

The Pyramids of Giza are the most famous monuments in the world; surviving from ancient times and inspiring awe and wonder in all who have ever visited and entered them. It is perhaps surprising that despite the intense interest in them and the efforts of hundreds of archaeologists and engineers over the centuries to measure them and try to understand their purpose, they remain such an enigma. The reason lies in part with the persisting idea that the pyramids were built merely as tombs for the dead pharaoh. It seems like an unlikely association but in order to understand the Pyramid complex of Giza you first need to understand an even more ancient group of stone monuments, built thousands of miles to the North; the Neolithic circles of Scotland. These Neolithic stone circles built half a millennium before the pyramids were constructed using a measuring system developed by the ancient astronomer druids of Scotland based on a series of pendulum lengths that integrated the measurement of physical length and time. Not only did the ancient Egyptians use a measuring system based on that pendulum system but the Pyramids themselves together with their valley temple complexes used the same alignment principles as the Scottish stone circles though on an altogether much grander scale. The perceived historical wisdom is that the northern lands of Scotland would have followed Egypt in terms of adapting its ideas and advanced technology for use in what was considered the wild barren conditions on the outer extremities of Europe. However, the measuring system and the stone circles developed in Scotland were adapted and developed for use in Ancient Egypt. The Stone Circles allowed the festival days when alignment of stellar deities occurred due South in the sky at Civil Twilight to be indicated by the alignment of the rising and setting Sun with the megaliths. This alignment technology was taken to extraordinary lengths in Ancient Egypt by building massive pyramids that in the style of the megaliths allowed the festival days dedicated to the celebration of a pantheon of Egyptian stellar deities to be indicated by observing the rising and setting of particular bright stars associated with the Egyptian gods into the peaks of each pyramid on those festival days when viewed from the valley temple complexes. The identification of the Egyptian gods as bright stars and their associated constellations and their relative positions in the sky and their movement across the night sky allows the stories of the Pyramid Texts and Book of the Dead to finally be understood for what they were, a belief system based on stars that made sense of the night sky and the cyclical movements of the stars and the Sun.



## The Pyramids of Giza



### PART I

#### The Measurement System used to Construct the Pyramids

Considering that the pyramids of the Giza plateau in Cairo are considered to have been constructed to within such fine engineering tolerances by the ancient Egyptians and that they have been so extensively and accurately measured today, it is surprising that although we know that the Egyptians used a measure called a Royal Cubit, its length cannot adequately account for the dimensions of the Pyramids of Giza and we know almost nothing about the measurement units actually used in their planning and construction.

It is therefore highly likely that the system of measurement used by the ancient Egyptians was completely different to those used and understood today.

To answer the question as to what measurement units were used to design and construct the pyramids of Egypt requires us to travel to an unlikely location in the far North of Europe; Scotland, where in Neolithic times some five thousand years ago, before the pyramids of Giza were constructed, hundreds of stone circles were measured out on the ground using a similarly unknown measurement system.

However, the fact that there are so many stone circles that remain in a good state of preservation has allowed the pre-historic measurement system used in Scotland to be re-discovered by applying a new mathematical analysis to extensive survey data collected by Professor Alexander Thom. The measuring system that emerges from the mathematical data is an ingenious one which utilises a series of pendulum lengths, that measured both distance and time. This unusual measurement system which uses, not one measure but a series of related measures, has been applied to the pyramid dimensions to see whether this might finally explain how the pyramid dimensions were determined.

The measurement system used in Scotland consisted of twelve pendulum lengths and is shown in Table 1. The term Megalithic Degree refers to the system used for measuring angles where 366 Megalithic Degrees = 360° (Modern Degrees).

Pendulum Length (cm)	Period (Swings/Megalithic Degree)
35.96	9000 / 23 MD
41.12	15000 / 41 MD
45.75	8000 / 23 MD
46.35	10000 / 29 MD
50.00	333 / MD
52.36	12000 / 37 MD
56.48	5000 / 16 MD
58.25	4000 / 13 MD
63.66	5000 / 17 MD
80.9	6000 / 23 MD
116.5	5000 / 23 MD
161.8	5000 / 27 MD

Table 1 The Pendulum measurement lengths used in Scotland from 3000BC

The circular relationships between each measurement length is shown in Diagram 1.

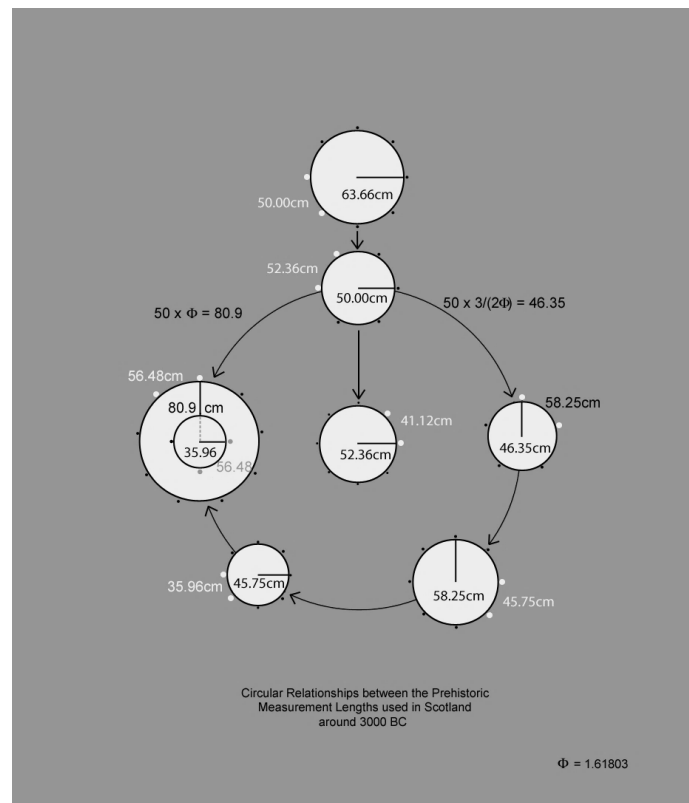
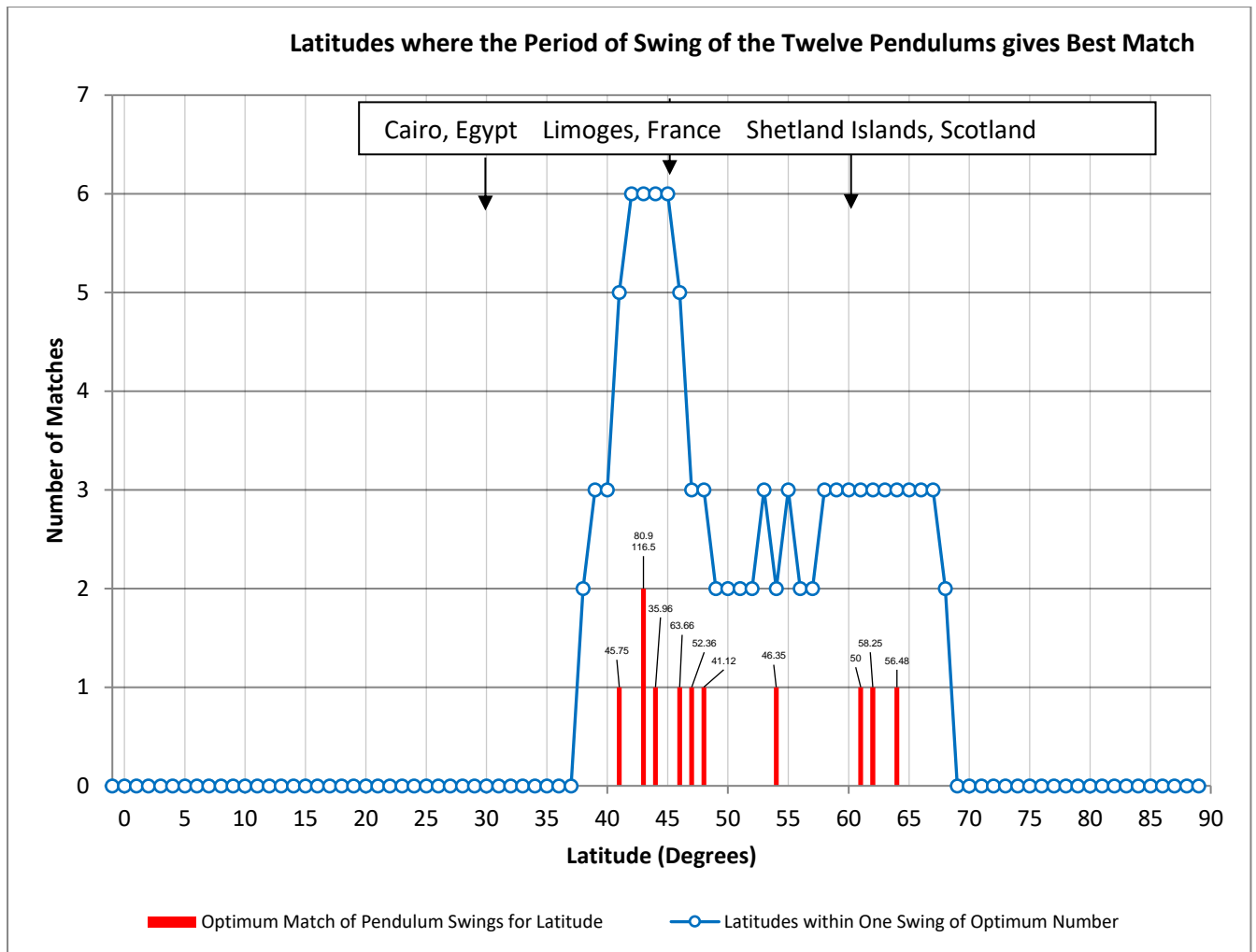


Diagram 1 showing the twelve pendulum lengths used in Neolithic Scotland and their geometrical relationships through multiple factors of  $\pi$  (pi) and  $\rho$  (rho).

The measurement system that was used in Scotland to construct the stone circles around 3000BC was based on a system of twelve pendulum lengths. Only whole integer multiples of the lengths were used but the availability of twelve different pendulums gave the builders the flexibility to achieve a particular dimension. The measurement system ingeniously integrated the measurement of time and length through the use of pendulum lengths related to each other through circular geometry. The measurement system seems particularly suited for the design of Stone circles that have been shown by the author to have been calendrical devices involving the alignment of the Sun on the horizon with the stones on festival days throughout the year when bright stars, representing stellar deities were aligned due South at Civil Twilight. Furthermore, the pendulum lengths used had specific periods that gave whole thousand numbers of swings for the time it took the Earth to rotate by certain special angles expressed as Megalithic degrees (where in ancient times the circle consisted of 366 Megalithic degrees compared with the 360 degrees used today). Those special angles comprise integers that can be described as Pythagorean Triplet, right-angle-triangle, hypotenuse lengths such as **13, 17, 23, 27, 29, 37** and **41** megalithic Degrees (which result from right angle triangles whose three sides are integer lengths such as 5,12,13, 8,15,17, 13,19,23, 17,21,27 etc. that could be easily constructed using an equally spaced knotted cord laid on the ground).

The fact that pendulum measures have specific periods of oscillation means that the likely origin for the development of the measuring system can be determined because the period of a given pendulum length varies as a function of gravitational field which in turn varies with latitude. Because the Earth is oblate, rather than spherical, being fatter around the Equator and thinner at the poles, has the effect that the gravitational field is lower at the equator and increases as you move towards the poles. The pendulum therefore swings at different rates at different latitudes and the latitude at which the optimum performance of the pendulum is achieved, given that the length was chosen to give a whole thousand number of swings for a particular number of Megalithic Degrees, can be determined. As a first stage, the match between the ideal period for each pendulum can be compared with the period that can be experienced at different latitudes in order to see where the pendulum measurement technology, now known to have been used in Scotland, is likely to have been developed.



**Graph 1** shows how the performance of the twelve pendulum lengths varies as a function of latitude.

There appear to be two main peaks where the various pendulums performance is maximised; one peak corresponds to a latitude between 41-48 degrees, peaking at 42-45 degrees corresponding to Mid France and the other between 61-64 degrees corresponding to the Shetland Islands lying in the very far North of Scotland. The assumption is that the pendulums have been developed in the Northern hemisphere but the latitude effect on the gravitational force and the resultant period of oscillation is the same in both hemispheres. The main peak appears to be that associated with a latitude of approximately 45 degrees but the particular pendulums having optimum performance at a latitude of around 60 degrees are vitally important in the measurement system, especially the 50cm pendulum that is central to the measurement system and the 58.25cm pendulum that is crucial in expressing a circle's circumference as 366 arc lengths of 1cm. It therefore appears that the measurement system was developed in two places for these two latitudes in order to be able to connect all 12 pendulums in terms of their circular relationships.

Pendulum Length (cm)	Megalithic Degrees	Ideal Number of Swings ( <i>N</i> )	Latitude ( <sup>o</sup> N) giving <i>N</i> Swings	Latitudes giving <i>N</i> +/- 1 Swings
35.96	23	9000	44	42-46
41.12	1	366	48	43-54
45.75	23	8000(Solar)	41	39-44
46.35	29	10000	54	51-56
<b>50.00</b>	1	333(Solar)	<b>61</b>	54-68
52.36	37	12000	47	45-50
<b>56.48</b>	16	5000	<b>64</b>	59-69
<b>58.25</b>	13	4000	<b>62</b>	56-69
63.66	17	5000	46	42-49
80.9	23	6000	43	40-46
116.5	23	5000	43	39-47
<b>161.8</b>	0.54	100(Solar)	<b>All</b>	All

**Table 2** shows the latitudes where each of the pendulums gives maximum accuracy of number of swings.

The latitudes where each of the pendulums gives a number of swings closest to the whole number proposed fall into two general areas, the latitude where five of the pendulums reach their optimum performance is somewhere around 45 degrees North whereas three pendulums give the desired numbers of swings at the more northerly latitude, corresponding to the Shetland Islands lying at latitude around 60 degrees at the very North of Scotland. It is interesting that there appear to be two groups of pendulums that reach their optimum accuracy at latitudes of 45 degrees and 60 degrees and which are also related to each other's lengths through circular geometry. If the lengths of the pendulums were adjusted to give the desired whole thousand number of swings for a lower latitude for instance, by slightly shortening the pendulum lengths, then the adjusted lengths would no longer have the same precise mathematical relationship with the other pendulum lengths as before. The long 161.8cm pendulum may have been developed to give 100 swings for the time it took the Sun to move an angle equivalent to its average diameter. The small number of swings required (100) means that there is less than half a swing difference between the Equator and the Pole. However, the same long pendulum also gives 5000 swings for a rotation of 27 Megalithic Degrees of the Earth relative to the Sun and this would attain optimum accuracy in the very far North peaking at a latitude of 72 Degrees North.

It is evident that none of the pendulums work at their most accurately at a latitude equivalent to Cairo in Egypt (30.0444<sup>o</sup> N) (Giza 29.9792<sup>o</sup>N). It therefore seems unlikely that the measurement system was developed in Egypt and taken North and more likely that the measurement system was taken South and adapted to account for the gravitational field and possibly the particular beliefs prevailing in Ancient Egypt.

## The Dimensions of the Great Pyramid

The measurement of the base lengths of the three pyramids was for a long time a huge problem because dunes of sand, several metres deep, covered the sides of the pyramids, indeed when Napoleon visited the pyramids in 1798 during his Egyptian campaign, artists in his entourage made paintings of the pyramids and sphinx showing that only the head remained above the level of the sand.



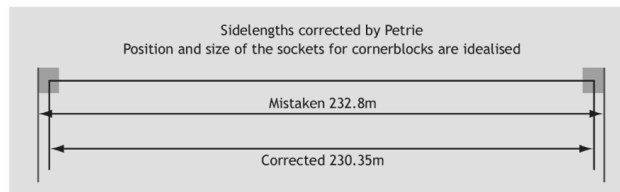
**Figure 1** Napoleon visiting the Sphinx in 1798

Furthermore, all the casing stones that originally had covered the Khufu pyramid had already been removed earlier in the eighteenth century to build the mosques of Cairo. It is difficult to imagine that the pyramids could look any more impressive than they do today but whilst the pyramids of Giza today have a step-like appearance, before the casing stones were removed the pyramids had finely finished smooth slopes of accurately carved precise-fitting limestone. The three pyramids were covered in beautiful white Tura limestone and must have seemed like an otherworldly construction, awe inspiring beyond anything that had ever been seen before, and arguably greater than anything that has been built since.

It was probably only at the time of the expedition of Napoleon in 1798-1801 that sand for the first time was removed down to the corners on the North side and what could be considered to be an accurate measurement made based on the position of the four corner sockets carved out of the base stone platform. The first estimate of base length of 232.76m was unfortunately wrong because it was assumed that the pyramid corner casing blocks fully covered the sockets and this mistake was repeated in 1837 by Howard Vyse and John Shae Perring. Eventually Flinders Petrie discovered the error during his measurements in 1881-1882 when sand and debris was removed and some original casing stones discovered left in place at the base of the middle section of the pyramid that had evaded the mosque builders and previous surveyors. Flinders Petrie realised from the position of the newly uncovered casing blocks that the sockets of the missing corner blocks had been only partially covered.



**Figure 2** Original Casing Stones found at the mid-section on the North side. The flat stone platform and bedrock under it are also visible



The projected base-lengths had to be reduced to:

- Northside:** 9069.4" or 230.363 m.
- Southside:** 9069.5" or 230.365 m. Longest.
- Westside:** 9068.6" or 230.342 m.
- Eastside:** 9067.7" or 230.320 m. Shortest.

**Figure 3** Base lengths of the Khufu pyramid determined by Petrie

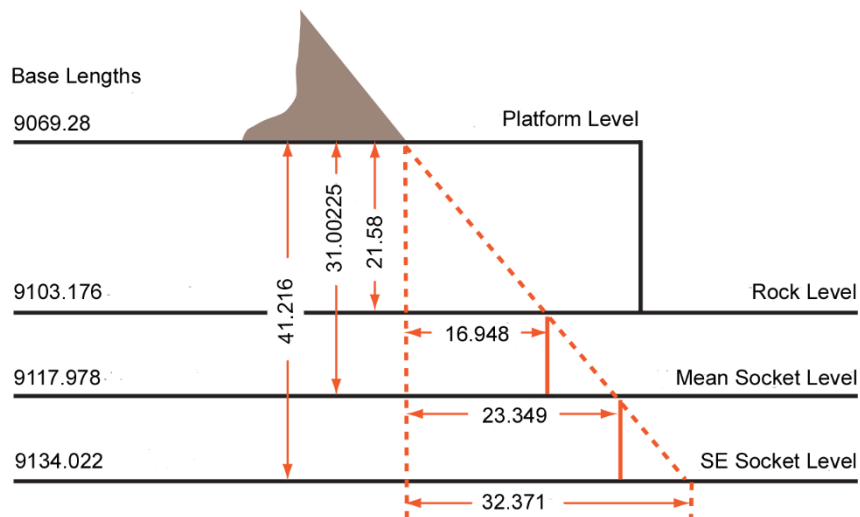
The pyramids, since the time of Flinders Petrie, have been measured numerous times and are perhaps the most often and amongst the most accurately measured structures on Earth. The following table gives the currently accepted dimensions of the pyramids.

Pyramid	Base (cm)	Height (cm)
<b>Khufu</b>		13854.66
North	23036.3	
East	23032.0	
South	23036.5	
West	23034.2	
<b>Khafre</b>		14350.0
North	21518.61	
East	21526.99	
South	21531.31	
West	21527.75	
<b>Menkaure</b>		6550.0
	10549.88	
	10538.96	
	10560.80	
	10550.90	

**Table 3**



However, it should be borne in mind, that despite the accuracy of the actual measurements, there is some debate about what dimensions constitute the base lengths of the pyramids and the height of the Great Pyramid which has generally been considered to have its top missing. There is a school of thought that rather than measure the base length where the casing stones meet the artificial stone platform that was laid on top of the bedrock, that considering the original rocky mound over which the Khufu pyramid was built was considered a sacred place, perhaps the base length should be determined at the point where the pyramid “joins” the bedrock constituting that sacred mound.



**Diagram 2** Measurements from the Egyptian Survey of 1925 in Inches.

### Measurement units used to Construct the Pyramids

The concept of a measurement system comprising multiple pendulum lengths as used in Scotland from 3000BC is an interesting, albeit surprising possible solution as to how the dimensions of the pyramids were determined. Especially as historically, it has usually been assumed that the spread of technology was from the advanced South to the “barbaric” North. Whilst the Ancient Egyptian Royal Cubit length could only possibly account for the base lengths of the pyramids if the number of lengths were not “round hundreds” of Royal Cubits, the dimensions of the King's Chamber within the Khufu pyramid can apparently be precisely described in terms of Royal Cubits (20 x 10 Royal Cubits).

Studying the dimensions of the pyramids at Giza has failed to convincingly identify the measurement lengths used in their construction. Despite the proposal that the base dimensions of pyramids at Giza can be accounted for by the known ancient Egyptian measure known as the Royal Cubit, typically considered to be equivalent to 52.4cm, the dimensions of the pyramids might be expected to consist of round whole hundreds of unit lengths whereas Khufu's pyramid expressed as Royal Cubits is 440x440 Royal Cubits whilst the Khafre pyramid can be accounted for as 411x411 Royal Cubits and the pyramid

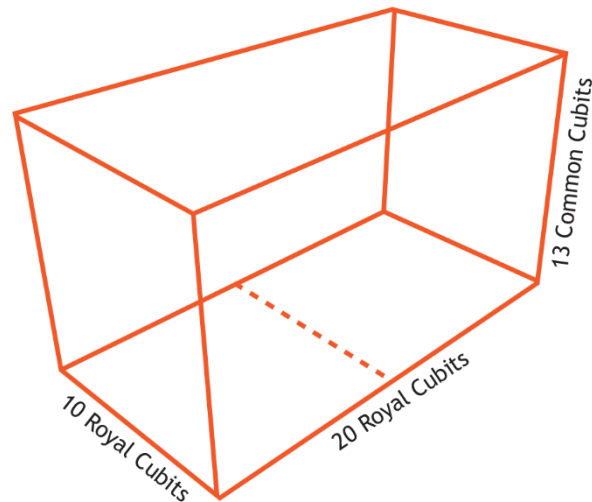
of Menkaure as 201.5x201.5 Royal Cubits which seem awkward dimensions if the pyramids were in fact measured using Royal Cubits.

A great deal of scepticism has been created about the science of Metrology due in large part to the clamber of antiquarians, pyramidologists, early archaeologists and engineers to make their proposed measurement units fit the dimensions of the pyramids and other ancient structures; invented measurements such as the "Pyramid Inch" have been proposed and rejected and the actual measurement lengths used in the construction of the pyramids remain a mystery. Worse, the metrology went further, crossing the bounds of science suggesting that the measurements embedded in the structure of the pyramids both externally and internally within the chambers and passageways hid a code of meaning that related to Christian beliefs. Even Scotland's Astronomer Royal, Charles Piazzi Smyth (1819-1900), working in the 19th century, was convinced that the structure's proportions were inspired by the Christian God. This however, as will be described later, despite our initial reaction to how ridiculous it sounds today, has a kernel of truth where the measurements embedded in the structures do in fact represent a sort of code that related the measurements used and the dimensions and positioning of the pyramids and valley temples but to the beliefs of Ancient Egypt.

If there was one measurement length used during the planning and construction of the pyramids it might be expected that that measurement would be seen throughout the dimensions of the pyramids both in terms of base lengths, height, the dimensions of passage ways and chambers within the pyramids and even the separation between pyramids. It would also be obvious to anyone what that measurement was by simply dividing the various lengths by a range of integers until a common length was found. Although the King's Chamber within the Khufu pyramid can be described in terms of its length and width being described as 20 Royal Cubits x 10 Royal Cubits which appear as good round numbers, and therefore a convincing argument for the use of the Royal Cubit, a length known to have been used in Ancient Egypt due to the presence of several ancient rulers called cubit rods made of wood or stone, even this apparently "cast-iron" proposal can be questioned due to the height of the King's Chamber which cannot be described in terms of the Royal Cubit and instead this dimension has to be accounted for by describing a different measurement unit called a Common Cubit allowing the height to be described as 13 Common Cubits.



**Figure 4** Cubit Rod from Maya Eighteenth Dynasty

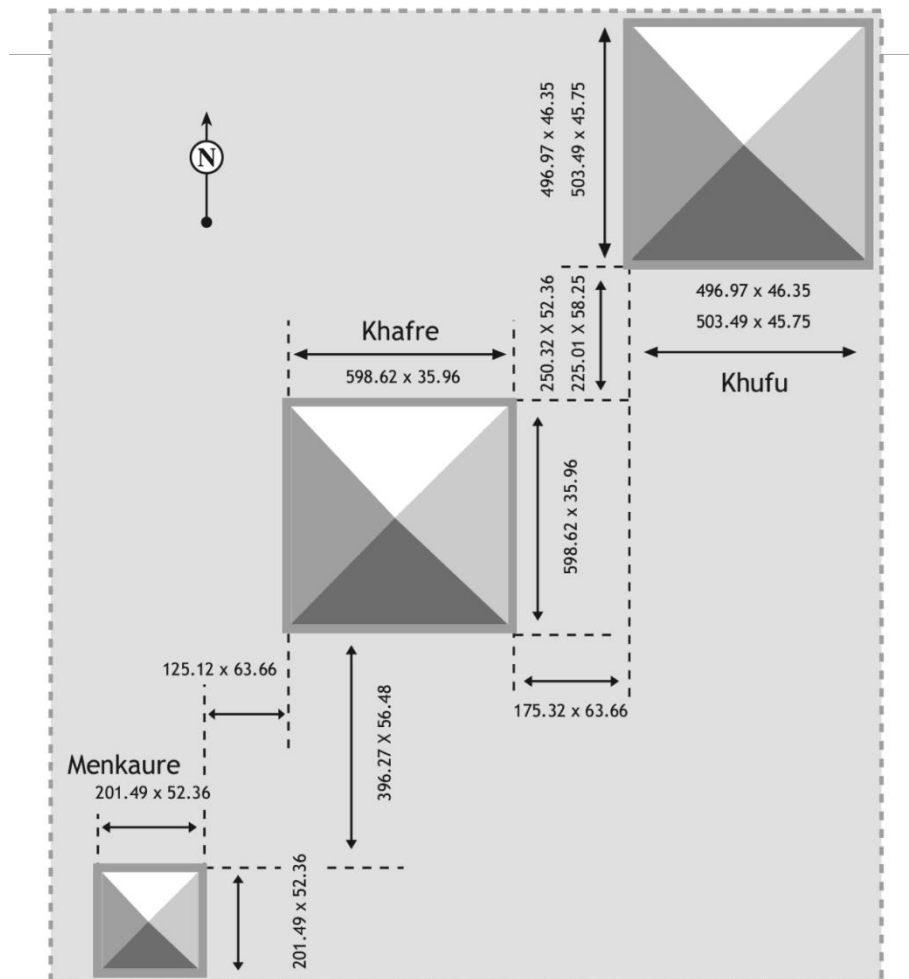


**Figure 5** Dimensions of the King's Chamber in the Great Pyramid Expressed as Royal Cubits

The Egyptian Cubit measurement varies in its reported length; there are several measurement rods that survive where the Royal cubit length varies from 523.5mm to 529.1mm. There are conflicting arguments about the Royal Cubit length, firstly the dimensions of the Kings Chamber in the Khufu pyramid have been accurately measured as 1048 x 524cm if this chamber was measured out using Royal Cubits then we can conclude that the length of the Royal Cubit was 52.4cm. It appears strange that a single chamber would require two different rulers to account for its dimensions. The height of the King's Chamber flat roof (5.825m) reminds us that there is a pendulum length from Scotland measuring 58.25cm, that would account for the height of the King's Chamber as 10x58.25cm. Furthermore, when the length, width and height dimensions of the King's chambers are re-examined, it can be seen that the same measurement length of 58.25cm can account for all three dimensions of the King's chamber as integer multiples of this measurement where the chamber length is 18 x 58.25cm, the width is 9 x 58.25cm and the height is 10 x 58.25m. The possibility is raised from the most certainly used example to demonstrate the importance of the Royal Cubit in the measurement of a chamber to a situation that casts doubt on that certainty and suggests that the lengths used to build the pyramids themselves were related to the ancient Scottish system of measurement rather than the Royal Cubit. Despite this proposal, it should be remembered that the length of 52.36cm, known in Egypt as "the Royal Cubit" and the length of 63.66cm, also known in Egypt, as the "Sacred Cubit", were also pendulum lengths used by the Neolithic Stone Circle builders in Scotland some 500 years before the construction of the pyramids around 3000BC.

## Pyramid Dimensions Described as “Scottish” Pendulum Lengths

The dimensions of the pyramids and the measured spaces separating them can be divided by the twelve pendulum lengths from Scotland to demonstrate how closely the resulting multiples relate to whole hundreds of measurement units.

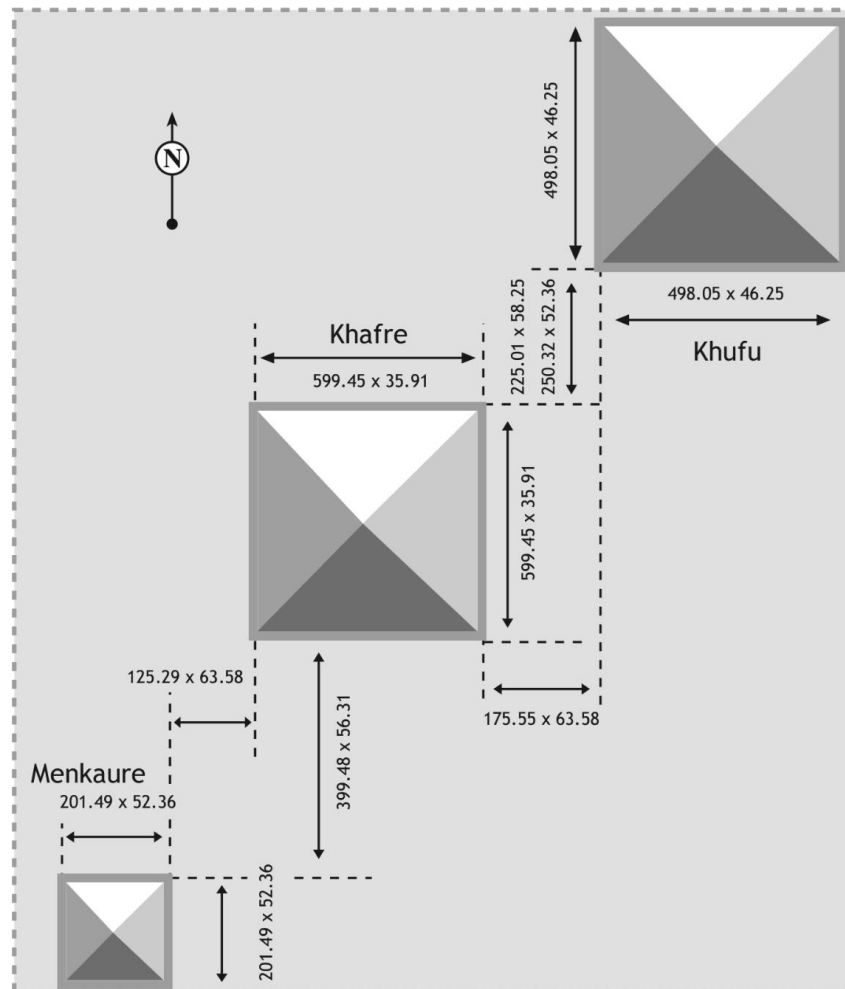


**Diagram 3** shows how the dimensions of the Pyramids, when expressed as Scottish pendulum lengths give close to whole hundreds or significant multiples of those units.

The expression of base-lengths and spaces between the pyramids as pendulum lengths that were also used to build the stone circles of Scotland around 3000BC gives a remarkably close match to significant whole rounded multiples of those pendulum lengths. The fact that the dimensions of the pyramids themselves are based on whole hundreds of measurement lengths but that most of the distances separating the pyramids are not whole hundreds of measurement lengths suggests that the relative positions of the three pyramids was important and that the three pyramids form a complex of related structures that acted as a single entity for some as yet unknown purpose.

## Adjusted Pendulum Lengths

The period of oscillation of a pendulum is latitude-dependent due to the different gravitational field resulting from the Earth's oblate shape. When the pendulum lengths used in the far North are shortened to give the same period of oscillation or swing at Cairo, the relationship with the pyramid dimensions as whole hundreds of units becomes even closer.



**Diagram 4** Dimensions of the Pyramids expressed as Scottish Pendulums shortened to give the same Period of Oscillation at the Latitude of Cairo

Adjusting the Scottish pendulum lengths to take account of the different gravitational force experienced at Cairo due to the fact that the Earth is fatter at the equator than the poles, the amended lengths give an even closer match to whole hundreds of measurement lengths for the base dimensions and height. The one measurement length that was not changed, because the slightly shortened length resulted in a worse match for the Menkaure pyramid was the Royal Cubit but more importantly, ancient Royal Cubit

rulers of the required 52.36cm length actually exist which may suggest that this length gave a period of oscillation that has some importance.

### Gravity Calculations

The gravitational force at the plateau of Giza at a latitude of 29.9772° North is 9.793232ms<sup>-2</sup>

The Geodetic Reference System (GRS) formulae refer to theoretical estimates of the Earth's shape and from these GRS formulae we obtain the International Gravity Formulae (IGF) the most recently developed GRS in 1980 leading to the World Geodetic System in 1984 (WGS84) gives rise to the following formula:

$$g_0 = 9.7803267714 \{ 1 + 0.00193185138639 \sin^2 \lambda - 0.00669437999013 \sin^2 \lambda \}^{1/2}$$

where  $g_0$  is referred to as the theoretical gravity or normal gravity and  $\lambda$  is the geographic latitude in degrees.

Substituting this value of gravity into the equation for the period of oscillation allows us to obtain an amended pendulum length for each of the pendulums normally used in Northern Europe. However, in order to have a precise optimum length required to give the same swing at Giza, the optimum period of oscillation at the Northern latitude can therefore be used as the basis for the adjustment. For the equation  $T = 2\pi\sqrt{L/G}$  the optimum value of T can be obtained for each pendulum by first using the precise number of swings required to occur for a precise angular rotation of the Earth. For instance the 46.35cm pendulum requires 10000 swings for an angular rotation of 29 Megalithic Degrees at Northern Latitudes and there are 235.42 seconds per Megalithic Degree of rotation. The ideal period for this pendulum is 29x235.42/5000 (as the period describes the to-and-fro oscillation of a pendulum rather than each individual swing). The ideal period can then be substituted into the pendulum equation along with the gravitational force calculated for Giza to obtain the new pendulum length.  $L' = G' \times (T/(2\pi))^2$  where  $L'$  is the amended pendulum length for use at Giza and  $G'$  is the gravitational field at Giza. The length of the new pendulum is 46.25cm (46.2497cm) or 1mm shorter than the original pendulum (46.35cm). In practise the pendulum lengths would have been adjusted by calibrating the length with respect to either a star pair with a known angular separation, measured in terms of the difference in Hour Angles of the two stars or a reference frame of vertical rods separated by the required angle, in this case 29MD, and using these rods for alignment with a star due South in the sky and count the required number of swings for that star to align with the second rod and adjusting that length accordingly.

For Khafre the approximately 35.96cm ideal period is 1.2032578 based on 9000 swings or 4500 oscillations per 23 MD. The new pendulum length for use in Giza is theoretically 0.3591566m.

Pyramid	Mean Dimensions (cm)	Dimensions Described as Royal Cubits where 1RC=52.36cm	Described as Scottish Pendulum Lengths	Amended Scottish Pendulum Lengths taking account of Gravity
Khufu	Base 23034.75 Height 13854.46 (without top)	439.93 264.60	46.35 x 496.97 46.35 x 298.91	46.2497 x 498.0514 46.2497 x 299.5578
Khafre	Base 21526.165 Height 14350	411.12 274.06	35.96 x 598.61 35.96 x 399.05	35.9157 x 599.3527 35.9157 x 399.5467
Menkaure	Base 10550 Height 6550	201.49 125.10	52.36 x 201.49 52.36 x 125.10	Adjustment not Applied

**Table 4**

The base dimensions of the Khufu pyramid using the bedrock level is 23122.07cm (Diagram 2) when this is divided by the adjusted pendulum-length we obtain 499.94 x 46.2497cm pendulum lengths. The height of the pyramid without the top is 299.5578 x 46.2497cm which suggests that the Khufu pyramid was never intended to have a peak in the manner of the other two pyramids at Giza, in which case it can be concluded that the small platform formed by its flat top was an important feature that perhaps served some ceremonial function. Perhaps it allowed the pharaoh to stand on the top of the Great Pyramid for certain ceremonies involving the alignment of the Sun or stars where it might appear from the Khufu Valley temple that on certain special days important stars set not only into Khufu but the Pharaoh himself. The way in which the Pharaoh managed to ascend the steep sided smoothly finished pyramid for such a proposed ceremony is more conjecture but would have perhaps involved either a sled pulled up the slope using ropes and counterweights, or maybe some casing stones, now removed had steps cut into them allowing the Pharaoh to ascend the pyramid himself in a similar manner to the steps of the later pyramids of South America or perhaps access to the top might have been gained by the recently discovered square spiral ramp hidden inside the pyramid if a suitable access and exit to and from this space was available.

The Khufu pyramid dimensions are those usually quoted and relate to the base dimensions at the level of the stone platform. When the pyramid base is measured at the level of the bedrock as determined by the Egyptian Survey of 1925, the length of 9103.176" equivalent to 23122.07cm is equivalent to 499.9398 x 46.2497cm. In other words, the adjusted pendulum lengths give an almost perfect match whole hundreds of lengths to describe the base dimensions of the Great Pyramid. The heights of the pyramids also can be described in terms of whole hundreds of the same adjusted pendulum lengths, for the Khufu and Khafre pyramids whilst the smaller Menkaure pyramid's height is the less rounded 125 Royal Cubits.

The heights of the three pyramids appear to give a closer match to whole hundreds of measurement units than the base dimensions, perhaps due to the larger effect of the stone platform on base measurements compared with the height measurement. It is usual that whole hundreds of measurement lengths were chosen to describe the dimensions of large structures. This could be achieved because of the in-built flexibility of the measurement system by selecting one of the available twelve pendulum lengths. The heights of Khufu and Khafre can also be described as whole hundreds of the same pendulum lengths used to measure their base lengths but the height of Menkaure described as 125x 52.4cm is at odds with this. The ratio of base length to height for the three Pyramids can be described as

Pyramid	Ratio (Base:Height)
Khufu	5 : 3
Khafre	3 : 2
Menkaure	8 : 5

Table 5

The ratios form a pattern of adjacent number pairs from the Fibonacci series,

1, 1, 2, 3, 5, 8, 13, 21.....

1, 1, 2, 3, 5, 8, 13, 21.....

1, 1, 2, 3, 5, 8, 13, 21.....

The fact that the base lengths and heights are related and that the number of units expressing each should be round integers, allows us to check the possibility that other pendulum lengths were used. The Menkaure dimensions can be best described in terms of the known pendulum measures as 200 Royal Cubits base by 125 Royal Cubits height. However given that two of the known pendulum lengths 58.25cm and 80.9cm, were precisely half the length of two other pendulum lengths (116.5cm and 161.8cm), there is the chance that a length equivalent to half a Royal Cubit, could have been used in order to obtain more rounded numbers of units describing the base and height dimensions.



To determine the likelihood of these proposed pendulum measures describing the base and height dimensions of the pyramids at Giza, a selection of sixteen other pyramids which have had their base lengths measured was analysed in order to determine whether these other pyramids could have also been measured using the same pendulum lengths that were used in Scotland.

Pyramid	Pharaoh	Base Dimensions (m)	Scottish Pendulum Length (cm)	Number of Pendulum Lengths
<b>Meidum</b>	Sneferu	144x144	<b>35.96</b>	400.44
Bent Pyramid Dahshur	Sneferu	189.5x189.5	63.66	297.68
Red Pyramid Dahshur	Sneferu	220x220	N/A	
Giza	Khufu	230.4x230.4	46.35	497.09
<b>Abu Rawash</b>	Radjedef (Djedefra)	106x106	<b>35.96</b>	294.77
<b>Zawiyet-el-Aryan</b>	Baka	180x180	<b>35.96</b>	500.56
<b>Giza</b>	Khafre	215.2x215.2	<b>35.96</b>	598.44
Giza	Menkaure	104.6x104.6	<b>52.36</b>	<b>199.77</b>
Saqqara	Userkaf	73.3x73.3	N/A	
<b>Sahura</b>	Sahura	78.5x78.5	<b>26.18</b>	<b>299.85</b>
Neferirkara	Neferirkara	72x72 (after 104x104)	<b>52.36</b>	<b>198.63</b>
<b>Abusir</b>	Neferefra	Planned as 78x78	<b>26.18</b>	<b>297.74</b>
<b>Abusir</b>	Neuserra	78.5x78.5	<b>26.18</b>	<b>299.85</b>
Headless Pyramid	Menkauhor	c.68xc.65	N/A	
<b>Saqqara</b>	Djedkara	78.5x78.5	<b>26.18</b>	<b>299.85</b>
Saqqara	Unas	57.7x57.7	58.25	99.06
<b>Saqqara</b>	Teti	78.5x78.5	<b>26.18</b>	<b>299.85</b>
<b>South Saqqara</b>	Pepi I	78x78	<b>26.18</b>	<b>297.94</b>
<b>South Saqqara</b>	Pepi II	78.75x78.75	<b>26.18</b>	<b>300.80</b>

Table 6

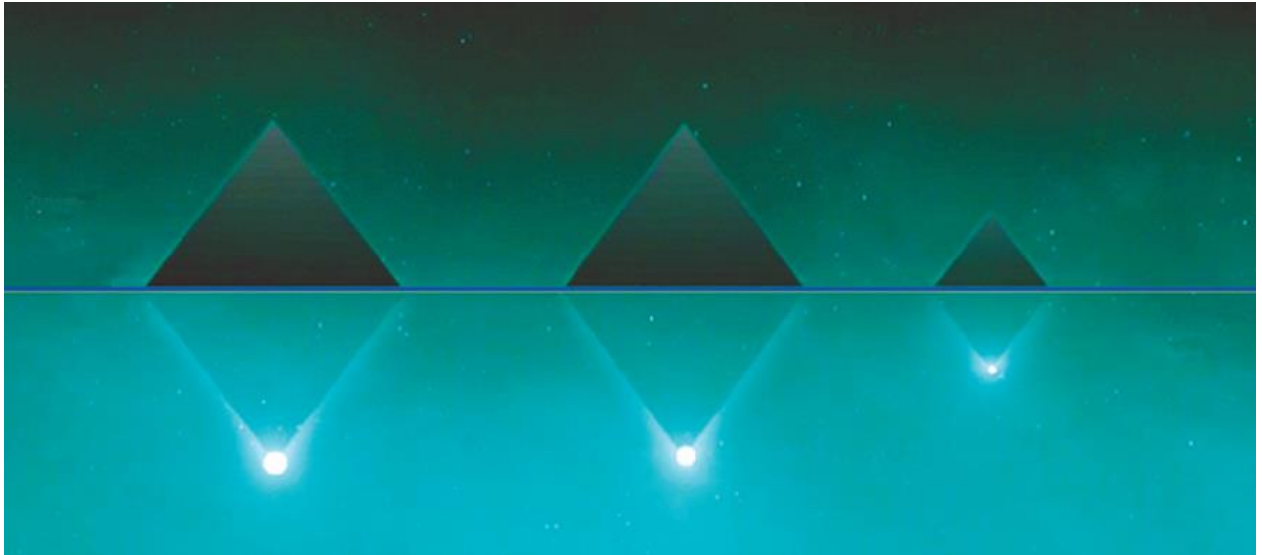
It is interesting to see that the base dimensions of 16 of the 19 Egyptian pyramids can be described in terms of pendulum lengths. The fact that the pyramids built during the reign of Sneferu, the father of Khufu, can be described in terms of the same pendulum lengths used in Scotland to construct the stone circles from around 3200-3000BC, establishes the fact that the pyramids constructed before those at Giza were similarly designed utilising the pendulum measurement system that integrated the measurement of length and time. The measurement unit of 35.96cm used at Northern European latitudes accounts for four pyramids, including Khafre's pyramid. The adjustment of length to 35.9157cm to give the same period at Giza as the 35.96cm pendulum used at Northern latitudes gives

a better fit to a whole hundred of unit lengths to describe two of the four pyramids, including Khafre's pyramid but a worse fit for the other two pyramids. The precision of measurement of the dimensions of the non-Giza pyramids is however uncertain but the general association between the pyramid dimensions and the 35.9cm pendulum is clear. The main interest in terms of describing the measurement lengths used to describe the base and height dimensions of Menkaure's pyramid at Giza is that nine of the 16 pyramids with pendulum length measures describing their base dimensions, can be presented as integer multiples of Royal Cubit lengths (52.36cm) however seven of the nine can only be expressed as whole hundreds of lengths of half a Royal Cubit which suggests that for these pyramids it was the 26.18cm pendulum length that may have been important. Two other pendulum lengths used to describe the dimensions of stone circles, namely the 58.25cm pendulum and the 63.66cm pendulum appear to have been the basis for the base dimensions of Unas's pyramid at Saqqara and Sneferu's Bent Pyramid at Dahshur. It appears from the base dimensions available that these two pendulum lengths may have been slightly shortened to give the same period as the original pendulums used further North.

