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The Egyptian Civil Calendar: a Masterpiece to Organize the Cosmos

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Abstract. The ancient Egyptians had just one calendar in operation, the civil one, during most of their history and before the overwhelming influence of Hellenic culture. This calendar may have been invented for a specific purpose in the first half of the third millennium B.C., when the previous local Nile-based lunar calendars were rendered useless, as the result of the unification of the country and new social, economic and administrative requirements. The civil calendar always started at the feast of *Wepet Renpet* in the first day of the first month of the Inundation season (I *Akhet* 1). Its peculiar length of only 365 days (without leap years) might have been established from simple astronomical (presumably solar) observations. Consequently, *Wepet Renpet* wandered throughout the seasons in a period close to 15 centuries. Our research has shown that this phenomenology was reflected in the Egyptian worldview by the orientation of most important sacred structures accordingly.

1. Creating a Calendar in ancient Egypt: the Nile-solar Paradigm

The civil calendar of ancient Egypt consisted of 12 months of 30 days each, grouped into three seasons, which from the very beginning received the names of *Akhet* (translated as Inundation in Greek texts), *Peret* (translated as Winter) and *Shemu* (translated as Summer). Each of the months was divided into three decades of 10 days. This 12 month year amounted to a total of 360 days. Normally, a civil date is expressed by a number for the regnal year (each reign represented a new era in ancient Egypt), followed by a set comprising a Roman numeral for the ordinal month within a season (similar to the actual Egyptian strokes for the numbers), then the season proper and finally the day of the month. One example is III *Akhet* 26, which reads as the 26th day of the 3rd month of the Inundation. However, it is highly probable that we should read 26th of Hathor, exactly as we write 29/02/2008 but we read 29th of February of 2008. To the end of this year of 360 days, five extra days known as the “Five above the Year” or epagomenals, were added throughout most of Egyptian history. With the epagomenals, the civil year completed 365 days, a number very close to the length of the tropical year (the seasonal year) which in 3000 B.C. lasted for some 365.2425 days. Consequently, the civil calendar has frequently been quoted as the Egyptian “solar” calendar, which, to a first approximation and in one generation (25 years) would be a very appropriate term.

However, one peculiarity of the civil calendar is that no days were added to the standard 365 (as we do in leap years) and so the civil dates wandered through the seasons, completing a circuit in nearly 1506 years. The Egyptian skywatchers probably know that the tropical year was almost a quarter of a day longer but they never did anything to resolve this fact. Consequently, important astronomical events, such as the stations of the sun (solstices and equinoxes) and the heliacal rising or settings of stars would also wander through the civil year, there being roughly a one day's delay every four years and one month's delay every 123 years. One of the bases of Egyptian chronology is that no reform was performed (although it was attempted) so that the seasons were wandering through the civil year, from the creation of the calendar, in the early third millennium B.C. to Augustus' reform and the creation of the Alexandrian calendar in 23 B.C.

Precisely due to the vague character of the civil year, Neugebauer (1942) pointed out that *every theory of the origin of the Egyptian calendar which assumes an astronomical foundation is doomed to failure*. As an astronomer, I regret such an affirmation because the vast majority of cultures worldwide and throughout history has used the observation of the heavens as the most reliable way of time-keeping, leading eventually to the creation of a calendar. So the origin of the 365 day year is a highly controversial issue that has been far from achieving a consensus. Can we put forward a reasonable solution?

Since the beginning of Egyptology, several theories have been proposed, discussed and established on a certain basis, with more or less success, and almost every specialist in the topic has tried to postulate his own hypothesis. The most reasonable have been: (a) A Sothic origin, 365 being the average value of days between two successive heliacal risings of the star Sirius (Sothis in Greek, *Sopdet* in ancient Egyptian). This has been defended by several scholars since the very beginning of Egyptology (even before the decipherment of hieroglyphs), because several classical sources associated the rising of Sirius with the beginning of the Egyptian year. Considering the length of the Sothic cycle as 1460 years, the inauguration of the civil calendar would have been around 2781 B.C. (b) A solar origin, based on the determination of the period of time between two successive repetitions of the same station of the sun, either a solstice or an equinox. This was never seriously considered (the previous hypothesis was more popular). (c) A lunar origin, based on an average lunar month and an average lunar year. Parker (1950) was the champion of this hypothesis, based on his defence of a lunar calendar heralded by Sirius. (d) A Nilothic origin, based on the average value of the interval of days between successive Nile risings. Neugebauer (1942) was the pioneer of this idea.

