diverted to the north. Photograph by J. A. Belmonte.

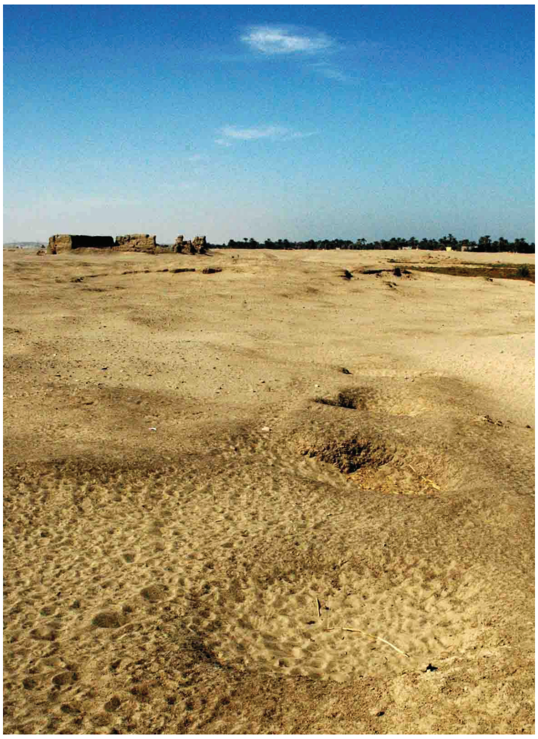

Figure 8.23. (right) The four aligned holes for standing poles probably located at the façade of the building known as structure HK29A in the ancient site of Hierakonpolis, one of the most important pre-Dynastic villages of Egypt. This could be the earliest known example in Egyptian history of a building simultaneously orientated both topographically and astronomically. The Fort of Nekhen, ascribed to the 2nd Dynasty, can be seen on the foreground. Photograph by J. A. Belmonte.

VII. The (mid) quarter-cardinal –or intercardinal– direction family, interactive landscape in action

The quarter-cardinal family is defined as a group of temples whose orientation is close to 45º (NE), 135º (SE), 225º (SW) or 315º (NW), producing in the histogram of declination of Fig. 8.12 a peak at −39º±¾º (VII−) and its symmetric at some 40º (VII+). We believe that it is a subgroup of the cardinal super-family. It is our contention that this orientation was achieved by the primary determination of a north alignment, whose axis was later rotated by either 45º or 135º degrees clockwise for temples open to the east side of the horizon, which are the most frequent, or anticlockwise for temples open to the west side of the horizon. By performing such an action, simultaneous astronomical and Nile orientations could be achieved in several cases. Some of the Million Year Temples of kings of the New Kingdom, especially in Abydos and Western Thebes, are good representatives of this group. However, the oldest temple excavated so far, whose plan has been partially recovered, estructure HK29A at Hierakonpolis would be the earliest example of the class. It was Rolf Krauss who kindly suggested a few years ago that the second largest peak in our declination histogram of the temples of Upper Egypt (see Paper 1) could actually be caused by monuments with a diagonal originally orientated in a N-S direction. This comment was the origin of the definition of the quarter-cardinal family.

Figure 8.23 shows the area of the site of Kom el Ahmar (ancient Hierakonpolis or *Nekhen*) with the four aligned pits for high-poles, now replenished with sand, which would have been located at the front of pre-dynastic structure HK29A, excavated by R. Friedman and his team. This is probably the earliest Egyptian temple we have information about, thus it is very important for our discussion. We believe that this was the first building in Egypt belonging to the quarter-cardinal family. We suggest that a N-S line was first determined by astronomical observations and that the axis of the temple was obtained by rotating this by 45º clock-wise. The question is how the N-S orientation was achieved.

We support the idea that HK29A is the first building ever orientated in Egypt to the simultaneous near meridian transit of Phecda (γUMa) and Megrez (δUMa) as shown in Figure 8.24a. This configuration was primarily proposed by the first author to explain the orientation of the gigantic pyramids of the Old Kingdom (see Fig. 8.15). Phecda and Megrez were two distinct stars of *Meskhetyu*, a most important ancient Egyptian constellation as we have already largely discussed. We believe that by rotating the astronomically determined axis by 45º, another objective was obtained: that the "temple" entrance would be almost perpendicular to the Nile, in agreement with the Nile hypothesis we proposed earlier.