The proposed 26.18cm pendulum length, representing one half the length of the Royal Cubit, was not one of the twelve pendulum lengths identified from the analysis of the stone circles of Scotland. The half-cubit pendulum length gives a close match to the dimensions of the pyramids but we must also guard against the issue that the archaeologists who measured these pyramids were very aware of the Royal Cubit as a known Ancient Egyptian Measure and may possibly have been influenced by its existence and subconsciously rounded dimensions to correspond to exact multiple lengths of the Royal Cubit. The 26.18cm pendulum used at Giza gives 5958 swings/13MD sidereal time and 5974swings/13MD for solar time. The shortening of the 26.18cm pendulum to 25.82cm gives 6000 swings/13MD at Giza but the match of this length to the pyramid dimension base dimensions is not so close. From this analysis it seems safe to assume that the Menkaure pyramid as with the Pyramids of Sahura, Neferefra, Neusera, Djedkara, Teti, Pepi I and Pepi II was designed with the 26.18cm at the heart of the design. In terms of any possible connection of its period of oscillation, the closest match is around 6000 swings for an angular separation of 13 Megalithic Degrees within 0.7% but the length of 26.18cm may have also resulted in important whole thousands of swings between important stars. On further examination Rigel, the brightest star in Orion is separated from Sirius by 12018 swings for the year 2560BC or within about 0.15% of 2x6000 swings.

By using a half-Royal cubit measure, a pendulum length of 26.18cm ( $52.36\text{cm}/2$ ) allows the base length of Menkaure to be described as  $400 \times 26.18\text{cm}$  whilst the height becomes  $250 \times 26.18\text{cm}$ . The further halving of this length again to 13.1cm allows the base and height to be described by whole hundreds of lengths ( $800 \times 13.1\text{cm}$  and  $500 \times 13.1\text{cm}$ ) but

the trouble with this is that the pendulum length of 13.1cm is practically too short to use as an accurate pendulum, the 26.18cm pendulum is therefore the most likely pendulum length used. The description of the height of Menkaure as 250x 26.18cm gives us a clue that it may not have been the height of the pyramids that was important and that the pyramids were considered to have a physical square pyramid form above the ground that was matched by a similar ethereal inverted square pyramid form extending down into the ground into the underworld, to transform the three pyramids of Giza into three octahedrons. In this way the height of the octahedron formed by putting two Menkaure pyramids base to base becomes 500 x 26.18cm so that the whole hundred units for the dimensions of the pyramids, condition regarding base and height dimensions is fulfilled. The two apices of each octahedral "pyramid" perhaps had special alignments the physical one with the stars of Orion in the sky above and the reflected imaginary peak below the ground with the stars as they passed through what was considered "the underworld", existing beneath the pyramids on their journey, having set on the western horizon, back to the east to rise again. The famous "As Above so Below" axiom first taught by Hermes in Egypt representing the idea that all things we think and feel and all objects and occurrences in the world are mirrored in the larger universe. This philosophy underpins the hypothesis that the pyramids themselves were built to reflect their physical form above the ground with their ethereal form below the ground and that the pyramids were constructed to reflect the pattern of stars in the night sky. It is also equally relevant that as well as considering "as above" referring to the heavens, and the pyramids "as below", that it may also refer to the pyramids and other structures on earth as "as above" in relation to the underworld described as "as below". It may be then that the pyramids rather than being thought of as square-based pyramids, that they may be considered as having virtual octahedral forms by considering the reflection of the pyramids into the ground below. In this case the dimensions of the three pyramids, described as octahedrons, maintain the same square base dimensions but their height is doubled allowing all three pyramid/octahedrons, including Menkaure to be expressed as whole hundreds of unit lengths. This consideration is also important when it comes to trying to match the positions of the stars of Orion with the three pyramids as any mapping "below" requires a rotation of the constellation, as it is normally viewed in the night sky to reflect its orientation as it passes beneath the pyramids.



**Figure 6** Image of Pyramids of Giza as virtual Octahedrons projecting down into the ground to align with stars after they have set in the West as they travel through the “underworld” to the Eastern horizon to rise once again.

## PART IIa

### Mapping the Stars of Orion onto the Pyramids of Giza and the Pyramids of Giza onto the Stars of Orion

It has been proposed that the Pyramids of Giza were constructed as physical representations of three stars in the constellation of Orion. The hypothesis that the three pyramids are identified as the three stars of Orion's belt has been proposed by Bauval in his Orion Correlation Theory. The idea seems like a reasonable proposal based on the apparent closeness of the mapping of the three stars onto the three pyramids. The hypothesis however is contentious and has been criticised by many academics because the hypothesis suffers from the fact that although the pyramids are generally accepted to have been constructed to extremely fine tolerances, the mapping of the stars of Orion's Belt onto the plan of the pyramids does not achieve the same level of accuracy and does not provide an absolutely precise match. Ignoring the level of precision, when viewed from the North, the pyramids and the stars of Orion belt can be closely mapped onto each other using a translation operation; mapping Alnitak onto Khufu, Alnilam onto Khafre and Mintaka onto Menkaure. The mapping as will be demonstrated, is close but not exact and in the absence of any other supporting evidence linking these stars with the pyramids, the proposed association of stars with pyramids is still to be proven. Others have argued that there are numerous star triplets in other constellations that could have equally well, if not better been used to give a closer mapping of stars and pyramids. Indeed, there are even three other star triplets in Orion itself that will be shown to give a closer match with the positions of the three pyramids than the stars in Orion's Belt. However, it is important to realise that the mapping of stars as they appear in the sky onto the plan of the three pyramids is not the only or even the most essential feature of the design of the pyramid complex and represents only a small part of the way in which the Giza complex was designed. The building of such monumental structures was obviously of central importance to the beliefs of the Ancient Egyptians and the idea that three pyramids requiring several decades to build, were designed and constructed merely to match the approximate positions of three relatively minor stars forming Orion's Belt seems unlikely.

The first question is how can the stars in the sky be mapped onto the ground in a way that the three pyramids of Giza can then coincide with the position of the stars. The problem is one of perspective, we can imagine looking towards the South and seeing the stars of Orion in the night sky forming their easily recognised pattern. If we look at the Pyramids from the North again looking South we could map their positions onto stars in two ways, either using a reflection of the stars in the axis of the horizon to map three

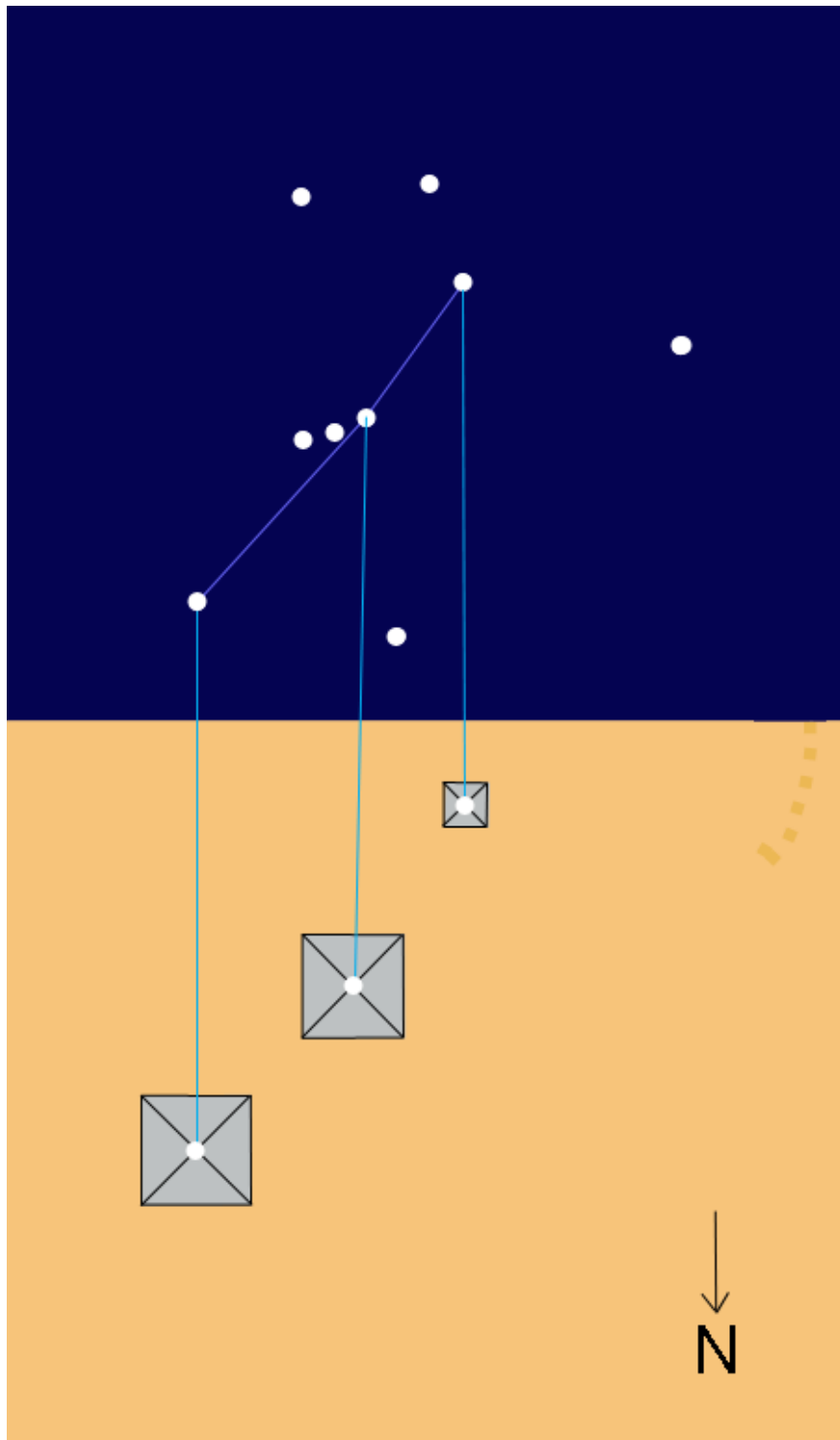
stars onto the three pyramids as if folding them down onto the pyramids , or as in the case of the Orion Correlation Theory to map the stars onto three pyramids using a translation, where the three stars are slid vertically down the sky and mapped onto the apices of the three pyramids. There is however a further way that the stars could be mapped onto the pyramids by rotation that needs to be considered, or rather a way of mapping the pyramids onto the stars of Orion as they pass through the underworld, beneath the pyramids as it were, on their journey after setting in the West, back to the eastern horizon to rise again the following night. When the different perspectives are taken into account, we find that there is not one correlation of stars in Orion with the three pyramids but five possible correlations involving three, star triplets in Orion. We can describe each of the mappings and examine the closeness of each match to determine which one is correct or take the view that perhaps all five were intended, intimately connecting all the stars in Orion with the Pyramids in as many ways as was possible. With respect to these stellar connections, it is also worth considering, that there was another connection between the pyramids and three stars in Orion and that rather than relying on mapping their positions onto a plan of the pyramids stars in Orion considered as particularly important could be viewed as rising from and setting into the pyramid's apex when viewing them from positions West and East of the Giza Plateau. This possibility is suggested by the differences in the sizes of the pyramids that rather than reflecting the relative brightness of the stars associated with each pyramid, the relative heights and spacings of the pyramids were determined by the relative positions of three stars in the Orion constellation and their angles of rising and setting to allow those stars to coincide with the peaks of the pyramids from chosen viewing points, a possibility that is examined in Part IIb. In this way the careful planning of the pyramids opens the possibility that they were positioned and designed to align and connect them to the Rising of Orion, the journey of Orion East-West across the sky during the night, the setting of Orion into the Western horizon and the journey of Orion through the underworld from West to East returning to the Eastern horizon to rise once again. It is also a clever prospect that three pyramids could be made to represent seven stars in the main body of Orion by adopting translation, reflection and rotational mapping operations and the rising and setting of stars into the pyramids thereby "minimising" the number of pyramids required to be built to represent the main stars representing the body of Osiris as represented by the constellation of Orion.

The five Orion star triplets can be examined by simply mapping scaled representations of their positions onto the plan of the three Pyramids taking into account the type of mapping required for each triplet, namely translation, reflection or rotation. There are two basic types of mapping that can be applied to the pyramids and stars in Orion

- 1) Mapping stars in the sky onto Pyramids on the ground
- 2) Mapping Pyramids on the ground onto stars beneath the ground after they have set

The first category involves two possible vertical translations (one of which comprises the Orion Correlation Theory) and one  $90^{\circ}$  reflection mapping by folding the stars down onto their pyramids. The second category involves looking down through the pyramids and mapping them onto the imagined positions of stars of Orion as they pass beneath the pyramids. This requires that the constellation is rotated through 180 degrees relative to the pyramids as Orion journeys from West to East beneath the horizon having set in the West. The proposed mappings are outlined in the following five diagrams but the closeness of the mappings is not to scale.

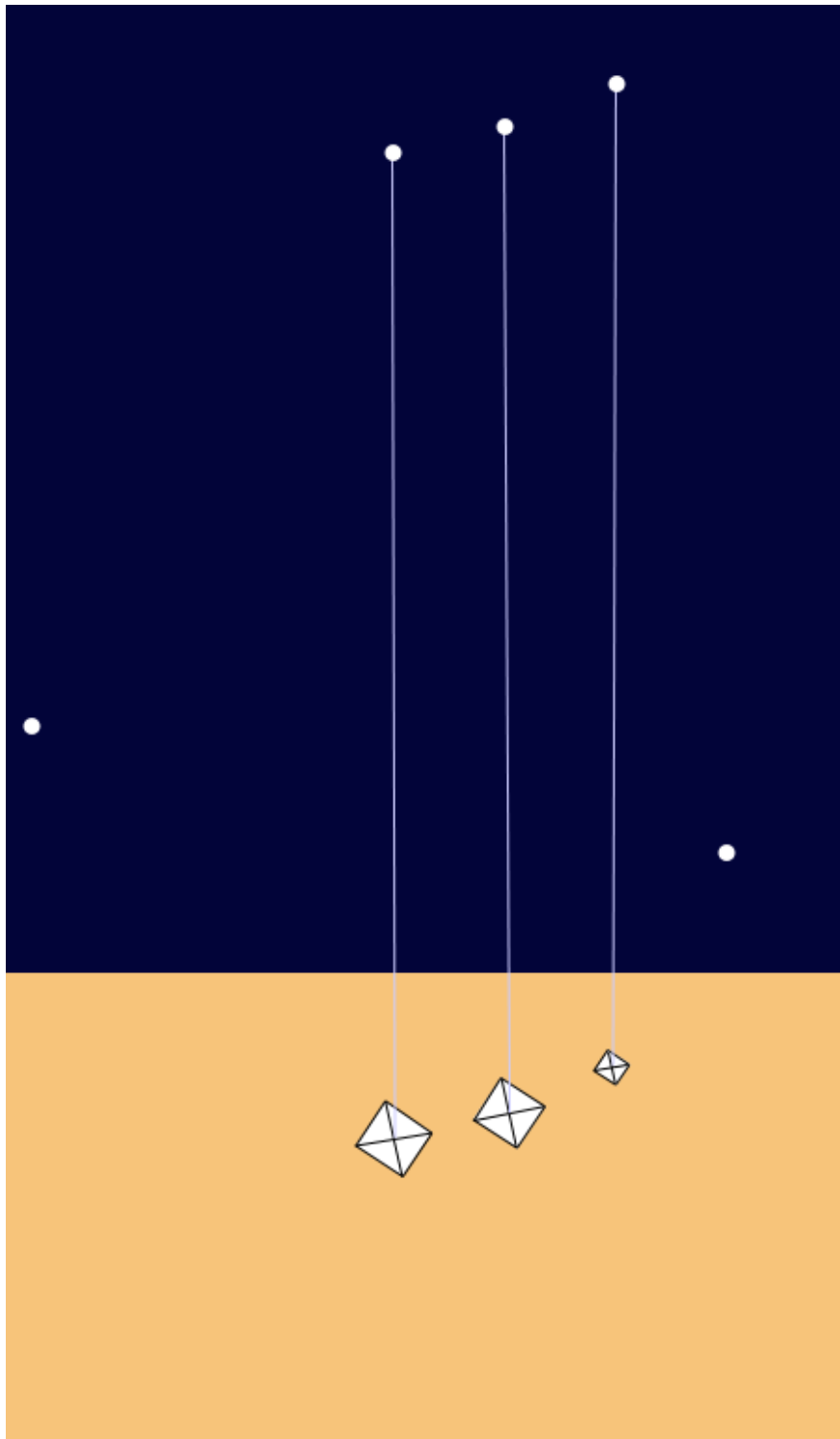
1 (i) Translation mapping of Saiph, Mintaka and Bellatrix onto Khufu, Khafre and Menkaure



**Diagram 5** Translation mapping looking South from a position North of the pyramids

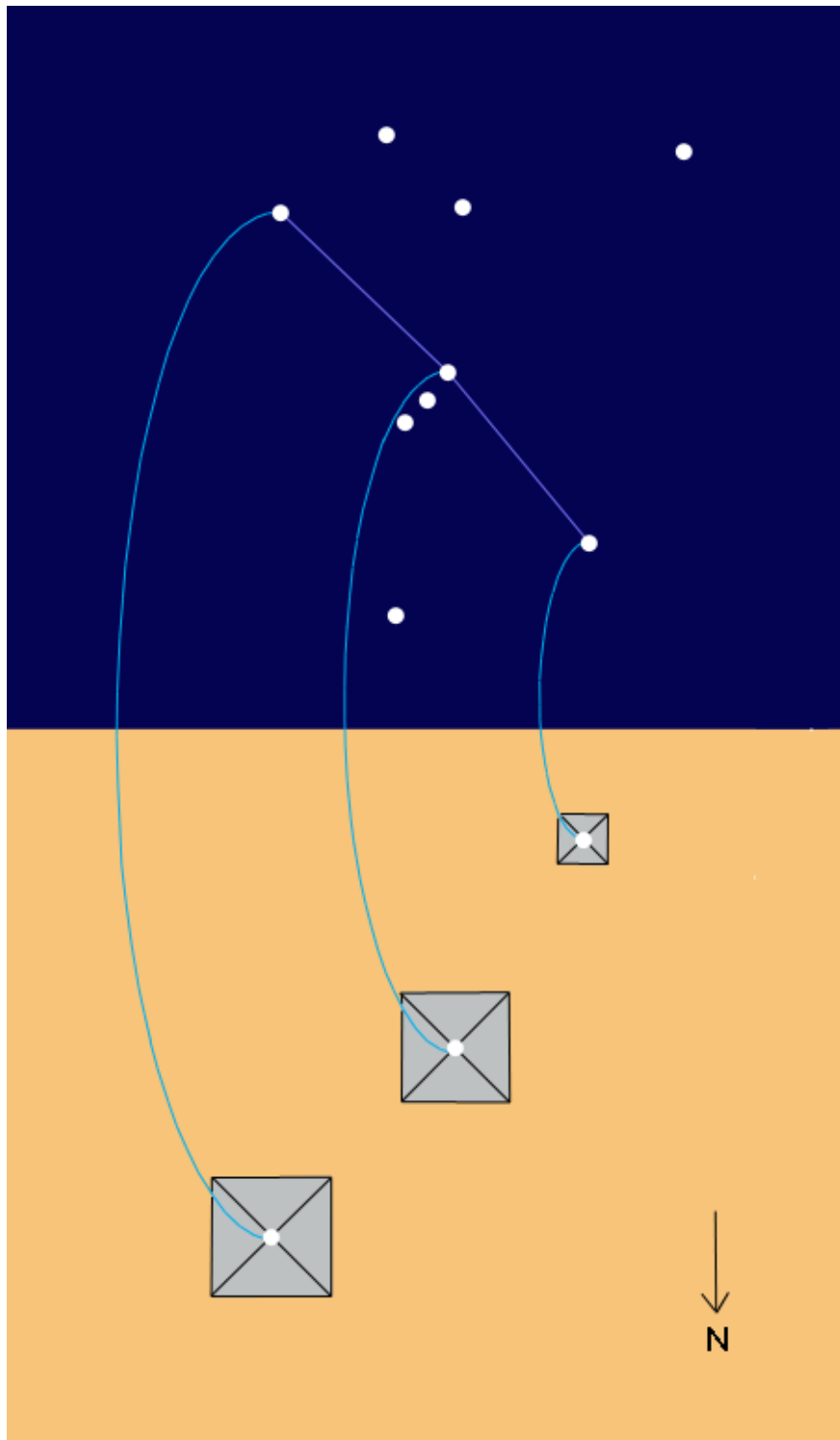


1 (ii) Translation mapping Alnitak, Annilam and Mintaka onto Khufu, Khafre and Menkaure



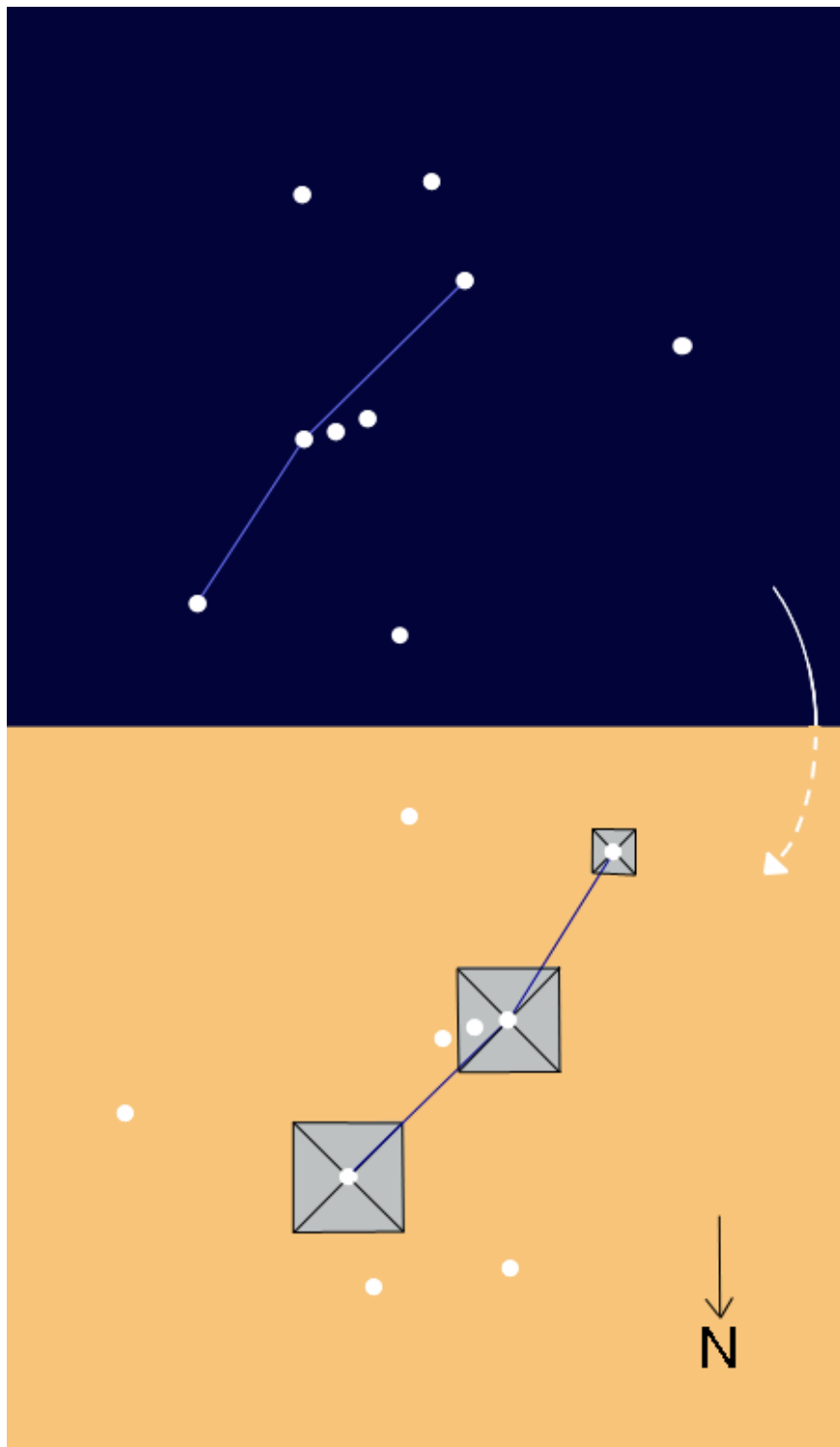
**Diagram 6** Orion Correlation Theory as proposed by Bauval. Note the much smaller scale required for the mapping due to the closer proximity of the three stars in Orion's Belt.

1 (iii) Reflection Mapping of Betelgeuse, Mintaka and Rigel onto Khufu, Khafre and Menkaure



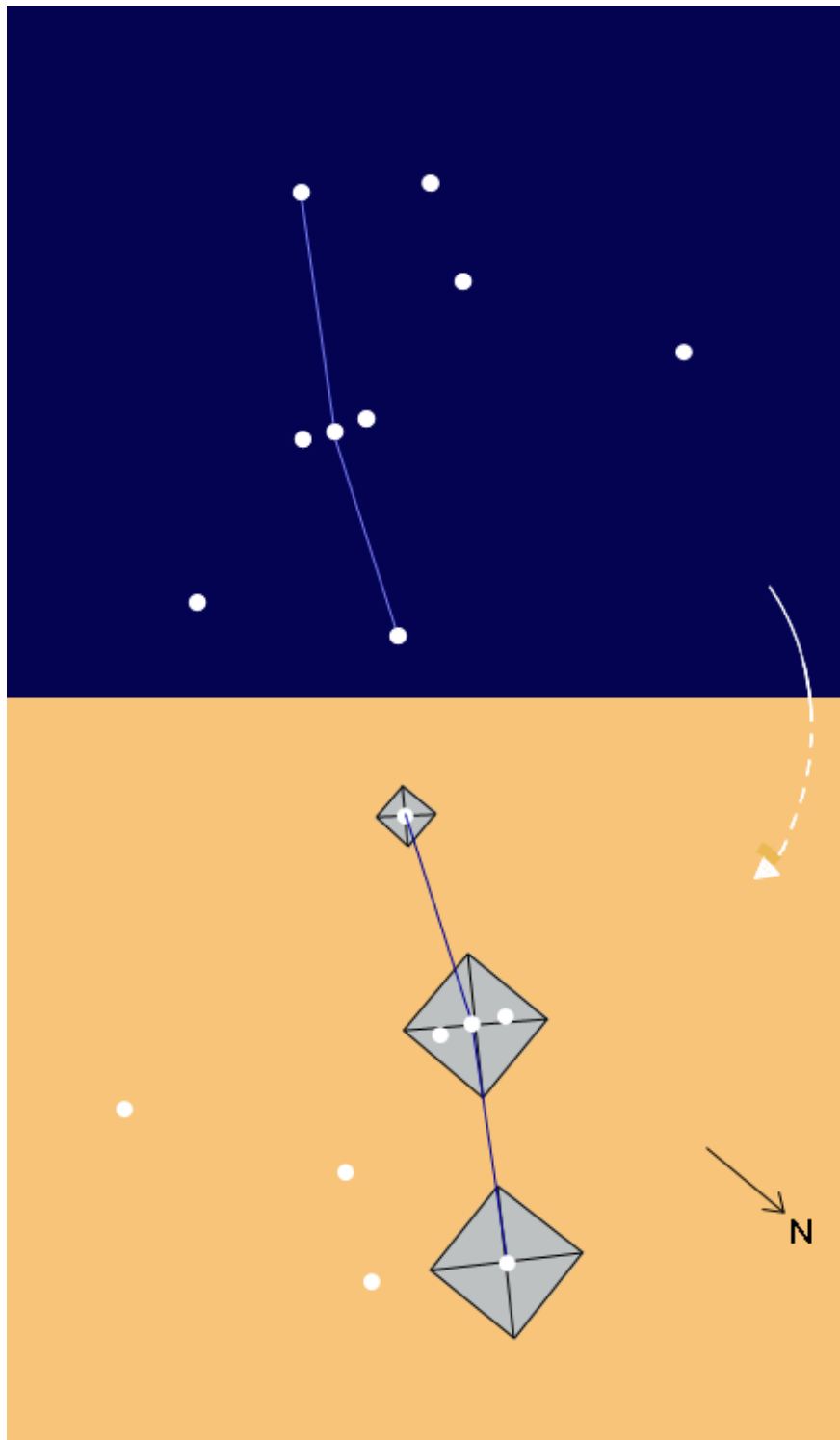
**Diagram 7** The stars in Orion can be folded down onto their pyramids

2 (i) Rotational Mapping of Bellatrix, Alnitak and Saiph onto Khufu, Khafre and Menkaure



**Diagram 8** The pyramids map onto the stars as they pass below the pyramids after setting in the West

2 (ii) Rotational Mapping of Betelgeuse, Alnilam and Rigel onto Khufu, Khafre and Menkaure



**Diagram 9** The Pyramids map onto the stars as they pass below the pyramids after setting in the West

## Closeness of Match of the five different Triplets of Stars in Orion with the Pyramids of the Giza Plateau.

The closeness of match can be most easily tested by establishing the angles between the apices of the three pyramids and comparing those angles with the corresponding angles between Alnitak, Alnilam and Menkaure. The analysis of angles avoids any need to take account of scaling and produces triangles whose congruency can be easily compared.

### Method of Analysis

The position of a star **P** can be defined on a celestial sphere by the astronomical equivalent of latitude and longitude, namely Declination and Right Ascension. These angular positioning co-ordinates can be converted into Cartesian co-ordinates in three dimensions described by  $(x', y', z')$ . The coordinates of the star on the projection plane can be described where **W** is the "longitude" or right ascension of the star from the chosen point of projection and **L** is the "latitude" or declination of the star.

The location of an object in space (**P**) can be described with the following vector notation: These co-ordinates, with the Earth located at the origin ( $\sigma$ ) relate to the ephemeris data as follows;

$r$  = the distance from the Earth to the object of interest

$\phi$  = declination of the object (**L**)

$\theta$  = right ascension of the object (**W**)

### Equatorial Stereographic Projection

$$x' = \cos(L) * \sin(W)$$

$$y' = \sin(L)$$

$$z' = \cos(L) * \cos(W)$$

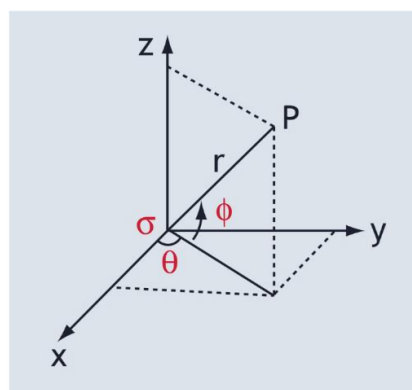


Diagram 10

These are the Cartesian co-ordinates of the star if the North Pole has co-ordinates (0,1,0) and the projection point has co-ordinates (0,0,1), and the South Pole has projection points (0,-1,0). The star is at a distance of 1 from the centre.

The co-ordinates in the plane of the projection are then given by

$$X=x'/(1+z')$$

$$Y=y'/(1+z')$$

Star	RA(h)	(m)	(s)	Degrees	Dec. Degrees	(°)	(‘‘)	Degrees
Kappa	2	18	2.83	34.51179	-21	-54	-32.1	-21.9089
Zeta	1	59	15.61	29.81504	-15	-21	-32	-15.3589
Gamma	1	32	39.66	23.16525	-8	-52	-46.9	-8.87969
Beta	1	42	33.79	25.64079	-23	-29	-51.1	-23.4975
Alpha	1	59	16.93	29.82054	-5	-21	-41.8	-5.36161
Epsilon	1	53	46.58	28.44408	-15	-3	-40.7	-15.0613
Delta	1	48	23.98	27.09992	-14	-34	-56.1	-14.5823

**Table 7** The Right Ascension and Declination of seven stars comprising the main body of Orion have been determined for 2560BC and their values converted into degrees.

Star	x'	y'	z'	X	Y
Kappa	0.291235	-0.19003	0.937588	0.150308	-0.09807
Zeta	0.254952	-0.13363	0.957675	0.130232	-0.06826
Gamma	0.200178	-0.07741	0.976696	0.101269	-0.03916
Beta	0.217247	-0.20362	0.954643	0.111144	-0.10417
Alpha	0.257024	-0.04677	0.965272	0.130783	-0.0238
Epsilon	0.243561	-0.13106	0.96099	0.124203	-0.06683
Delta	0.232399	-0.12691	0.964305	0.118311	-0.06461

**Table 8** Using the equations, the co-ordinates can be converted to give x',y' and z' and finally map co-ordinates (X,Y)

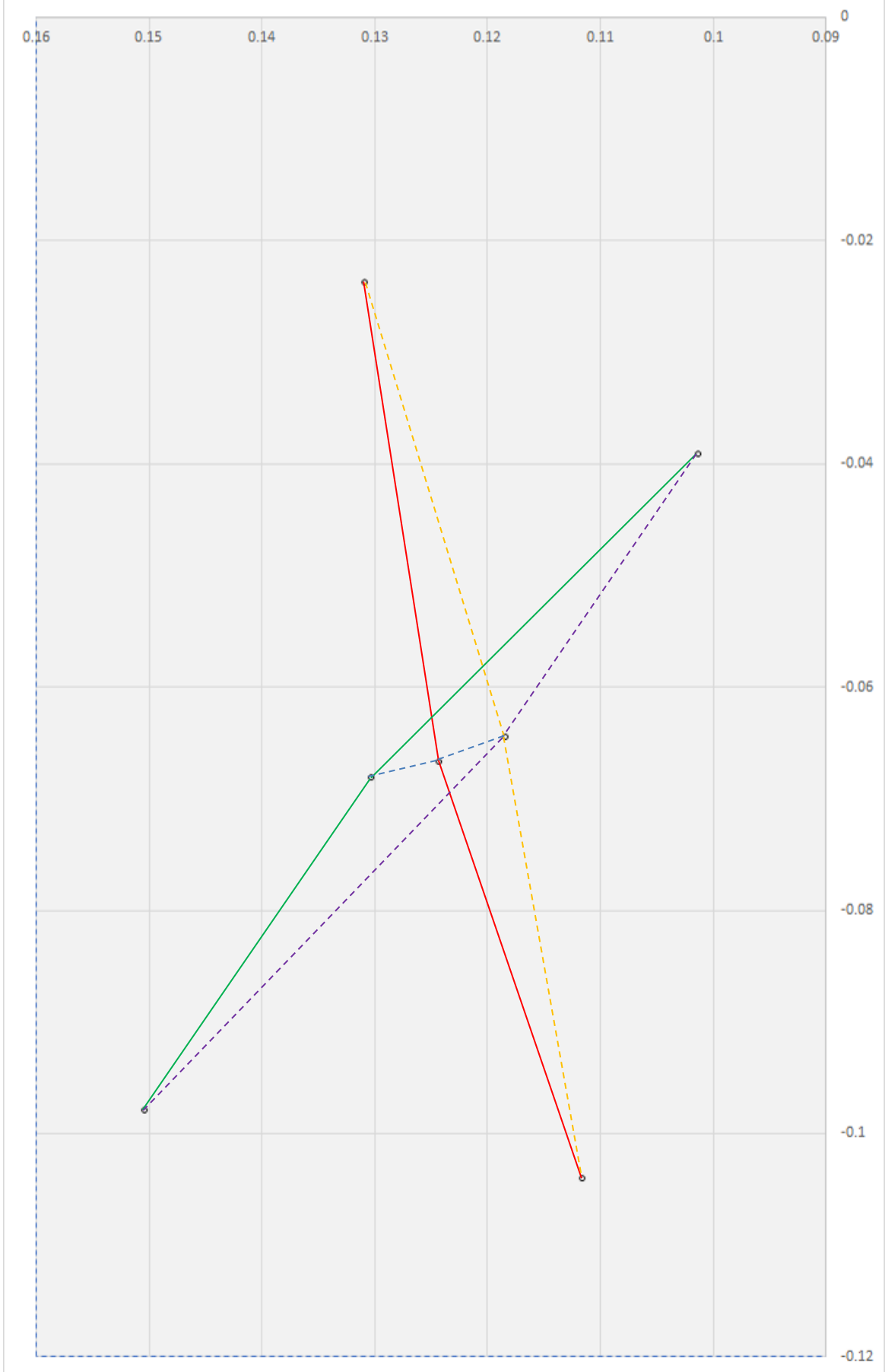
The three stars in Orion's belt are Alnitak, Alnilam and Mintaka or Zeta-Orionis, Epsilon-Orionis and Delta-Orionis. The X,Y co-ordinates for these three stars can be plotted out and the points representing the stars joined by straight lines to form a triangle. The same process can be carried out for the apices of the three pyramids to compare how closely the position of the stars match the positions of the apices of the three pyramids. Likewise, the co-ordinates of the other four Orion star triplets can be plotted as triangles for comparison with the triangle produced by plotting the positions of the apices of the pyramids of Khufu, Khafre and Menkaure.

Positions of triplets of stars taken from Betelgeuse, Alnilam, Rigel, Bellatrix, Alnitak, Saiph and Mintaka described as triangles and the internal angles of those triangular arrangements compared with the triangular plan of the three major pyramids of Giza.

Star Triplets in Orion			Angle		
Betelgeuse	Alnilam	Rigel	5.037	169.417	5.545
Bellatrix	Alnitak	Saiph	5.090	169.094	5.816
Saiph	Mintaka	Bellatrix	3.945	170.087	5.968
Betelgeuse	Mintaka	Rigel	3.262	173.275	3.463
Alnitak	Alnilam	Mintaka	3.680	172.698	3.622
Pyramids			Angle		
Khufu	Khafre	Menkaure	5.536	168.530	5.934

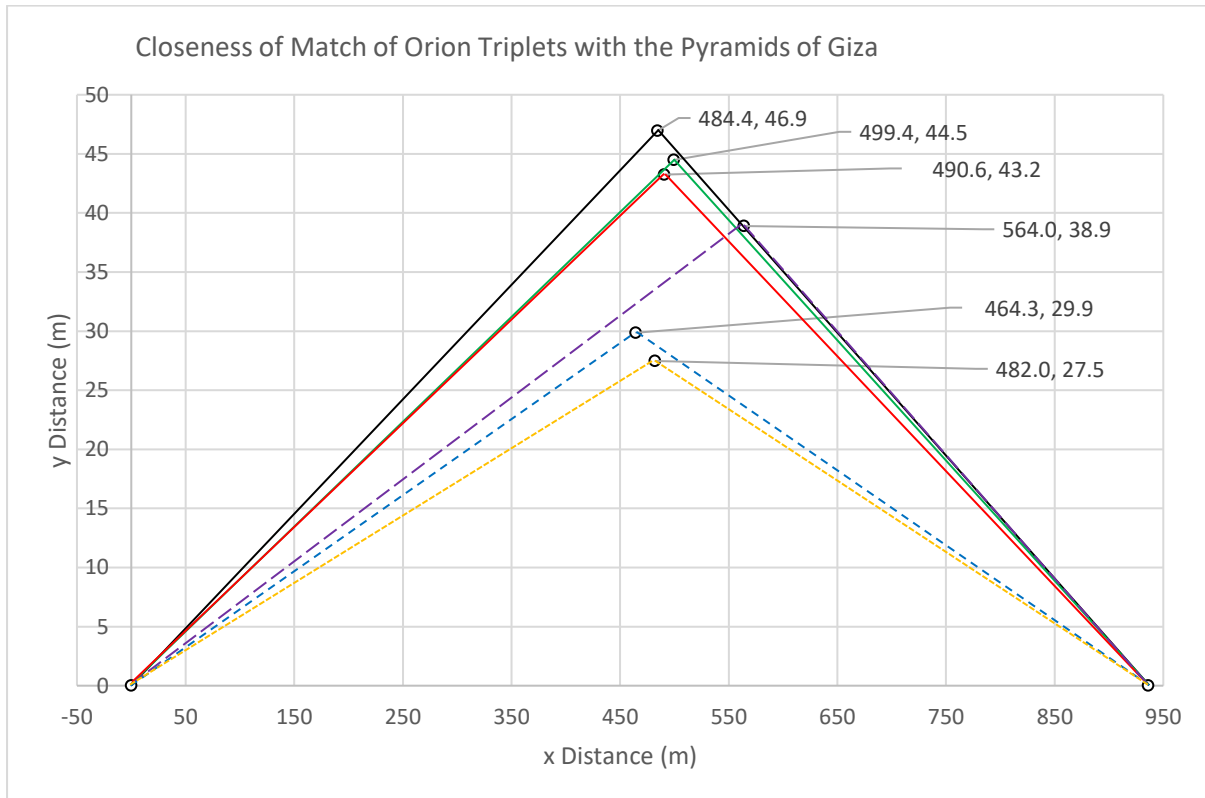
**Table 9** Internal angles of triangles formed by different triads of stars in Orion

# Constellation of Orion





It is interesting that the consideration of five, star triplets in Orion which share the same general arrangement of the pyramids of Giza, with the middle star displaced, produces a saltire cross. It will be seen later that the saltire cross was used by the ancient Egyptians as a shorthand representation of Orion as the god Osiris.