The hypothesis we are now defending is a mixed of (b) and (d). According to this, the civil calendar would be the result of a combination between an old local Nilotic calendar with precise timing solar observations. A deeper analysis of the process, discussing the alternatives, can be found in Belmonte (2008). Here we will concentrate only in the basic points.

Neugebauer (1942) sought that origin of the Egyptian calendar in the inundation of the Nile. Each year, the heavy monsoon rains on the Ethiopian Plateau produce the rising of the waters of the Blue Nile. By early spring the waters reach Khartum and the White Nile, moving north at such a rate that they reach the first cataract and the traditional frontier of Egypt at Elephantine at the latest for the time of the summer solstice (Gregorian 21^{st} of June) and Memphis some 10 days later. Actually, the phenomenon, although cyclic, is highly non-periodic and relatively unpredictable, with reported risings of the waters arriving at Cairo (or Memphis) as early as April 25 and as late as July

3. This means that, within two consecutive Nile risings, a period as short as 10 lunations or as long as 14 might have elapsed.

For the inhabitants of the Nile valley, the most important fact of their year would undoubtedly have been the arrival of the new waters, which would control the whole vegetative cycle and, as a consequence, the economic life of local societies. Indeed, the arrival of the Inundation (as the name of the first season might show, see below) may have acted as the herald of that calendar and as the point to start counting the moons. When the unified state was formed, it was necessary to unify the criteria for the entire country and a new calendar ought to have been developed. This new calendar would be the civil one. One important fact is that, considering the high variability of the arrival of the inundation, only after two or three centuries would this Nile calendar be considered as no longer accurate (when I *Akhet* 1, also known as *Wepet Renpet*, was systematically ahead of the arrival of the inundation anywhere in Egypt), and consequently, he argues, the Egyptians were forced to adopt a new criterion for the flood, which happened to be the reappearance of the star Sirius (i.e. *Peret Sopdet*). I find this last point quite probable.

A few years ago, when visiting our institution, the German Egyptologist and chronologists Rolf Krauss offered me a completely new perspective for the Palermo Stone, the largest fragments of a stela with the annals of the first five Egyptian dynasties. For me it was a revelation to learn that Palermo contained a clue to the importance of the Nile year in ancient Egypt. Krauss interpreted a certain series of registers in the annals as reflecting a single year, straddling two first dynasty reigns, and amounting to a total of only 10 months and 20 days. Of course, this “year” is too short for either a civil year of 365 days or even for the shortest possibility for any kind of lunisolar or lunistellar year (354 days). However, it fits a Nile year perfectly, in which a period between 315 and 320 days has elapsed between two successive measurements of the lowest (or highest) level of the inundation. From my point of view, this is perhaps the best proof, not known to Neugebauer, of the possible existence of a Nile-governed calendar before the invention of the civil one.

Another proof would be the names of the seasons. The names of the three seasons *Akhet* (from the root “to be verdant”, Depuydt 2007), *Peret* and *Shemu* are normally translated as Inundation, Winter or Growing, and Summer or Harvest, respectively, on the basis that this set of names was apparently related to an agricultural year. However, they also perfectly fit the ecology of the process followed by the Nile in a yearly cycle. On the one hand, when the waters started to rise, more or less at the period of the summer solstice a formidable biological process occurred. Millions of micro-organisms, whose parents had been dormant for months in the waters of the river, blossomed as the level of the waters started to rise, changing the water colour from a pale blue-grey to a dark green. This would last for several weeks until the typical red waters, full of sediments of the Ethiopian Plateau, become dominant. This idea would fit epigraphy and nature and *Akhet* could be translated as the arrival of the Inundation in the sense of becoming verdant. On the other hand, the other two seasons may refer to other important periods in the Nile ecology: going forth (*Peret*) of the land, after the period in which it had been covered by the waters and, finally, drought (i.e. *Shemu*), with the river at the lowest level and most of the useful water stored in