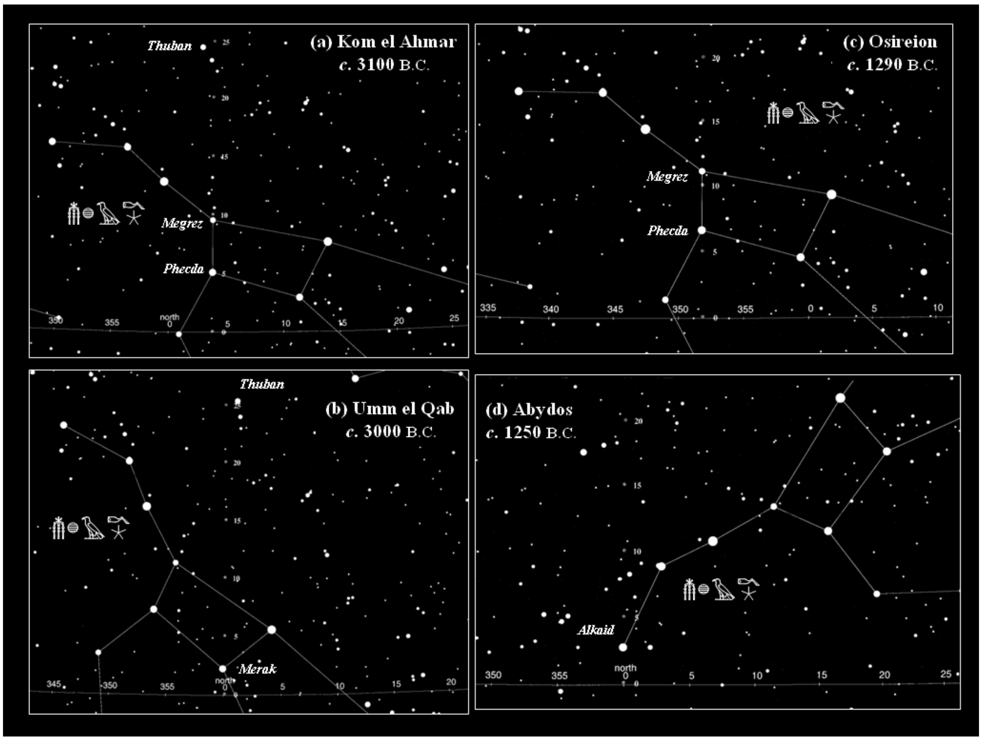

Figure 8.24. Different celestial configurations of the asterism of *Meskhetyu* as observed from two important locations and different epochs. (a) Simultaneous meridian transit of Phecda (γUMa) and Megrez (δUMa) in pre-Dynastic times in Kom el Ahmar for the alignment of Structure HK29A. (b) Lower culmination of Merak (βUMa) in early Dynastic times at the royal cemetery of Umm el Qab (Abydos), perhaps explaining the sacred character of the site. (c) As in the first case, but *c.* 1290 B.C. in order to explain the anomalous orientation of the Osireion and the associated temple of Sethy I in Abydos. Notice the different azimuth and angular height of the two stars caused by precession. (d) Lower meridian transit of Alkaid (ηUMa) in Abydos at a period when *Meskhetyu's* circumpolar character was coming to an end on site after two millennia because of precession. See the text for further discussions.

This peculiar configuration of *Meskhetyu* would have been used at Kom el Ahmar perhaps because the constellation was not circumpolar on site at pre-Dynastic times, since Merak (βUMa) would have slightly disappeared below the local horizon. As a rough first approximation, under standard atmospheric conditions, a star is not visible until it reaches an angular height equivalent to its visual magnitude. This is the reason why Merak (m_V=2.36) was invisible at Hierakonpolis when HK29A was erected. However, *Meskhetyu* was fully circumpolar at another important pre-Dynastic spot a few hundred kilometres to the north, Umm el Qab, as shown in Figure 8.24b. Umm el Qab, in the desert area of Abydos, was the site of a huge pre-Dynastic cemetery and also contained the tombs of the first kings of Egypt (0 and 1st Dynasties), when the Egyptian state was forming and perhaps some metaphysical aspects relating to the king, including the stellar eschatology of the Pyramid Texts, were developing.

We can easily imagine two scenarios. On the one hand, we can imagine that Umm el Qab was selected as the place for the royal cemetery because it was the first place travelling north where *Meskhetyu* would have been circumpolar or, on the other hand, that the relative importance of the stars of *Meskhetyu* as the *ikhemu seku* ("imperishable" stars) par excellence was due to the fact that they were circumpolar at the site of the royal necropolis. Both solutions might be possible but we tend to favour the first one, which would certainly be in agreement with the intimate relationship between astronomy and landscape that we have encountered throughout our work so far. In this respect, T. Wilkinson has suggested that the kings that unified Egypt (Dynasties 0 and I) were originally from Hierakonpolis, but that they established their royal cemetery a few hundred kilometres to the north at Umm el Qab, in Abydos. This might support the idea that the place of the royal necropolis was deliberately chosen for religious purposes.

The importance of *Meskhetyu* in the Abydos area would have been linked to the orientation shown by other important constructions. For example, the funerary enclosure of king Khasekhemuy at Shunet el-Zebit would also be a member of the quarter-cardinal family orientated to the same configuration of Phecda and Megrez as structure HK29A, but a few centuries later (*c*. 2650 B.C.), as would have been the Osireion of Sethy I that would have been adjusted to the visibility of Phecda and Megrez, when the vertical transit of these two stars actually occurred due to precession quite far from the Meridian, as demonstrated in Figure 8.24c.

However, it is plausible that the "rising" or "setting" of Alkaid (ηUMa) close to due-north was the most common celestial configuration chosen to establish the Meridian line during the New Kingdom in Abydos as shown in Figure 8.24d. Interestingly, as in the case of Hierakonpolis, we believe that by rotating the astronomically determined axis by 45º, the temple entrances in the area of Abydos would be nearly perpendicular to the Valley of the Nile in the area (not necessarily with the river itself), once more in rough agreement with the Nile hypothesis.