—	Khufu	Khafre	Menkaure
—	Bellatrix	Alnitak	Saiph
—	Betelgeuse	Alnilam	Rigel
- - -	Saiph	Mintaka	Bellatrix
- - -	Alnitak	Alnilam	Mintaka
- - -	Betelgeuse	Mintaka	Rigel

Graphs 2(i) (previous page) and (ii) Show the main stars of Orion plotted out and the closeness of match of different triads of stars in Orion to the positions of the three major pyramids of Giza.

The y-axis scale has been exaggerated ten times compared with the x-axis, to emphasise the separation of the various star triplets and the three pyramids. The black top line marks the relative positions of the peaks of the three Pyramids of Giza. The positions of

the five different star triplets have been scaled to fit the distance between the apices of Khufu and Menkaure (936.06m) and the closeness of match illustrated by the position of the middle star of the trio.

It is apparent from the graph that the triplets of stars most closely matching the positions of the pyramids are the two triplets that the pyramids map onto when they pass beneath the pyramids. The two triplets that can be mapped using a rotation are Bellatrix, Alnitak and Saiph and Betelgeuse, Alnilam and Rigel respectively. Perhaps this association reflects the importance of Osiris with the Underworld.

The closest fit to the pyramids is for the rotation mapping of Bellatrix, Alnitak and Saiph that match Khufu, Khafre and Menkaure as they pass beneath the Pyramids after Orion has set in the West. The next closest match is the other rotation mapping involving Betelgeuse, Alnilam and Rigel again mapping onto Khufu, Khafre and Menkaure as Orion makes its way beneath the pyramids from the western horizon back to the eastern horizon. The closest mapping of stars visible in the night sky onto the pyramids below involves the stars Saiph, Mintaka and Bellatrix that map onto Khufu, Khafre and Menkaure by a translation of the stars down onto the pyramids below. Although the obtuse angle is close to that corresponding to the angle at Khafre, Mintaka is displaced from the ideal almost half-way position between Saiph and Bellatrix and is too close to Bellatrix to give the closeness of match of the previous two Orion triplets. The next trio of stars comprises the stars of Orion's Belt, Alnitak, Alnilam and Mintaka that map through a translation onto Khufu, Khafre and Menkaure from a position again North of the Pyramid complex looking South. This is the proposed match referred to as the "Orion Correlation Theory" but it can be seen that the alignment of stars with the three pyramids as far as mapping is concerned is only the fourth closest of five triplets of stars in Orion. The final triplet of stars again involves the two brightest stars in Orion Rigel and Betelgeuse but this time the mapping is a reflection of the stars visible in the night sky as if they were "folded" down onto each of their respective pyramids. It is clear that the two triplets of stars that map closest onto the pyramids are those that require a rotational mapping, suggesting that the most important association between Orion and the Pyramids was that which occurred as the constellation passed through the underworld on its journey beneath the pyramids. The Pyramids in some way perhaps acting to ensure that each night that journey was safely completed

Different Mapping Operations of the Stars of Orion and the Pyramids of Giza represented in order of closeness of mapping to the Pyramids of Giza.

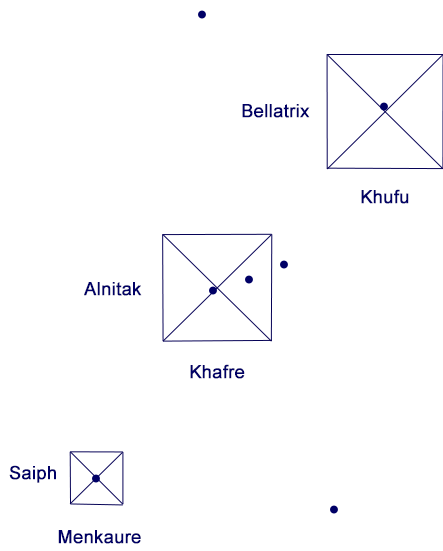


Diagram 11 Rotation (i) Mapping of Pyramids onto the Stars

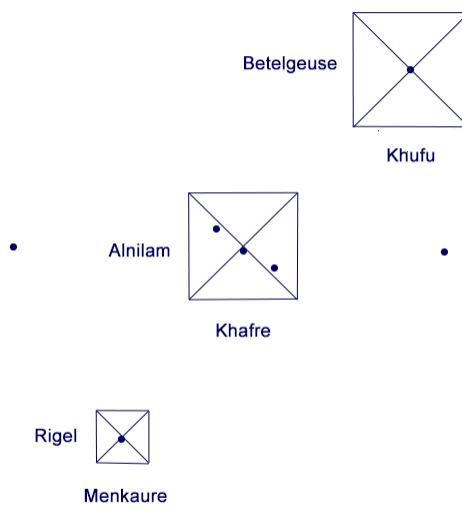
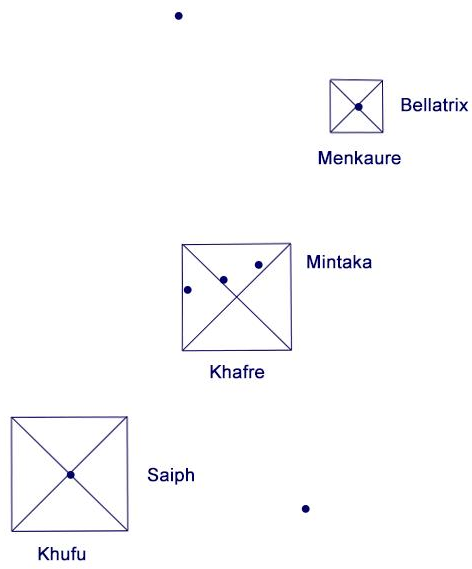
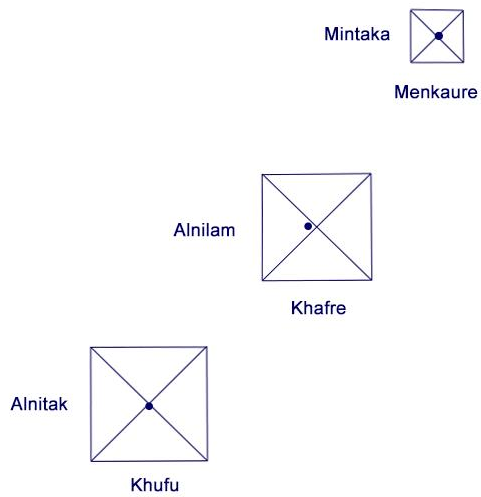


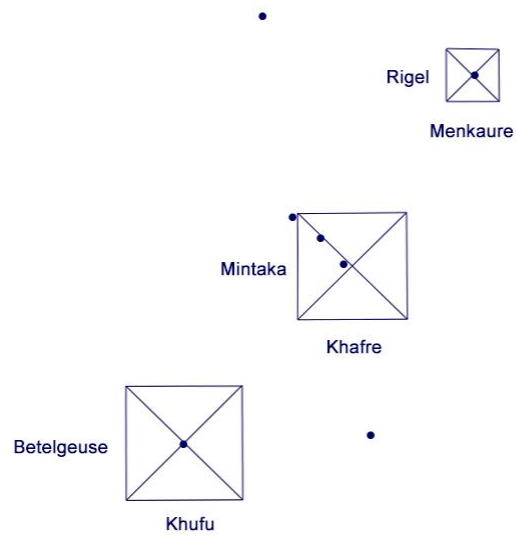
Diagram 12 Rotation (ii) Mapping of the Pyramids onto the Stars



**Diagram 13** Translation Mapping of Saiph, Mintaka and Bellatrix onto the Pyramids



**Diagram 14** Orion Correlation Theory Translation Mapping



**Diagram 15** Reflection Mapping Stars onto the Pyramids

## PART IIb

### Stars of Orion Rising from and Setting into the Pyramids

The first section of this part analysed how triplets of stars in Orion could be mapped onto the pyramids by translation, reflection and rotation operations and how these could be applied as the stars moved across the night sky and then after setting in the West moved eastwards through the underworld, beneath the pyramids. In this second section we look at how stars in Orion might rise out of and set into the peaks of the three pyramids at the transitional times when the stars move between the underworld and the sky and vice versa when the stars rise from the eastern horizon and set into the western horizon.

The changing positions of the stars in Orion as they rise, travel across the sky and then set can be determined in terms of their azimuth and altitude as a function of time using the SkyMap Pro II archaeo-astronomy program. The angles of elevation of the apex of each pyramid and the virtual apex of Khufu can be calculated as a function of distance from the pyramid. A range of distances radiating from each of the pyramid peaks is used to calculate the angle of elevation from that distance anywhere on a circle with a radius equivalent to the distance with the pyramid peak at its centre. The angle of elevation calculated for the pyramid peak at a given distance from the pyramid can then be matched to the altitude of a star and the azimuth of the star corresponding to that altitude using the archaeo-astronomy program. The azimuth determined can then be used to determine the precise point on the circle at which the star could be seen to coincide with the peak of the pyramid. A series of points can be obtained for each pyramid and for the different stars in Orion to create a series of curves. If there is a point at which three stars can be seen to coincide with the peaks of the three pyramids the curves representing the star and its pyramid will intersect at a single point.

The seven main stars making up the body of Orion give twelve permutations of star triplets that might align with the pyramid peaks as the seven stars form three groups of 2 or 3 stars that could rise from the three pyramids.

The stars of Orion rise a few degrees South of East and set a few degrees South of West. As a result, the viewing positions might be expected to be slightly North of Khufu and to the East for setting stars and to the West for rising stars.

As the angle of the slopes of the three pyramids are 52.08 for Khufu, 53.13 for Khafre and 51.18 for Menkaure and the angles of star rise and star set for the stars of Orion examined lie in the range 56-60 degrees, if the stars correspond with the apices of the three pyramids they would appear to disappear into each pyramid after that alignment.

The other small consideration is that the Great Pyramid of Khufu does not have a peak like those of Khafre and Menkaure. There is therefore a question of alignment and

whether the star should be measured as aligning with the projected peak or aligned with the centre of the flat platform at the top of Khufu. This effect might be considered small given that the viewing points lie at least a kilometre from the pyramids and the difference in the projected height of a pyramid with a peak and the existing flat top pyramid is only 5.8m. It is however possible that this precise alignment was important to those assembled at the viewing position especially if the Pharaoh was standing on the platform at the time when the star in Orion appeared to set into or rise from Khufu.

### **Identification of possible Viewpoints East and West of the Pyramids**

The known arrangement of the pyramids of Giza and the known astronomy of the movement of stars in Orion as they rise and set allow us to calculate whether there are positions to the East that allow three stars in Orion to set into the three pyramids and likewise a position to the West that allow the observation of three stars in Orion to rise from the peaks of the three pyramids.

The way in which a general idea of where a viewing position might be located and which stars in Orion might coincide with the pyramid peaks can be identified by considering the azimuths of the main stars in Orion on the horizon as they rise and set. These azimuths can be determined using an archaeo-astronomy program for the time of construction of the Pyramids at the longitude and latitude of the Giza plateau. The azimuths can be converted to bearing angles for each of the stars in Orion and plotted as curves. The series of radial lines for the rising and setting stars can be laid over the plans of the pyramids to determine potential positions where three of the lines coincide with three pyramids. The general location of the viewing position to the East and North of Khufu that would allow setting stars to set into the three pyramids is in the general vicinity of where we might have expected the Khufu Valley Temple to have been originally located before it became a ruin and built over. This only gives a rough idea because the stars set into the pyramids before they reach the horizon and the pyramids have different altitudes.

### **Method of Calculating Possible Viewing Positions.**

The advantage of having pyramids that have been so accurately surveyed and measured is that the required information for trigonometrical analysis is readily available. The information required to determine the alignment of pyramid peaks and setting Sun and stars requires the height of the pyramids, the height above sea level of each pyramid base, the height above sea level of each viewing position, the distance between the viewing point and the pyramid peak as vertically projected onto the ground and the bearing of that projected peak relative to North.

The angle or altitude of the peak of each pyramid from a viewing position can be calculated using the following formula.

$$A = \text{atan}(H_{\text{app}}/D)$$

and

$$H_{\text{app}} = H_{\text{pyr}} + L_{\text{pyr}} - L_{\text{vp}}$$

Where,

A is the Angular Altitude of the Pyramid Peak in degrees

$H_{\text{app}}$  is the apparent height of the Peak from the viewing position in metres

D is the horizontal distance between the viewing position and the pyramid peak in metres

$H_{\text{pyr}}$  is the vertical height of the pyramid from ground level to its peak in metres

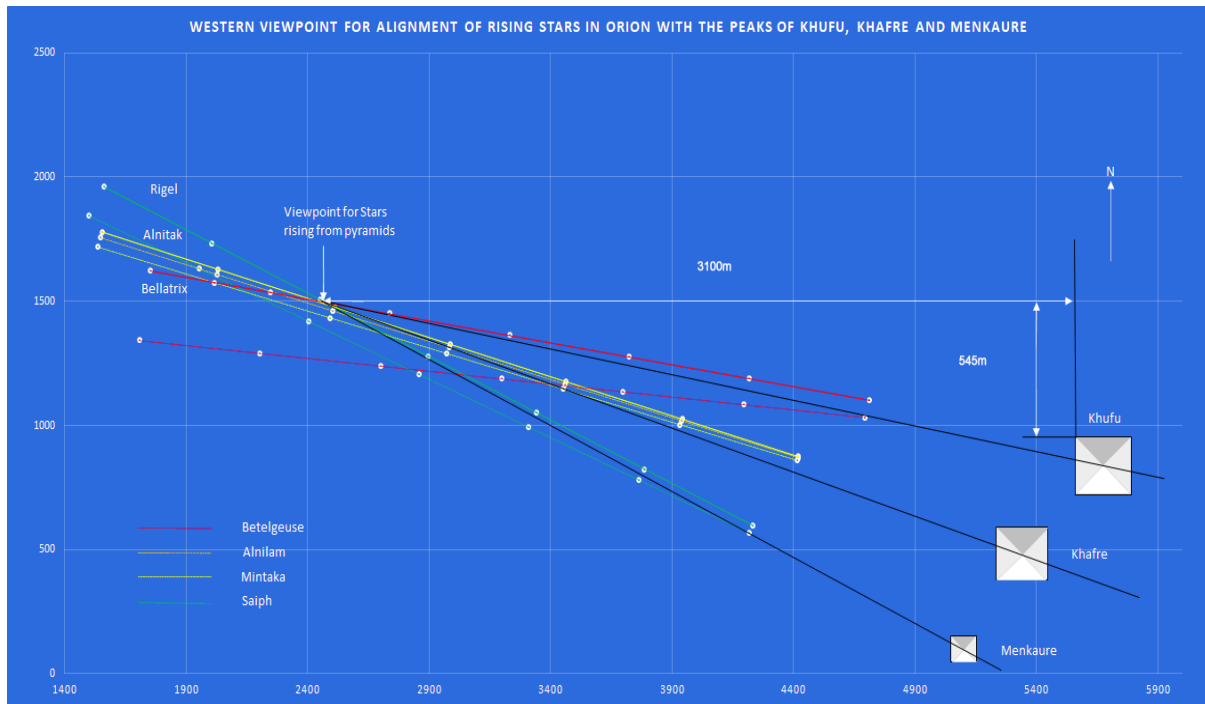
$L_{\text{pyr}}$  is the height above sea level of the pyramid base in metres

$L_{\text{vp}}$  is the height above sea level of the viewing position in metres

Although there appear to be no temples situated to the West of the pyramids, it is possible that another viewing position existed where the stars of Orion appeared to rise out of the pyramids exiting the pyramids through their peaks. The configuration of the pyramids means that any viewing position for stars in Orion rising out of their peaks, unlike the Khufu Valley Temple, has to be located several kilometres to the West of the pyramid complex. The topography of the area to the West of the Giza Plateau was studied as a function of distance from the Giza plateau. The area of land to the West and North of the Pyramids is at the same approximate height as the Giza Plateau at around 70m above sea-level. The method of determining the position where three stars in Orion can be viewed as exiting the peaks of the three pyramids is to determine the altitude of the pyramid peaks as a function of distance from the pyramid peaks. The altitudes of the peaks are then used to find the Azimuths of the stars in Orion corresponding to these altitudes. The azimuths of the stars at the required altitudes to coincide with the pyramid peaks are converted from bearings to angles and then to x, y co-ordinates by considering the distance between the viewing point and the pyramid peak. The co-ordinates (x, y) = (zcos A, zsinA) where z is the distance between each viewing position and the centre point of the base of each pyramid. Each of the (x,y) co-ordinates for a range of distances from 1000m to 4000m at 500m intervals was plotted as a curve for each of seven stars in Orion. The layout of the pyramids is such that the stars fall into three groups that could align with the three pyramids. Betelgeuse and Bellatrix may align with the peak of Khufu, Alnitak, Alnilam and Mintaka could align with the peak of Khafre and Saiph and Rigel could align with the peak of Menkaure. The curves representing three stars, one from each



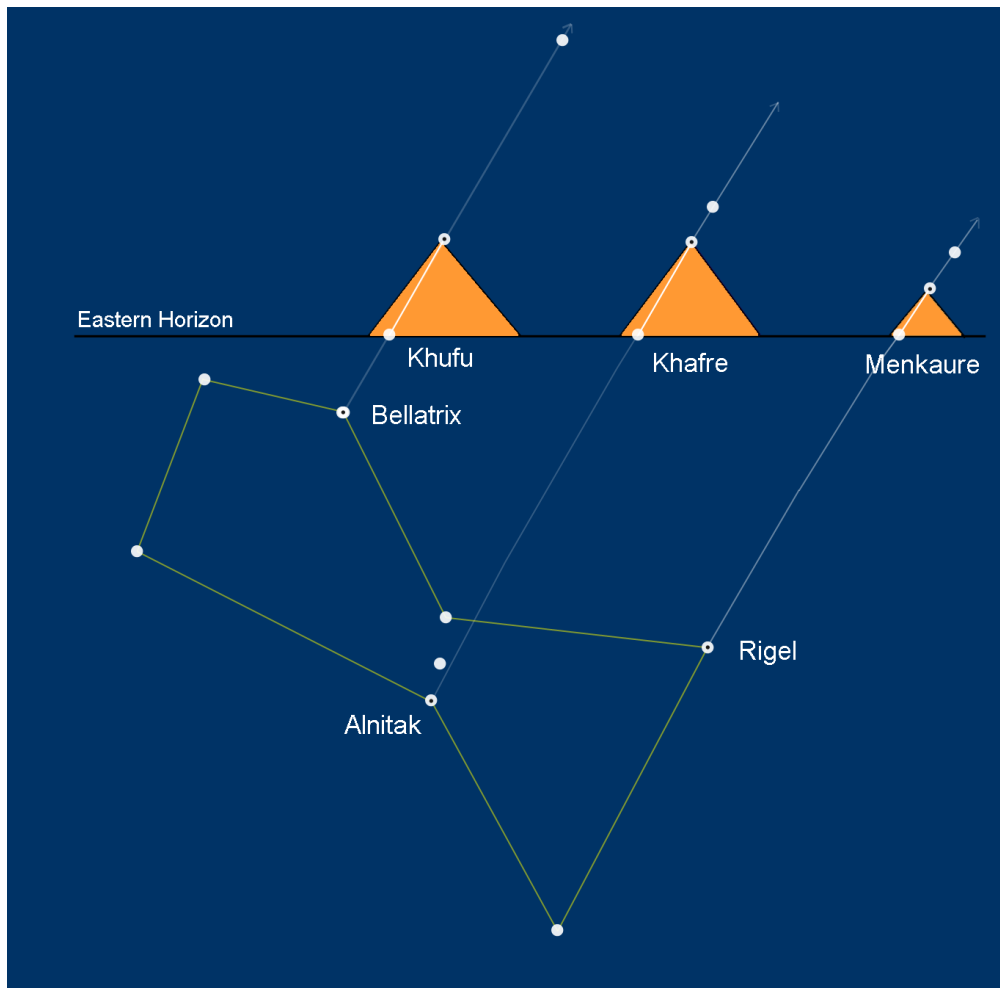
pyramid group will intersect at a single point if there is a viewpoint where three stars in Orion can be viewed as exiting in turn the peaks of each of the three pyramids. The graph below shows the graph which indicate that three curves representing the stars Bellatrix, Alnitak and Rigel intersect at a position some 3.1km West and 545m North of the N-W corner of Khufu.



**Diagram 16**

The curves representing the other stars in Orion for the three pyramids do not intersect at a common point indicating that there is no other viewing position where three stars can be observed exiting the three pyramid peaks. There is no evidence on the ground of any ruins that may have represented a viewing position in the same way as the valley temples on the eastern side of the pyramids. It may be that the viewing point of the rising stars was not important and too far from the pyramids, but on the other hand the location is today covered with buildings and perhaps there are remains of some kind of viewing area or temple that has been built over.

The order of stars rising from the pyramids as viewed from the western viewpoint is Bellatrix exiting Khufu, followed about 43 minutes later by Rigel exiting Menkaure followed by Alnitak exiting Khafre about 2 and a half minutes later.

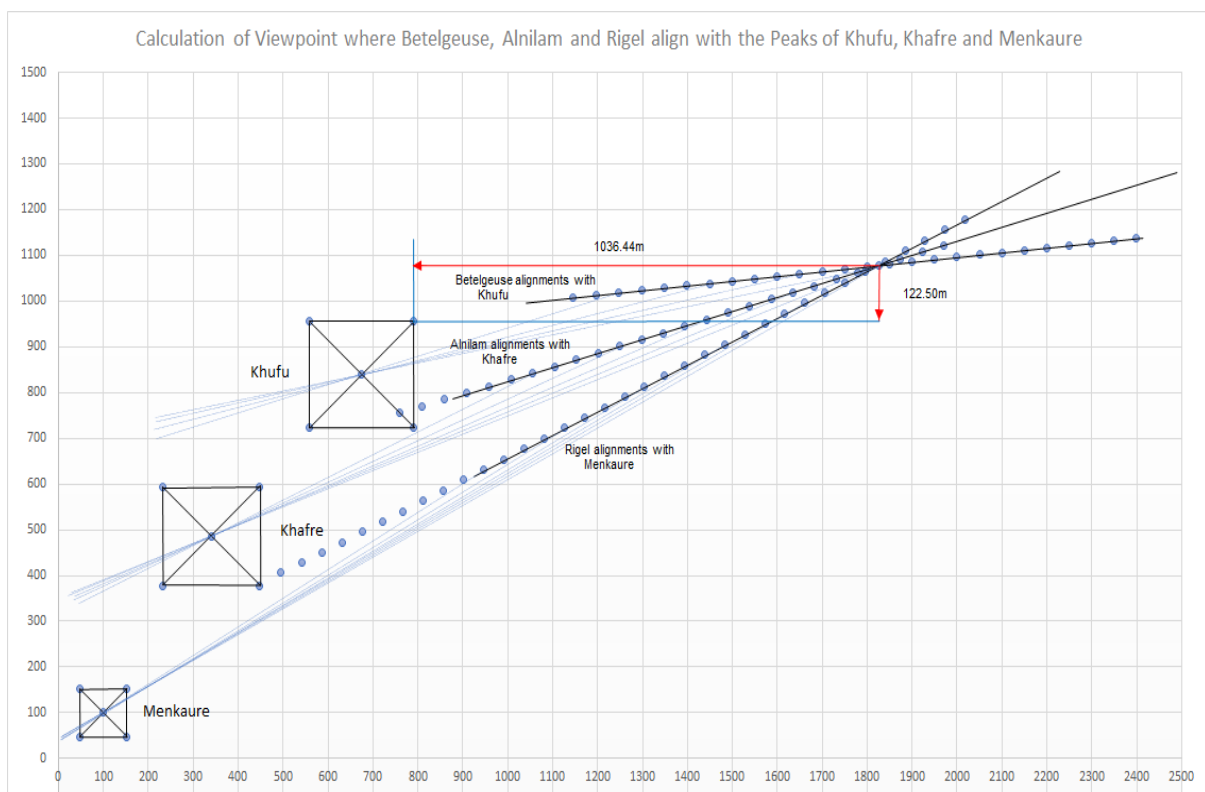


**Diagram 17** showing how the three stars Bellatrix, Alnitak and Rigel appear to rise out of the peaks of Khufu, Khafre and Menkaure from a viewing position 3.1km West and 545m North of NW corner of Khufu

### Determination of the location of the Eastern Viewing Position

The method of calculating the viewing point only assumes that it was at a height above sea-level equivalent to the ancient basalt paving stones found in the area of Nazlet el Samman. The causeway from Khufu is known to travel eastwards bending northwards at an angle of some 30 degrees so the temple was somewhere to the East and slightly to the North of Khufu. We also know that the pyramid temples in all cases were constructed at the base of the Giza plateau escarpment at a level above the level of the Nile but some 40 metres lower than the plateau, hence their commonly applied descriptions as valley temples. The level of the Khufu Valley Temple has been assumed to be at the level of the basalt paving blocks found during sewage construction works in 1990 at a height of 14-14.5m above sea-level. The angle of elevation of the pyramid peaks relative to this viewing level was calculated and by choosing a range of distances from each of the three pyramid peaks, the altitude of the peak calculated as a function of distance from each peak. The azimuth of a chosen star such as Betelgeuse can be determined that corresponds to this same altitude. So that for each distant point a bearing can be found that would allow the

viewer to observe the star aligned with the peak of the pyramid. For the different distances from the pyramid peak, multiple azimuth bearings can be drawn as lines that cut through the apex of Khufu and a series of radial lines intersecting at the apex of the pyramid is produced. The same procedure can be carried out for Khafre with respect to another star in Orion, say Annilam and then Menkaure with Rigel and the three sets of radial lines can be examined to see whether there is a single point where the three lines intersect. If there is a single point of intersection, this represents the point at which all three stars can be seen to coincide with the three pyramid peaks. The location can be converted from a direct length from the pyramid peaks and the associated bearing angles to an (x,y) co-ordinate E-W and N-S of a known point such as the north-east corner of Khufu's pyramid.



**Diagram 18**

There exists a point where three stars in Orion, Betelgeuse, Annilam and Rigel each in turn set into the peaks of the three pyramids. Firstly, Rigel the brightest star in Orion, aligns with and then sets into the smallest pyramid Menkaure. Then Annilam, the centre star in Orion's belt aligns and then sets into the peak of Khafre. Finally, Betelgeuse aligns with the "missing" peak of Khufu before appearing to set into the pyramid. The viewpoint where all three stars can be seen to set into their pyramid is calculated to be located 1036.44m to the East of the eastern side of Khufu and 122.50m North of the northern side of Khufu. This position appears to coincide with the position for the Khufu Valley Temple that was proposed after finding the remains of basalt paving blocks in this

location believed to be the remnants of the Valley Temple courtyard. The observation of three stars in Orion consisting of the two brightest stars in the constellation must have been a magical spectacle as viewed from the open courtyard of the Khufu Valley Temple and had a special significance in connecting the pyramids with the stars identified with Osiris as they set in the West entering the underworld via the pyramids.



**Diagram 19** shows how three stars in Orion, Rigel, Alnilam and Betelgeuse set into the peaks of Menkaure, Khafre and Khufu when viewed from a position 1036m East and 123m North of the NE corner of Khufu pyramid which may correspond to the position of the now lost courtyard of the Khufu valley Temple

### Stars Rise and Stars Set

The final piece of the great design that connected the stars of Orion to the Pyramids is perhaps the simplest and most dramatic. From a position West and North of the Pyramid complex as the Sun has set, the skies darken and the first bright stars appear in the sky, the constellation of Orion rises and as it does the three stars Bellatrix, Alnitak and Rigel appear each in turn from their respective pyramid's apex. First Bellatrix appears out of the top of Khufu and then around 40 minutes later, as the constellation continues to rise in the sky, Rigel, the brightest star in Orion, the "Toe Star" shines brightly atop the

Menkaure pyramid. Finally, two and a half minutes later, Alnitak appears out of the peak of the middle pyramid Khafre.

Later as the stars set, three stars in Orion are seen to sink into their respective pyramids from a viewing point to the East and North of Khufu. First Rigel aligns with the peak and then sets into Menkaure, followed by Alnilam which sets into the apex of Khafre and finally Betelgeuse aligns and sets into Khufu.

The association of stars in Orion with the pyramids is complete in terms of mapping operations and the alignment and rising and setting of stars into the peaks of the pyramids. The various relationships between the stars of Orion and the pyramids are shown in the diagram below.



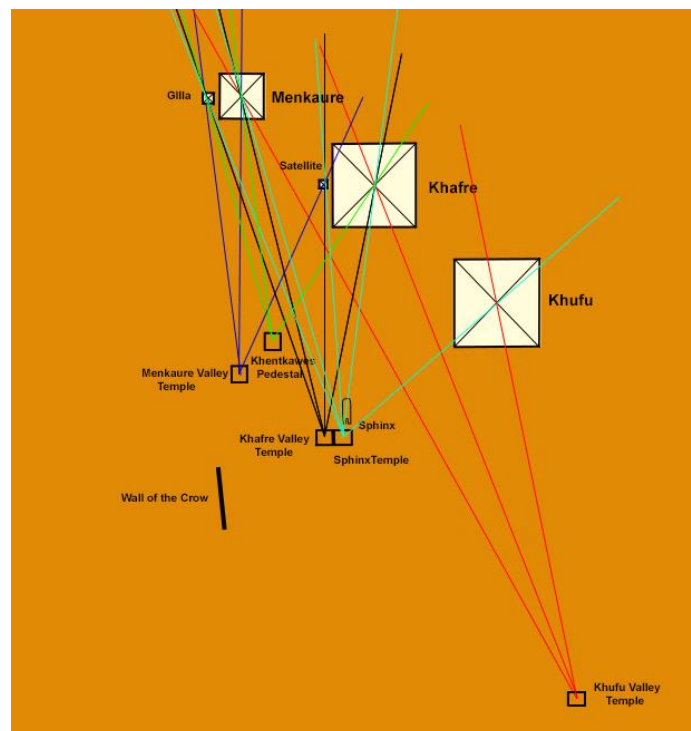
Diagram 20

As the stars rise at a position to the West and North of the Giza Plateau, three stars in Orion; Bellatrix, Alnitak and Rigel are seen to rise from the apices of Khufu, Khafre and Menkaure. As the constellation moves across the sky Bellatrix, Mintaka and Saiph could map onto the pyramids using a translation mapping operation and Betelgeuse, Mintaka and Saiph could map onto the pyramids using a reflection mapping operation. Then as the constellation sets into the western horizon, viewed from a position proposed to be the Khufu Valley Temple, Rigel, Alnilam and Betelgeuse could be seen to sink into the pyramids, Menkaure, Khafre and Khufu respectively via their peaks. As the constellation sinks below the western horizon and move below the pyramids to the eastern horizon, the pyramids Khufu, Khafre and Menkaure can be mapped onto Betelgeuse, Alnilam and Rigel from above using a rotation mapping. Similarly, Khufu, Khafre and Menkaure can be mapped onto Bellatrix, Alnitak and Saiph using the same rotational mapping operation. The cycle of mapping is completed as Orion rises once more from the eastern horizon.

### Part III

#### Stars from other Constellations Rising from and Setting into the Pyramids as viewed from the Valley Temples

Three stars in Orion, Betelgeuse, Anilam and Rigel appeared to sit at the peaks of the three pyramids before setting into them from the viewpoint proposed as the original location of the Khufu Valley Temple. The idea that the viewing point calculated as being E-N-E of Khufu may have coincided with the Khufu Valley Temple opens up the possibility that the other Valley Temples for Khafre and Menkaure were also positioned to allow the observations of stars and the Sun coinciding with the peaks of pyramids visible from their open courtyards. There is also the possibility that other viewing positions also located to the East of the pyramids such as the Sphinx Temple and the Khentkawes Pedestal were also used as viewing platforms to observe special alignments of stars with the peaks of the pyramids. Furthermore, there are, apart from the three main pyramids of Khufu, Khafre and Menkaure, other smaller pyramids such as the Satellite pyramid lying to the South of Khafre and the Subsidiary pyramid Gilla lying to the South of Menkaure which are within the sight lines of the various viewing platforms.



**Diagram 21** Alignments from the Valley Temples, the Sphinx Temple and Khentkawes Pedestal with the Peaks of the Pyramids of Khufu, Khafre, Menkaure, Gilla and the Satellite to Khafre.

The altitude of each pyramid peak was determined from each of the four possible viewing positions (the Khafre, Valley Temple, the Sphinx Temple, the Menkaure Valley Temple and the Khentkawes platform) by calculating the distance of each viewing position from the centre of the base of each pyramid and the height of the pyramid's peak relative to the

viewing position. The angle of alignment or bearing of each pyramid peak to each viewing position was then measured.

The angle of altitude and azimuth of bright stars for 2560BC was determined using the SkyMap Pro II archaeo-astronomy program to see whether there were stars that corresponded to the calculated bearings and altitude of the different pyramid peaks viewed from the various temples and rock pedestal.

Viewing Position	Pyramid Peak	Altitude Peak Star	Azimuth Peak Star	Star
"Khufu Valley Temple"	Khufu	8° 48' 16" <b>8° 48' 18"</b>	258° 37' 11" <b>258° 37' 21"</b>	Betelgeuse
"Khufu Valley Temple"	Khafre	6° 51' 25" <b>6° 31' 29"</b>	248° 22' 26" <b>248° 30' 42"</b>	Alnilam
"Khufu Valley Temple"	Menkaure	3° 12' 48" <b>3° 12' 42"</b>	240° 29' 15" <b>240° 36' 25"</b>	Rigel
Sphinx Temple	Khufu	17° 36' 6" <b>17° 36' 7"</b>	319° 0' 0" <b>318° 59' 37"</b>	β-Comae Berenices
Sphinx Temple	Khafre	14° 11' 2" <b>14° 11' 7"</b>	277° 18' 0" <b>277° 14' 13"</b>	Spica
Sphinx Temple	Menkaure	6° 22' 51" <b>6° 22' 51"</b>	253° 30' 0" <b>253° 12' 39"</b>	Menkent
Sphinx Temple	Satellite to Khafre	4° 18' 10" <b>4° 18' 9"</b>	266° 4' 0" <b>266° 24' 45"</b>	Hamal
Sphinx Temple	GIIa subsidiary to Menkaure	4° 8' 24" <b>4° 8' 31"</b>	248° 0' 0" <b>247° 35' 2"</b>	NGC7009
Khafre Valley Temple	Khafre	14° 13' 6" <b>14° 15' 35"</b>	281° 30' 0" <b>282° 16' 57"</b>	Beta Sagittae
Khafre Valley Temple	Satellite to Khafre	4° 32' 44" <b>4° 40' 0"</b>	270° 0' 0" <b>269° 46' 44"</b>	Pleiades
Khafre Valley Temple	Menkaure	6° 37' 40" <b>6° 37' 57"</b>	256° 0' 0" <b>255° 49' 28"</b>	Bellatrix
Khafre Valley Temple	GIIa subsidiary to Menkaure	4° 25' 1" <b>4° 25' 7"</b> <b>4° 25' 7"</b> <b>4° 25' 4"</b>	250° 42' 0" <b>250° 30' 51"</b> <b>249° 56' 40"</b> <b>249° 35' 25"</b>	Mintaka Alnilam Alnitak
Menkaure Valley Temple	Satellite to Khafre	4° 18' 45" <b>4° 18' 51"</b>	295° 30' 0" <b>295° 35' 39"</b>	Regulus
Menkaure Valley Temple	Menkaure	8° 12' 38" <b>8° 12' 30"</b>	270° 30' 0" <b>270° 24' 0"</b>	Procyon
Menkaure Valley Temple	GIIa subsidiary To Menkaure	5° 40' 0" <b>5° 40' 45"</b>	262° 42' 0" <b>262° 28' 34"</b>	Sheratan
Khentkawes Pedestal	Khafre	17° 11' 22" <b>17° 11' 23"</b>	303° 0' 0" <b>302° 27' 36"</b>	Deneb
Khentkawes Pedestal	Menkaure	7° 41' 26" <b>7° 41' 36"</b>	263° 0' 0" <b>262° 35' 12"</b>	Aldebaran
Khentkawes Pedestal	GIIa subsidiary To Menkaure	4° 26' 57" <b>4° 27' 1"</b>	254° 42' 0" <b>254° 27' 1"</b>	Menkent

Table 10



It is interesting that seven of the eighteen possible alignments of stars with the peaks of the pyramids involve the brightest stars in the sky and that these stars are likely candidates for the stellar embodiments of the Ancient Egyptian deities. Just as the stars of Orion, particularly its brightest stars Rigel and Betelgeuse have been associated with Osiris, through their alignments with Menkaure and Khufu, the other bright stars seen to align with the other pyramids from different viewing points may also represent Egyptian deities such as Hathor in the case of the alignment of the star Spica in Virgo with the peak of Khafre viewed from the Sphinx Temple, or Anubis in the case of the alignment of the star Procyon in Canis Minor, with Menkaure from the Menkaure Valley Temple. Other stellar alignments involving stars such as Hamal in Aries, Menkent in Centaur, Regulus in Leo, Aldebaran in Taurus and Deneb in Cygnus are proposed as representing other important ancient Egyptian Deities such as Atum/Khnum, Thoth, Sekhmet, Apis and Nephthys respectively.

Some of the alignments of the peaks are with less bright stars such as Beta Comae, in the constellation of Coma Berenices but this constellation, at least in Northern Europe was an important marker of the festival known as Beltane at the beginning of May (6<sup>th</sup>). Furthermore, this constellation has a cluster of small stars known as MEL 111 that was popularly known as the Nine Maidens and which may have had some similar association with Ancient Egyptian deities such as the idea of the Ennead or "nine gods" as the sprinkling of nine stars set into Khufu. Another alignment that occurs is the alignment of the deep space object NGC7009 or the Saturn Nebula with the peak of the subsidiary pyramid GIIIa viewed from the Sphinx Temple. This may have merely been a coincidental alignment as GIIIa is perhaps not easily viewed from the Sphinx Temple, and may have been viewed from the pavement in front of the temple, and as the Saturn Nebula bisects the constellation of Capricorn it may have been the setting of the constellation itself into the subsidiary pyramid that was important with Capricorn proposed as representing the Cat-headed Egyptian deity Bastet. Another alignment is the disappearance of the small arrow shaped constellation of Sagitta which appears to set into the peak of Khafre when viewed from the Khafre Valley Temple. It is not known what deity may have been associated with the Arrow Sagitta, though there is a possibility that rather than an arrow, Sagitta represented the forked tongue of a snake and by association the snake goddess Wadjet depicted as a cobra and who became the uraeus symbol used on royal crowns. The alignment of Sagitta with the uraeus on the head of the Sphinx from the Sphinx Temple supports this suggested association.

### **Stars switching on and off as they align with the Pyramid peaks**

There is an interesting effect with the alignment of stars with the pyramid peaks as for about half the year certain stars appear to move across the night sky and set into a pyramid via its apex. These stars however are only visible for part of the year as during

certain months they are travelling across the sky during the daytime and therefore are not visible. There are two days that are interesting in the transition between the stars being visible and invisible representing the day when the star becomes visible at the End of Civil Twilight just at the moment when the star is aligned with the peak of its pyramid and the day at the end of the six month period of its visible setting into the pyramid when, just as it arrives at the peak of the pyramid, it disappears due to the arrival of the Start of Civil Twilight at that very moment. The effect is a magical one where the stars appear to switch on or off at the precise moment of arriving at the pyramid peak.

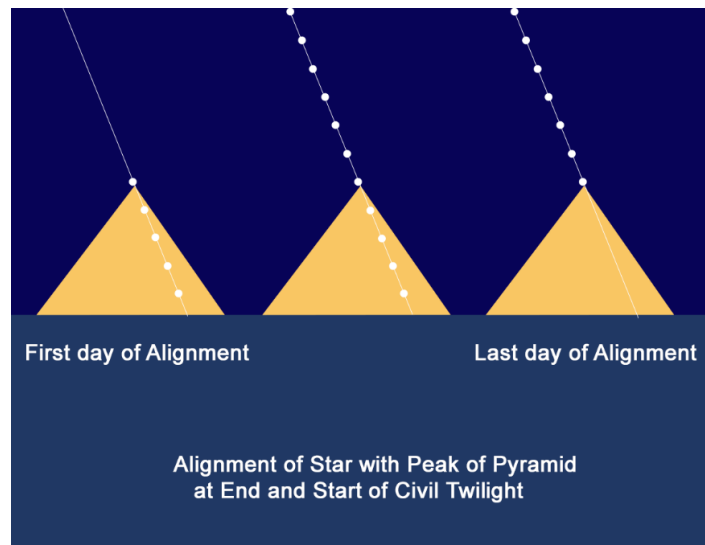


Diagram 22

The days when this occurred can be calculated by considering the altitude of the star and the pyramid peak and the times at which Civil Twilight occurred. The table below details the first and last days when each star was visibly aligned with the relevant pyramid peak. The alignment refers to the visible alignment of the star with the peak of the pyramid as this occurs only when the sky is dark enough to observe this alignment. The first day that the star is visibly aligned with the peak of the pyramid occurs on the day when the star has the same altitude and azimuth of the pyramid peak, when viewed from a particular viewpoint at the End of Civil Twilight when the Sun is six degrees below the horizon. At this time the sky is just dark enough to view the brightest stars and there is therefore the effect of certain bright stars that align with the peaks of the pyramids, just switching on at the End of Civil Twilight and at that precise moment appearing to sit at the apex of the pyramid. As the days pass, the same star appears at an increasingly elevated altitude and a bearing to the South of the pyramid peak and then as the skies continue to darken the star moves to align with the pyramid peak before setting into the pyramid. After a period of around six months the star can be seen to sit at the apex of its pyramid the moment before the Start of Civil Twilight marking the end of its visible alignment with the peak. The following day the star disappears short of reaching the peak and continues to fall increasingly short of its peak as the days progress.