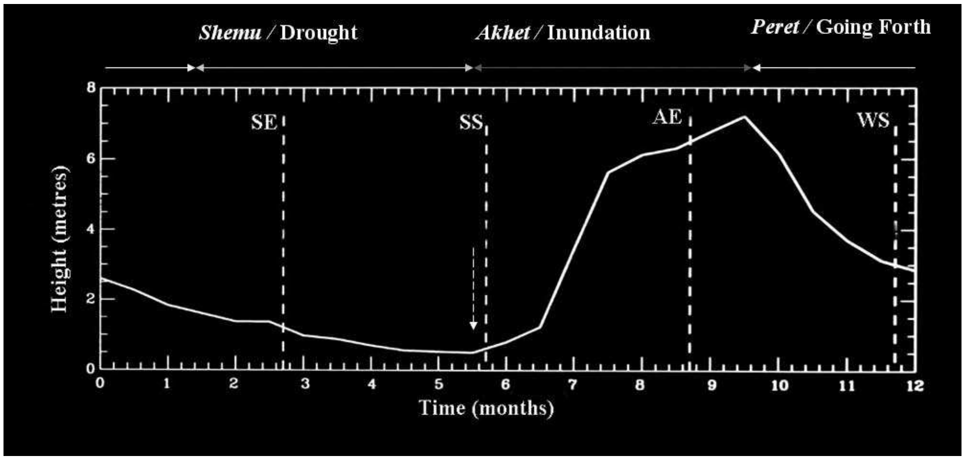

Figure 1. "Egypt is a gift of the Nile". Without the river and its inundations there would have not been Egyptian civilization and the country would be an extension of the Saharan Desert. The river controlled the economy of the country with its different ecological phases: the flooding or inundation often starting close to the summer solstice (SS), the decreasing of the waters four months later, allowing the land to be cultivated, and the nearly four month drought period, when the level of the waters was very low. This three periods were later structured in the three seasons of the civil calendar: *Akhet, Peret* and *Shemu*.

the basins. Hence, in a calendar year, we would have a complete Nile year (see Figure 1).

Afterwards, the original meaning of the seasons was probably forgotten as time passed, especially when due to the wandering nature of the calendar they no longer adjusted the actual behaviour of the river, and, in later periods, other meanings had to be found when the names were translated into foreign languages. In this line of argument, the current Coptic meaning, that has been translated into other languages as Inundation, Winter and Summer, is perfectly explained by the fact that the Coptic year starts in August 29 Julian (today, 11 of September Gregorian). This implies that Inundation covers from late August to December (a period when the waters are high, see Fig. 1). Besides, Winter extends from December to April and Summer from late April to August. The parallelism with the traditional Mediterranean winter and summer seasons is appealing and the translation is thus obvious.

Consequently, I would be tempted to believe that, prior to the invention of the civil year, the Egyptians did have a year connected with the Nile. The logical way of operating it would have been to wait for the arrival of the rising waters and then start to count the months, in this case obviously lunar months, with the first subsequent conjunction or the first crescent visibility. This Nile year would then run until the next rising of the waters or perhaps until the end of the harvest epoch. Such a calendar would have been efficient for a small local community, but would have had some problems for a centralized state.

On the one hand, although average years would normally have been 12 or 13 lunar months long, they might occasionally have included only 10 or 11 lunations or as many as 14 lunar cycles. On the other hand, since the flood lasted some 12 days from Elephantine to the Mediterranean, different communities along the river (to the north), would surely have started their year one month after other groups to the south of the country, whenever a new lunar month had started in any of those 12 days. Once the country was unified, such a situation must have been unacceptable. Obviously, a reform was absolutely necessary. For the new calendar, two solutions were adopted: first, a standard month of 30 days was created, very probably taking as a model the synodic month; then a year of 365 days was inaugurated with an origin that, despite Neugebauer, I maintain was astronomical. Both processes are from my point of view intimately related to each other and, at the same time, to the Egyptian way of understanding the cosmos.

Apparently, from the very beginning, the Egyptians used a base ten counting system, which was also applied to time-keeping, as it is the origin of the decades, an extremely important period of time throughout Egyptian history. A lunar synodic month is on average $29\frac{1}{2}$ days long. In many societies, the best way to approach $29\frac{1}{2}$ is by the alternation of 30 and 29 day periods. However 29 is not divisible by 10 and when creating a new average month, the Egyptians might have preferred to choose a single value that, at the same time, could easily be counted in three decades. For the origin of the 365 day period, I will introduce a new astronomical concept which, from my knowledge, has been hardly taken into account in Egyptian historiography. In the second half of the 3^{rd} Century B.C., the Alexandrian scholar Eratosthenes made a revolutionary measurement of the circumference of the Earth [Cleomedes, *De motu circulari corporum caelestium* I, 10]. To accomplish this, he made use of what must have been a well known fact to contemporaneous Egyptian society, that the noonday sun at the summer solstice was able to illuminate the water at the bottom of a very deep well in the city of Syene (Aswan). This happened because at that exact moment of the year and at that latitude the sun (in fact only part of it, see below) passed exactly overhead. This is a phenomenon known as the zenith pass.

