

Probability Hypothesis and Evidence of Astronomical Observatories in Ancient Egypt

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Abstract

Ancient Egyptians constructed their temples and tombs in a precise orientation to specific astronomical points, as seen in the designs of the Old Kingdom pyramids and related temples. This precise orientation is seen in many religious and funerary buildings across the sequential historical epochs of ancient Egypt. This research introduces what can be called "astronomical design improvements" created by ancient Egyptians in order to better secure the precise orientation of religious and funerary monuments. Moreover, this precise orientation requires observatories to be built and used for the orientation and monitoring of celestial objects in order to determine geographical directions. Therefore, this paper discusses the Probability or Possibility hypothesis of Evidences of the existence of Astronomical Observatories in ancient Egypt, the Probability hypothesis leads to suppose the statistical evidences of this research.

Keywords

Observer, Monitoring, Astronomical Improvements, Observatories, Solstice, Axial Precession, Azimuth

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1. Introduction

Ancient Egyptians depended on the Nile flood for agriculture and needed to know when inundation would occur in order to cope with the flooding. A critical function of the state therefore evolved around careful, accurate astronomical observations which allowed prediction of the annual flood. The control of information and calculations predicting the flood became a vital function. This need created an important reason to look toward the sky and try to control information derived from the stars [1]. In ancient Egypt, the process of monitoring the stars used to be conducted by the senior high officials of the state, especially Ministers or the High Priest who was bestowed an important title [2]. This title is "the great observer of Heliopolis/Iwnw" [3]. Heliopolis is considered one of the most important centers of the sun worship [4], is the central location for one of the universal creation theories of ancient Egypt [5] and is the capital of the XIII Nome of Lower Egypt. [6]

2. Astronomical Improvement of Masonry Designs and the Precision in the Orientation

Ancient Egyptians insisted that temples and tombs were constructed in a direct line to specific astronomical points "the four cardinal points of the world" [7], as evidenced by the design and alignment of the Old Kingdom pyramids and their related temples [8]. This research therefore suggests that improvements in this architectural accuracy over time can be called the astronomical improvement of designs of the Old Kingdom pyramids and related temples [9]. Most ancient Egyptian temples built along the River Nile were oriented on an east-west axis, according to local cardinal directions as determined by the River Nile. Likewise, the topography of Egypt was another controlling factor for temple orientation. Occasionally, the orientation of temples was towards the sun or towards significant stars [10]. Similar cases exist in many

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religious and funerary buildings across the later historical epochs of ancient Egypt, such as the temple of Amoun-Re at Karnak which is oriented towards the west side of the River Nile. Khonsu Temple, which is located to the south of Karnak temple and also oriented towards the south, the temple of Mntw located to the north of Karnak temple and oriented towards the south, the temple of Imn-Htp II located between the IX and X pylons of Karnak temple and oriented towards the west, and Luxor Temple which was oriented from the south towards the north [11]. It should also be noted that the entrance of Karnak Temple was oriented to receive

the procession of Imn from Luxor to Karnak during the Ipt feast [12]. Moreover, Medamud temple, which is located to the northeast of Karnak was almost oriented along an east-west axis. Before reaching the First Intermediate Period structure of Medamud temple, there are the remains of a mud-brick temple which was found to be oriented along a north-south axis [13]. This precision in the orientation of temples and tombs must have been achieved through careful observations of geographical directions and orientation of the structure to specific astronomical points. [14] (Figs. 1-2)

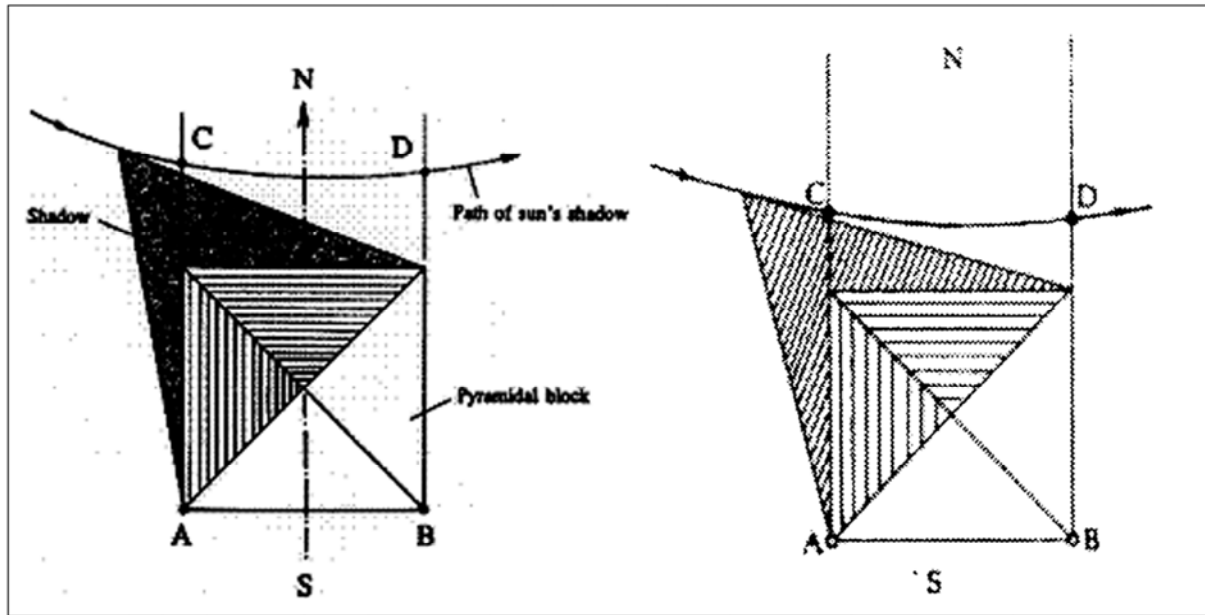


Fig. 1. The Orientation and Monitoring of Geographical Directions as Neugebauer's method of finding true North.