Ancient Egyptian Association	Pyramid	Viewing Position	Start of Alignment (Switch On)	End of Alignment (Switch Off)
Pleiades	Satellite to Khafre	Khafre Valley Temple	13 <sup>th</sup> October	28 <sup>th</sup> March
Bull's Leg (Seth)				
Aldebaran	Menkaure	Khentkawes Pedestal	18 <sup>th</sup> October	2 <sup>nd</sup> April
Apis				
Rigel	Menkaure	Khufu Valley Temple	25 <sup>th</sup> October	10 <sup>th</sup> April
Osiris				
Bellatrix	Menkaure	Khafre Valley Temple	28 <sup>th</sup> October	14 <sup>th</sup> April
Osiris				
Alnilam	Khafre	Khufu Valley Temple	29 <sup>th</sup> October	14 <sup>th</sup> April
Osiris				
Mintaka, Alnilam Alnitak	Gilla	Khafre Valley Temple	31 <sup>st</sup> October	16 <sup>th</sup> April
Osiris				
Betelgeuse	Khufu	Khufu Valley Temple	2 <sup>nd</sup> November	19 <sup>th</sup> April
Osiris				
Procyon	Menkaure	Menkaure Valley Temple	29 <sup>th</sup> November	17 <sup>th</sup> May
Anubis				
Regulus	Satellite to Khafre	Menkaure Valley Temple	9 <sup>th</sup> January	29 <sup>th</sup> June
Sekhmet				
Spica	Khafre	Sphinx Temple	16 <sup>th</sup> February	4 <sup>th</sup> August
Hathor				
Menkent	Menkaure	Sphinx Temple	23 <sup>rd</sup> February	10 <sup>th</sup> August
Thoth				
Menkent	Gilla	Khentkawes Pedestal	26 <sup>th</sup> February	12 <sup>th</sup> August
Thoth				
Beta Comae Berenices	Khufu	Sphinx Temple	3 <sup>rd</sup> March	16 <sup>th</sup> August
Ennead?				
Saturn Nebula	Khafre	Khafre Valley Temple	21 <sup>st</sup> June	29 <sup>th</sup> November
Bastet				
Gamma Sagittae	Gilla	Sphinx Temple	23 <sup>rd</sup> July	1 <sup>st</sup> January
Wadjet				
Deneb	Khafre	Khentkawes Pedestal	7 <sup>th</sup> August	17 <sup>th</sup> January
Nephtys				
Hamal	Satellite to Khafre	Sphinx Temple	22 <sup>nd</sup> September	6 <sup>th</sup> March
Atum				

Table 11

Only the brightest stars are visible at the moment of start and end of Civil Twilight. The first and last days calculated when stars align with the pyramid peaks at Civil Twilight only apply to the stars that are bright enough to be visible at Civil Twilight. The less bright stars will only be seen to align with the pyramid peaks after twilight in the evening when the sky is darker and the switching on and off phenomenon for these stars will occur some days after and before the days of alignment stated for the start and end in the table. Rigel, Procyon, Betelgeuse, Aldebaran, Spica, Deneb and Regulus are first order magnitude stars amongst the top twenty-two brightest stars. Other less bright stars such as Alnilam, Hamal and Menkent may also have been visible at Civil Twilight.

By considering several viewing positions from the open courtyards of the Khufu Valley Temple, the Khafre Valley Temple, the Menkaure Valley Temple, the Sphinx Temple and the Khentkawes Pedestal platform, several important stars can be viewed as setting into each of the pyramid peaks.

Pyramid	View Point	Star	Association
Khufu	Khufu Valley Temple	Betelgeuse	Osiris
	Sphinx Temple	Beta Comae Berenices	-
	Khafre Valley Temple	Errai	Shen Ring
Khafre	Khufu Valley Temple	Alnilam	Osiris
	Sphinx Temple	Spica	Hathor
	Khafre Valley Temple	(Saturn Nebula)	Bastet
	Khentkawes Pedestal	Deneb	Nephthys
Menkaure	Khufu Valley Temple	Rigel	Osiris
	Sphinx Temple	Menkent	Thoth
	Khafre Valley Temple	Bellatrix	Osiris
	Menkaure Valley Temple	Procyon	Anubis
	Khentkawes Pedestal	Aldebaran	Apis
Satellite to Khafre	Sphinx Temple	Hamal	Atum/Khnum
	Khafre Valley Temple	Pleiades	Leg of the Bull (Seth transformation)
	Menkaure Valley Temple	Regulus	Sekhmet
Gilla	Sphinx Temple	Gamma Sagitta	Forked Tongue of Wadjet
	Khafre Valley Temple	Mintaka, Alnilam, Alnitak	Osiris
	Menkaure Valley Temple	Sheratan	Atum/Khnum
	Khentkawes Pedestal	Menkent	Thoth

Table 12

There is little surviving evidence to support the links proposed between the stars and the pyramids as viewed from the valley temples and Khentkawes platform. However, there is a possible link between the Sphinx Temple and Khafre with regards the alignment of Spica with the pyramid peak. Spica the brightest star in Virgo was identified with the goddess Hathor

Fragments of greywacke statue of crouching jackal (Anubis); rear part of figure and section of head and neck only, much battered. [1908 no. 26 = published no. 45 = 08-7-22a] Found in Room 2 – the Offering Room



**Figure 7** This object was excavated by the Harvard University–Boston Museum of Fine Arts Expedition, but was not recorded in any object register book. 1908: Excavated by the Harvard University–Museum of Fine Arts Expedition; 1911: assigned to the MFA in the division of finds by the government of Egypt. (Accession date: March 2, 1911)



**Figure 8** Wall painting from the Valley Temple of Menkaure showing Anubis on a Sarcophagus.

Further support that the alignment of the alignment of the star Procyon in Canis Minor with the peak of Menkaure, viewed from the Menkaure Valley Temple was an important alignment comes in the form of a wall painting from the Menkaure Valley Temple that depicts Anubis sitting on a sarcophagus.

## Part IV

### Alignment of the Sun with the Pyramids of Giza

The alignment of star in Orion with the position of the pyramids and the rising and setting of stars of Orion from and into each of the pyramids illustrates the strong association between the constellation of Orion with the Pyramids of Giza. The alignment of other bright stars with pyramid peaks as they set suggests that apart from the stars of Orion, identified by the Ancient Egyptians as Osiris being important, other bright stars represented other stellar deities in the pantheon of Egyptian deities. It should be remembered that the Sun is a star and its alignment with the pyramid peaks might also be examined to determine whether days of alignment with the pyramids represented significant days in the Egyptian calendar in a similar manner to the way in which Stone Circles were used as calendrical devices in Neolithic times.

### The Calendar of Fourth Dynasty Ancient Egypt

There is a great deal of confusion about the calendar of Ancient Egypt as it is difficult to match the festival days with dates corresponding with our own calendar. Furthermore, the festival days changed as a function of time as pharaohs changed and the deities worshipped changed during dynasties covering millennia. Whilst we understand how the Egyptian agricultural year was divided into periods relating to the flooding of the Nile and we know the Egyptian deities that formed the pantheon of gods, the actual days chosen to celebrate these deities has been lost in time. There is however an obvious monument in Egypt that allows us to re-discover the festival days that were celebrated at the time of its construction.

If we consider that in Neolithic Scotland, over five hundred years before the construction of the pyramids of Giza, the stone circles served as calendrical devices where the alignment of the Sun on the horizon with megaliths sunk into the ground viewed from two peripheral viewing positions, marked festival days when bright stars representing deities aligned due South at Civil Twilight, then it might be that in Egypt, the Pyramids served a similar purpose. The difference is that the Pyramids are much fewer in number than the megaliths required for a stone circle and they are so massive, in terms of their height and width of their base, that precise alignment with the rising or setting Sun on the horizon is impossible. It is therefore not immediately obvious how and where alignments between the Sun and the pyramids would be made. Although the massive size of the pyramids is actually an impediment to their usefulness as solar markers when the Sun is on the horizon, the solution could be that the alignment of the Sun with the pyramids was indicated when the Sun coincided with the peaks of the pyramids well before sunset from particular viewing positions for each pyramid. This overcomes the issue of the precision of alignment but requires the viewing positions to be identified.

Three potential viewing positions are conveniently provided by three temples connected to the three main pyramids by stone causeways, namely the lost Khufu Valley Temple, the Khafre Valley Temple and the Menkaure Valley Temple. The ruins of the Khafre and Menkaure temples survive on the Giza plateau but the ruins of the Khufu Valley Temple lie somewhere to the North and East of Khufu buried under the conurbation of Nazlet es Samman on the outskirts of Cairo. In 1990 a pavement of basalt blocks similar to those used in the upper temple besides Khufu's pyramid were uncovered during construction of a sewage system. This may represent the remnants of the courtyard of the Khufu Valley Temple. The floor level was measured as 14-14.5 metres above sea level, some 4.5m below the current ground level. Herodotus described the causeway between Khufu's Pyramid and the Khufu Valley Temple as being about 1km in length. He also describes it having taken ten years to construct having to rise some 45m to bridge the difference in altitudes of the temple lying in the valley and the pyramid lying up the escarpment on the Giza plateau. Evidence from Khafre's causeway suggests that the causeways were roofed with limestone slabs that left a narrow central gap that allowed people to follow a slit of light, marking a line on the floor of the causeway along the long narrow dark corridor. The position of the valley temple proposed by Egyptologists lies about 280m North of the East -West axis of the Khufu pyramid and about 825 metres East of its North-South axis. This position is a close match for the eastern viewing position calculated where Betelgeuse, Alnilam and Rigel can be seen to coincide with the peaks of Khufu, Khafre and Menkaure. The position calculated measured from the North-East corner of Khufu at 1036.44m East and 122.50m North relates to 1152.06m and 238.12m measured from the East-West and North-South axes.

The three Valley Temples are the logical situation for viewing any possible alignments of the Sun or stars with the peaks of the pyramids from their open-air courtyards. There are only temples on the eastern side of the pyramid complex and therefore only the setting sun and setting stars could be viewed from these locations unlike the stone circles that were designed to allow alignments of both the rising Sun and the setting Sun with the megaliths.

The dates when the Sun aligned with the peaks of the pyramids was calculated for 2560BC from each of the three valley temples by considering both the altitude of the Sun and its azimuth and the day on which these matched the altitude and azimuth of the pyramid peaks from the valley temples. There are two dates, one either "side" of the solstices. that correspond to each alignment of the Sun with the pyramid peak except for the days corresponding to the summer and winter solstices which correspond to single day alignments for each solstice, representing the ultimate range of the Sun's passage North and South along the horizon.

The following table describes the measured altitudes and azimuths of the Pyramid Peaks relative to the relevant Pyramids used for solar alignments on the festival days.

Viewing Point	Pyramid	Altitude	Azimuth	Alignment Dates
Khufu Valley Temple	Khufu	9° 18' 10"	258° 19' 20"	October 26 March 28
Khufu Valley Temple	Khafre	6° 51' 25"	248° 17' 10"	November 20 March 1
Khufu Valley Temple	Menkaure	3° 28' 22"	240° 29' 15"	December 28 January 21
Khafre Valley temple	Khafre	14° 13' 6"	281° 30' 0"	August 28 May 29
Menkaure Valley Temple	Menkaure	8° 12' 38"	270° 30' 0"	October 2 April 23
Menkaure Valley Temple	Satellite to Khafre	4° 18' 45"	295° 0' 0"	July 9 July 19

**Table 13**

The alignments of all three major pyramid peaks with the setting Sun was determined for the Khufu Valley Temple as they all lie within the range of the bearings for the setting Sun on the horizon. The valley temples of Khafre and Menkaure were positioned too far South to make solar alignments with Khufu and in the case of Menkaure, both Khufu and Khafre as the northern limit for the Sun on the horizon at the summer solstice is 298° 31' 43" and the pyramids have bearings in excess of 300 degrees from these valley temples. In order to have solar alignments with a pyramid peak during July, the satellite pyramid built on the South side of Khafre was included as viewed from the Menkaure Valley Temple.

Having obtained the dates when the Sun aligns with the Pyramid peaks and appears to sink into each pyramid from the three Pyramid Valley Temples, the question is what significance does this have? The first analysis is to plot the dates indicated as a Wheel of the Year with spokes indicated by the possible festival dates indicated by the Pyramid Peak-Sun alignments to see the pattern of distribution of the "festival spokes" (with each day representing 1/366 of the circle). The second analysis is to determine why these days may have been significant to the Ancient Egyptians. This can be done by adopting the same analysis that was used to determine the Neolithic festival days in Scotland where the Megalith-Sun alignments marked days when the brightest stars, representing stellar deities aligned with a cardinal point at Civil Twilight.



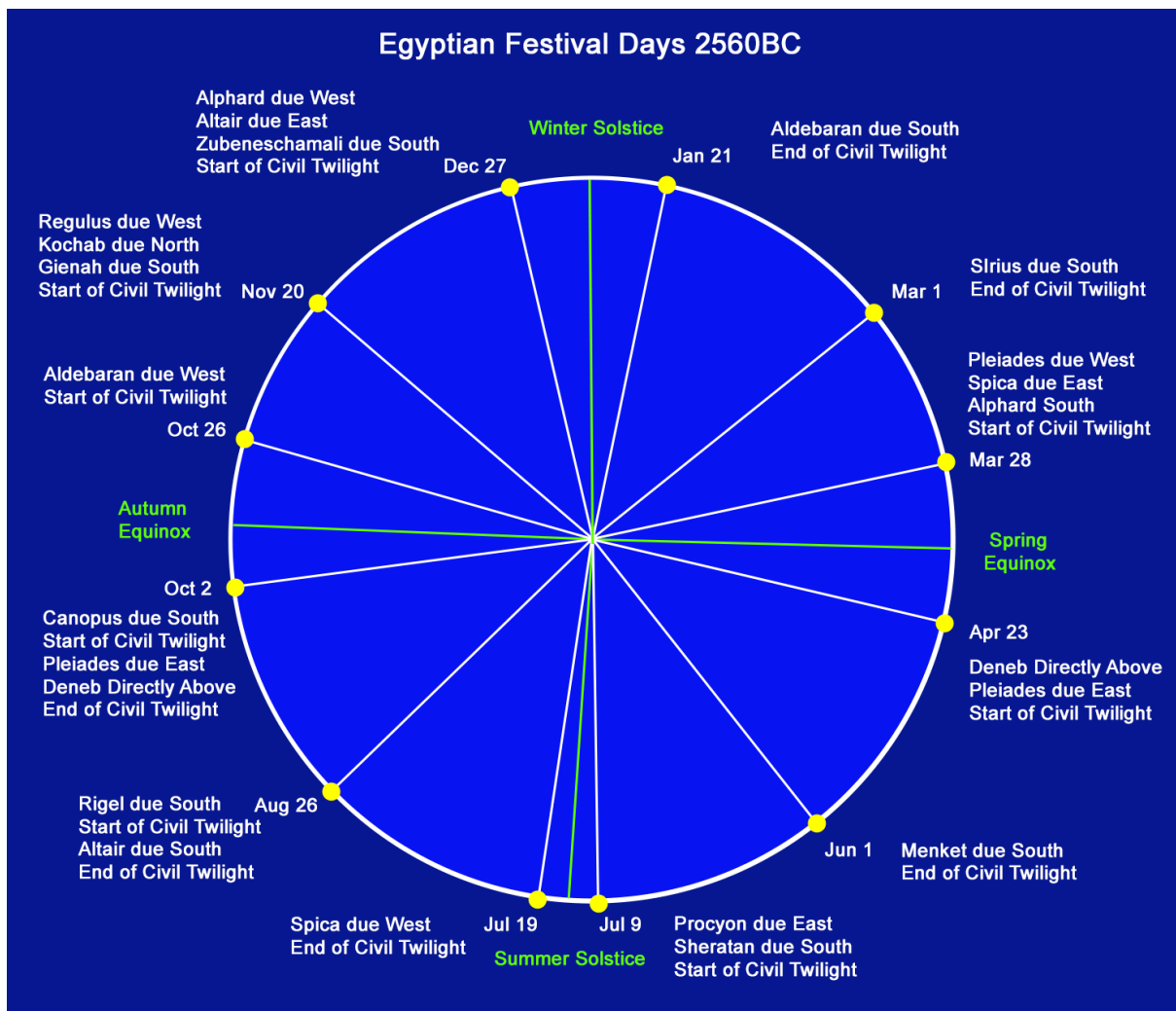


Diagram 23

When the alignment of the Sun coincides with the pyramids, touching the pinnacle of each of the three main pyramid peaks of Khufu, Khafre and Menkaure and the subsidiary pyramid of Khafre, as viewed from the courtyards of the Valley temples of Menkaure and Khafre and the calculated position of the Khufu Valley Temple, the days on which these alignments occur give an evenly spaced distribution of festival dates when plotted as the Wheel of the Year. The calendar consists of twelve stellar festival days symmetrically arranged with respect to the solar festival days represented by the solstices and equinoxes. Moreover, on those days indicated by the alignment of the Sun with the pyramid peaks, just as with the Neolithic stone circle alignments, important bright stars appear to be precisely aligned due South, due East or due West at Civil Twilight, either at the precise time of End of Civil Twilight, at dusk or at the Start of Civil Twilight, at dawn when the Sun is 6 degrees below the horizon. Furthermore, the bright stars that are aligned on those days are believed to have been special stars identified by the Ancient Egyptians as stellar deities and these days may have been dedicated to the Egyptian deities and celebrated as festival days venerating them.

Day	Star (Constellation)	Position		Egyptian Deity
		Start of Civil Twilight	End of Civil Twilight	
January 21	Aldebaran (Taurus)		South	Apis
March 1	Sirius (Canis Major) Regulus (Leo) Algorab (Corvus)		South  East  East	Isis  Sekhmet  Feather of Maat
March 28	Pleiades (Taurus) Spica (Virgo)		West  East	Horus victory over Seth Hathor
April 23	Pleiades (Taurus) Deneb (Cygnus)	East  Directly Above		Horus victory over Seth Nephthys
June 1	Menket (Centaur)		South	Thoth
July 9	Procyon (Canis Minor) Sheratan (Aries)	East  South		Anubis  Atum/Khnum
July 19	Spica (Virgo)		West	Hathor
August 26	Rigel (Orion) Altair (Aquila)	South  South		Osiris  Horus
October 2	Canopus (Carina) Pleiades (Taurus)	South	East	Solar Boat  Horus victory over Seth
October 26	Regulus (Leo) Aldebaran (Taurus)	Directly Above  West		Sekhmet  Apis
November 20	Regulus (Leo) Gienah (Corvus) Kochab (Ursa Minor)	West  South  North	North	Sekhmet  Feather of Maat  Taweret
December 27	Alphard (Hydra) Altair (Aquila) Zubeneschamali (Libra)	West  East  South		Seth  Horus  Scales of Judgement

**Table 14** Stars aligned with cardinal points on days when the Sun coincides with the pyramid peaks viewed from the Temple Valleys and the Egyptian Deities identified with them.

It is interesting and highly significant that in almost every case it is the brightest star in its constellation that is precisely aligned due South, East, West or North at Civil Twilight. Rigel is the brightest star in Orion, Procyon the brightest star in Canis Minor, Sirius the brightest

star in Canis Major, Canopus the brightest star in Carina, Regulus the brightest star in Leo, Alphard the brightest star in Hydra, Altair the brightest star in Aquila, Aldebaran the brightest star in Taurus, Gienah the brightest star in Corvus, Zubeneschamali, the brightest star in Libra. Kochab and Sheratan are the second brightest stars in Ursa Minor and Aries whilst Menkent occupies a significant position in the head of the constellation of Centaur and may represent the eye of the Ibis and the deity Thoth who was associated with this bird constellation in Ancient Egypt. It seems likely that the pyramids and the positions of the pyramid valley temples were designed to allow certain important stars to set into the three pyramids on the Giza plateau and at the same time to indicate major stellar festival days when the Sun set into the pyramid peaks on days when bright stars identified with the Egyptian gods aligned precisely due South, East and West at Civil Twilight. The level of sophistication of the design of the pyramids becomes evident through the multiple mapping associations of the pyramids with the stars of Orion, the alignment of bright stars in constellations representing the pantheon of Egyptian deities with the pyramid peaks, star pairs identified as Egyptian deities associated with each other through the pendulum lengths used to construct each pyramid and the alignment of the Sun with the pyramid peaks on festival days comprising the calendar of Ancient Egypt. The multiple associations between the pyramids and the stars and their relevance to the beliefs of Ancient Egypt, their gods and the stories of death and resurrection, even the measurements embedded in the pyramid dimensions themselves which give a temporal relationship between the stars and the pyramids are of the same intellectual order as the Herculean physical task of actually constructing the pyramids.

## Part V

### The Sphinx

#### Stellar Alignments with the Sphinx from the Sphinx Temple



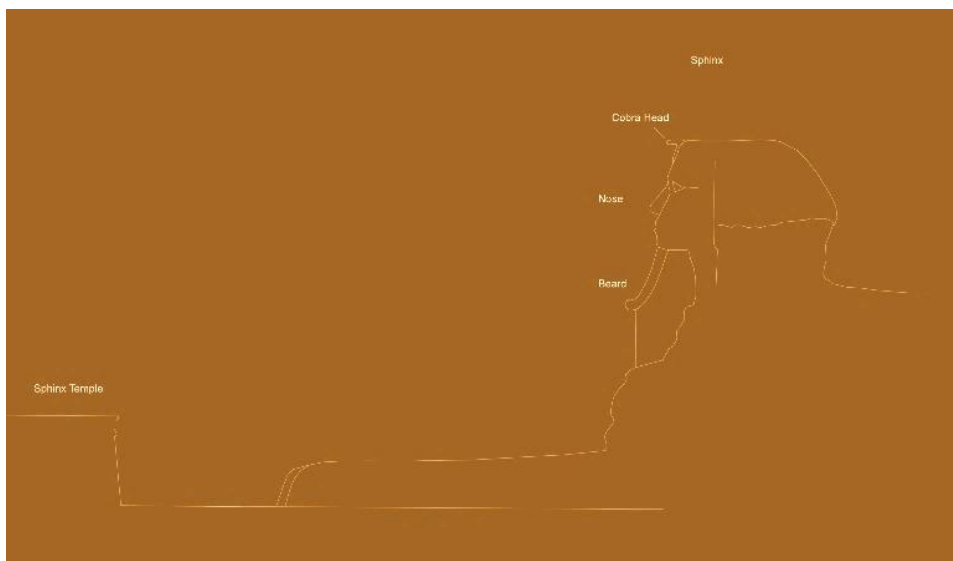
**Figure 9 The Sphinx facing East with Khafre behind it.**

The Sphinx temple is unlike the other Valley temples of the Giza complex in certain important aspects. The Khufu Valley Temple, the Khafre Valley Temple and the Menkaure Valley Temple were all connected to their respective pyramids via three causeways whilst the Sphinx Temple has no causeway and sits right beside the Khafre Valley Temple and directly in front of and very close to the Sphinx. The Sphinx temple, in common with the valley temples has a large open air courtyard which allowed the stars and the pyramids to be seen clearly from the courtyard , however the Sphinx temple lies almost directly in front of the Great Sphinx and being so close to it, the view framed by the colonnades of the open courtyard is dominated by the Pharaonic head of the Sphinx that looms some 22 metres above the courtyard level with the paws of the leonine body less than 10 metres from the outside West wall of the temple. Whilst the peak of Khafre can be seen in the distance down the southern side of the Sphinx, the proximity of the temple to the Sphinx opens the possibility that like the alignments between the Valley Temples and the pyramid peaks, important alignments were made from the Sphinx temple and the Sphinx. Unlike the pyramids, that have a narrow peak for alignments with the Sun and stars, the sphinx has a broad head but it was originally adorned with a Uraeus or cobra that, before it was chiselled off in antiquity, would have sat proud of the stone carved head and

allowed precise alignments to be made between the setting stars and the head of the cobra from within the courtyard of the Sphinx Temple.



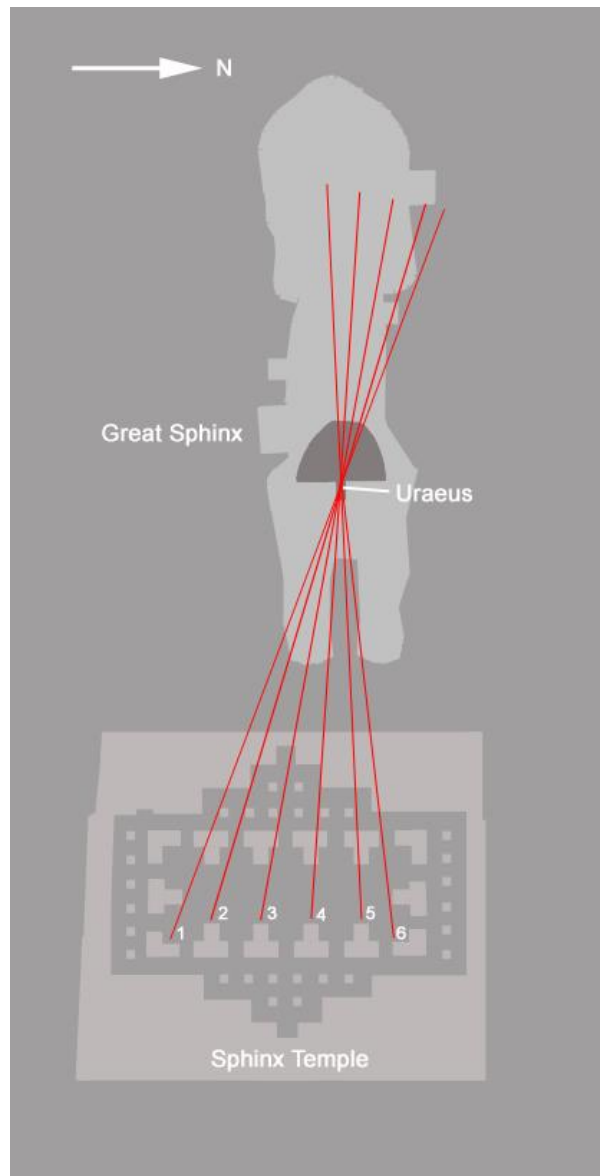
**Figure 10** Serpent head in the British Museum believed to have formed part of the Uraeus on the Sphinx's Head. The 61.7cm limestone snake head would have protruded from the rounded head of the Sphinx and provided an alignment marker for setting stars viewed from the Sphinx temple.



**Diagram 24** Diagram to show missing features of the Cobra head, Nose and Pharaonic Beard

The question is where within the temple might alignments have been made from, as the sphinx is so close to the temple that the range of angles of alignment possible within the court yard vary by around thirty degrees. The first thought is that the viewing positions are most likely to have been from the eastern side of the courtyard which is furthest from the sphinx and maximises the visibility of the sphinx head to the West. The next question is where would somebody position themselves along the length of the eastern side of the

courtyard. There are four pillars demarcating the courtyard on the eastern edge of the courtyard, matched by four pillars along the western side of the courtyard. In addition, four L-shaped pillars defined the corners of the rectangular courtyard whilst two further pillars, positioned centrally on the northern and southern edges of the courtyard completed the courtyard opening. Today there are in front of each of the ten rectangular pillars, rectangular sockets that are believed to have once held statues. The identification of the Egyptian deities or Pharaoh that were carved as these statues that once stood in the sockets in front of each pillar is not known but these statues may have marked the discreet positions where alignments between the stars and the Uraeus on the Sphinx's head were made from. Four points in front of the four eastern sockets and two further positions in the North and South corners of the eastern edge were selected as possible viewing positions within the temple. The horizontal distance from each point to the forehead of the Sphinx was measured from a scaled plan of the site. The apparent height of the Uraeus was measured as 20.22metres above the Sphinx terrace (II) and a further 2.5metres above the Sphinx Temple's courtyard floor. The estimated height of a man's eyes above the ground was subtracted from this height to get an apparent Uraeus height of 21.22m. The angle of altitude of the Uraeus from each of the six proposed viewing positions was calculated and the bearing from each point to the Uraeus measured from plans of the Sphinx and its temple. The position of stars as they set was determined to see if any of them matched the altitude and bearing of the uraeus from each of the six proposed viewing positions.



**Diagram 25** Plan of Sphinx Temple with Viewing Positions 1-6 marked in front of Statues  
along the East Side of the Courtyard

Position	Altitude of Uraeus	Bearing of Uraeus	Star	Altitude	Azimuth
1	18° 38' 53"	290° 36' 0"	Castor Gemini	18° 38' 53"	290° 40' 0"
2	19° 56' 58"	286° 54' 0"	Regulus Leo	19° 56' 50"	287° 4' 16"
3	20° 26' 41"	280° 0' 0"	Alpha Sagittae Sagitta	20° 26' 36"	279° 49' 28"
4	20° 47' 17"	273° 42' 0"	Spica Virgo	20° 47' 15"	273° 35' 33"
5	20° 47' 17"	268° 0' 0"	Altair Aquila	20° 47' 21"	268° 7' 46"
6	19° 46' 48"	263° 30' 0"	Procyon Canis Minor	19° 46' 47"	263° 29' 30"

**Table 15**

The six proposed viewing positions at the four statues and in the corners at positions that allowed a sight line to the Uraeus, avoiding the central North and South Statues, allowed bright stars to be seen coinciding with the head of the snake of the Uraeus and setting into the sphinx's head.

1. Castor, Gemini identified as Tefnut/Shu
2. Regulus, Leo identified with Sekhmet and possibly the Sphinx itself
3. Alpha Sagittae, Sagitta with an arrow or possibly the forked tongue of the cobra
4. Spica, Virgo identified with Hathor
5. Altair, Aquila identified with Horus
6. Procyon, Canis Minor identified with Anubis.

It may be that the missing statues were those of the deities identified by the stellar alignments, namely Sekhmet, Wadjet, Hathor, Anubis and Horus or perhaps statues of the Pharaoh to empower him with the alignments of the stars, the uraeus and the statues carved in his image throughout the year.

It seems that the brightest or most prominent stars in six important constellations are the ones that align with the head of the Uraeus from the statues and corners along the eastern edge of the courtyard.



## Part Vb

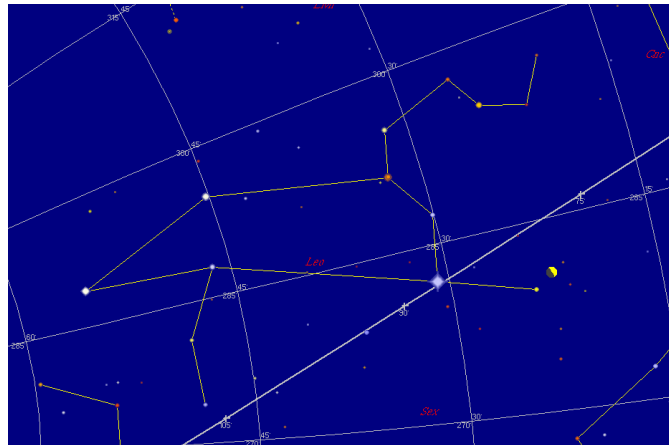
### The Great Sphinx – What it Represents and How it Relates to the Pyramids

The Sphinx is a colossal stone statue of a hybrid animal comprising a lion's body and a human Pharaonic head standing on the Giza Plateau to the East of Khafre's Pyramid. The monument has been cut from the limestone bedrock and has been eroded over the millennia and been the subject of many repairs over recent centuries. Some damage has occurred in prehistoric times resulting in the loss of the Pharaoh's nose, beard and the removal of the cobra head forming part of the Uraeus carved as a head band on the statue. As with most of the Giza plateau, a great deal of discussion has been generated regarding what the Sphinx represents, how old it is, which pharaoh's head is represented and whether the Sphinx once had a different form. Some geologists consider that the erosion of the Sphinx's body, that has resulted in a striated body where softer layers of the bedrock have been eroded more than other layers, must have occurred when the climate of Egypt was much wetter. This has led some to consider that the Sphinx is much older than the generally accepted view of archaeologists that it was carved in the 4<sup>th</sup> Dynasty. The possibility that the Sphinx was related to Leo has also been taken as justification of a much earlier dating for the Sphinx based on the position of Leo on the horizon at sunrise at the spring equinox around 10500BC, the justification being that as the Sphinx faces East it faces the Sun on the Horizon at Sunrise at the Spring and Autumn equinoxes and Leo only aligned with the rising Sun due East at this earlier age. The identification of the body of the Sphinx as being that of a lion has been questioned by some and suggested as being that of a dog or jackal in the manner of the outstretched jackal Anubis. The head of the Sphinx is considered by many to appear too small in relation to the body of the Sphinx and there is debate as to which Pharaoh the head of the Sphinx represents. The relatively small size of the head may be due to the size of the original protruding rock feature that was available to the carvers or may have resulted from re-carving and changing the form of the head that may have originally been carved as a lion's head for instance. There are therefore many possible avenues of exploration regarding the Sphinx but all we can do for now is to forget everything we think we know about this monument and start from first principles to see if we can get more concrete evidence about what the Sphinx might represent.

#### The Constellation of the Sphinx

The first thing that can be analysed is the form of the Great Sphinx. Given the proposal that the Ancient Egyptian Deities were identified as stellar deities associated with the brightest stars in constellations what constellation might be associated with the Sphinx? Looking at the pattern of stars in the different constellations, one constellation, Leo, stands out as the most obvious candidate as representing the celestial counterpart of the

Sphinx due to i) the similarity in form between the stars when joined up and the shape of the Sphinx and ii) the identification of the constellation of Leo as a lion couchant.



**Figure 11** Constellation of Leo as depicted on Astronomical Maps

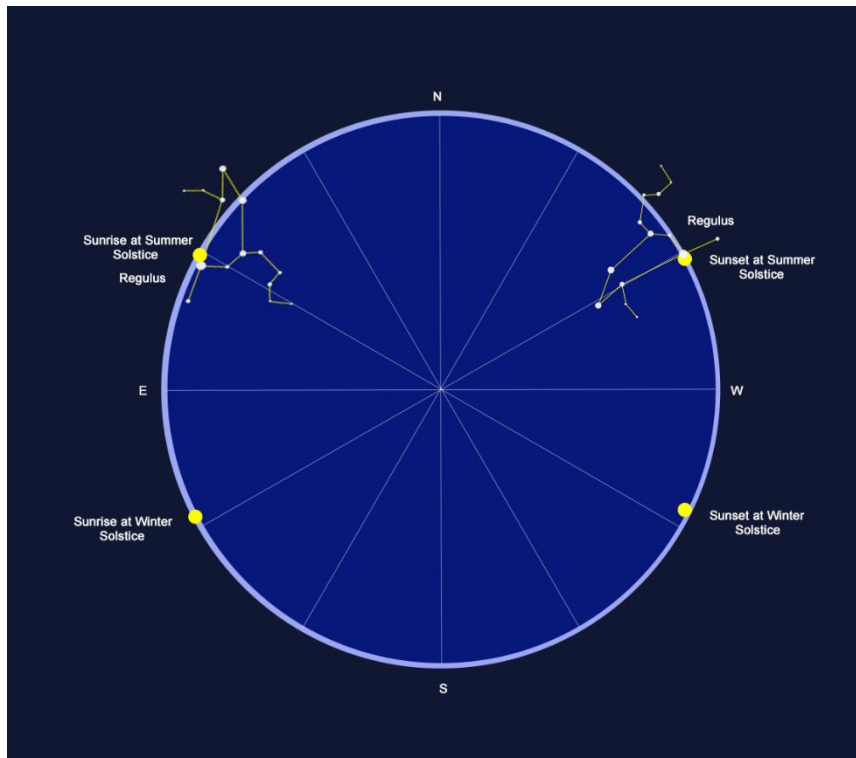


**Figure 12** The Great Sphinx of Giza

The similarity between the pattern of stars in the constellation when its brightest stars are joined by imaginary lines and the form of the recumbent Sphinx with outstretched front paws is clear. The constellation may have been associated with a lion from prehistoric times in many countries where lions were known. In Scotland from before 1200BC, the people later named by the Romans as "Picti" the painted people or Picts, associated the constellation of "Leo" with a wild Boar, possibly because lions were unknown to them and wild boars represented the most ferocious native animal living in Scotland at that time apart from the Bear that was identified with the constellation of Ursa Major whilst the smaller Scottish Wildcat was associated with the constellation of Capricorn which may have similarly been identified with the Cat goddess Bastet in Ancient Egypt.

The question is, if the Sphinx does represent the constellation of Leo, why was this constellation so important that it merited being carved out of the bedrock in such a

monumental form? One possible answer lies in the position of the constellation and its brightest star Regulus at the solar festivals comprising the Summer and Winter solstices and the Spring and Autumn equinoxes. The following diagram shows the position of the constellation at sunrise and sunset on the days of the solstices. It can be seen that the constellation of Leo and the Sun are intimately connected on these solar festival days as the position of the Sun on the horizon at sunrise and sunset closely coincides with the position of Regulus, the brightest star in Leo.

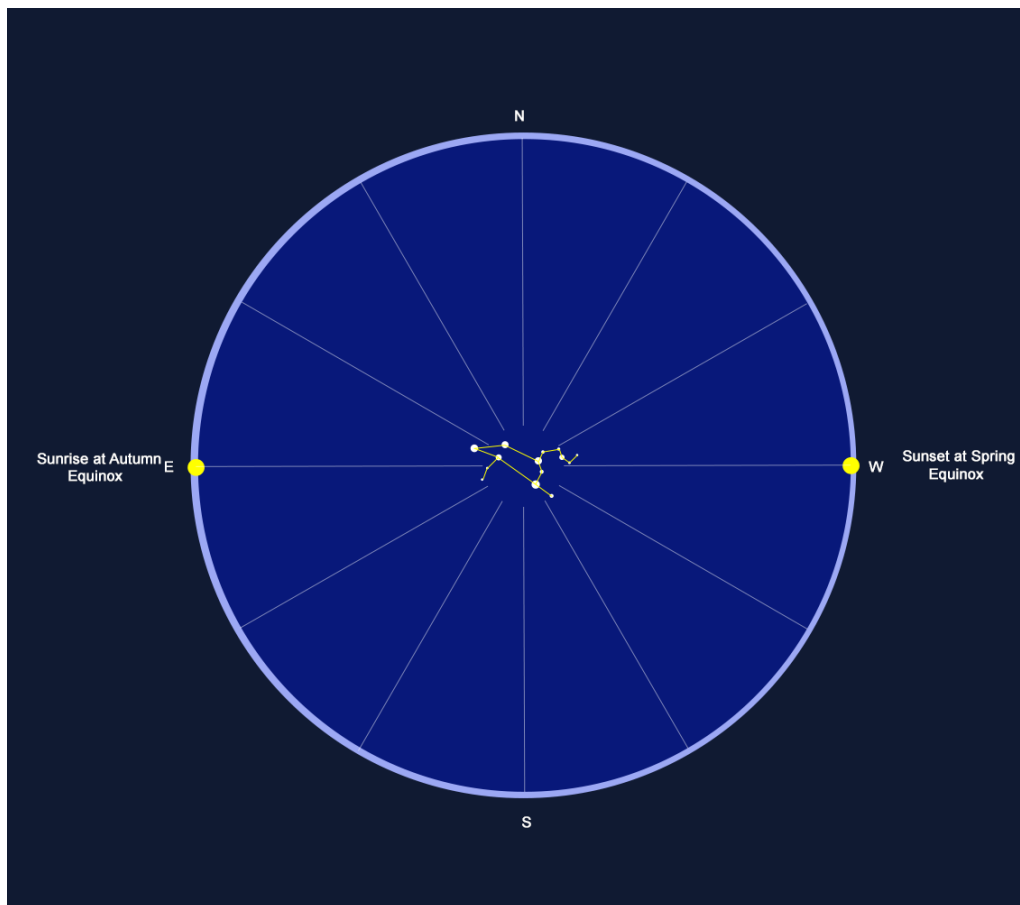


**Diagram 26** Sky map to show the positions of Regulus in Leo at sunrise and sunset on the days of the summer solstice and winter solstice in Giza 2560BC.

As the Sun rises at the summer solstice in the north-east, it does so with the star Regulus. Regulus moves across the sky with the Sun and sets in the north-west at sunset. Regulus and Leo are therefore closely linked with the Summer solstice. More specifically the Sun and Regulus are intimately linked and as Regulus has been associated with the lion headed goddess Sekhmet, the association between Regulus and the Sun may reflect the association between Sekhmet and her father, the Sun God Ra.

At the winter solstice, Leo and its brightest star Regulus rise and set at the same positions on the north-east and north-west horizon and Regulus is again on the horizon at the same time as the rising and setting Sun. However now the Sun and Regulus lie diametrically opposite one another, the rising Sun, lying south-east on the horizon and Regulus lying north-west on the horizon at sunrise. At sunset on the day of the winter solstice, the Sun lies on the horizon in the south-east whilst Regulus is on the horizon in the north-west.

Regulus and the Sun therefore sit on the horizon at the same time at the solstices. The Sun and Regulus lie besides each other at the Summer solstice and opposite each other across the sky at the winter solstice.

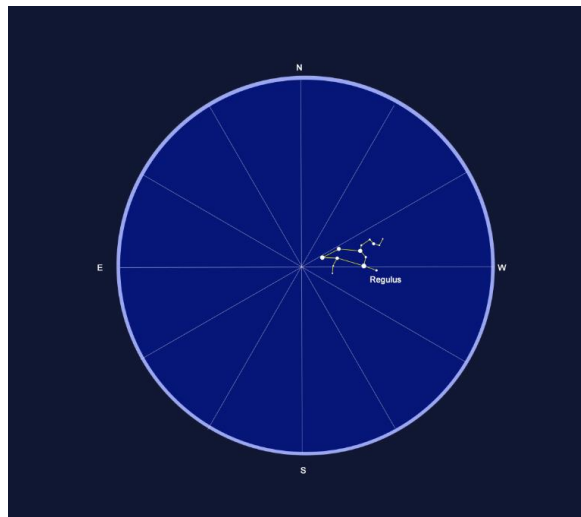


**Diagram 27** Sky map to show the position of the Constellation of Leo directly overhead at sunrise at the Autumn Equinox and sunset at the Spring Equinox in Giza 2560BC

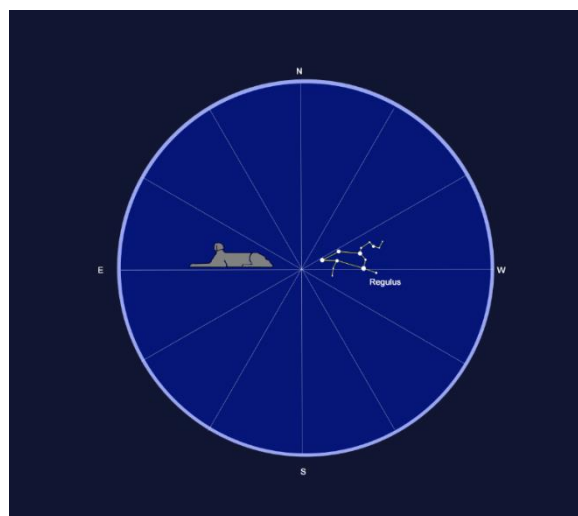
At the autumn and spring equinoxes, Leo lies directly overhead at sunrise and sunset respectively giving a further positional relationship between Leo and the Sun and allowing all four solar festivals to be indicated by the alignment of Regulus and Leo either on the horizon or directly overhead. It is interesting that the Equinox alignment of the Sun and Leo on the eastern horizon at sunrise was considered as indicating the possible early date of 10500BC for the construction of the Sphinx when in 2560BC, the date accepted by archaeologists for the construction of the Sphinx, at the equinox when the Sphinx faced the rising Sun, there was another alternative significant alignment of the Sphinx, when the constellation of Leo was located directly overhead at sunrise. This association considered alongside the alignment of Regulus and Leo with the Rising and setting Sun at the solstices gives a close relationship of the Sphinx and Leo with the solar festivals for 2560BC. The other consideration is the relationship between the Sphinx possibly associated with Leo and the pyramids when identified with Osiris.