This phenomenon happens in two occasions each year only in those places located between the tropics of Cancer and Capricorn, which of course receive the name of tropical zones. The limits are located exactly at the tropics, where the sun has a zenith pass only once at the day of the local summer solstice, when it reaches its maximum declination. Curiously, in 3000 B.C., the maximum declination of the sun was 24° 5', exactly the latitude of central Aswan and, of course, of one of its most important areas, the island of Elephantine. The island of Elephantine was already at that time a very important settlement and archaeology has shown that a sanctuary (and perhaps a Nilometer) was already in operation on the site of the later temples of the goddess Satet and the god Khnum (the divinities of the first cataract and of the inundation) at least from 3200 B.C. Was the zenith pass observed at Elephantine in that epoch? I suggest that it was and, going even further, I speculate that this would have been in fact the way to determine the length of the (solar) year as 365 days.

We have not yet considered the interval between two sunrises or sunsets at consecutive summer solstices (or winter solstices) as a good candidate for the determination of the period of 365 days because it had been argued that, within a short time, it would have been obvious that the exact moment of the

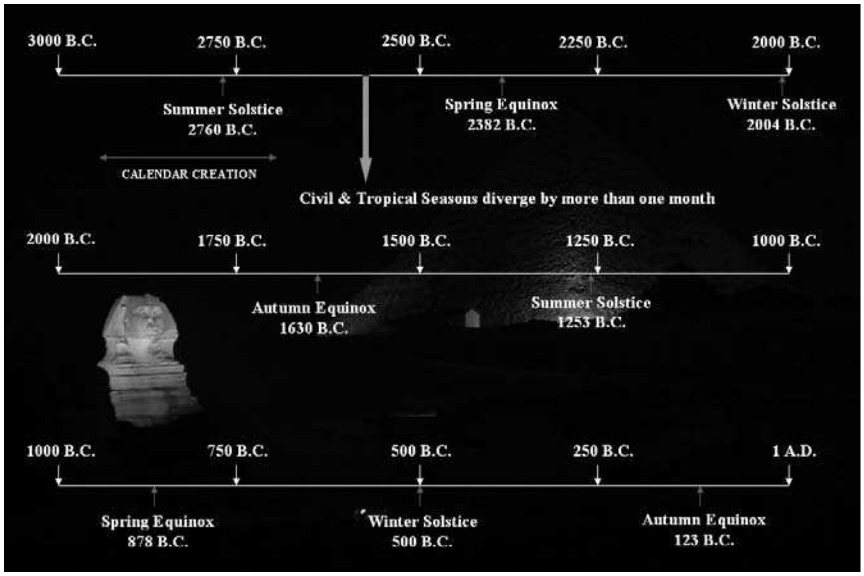

Figure 2. Diagram showing the evolution of the wandering *Wepet Renpet* with respect to the seasons and the corresponding stations of the sun. Since the creation of the calendar in the early dynastic period, there were some important milestones of this evolution such as the concordance with spring equinox in the 5th Dynasty, when solar temples where erected, with winter solstice at the beginning of the Middle Kingdom when Thebes and its solstitial alignments became relevant, and with summer solstice during the reign of Ramses II, when civil and tropical seasons once more became coincident for the first time after the creation of the civil calendar.

solstices was moving backwards in relation to the civil year. However, this is not exactly true. During the solstices, the sun stands at almost the same declinations for several days and hence its rising or setting positions arrived at a standstill (hence the name). Even if the proto-dynastic period Egyptians were able to determine precisely these positions on the horizon, they would hardly have reached a precision better than 2', equivalent to 8 days and, considering the wandering of the civil calendar of 4 years per day, it would have lasted at least 32 years before the displacement was obvious.