Source: Neugebauer, O., "On the Orientation of Pyramids", Centaurs, Vol. 24, Copenhagen, 1980, Fig.1.

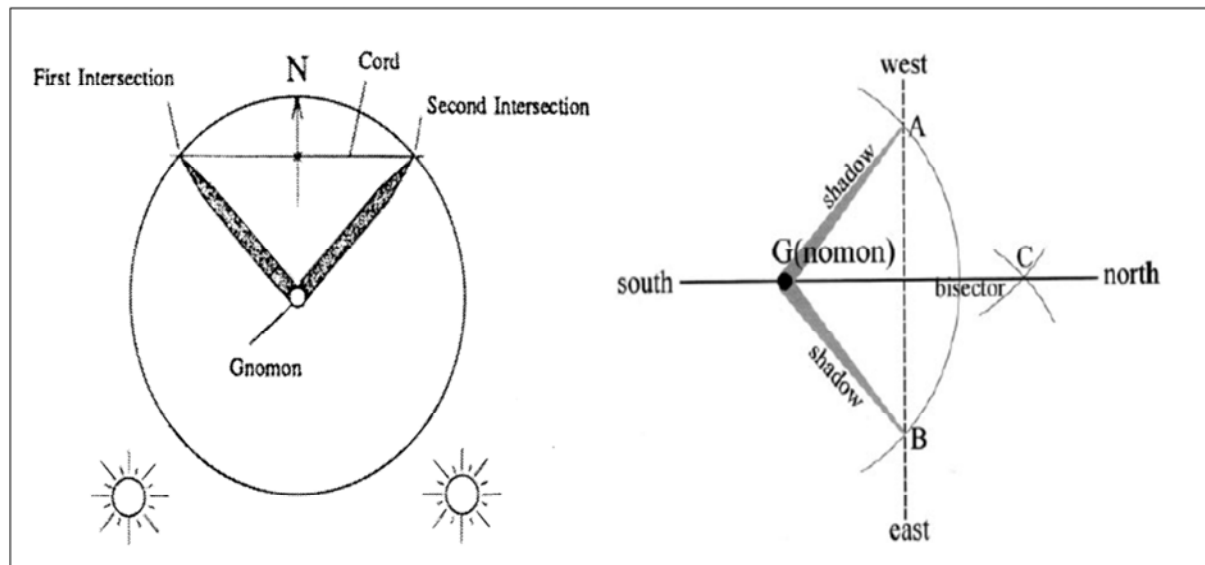


Fig. 2. The Orientation and Monitoring of Geographical Directions as Isler suggested on the left side. Whilst on the right side is a Couprie's method.

Source: Isler, M., "An Ancient Method of Finding and Extending Direction", JARCE.26, 1989, Figs.3, 4; Couprie, D. L., "Heaven and Earth in Ancient Greek Cosmology from Thales to Heraclides Ponticus", New York. 2011, Fig. 2. 11.

Therefore, the first step for the ancient Egyptians in building a temple would be the identification of geographical or true north– south axes by monitoring the Polar stars/MsXtyw located in the northern section of the sky or northern hemisphere, as well as the Non-Polar stars/ caHw located in the southern part of the sky or southern hemisphere [15]. It is already clear that there must have been observatories to monitor these directions accurately. It can be deduced that the northern and southern hemisphere monitoring process started in the form of harbingers indicating expectations of simple astronomical phenomena including stars' movements in the northern and southern sections of the sky [16]. It is noteworthy that there are some harbingers which indicate the astral dogma was known, practiced and of great importance in both a scientific aspect and decorative purpose since the Pre-dynastic age [17]. Consequently, the ancient Egyptians were interested in many branches of science related primarily to ancient Egyptian beliefs. Astronomy was one of those promoted branches of science as it was related to the astral dogma. There are links between astronomy and aspects of

ancient Egyptian religion. It is therefore believed that ancient Egyptians were well-informed about the daily passage of the stars [18]. Furthermore, several of the Pyramid Text spells referred to the deceased king's ascension to the sky amongst the immortal stars. The ancient Egyptians link between astral beliefs and the deceased's ascension to sky is believed to illustrate that the astral dogma preceded the solar doctrine. [19]

3. Astronomical Observatories Evidences

3.1. Nabta Playa Observatory

The Neolithic Nabta Playa archaeological site is located about 800 km south of Cairo in the Nubian Desert, about 100 km west of Abu Simbel, and about 30 km to the north of the Egyptian-Sudanese borders. [20] (Figs. 3-4)