## Connection between the Constellations of Leo and Orion

The Sphinx lies to the East of the Pyramids of Giza, more specifically aligned to the East of Khafre's pyramid. The next objective is to examine whether there is a relationship between the constellations associated with the pyramids and the sphinx. Assuming the pyramids are associated with Orion and the Sphinx is associated with Leo, the positions of these constellations relative to each other at important times can be analysed to see whether there exists a relationship between the Pyramids and the Sphinx which is reflected in the relationship between the constellations of Orion and Leo. The close relationship between the Sun and Regulus was seen at the solstices and the equinoxes which reflected the relationship between the Sun god Ra and his daughter Sekhmet. As a first step a celestial map can be drawn showing the constellation of Leo at the moment when Regulus is aligned due West.



**Diagram 28** Regulus in Leo Due West



**Diagram 29** The Sphinx added to the celestial map in its orientation facing due East

The combination of the celestial lion and the monumental Sphinx produces two leonine forms oriented back to back, Leo facing the western horizon and the Sphinx facing the eastern horizon. This opens the interesting possibility that the Sphinx represents half of the Egyptian deity known as Aker.

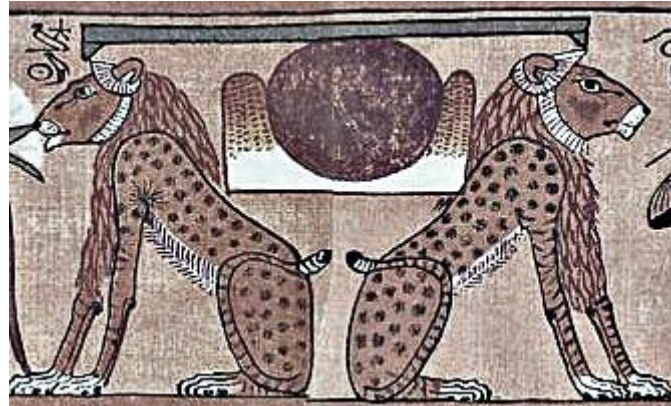
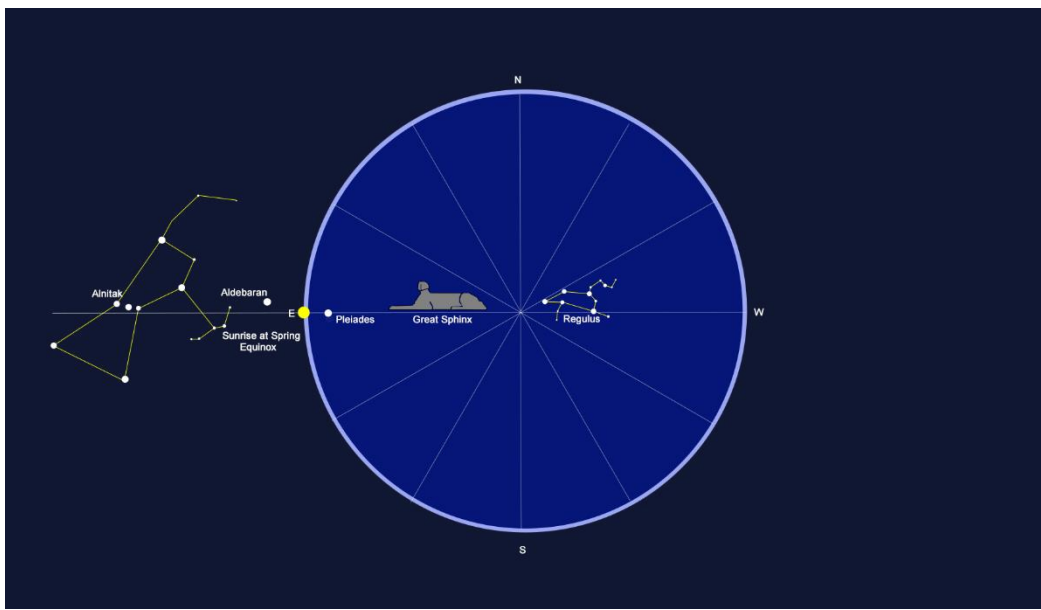


Figure 13

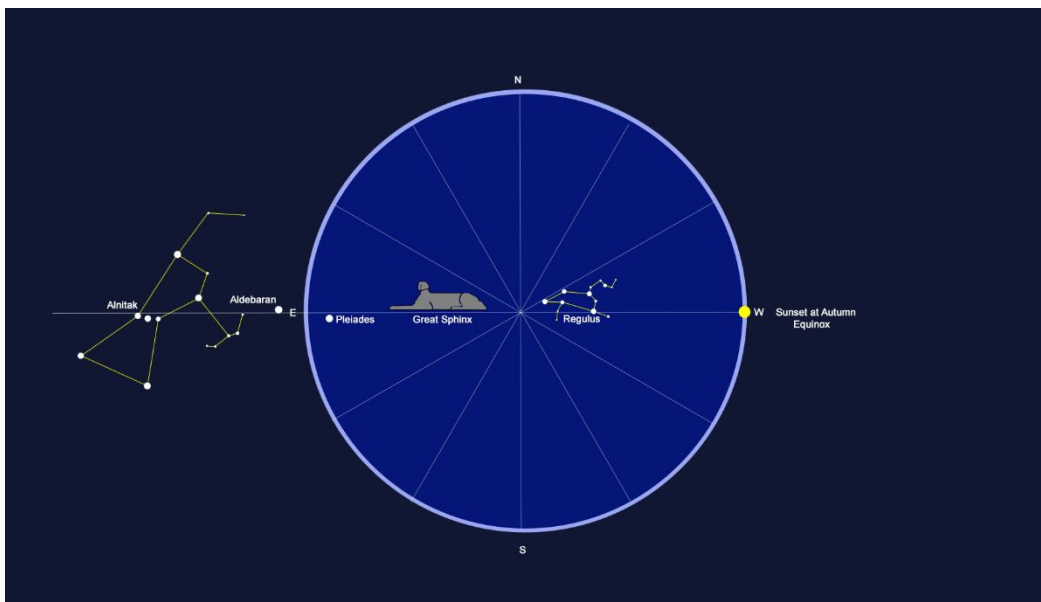
The symbol of Aker, two lions facing East and West is the god of the Horizon. On the back of the lions is the symbol of Akhet where the solar disc is supported between the East and West summits of the mountain Djew. The black horizontal symbol above the lions is the hieroglyph meaning "sky". Therefore, as the constellation of Leo from its orientation in the night sky faces and looks over the western horizon, the Sphinx statue as its earthly equivalent watches over the eastern horizon guarding the rising Sun and stars and by association the Egyptian star gods.

Aker is one of the earliest Egyptian earth gods and is the protector of the horizon and the Sun God Ra as he enters the netherworld at sunset in the West and re-emerges from the East into the land of the living at sunrise. Above all Aker was a protector deity, of the pharaoh as well as the Sun and the guardian and gatekeeper of the underworld. Originally Aker was portrayed as a strip of land with a lion or a human head at both ends usually one facing east and the other west. Later Aker was depicted as two lions facing in opposite directions. The lions are often portrayed with spots like a leopard that probably represent spotted Barbary lions that are now extinct. At sunrise on the day of the Spring Equinox the Sphinx, facing due East, is precisely aligned with the Rising Sun and Orion's belt that lies below the horizon but is aligned due East.

The connection between the Sphinx/Leo and the constellation of Orion can be seen at the equinoxes. Firstly, at the spring equinox at sunrise, the Sun sits on the horizon due East. The Sphinx faces the Sun on the horizon and below the horizon at this time Alnitak in Orion's belt is also aligned due East. Above the horizon the Pleiades are also aligned due East but are not visible until twilight.



**Diagram 30** At sunset on the day of the Autumn equinox, again the Sphinx is precisely aligned with the stars of Orion's belt that are aligned due East but slightly below the horizon before they rise.



**Diagram 31** The alignment of the Sphinx with Orion to the East can therefore be seen on the days of the Equinoxes. If Aker is associated with the Sphinx and its stellar other half, Leo, it might be expected that there is some relationship between the Sphinx and Orion relating to the western horizon.

The head of the Sphinx faces East, however the head of the constellation of Leo faces West and when its brightest star Regulus is aligned due West two stars in Orion, Betelgeuse and Bellatrix, align with Regulus due West, but again the stars lie below the horizon.

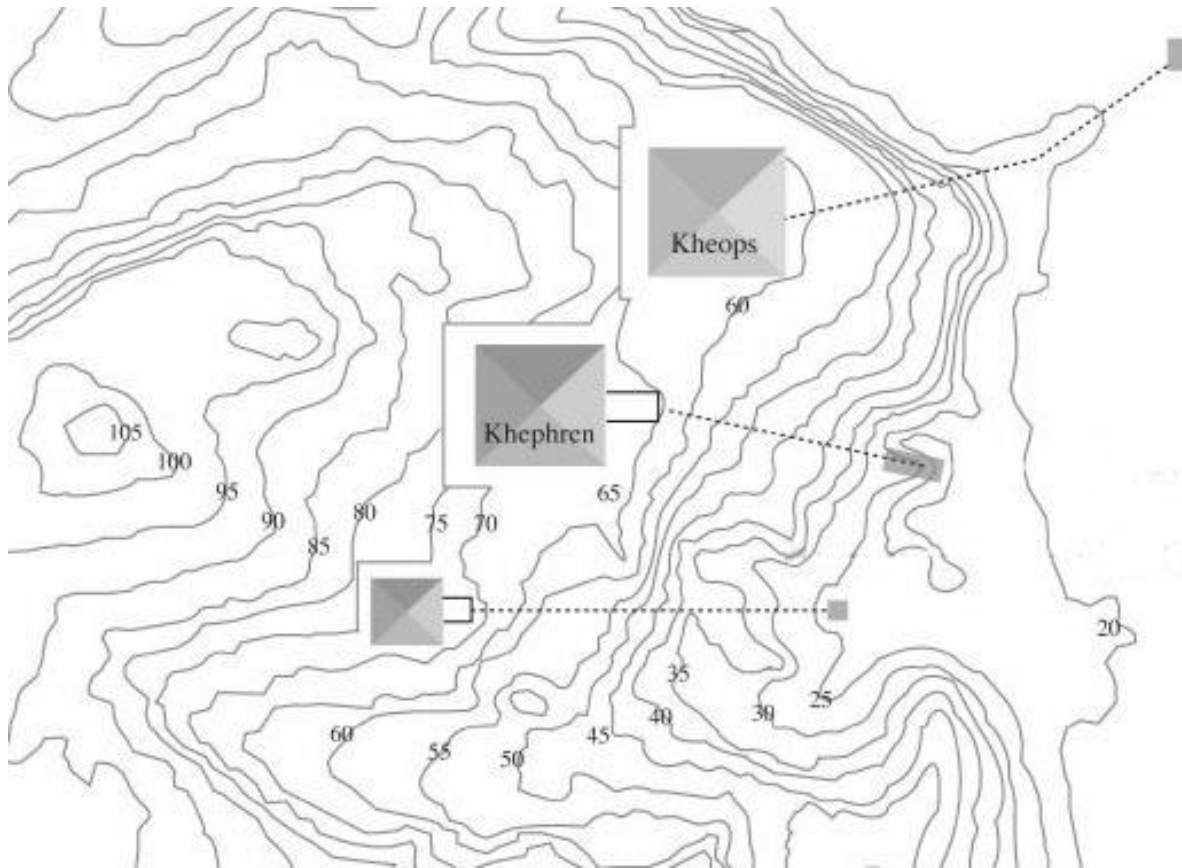
Looking at the night sky in general throughout the year, from May 9<sup>th</sup> until November 20<sup>th</sup> 2560BC, a relationship can be seen when Regulus is due West in the sky, Orion has set below the western horizon but at the moment of alignment of Regulus due West, Betelgeuse and Bellatrix in Orion, although below the horizon, also lies due West. On the Giza plateau this general positioning of Orion and Leo are replicated with the three pyramids lying to the West of the Sphinx, that is, behind the Sphinx.



**Diagram 32** The alignment of Orion and Leo along the western axis has the Sphinx facing the opposite direction to Orion just as it faces the opposite direction to the Pyramids.

The idea of combining the earthly construction of the Sphinx with the heavenly constellation of Leo is another example of the “As above, so below” maxim and the combination of two leonine forms lying back-to-back facing the eastern and western horizons aligned with the stars of Orion as they lie just below the horizon appears to fit well with the known relationship of the Egyptian god Aker and his role as the protector of the horizon for both the Sun god Ra and the Pharaoh Osiris.





**Figure 14** Topography of Giza Plateau and surrounding area. Altitudes were obtained within 1metre for the Valley temples using Google Earth

## PART VI

### Linking the Pyramids with the Stars and the Egyptian Gods

#### through Pendulum Lengths

It is important to remember that the physical association of star triplets with the pyramids by mapping the apparent position of the stars onto the plan of the three pyramids or observing the alignment of stars and the Sun with the peaks of the pyramids from given viewing positions is only one aspect of the association between the stars of Orion, representing Osiris and the Pyramids of Giza. The association of stars with the pyramids through the use of pendulums with specific periods of oscillation to construct the pyramids is a more sophisticated temporal relationship. By embedding pendulum lengths within the dimensions of the pyramids, the pendulum lengths may have been believed to have imbued the pyramids with properties that allowed them to connect with bright stars. The pendulum lengths encapsulated into the very fabric of the pyramids acted as time bridges between the pyramids and numerous bright stars associated with Ancient Egyptian Deities

The brightest stars in the constellations can be selected and their position, in terms of their Hour Angles determined for the year 2560BC. The angular separation between all the selected star pair combinations can then be calculated by firstly converting the Hour Angles into Second Angles and then subtracting one from the other to give both the smaller and larger angles of separation. As the pyramids of the Giza Plateau are believed to be connected with Osiris and the constellation of Orion the seven stars comprising the body of the constellation were selected along with the brightest stars or prominent stars in the constellations of Virgo, Canis Major, Canis Minor, Aries, Spica, Hydra, Lyra, Cygnus, Pegasus, Taurus, Auriga, Aquila, Libra, Corvus, Ursa Minor, Centaurus and Cepheus. The idea is that the calculated angular separation of star pairs may in some cases result in whole thousands of swings of the pendulum lengths found to account for the base and height dimensions of each of the pyramids. The identification of the deities associated with each of the bright stars in star pairs showing this relationship may reflect known relationships between the Egyptian deities associated with these stars. Furthermore, the relationship between each of the three pyramids and three particular stars in Osiris may be revealed if the pendulum used in the construction of each pyramid gave a whole integer of thousand swings for the angular separation between that particular star in Osiris and another bright star, identified as an important deity in the stories about Osiris.

Given that the pendulum lengths from Scotland and Northern Europe lost their associations with each other in terms of circular geometry when they were adjusted for use in Egypt, having been shortened to maintain the same period of oscillation, it is interesting to examine the angular separation of bright stars, at the time the pyramids

were constructed, to determine whether certain star pairs were separated by angles that gave whole thousands of swings of the three pendulums used in the design and construction of the three pyramids. It is possible that since the pendulum system used in Scotland in Neolithic times was used to integrate the measurement of distance and time, that the pendulum lengths chosen to construct the Pyramids of Giza were selected to associate the pyramids with important bright stars and Ancient Egyptian deities associated with them. The way in which the association between pyramids and stars may have worked was that each of the three pyramids may have been associated with a star in Orion, identified by the Ancient Egyptians with Osiris, and the number of swings separating that star in Orion, and another bright star representing another important Egyptian deity might form a bridge between the two stellar deities when the time between them, represented by the number of swings of the pyramid pendulum, consisted of a whole thousand number of swings resulting in a sort of time bridge between the star pair.

Knowing the periods of the original pendulums and the way in which they were calibrated using star pairs separated by certain integer multiples of Megalithic Degrees, may indicate special star pairs in Ancient Egypt that were separated by the same required angles or multiples of those angles to give the whole thousands of swings normally used to calibrate these pendulum lengths.

Thirty-eight of the brightest stars in the night sky observed from Giza were selected and their positions in terms of their Hour Angle determined for 2560BC at the time the bright star Thuban in the constellation Draco, the star considered closest to the Celestial Pole was located due North. The precise time selected for measurement of each star's hour angle was 06:46:39 on January 2<sup>nd</sup> 2560BC (Giza Latitude 29° 58'45", Longitude 31° 8'3") corresponding to the time when Thuban was aligned precisely due North at an Hour Angle of 24h 0m 0s. The Hour angles for each star was converted to second angles and the angular separation of each star pair permutation (1332) calculated by subtraction. The angular separation of each two-star permutation was calculated in an anticlockwise direction from each star in the pair to the other star. That is, both the shorter and the longer angular separation routes were measured for each star pair in the search for whole thousands of swings separating the two stars. Having determined the Hour Angles in seconds separating pairs of stars this was then converted to the equivalent number of swings for each of the three pendulums associated with the three pyramids by considering the period of swing for each pendulum for Giza and then identifying star pairs whose angular separations can be described to very close to whole thousands of swings.

It is clear that the mapping of three stars onto three pyramids is never going to be considered as more than coincidental unless either the mapping produces an absolutely precise match or that other evidence can be found to link the association of the particular stars involved with the three pyramids. The discovery of alignments between the

brightest stars with the pyramid peaks and their subsequent setting into their pyramids adds some substance to the idea that the coincidence of stars and pyramid peaks results from a planned design. Similarly, the alignment of the Sun with the pyramid peaks viewed from the Valley Temples of each of the pyramids on certain days, indicating a possible calendar in the manner of the stone circles of Scotland adds further evidence of the complexity of design of these monuments and their possible connection with the stars demonstrating an incredible level of technological and astronomical knowledge possessed by those that designed the pyramid complex over four and a half thousand years ago. Another connection between the pyramids and the stars, deeper than these physical visible associations would provide confirmation that the Pyramid represents the most remarkable example in the world of a monument that was designed to connect the people to their star gods and their beliefs.

It may be that the pyramids were designed to achieve a much greater purpose, commensurate with the efforts that were involved in their construction and that they were intimately concerned with the Ancient Egyptian belief system and the resurrection of the deceased pharaoh. The stories of how the deceased entered the afterlife and the requirements for this to happen is described in the Pyramid Texts which gives us an indication of the other deities involved in the process and may help to identify the bright stars identified with those deities. If the association between stars associated with Osiris in Orion and other stars associated with Egyptian Deities such as Atum, Isis, Hathor, Sekhmet, Anubis, Nephthys, Seth, Seshat, Bastet, Thoth and other deities described in the pyramid texts was important, a clever way of connecting the pyramids with the stars associated with these deities could be provided by the clever choice of the pendulum lengths embedded in the fabric of the pyramids that defined the dimensions of these monuments. One possibility is that the Ancient Egyptian stellar deities may have been linked through the period of the pendulum chosen to construct each of the three pyramids by choosing pendulum lengths that gave whole thousands of swings for the time representing their angles of separation. This offers us another avenue of exploration for the association of the stars and the pyramids, especially that between stars in Orion representing Osiris and other bright stars representing other important Egyptian deities. The number of overlapping associations between the stars, the Sun, the Egyptian deities associated with the stars and the dimensions and arrangement of the three pyramids represents a truly mind-boggling effort by the astronomer priest architects involved in their planning.

## Stars selected for Analysis

Star	Constellation	Possible Association with Egyptian Deities (See Appendix)
Thuban	Draco	Sophis Snake of Chaos
Antares	Scorpio	Serket Scorpion Goddess
Vega	Lyra	Seshat
Altair	Aquila	Horus Falcon headed god Son of Isis and Osiris
Deneb Algedi	Capricorn	Bastet Cathead goddess
Deneb	Cygnus	Nephthys Sister of Isis, Osiris and Set
Kochab	Ursa Minor	Ipet Hippopotamus Deity
Sheratan	Aries	Atum Ra as the Ram Headed God
Hamal	Aries	Atum Ra as the Ram headed God
Capella	Auriga	Oryx
Aldebaran	Taurus	Apis The Bull Deity
Bellatrix	Orion	Osiris
Rigel	Orion	Osiris
Mintaka	Orion	Osiris
Alnilam	Orion	Osiris
Alnitak	Orion	Osiris
Betelgeuse	Orion	Osiris
Saiph	Orion	Osiris
Castor	Gemini	Tefnut/Shu Twins of Atum
Pollux	Gemini	Tefnut/Shu Twins of Atum
Sirius	Canis Major	Isis Wife and Sister of Osiris
Procyon	Canis Minor	Anubis Jackal/Wolf
Canopus	Carina	Solar Boat
Alphard	Hydra	Set Brother of Osiris, Isis & Nephthys
Regulus	Leo	Sekhmet Lioness headed Goddess
Spica	Virgo	Hathor, Daughter of Ra
Menkent	Centaurus	Thoth
Ennai	Cepheus	Shen Ring
Zubenelgenubi	Libra	Scales of Judgement
Algorab	Corvus	The feather of Maat
Gienah	Corvus	The Feather of Maat
Arcturus	Bootes	-
Markab	Pegasus	-
Scheat	Pegasus	-
Algenib	Pegasus	-
Alpheratz	Andromeda	-
Gamma Ceti	Cetus	-
Kaus Borealis	Sagittarius	-

Table 16

With respect to identifying significant numbers of pendulum swings separating the various star pairs, we could simply consider all multiple whole thousands of swings as being significant, however as the pendulums associated with each of the three pyramids had a period that gave a particular integer of thousands of swings for a particular angular separation measured in Megalithic degrees, considering only multiples of that number of swings would provide more convincing evidence that the pendulums chosen to construct the pyramids were chosen to represent a relationship between certain star pairs.

### **Pendulum Swing Multiples**

The three pendulums incorporated in the dimensions of the pyramids have lengths that result in the following periods, in terms of swings per megalithic degrees.

Khufu Pendulum Length = 46.2497cm 10000 swings per 29 Megalithic Degrees

Khafre Pendulum Length = 35.9157cm 9000 swings per 23 Megalithic Degrees

Menkaure Pendulum Length = 26.18cm 6000 swings per 13 Megalithic Degrees

The initial search is to identify star pair angular separations that can be described in terms of multiples of 10000 swings using the Khufu pendulum, multiples of 9000 swings using the Khafre pendulum and multiples of 6000 swings using the Menkaure pendulum.

The next consideration is to find stars in Orion which exhibit a relationship with another bright star that can be described in terms of multiples of those identified for the three pyramid pendulums. The five triplets of stars in Orion that have already been shown to be able to be mapped onto the pyramids are of particular interest in establishing whether these triplets reveal special relationships with other bright stars that might reflect a known association between Ancient Egyptian Deities.

Tables were set up detailing the angular separation of each star pair as seconds based on each star's Hour Angle. The period of each of the pyramid pendulums was then calculated taking into account the calculated gravitational field at Giza. The number of swings, expressed as a single swing "to" followed by a separate single swing "fro" was calculated by dividing the seconds (s) of separation by the value of period ( $s^{-1}$ ) and multiplying that value by two because the period of a pendulum described the oscillation of a pendulum as the "to" and "fro" motion as one oscillation. However in previous work on the Scottish Pendulums it can be seen that many of the pendulums have an odd thousand number of pendulum swings describing the time it takes for a star to appear to move by the required angle, so each individual swing allows a whole thousand number of swings to express that movement. For example the 35.96cm pendulum swings 9000 times for a rotation of 23 Megalithic degrees and the 41.12cm pendulum requires 15000 swings for a rotation of 41 Megalithic Degrees, the counting of the number of swings as

opposed to oscillations “to and fro” avoids the need to count 4500 and 7500 oscillations respectively, it also allows whole thousands of swings between stars to be more easily recognised from the tables.

Examining the tables detailing the number of swings between stars

### Associating the Stars of Orion with the Great Pyramid of Khufu

The pendulum used to design Khufu’s pyramid had a length of 46.2497cm adjusted to give the same period as the 46.35cm pendulum used in Scotland. The period of swing of this pendulum is  $1.3654s^{-1}$  so that 10,000 swings of the pendulum occur during a 29 Megalithic Degree rotation relative to sidereal time.

Stars separated by multiples of 10,000 swings within 0.5% are listed in the table below

#### Khufu Pendulum Length

Star Pair	Number of Swings (46.2497cm Pendulum)	Closeness to Multiple of 10000 swings (%)
Regulus – Hamal	39984	99.96
Vega - Antares	20030	100.15
Pollux – Scheat	40030	100.08
Castor – Deneb Algedi	50018	100.04
<b>Saiph</b> - Errai	99934	99.93
<b>Saiph</b> – Kochab	29929	99.76
<b>Betelgeuse</b> – Hamal	19961	99.81
<b>Betelgeuse</b> – Regulus	20023	100.12
<b>Alnitak</b> – Hamal	19958	99.79
<b>Alnitak</b> – Regulus	20026	100.13
<b>Mintaka</b> – Sheratan	20020	100.10
<b>Rigel</b> – Deneb	39967	99.92
<b>Rigel</b> - Algorab	89964	99.96
<b>Bellatrix</b> - Sirius	9913	99.13
Deneb - Errai	110086	100.08
Deneb - Algorab	49997	99.99
Menkent – Kaus Borealis	20076	100.38

Table 17

Ten of the seventeen multiples of 10000 swings separating star pairs involve a star in Orion. This is perhaps significantly high given that 38 stars were examined involving 1406 star-pair permutations. Looking for a star to identify with Khufu based on the period of the pendulum length used to construct the Great Pyramid we are left to consider that six stars in Orion gave integer multiples of 10000 swings with an important star or stars that may have been identified with an important Egyptian Deity.

However, it can be seen that Betelgeuse having an almost exactly the same Hour Angle as Alnitak has the same associations with Hamal and Regulus. Hamal, (meaning Ram's head in Arabic) in the constellation of Aries is associated with the Sun God Ra, believed to set as Atum, in the form of a ram. The night boat was then believed to carry the ram head god through the underworld and back towards the east in preparation for his rebirth. The Ram head god gained its ancient importance due to the fact that the Sun travelled across the sky in close proximity to Aries during the Spring Equinox. Sekhmet, the lioness headed goddess was believed to be the daughter of Ra and ferocious protector of Ra and the pharaoh so the association of Regulus with Hamal and both stars in Orion is a logical choice if planned.

Bellatrix in Orion is separated from Sirius, the brightest star in the sky by 20000 swings which is important in connecting Osiris with Isis, the sister and wife of Osiris.

Rigel the brightest star in Orion, the "Toe Star" is separated from Deneb in Cygnus by almost 40000 swings which perhaps connects Osiris with his sister Nephthys identified with the star Deneb.

The second process is to determine which stars in Orion have a relationship with bright stars based on the pendulum length used to build the Khafre pyramid. In this case the search is for star pairs including a star in Orion that have angular separations that can be described as multiples of 9000 swings, as the 35.9157cm pendulum used in the construction of Khafre has a period that equates to 9000 swings per 23 Megalithic Degrees.

### Khafre Pendulum Length

Star Pair	Number of Swings (35.9157cm Pendulum)	Closeness to Multiple of 9000 swings (%)
Vega - Kochab	27075	100.28
Vega - Algorab	99020	100.02
Capella - Spica	53973	99.95
Kochab - Alphard	54057	100.11
Kochab - Algorab	71945	99.92
Castor - Regulus	17994	99.97
Saiph - Deneb Algedi	53904	99.82
Mintaka - Canopus	17981	99.89
Alnitak - Spica	45044	100.10
Betelgeuse - Spica	45041	100.10
Rigel - Errai	116943	99.95
Alnilam - Zubenelgenubi	54037	100.07
Thuban - Errai	54091	100.17
Antares - Errai	90049	100.05
Menkent - Castor	99036	100.04
Menkent - Hamal	71953	99.93

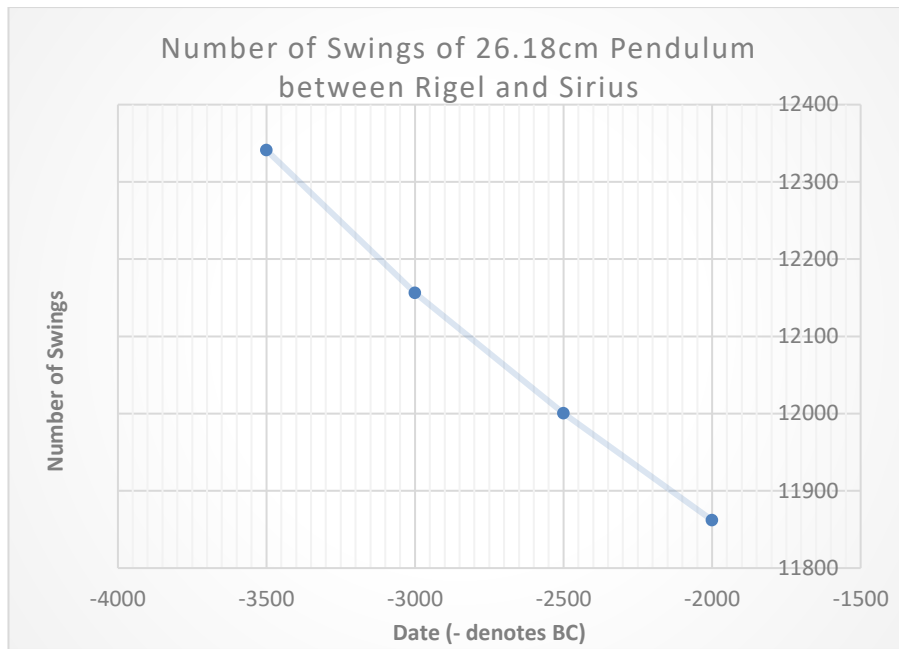
Table 18



There are fewer associations between the stars of Orion and other bright stars than seen with the Khufu pendulum. The Orion associations are for Mintaka with Canopus, Betelgeuse with Spica, Alnitak with Spica, Alnilam with Zubenelgenubi, Saiph with Deneb Algedi and Rigel with Errai. These associations are proposed as linking Osiris with the Solar Barque, Hathor, the Scales of Judgement, Bastet and the Shen Ring respectively.

Finally, the third and smallest pyramid, Menkaure was examined to see whether stars in Orion were separated by other bright stars by multiples of the number of swings defining the pendulum used in the construction of Menkaure. It was proposed initially that the Royal Cubit pendulum could have been used to design and construct Menkaure, but the odd number of Royal Cubits required to account for the height of the Menkaure pyramid, together with the fact that several other pyramids appear to have used a 26.18cm pendulum to measure their base lengths, suggests that it was a 26.18cm pendulum that was used to measure the base and height dimensions of the Menkaure pyramid.

Given that the lengths used as pendulum lengths have specific periods of oscillation and that a "half a cubit" doesn't result in a period that is simply half that of a cubit, there must have been a good reason for the choice of a 26.18cm as a pendulum length especially as there is no obvious evidence for its use in the earlier measurement system used in Scotland. The 52.36cm pendulum gave 12000 swings to-and-fro for 37 Megalithic Degrees. At the latitude of Cairo, the closest whole thousand match for an angle equivalent to a Pythagorean Triplet Hypotenuse integer would be 10977 swings for 34 Megalithic Degrees. Perhaps this relationship was not particularly useful in connecting important star pairs and so was halved to give the 26.18cm length which resulted in close to 6000 swings per 13 Megalithic degrees (5958) but more importantly the period of the "half a cubit" pendulum connects the two brightest stars in Orion, representing Osiris, with another two very bright stars, Sirius in Canis Major representing Isis, the wife and sister of Osiris and Aldebaran the brightest star in Taurus representing the god Atum or the Sun God after it has set below the western horizon.



**Graph 3** The Number of Swings of the 26.18cm Pendulum separating Rigel and Sirius approaches 12000 around 2500BC

If we assume that 6000 swings was the number of swings associated with the 26.18cm pendulum, the following star pairs were related to each other through this pendulum length, being separated by multiples of 6000 swings.

### Menkaure Pendulum Length

Star Pair	Number of Swings (26.18cm Pendulum)	Closeness to Multiple of 6000 swings (%)
Scheat - Algenib	6029	100.45
Scheat - Regulus	72031	100.00
Sheratan - Gamma Ceti	6023	100.35
<b>Rigel - Sirius</b>	<b>12018</b>	<b>100.11</b>
Saiph - Gamma Ceti	24049	100.17
Saiph - Sheratan	30073	100.20
Mintaka - Spica	54027	100.01
Mintaka - Algorab	47950	99.90
Bellatrix - Errai	30077	100.26
Spica - Algorab	6076	101.27
Vega - Zubenelgenubi	131946	104.72
Vega - Errai	132000	104.76
Regulus - Zubenelgenubi	36034	100.09
Pollux - Canopus	12002	99.98
Pollux - Alphard	17940	99.63
Menkent - Hamal	83930	99.92
Canopus - Alphard	5938	(98.93)

Table 19

Once again four stars in Orion account for six of the star pairs separated by multiples of 6000 swings, these stars are the same four stars, in the five sets of star triplets, that could be mapped onto the Menkaure pyramid. Those stars are Saiph, Rigel, Bellatrix and Mintaka. The associations of the Orion stars are proposed to be with stars identified with Isis (Sirius), Atum (Aldebaran), Hathor (Spica), the Shen Ring (Errai) and the Feather of Maat (Algorab).

It may have been that the 26.18cm pendulum was chosen in preference to the Royal Cubit pendulum because it resulted in whole number of thousands of swings between very important star pairs. Looking at the two brightest stars in Orion, Rigel and Betelgeuse it can be seen that they form a quartet of important stars with Sirius in Canis Major and Aldebaran in Taurus.

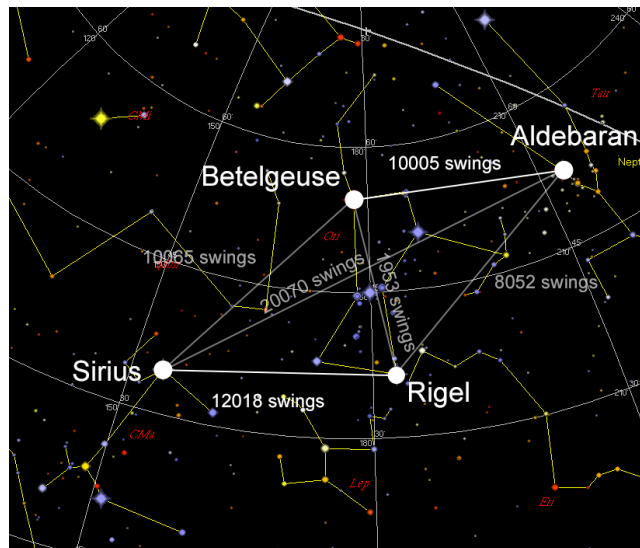


Diagram 33 Map showing the location and temporal separation of four important stars

Star Pair	Swings Separating the Star Pair
Rigel – Aldebaran Osiris - Atum	8052
Rigel – Sirius Osiris - Isis	12018
Betelgeuse – Aldebaran Osiris – Atum	10005
Betelgeuse – Sirius Osiris - Isis	10065
Aldebaran – Sirius Atum - Isis	20070

Table 20 Number of swings separating star pairs using a 26.18cm pendulum

It is interesting to compare the five mappings from Part IIa in terms of the multiple of each of the required number of swings used to calibrate the three pendulums.

<b>Mapping Orion Stars - Pyramids</b>	<b>Khufu Pendulum (46.2497cm)</b>	<b>Khafre Pendulum (35.9157cm)</b>	<b>Menkaure Pendulum (26.18cm)</b>
Reflection	<b>Betelgeuse</b> to 19961 Hamal 20023 Regulus (2x10000) Spica (4x10000)	<b>Mintaka</b> to 17981 Canopus (2x9000) Errai (3x9000) Thuban (9x9000)	<b>Rigel</b> to 12018 Sirius (2x6000)
Rotation	<b>Bellatrix</b> to 9913 Sirius (1x10000) Vega (5x10000) Altair (5x10000) Zubengelgenubi (5x10000) Gienah (9x10000)	<b>Alnitak</b> to 45044 Spica (5x9000) Sirius (5x9000) Aldebaran (15x9000) Zubengelgenubi (10x9000)	<b>Saiph</b> to 30073 Sheratan (5x6000) Aldebaran (2x6000) Zubengelgenubi (18x6000)
Rotation	<b>Betelgeuse</b> to 19961 Hamal 20023 Regulus (2x10000) Spica (4x10000)	<b>Alnilam</b> to 54037 Zubengelgenubi (6x9000) Sirius (1x9000) Canopus (14x9000)	<b>Rigel</b> to 12018 Sirius (2x6000)
Translation	<b>Alnitak</b> to 19958 Hamal 20026 Regulus (2x10000) Spica (4x10000)	<b>Alnilam</b> to 54037 Zubengelgenubi (6x9000) Sirius (1x9000) Canopus (14x9000)	<b>Mintaka</b> to 54006 Spica 9x6000 47950 Algorab 8x6000 Deneb 9x6000 Kochab 22x6000
Translation	<b>Saiph</b> to 29929 Kochab (3x10000) 99934 Errai (10x10000)	<b>Mintaka</b> to 17981 Canopus (2x9000) Errai (3x9000) Thuban (9x9000)	<b>Bellatrix</b> to 30077 Errai 5x6000 Vega 11x6000 Altair 11x6000 Regulus 5x6000 Zubengelgenubi 11x6000 Gienah 20x6000

Table 21

Five Orion star triplets appear to give associations with other bright stars that give integer multiples of the optimum number of swings used to calibrate the pendulum used in the design of the pyramid.

It is interesting that so many of the star pairs involving one star in Orion are associated with stars that could be reasonably identified with the major Egyptian Deities.

Star	Egyptian Deity or object needed to enter the Afterlife	Number of Associations with Star in Orion
Sirius	Isis	6
Zubenelgenubi	Scales of Judgement	6
Spica	Hathor	5
Canopus	Solar Boat	4
Regulus	Sekhmet	4
Errai	Shen Ring	4
Hamal/Sheratan	Khnum or Atum	4
Algorab/Gienah	Feather of Maat	3
Vega	Seshat	2
Altair	Horus	2
Aldebaran	Apis	2
Kochab	Ipet/Taweret	2
Thuban	Apep	2
Deneb	Nephtys	1

**Table 22**

Four stars that have been proposed as representing the Solar Boat, the Scales of Judgement and the Feather of Maat have 14 associations of the 47 total associations with stars in Orion. This high proportion supports the suggestion that these associations between stars in Orion, represented by the three Pyramids, in turn representing the god Osiris, and the bright stars, is concerned with the resurrection of the deceased pharaoh and his journey to the afterlife. The inclusion of Thuban in the constellation of Draco very close to the Celestial Pole has been proposed as representing the Snake of Chaos, Apep or Apophis. This snake inhabited the underworld and was the enemy of the Sun God Ra. Its inclusion in the associations with stars in Orion supports the idea of the pyramid complex being involved or a means of negotiating the trials of the journey through the underworld and aiding the pharaoh enter the afterlife.

Three female deities identified as Regulus in Leo as Sekhmet, Spica in Virgo as Hathor and Sirius in Canis Major as Isis are involved in 15 of the 47 associations. The other stars are believed to have been identified with other important male Egyptian deities and objects associated with the passage through the underworld and entering the afterlife. Hamal in Aries as Atum the Sun god Ra after the Sun has set. Sheratan also in Aries may have been similarly been associated with Atum. Canopus in the constellation of Carinae is the second brightest star visible in Egypt, after Sirius and is believed to have represented the

Solar Boat and means of resurrection of Osiris. The association of stars in Orion identified with Osiris and stars associated with Hathor Sekhmet and Isis as protectors of the Pharaoh and Sun God and the Sun God himself and his solar boat are a good choice of deities to be related to Osiris in his journey of rebirth. The idea of the known stories of Ancient Egypt being embedded in the very measurements of the three pyramids is in line with the grandeur of these monuments and the efforts that went into the design and construction of these amazing monuments. The high number of occurrences of associations with Zubenelgenubi, in Libra and Algorab and Gienah in Corvus, proposed as representing the Scales of Judgement and the Feather of Maat are exclusively associated with the judgement of the dead when the deceased's heart is weighed against the feather to determine whether his soul is allowed to enter the afterlife. The Shen Ring proposed as being represented by Errai in the constellation of Cepheus is a symbol of eternal life.

It is also pertinent to revisit the other pyramid dimensions outlined in Table 5. It might be asked why so many of the pyramids constructed, as single pyramids were based on the Half a Royal Cubit Pendulum measure. Seven of the 16 pyramids were based on this measure and it might be considered that a further two, assumed to be based on the Royal Cubit were also designed and constructed based on the half a cubit measure. If we consider that in the case of Menkaure, itself based on the half a Royal Cubit measure connected Menkaure to Rigel and Sirius, it might be considered that in all of the nine other cases where the Half a Royal Cubit may have been used in the design of the pyramids, that each pyramid was associated with Osiris as one star, and that star was the brightest star in the constellation of Orion, Rigel described in the Pyramid Text as "the Toe Star". In which case all nine pyramids together with Menkaure at Giza could have represented Rigel as Osiris and related to Sirius as Isis by the pendulum used in their construction. It is interesting to apply this same proposed association to the other pyramids that used other pendulum lengths to describe their base dimensions to see whether these pendulum lengths are able to describe a significant relationship, in terms of the period of that pendulum between a star representing Osiris and Isis or another Egyptian deity.

The 58.25cm used on the pyramid gives 8000 swings ( $2 \times 4000$ ) for the angular separation of Rigel and Sirius confirming the importance of the connection between Rigel and Sirius. The 63.66cm pendulum gives 35000 swings ( $7 \times 5000$ ) for the angular separation of Rigel and Spica. The choice of Spica to connect to, if this was intentional is reasonable because Spica was identified with Hathor, the lioness headed goddess that together with her more fearsome alter ego, Sekhmet was considered as the protector of the Pharaoh and Ra himself.

Four of the pyramids in Part I, Table 5, including Khafre at Giza, have dimensions described as 35.96cm pendulum lengths. The Khafre pyramid is connected to Mintaka using this pendulum length but the other three pyramids at Meidum, Abu Rawash and Zawi-el-Aryan built by Sneferu, Radjedefra and Baka may represent single pyramids. The star in Orion representing Osiris as the Toe Star is Rigel but in other descriptions Orion has been described as the star under the arm of Osiris, or perhaps Betelgeuse. The 35.91cm pendulum gives 45000 swings (9x5000)

Star Pair	Khufu Pendulum Swings	Khafre Pendulum Swings	Menkaure Pendulum Swings
Regulus – Hamal Sekhmet - Atum	39984		
Pollux – Scheat Tefnut/Shu-?	40030		
Castor–Deneb Algedi Tefnut/Shu-Bastet	50018		
Vega – Antares Seshat-Serket	20030		
Menkent – Hamal Thoth - Atum	20076		
Kochab – Alphard Ipet-Set		54057	
Capella-Spica Oryx-Hathor		53973	
Castor-Regulus Tefnut/Shu- Sekhmet		17994	
Menkent – Hamal Thoth - Atum		71953	
Menkent – Castor Thoth – Tefnut/Shu		99036	
Scheat-Algenib			6027
Scheat – Regulus - Sekhmet			72003
Sheratan - Gamma Ceti Atum-			6021
Pollux – Canopus Tefnut/Shu – Solar Boat			11998
Pollux – Alphard Tefnut/Shu-Set			17933
Canopus – Alphard Solar Boat- Set			5936
Spica – Deneb Hathor - Nephthys			18094
Menkent – Hamal Thoth - Atum			83930

**Table 23**

In view of the proposed associations found between the stars of Orion and other bright stars associated with Egyptian deities the associations between the other stars giving whole multiples of swings with the Khufu, Khafre and Menkaure pendulums was examined.