However, the effect becomes much more dramatic when zenith pass is considered. If the non-shadow effect on a gnomon (an obelisk or little pyramid for example, since both are known as extant monuments in early dynastic Elephantine) or either the illumination of a deep well were the phenomena observed, the length between two consecutive zenith passes would have been easily established as 365 days. But, at the same time, once the civil year had been in operation, it would have been extremely difficult to detect the displacement of zenith pass events during the months. The reason for this is that the sun is not a point source of light, but rather it has a well defined circular shape with a diameter of some 36'. That is also the reason why the illumination phenomenon was still observed in the well in Aswan in Eratosthenes's times, despite the fact that the extreme declination of the sun at that moment was of only 23° 47' due to the decreasing value of the inclination of the axis of the Earth with respect to the plane of its orbit (the obliquity of the Ecliptic). Hence, one third of the solar disc was still able to shed light on the bottom of the well.

With this fact in mind, we can even give an estimate of the interval when the civil calendar was inaugurated, provided our hypotheses are correct. Imagine that the civil year was inaugurated at the beginning of a lunar month following the summer solstice and the moment of zenith pass at Elephantine. This was also the latest average date of the arrival of the flood at this particular spot and we can thus consider it as the beginning of the corresponding Nile year. We can easily calculate that the earliest time in Egyptian history when *Wepet Renpet* coincided with the summer solstice was in the four year period centred more or less on 2760 B.C. Considering the different observables and the errors, we reach to an interval roughly between 2950 B.C. and 2690 B.C. for the inauguration of the civil calendar (slightly later dates could also be acceptable). This is an interval of time more or less between the beginning and the end of the proto-dynastic period, when several relevant aspects of the Egyptian civilization would have been developing. Indeed, the calendar could be one of them.

An important feature of our proposal is that a zenith pass event did not occur at any other important city to the north of Elephantine and thus its people would not have been cognisant of the phenomenon. This is relevant to Neugebauer's point about the impossibility of an astronomical origin of the calendar because with the nucleus of the kingdom well established in the Memphis region, nobody would have cared about the displacement of the civil year from an unobservable (for them) celestial event. Once the periods of 30 and 365 were established, the internal distribution of the calendar was forced by the simplest arithmetic: 36 decades of ten days, grouped in 12 months of 30 days, plus 5 extra troublesome days located above the year. As a heritage of the old Nile year, the set of 3 seasons was kept, with 4 months as their standard length.

To conclude my argument, I would like to stress that nobody in late Antiquity doubted that the origin of the Egyptian civil calendar was solar. The following texts are good examples of this: *"...the Egyptians organise months and years in a very special way. Relating the days not to the movement of the moon but of the sun, ..."* [Diodorus Siculus I, L]; and "*It is said that the priests in Thebes are mostly astronomers and scholars: to the priests we owe the habit of calculating the days, not according to the moon but to the sun, and to add each year 5 days to the 12 months of 30 days each"* [Strabo, *Egypt* XVII, I, 46].

One question that we could ask is what would have happened once it was obvious that the civil calendar and the climatic (ecological) seasons were no longer in agreement. (when I Axt 1 was systematically ahead of the arrival of the inundation anywhere in Egypt). This may have happened some 120 to 200 years after the creation of the calendar (see Figure 2), or nearly 500 years for a complete seasonal displacement (the complete flooding period occurring in *Peret*). I guess that further systematic astronomical observations should have been made in connection with the solstices or other cyclic annual phenomena in order to test the accurate behaviour of nature. My contention is that the relevance of solstitial observations during the Pyramid Age (Belmonte and Zedda, 2007) and the introduction of the heliacal rising of Sirius (*Peret Sopdet*) as the harbinger of the Flooding, attested at least from the Middle Kingdom onwards (Belmonte, 2003), were the collateral effects of this necessity.