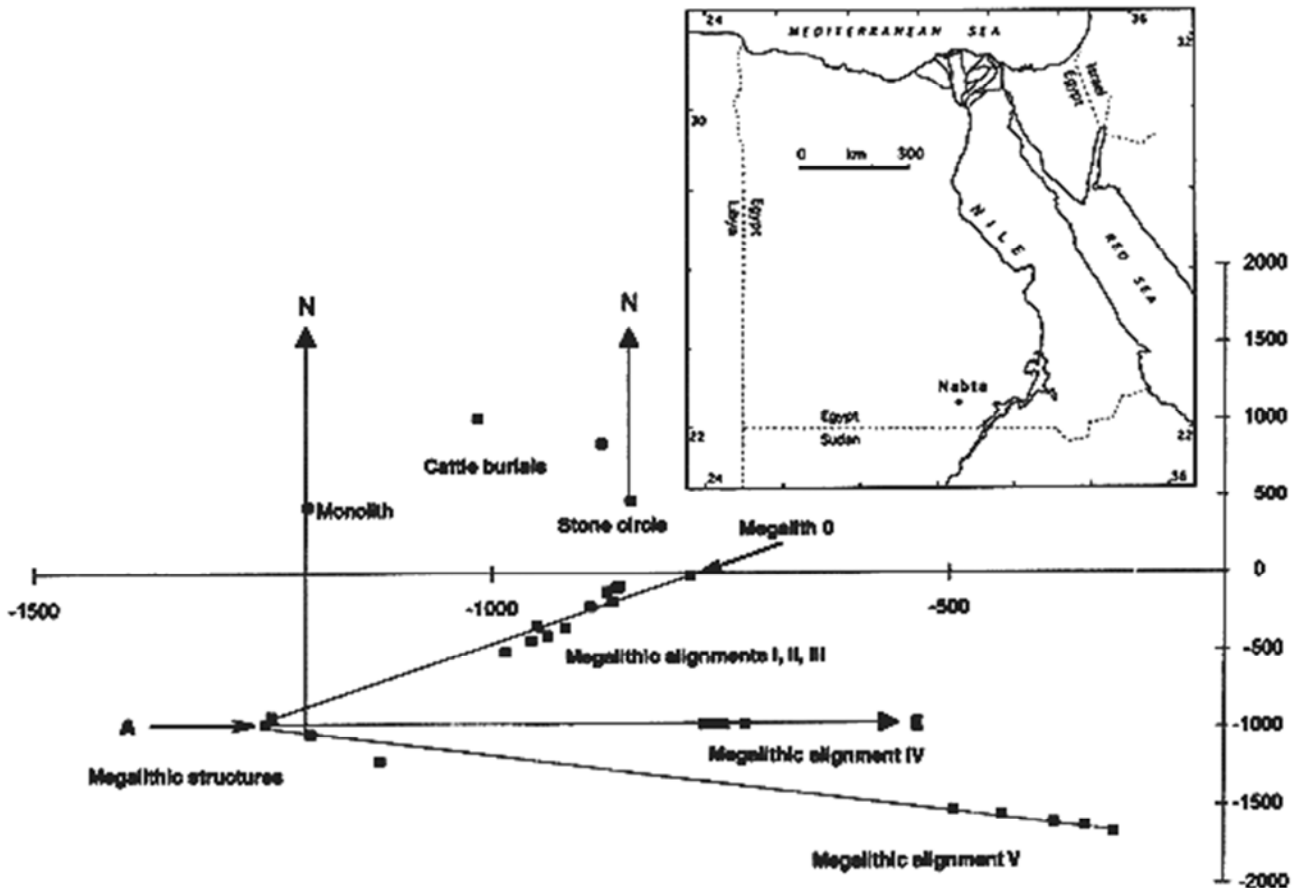


Fig. 3. The Location of Nabta Playa on the Map of Egypt. (A) Indicates the largest Megalithic structure. Whilst (E) is a smaller Megalithic structure. Source: Malville, J. M., Wendorf, F., & Others, "Megaliths and Neolithic Astronomy in Southern Egypt", Nature, Vol. 392, Issue 2 April, 1998, Fig. 1.

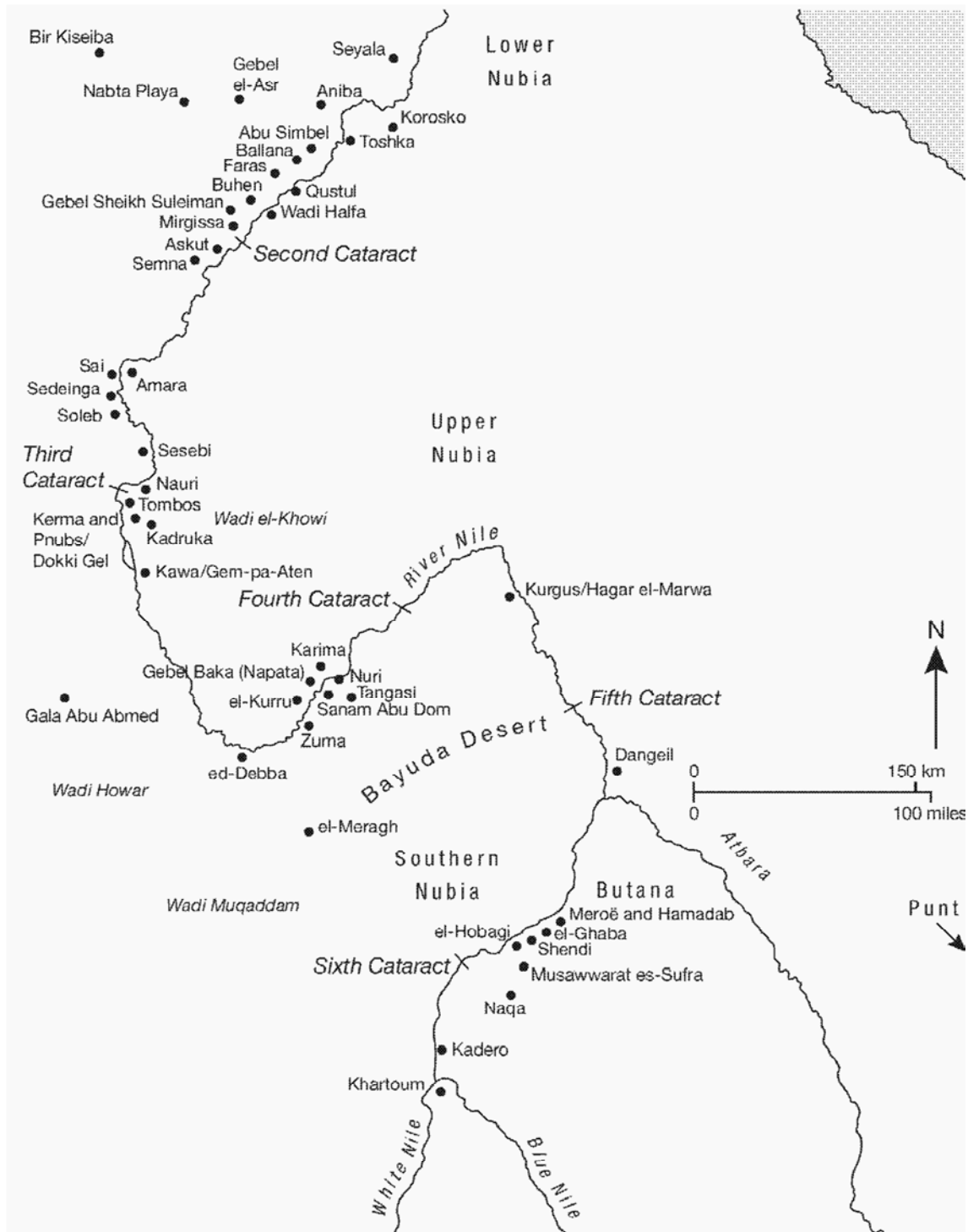


Fig. 4. The Location of Egyptian-Sudanese borders from Lower Nubia to Khartoum.