Secondly, the search for star pairs separated by whole thousands of swings (within a range of 0.5% of an integer thousand multiple) may similarly result from the careful selection, by the pyramid designers, of pendulum lengths that embedded important information about stars, identified as Egyptian Stellar Deities, into the very fabric of the pyramids. If the associations between the stars and the gods of Ancient Egypt can be found, these relationships may reflect the myths and stories important in Ancient Egypt, particularly in relation to the Osiris Myth and the stories of the Pyramid Texts involving the resurrection of the Pharaoh.



## Part VII

### The Celestial Star Gods of Ancient Egypt

The Egyptian deities have always been portrayed in what might be considered as a slightly strange way in that many have the bodies of a man or woman and the head of an animal. It is proposed that the reason for this is that an animal alone could not be considered as a deity and required some human form to identify it as a god, but the deities were in heaven and were associated with bright stars and their constellations, that were often identified as animals and birds, which resulted in the hybrid form of the gods depicted. Furthermore, some deities are portrayed as having wings which reinforces the idea that these deities inhabited the heavens as in the skies above us and additionally may have been particularly associated with constellations identified as birds such as Cygnus, Aquila and Corvus.

#### The Saltire Cross of Osiris

It appears that despite the obvious similarity between the relative positions of the three stars in Orion's belt and the relative positions of the three pyramids of Giza, there are closer matches between other star triads in Orion and the three Pyramids. The plan of the Pyramids allows all seven major stars comprising the body of Orion to connect with the pyramids, by means of stars in Orion, representing Osiris, mapping onto the pyramids by operations involving either a translation, reflection or rotation. The translation and reflection mapping operations of the stars onto the pyramids, apply to the time when the stars in Orion are above the horizon and visible in the night sky. The rotation operations involve mapping the Pyramid peaks onto the stars of Orion as they are imagined to pass beneath the pyramids after they have set in the West. Three stars in Orion can also be seen to rise up out of the apex of each of their pyramids when viewed from a position West of the Giza plateau and another three stars in Orion can be seen to sink into each pyramid's apex as they set, when viewed from a position East of the Giza Plateau. There are therefore seven permutations of Orion star triads that can be associated with the Pyramids of Giza. The joining up of the triads of stars in Orion as seen in Part IIa creates the pattern of a saltire cross.

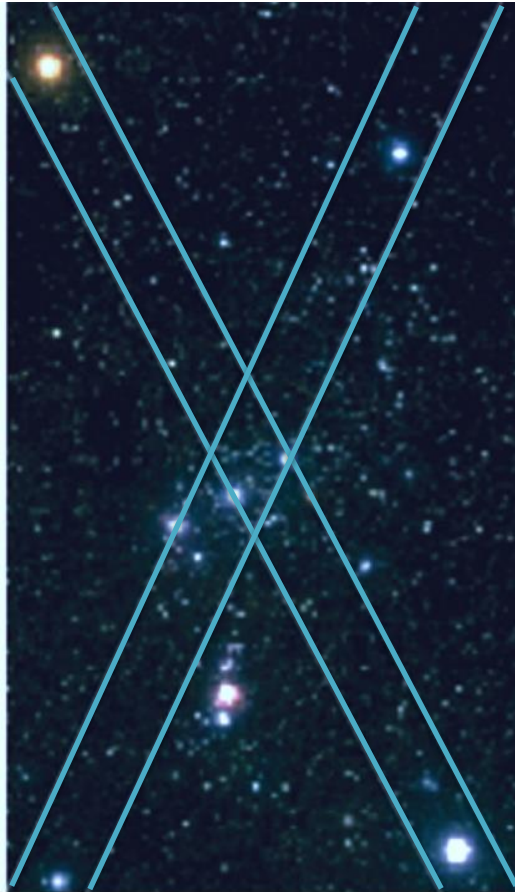
It is the cross pattern of stars that allows the various triplet pairs of stars to be matched both as a reflection and as a rotation thereby linking the pyramids with the stars both in the heavens above and the underworld below. The saltire imagery itself is not obvious when we look at the arrangement of stars in Orion just as the other sets of slightly offset star triads matching the pattern of pyramids is drowned by the more "obvious" offset arrangement of three closely positioned stars lying at the centre of the constellation, comprising Orion's Belt, which could be considered in isolation to the other stars in the constellation. However, when painted and carved images of Osiris are more closely

examined, the pattern of the saltire is to be seen everywhere, in the patterns decorating his cloak and nearly everywhere embedded in his posture of crossing his arms holding his crook and flail, in the saltire pattern of bandages covering the chest of the deceased pharaoh, in the shape of the saltire cross used to decorate faience beads that was possibly the short-hand symbol used to represent this god in prehistoric times.

From ancient times certain patterns or symbols have been painted on walls and scratched into pottery. One such symbol is the cross, represented as a saltire and whilst it has been assumed to merely represent a simple pattern for decorative purposes, the pattern may have symbolised something more significant to the people who painted it, in the same way that the Triangle may have represented the Summer Triangle consisting of the stars Deneb, Vega and Altair and the Square represented the constellation of Pegasus.



**Figure 15** Osiris depicted with his arms crossed with Crook and Flail forming the Saltire Cross identified with the pattern of stars in Orion. Osiris's cloak is also decorated with a pattern of Saltires.



**Figure 16** The symbol of the Saltire Cross and how it relates to the pattern of stars in Orion.

The symbol of the saltire cross was used as a shorthand symbol for the constellation of Orion and the god associated with the constellation namely Osiris, in Egypt and Baal by the Phoenicians, later it was syncretised into Christianity as Saint Andrew and perhaps helps to explain the ancient origins of the Saltire Flag used to represent Scotland.



**Figure 17** Osiris with Saltire cross on his chest



**Figure 18** Egyptian Faience Beads Representing Osiris

## **Celestial Egypt**

In terms of the importance of astronomy to the Ancient Egyptians, the oldest astronomical stone circle in the world, dating from around 4500BC was found in Nabta, Egypt. Although, now a desert, at the time of its construction there was a lake there and agriculture was practised. The Megaliths around the perimeter of the circle at Nabta appear to define four alignments with the Summer solstice and the North and South poles. Possible alignments with Arcturus, Sirius, Orion and Ursa Major have been proposed suggesting these constellations were important to the Egyptians some two thousand years before the construction of the pyramids.

Later the Ancient Egyptians tried to live in harmony with the celestial world and they tried to reflect the heavens in the way in which their country was organised. Districts or “nomes” corresponded to a particular constellation or star and each nome had a capital city and a patron god. According to Daressy’s theory of the celestial Nile, sailing down the river was like sailing along the path of the Sun as it passed through the stars and constellations and conversely the Milky Way was identified as the “Nile of the sky”.

It is important to realise the relevance of the stars to the gods worshipped by the Ancient Egyptians. The Ancient Egyptians depicted their gods with human bodies and animal heads that formed a pantheon of deities that had an other-worldly and intimidating appearance but these deities are not a random group of invented gods. Rather, these deities were identified as constellations in the night sky, more specifically the deities were associated with the brightest stars in their constellation, and the particular animal heads of each deity reflected their association with the animals identified with those constellations.

### **Stars connected with Egyptian Gods**

There are very many Egyptian deities and it would be extremely difficult, if not impossible, to definitively associate each one with a particular star or constellation. However, given the likely association between Osiris and the pyramid complex at Giza it is useful to try to find associations between the stars and the main deities involved in the stories about Osiris. Characters such as Isis, Nephthys, Seth, Anubis, Horus and Hathor are central to the story of the Osirian myth. The identification of stars associated with each of the deities may be reflected in special associations between star pairs with respect to the number of pendulum swings describing their angular separation.

The possible association of particular stars with known gods and goddesses of Ancient Egypt was carried out as a preliminary exploration. It is however notoriously difficult to identify Egyptian gods with stars as the gods changed as a function of time and place and may have had different associations in Lower and Upper Egypt and some gods may have had different or overlapping incarnations reflecting different aspects of their personality

depending on the needs of the time and stories that were created. There are however some deities that have stellar associations which appear to be more secure than others such as the associations between Hathor and the star Spica and Isis with the brightest star in the sky, Sirius.

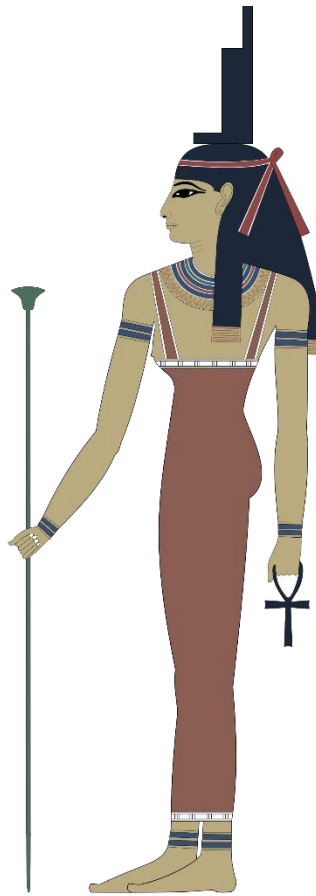
### Hathor as Spica, in Virgo



It is known that Spica, the brightest star in Virgo, is associated with the Egyptian Goddess Hathor. A temple in Thebes dedicated to Menat, an early version of Hathor was oriented with reference to Spica when it was built in 3200BC. (Allen, Richard Hinckley, 2003, *Star Names and their Meanings*, Kessinger Publishing p468 ISBN 978-0-7661-4028-8)

Hathor and Isis were very closely associated and often are so alike in appearance that only the hieroglyphic inscription can confirm which of them is depicted. The star Spica first appears around harvest time.

## Isis as Sirius, in Canis Major



Sirius was identified by the ancient Egyptians as Sopdet, the wife of Sah who was associated with Orion. Sopdet was later associated with the goddess Isis and Sah was linked with Osiris. The fact that Isis was the wife and sister of Osiris links Sirius with the neighbouring constellation of Orion. The identification of Sirius as Isis is supported by the historian Plutarch who states “the soul of Isis is called Dog by the Greeks” which is consistent with the fact that Sirius is the brightest star in the sky, referred to as “the Dog Star”; the brightest star in the constellation of Canis Major, the Great Dog.

## Osiris as Betelgeuse, in Orion



It has become generally accepted that Osiris was identified by the Ancient Egyptians with the constellation of Orion. This association has become further embedded in today's popular culture by Robert Bauval and his best-selling book "The Orion Mystery" in which he proposes the three stars of Orion's belt represent the three pyramids of Giza. Whilst the three stars have a generally similar arrangement to the three pyramids, when the pyramid plans and star maps are over-laid, the match is close but not perfect. Re-examining the evidence as to the possible stellar identity of Osiris. In "The Stellar Destiny of Pharaoh and the So-Called Air Shafts of Cheop's Pyramid", Alexander Badawy translating the Pyramid Texts refers to Orion not as a constellation but as a star. The Pyramid Texts refer to the word s3h, written in the singular with the "star" determinative and the s3h hieroglyph meaning "toe". The literal translation of s3h is therefore "Toe Star". When this translation is substituted into several passages in the pyramid texts it appears to make sense of their meaning. Badawy translates Pyramid Text 723 as "thou must approach the sky on thy toes as the Toe-Star". In Pyramid Text 959 Seth's complaint that Osiris had kicked him "when there came into being this his name of Toe-Star, long of leg and lengthy of stride". In Pyramid Text 1763 the method by which the dead king's soul was supposed to ascend to the heavens is described "I have gone up the ladder with my foot on the Toe-Star".



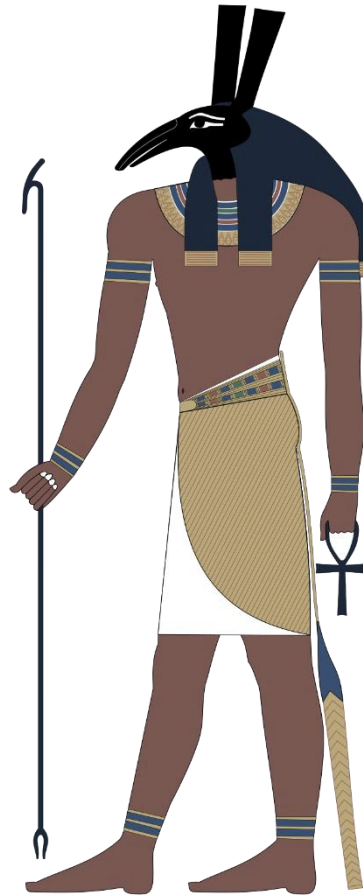
There are several interpretations of these passages; firstly, if the stars in Orion are considered to form the shape of a man, based on the position of stars in the constellation, the Toe-Star might be considered to be one of the two “lower” stars Saiph or Rigel. Rigel or Beta Orionis, being the brightest star in the constellation of Orion is perhaps the more likely star to be identified as the “Toe-Star”. In the Coffin Texts of the Middle Kingdom the order in which the stars appear in the night sky is described “I am the Toe-Star who leads his two lands who navigates in front of the stars of the sky on the belly of my mother Nut” (CTIII,263). The Goddess Nut was the ancient Egyptians goddess of the heavens and sky pictured as a naked female arching her body across the sky from East to West in a protective posture over the Earth. Nut’s body has therefore been identified with the Milky Way. In the “Book of Coming Forth by Day” in chapter 69 a relationship between the constellation of Orion and the Milky Way who is mentioned as goddess Nut shows the constellation of Orion moving closely amongst the bright stars of the body of Nut. This position of Orion relative to the Milky way is consistent with the description of the Toe star on the belly of his mother Nut. When Orion rises in the East it is Bellatrix or  $\gamma$ -Orionis which is first to rise but the orientation of the constellation means that it is Rigel that leads the other stars in the constellation in terms of being the most westerly of Orion’s stars and it is Rigel that is first to set into the western horizon. Perhaps this makes sense if one considers the constellation of Orion as representing a ladder as mentioned in PT1763, and the King’s soul could only ascend heaven once the ladder had been climbed and in this context the King’s foot would make its first step onto the ladder of Orion formed between Saiph and Rigel, “the Toe Star”. In Pictish mythology it was Betelgeuse which was used for alignment purposes on the festival day dedicated to Orion. In the tombs of Senmut, Pedamenope and Montemhet, Osiris is associated with the star known as hr rmn s3hu, meaning the star “under the arm of Orion”, this seems to identify the Toe-Star as either Bellatrix or more likely Betelgeuse as it is Osiris’s right arm that is raised and Betelgeuse is more suited to the description as being the star under the arm.

It can be seen how difficult and contentious it is to associate a particular star with even one of the major deities of Ancient Egypt. This confusion may simply reflect the fact that different stars in Orion were identified as Osiris by different people at different times.

Indeed, there are others who associate the second brightest star in the Egyptian night sky, Canopus as being connected to Osiris. This interpretation however, is likely to have arisen due to the secondary association of Osiris with the solar boat identified with the constellation of Argo Navis, more specifically with Carina and its brightest star Canopus.



## Alphard as Seth, in Hydra



It is possibly easier to identify stars that were associated with known festival days, such as the solar festival days comprising the solstices and equinoxes. The dates of the solar festival days in 2560BC are

Winter Solstice	January 10 <sup>th</sup>
Spring Equinox	April 12 <sup>th</sup>
Summer Solstice	July 14 <sup>th</sup>
Autumn Equinox	October 12 <sup>th</sup>

When the night sky is examined at civil twilight on the winter solstice, the constellation of Hydra is setting in the West whilst at dusk the head of hydra is rising on the horizon due East. At the equinoxes Hydra is due South in the sky at dusk at the Spring Equinox and due South at dawn at the Autumn equinox. It is a strong possibility that this constellation was an important marker to the ancient Egyptians of the arrival of the different solar festivals. The symbol of the Sun disc between two cobras may represent the association between Hydra and the equinoxes and the winter solstice. The snakes appear to have a star decorating each of their carved bodies, and perhaps this represents the brightest

star in Hydra, the red giant Alphard. By examining the pattern of stars in the night sky we begin to understand the imagery of our ancient ancestors art. The identification of Alphard in the pantheon of Egyptian gods is difficult but if a different approach is employed perhaps some other clues will reveal themselves.

The angular separation of Alphard in Hydra and Sirius in Canis Major can be “timed” by precisely 10000 swings of a pendulum of 63.567cm in length. This pendulum length represents a Sacred Cubit. Isis, sister and wife of Osiris, was also the sister of Seth. Seth the red-haired god of pre-historic invaders who slew Osiris became the Egyptian Satan and was depicted in various guises including a black serpent, a black pig, a red-haired mythical monster or simply a man with red-hair. The association of Seth with Hydra is not straight forward though because the way in which Seth was most often depicted was an unknown creature with strange shaped ears an elongated nose and a twin pronged tail.



**Figure 19 Statue of Seth**

Perhaps some of these features can be associated with a serpentine form as snakes can shed their tails and grow them again sometimes leading to multiple tails and the Egyptian viper is characterised by two strange protuberances on its head. Seth was also considered the king of the desert and this description may be consistent with the Egyptian Horned Viper.



**Figure 20** The Horned Egyptian Viper, "King of the desert"



**Figure 21** The horned viper symbol thought to be associated with the constellation Hydra (Alessandro Berio "The Celestial River" Sino-Platonic Papers 253 (Dec 2014))

## Anubis as Procyon in Canis Minor



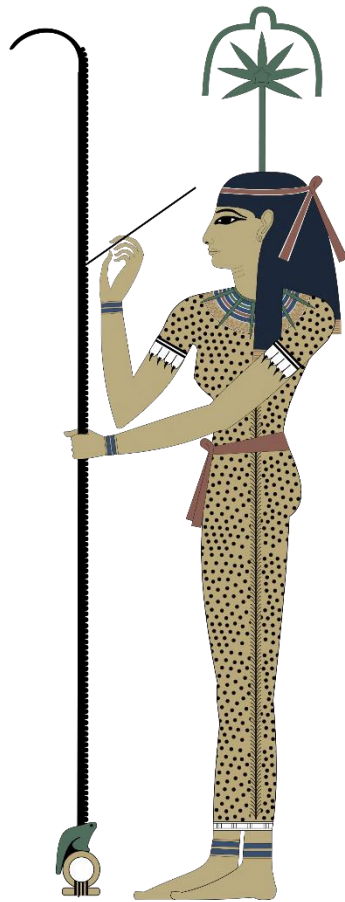
The Egyptians, according to Chartrand (1982), considered the Canis Minor constellation to be Anubis; which he summarizes as follows: [4]

“The small dog, placed in the sky for faithfulness, drinks from the Milky Way, once thought to be a river. In Egypt, he was **Anubis**, the jackal god. The Greeks called the whole group Procyon.” In many ways it seems logical that Anubis would be identified as a separate constellation from Canis Major whose brightest star Sirius was so consistently identified with Isis. The existence of a second constellation identified as a canine, Canis Minor, with its bright star Procyon, seems like the most likely candidate for the identity of Anubis.

Anubis is the god of death, mummification, embalming, the after-life, cemeteries, tombs and the underworld. Originally it was identified with the African Golden Jackal, but today through genetic analysis it would be more properly identified as the African Golden wolf. The jackal and wolf were initially associated with death and burials due to the problem of these animals frequenting graves and digging up the corpses of the deceased. The fact that Anubis is depicted in black is because despite his association with death, black is the colour that symbolises regeneration and he played an essential role in the resurrection of the deceased. One of Anubis’s prominent roles was as a god who ushered souls into the afterlife. He attended the weighing scale during the “weighing of the heart ceremony” when the soul of the deceased could only enter the afterlife if his heart weighed less than a feather. Despite being one of the most ancient gods in the Egyptian pantheon, Anubis

played very little role in Egyptian myths. The Jumilhac papyrus recounts a tale where Anubis protected the body of Osiris from Seth as he attempted to attack the of Osiris transforming himself as a leopard. Anubis stopped Sdet and branded Set's skin with a hot iron rod. Anubis then flayed Set and wore his skin as a warning against evil-doers. Priests attending the dead wore leopard skins to commemorate Anubis's victory over Set and the legend of Anubis branding the hide of Set in leopard form was used to explain how the leopard got its spots.

### Vega in Lyra as Seshat



Seshat was the daughter of Thoth and was considered as the goddess of wisdom, knowledge, writing and measurement. As such she was also identified as the goddess of architecture, astronomy, astrology, building, mathematics and surveying.

Seshat was usually represented as a woman clad in a long panther skin dress and wearing a headdress consisting of a band surmounted by a seven-pointed star and an inverted bow. In this imagery we can imagine the brilliant star Vega in its constellation of Lyra that is today represented by the bow-shaped symbol of a Lyre and was in prehistoric times in Scotland represented as a horseshoe in Pictish symbols, both symbols reflecting the bow-shaped arrangement of stars in the constellation.



**Figure 22** The “Horseshoe” Pictish Symbol representing the constellation of Lyra shown beneath it.

In some images, the seven-pointed star has more of the appearance of the papyrus flower, used to make parchment, pictorially associating Seshat with writing, and indeed the star in Egypt was usually represented with five points and never represented with seven. Furthermore, at the centre of the seven-pointed leaf in some images is the pattern of a five-pointed star thereby differentiating the image of a star from a leaf.

More often the interpretation is that the leaves are those of hemp that apart from being associated with cannabis were used to make the cord that Seshat used in assisting the pharaoh in the foundation ritual of “stretching the cord”.



**Figure 23** Seshat

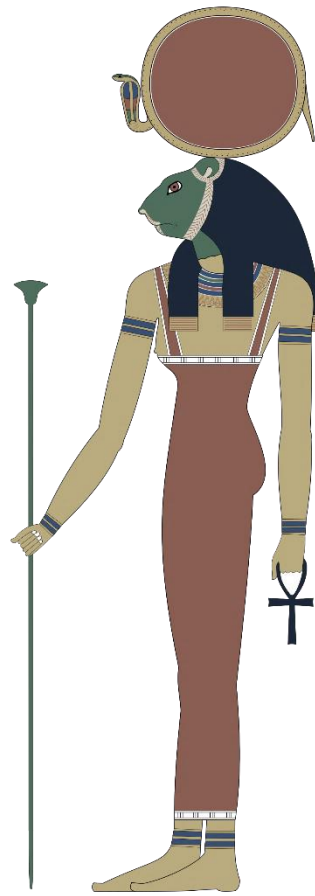
Seshat was never a deity of the people and belonged to the king alone. Seshat was important in the resurrection of the pharaoh as Spell 10 of the Coffin Text states “Seshat

opens the door of heaven for you". Her association with cords, measurement of foundations and passing of time is intimately associated with the pyramid complex and its association with Osiris given the use of pendulum measures to mark out the foundations of the pyramids and how these same measures when used to measure the passing of time by alignment with the moving stars gives whole thousands of swings between special star pairs.

Further support for the identification of the seven-leaf image as being associated with the material used to make a cord comes from the image of what is usually described as "the inverted bow" depicted in Seshat's headdress. Apart from being too small, the shape although "bowed" does not resemble a known weapon-type bow. Instead, the author believes the bow is a long-forgotten tool used to make cord. A model of the bow was carved in wood and was used to test how it could be used to make a cord using a single line of hemp twine.

It was found that by putting a long loop of hemp around the small semi-circular central protuberance and attaching the other end to a fixed point, the two handles of the cord tool pointing away from the length of line towards the cord maker, could be turned to impart twists in the looped hemp. The twisting process can be achieved quickly by holding just one handle in the palm of the hand and the other hand positioned with the palm over the central protuberance with the line placed between the space between the fore-finger and middle finger and imparting just enough pressure with the palm to balance the tool so that the handle can be easily and quickly turned with the string remaining in a stable central position. The handle can be turned hundreds of times until there are sufficient twists in the loop to cause it to just start to "bunch-up" when the tension on the twisted string is released. The twisted double hemp line is pulled taught several times by pulling on both handles simultaneously during the twisting process to help align the hemp fibres in the twisted line. The loosened twisted line is then passed over the fixing at the fixed end of the twine and with the other end of the twine looped around the centre of the tool, the person moves back from the fixed point to form three equal length taught, twisted lines. The tool is then rotated as before but in the opposite direction, in this case, anti-clockwise applying an even pressure on the string. The twisted cord consists of six spiralling lines that can be tied off at either end which has very little stretch, making it an ideal measuring cord both for measurement lengths and for use as a pendulum.

## Sekhmet as Regulus in Leo



Sekhmet was a lioness-headed warrior goddess as well as a goddess of healing. She was the protector of pharaohs and led them in warfare and upon death Sekhmet continued to protect them bearing them to the afterlife.

Sekhmet is also a solar deity, the daughter of Ra and is often associated with Hathor as her wrathful form. Sekhmet represented the scorching heat of the Sun at midday and as the Sun shines most brightly during the month of Leo, Sekhmet may have been its original archetype and associated with its brightest star Regulus.



## Horus as Altair in Aquila

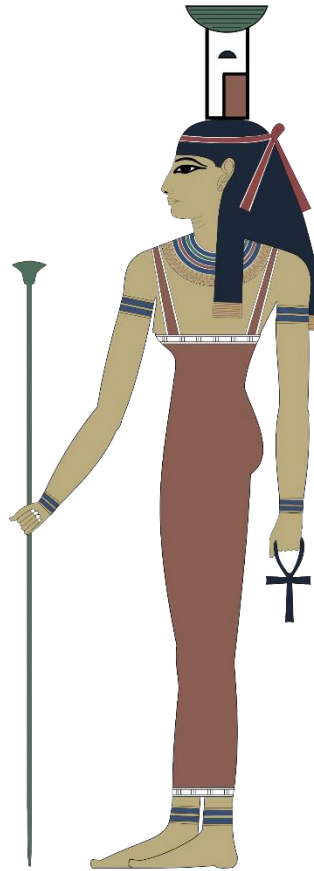


Horus the falcon-headed god is proposed as representing the constellation of Aquila and more specifically Altair, the brightest star in Aquila.



**Figure 24** The constellation of Aquila the Eagle showing its brightest star Altair

## Nephthys as Deneb in Cygnus

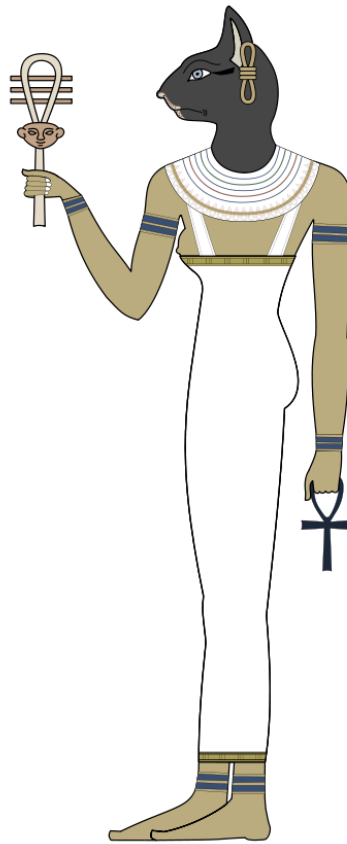


**Nephthys** is the sister of Isis and Osiris and wife and sister of Seth. She was often depicted as a woman with outstretched wings which has been interpreted by many as reflecting her protective role towards everyone. She assisted her sister in gathering and mourning the dismembered portions of the body of her brother Osiris after his murder by Seth. Nephthys also serves as a nursemaid and watchful guardian of the infant Horus. Nephthys was also considered the unique protector of the Bennu Bird. The Bennu bird is believed to be a type of large Heron, the size of a man that became extinct around 1500BC. The large white heron only occasionally visited Ancient Egypt, coming from the lands of Arabia and was believed to be



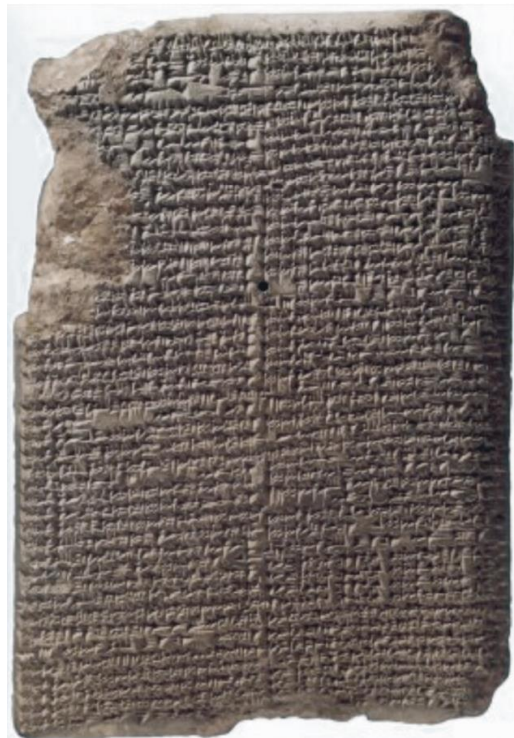
Nephthys was the sister of Isis, Osiris and sister and wife of Seth. In some accounts she reportedly tricked Osiris into thinking she was Isis and bore his child, Anubis who was cared for by Isis.

## Bastet as Deneb Algedi in Capricorn



Bastet was worshipped in Lower Egypt originally as a lioness goddess like Sekhmet. A goddess of the Sun worshipped throughout most of Egyptian history, Bastet was the daughter of Ra, protector of Lower Egypt and of the king, her father, the Sun god. Bastet and Sekhmet were characterised as two aspects of the same goddess, with Sekhmet representing the powerful warrior goddess and Bastet the protector goddess. Bastet increasingly became depicted as a Cat or a Cat's head deity. The idea of Bastet being associated with the protector of the Sun is an ancient one and it may arise from the fact that Bastet was associated with the constellation of Capricorn which from around 3000BC rose and set with the Sun during the winter months. Because of this property, Capricorn, alone amongst the constellations was never visible in the night sky during the winter months. As such the constellation of Capricorn was considered as the guardian and protector of the winter Sun. The stars in the constellation are today represented as a fish-tailed goat but the way in which the brightest stars in the constellation are joined both today and from ancient times results in a triangular form that shares the general appearance of a Cat's head. Furthermore, if the brightest stars within the triangle are joined a single eye can be formed. The other "missing" eye could be interpreted as being supplied by the Sun God as they move together through the daytime sky during the winter months.

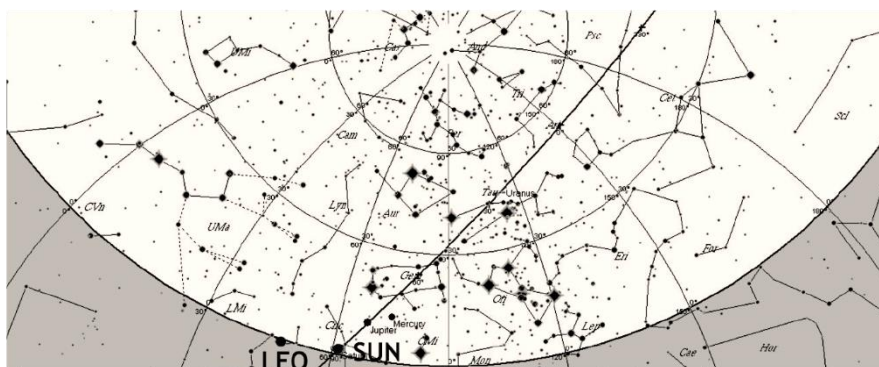
The importance of Capricorn is evident in the Mul Apin tablet from Mesopotamia (687BC) detailing astronomical observations. The ancient astronomical text translates as



**Figure 25** Mulapin tablet, Mesopotamia 687BC

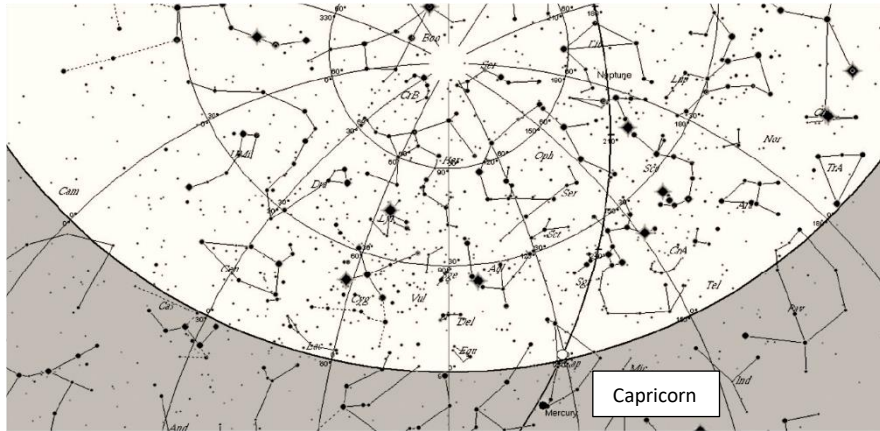
*"the Sun which rose towards the North with the head of the Lion turns and keeps moving down towards the South at a rate of forty Ninda per day. The days become shorter, the nights longer.....the Sun which rose towards the South with the Head of the Great One then turns and keeps coming up towards the North at a rate of forty Ninda per day. The days become longer, the nights become shorter."*

The text describes the rising of the Sun in the summer and then the rising of the Sun during the winter months. To reveal the identities of "the Lion" and the "Head of the Great One" the arcaeo-astronomy program Sky-Map Pro was used.



**Figure 26** Sunrise looking East at the Summer Solstice in Baghdad 1000BC

## Sun Rises with Leo



**Figure 27** Sunrise looking East at the Winter Solstice in Baghdad 1000BC.

## Sun rises with Capricorn

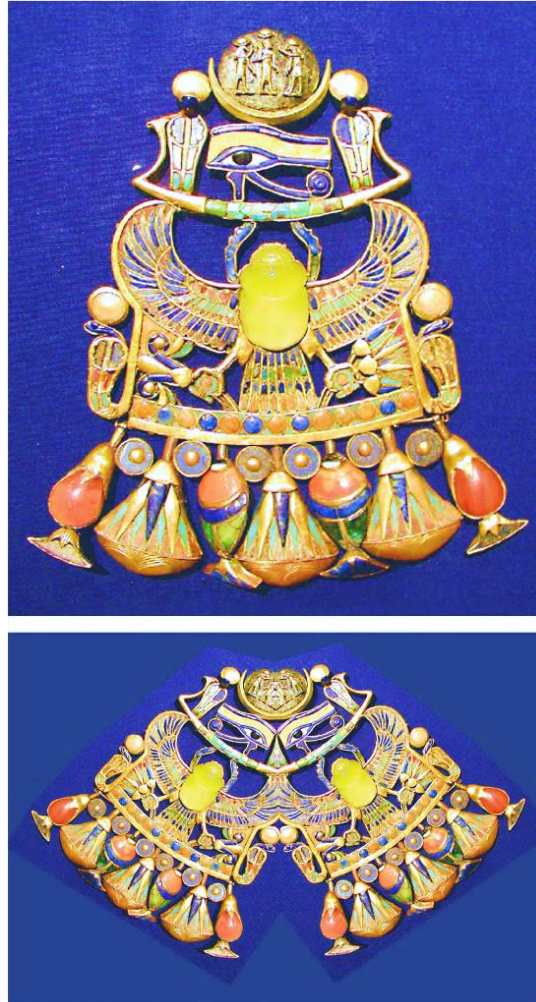
The description of the rising of the sun with Leo in summer and with Capricorn in winter is in-keeping with the two aspects of the cat-headed goddesses, the daughters of the Sun God Ra; Sekhmet and Bastet, where Sekhmet is identified with the constellation of Leo and Bastet identified with Capricorn. The brightest star in Capricorn is Deneb Algedi and maybe it was the star identified as Bastet just as the brightest star in Leo, Regulus was identified as Sekhmet.

It is interesting that with the passing millennia the paths of the Sun and Capricorn started to part due to the precession of the equinoxes. This parting of the ways was reflected in changes in the way the Egyptians treated cats. Whilst the Cat had protected status in the early days when killing a cat was punishable by death, the export of a cat was not allowed and when a family cat died from natural causes it was mourned by the family who reportedly shaved off their eyebrows. However the paths of the rising Sun and Capricorn started to part around 300BC which initiated the killing and mummification of hundreds of thousands of kittens which were offered to Bastet at her temple in Bubastis as a way of stopping the movement of the guardian god of the winter Sun away from the rising and setting Sun. However, by around 8BC, the constellation of Capricorn could be seen after the Sun had set and the old beliefs could be seen to be flawed requiring the belief system to be changed.

The eye of Horus has remained an enigmatic symbol amongst Egyptologists despite many different theories as to its origin. We believe that the association of the Sun god Ra with the constellation of the One-Eyed-Cat and the completion of that cat with the donation of the eye of Ra goes some way to explaining the significance of the Eye of Horus symbol.



When we carry out a reflection in an axis that touches the yellow jewel on the lower left-hand cobra's head, we produce the image of an exotic domestic cat. Apart from the appearance of the Cat head we also see the symbol above the cathead as a triple disc which bears a resemblance to the Saturn Nebula above the constellation of Capricorn.



**Figure 28** Tutankhamun's Necklace depicting the Eye of Horus (above)

Which produces a Cat's Head on Reflection (below)



**Figure 29** The Constellation of Capricorn depicted as a Cats Head with One Eye

## The Solar Barque as Canopus in Argo Navis



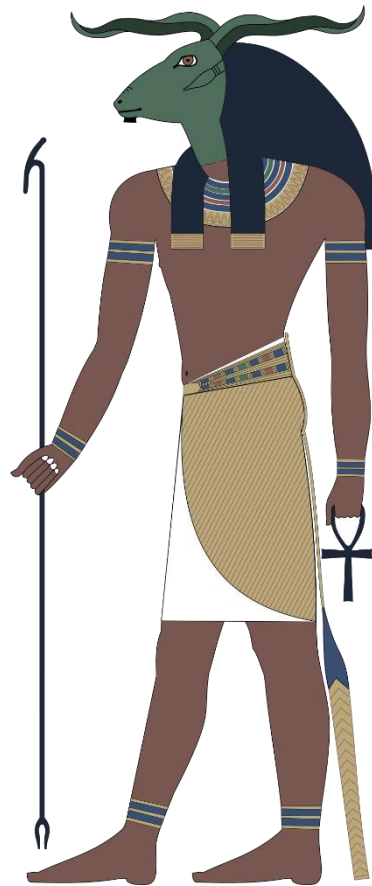
Figure 30

The solar barge of the Sun God Ra. The sun boat is the great ship in which Ra (or Atum or other gods) and his companions sailed through the sky giving light to the world. It was also the ship in which gods travelled from the heavens to earth when the gods used it to travel between worlds it was called "The Boat of a Million Years" Traditionally the sun boat is portrayed with Ra in the centre wearing the Sun Disc on his head. Osiris and Isis often stand behind him, arms raised in prayer. Sometimes Nephthys the sister of Isis and Osiris are also depicted with their brother Set standing at the prow, weapons raised to strike the snake of chaos Apep.

The identity of the boat with the constellation of Argo Navis is supported by the description of Plutarch who attributed the constellation with "the Boat of Osiris". Canopus, together with Sirius represented a plumb line, a device for measuring the depth of the sea when navigating. Canopus, the brightest star in Argo Navis and second brightest star in the sky was called in Arabic Suhail el wezn "the heavy weighing" represented the lead weight suspended by a vertical line to Sirius directly above. The star Canopus was important to sailors of the time as a navigational marker star and it seems appropriate that Canopus was associated with the boat that was the means of travel between earth and the heavens.



## Khnum as Hamal in Aries



Khnum was one of the earliest Egyptian deities being the god associated with the source of the river Nile. He was represented with the head of a ram. The constellation associated with the ram is Aries and its brightest star Hamal. It is notoriously difficult to try and work out the festival days of Ancient Egypt, however it may be interesting that the festival of Khnum took place on the eighteenth day of the second month of the Season of Flood, believed to coincide today with September, during the reign of Thutmose III around 1479BC at the end of Civil Twilight the brightest star in Aries, Hamal is aligned precisely due East whilst at the start of Civil Twilight on the 18<sup>th</sup> September, Hamal and Sheratan in Aries are aligned almost due West.

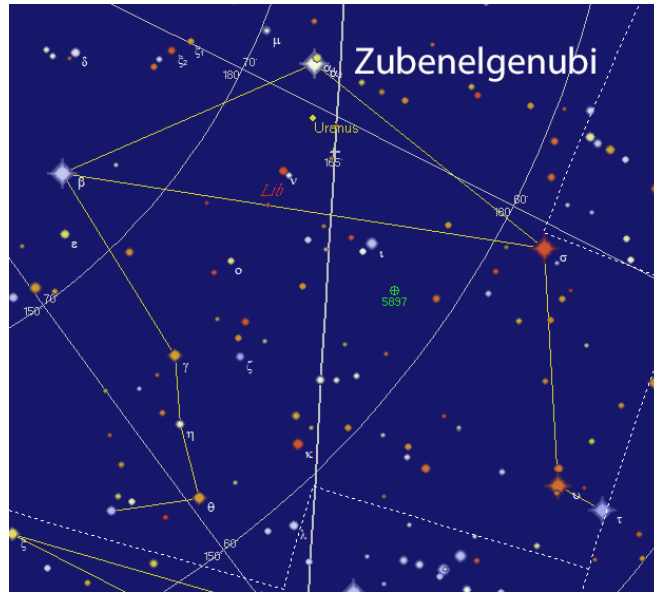
## The Scales of Judgement and the Feather of Maat



Figure 31

In spells 30 and 125 in the Book Coming Forth by Day a ceremony attended by Anubis is described where the soul of the dead is judged by weighing the heart of the deceased against the Feather of Maat on the Scales of Judgement. The heart had to weigh less than the Feather of Maat in order to enter the afterlife. The Ancient Egyptians believed that the heart was the key to entering the afterlife as they believed it was the heart and not the brain that was the centre of human wisdom, memories and emotions and was left in the deceased body during mummification unlike the brain which was removed. If the heart weighed more than the Feather of Maat it was instantly eaten by the monster Ammit, seen at the bottom right of the mural.

The Scales of Judgement are consistently represented in the form shown and this configuration shares its shape with the pattern of stars in the constellation of Libra.