Nevertheless, the most interesting group of monuments surely pertaining to Family VII is that formed by the Million Year and nearby temples of Western Thebes (see Figure 8.25). Here, the northern horizon of the temples, except in the case of Seti I, is hidden by the Theban hills which distend large angular heights from 4º to more than 10º. However, we can easily demonstrate that most of the buildings would have had a reasonable link with the risings or settings of certain stars of *Meskhetyu* during the New Kingdom and beyond. Among these temples, we have some interesting cases and a few exceptions. Among the exceptions, we can include the Million Year temple of Amenhotep III and its fine witnesses the Colossi of Memnon, which we strongly believe were orientated to sunrise at the winter solstice and hence deserve a different analysis (see Fig. 8.2). Actually, Betsy Bryan has proposed that this temple was a sort of huge celestial diagram. Among the interesting cases are the couple of temples at Medinet Habu and the Ramesseum.

Figure 8.26 shows the northern horizon as seen from the outer court of the Ramses III temple at Medinet Habu. One topographic feature stands out from the rest of the landscape, the plateau aspect of a section of the cliffs of Deir el Bahari which covered a range of azimuths of ~6º. Alkaid would have risen over this feature to provide the orientation of the Amon temple on site at the time of Thutmose III, the constructor of this temple together with Hatshepsut *c*. 1450 B.C. A quarter of a millennium later, the Million Year temple of Ramses III was built close-by. On this occasion, however, a much better orientation (2½º vs. 8º) was achieved by the observation of the rising of another star of *Meskhetyu* (possibly Phecda) on the same topographic feature.

We shall now take into account a building whose plan and orientation has been a puzzle for most Egyptologists. The Ramesseum (see Figure 8.27) has a trapezoidal plan that makes it difficult to define an axis of symmetry for the complex. We have defined two primary axes on site: the first is the one which permits a clear view from the sancta sanctorum all the way long to the entrance of the complex (Main Axis) and the second is the line perpendicular to the main pylon. They differ by ~2º, showing that Ramses II perhaps faced two possible alternatives in defining the orientation of his Million year temple. In this respect, Badawy suggested that one of the causes for the double axis could be the early temple built on site by Seti I with the same orientation as the Main Axis of the Ramesseum. This would imply that Ramses II respected an older axis but also established a new one (that of the pylon) for his own temple.

In neither of these two cases, have we found any reasonable hypothesis that could explain this double orientation if the actual directions are taken into account, either in looking out (to the river) or looking in (to the mountains), or even considering the perpendicular directions (±90º). Prosaic interpretation, for example such as arguing that the Ramesseum is orientated to Luxor temple must be abandoned since it is unable to explain the dichotomy or is simply wrong. So we believe that once more the quarter-cardinal family is the solution. From the Ramesseum, the Theban hills extend near due-north, with a height between 4º and 5º, depending where you are located within the complex. At the time of Ramses II (*c*. 1250 B.C.), four stars of *Meskhetyu* were circumpolar in that direction, another star (Alkaid) would offer a wrong alignment and two, Merak and Phecda, offer reasonable alternatives to obtain an orientation close to the Meridian. So we play with the idea that the Main Axis, or its parallel for Seti's temple, might have been obtained by the observation of the setting of Phecda and the perpendicular to the pylon by the setting of Merak. We could also speculate that the topographers of the king were facing the problem of which orientation was the correct and which star should be definitively chosen, their solution being to select two axes so that the temple would be appropriately orientated.

Another good example of the quarter-cardinal family is the group of temples and chapels at the frontier fort of Zawiyet Umm el-Rakhman (ZUR) from the reign of Ramses II. The excavation of the Liverpool University leaded by S. Snape at this outpost of the Egyptian kingdom has revealed the well preserved foundations of a stone temple (see Figure 8.28), another minor temple, a few chapels and a monumental gate.