Source: Wilkinson, T., (Ed.), "The Egyptian World", 1st Edition, London & New York, 2007, p. XXVII.

It is believed that the first observatory to monitor the stars was at Nabta Playa in the form of a collection of stones stacked in a certain way. It measures about three meters in diameter and contains four windows in the north and the south in a sloping direction from East to West. A one meter high sandstone column was also discovered and used as sundial to measure the hours of the day and months of the year. It was noted that one

part of this observatory was facing east combined within a range of Ursa-Minor or the Little-Dipper and with the heliacal rising of the star Sirius [21]. Obviously, in order to live in deserts and know when the monsoon season would arrive, the ancient Egyptians used the sun by day and the stars at night in a simple primitive monitoring process. The technique they used was to target a particular star in the northern hemisphere

which must be unique and can be seen by the naked eye. Moreover, this observatory was constructed in the form of a circular wall, high enough to prevent a standing person from seeing anything else outside this wall other than the sky [22]. It is believed that the astronomical observatory located in Nabta Playa which consists of Megalith stones (Fig.5), does not support the concept of the ancient alignment and was built in order to point to the rising of Sirius at some subsequent time to the end of Playa sedimentation (7200 years ago). (Figs. 3-4-5)

If Sirius was the intended alignment, it had to have been built earlier, more than 8000 years ago. A compelling type of design of astronomical structures at Nabta Playa may include a complex structure which included alignments to the spring moderation of heliacal rising of Orion's zone and Orion's Transfiguration on the meridian before the Summer solstice[23]. Subsequently, the Megalith line zones probably coordinated with the spring moderation heliacal rising of some stars, which span from 6400 BC for the rising of the first star from the Orion's zone till 5200 BC. (Figs. 3-5), likewise, for the northerly features of the Megaliths. Thereupon, there is a relationship between the movements of the brightest star located in the northern hemisphere called Vega. The starting of Vega's rising over the Calendar circle occurred from about 6400BC. [24] (Fig. 6)

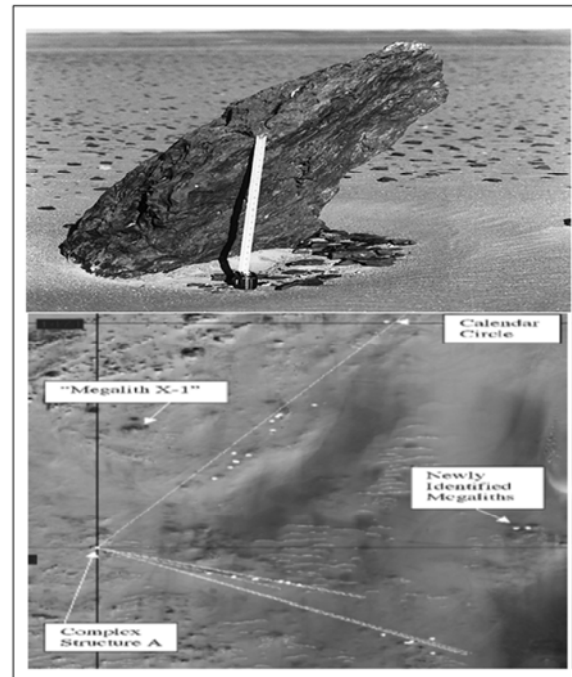


Fig. 5. The Northern Megalithic stone of Nabta Playa structure. The Calendar circle located just off the edge of the ancient Playa is nearly in line with northerly megalith line at 6270B.C.

Source: Malville, J. M., Wendorf, F., & Others, "Megaliths and Neolithic Astronomy in Southern Egypt", Figs. 2, 8.