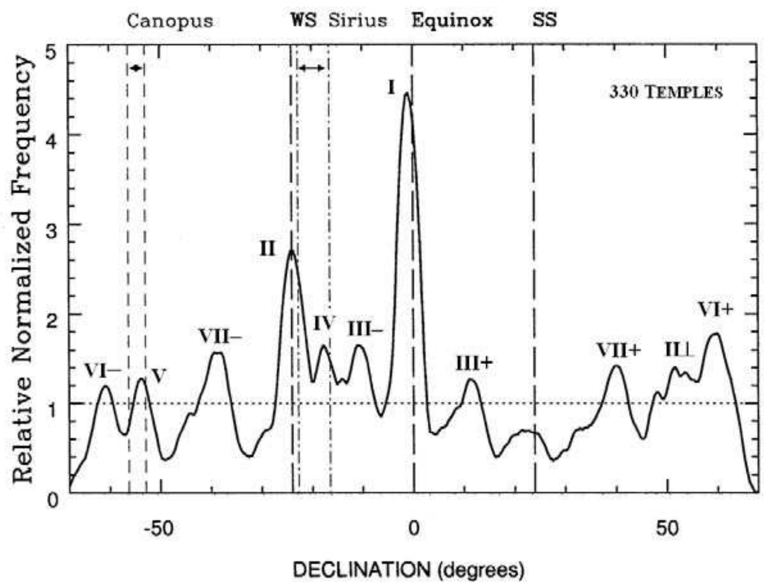

Figure 3. Declination histogram of some 330 temples of ancient Egypt obtained from the data measured in our five field campaign across Egypt. Each peak is identified by a Roman numeral referring to each of the seven families of astronomical orientations. Long-dashed lines stress the extreme and medium 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.

However, there might have been another most interesting corollary of this phenomenology which would have been related to the slow displacement of *Wepet Renpet* along the climatic (either solar or Nilothic) seasons (see Figure 2). Our contention is that this important date could have been given substance in the landscape by means of the orientation of sacred structures to sunrise or sunset at such a dramatic moment of the civil year. Indeed, if this were the case, we could count on an additional and independent astronomical procedure in tentatively dating ancient Egyptian monuments. Our archaeoastronomical research has shown that this was most likely the case.

2. Orienting temples in ancient Egypt: the *Wepet Renpet* paradigm

During the last five years, the Egyptian-Spanish Mission on ancient Egyptian astronomy and archaeoastronomy, conducted under the auspices of the Egyptian Supreme Council of Antiquities, has been performing an ambitious scientific project with the aim of studying the cosmovision of the ancient civilization of the pharaohs. 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 (Belmonte et al. 2009). More than 300 sanctuaries and temples have been measured so far. A series of successive papers (see e.g. Belmonte et al. 2008) has been published about them in which, stage by stage, we have analysed the relation 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 have shown that both components were necessary and indeed intimately correlated.

The orientation has always been taken from inside looking outside, from the sanctuary of the temple to the gate, often across several halls, courts and pylons. During our fieldwork, we tried to measure as many monuments as we were able to, in an attempt to put at our disposal as much statistical weight as possible. The idea was to put an end to the controversy about the question of whether the Egyptian temples were astronomically orientated or not. The results of the experiment are presented in Figure 3 and are very suggestive. As a matter of fact, eleven peaks are significant in the plot and we believe that they correspond to seven possible different families of astronomical alignments of Egyptian temples.

These could be classified as follows (same Roman numbers as in Figure 3, see Belmonte et al. 2009 for more details): (I) The eastern (or "equinoctial") family. The peak corresponds to an orientation to the equinoctial sun when the disk has completely risen above the horizon. This family could also 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. (II) The solstitial family. This group is dominated by a series of temples orientated to sunrise at the winter solstice. (III) The seasonal sun family. We speculate on the idea that this family had also a solar origin. This group of temples corresponds to monuments orientated to a peculiar interval of declinations related to the real sowing and harvest seasons, hence the name. (IV) The *Sopdet* family. The star Sirius was very important as the Harbinger of the actual Flooding at least from the Middle Kingdom onwards, although its name is also largely mentioned in the Pyramid Texts within the context of the stellar eschatology of the Old Kingdom. (V) The Canopus family. The stellar interpretation of this family is more complicated because we can not prove the importance of Canopus for the ancient Egyptians, notwithstanding the fact that it was their second brightest star in the sky. (VI) The Meridian (or northern) family. This clearly speak of the great importance of near-Meridian, not to say precise N-S, orientations in ancient Egypt. 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 (see Figure 4). (VII) The family of inter-cardinal directions. It is defined by those temples with an orientation close to the SE-NW and SW-NE lines and we believe that it is a subgroup of a cardinal super-family. In summary, by defining these seven families, we have shown the importance of astronomical orientations in ancient Egypt. Indeed, by analyzing the previous lines, we might reach the conclusion that actually only three customs of astronomical orientations were present in ancient Egypt throughout her land and in the course of her history: cardinal, solar and stellar.