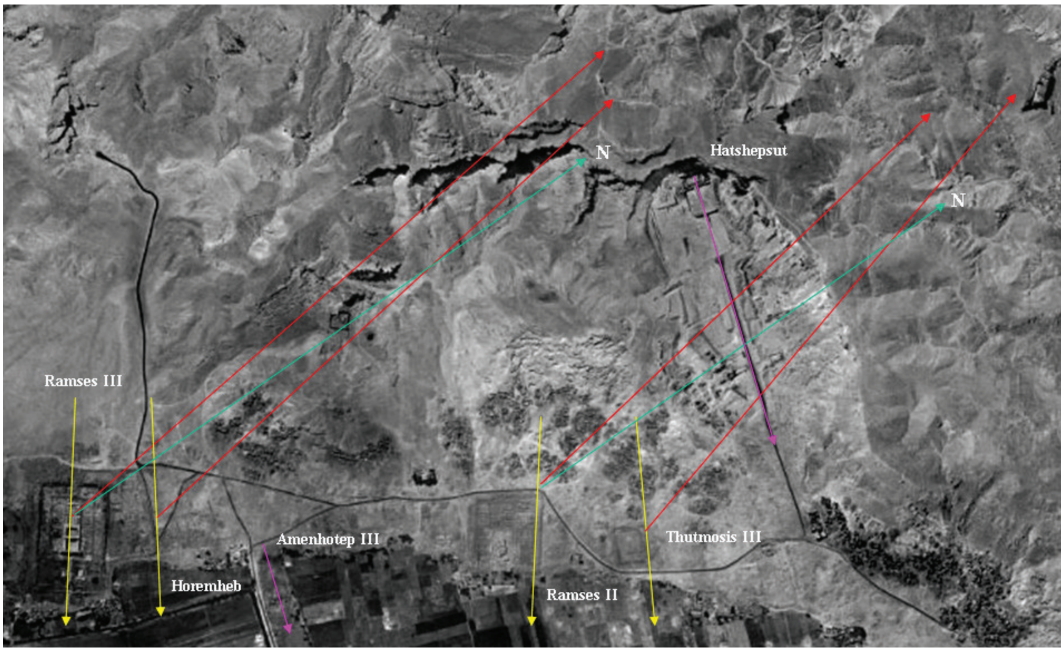

Figure 8.25. The orientation of the Million Year Temples in Western Thebes obeys two different patterns. On the one hand, there are temples orientated to winter solstice sunrise (purple lines) and perpendicular to the Nile flow. On the other hand, a handful of temples were first aligned (red lines) by the observation of the setting of certain stars of *Meskhetyu* in the hills close to due north (green line) while the final axes of the temples (yellow line) were achieved by rotating these alignments by 135º in the clockwise directions. See the text for further discussion.

Figure 8.26. The cliffs of Deir el Bahari (arrow) seen as a flat-topped plateau, with an angular height of some 5¼º, from the temples of Medinet Habu. The buildings of this sacred area, including the 18th Dynasty temple of Amon (right) and the Million Year Temple of Ramses III (left), may have been orientated through the observation of the rising of appropriate stars of *Meskhetyu* at a different period at this perfect spot on the horizon. Photograph by J. A. Belmonte.

Figure 8.27. The Ramesseum of Thebes as seen from the top of the Theban Hills. This fantastic monument has a bizarre trapezoidal planning with at least two main axes of orientation. This may have been the result of construction constrains possibly connected to the two different axes of orientation established by the observation of near north settings of two stars of *Meskhetyu*, notably Phecda and Merak, in the cliffs above Deir el Bahari. See the text for further discussion. Photograph by J. A. Belmonte.

Figure 8.28. The temple of Ramses II at the border fortress of Zawiyet Umm el-Rakhmam (*c.* 1270 B.C.). Orientated to an azimuth of 133º, almost parallel to the contemporary Ramesseum 700 km. distant, this would be a good example of the quarter cardinal family although in this case a simultaneous Nile orientation was obviously not mandatory. Photograph by J. A. Belmonte.

The measurements at ZUR (see Appendix II) show that most of the buildings have an azimuth near 45º or 135º. We believe that during the probable foundation ceremony of the fort, a N-S line was first sought, then it was tilted 45º and the almost square plan of the fort built following this new axis (that of the main gate). Afterwards, as in the Roman cities of Northern Africa studied by the first author and his Canarian colleagues, the temples would simply have repeated this square plan. It is surprising how the same procedure, possibly "invented" to cope with the restrictions of Nile orientation (see below), was repeated in the distant arid shores of the Mediterranean, hundreds of kilometres away from the river. This fact may suggest that the quarter-cardinal method of alignment was very important at this particular period.

Later on, in most of the temples of Million Years at Thebes, the axes of the monuments were later rotated by 135º from the astronomically determined N-S line. By doing this, the temple façades were almost perpendicular to the Nile but not exactly. As we have shown in Fig. 8.5 and will further discuss below, it is the solstitial line which is perpendicular to the Nile at the site of ancient Thebes and the result of the quarter-cardinal exercise does not give a completely satisfactory result.

We now believe that in early Egyptian history there was a conflict between two issues about temple orientation. In order to fulfil religious requirements: (i) a temple should be orientated according to the celestial realm, and (ii) a temple should be orientated according to the Nile. The quarter-cardinal family of orientations was the solution found to the problem in many areas of the country, notably Upper Egypt. A preliminary axis (generally a N-S line) would be established through astronomical observations (we believe mostly from stars of *Meskhetyu*) and later by rotating this by 45º or 135º (or even 90º as we have seen) the definitive axis of the temple, perpendicular or nearly perpendicular to the Nile (sometimes parallel), would have been obtained. This intelligent procedure was applied from the very dawn of Egyptian history at Hierakonpolis to the Roman era (the Serapis temple at Luxor or the temple of Kom Ombo are members of the family). It would have been so common that even when there were no Nile restrictions, as in ZUR in the Mediterranean coast, the procedure was applied.

As a corollary of this result, and applying Ockham's Razor, we suggest that our team's early proposals about the orientation of individual or groups of temples of this family to bright stars like Vega or Arcturus (for positive declinations), or to the stars of the Southern Cross and α and β Centauri (for negative ones), should be taken with extreme cautions o even directly rejected.

8.2.3. *Evolution in time and space. The history of a process*

One advantage of having such a great volume of data at our disposal is that it becomes possible to perform comparative analyses with independent series. We have imagined two such experiments, one with the data of temples separated by historical period and another by geographical location. The results of the first are presented in Figure 8.29, where panel (a) shows for comparison the declination histogram of the whole series, panel (b) for the most ancient temples from the early dynastic period to the Old and Middle Kingdoms, panel (c) is for the temples of the New Kingdom and the Late Period up to the Persian conquest and, finally, panel (d) from that moment to the end of the pharaonic era, including the Ptolemaic and Roman periods.