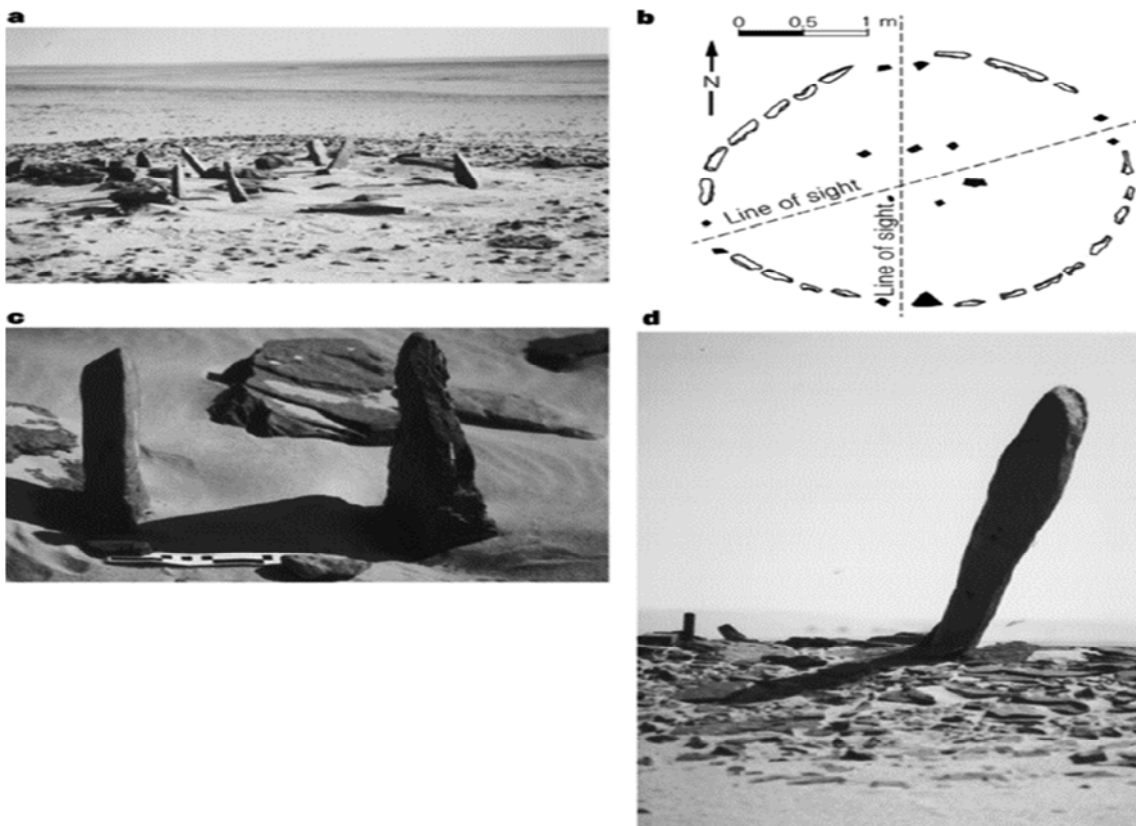


Fig. 6. Megalithic stone circle as for (a-b), as for (b) represented the outer sighting slots of the Megalithic stones, as for (c-d) represented the standing Megalithic and Monolithic stones (Height 1 M).

Source: Malville, J. M., Wendorf, F., & Others, "Megaliths and Neolithic Astronomy in Southern Egypt", Fig. 3.

3.2. Ausim Observatory

It is noted that the directions of Khufu pyramid had been identified in a way that makes the northern side centered and oriented towards the city of Ausim[*]. Similarly, the pyramids of the kings "Menkaure, Shepseskaf, Sahure, Userkaf, Neferirkare" had been found to be oriented towards that city [25]. In fact, Ausim/Letopolis has a great religious importance as it was where the shoulder bones of the god Wsir were buried [26]. Moreover, there is a supposition on the existence of a guard tower in Letopolis, which was used as a celestial observatory and was built over a high hill far from the dangers of the Nile flood. It is believed that the shiny metal sign created by architects in the reign of Khufu was to facilitate the direction determining process to the north, which had to be determined accurately by Polar stars/ the set of Ursa Major. It also takes the features of the Sun

temples dating back to the fifth dynasty [27]. Philologically, there is an important title from the fifth dynasty Mastaba of Nfr-Irt-n-f in the Saqqara necropolis, the owner held the title "great observer for Re" [28], and the more comprehensive and precise title "who clarifies the god Re" [29]. Thereupon, it is noted that the distance between the northern axis of the Khufu pyramid and Ausim city is approximately 15 km, and in the case of making a line in this direction, will start from the city of Ausim in an eastly direction and extend to the Senusert obelisk at Heliopolis/Iwnw [30]. According to the foregoing, it could be drawn as equilateral triangle points; the top of the triangle is located in Ausim/Letopolis, while the other side of the triangle in the zone of Khufu pyramid and the last triangle point is located in the city of Heliopolis. [31] (Fig.7)

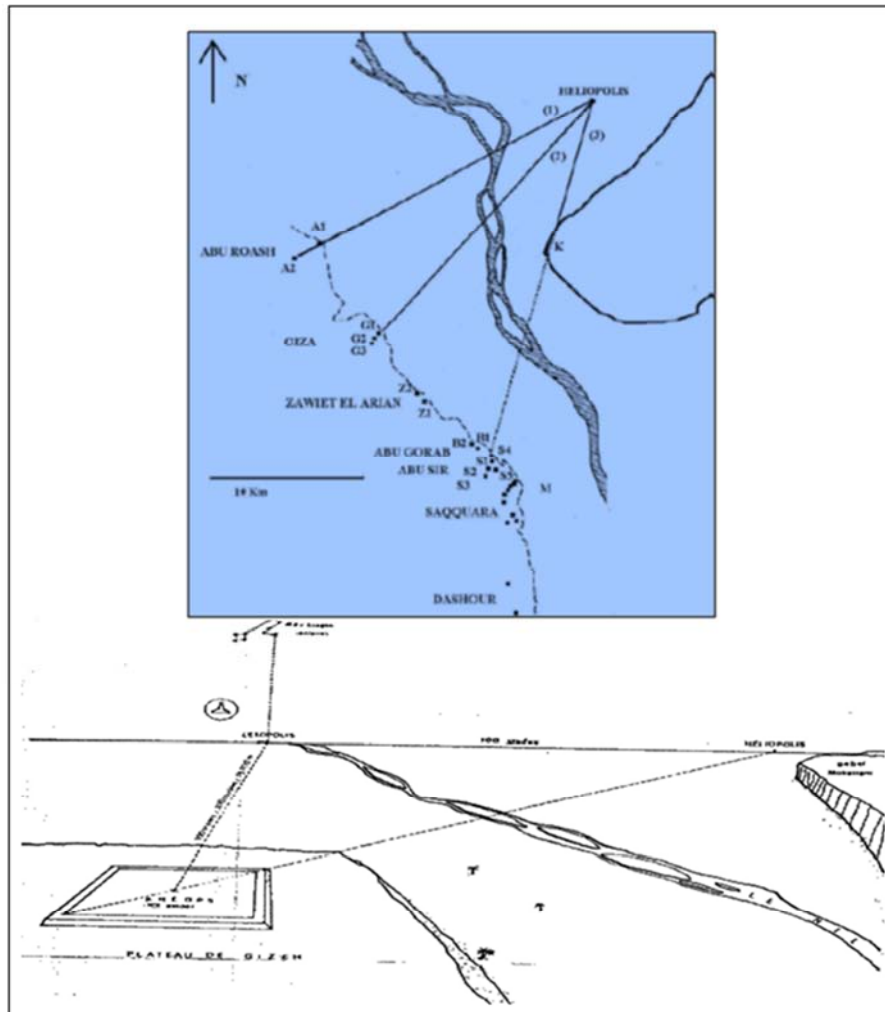


Fig. 7. The northern axis of Khufu pyramid and Ausim city. The top of the triangle is located in Ausim/Letopolis, the other side of the triangle in zone of Khufu pyramid and the last triangle point is located in the city of Heliopolis.