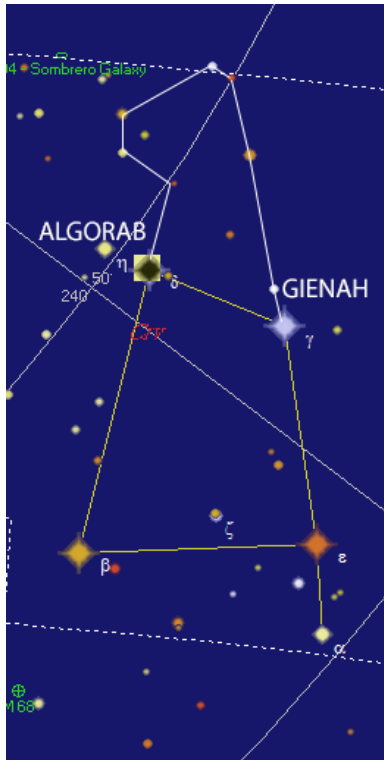
**Figure 32** The Weighing Scales of the Constellation of Libra

The star called Zubenelgenubi at the apex or fulcrum of the scale is the star that was most likely identified by the Ancient Egyptians as the Scales of Judgement.



**Figure 33** The Feather of Maat

Situated close-by to Libra is the constellation of Corvus, the Crow. This constellation again shares a striking similarity with the form in which the Feather of Maat is portrayed with the five brightest stars in Corvus joined to form a pattern that replicates the unusual stylised Feather.



**Figure 34** Constellation of Corvus proposed to be identified as the Feather of Maat

(Current representation of Corvus are the five stars joined by a yellow line)

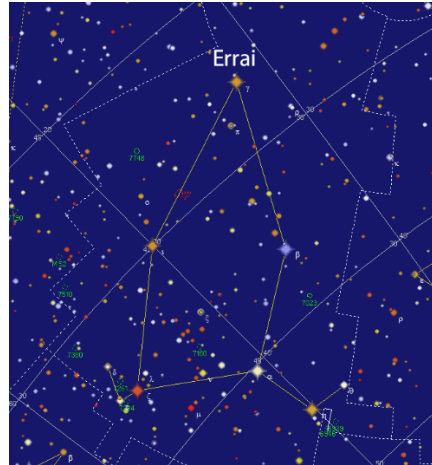
The main star identified with the Feather of Maat is Algorab but the star Gienah was also important in connecting all the stars of Orion with the Feather. Other stars in the constellation of Corvus have been joined by a white line to show how the constellation could have be represented to appear more like the elongated way in which the Feather of Maat was portrayed.

### The Shen Ring



**Figure 35**

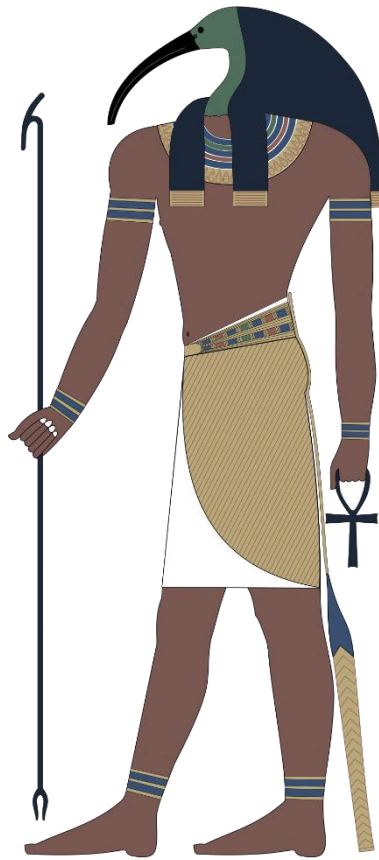
The Shen Ring appears in form as a tied loop of rope with its end protruding either side of the loop, it symbolises eternal protection. In an elongated loop form it was used as a cartouche to protect the person named on the cartouche. The constellation of Cepheus shares a close similarity of form with the Shen ring when its brightest stars are joined by imaginary lines. Errai is situated at the top of the loop and this star was used to represent the Shen Ring in its heavenly form.



**Figure 36** Constellation of Cepheus as the Shen Ring

The word Shen in Ancient Egyptian means “encircle” and the Shen Ring represented eternal protection. The Shen Ring is often seen being carried in the talons of the falcon god Horus and the Vulture god. It is considered by E. A. Wallis Budge and Wolfhard Westendorf (1904) and Sir Alan Gardiner in Egyptian Grammar (1927) that the Ankh, the symbol of eternal life was related to the Tyet or “Knot of Isis” which may have itself been related to the Shen Ring. The possible involvement of the Shen Ring in all three symbols would therefore imply that the constellation of Cepheus played an important role in the protection of the pharaoh’s life for eternity if the assertion that the Shen ring is associated with this constellation. There is further astronomical evidence that the Shen ring was indeed associated with the Tyet and also intimately associated with the Djed pillar in a joint role of supporting the celestial sphere, however the evidence is not included in this work as it requires an expanded examination of the astronomical knowledge of the Ancient Egyptians which is beyond the scope of this study.

Toth as Menkent in Centaur



**Figure 37** Constellation of Centaur, the shape of the constellation possibly interpreted as an Ibis by the Ancient Egyptians with the star Menkent as the eye of the Ibis.

## Part VIII

### Deep Space Objects in Ancient Egypt

It was evident during the examination of the alignment of stars on the festival days, indicated by the alignment of the Sun with pyramid peaks from each of the Valley Temples, that apart from bright stars being aligned due South, due East, due West and due North being aligned at Civil Twilight, galaxies and nebulae were in many instances also precisely aligned with the cardinal points on the same festival days. The deep space objects aligned on the festival days are described in the Table below. The question is whether these alignments occur by chance or whether the Ancient Egyptians or at least the architects of the Pyramid complex were able to view deep space objects some four thousand years before the documented invention of the telescope by Galileo in the 17<sup>th</sup> Century.

There is no obvious reference to or even clues for the existence of a telescope in any of the thousands of carved stones and painted friezes that survive from Ancient Egypt. The conclusion therefore must logically be that the alignment of particular deep space objects with cardinal points on the festival days was coincidental and that the telescope was not invented at this time. There is one proviso in that if a telescope was available to see deep space objects, it would be the preserve of only a very small select group of elite astronomers and architects and possibly the pharaoh himself. In this way it could be expected that the knowledge of such a device that allowed man to see beyond the stars would be kept secret and that the image of a telescope was never portrayed. However, the imagery and mythology of deep space objects that had been viewed by the elite group of druids and wise men might have been incorporated into the religious beliefs of the time and woven into popular imagery and stories that were shared with the populace.

Deep Space objects that had a particular appearance which may have been associated with Egyptian sacred imagery. NGC7743 the Fried Egg Nebula, NGC7293, the Helix Nebula and NGC7009, the Saturn Nebula, M27, the Dumbbell Nebula, M31, the Andromeda Galaxy, M33, the Triangulum galaxy

Day	Start of Civil Twilight				End of Civil Twilight				Above
	East	South	West	Other	East	South	West	North	
Jan 21	M27		M104		Pollux	Aldebaran			Capella
Mar 1	Stephan's Quintet				Regulus Algorab	Sirius			
Mar 28	M31	<b>M27 NGC7009</b>			Spica		Pleiades		
Apr 23	Pleiades	<b>NGC7293</b>		Deneb Above	M61	<b>Eight-Burst Nebula</b>			
June 1	M16	<b>NGC7742</b>				Menkent	M61		
July 9	Procyon NGC2266	Sheratan			M27		M104		
July 19	NGC2266	M77	Spica Gienah Stephan's Quintet		M27	Trifid Nebula			
August 26		Rigel	Capella			Altair			
October 2	M104	Canopus	Castor		Pleiades M31	<b>NGC7293</b>		Deneb	
October 26	M61		NGC2266	Regulus Above		<b>Stephan's Quintet</b>			
November 20	M16	Gienah <b>NGC3372</b>	Regulus NGC2264	Kochab M51 North	NGC2264	<b>NGC3372</b>	M16	M51 Cepheus	
December 27	Altair	Zubenescamali	Alphard		NGC2266				

**Table 24**

It is surprising that so many deep space objects are aligned with cardinal positions. There are 35 alignments of nebulae and galaxies on the festival days whilst there are only 28 stellar alignments. Furthermore only sixteen deep space objects account for the 35 alignments and seven of these are aligned on three or four occasions that seem to be more frequently aligned than if these alignments were coincidental though putting a figure on the statistical probability is difficult, especially because more deep space objects as a percentage of the total alignments are aligned East or West than the star alignments and these alignments are more likely to occur alignment of a nebula may occur coincidentally East for instance when a bright star is aligned due South at the start of Civil Twilight, the same deep space object is likely to align due West at the end of Civil Twilight when

There is one festival day, November 20<sup>th</sup>, that is particularly interesting with respect to the alignment of deep space objects in that i) there are so many alignments and ii) they are the same deep space objects aligned at both Star of Civil Twilight and End of Civil Twilight. The alignments are on the horizon due East, due South and due West and the deep space objects are particularly interesting because there is the possibility that the deep space objects have been represented as Egyptian symbols.



What is so special about the festival on November 20<sup>th</sup>? The only bright star that is aligned due South on that day at Civil Twilight is Gienah in Corvus associated with the Feather of Maat

## The Eye of Ra

### The All-seeing Eyes of Heaven

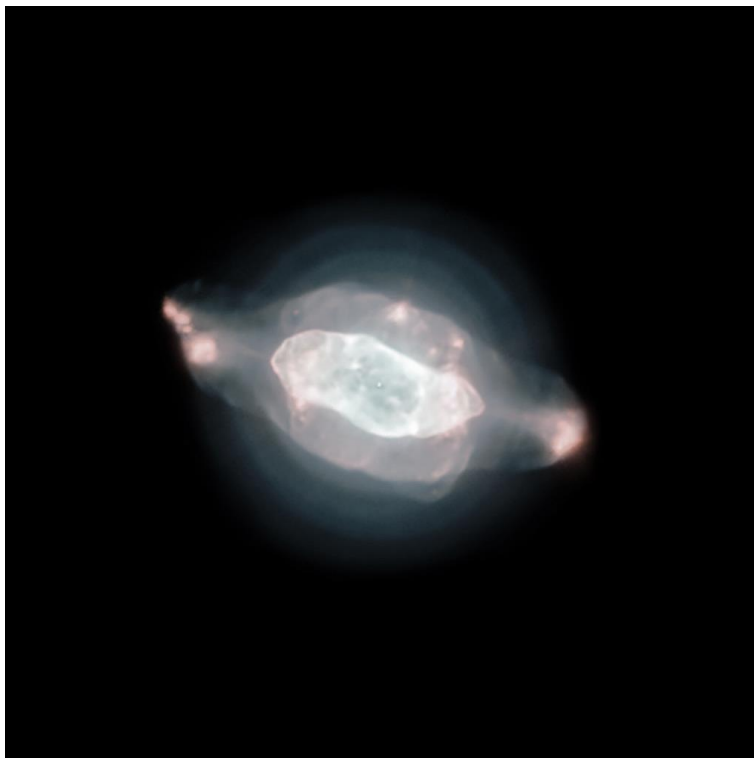
Imagine that when you look up at the night sky just as night has fallen and their due South in the sky you see an eye looking back at you, and then just before the Sun rises again you look up and there due South in the sky once again you see another eye looking back at you. It is understandable that such a “coincidence” would have been regarded as a heaven sent confirmation that the ancient gods of Egypt inhabited the night skies and found form in the stars and deep space objects around which the stories of their belief system could be woven to reflect the pattern of stars and their positions relative to each other. Of course, the problem is that if you look up at the night sky, stars that may be joined to form what looks like an eye can be seen, but the nebulae at the heart of these star patterns are not visible to the naked eye and require the use of a telescope.



**Figure 38** Eye of Horus portrayed above glass Scarab on Tutankhamun Necklace



**Figure 39** The Helix Nebula, NGC7293

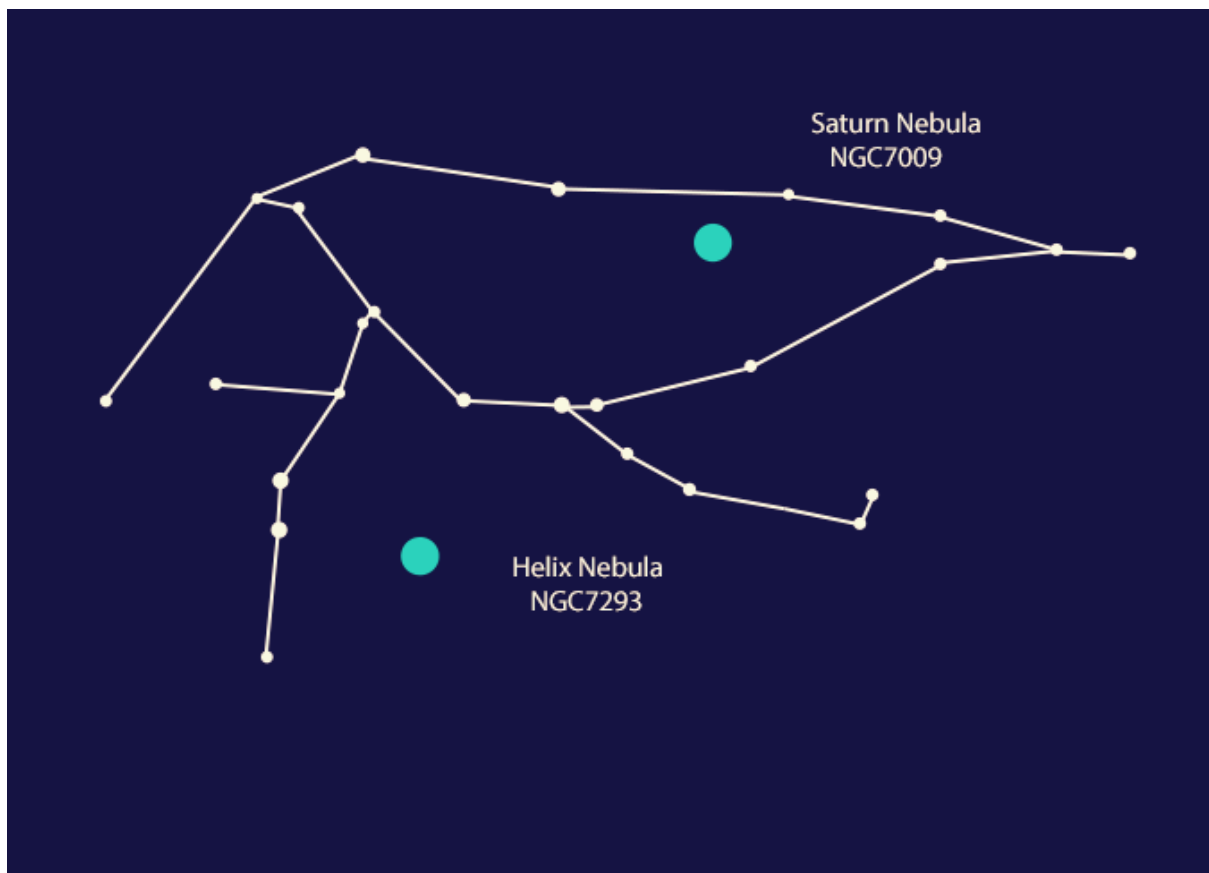


**Figure 40** The Saturn Nebula NGC7009

## Eye of Horus

According to mythology Horus lost his left eye in the fight with Seth. Later the Goddess Hathor restored his eye. This story is perhaps reflected in the movement of stars across the night sky and their alignment with the horizon and cardinal points. When Altair, the brightest star in the constellation of Aquila is aligned due South, the constellation of Capricorn and its brightest star Deneb Algedi, associated with Bastet, the cat-headed goddess also known as “the Eye of Ra” is aligned directly beneath Altair identified as the Falcon-headed god Horus. This alignment of constellations suggests that as Spica in Virgo is aligned due West the Helix Nebula in Aquarius is rising from the south-east horizon. The alignment of Altair and the Helix Nebula beneath it and the rising or renewal of the Helix Nebula coinciding with the alignment of Spica representing Hathor are both in-keeping with the mythology of the Eye of Horus being associated with Horus and being renewed by Hathor.

The mythology of the Eye of Horus as being the left eye of Horus might be reflected in the pattern of stars associated with Capricorn and Aquarius that sandwich the Helix Nebula.



**Figure 41** Possible Eye of Horus formed by joining the Stars of Capricorn and Aquarius

The *wedjat* eye is one of the most common icons associated with ancient Egypt. This is because the eye fulfilled a number of different roles in Egyptian mythology, thereby lending itself to many different amuletic uses. *Wedjat* eyes could be either left or right eyes, the left lunar eye being that of the powerful falcon-headed god, Horus, and the right solar eye being that of the sun god, Re. The “eye of completion” (the Horus eye) is lunar because, like the moon, it waxes and wanes. The lunar eye of Horus, as the eye of completion, is a healing and regenerative entity, thought to bring health and safety to its wearer. Likewise, the regenerative eye of Horus was thought to help the dead pass safely into the afterlife, and *wedjat* eye amulets were commonly placed within mummy wrappings to help the dead. In one myth, Horus presents his healed eye (repaired by the god of wisdom, Thoth) to his deceased father, the lord of the netherworld, Osiris, to help him pass safely into his afterlife.

The right *wedjat* eye, the solar eye of Re, was thought to be embodied by a vengeful but protective feline goddess. Like the Horus eye, the eye of Re was thought of as protective entity. Her ferocity warded away evil, protecting those who used the image apotropically.

The color green held associations with fertility and rebirth for the ancient Egyptians, especially in an Osirian context. *Wedjat* eyes were most commonly made in green and blue-green faience, like the objects seen here, JHUAM 3685 and 2031 D. Other colors could hold other meanings, like the solar significance suggested by the red color of 3671. The markings above the eye represent a typically Egyptian cosmetic line and those underneath the eye are thought to mirror those observed under the eyes of the lanner falcon, a form which Horus frequently assumed. Very specific proportions were ideally maintained by artists in rendering *wedjat* eyes, but these were not always upheld.

It may at first seem confusing that the Eye of Horus is associated with the Constellation of Capricorn and Bastet when Bastet was known as “the Eye of Ra”. The reason for this is that the Sun or Sun God Ra rose and set in the constellation of Capricorn during the winter months. Capricorn or the cat-headed goddess Bastet was considered as the Guardian god of the winter sun. The cat headed god might be considered as having an eye provided by the Helix Nebula, a left eye of Horus associated with the moon, whilst the Sun god Ra himself provided the right eye and hence the name associated with Bastet as the Eye of Ra relates to the association between the Sun and Capricorn during the winter months rather than the name of the close-by eye of Horus which remained a constant feature of the constellation.

On the festival of December 27<sup>th</sup> at the Start of Civil Twilight Altair is aligned due East whilst Alphard is aligned due West. These stars represent arch rivals Horus and Seth. Later as the Sun sets and goes below the horizon the Helix Nebula sits on the SW horizon with the Sun lying about 3.5 degrees below the horizon, Altair sets into the horizon less than nine minutes later minutes later into the SW horizon as the Sun is just over five

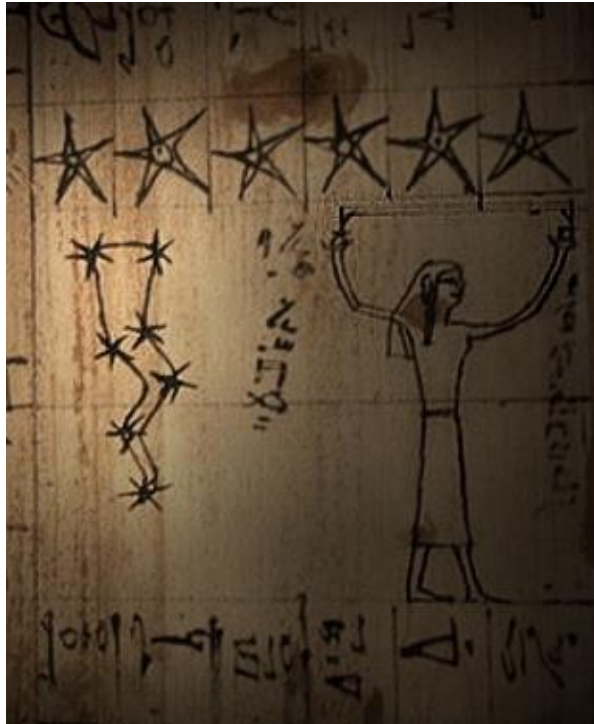
degrees below the horizon so that Altair is fleetingly visible on the horizon in the twilight as it sets and disappears.



**Figure 42** Thoth restoring the Eye of Horus, Dendera (Note that it is the left eye of Horus which was damaged by Seth, but the eye depicted appears in a mirror hence it appears as if it was a right eye)

When the Helix Nebula is due South in the sky at the Start of Civil Twilight on the 23<sup>rd</sup> April Festival day, the Pleiades are aligned due East. In the stories of the battle between Horus and Seth, Seth transformed himself into a bull, during the fight, the left eye of Horus was torn out. Thoth restored Horus's eye and then Horus chased after Seth who was still in the form of a bull and cut off his leg. The Pleiades might just therefore be a representation of the severed leg of the bull, though as Seth was usually associated with Alphard, in Hydra, it can be seen how the story has been twisted to make sense of the star alignments that actually occurred in the night sky on the particular festival day. These transformations that needed to be made seem confusing and unnecessary details until the night skies are examined and it can be seen how the stories may have been tweaked over the centuries and millennia to take account of the changing alignment of stars due to precession of the equinoxes and make sense of what people could see of their star gods in the night sky. The story of Horus and Seth, the transformation of Seth into a bull and the loss of his leg associates the Helix Nebula with the Eye of Horus through the alignment of the Pleiades due East and the Helix Nebula due South.





**Figure 43** Coffin lid where seven stars are depicted as a bull's leg.



**Figure 44** Image of the Pleiades in Taurus



**Figure 45** Detail from Hathor's Temple at Dendera Ceiling of Sirius depicted as a one-legged bull surrounded by seven stars, Seth (transformed as a bull) being attacked by Horus whilst the severed leg is tethered to the Hippopotamus God Taweret, symbolising the Celestial Pole to prevent the leg from drifting away from the Bull god, Apis.



## Eye of Ra

The eye of Ra is the feminine counterpart of the Sun god Ra and is often associated with the goddesses, Hathor, Sekhmet and Bastet. The reason for these association may lie in part from the fact that the stars and constellations associated with these goddesses lie on the same orbital path across the sky as the Sun. Because of this, there are certain times in the year when the Sun rises and sets within these constellations.



**Figure 46** Eye of Ra using stars of Vela and Carina

The Sun rises and sets with different constellations throughout the year. In particular, the Sun rises and sets with Capricorn in the winter. The Eye of Ra is an extension of Ra's power and is a violent force associated with female deities such as Sekhmet but the eye goddess also acts as mother sister, wife and daughter of the Sun God and defends Ra against the

agents of disorder that threaten Ra. In its more protective role the goddess Bastet is often associated with the eye and the ferocity of the leonine form of Sekhmet is replaced with the domestic cat form of the goddess Bastet. Sometimes the eye goddess is represented by the uraeus or cobra, a symbol of protection and royal authority.

The Eye of Ra is portrayed as a right eye whilst the Eye of Horus is the left eye (as they look down from the heavens to Earth)



**Figure 47** Eight-Burst Nebula, NGC 3132 in Vela

The Eye of Ra

Constellation	Period when Sun Rises and Sets With the Constellation	Associated Deity
Capricorn	December 12-31	Bastet Eye of Ra
Aquarius	January 1-23	Eye of Horus
Leo	July 9-31	Sekhmet
Virgo	August 19- September 7	Hathor

**Table 25**

## The Tyet and Djed pillars supporting the Heavens

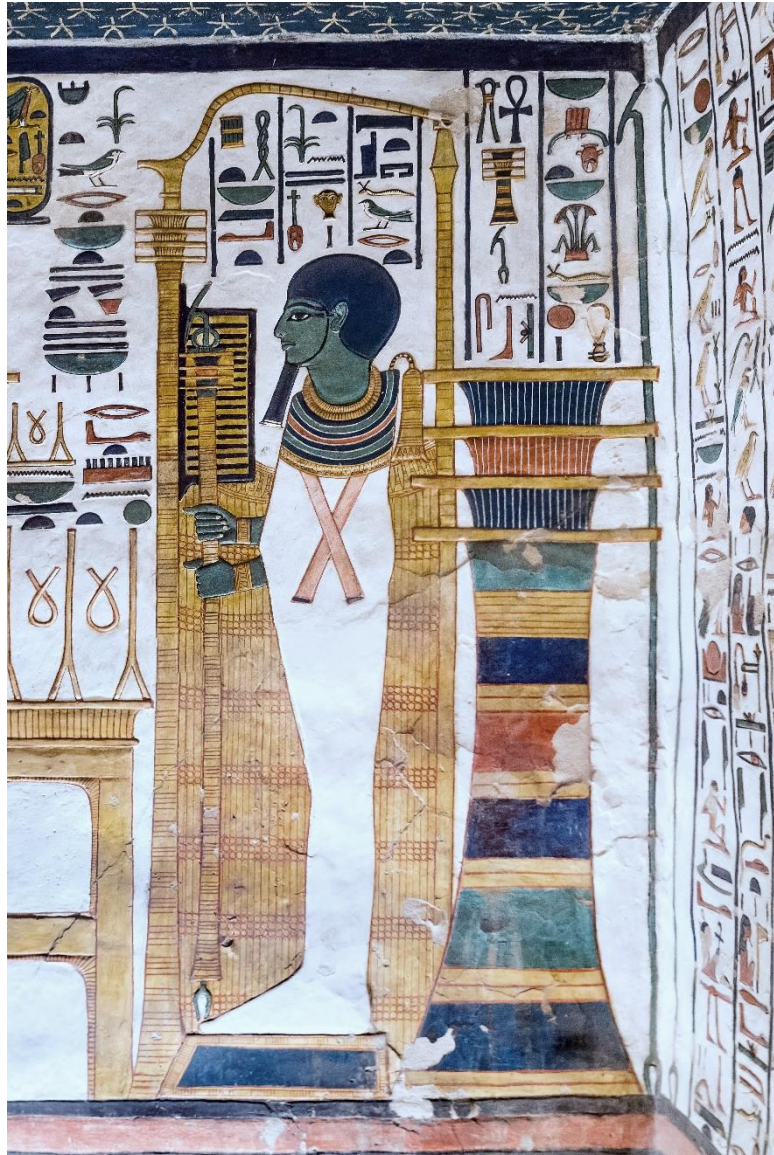
There are two symbols that are very frequently represented as painted, stone and wood carved images. Amulets of the Djed pillar and less frequently, the Tyet or Knot of Isis made in faience or carved in stone and worn around the neck are common artefacts. The Djed pillar is described as a cruciform symbol consisting of a pillar or column with four cross bars at the top half of the pillar. The origins of the Djed pillar are from the pre-dynastic period and one suggestion is that it represents a pole around which grain was tied. Over time, the Djed pillar came to represent the idea of stability and permanency and like the ankh, tyet and was sceptre frequently portrayed in decorative friezes.

The Djed pillar was originally associated with the god Sokar and Ptah, the latter being known as "the noble djed". But as Ptah was associated with Sokar and therefore also Osiris, the djed pillar eventually became the symbol of Osiris and in the Book of the Dead the Djed Pillar is said to represent Osiris's backbone.

R.T.Rundle Clark described the wall decorations at the Step Pyramid at Saqqara including the Djed Pillar that formed columns supporting the windows in the royal palace. He concluded that looking through the windows gave the appearance that the pillars were holding up the sky and he wrote "the purpose is clear.....the djed columns are world pillars holding up the sky and so guaranteeing the space of air and world in which the king's authority holds good."

The ancient Egyptians divided the sky into two parts in early times. Later, a division into four parts was made and the four corners of the heavens were protected by four gods. In the Pyramid Texts heaven is described as resting on the staffs of these four gods indicating that the division of the sky into four quarters occurred at a very early time.

In Wallis Budge's Egyptian Hieroglyphic dictionary, the symbol representing a papyrus stem has the meanings of "youthful", a "sceptre" and also a "pillar, support or column". Often the columns supporting temple roofs had the appearance of papyrus stems and whilst four columns can be viewed "head-on" as four horizontally separated columns, if viewed from the side, four aligned columns could be portrayed in a way that gave a similar appearance to the Djed pillar.



**Figure 48** Image of Ptah and the Djed Pillar. Ptah shares a resemblance with Osiris with the cross of Orion on his body.

The ancient Egyptians may have represented four columns aligned one behind the other, in the artistic style adopted in Ancient Egypt for many scenes where multiple similar forms were portrayed such as groups of people and horses or oxen as seen in the frieze from the Mortuary temple of Menna.





**Figure 49** Mortuary Chapel of Menna, Thebes, 18<sup>th</sup> Dynasty.



**Figure 50** Faience Djed Pillar

Continuing the theme of four aligned pillars the question is that if the four pillars represented the four columns supporting the four quarters of heaven, then how could pillars separated by ninety degrees possibly be represented in this aligned way. The alignment of four pillars could only occur for four pillars that were aligned along a common axis, such as the North-South axis or East-West axis for instance. If this was the case two questions arise, why would you need four columns, rather than two, to support two ends of the sky? and secondly, given that the heavens were considered to consist of four parts, how was the other axis of the heavens supported?

The first question relating to the portrayal of four columns supporting a single axis of the sky can be further explored.

Observing the spacing of the cross bars it was apparent that the spacing between the bars was not equidistant. Eleven examples of Djed pillar images were taken as a sample and the distance between the cross bars measured. The shortest distance was obtained on average for the distance between the first cross bar and the collar lying beneath it. The distances between the top of the first cross bar and the top of the second cross bar, the distance between the top of the second cross bar and the top of the third cross bar and the distance between the top of the third cross bar and the top of the final fourth cross bar were compared. The smallest distance for each of the four measured distances was taken as unity and the other distances compared with this shortest length to obtain an idea of the relative separation of each of the cross bars.

Average Relative Distance Collar to Top of First Cross Bar	Average Relative Distance from top of First Cross Bar to Top of the Second Cross Bar	Average Relative Distance from top of the Second Cross Bar to Top of the Third Cross Bar	Average Relative Distance from top of the Third Cross Bar to Top of the Fourth Cross Bar
100.8%	113.2%	114.7%	125.9%

Table 26

The space from the collar at the top of the column to the top of the first cross bar is generally the smallest whilst the distance between the first and second cross bar and the second and third cross bar are approximately the same. The biggest space occurs between the third and fourth cross bars. The pattern of the spacing of the cross bars on the Djed Pillars might reflect the lengths of the columns being represented and/or the distance between them for instance it may be that the four pillars are arranged as three closely spaced pillars separated from a further remote single pillar lying on the same axis.

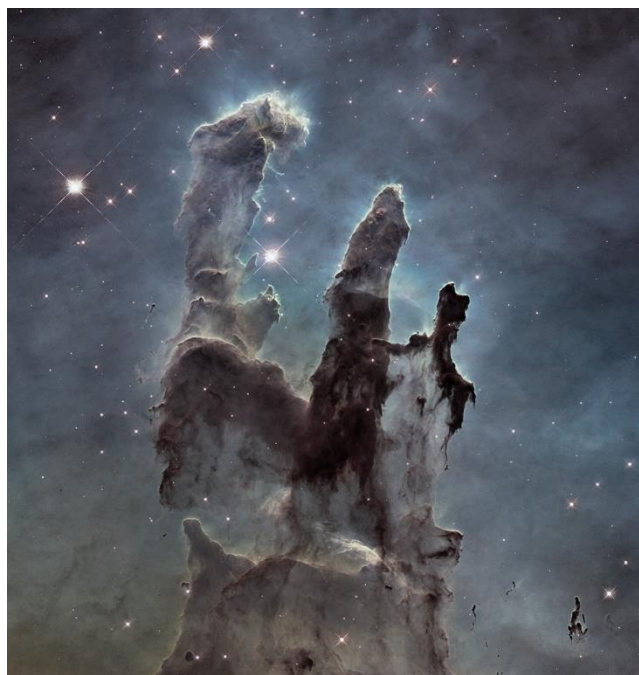
The question as to why three columns would support one side of the heavens and only one column on the other seems like a strange conclusion to have reached that leaves us at a dead end until the night sky of festival days are considered. One festival day indicated by the alignment of the Sun with the peak of the Khafre pyramid from the proposed position of the Khufu Valley Temple is the 20<sup>th</sup> November. On this day at the start of Civil Twilight two deep space objects are positioned on the East-West axis, M16, the Eagle Nebula is located on the eastern horizon and NGC2264, the Cone Nebula is located on the opposite western horizon. Amazingly the same two deep space objects are aligned

on the East-West axis at the End of Civil Twilight on the same festival day but now it is the Cone Nebula that is due East and the Eagle Nebula is due West. When the appearance of these two nebulae are examined it can be seen that the Cone Nebula appears as a conical shaped column, in-keeping with its appearance in Monoceros, the Unicorn.



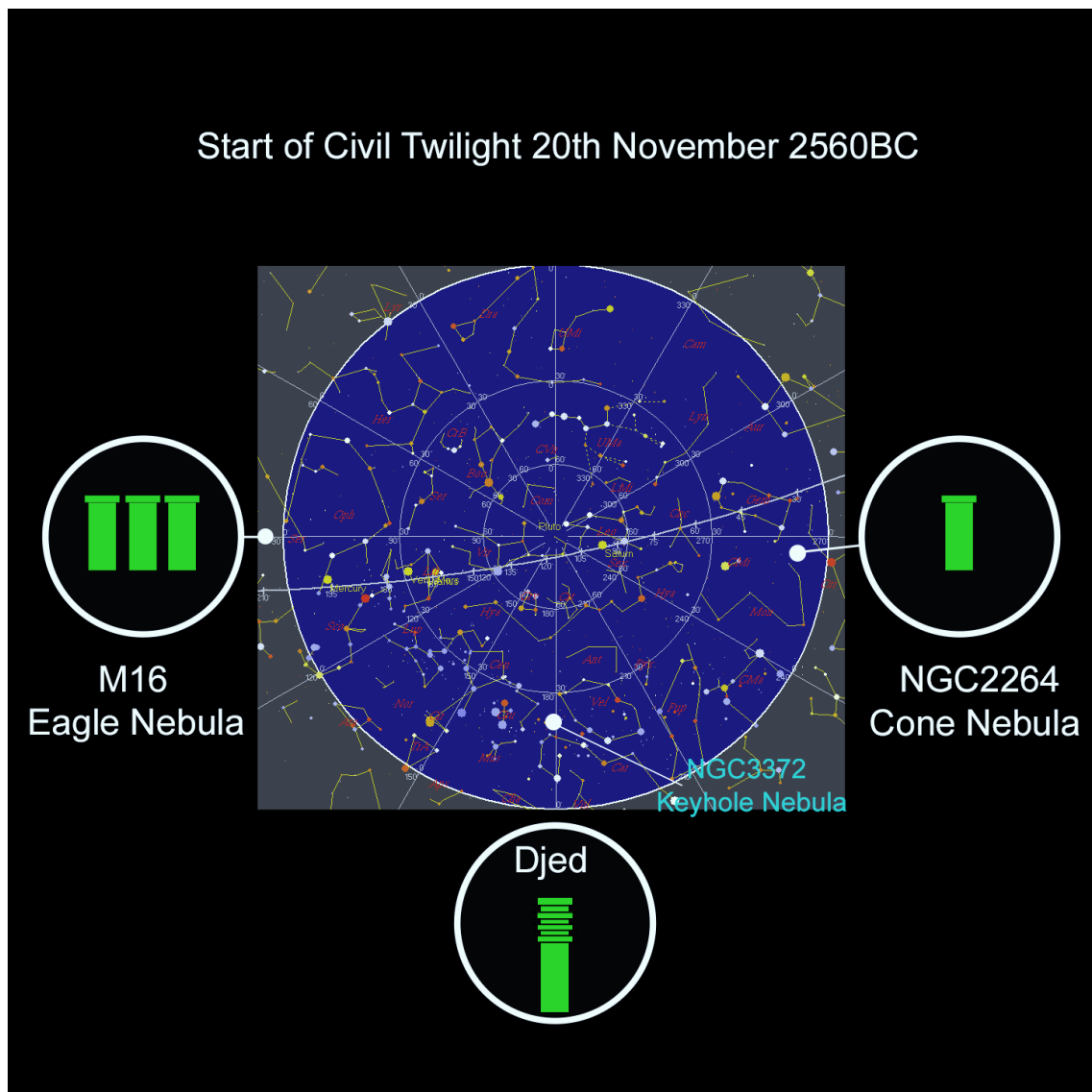
**Figure 51** NGC2264 The Cone Nebula in Monoceros

Meanwhile the Eagle Nebula contains the spectacular clouds described as the “Pillars of Creation”, consisting of three columns.



**Figure 52** M16 Eagle Nebula containing a feature known by astronomers as The Pillars of Creation

The combination of the two nebulae could be considered as fitting the requirements for the appearance of four pillars aligned along the East-West axis with three pillars provided by the Eagle nebula and one pillar by the Cone nebula.



**Diagram 34**

The second issue was that if the Djed pillar represented the supports along one axis of the sky what supported the other axis? As the pillars of the Eagle Nebula and Cone Nebula supported the East-West axis, it is the North-South axis of the sky that needs a comparable support.

It might be expected that the columns supporting the heavens on the North-South axis would be present at the same time as the M16 and NGC2264 nebulae, in other words on the same festival day of the 20<sup>th</sup> November. When the sky is observed at the start of Civil Twilight there is another nebula, NGC3372, the Keyhole Nebula in Carina that is aligned due South in the sky. At the End of Civil Twilight, the same nebula is aligned on the North-



South axis but it lies below the horizon. However, there is another object that aligns due North at the End of Civil Twilight, namely the constellation of Cepheus. Cepheus is also aligned due North as the start of Civil Twilight but lies just as NGC3372 lay beneath the horizon at the end of Civil Twilight. When the pattern of stars in Cepheus is examined and compared with known deities and sacred objects, the similarity of the pattern of stars in the constellation with that of the shape of the Shen Ring becomes apparent. Remembering the Djed Pillar represented the coming together of two nebulae on the East and West horizons to form Osiris's backbone or Djed Pillar, when the northern horizon Shen Ring and the southern Keyhole nebula are combined, something similar to the Tyet Pillar is formed otherwise known as the Girdle of Isis.



**Figure 53** NGC3372 Keyhole Nebula in Carina



Figure 54 Constellation of Cepheus



Figure 55 Shen Ring amulet

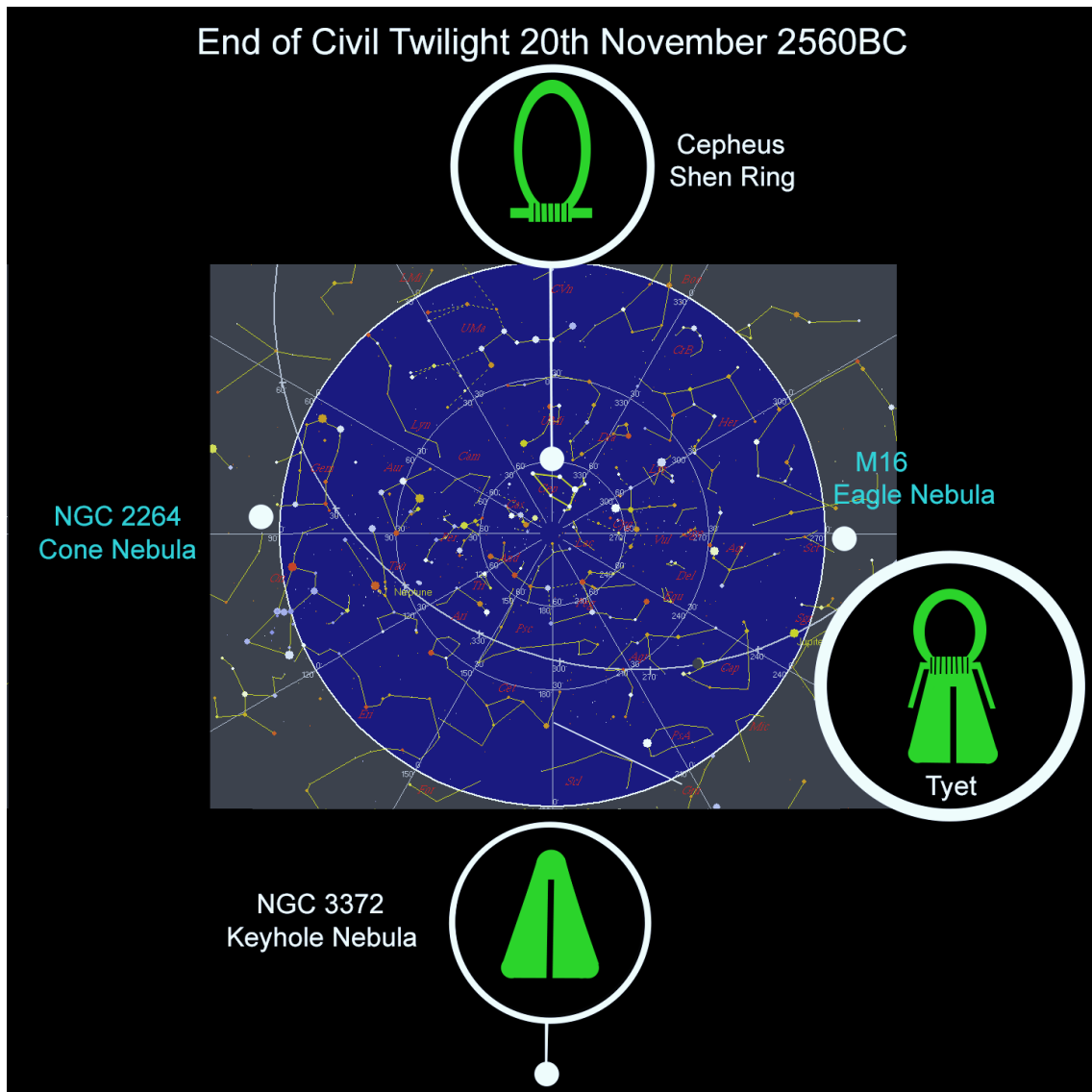


Diagram 35

Investigating the means of supporting the North-South axis of the firmament, due South in the sky, lying on the horizon beneath Bes is the Keyhole nebula NGC3372, whilst due North on the horizon sits the constellation of Cepheus. When the pattern of stars in Cepheus is examined and compared with known deities and sacred objects, the similarity of the pattern of stars in the constellation with that of the shape of the Shen Ring becomes apparent. Remembering the Djed Pillar represented the coming together of two nebulae on the East and West horizons to form Osiris's backbone or Djed Pillar, when the northern horizon Shen Ring and the southern Keyhole nebula are combined, something similar to the Tyet Pillar is formed otherwise known as the Girdle of Isis. This is interesting in that both symbols are depicted alongside Bes on a chair panel found in Tutankhamun's tomb. In this sky image Bes is central to the heavens and the North, South, East and West positioned supporting columns of the heavens and this might help to explain how the

importance of this small and strange god grew with time eventually even surpassing the popularity of the Osirian triad.



**Figure 56** Detail of Djed Pillars and Tyet Pillars from outer Tutankhamun Shrine



**Figure 57** Chair from tomb of Ramose and Hatnefer decorated with Djed and Tyet Pillars and Bes

It is interesting that the Djed and Tyet pillars are portrayed either side of the god Bes. This association is reflected by the night sky on the festival day of the 20<sup>th</sup> November when at the Start of Civil Twilight the constellation of Crater, representing the god Bes is situated due South, whilst the East -West axis of the sky is supported by M16, East and NGC2264, West and the North-South axis of the sky is supported by Cepheus, North and NGC3372, South.