The results of the study by geographical location are presented in Figure 8.30. Panel (a) repeats for completeness and ease the same histogram as panel (a) of the previous figure, panel (b) stands for the temples of Lower Egypt from the province of the “White Wall” (area of Memphis) to the sea, panel (c) is for classical Upper Egypt, including what today we know as Middle Egypt and also Lower Nubia up to the Sudanese border, and panel (d) shows the data of all the temples of the deserts and oases of Egypt from Siwa to the Sinai. The three series of both analyses have a large enough number of monuments for the comparison between the different series to be considered realistic and statistically significant.

The comparative analysis will be performed by families of orientations and we will try to recognize effects such as possible evolutions, period specialization or geographical peculiarities.

Family I is very interesting. Indeed it is never appropriately working as “equinoctial” as may clearly be seen in the successive panels of Figs. 8.29 and 8.30. This justifies the fact that we will simply call it the eastern (cardinal) family from now on. It appears in the oldest periods and predominantly in Lower Egypt. Certainly, it is mostly related to the pyramid complexes of the Old and Middle Kingdom. It shows values of the declination of –¾º and –¼º, for 8.29b and 8.30b, respectively. These values do not fit either the astronomical equinox or the mid-day between the solstices (the so-called “megalithic” equinox), recently discussed by Ruggles in his *Who´s equinox?*, and by González and Belmonte in their *Which Equinox?*

However, considering this possibility, we suggest that we could be facing a situation similar to that of the quarter-cardinal family. Primarily a Meridian axis would have been established for the pyramid complex (see Fig. 8.15) and then the gate of the temple would have been open to the east afterwards, in order to face sunrise and to accomodate the topographical requirements of the Nile. This idea would be reinforced by the fact that, in later periods and, especially, for other geographical areas, eastern orientations were either imprecise (–1º, –2¾º and again –2¾º for Figs. 8.29c, 8.29d and 8.30d, respectively) or simply absent (see Fig. 8.30c).

The solar temples of the 5th Dynasty would be a particular exception, as we will show in Section 8.3.3, since the original intention of their orientation may have been to face sunrise at *Wepet Renpet* (Egyptian New Years´s Eve) at the moment of their construction.

Family II is associated with the winter solstice and it is ubiquitous in time and space. This demonstrates its importance. It is dominant during the New Kingdom and in Upper Egypt (see Figs. 8.29c and 8.30c, respectively). Curiously, there is a peak related to summer solstice (II+) both in Fig. 8.29b (OK and MK) and Fig. 8.30d (Oases). We propose that the former may be associated with an interest in this time-marker during the Old Kingdom that might be related, among other aspects, to the foundation of the civil calendar (see Chapter 4). The latter would express the general interest in solar orientations in the outskirts of the Nile Valley as already discussed in Section 8.2.1.

However, there is one peculiar and striking fact of the peaks related to Family II in Fig. 8.29. We have obtained values of –24½º±¾º, –24¼º±¾º and –23½º±¾º for the peaks of the earliest (b), middle (c) and latest (d) periods, respectively. All these values are in agreement, within the errors, with the extreme values of the solar declination in the respective periods. However, we have detected a certain trend towards lower declinations (in absolute values) versus time which perhaps, and this is quite speculative, may be related to the decreasing value of the Ecliptic obliquity during Egyptian history.