Source: Goyon, G., "Nouvelle Observations relatives a l'Oriention de la Pyramid de Kheops", Rde. 22, 1970, Pl. 8; Magli, G., "Topography, Astronomy and Dynastic history", Mediterranean archaeology and Archaeometry, Vol.10, No.2, Fig.5.

According to Strabon, there was a guard tower in the city of Letopolis/Ausim that was used as an astronomical observatory. It was logical to use the tower since the city was established on a high hill making it safe from the annual inundation which would rise approximately 12 meters above the surface of the neighboring fields. At this spot a 4-meter high mosque is currently constructed and connected with an 8-meter high minaret. Therefore, through looking from the mosque minaret towards an easterly direction, the two banks

of the Nile can be seen with a clear view toward the Delta and also toward the city of Heliopolis. It is believed that the observatory was built in the same location as the mosque or just a little to the north of it, and it is thought this was where the optical or metal sign was placed to determine geographical north. In conclusion, it is believed that Letopolis was the spot where architects in the reign of the king Khufu monitored geographical north in order to be able to construct the Great Pyramid. [32] (Figs. 7-8)

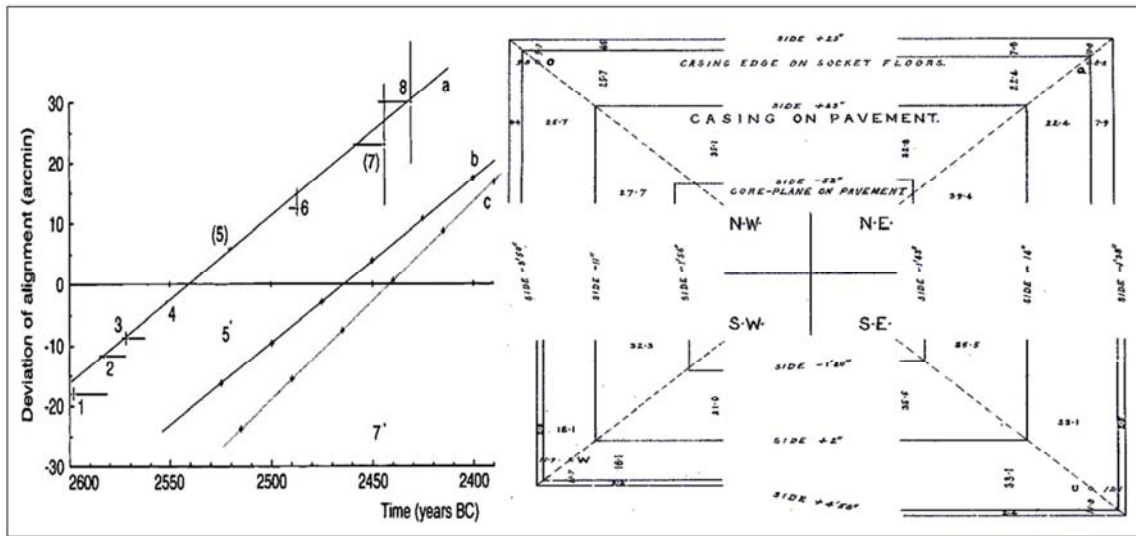


Fig. 8. The diagram at the right side shows orientation method of the geographical north and the relative position of the core masonry at the corners during the construction of the Great Pyramid by scale 1/50. Whilst the Astronomical diagram at the left side shows the transit method of determination and orientation.

The solid line is a plot of the deviation from true North in Arc minutes of the cord between β UMi, β Ursae Minoris, known as the "Little Dipper" and Zeta Ursa E Majoris, Zeta UMa, Ursa Major, known as the Great Bear. The deviation between that duo of constellations, known as a pair of celestial astronomical objects in Arc minutes were versus time. The numbered points allow a recalibration of the dating; 1. Meidum, 2. Bent pyramid, 3. Red pyramid, 4. Khafre, 5. Khufu, 6. Menkaure, 7. Sahure, 8. Neferirkare.

Source: Petrie, F., *The Pyramids and Temples of Gizeh*. Republished and Revised Online by: Ronald, B., (Ed.), London & New York, 2003, Last Rev. at August 27, 2014, Pl.X.; Spence, K., *Ancient Egyptian chronology and the astronomical orientation of pyramids*, *Nature*, Vol. 408, 16 November, 2000, Fig. 4.; Spence, K., *The astronomical orientation of pyramids*, *Nature*, Vol. 412, 16 August, 2001, Fig. 1.

It is notable that the method of building using an observatory is discussed in the fifth dynasty Mastaba of Nfr-Irt-n-f discovered by Mariette in Saqqara necropolis [33]. He held the title "Supervisor of observation for Re", and he was practicing his priesthood in the Sun temples of Userkaf [34], and Neferirkare, where he held the same title [35]. It is noted that the obelisk determinative or the sun disk appendage may have been affixed to the top of the obelisk of the sun temple of Userkaf. Similar cases exist in other excavated sun temples [36]. The engraved graffiti of Userkaf that was published by Ricke confirms that it is similar to a lighthouse shape topped by an illuminated sign [37]. Philologically, the sun disk determinative representing the illuminated sign depicted on the offering table preserved in the Berlin Museum No. 1159 mentions astronomical priest titles of the sun God Re in the sun temple of Niuserre. Likewise, with other astronomical priestly titles of the Goddess Hathor in the sun temple of King Neferirkare [38]. According to Goyon, it

is impossible to think that Ancient Egyptians were not aware of the possibilities that result from light reflectivity of a golden sun disk sign that represents an illuminated sign, which is similar to the lighting eyepiece [39]. Actually, this appears logical according to the evidences mentioned previously [40].