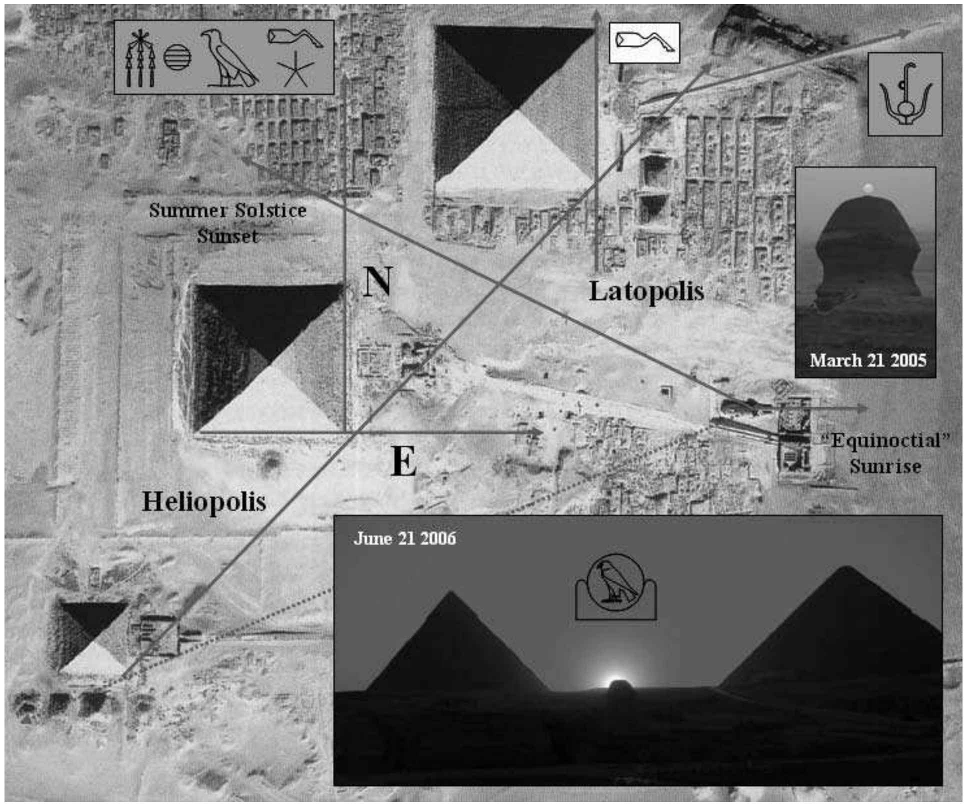

Figure 4. Schematic diagram where we show the astronomical and topographical relationships between the different monuments erected in the Giza Plateau, notably the Sphinx and the pyramids, and certain elements of the sky or nearby geography. However, in this diagram, we additionally relate the original northern orientation of the pyramids, based on the observation of *Meskhetyu's* meridian transit, to the similar name of the province which had Letopolis as capital, the Bull's Foreleg. Astronomical connections of the Sphinx with equinox sunrise and summer solstice sunset (behind *Akhet Khufu*, the Horizon of Khufu) are also stressed. Finally, the alignment of Khufu's causeway to *Wepet Renpet* during his reign is emphasized. The beginning of the reign of Khufu could be dated c. 2550 B.C., accordingly. Photographs by Juan A. Belmonte.

An important final remark would be that solar orientations were transformed at certain historical periods with a view to orientating buildings to the beginning of the seasons of the civil calendar, notably *Wepet Renpet*, I *Akhet* 1 or New Year's Eve, but also I *Peret* 1 and I *Shemu* 1. On some occasions, the coincidence of these dates with important points of the tropical year, like summer or winter solstice and spring equinox, might have acted as a mutual reinforcement in the interest of ancient Egyptians for these special days of both the tropical and the civil year. We could mention several examples such as Abu Simbel or the 5th Dynasty solar temples (Belmonte et al. 2009). However, we will concentrate in this short essay in a pair of examples related to the most famous monuments of ancient Egypt, the 4th Dynasty pyramids at Giza and the temple of Amun at Karnak.