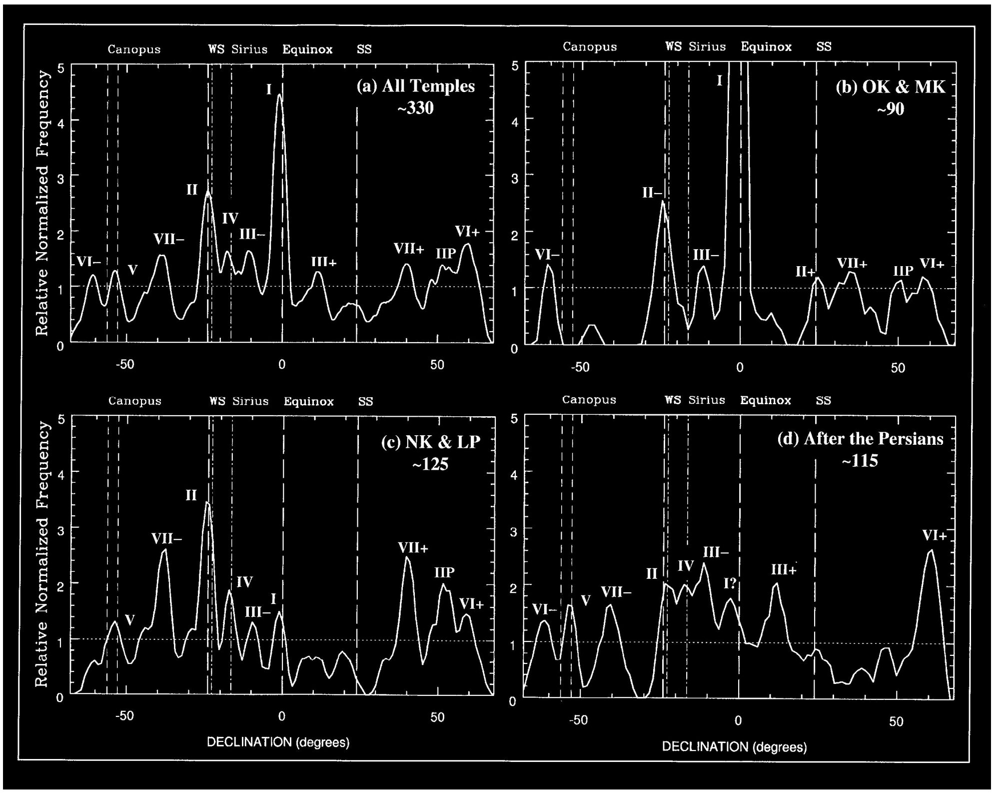

Figure 8.29. Histogram of declinations of the temples on ancient Egypt versus historical period. (a) Total histogram of our sample of 330 temples showing the 7 families of orientation, including those like III, VI and VII with positive and negative subfamilies. (b) Temples from the pre-Dynastic period to the end of the Middle Kingdom. (c) Temples of the New Kingdom and the Late Period until the Persian conquest. (c) Late temples with a dominance of buildings of the Graeco-Roman period. The three series of data plotted in panels (b), (c) and (d) are independent of each other and are statistically significant. Notice the persistence of several families of orientation across time and the fluctuations of some others. In panel (b), the peak of family I rises to more than 12 but has been cut to keep the same scale in the different plots. Long dashed lines stand for equinox and solstice declinations. Plot lines as in Fig. 8.12.

The obliquity of the Ecliptic (the angle between the Earth rotation axis and the perpendicular to its orbit plane) is diminishing at a rate of ~0.46 seconds of arc per year. It varied from some 24º to 23º 37’ from 2900 to 1 B.C. If we are to believe the figures yielded by our solar alignments (of families I and II, fundamentally), one might suggest that our solar orientations were obtained when the disc was completely above the horizon. Indeed, this would not mean that ancient Egyptian were familiar with this physical phenomenon. The trend would simply be a collateral effect of their continuous interest in the phenomenon across time and the orientation of temples accordingly.

We have largely discussed Family III and in these new studies it is demonstrated that seasonal orientations (predominantly associated to peak III–) were present in all periods and geographical areas.

Family IV has two peculiarities. On the one hand, it is not apparently present in the oldest monuments, on the other, it is absent from the temples of the deserts and oases. We suggest that the explanation for the former could rely on the lesser importance, in certain aspects, of Sirius (*Sopdet*) in the earliest phases of Egyptian history. In the second case, the solution may result from the fact that *Sopdet* was most important because of her connection with the arrival of the waters of the Inundation. In lands where this phenomenon was not present, and thus irrelevant, temples orientated to this prominent star were not so “mandatory”.

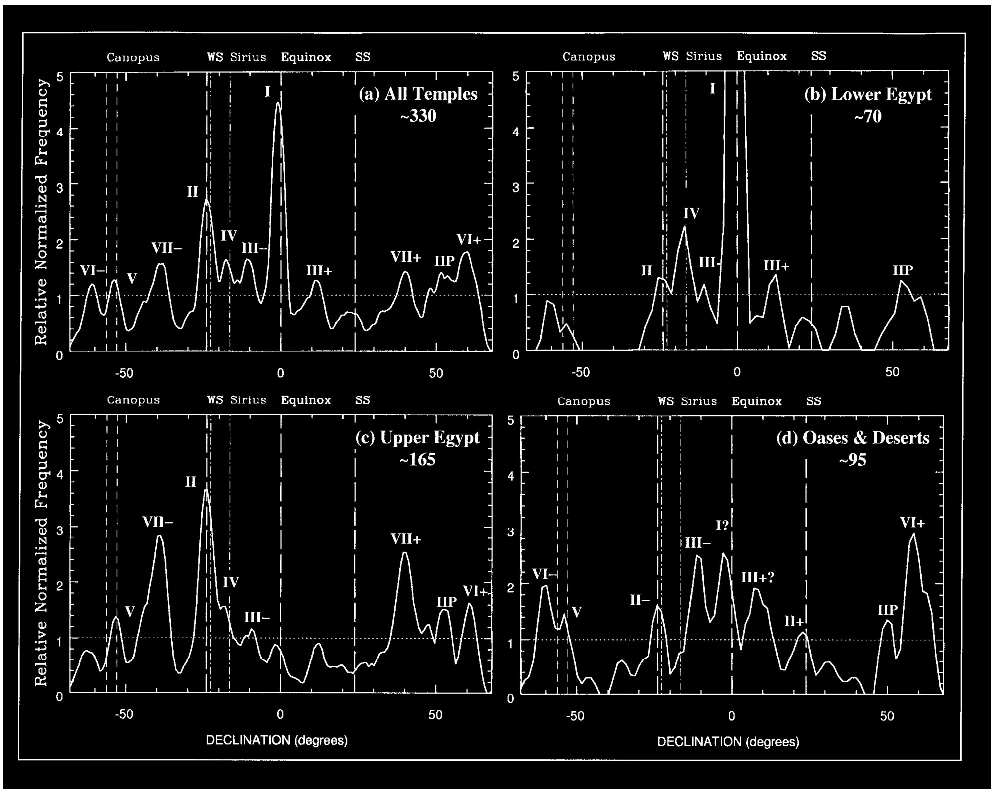

Figure 8.30. Histogram of declination of the temples of ancient Egypt versus geography. (a) Total histogram (as in Fig. 8.29) presented for comparison. (b) Temples of Lower Egypt, from Meidum to the sea. (c) Temples of Upper Egypt and Lower Nubia, until Abu Simbel. (d) Temples of the oases and deserts of ancient Egypt, corresponding to the diagram of orientation of Fig. 8.10. Once more, the series of data plotted in panels (b), (c) and (d) are independent of each other. However, the continuity of different traditions, like the solstitial (II), across all Egyptian geography, is obvious. In panel (b), the peak of family I rises to more than 12 but has been cut to keep the same scale in the different plots. Plot lines as in Fig. 8.12.