Thus, it is believed that King Khufu established a facility used as an astronomical observatory in the city of Letopolis/Ausim to determine and monitor geographical North in order to complete his pyramid building process. The same approach was used by the Kings of the fifth dynasty who were from the city of caXbw located in the zone of Letopolis. The astronomical observatories in Heliopolis were established on the same pattern as the Letopolis Observatory with the same characteristics and in addition some technical development [41]. That development over time is what can be called "astronomical design improvements". It is clear, therefore, that there was Astronomical Observatory in

Letopolis/Ausim, at least since the reign of King Khufu, in addition there were design improvements and technical developments added to the astronomical Observatory since the reign of King Userkaf which can be compared to the development of a lighting eyepiece for monitoring geographical North easily. [42] (Figs. 1-2, 7-8)

3.3. Panorama Area Observatory

There is a supposition on the existence of an astronomical observatory in the Panorama area located to the south of the Menkaure pyramid or in the surroundings of Giza plateau [43]. This is because the pyramid directions were identified as being based on the orientation of previous holy buildings

and on the religious features of the cities located in this archaeological site [44]. It is also believed that, after determining directions effectively, the astronomers continued to assist the builders and supervisors of the building process to measure the length sector of the pyramid' base to be built on the north-south axes. The direction of the Khufu pyramid has the most accurate orientation to the cardinal points [45]. Therefore, it is believed that the architect and the supervisor of the construction process held permanent control of the construction process in order to prevent deviations in the required directions. [46] (Figs. 1-2, 7-8, 9-10)

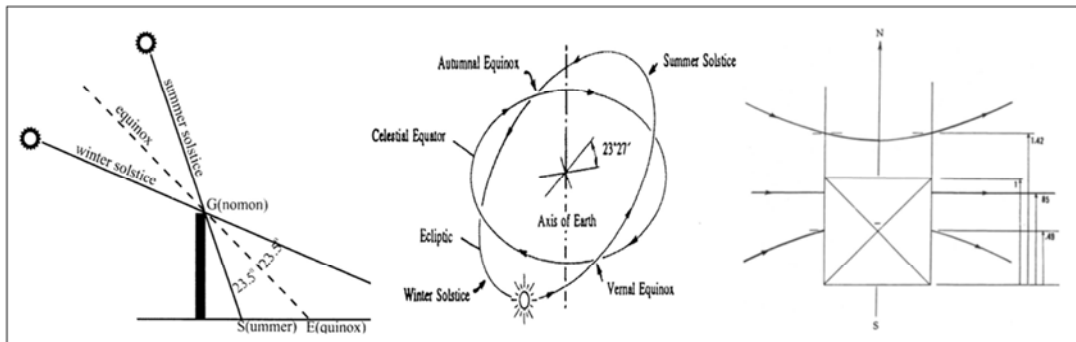


Fig. 9. The Great Pyramid's north-south axis is nearly aligned to true north and how to observe and monitor the path of the shadow cast by the apex of the Pyramid. This path describes a curve, which presently known as a branch of a hyperbola, concave toward North in the winter, concave toward South in the summer and a straight line at the Equinoxes.

Source: Neugebauer, O., "On the Orientation", Fig.2. ; Isler, M., "Finding and Extending Direction ", Fig.9; Couprie, D. L., "Heaven and Earth",Fig.2.13.

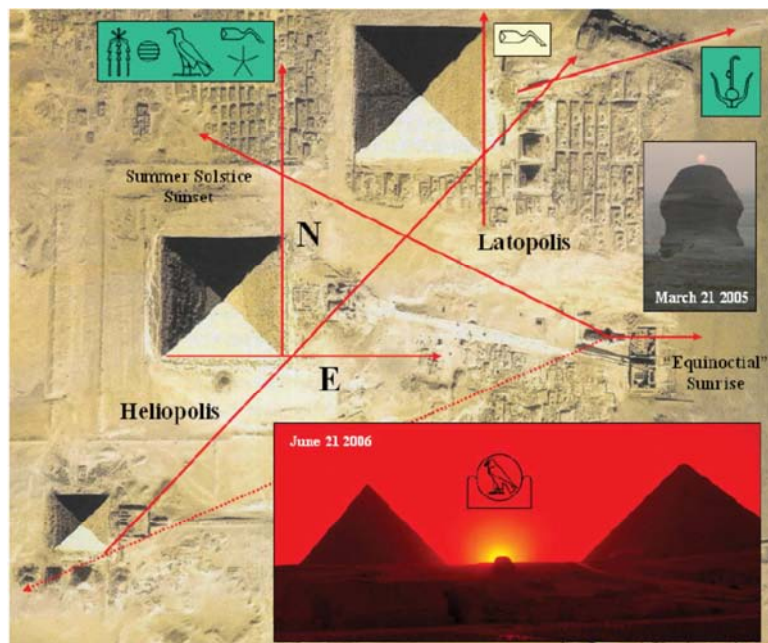


Fig. 10. This diagram shows the orientation process for determining the required directions, in addition to the Astronomical and Topographical relationships between the different structures constructed in the surroundings of Giza plateau. The relation between Letopolis and Heliopolis was first suggested by Goyon. Notably, this diagram also shows the relation between the northern orientation of the Pyramids and other astronomical relationships between the Sphinx and astronomical events such as the equinoxes, summer and winter solstices were two astronomical phenomena which were associated with a specific set of stars in each hemisphere, it would have been used for scheduling religious and funerary practices. The astronomical relationship between the Sphinx and Winter solstice at the time of sunset was along a south-east corner of Menkaure's pyramid, this is what can be connected with the astronomical term called "dot-line".