In this sense, we believe that astronomy played a most relevant role in the planning of the monuments of the Giza plateau, with important northern alignments, probably in respect of the Imperishable Stars, notably *Meskhetyu* (*Akhet Khufu* complex, including the Great Pyramid, could have been aligned accordingly in the years centred in the interval 2559-2541 B.C.) and solar alignments of solstitial and perhaps "equinoctial" character. This is partially illustrated in Figure 4. The figure also shows the peculiar orientation of Khufu's causeway, so divergent from the standard orthogonal plan of the necropolis, which has always been an enigma. However, the solution is quite appealing if the *Wepet Renpet* case is taken into account, since the causeway may have been aligned to sunrise at New Year's Eve c. 2528 B.C., with a margin of plus 30 or minus 20 years. The concordance of this interval with the dates of alignment of the pyramids yielded by the simultaneous transit theory of two stars of *Meskhetyu* is indeed appealing. According to this, we might astronomically date the beginning of the reign of Khufu *c.* 2550 B.C., with a margin of a few years.

Regarding Karnak, in a recent work, Carlotti (2005) demonstrated that the complex of the Amon temple was surrounded during the Middle Kingdom by a village organized through a hyppodamian network whose main axis was that of the *dromos* connecting the temples of Mut and Amon. This was also the orientation of the axis of Mut temple. However, the E-W axis of this network diverged by more than 7° to the main axis of the Amon-Re temple. This fact suggests that the orientation of this temple towards winter solstice sunrise (see Figure 5) was deliberately chosen and not at all restricted by local urban necessities. This is related to a pair of additional important facts.

On the one hand, the oldest dated remains at Karnak, perhaps belonging to an earlier sanctuary, come from the pharaohs of the 11th Dynasty, while Senuseret I is credited to have been the constructor of the temple on site. We are then located in a chronological framework roughly centred in c. 2000 B.C. when due to the wandering nature of the civil calendar, *Wepet Renpet* was coincident with the winter solstice, a fact with a most probable set of social and religious consequences that we can only envisaged today. On the second hand, Karnak, and most of Thebes, is located at the only site in the Nile Valley, down stream the First cataract, where the river flows in such a way that the average perpendicular direction to the water course is the solstitial line connecting winter solstice sunrise and summer solstice sunset. We support the idea that this natural accident may have been discovered by the Egyptians and may have helped to establish the sanctity of Thebes. Consequently, wit these pair of facts in mind, we would then be facing an extraordinary case of a combination of topography, time-keeping and astronomy; a singular case of what has been called the archaeology of landscape, understanding by "landscape" not only the earthly one but also that of the sky that would have contributed to make of Karnak the most important place of cult of ancient Egypt for generations and of winter solstice orientations one of the most common and conspicuous throughout Egyptian history and geography.

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Figure 5. Sunrise at the winter solstice in the main axis of the temple of Karnak. The phenomenon would have been more accurate 4000 years ago when the temple was first aligned at a moment when the phenomenon was nearly coincident with *Wepet Renpet*. This huge complex of temples was located at one of the few places in the Egyptian geography where the solstitial line, connecting winter sunrise and summer sunset, was at the same time perpendicular to the Nile. Photograph by Juan A. Belmonte.

(IAC), AYA2004-01010, AYA2007-60213 "Orientatio ad Sidera I & II" of the Government of Spain.

References

Belmonte, J.A. 2003, TdE, Papers on Ancient Egypt, 2, 7

Belmonte, J.A. & Zedda, M. 2007, in Lights and shadows in cultural astronomy, ed. by M. Zedda & J.A. Belmonte, 188 (Agora Nuràgica, Dolianova)

Belmonte, J.A., Shaltout, M. & Fekri, M. 2008, JHA 39, 181

Belmonte, J.A., Shaltout, M. & Fekri, M. 2009, in In search of cosmic order, ed. by J.A. Belmonte & M. Shaltout (Supreme Council of Antiquities Press, Cairo) (in press)

Carlotti, J. F. 2005, in Structure and significance: thoughts on ancient Egyptian architecture, ed. by P. Jánosi, 169 (Vöaw, Wien)

Depuydt, L. 2007, in Calendars and years: astronomy and time in the ancient Near East, ed. by J. M. Steele, 35 (Chicago: Oxford University Press)

Neugebauer, O. 1942, JNES 1, 397

Parker, R.A. 1950, The Calendars of Ancient Egypt, (Chicago: Chicago University Press)