The family of Canopus (V) has a similar behaviour, being absent also in the earliest phases. Perhaps the absence of individual stellar alignments for these period could be related to the overwhelming dominance of cardinal (I, VI and VII) and solar (II, III and again I) orientations in those periods, reflecting different aspects of the stellar eschatology and the solarisation process of the kings in these earlier phases of Egyptian history. The Pyramid Texts are crystal-clear in this respect. The Sun (or the solar bark) and the Imperishable Stars (the *Ikhemu Seku* of ancient Egyptians of which *Meskhetyu* was a fine example) are frequently mentioned as celestial destinies for the soul of the king after death.

It is now the moment to discuss the II Perpendicular family (II⊥, symmetrical to V, see Fig. 8.12). II Perpendicular is present for almost all geographical areas and almost for all periods, being especially significant during the Old and Middle Kingdoms, when we do not find Canopus orientations (family V), and during the New Kingdom when the corresponding peak is quite significant. The hypothesis we are defending (first proposed in Paper 4) is that this peak does not actually correspond to astronomical alignments to celestial bodies with a declination ~54º but rather to an axis originally orientated by sunrise (or sunset) at winter solstice (or summer solstice in a few cases) rotated by 90º in the solicited direction afterwards.

The idea came during our visit to the excavation of the Ahmose pyramid complex at Abydos, during our last campaign, when we met on site the director of the excavations, Stephen Harvey from the University of Chicago (see Figure 8.31). Once discussion got going and we had explained what we wanted to do on site, he enthusiastically asked if we could find a solution for the strange orientations of the structures he was excavating, apart from the prosaic Nile orientation, as they were absolutely abnormal for the area of Abydos, where alignments are predominantly quarter-cardinal, as we have already analysed. The preliminary analysis of our measurements on site revealed one fascinating alternative. The perpendicular clockwise direction of the main axes of three temples (and probably of the pyramid still under excavation) was that of sunrise at the winter solstice. We discussed on site the possibility that Ahmose, being a Theban, would have imported to Abydos a custom that was typical from his homeland (see Section 8.3.4).

We suggest that even some examples of Family V might follow the same rule (rotating clockwise in this sense), although there are cases where we could find perpendicular axes to solstitial alignments which were perhaps deliberately orientated to Canopus, as in the secondary axis of Karnak as defined by pylons VII and VIII, according to a recent proposal by L. Gabolde.

Figure 8.31. The excavations of the Ahmose pyramid complex by the joint University of Pennsylvania-Yale-Institute of Fine Arts New York University Expedition at Abydos, showing the foundations of several temples of the complex. Most of these temples would belong to a particular family of orientations, II perpendicular (II⊥ or IIPer) which might have included buildings orientated to winter solstice sunrise, whose axis was later rotated by 90º in a anti-clockwise direction. Photograph by J. A. Belmonte by kind permission of Stephen Harvey, the Director of the excavation.

The cardinal family (VI) is present during all periods of Egyptian history and in most areas of the country. Northern orientations (VI+) are dominant to southern counterparts (see Figs. 8.29 and 8.30), a fact presumably reflecting that N-S orientations were predominantly, if not exclusively, traced to the north. Curiously, we have only an insignificant presence of the family in Lower Egypt, where eastern (cardinal) orientations are predominant. However, this could be related to the fact already mentioned that most eastern cardinal orientations would have originated as northern cardinal orientations.

Finally, our analysis shows two peculiarities for the quarter-cardinal family (VII). On the one hand, it is most typical of the New Kingdom and the early Late Period, when it is only second to the solstitial family and, in a certain aspect, substitutes family VI which is scarcely represented. On the other hand, it is practically exclusive to Upper Egypt. This could relate to the fact, already analyzed, that this procedure of orientation was developed simultaneously to accomplish stellar and river orientation requirements, in the Nile Valley.

As a summary of our exercise on evolution in time-and-space, we might reach the conclusion that actually only three conventions of orientation were present in ancient Egypt throughout her land and her history: cardinal (i), solar (ii) and stellar (iii).

i. The cardinal convention would be incorporated by families I (in most occasions), VI and VII and would be achieved by the observations of certain configurations of stars in the north (predominantly, if not exclusively, stars of *Meskhetyu*). This procedure would initially give a near Meridian axis that would later offer various alternatives: a gate opening north, a gate opening south, a gate opening east (or west) or a new axis by turning the original by 45º or 135º, with the gate opening near NE (or NW) or SE (or SW), respectively.
ii. The solar convention is formed by families I (in a few occasions), II, II⊥ and III and would basically be related to important points of the annual cycle, or in some cases to special dates in the civil calendar such as *Wepet Renpet* or the eves of the other two seasons *Peret* and *Shemu*. Paradigmatic examples would be the 5th Dynasty solar temples at Abu Ghurob (I) and Karnak (II and II⊥), which will be analysed in depth in the case studies, and Abu Simbel (III).
iii. The stellar convention would be represented by families IV and V. We have no doubts of the pertinence and the relevance of the alignments to *Sopdet*. However, we have minor doubts as to whether many of the presumed alignments to Canopus ought to be interpreted in a different way. In this case, it is problematic whether new field data can provide a final answer. Hence, new epigraphic information confirming the importance of this star is highly desirable.