## Alternative representation of the Tyet



**Figure 58** Tyet Pillar with Head of Hathor portrayed with cow's ears

Hathor was portrayed in two different ways, usually as a woman with a solar disc and horns on her head or as a pillar, a support for the firmament. When Hathor wore horns and a solar disc she had a normal human face, but as a pillar she was portrayed with a triangular face and cow-like ears. In the temple of Hathor at Dendera she is shown as six pillars of the firmament.



**Figure 59** Temple of Hathor, Dendera

The association of Hathor with a pillar of the Firmament and the Tyet Knot or Pillar suggests that the Tyet Knot was a pillar just as the Djed Pillar was a pillar. Perhaps both the Djed Pillar and the Tyet Pillar were regarded as columns supporting the heavens.

When the alignment of stars at Civil Twilight was examined on the festival days indicated by the alignment of the Sun with the peaks of the pyramids when viewed from the Valley temples, in most cases bright stars were seen to align precisely with the cardinal points, South, East and West. However, for some of the festival days indicated by the Sun-Pyramid alignments, the alignment of bright stars with cardinal points does not occur at either start or end of civil twilight. In these cases, it can be seen that there are deep space objects such as galaxies and nebulae that are precisely aligned due South, due East and due West at Civil twilight. The assumption, given that the telescope was not invented until the 17<sup>th</sup> century, by Galileo is that any such alignments are coincidental but perhaps that assumption needs to be questioned.

## Part IX

### The Wall of the Crow



**Figure 60** Wall of the Crow showing the Immense Stone Lintel above the passageway

The Wall of the Crow or Heit-el-ghurab is a 200metre long stone wall, 10 metres high and 10 metres wide at its base, constructed of massive stone blocks. It lies to the south-east of the pyramids and is a linear monumental structure that is aligned 6 degrees North of due East and 6 degrees South of due West. The wall is believed to have been constructed in the 4<sup>th</sup> Dynasty, around the same time as the pyramids and sphinx around 2575-2465BC. The wall contains a passage through its mid-section that is 2.5-2.6metre wide and 7m high and 10m wide forming a passage that is more like a short tunnel than a gate. The floor of the passage was paved and cambered but the most impressive feature of the wall is the huge stone lintel block that forms the ceiling of the passage, weighing some 300 tonnes. The wall appears to stand alone in the desert having no visible ancient structures associated with its terminals, though at its eastern end there is a large Islamic cemetery. The geo-archaeologist, Karl Butzer believes that the wall could have protected the small settlement that shares its name with the wall from flooding as the wall was built to the South of a stream bed or wadi that sometimes was subjected to heavy floods running off the high desert and could have deflected floodwaters away from the settlement.

There is some thought that the wall is more like a dyke or causeway and that it may have been unfinished due to the rough nature of stone blocks from which it was formed. It should be considered that the Wall was never meant to have neatly finished sides and that there was never any intention to build a temple or temples at its terminals because the essential feature of the wall was its top raised surface, a causeway that from its ends was long enough to appear to stretch to the horizon. But if this was the case what purpose would such a wall serve?

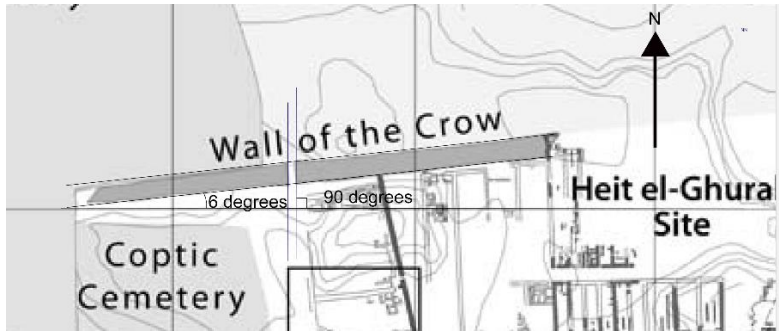


**Figure 61** People on the massive wall as the Sun sets have the appearance of crows

The name that has been given to the wall, is “Wall of the Crow” or Heit-el-Ghurab. We could speculate that the association with the Crow could result from the association of the crow as a messenger with the afterlife in Ancient Egyptian beliefs perhaps associated with the presence of both a Coptic cemetery and Islamic cemetery at the eastern end of the wall. Alternatively given the massive scale of the wall, people standing on the wall or promenading along its length would appear to be the relative size of crows and their silhouettes may have appeared from a distance like crows on a wall. Whilst Heit or حائط (hayit) means wall and الغراب (alghurab) means crow there are other Arabic words that share a passing resemblance to the word for “crow” namely غروب (ghrwb) which means “sunset” and الغرب (algharb) which means “the West” though phonetically these words are unlikely to have been confused, the similarity of sounds initiated the thought that the orientation of the wall and the alignment with the setting Sun may have had some significance. Perhaps the wall standing in isolation was actually a causeway that people may have walked down even though there was nothing to walk to over its 200m length. The fact that the wall is oriented approximately East-West suggests that perhaps the alignment of the causeway with the Sun on the horizon was important to its function.

The wall has a bearing of 84 degrees from North or six degrees displaced from the East-West axis. There are two days in the year when the Sun rises on the horizon at this bearing, and two days when the Sun sets at a bearing of 264 degrees, either side of the equinoxes, where the Sun aligns with the wall or causeway at its eastern and western ends respectively. The days indicated for these alignments were the 2<sup>nd</sup> October and April 24<sup>th</sup> at sunrise and the 26<sup>th</sup> October and 27<sup>th</sup> March at Sunset. On further examination, at the start of Civil Twilight on the 2<sup>nd</sup> October, Canopus representing the Solar Boat is due South perhaps carrying the Eye of Ra (NGC3132, the Eight-Burst Nebula), whilst Spica representing Hathor is due East and Castor representing Tefnut/Shu is due West. At the End of Civil Twilight the Pleiades are due East, the Helix nebula proposed as representing the Eye of Horus is due South, Deneb representing Nephthys is almost directly above and the Cat's Eye Nebula (NGC6543) is aligned due North.

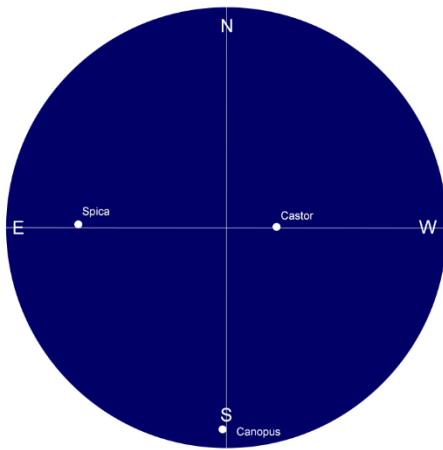




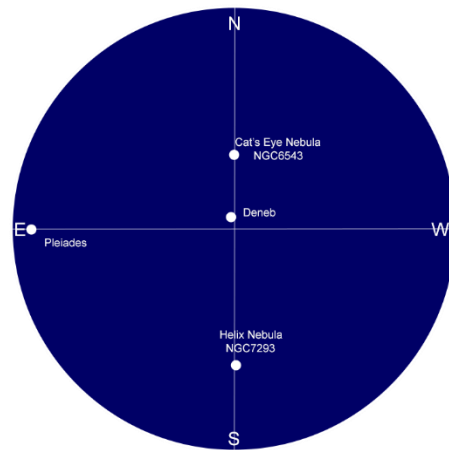
**Diagram 36** Plan of the Wall of the Crow showing the bearings of the wall and the gate.

The bearing of the wall is 84 degrees +/- 1 degree to take account of the width of the wall (10m) from a central viewing position at the western terminal.

2<sup>nd</sup> October 2560BC

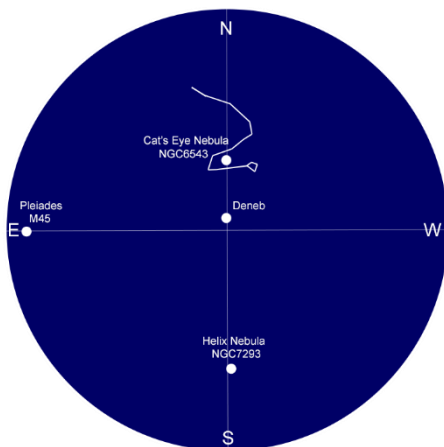


Start of Civil Twilight



End of Civil Twilight

24<sup>th</sup> April 2560BC



Start of Civil Twilight

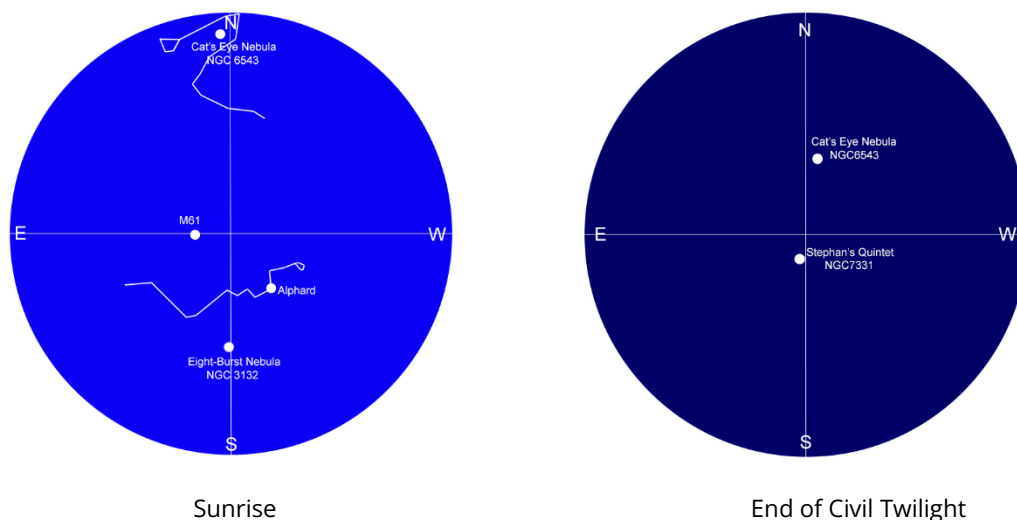


Sunset

**Diagram 37** The positions of the Snake constellation Draco (North) and Serpent Constellation Hydra (South) are indicated

On the 24th April, the other day when the rising Sun aligns with the eastern end of the wall, at the Start of Civil Twilight the Helix Nebula is aligned due South and the Pleiades are aligned due East whilst Deneb and the Cat's Eye Nebula are aligned due North in the night sky mirroring the pattern of the night sky at the End of Civil Twilight on the 2<sup>nd</sup> October. The constellation of Draco, the Snake associated with NGC6543 has been included to show the possible relationship between an Egyptian Snake deity, Apophis or Apep and the Eye of Apophis, known as the "Evil Eye" with the constellation Draco and the nebula described as the Cat's Eye Nebula. At sunset on the 24<sup>th</sup> April, the Eight-Burst Nebula, representing the Eye of Ra is aligned due South. Alphard and the constellation of Hydra, the Serpent is situated between NGC6543 and NGC3132, perhaps reflecting the story of Apophis trying to steal the Eye of Ra and Seth being the god that protected the Eye of Ra because he was the only deity unaffected by the stare of the Evil Eye of Apophis. Perhaps this ability is further evidence that Seth was or could transform himself into a snake and that as a massive serpent stretching across the sky was the ideal protector god of the Eye of Ra from Apophis.

26<sup>th</sup> October 2560BC

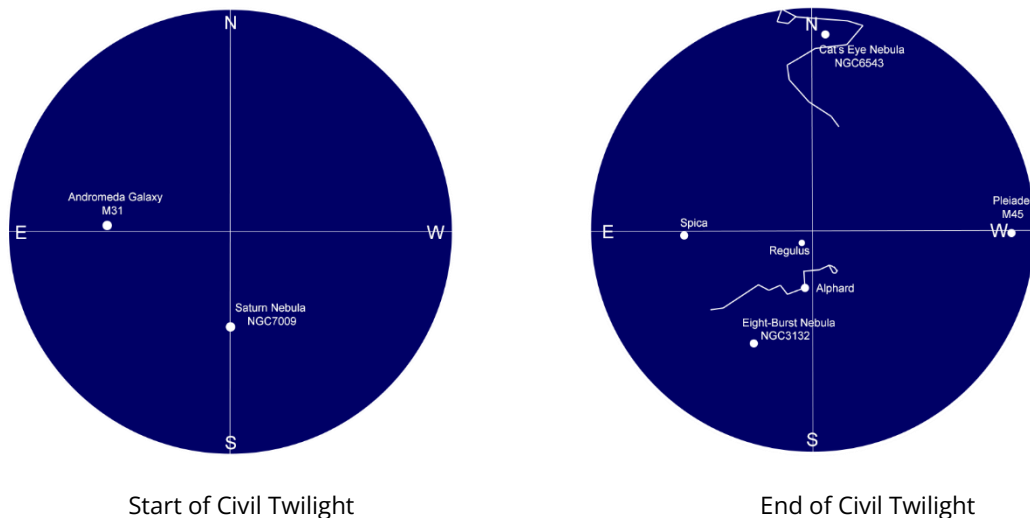


**Diagram 38**

On the 26<sup>th</sup> October and the 27<sup>th</sup> March, the setting Sun sits on the horizon aligned with the western end of the wall when viewed from the eastern end of the Wall of the Crow. At sunrise, the Cat's Eye Nebula is aligned almost due North whilst the Eight-Burst Nebula is aligned due South. At the End of Civil Twilight on the same day, the Cat's Eye Nebula, or "Evil Eye" is again aligned almost due North and Stephan's Quintet is aligned due South. It is interesting that whenever Hydra is present due South in the sky, Draco is facing away and appears to be retreating northwards. At other times when the Eye of Horus is aligned due South for instance, Draco is closer and facing towards NGC 7293 though this is due to the fact that the constellation is circumpolar, (apart from the star Eltanin at the head of Draco that does skim and sink below the northern horizon for a short period) and

appears to rotate about the star Thuban or Alpha Draconis close to the end of the snake constellation tail.

27<sup>th</sup> March 2560BC



**Diagram 39**

On the 27<sup>th</sup> March when again the setting Sun aligns with the wall, at the start of civil twilight on the following day, the Saturn Nebula is aligned due South. NGC7009, the Saturn Nebula sits directly above the constellation of Capricorn which was identified by the Ancient Egyptians as the cat-headed goddess Bastet. At the end of Civil twilight Spica identified as Hathor is aligned due East and the Pleiades are due West whilst Alphard representing Seth is aligned close to due South in the sky.

It is apparent that the days when the Sun aligns with the Wall of the Crow at Sunrise and at Sunset are the same days within a day when stars align with peaks of the pyramids when viewed from the valley temples. For instance, the alignment of the Sun with the “peak” of Khufu viewed from the Khufu Valley Temple, which occurs on March 28<sup>th</sup> and October 26<sup>th</sup>, is matched by the alignment of the Sun at sunset with the Wall of the Crow when viewed from the East end of the wall along its length which occurs on March 27<sup>th</sup> and October 26<sup>th</sup>. Similarly, the alignment of the Sun with the peak of Menkaure when viewed from the Menkaure Valley Temple occurring on March 28<sup>th</sup> and April 23<sup>rd</sup> is mirrored by the alignment of the Sun at sunrise with the Wall of the Crow when viewed from the West end of the wall along its length on March 27<sup>th</sup> and April 24<sup>th</sup>. This mirroring of possible festival dates either side of the equinoxes by pyramid peak alignments with stars and the alignments of the Sun on the horizon with the Wall of the Crow, is supportive evidence that these festival days were real and important days and less likely that these alignments occurred through chance.

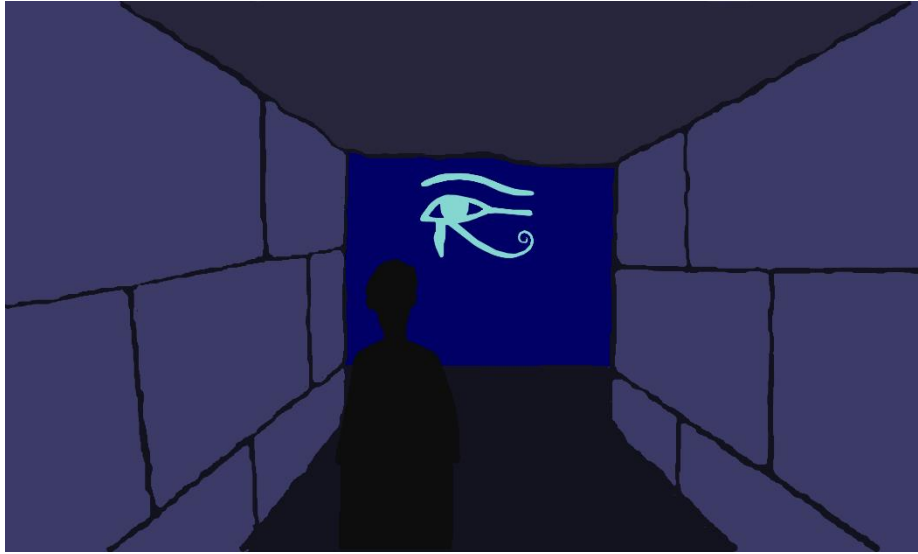
The most interesting feature of the alignments is that the Wall of the Crow aligns with the rising and setting Sun on days when three deep space objects, nebulae which have each

have the awe-inspiring appearance of eyes, are aligned more or less due South and due North at Civil Twilight. The alignment of Spica twice, representing Hathor and the alignment of Pleiades, three times, on these days with cardinal points would have been important as, unlike the nebulae, they are easily visible and therefore good markers for the alignments of the nebulae. The alignment of Alphard, representing Seth in the constellation of Hydra, the Serpent, due South, may have been the inspiration for the mythology relating to the part that Seth played in protecting the Solar Barque and the Eye of Ra from Apophis the god of chaos as it journeyed through the Underworld when Apophis attempted to steal the Eye of Ra.

It is also interesting to consider the gate or passageway that passes through the wall that has such an immense lintel, weighing over 300 tonnes, it is by far the largest lintel stone on the Giza Plateau. Why was this gateway made into such an immense feature? It appears from the plans of Lehner that the tunnel or gate that passes under the causeway does so, not quite perpendicularly to the wall but, perpendicular to the East-West axis. It might be considered that standing at the eastern end of the causeway and seeing the Sun set at its far end, to the West, a person would then make his way along the causeway bathed in the last rays of the setting Sun, he could then climb down from the causeway and make his way to the passageway in the mid-section of the wall. Standing at the northern end of the passage through the wall, as the first bright stars appeared at twilight, looking South at that moment down the passageway, he would know that on the 24<sup>th</sup> April, the Eye of Ra would be looking back at him, framed by the southern passage gateway. It is interesting to consider that the alignments of deep space objects may have resulted in certain conventions being followed on festival days when the Eye of Ra could be viewed through the Wall of the Crow passage. A person entering the passage may only have done so from the North side of the wall and always looked South down the passageway, averting his eyes from the view to the North as if he ever turned round and looked northwards the viewer would be facing the Evil Eye of Apophis (NGC6543) and might suffer the consequences of that meeting of eyes.

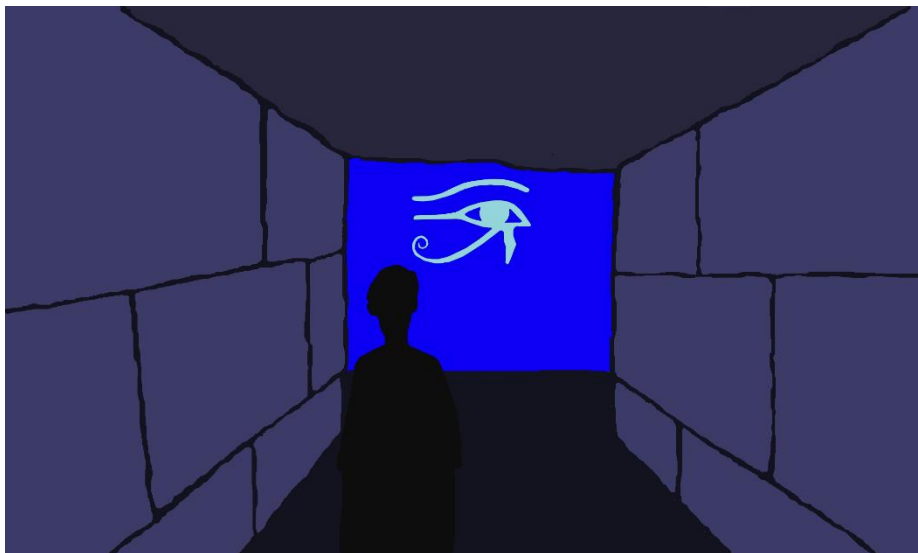
At dawn the next day he could similarly again make his way to the passageway through the Wall of the Crow and now just before sunrise as the stars began to disappear another eye, the Eye of Horus would be looking back from the South down the tunnel. Once again, he might be careful not to look northwards because again sitting low in the sky is the Cat's Eye Nebula or the proposed Eye of Apophis perhaps. The passage through the wall thus provided a special connection between a person standing in the passageway and the Eye of Ra and the Eye of Horus for anyone who knew of the alignments. Of course, it would be impossible to see these nebulae with the naked eye, but the patterns of stars in the constellations surrounding the nebulae may have formed the recognisable patterns of the Eyes of Horus and Ra as depicted by the Ancient Egyptians. Whether a ceremony was involved on these days of alignment is unknown and if so, whether it involved a small

number of priests or a larger number of people that filed through the gateway at the appropriate time can only be imagined.



**Figure 62** The Eye of Horus aligned with the Gate through the Wall of the Crow April 24<sup>th</sup> Start of Civil Twilight and 2<sup>nd</sup> October at the End of Civil Twilight

The alignment of the Eye of Ra with the passageway also occurred at sunrise on 26<sup>th</sup> October, a day when the Sun aligned with the Wall of the Crow at sunset. The Eye of Horus aligned with the passageway on the 2<sup>nd</sup> October at the End of Civil Twilight, when the Sun on the horizon at sunrise aligned with the East end of the Wall of the Crow.



**Figure 63** The Eye of Ra aligned with the Gate through the Wall of the Crow April 24<sup>th</sup> at Sunset and 26<sup>th</sup> October at Sunrise

## Conclusions

The pyramids were designed using a measuring system based on pendulum lengths. The series of pendulum lengths used were those that had been previously developed and used in Northern Europe in Neolithic times to measure out the Stone Circles in Scotland some five hundred years before the building of the pyramids of Giza. The pendulum lengths developed and used in the North were slightly shortened to give the same period of swing in Cairo, due to the lower gravitational force at the lower latitude due to the oblate shape of the Earth. Whole hundreds of these pendulum lengths were used to describe the base dimensions and heights of the three Pyramids of Giza. The base dimensions of the pyramids can be described as 500x46.25cm for Khufu, 600x35.9cm for Khafre and 400x26.18cm for Menkaure. The heights of the three pyramids can be described as 300x46.25cm for Khufu, 400x35.91cm for Khafre and 250x26.18cm for Menkaure. It should also be considered that the Pyramids didn't merely sit on the ground and extend upwards into the sky but equally importantly were considered to extend down into the Earth forming octahedrons, that is two back to back pyramids with a square base at ground level. In this way the height of Menkaure can also be expressed as a whole-hundred of the measurement units used to define its base (500x26.18cm).

The pyramids have popularly been associated with the stars of the constellation Orion. In particular the three pyramids of Giza have been recognised as sharing a similar pattern, as viewed from above, to the three stars of Orion's Belt. This association has been described as the Orion Correlation Theory by Bauval. There are however at least two other star triplets in Orion that could be considered to give a much closer match to the Pyramids. Whereas the association between the stars of Orion Belt and the pyramids occurs by mapping the stars in the night sky directly down onto the pyramids by a translation operation, the alternative closer matching star triplets occur by mapping the pyramid peaks onto the stars of Orion as they are imagined to pass below the pyramids having set in the West as they travel through the underworld beneath the pyramids to the eastern horizon to rise again. This mapping of the pyramids onto the stars "below" involves a rotation operation. The star triplets involved are Bellatrix, Alnitak and Saiph and also Betelgeuse, Alnilam and Rigel which coincide with the peaks of Khufu, Khafre and Menkaure respectively. A third triplet of stars in Orion, Saiph, Mintaka and Bellatrix gives a less close match using a translation mapping of the stars onto the pyramids, a closeness of match that is similar to the mapping of the stars of Orion's Belt onto the pyramids.

There is a further, more tangible connection between the stars of Orion and the Pyramids where three stars in Orion can be seen to rise in turn from each of the three peaks of the Giza pyramids viewed from a position West of the Pyramids. Later in the day three stars in Orion can be seen to set into the peaks of the three pyramids viewed from a position

East of the Pyramids. The three stars, Bellatrix, Alnitak and Rigel appear to rise from the peaks of Khufu, Khafre and Menkaure respectively when viewed from a position 3.1km West and 545m North of the NW corner of Khufu. In the evening as Orion starts to set, Betelgeuse, Alnilam and Rigel appear to set into Khufu, Khafre and Menkaure, via their peaks from a position about 1036m East and 122.5m North of the NE corner of Khufu corresponding to the approximate position of the Khufu Valley Temple now buried beneath the conurbation of Nazlet es Samman on the outskirts of Cairo.

The Khufu Valley Temple together with the two other pyramid valley temples of Khafre and Menkaure, the Sphinx Temple and the Khentkawes Pedestal provide five convenient viewing positions from which to observe the setting of stars into the three main pyramids of Giza together with two other smaller pyramids, the satellite pyramid of Khafre and the subsidiary GIIIa pyramid besides Menkaure. Bright stars associated with Egyptian gods are seen to set into the peaks of the various pyramids, thereby connecting the stellar deities with the pyramids. Betelgeuse and Beta Comae Berenices set into Khufu when viewed from the Khufu Valley Temple and the Sphinx temple respectively. Alnilam, Spica, the Saturn Nebula and Deneb set into Khafre when viewed from the Khufu Valley Temple, the Sphinx Temple, the Khafre Valley Temple and the Khentkawes pedestal respectively. Rigel, Menkent, Bellatrix, Procyon and Aldebaran set into Menkaure when viewed from the Khufu Valley Temple, the Sphinx Temple, the Khafre Valley Temple, the Menkaure Valley Temple and the Khentkawes pedestal. Hamal, the Pleiades and Regulus set into the satellite pyramid when viewed from the Sphinx Temple, Khafre Valley Temple and Menkaure Valley Temple. Finally, Gamma Sagittae sets into GIIIa when viewed from the Menkaure Valley Temple. These setting stars are likely to have been identified with the Gods of Ancient Egypt. The stars of Orion are associated with Osiris, Spica in Virgo with Hathor, the Saturn Nebula and Capricorn with Bastet, Deneb with Nephthys, Menkent with Thoth, Procyon with Anubis, Aldebaran with Apis, Hamal with Atum/Khnum, the Pleiades with the cut-off leg of the bull (when Seth transformed himself as a bull for a fight with Horus who then cut off his leg), Regulus with Sekhmet and Gamma Sagittae with the forked tongue of Wadjet.

The pyramids and valley temples were also designed to function as a calendar for the Ancient Egyptian Year that worked in a similar way to the Neolithic stone circles of Scotland, where instead of alignments between the Sun on the horizon and the Megaliths, the festival days in Egypt around 2560BC were indicated by the alignment of the Sun with the peaks of the pyramids. The festival days are indicated by the alignment of the Sun with the peaks of the three pyramids and the Satellite pyramid when viewed from each of the three Valley Temples. The days when the Sun aligns with the pyramid peaks form a Wheel of the Year calendar where the twelve spokes of the wheel represent the festival days. The spokes form a symmetrical and fairly evenly spaced pattern of twelve festival days consistent with the pattern expected of a calendar. When the pattern of stars is

examined on those festival days indicated by the solar-alignments with the pyramid peaks, it is significant that important bright stars are precisely aligned with cardinal points at Civil Twilight at dawn and dusk when the Sun is six degrees below the horizon. Again, these bright stars are believed to have been identified as the gods of Ancient Egypt and the days when they were aligned due South, East or West may have been days when these gods were celebrated by the people. The twelve festival days indicated by the alignment of the Sun with the pyramid peaks are January 21<sup>st</sup> when Aldebaran, identified with the god Apis was due South at the End of Civil Twilight, March 1<sup>st</sup> when Sirius identified as the goddess Isis was aligned due South at the End of Civil Twilight, March 28<sup>th</sup> when Spica, identified as the goddess Hathor was aligned due East at the End of Civil Twilight. April 23<sup>rd</sup> when Deneb identified as the goddess Nephthys was aligned directly overhead at the End of Civil Twilight. June 1<sup>st</sup> when Menkent identified with the god Thoth was aligned due South at the End of Civil Twilight. Then on July 9<sup>th</sup> Sheratan representing Atum/Khnum was aligned due South at the Start of Civil Twilight. On July 19<sup>th</sup>, Spica identified as the goddess Hathor was aligned due West at the End of Civil Twilight. August 26<sup>th</sup> celebrated Osiris and Horus as Rigel in Orion, identified with Osiris and Altair in Aquila, identified with Horus, were both aligned due South at the Start of Civil Twilight. On October 2<sup>nd</sup>, Canopus identified as the Solar Barque was aligned due South at the Start of Civil Twilight. On October 26<sup>th</sup> Regulus identified as the lioness headed goddess Sekhmet is aligned directly overhead at the start of Civil Twilight. On November 20<sup>th</sup> Gienah identified as the goddess Maat was aligned due South at the Start of Civil Twilight and finally on December 27<sup>th</sup> Alphard representing the god Seth and Altair representing the god Horus were aligned due West and due East at the Start of Civil Twilight whilst Zubeneschamali in Libra representing the Scales of Judgement were aligned due South.

Apart from the Pyramid peaks aligning with the Sun and stars, alignments of certain bright stars could be made as they aligned with the Cobra or Uraeus on the forehead of the Sphinx from the courtyard within the Sphinx Temple. Four statues and two corner pillars marking the eastern edge of the open courtyard were viewing points where alignments could be made with six bright stars as they aligned with the head of the cobra before they set into the head of the Sphinx. The stars that align with the uraeus on the Sphinx's head from positions within the Sphinx Temple are Castor, Regulus, Alpha Sagittae, Spica, Altair and Procyon viewed from the south-east corner, and then travelling North along the eastern edge of the courtyard from viewing positions directly in front of each of the four statues and then the sixth viewing position in the north-west corner of the courtyard respectively. These stars are identified as representing the gods Tefnut/Shu, Sekhmet, Wadjet, Hathor, Horus and Anubis.

The Sphinx appears as a statue with the body of a lion and the head of a pharaoh in the recumbent position with front paws stretched out in front. The adopted position and the leonine form of the Sphinx show a remarkable similarity to the pattern of stars in the



constellation of Leo. The brightest star in Leo is Regulus that has been identified as the goddess Sekhmet, the daughter of the Sun god Ra. The connection between Regulus in Leo and the Sun is that the two rise and set almost touching each other at sunrise and sunset on the day of the summer solstice and at the winter solstice where again they rise and set at the same time but on this day Regulus and the Sun are diametrically opposite each other on the horizon, the Sun rising in the South-east and Regulus setting in the north-west whilst at sunset, when the Sun is on south-west horizon Regulus is rising on the north-east horizon. The other relationship of Regulus with the solar festivals occurs at the equinoxes when the Sun is rising from the eastern horizon at the autumn equinox and setting into the western horizon at the spring equinox, the constellation of Leo is located directly overhead as if protecting everyone below. The other consideration is that the Giza plateau is shared by the Pyramids of Khufu, Khafre and Menkaure and the Sphinx. If the pyramids represent Osiris and the constellation of Orion, and the Sphinx represents a leonine deity the question is what relationship is there between the Sphinx and Orion? The Sphinx faces the eastern horizon with Khafre behind it to the West. The connection between the Sphinx/Leo and the constellation of Orion can be seen again at the Equinoxes. Firstly, at the Spring Equinox at sunrise, the Sun sits on the horizon due East. The Sphinx faces the Sun on the horizon and below the horizon at this time Alnitak in Orion's belt is also aligned due East. Above the horizon the Pleiades are also aligned due East but are not visible until twilight. At sunset on the day of the autumn equinox, again the Sphinx is precisely aligned with the stars of Orion's belt that are again aligned due East but below the horizon before they rise. The Sun sits due West on the horizon and the celestial version of the Sphinx is aligned due West facing the setting Sun. The equinoxes therefore have a situation where there are two leonine deities, the Sphinx and the constellation of Leo facing back to back aligned along the East-West axis. The Sphinx facing the Eastern horizon and Leo facing the western horizon. The Sphinx connects with Orion as it rises from the eastern horizon at the equinoxes. The Sphinx aligns with both the rising Sun at the spring equinox and the stars of Orion's Belt that are aligned due East but just below the horizon at sunrise. At the same time Regulus is aligned due West as Leo faces the western horizon. At sunset on the day of the autumn equinox Orion's Belt is again aligned due East below the horizon with the Sphinx facing it but now Regulus aligned due West and Leo is facing the Sun as it sits on the horizon aligned due West. The Sphinx is associated with the western horizon through its celestial counterpart, the constellation of Leo which every night between May and November aligns with the constellation of Orion when Regulus is aligned due West, Betelgeuse and Bellatrix are also aligned due West but lie just below the horizon.

The fact that the Sphinx aligns with the stars of Orion as they are rising from the Eastern horizon at the equinoxes and that the constellation of Leo aligns with stars in Orion after they have set beneath the western horizon means that the East facing Sphinx and West facing Constellation of Leo have the appearance of the god Aker that consisted of back-

to-back lions or later as back to back sphinxes and was considered in Ancient Egypt as the god of the horizon. On the back of the lions is the symbol of Akhet where the solar disc is supported between the East and West summits of the mountain Djew representing the Sun on the horizon at sunrise and sunset. The Sphinx may therefore be considered as representing both Sekhmet through the bright star Regulus and by association the constellation of Leo, but also the God Aker when the Sphinx is combined with the constellation of Leo when it is aligned facing due West.

The measurement lengths used to describe the base and height dimensions of the pyramids consist of three pendulum lengths. These lengths used as pendulums connect important star pairs identified as Egyptian deities through whole multiple number of swings that are intimately related to the particular lengths of each pendulum length. These lengths embedded within the dimensions of the pyramids when applied to the angular distances separating the stars of Orion, from other bright stars provide a temporal link between Osiris and other Egyptian deities when the number of swings of the pyramid pendulums describing the angular separation between the star pairs can be described as a whole thousand number of swings.

The pendulum length used in the design and construction of Khufu was 46.25cm long and had a period of 10000 swings per 29 Megalithic Degrees. The pyramid Khufu was associated with both Betelgeuse and Bellatrix in Orion in terms of mapping stars onto pyramids or vice versa and the setting of stars into the pyramids and these stars are separated by multiples of 10000 swings from other bright stars associated with Egyptian deities using a 46.25cm pendulum. The stars connected to Betelgeuse are Hamal representing Atum/Khnum 20000 swings and Regulus representing Sekhmet again 20000 swings whilst Bellatrix is connected to Isis representing Sirius through 10000 swings. The brightest star in Orion, Rigel is connected to Deneb representing Nephthys through 40000 swings of the 46.25cm pendulum and connected to Maat through 80000 swings of the pendulum.

The pendulum length embedded in the design of the Khafre pyramid is the 35.91cm pendulum that has a period resulting in 9000 swings per 23Megalithic Degrees. The stars associated with Khafre from the various mappings and the stars that rise from and set into Khafre are the stars of Orion's belt, Alnitak, Alnilam and Mintaka. These stars form star pairs separated by multiples of 9000 swings with stars identified with important Egyptian deities and objects associated with the resurrection of the Pharaoh. Alnitak is associated with Spica representing Hathor though 45000 swings of the 35.91cm pendulum. Alnilam is associated with Zubenelgenubi representing the Scales of Judgement through 54000 swings of the pendulum and Mintaka is associated with Canopus identified as the Solar Boat also through 54000 swings of the Khafre pendulum. Three other stars in Orion, Rigel, Saiph and Betelgeuse are associated with Errai,

identified with the Shen Ring through 117000 swings, Deneb Algedi identified with Bastet through 54000 swings and Betelgeuse, like Alnitak with Spica identified as Hathor through 45000 swings.


The pendulum lengths embedded in Menkaure are the 52.36cm Royal Cubit length and the 26.18cm pendulum length, which gives a whole integer multiple hundred pendulum lengths for the height of the pyramid when considered as an octahedron (500x26.18cm), associate the stars in Orion that can be mapped onto Menkaure or rise and set from and into Menkaure, namely Rigel, Bellatrix, Mintaka and Saiph. The 26.18cm pendulum length connects Rigel the brightest star in Orion with Sirius identified with Isis through 12000 swings of the pendulum. Bellatrix is associated with Errai identified as the Shen Ring through 30000 swings, whilst Mintaka is associated with both Spica identified as Hathor through 54000 swings and with Algorab identified with Maat through 48000 swings. Saiph is associated with Sheratan identified as Atum/Khnum through 30000 swings of the Menkaure pendulum length.

The Ancient Egyptian Gods have been tentatively identified with the brightest stars in the Night sky. The stars of Orion particularly Rigel and Betelgeuse are associated with Osiris, whilst Spica in Virgo was identified as Hathor and Regulus in Leo, with Sekhmet. Procyon in Canis Minor was identified as Anubis and Alphard in Hydra with Seth. Vega in Lyra was identified as the goddess Seshat and Deneb in Cygnus postulated as Nephthys. Altair in the constellation of Aquila was identified as Horus and Aldebaran in Taurus was Apis. Hamal and sometimes Sheratan in Aries were identified as Atum or Khnum. Castor and Pollux may have represented Tefnut and Shu the twins of Atum though it is difficult to distinguish which star was related with which twin!. Thoth is proposed as being identified with the star Menkent in Centaur. Other important objects associated with the Egyptian myths and the Pyramid and Coffin Texts are the Solar Barque, the Scales of Judgement, the Shen Ring and the Feather of Maat. These were identified with Canopus in Carina, Zubenelgenubi in Libra, Errai in Cepheus and Algorab in Corvus respectively. These associations are based on several different avenues of exploration and the level of certainty associated with the identification of deities such as Hathor, Osiris, Horus, Isis, Bastet and Seshat is higher than others that should be regarded as tentative, however the association of stars with Egyptian deities is the key to understanding Egyptian mythology and this association together with the relative positions of these stars to each other and their alignments on festival days may allow the stories behind the pyramid texts to be understood.

The final thought is that there are symbols from Ancient Egypt that can be explained as deep space objects. This is the most controversial of the proposals in that it requires the existence of a telescope over 4000 years before the "believed" invention of the telescope in the 17<sup>th</sup> Century by Lippershey and Galileo. Furthermore, the pre-historic telescope

would need to have had the magnifying strength of a fairly powerful telescope akin to an 18<sup>th</sup> Century telescope of the same power as Charles Messier's 4 inch refractor that would enable nebulae to be observed.

The Eye of Horus symbol  is described as the left eye of Horus, the falcon god whose left eye was gouged out by Seth as they battled. There are two nebulae in the night sky that have a very strong resemblance to eyes, namely the Helix nebula and the Eight-Burst nebula. Furthermore, both these eyes appear due South on the same day, April 24<sup>th</sup> 2560BC at Civil Twilight, the Helix Nebula aligning due South at the Start of Civil Twilight and the Eight-Burst Nebula aligning due South at the End of Civil Twilight. The Helix Nebula which has the appearance of an eye, lies in the constellation of Aquarius. The pattern of stars surrounding the nebula in Aquarius and Capricorn can be joined to form a pattern that is very similar to the pattern of the Eye of Horus symbol. Like-wise another eye-like nebula, the Eight-Burst Nebula NGC3132 in the constellation of Vela fits the stories of another eye symbol in Egyptian mythology, namely the Eye of Ra . The Eye of Ra is the right eye of the Sun God and is often associated with the leonine and feline goddesses, Sekhmet and Bastet and to a lesser extent Hathor. With Sekhmet, the association of the Eye of Ra is one of ferocity and protection of her father Ra, whilst with the gentler protective goddess represented by the goddess Bastet with the head of a domestic cat rather than a lioness, acts as a guardian goddess of Ra accompanying him through the winter months in his journey across the sky during the day and through the underworld at night. The symbol of the Eye of Ra can be achieved by joining the brightest stars in the constellations of Vela and Carina which containing the bright star Canopus is identified with the Solar Boat that ferries the Sun god across the sky and through the underworld. There is a third nebula, NGC6543 or the Cat's Eye Nebula which has the appearance of an eye. In this case the eye is in the North in the constellation of Draco. Draco is identified with the god of chaos, Apophis whose stars form and rotate around the celestial pole. Each night as the solar barque made its journey through the underworld carrying the Eye of Ra, Apophis attempted to steal the Eye by using his Evil Eye, presumed to be NGC6543, to overcome those deities on the barque. Seth however was able to withstand the stare of the evil eye by some magical means. It may be that Seth was associated with Alphard in the constellation of Hydra, the Serpent. Perhaps Seth was able to transform himself into the form of a serpent himself, (just as mythology states that Seth was able to transform himself into a bull during his fight with Horus), and so was unaffected by the evil eye of Apophis.

There are two other examples of possible evidence that the Ancient Egyptians, or at least the elite astronomer-priest-architects associated with relating the stories of the gods knew of or had the ability to see deep space objects. There is the Djed pillar  and the Tyet pillar that appear to hold up the corners of the heavens. The Djed could be considered as consisting of three pillars in the Eagle Nebula M16 and a fourth "pillar"

provided by the Cone Nebula NGC2264 in Monoceros which between them support the East-West axis of the sky as the two nebulae sit on the horizon on November 20<sup>th</sup>. Aligning the four nebula pillars along the East-West axis produces a symbol that when viewed side-on is a good representation of the Djed pillar. Meanwhile on the same day the Tyet pillar can be considered as supporting the North-South axis of the sky. The Tyet pillar can be formed by the combination of the deep space nebula NGC3372, the Keyhole Nebula that aligns due South at Civil Twilight and the constellation of Cepheus whose stars form a ring that strongly resembles the Shen Ring and aligns due North at Civil Twilight. The hybridisation of Cepheus and the Keyhole nebula results in a celestial equivalent of the Tyet that supports the North-South axis of the sky.

The preceding work is an attempt to try and introduce new ways of thinking about prehistoric measurement systems that utilised pendulum lengths to combine the measurement of length and time in the same system. The other development is the idea of aligning stars and the Sun with the pyramid peaks to connect the pyramids with Egyptian stellar deities and to mark festival days forming a calendar. The analysis is different from anything that has hitherto been proposed and no doubt it will be received with a high level of scepticism, and quite rightly so. Perhaps if the ideas are examined with due diligence and without prejudice perhaps there are those with the necessary skills that will see that though incredible, the conclusions are reasonable.