A final point to discuss is how once an alignment was provided by astronomical observations in a certain direction, the new axes at 45º, 90º, 135º (in both clock-wise or anti-clockwise directions) or 180º were obtained. The answer to this question may be found in Chapter 7, where it has been suggested that the sign of Seshat (the divinity mostly involved in temple orientation ceremonies, notably the stretching of the cord), carried by the goddess upon her head in all representations, might perhaps have been a schematic and symbolic representation of an archaic transit instrument, similar to a Roman *groma*, that would have later become the emblem of the goddess. This instrument would have had eight radii and a viewpoint, and could have been used at the "stretching of the cord" ceremonies since the dawn of Egyptian history, directly offering the eight directions under discussion from a single astronomical or topographical observation.

8.3. Some case studies: when astronomy and topography combined to organize the Cosmos

In the previous sections of this chapter we have dealt with a series of generalities that have largely demonstrated the important role that sky-watching played in the alignment of temples in ancient Egypt. In the next section we shall study in depth a few of the most striking cases which will certainly help further to emphasize this fact and, in most of cases, how this combines with local topography or geography on a larger scale in order to fight chaos and maintain cosmic order.

Two studies refer to some of the most famous archaeological sites in Egypt, the Giza Plateau (8.3.2) and the Karnak Complex in Luxor (8.3.4). Others analyse important moments of Egyptian history, such as the beginning of the Old Kingdom (8.3.1), the triumph of the solar cult (8.3.3) or the end of the New Kingdom and the creation of a new capital city (8.3.5). Finally, we will devote a few paragraphs to one of the most enigmatic temples of Egypt, Serabit el Khadim, and the problem of precession (8.3.6). For those readers who may have an interest beyond this, some additionally important cases are studied in the relevant sections of Papers 1, 2, 3 and 4.

Figure 8.32. The *serdab* of Neterirkhet (popularly known as Djoser, *c.* 2630 B.C.) in the north-eastern corner of the Step Pyramid at Saqqara. This tiny chapel contains a statue of the king (actually a replica) facing the two openings visible in the northern wall. Both openings (or sighting devices) have a certain inclination and orientation and would have permitted the "king" to envisage the court in front of him or, perhaps, some celestial events happening in the appropriate area of the firmament. Photograph by J. A. Belmonte.

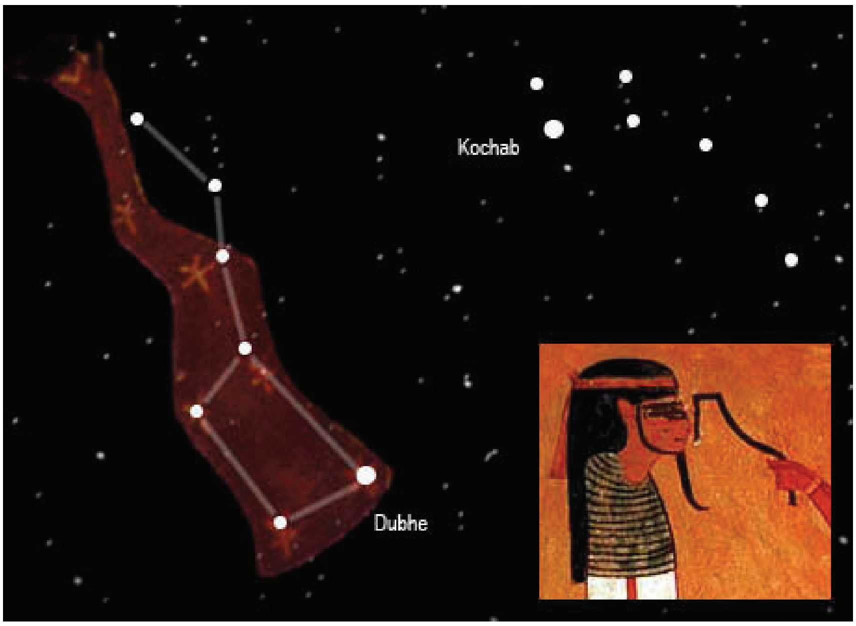

Figure 8.33. Celestial diagram of the northern skies as seen from Saqqara at the time of Neterirkhet. The two sighting devices of the *serdab* would have been positioned facing towards the lower culmination of the circumpolar stars Dubhe (α UMa) and Kochab (βUMi). These were located within the two "celestial adzes" (the Dippers) at the most relevant position of the devices for the important opening of the mouth ceremonies, as shown in the image from the tomb of Inherkha at Deir el Medina (*c.* 1150 B.C.). See the text for further discussion. Celestial diagram by SMM/IAC. Photograph by J. A. Belmonte.