Source: Belmonte, J., Shaltout, M., & Fikri, M., "On the Orientation Of ancient Egyptian Temples", JHA.38, Nos. 2-4, 2007, Fig. 8. 35.

When a magnetic compass was placed toward the middle of the northern facade of the Khufu pyramid to conduct the monitoring process, at an angle of $35^{\circ}.9$ three high hills could be seen on the site horizon. Moreover, by conducting an angle to $1^{\circ}.25$ to the east in order to access true north, it was observed that the same axis extends in the direction of the top of the Userkaf pyramid. Also, it was observed that the eastern side of the Khufu pyramid's base aligned parallel to Userkaf pyramid. [47], (Figs. 11-12)

It was additionally noted that the south-north axes of Djedkare-isesi pyramid aligned parallel to the pyramid of Teti. Likewise, the axis of the pyramid of Pipe aligned parallel to the axis of the pyramid of Unas (Figs. 11-12). The axes of the Khafre and Menkaure pyramids were aligned parallel to the Khufu pyramid [48]. Therefore, the researcher

supposes that there is an astronomical observatory in the surroundings of the Giza plateau which was used to conduct the observing and monitoring processes accurately. [49], (Figs.1, 2, 7, 8, 10, 11, 12)



Fig. 11. The same axis extends in the direction of the top of the Userkaf pyramid, and the eastern side of the Khufu pyramid' base aligned parallel to Userkaf pyramid.

Source: Goyon, G., "Nouvelle Observations", Rde, 22, Pl.6.

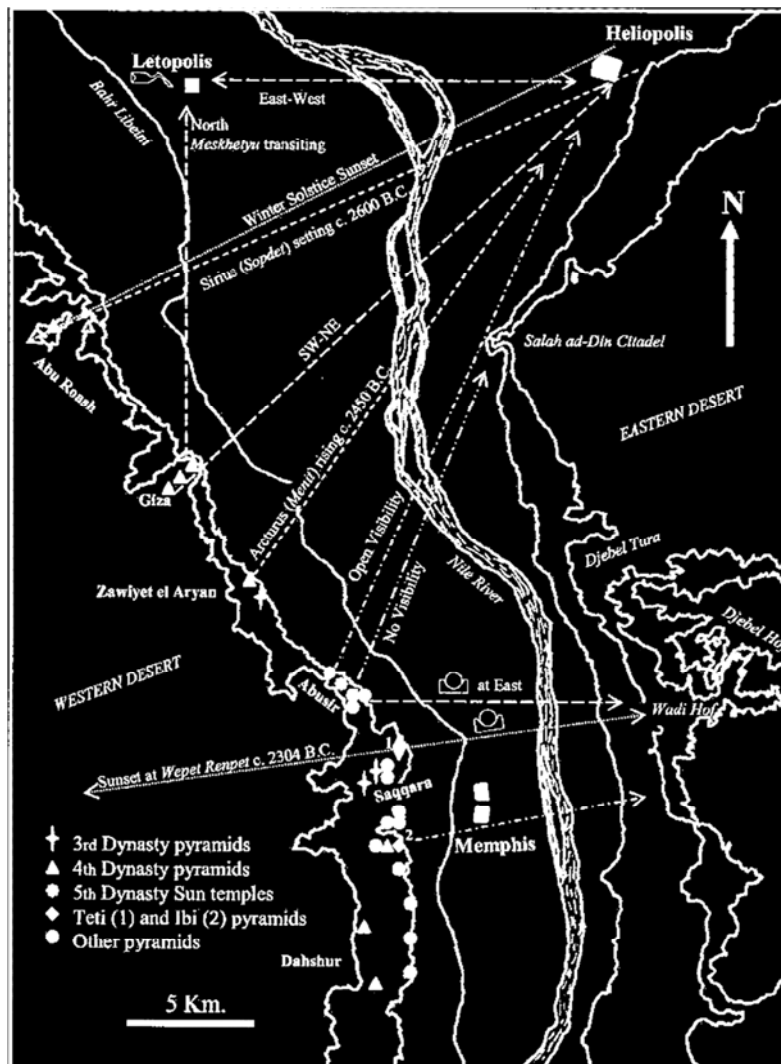


Fig. 12. At the late 1960s, Goyon observed that the layout or design of the three large pyramids of Giza, suggested that there is a connection between that pyramids and the cities of Letopolis and Heliopolis. The axe connecting was along a south-east corners of the three pyramids, with an azimuth slightly smaller than 45° , was directed towards Heliopolis, while the orientation to the north led directly to Letopolis. Additionally, there are astronomical and topographical alignments between the location of the solar temples in Abu-Ghurob and the pyramids of Abu-Roash, Giza and Abusir. At all the importance of the city of the sun-god/Heliopolis is confirmed. Source: Belmonte, J., Shaltout, M., & Fikri, M., "Orientation", Fig.8.38.

3.4. Iwnw Observatory

The city of Heliopolis, considered one of the most important cultural centers in Egypt both in astronomy and engineering. Therefore, it probably possessed an important role in observing, monitoring and studying the stars (Figs. 7-8, 9-10). Thus, it is supposed that there is in it an astronomical observatory for monitoring the stars. Significantly the Minister "Ii-m-Htp" had held the title of "greatest of the Observers/Wr-Maaw" [50]. This is the greatest priest's title in "Iwnw". Thus, it is described as "a senior overseer of the sky secrets" or "a major observer of the celestial objects movement". He could therefore be called "the greatest astronomer of the city" [51]. Additionally, it is believed that Heliopolis took its name from one of the astronomical observatory towers. Moreover, the astronomical orientation used by the ancient Egyptians was based on monitoring, observing, testing and analysis, so it is most precise [52] (Figs.1, 2; 7-8; 10, 11, 12). The observation process was of great importance in ancient Egypt, particularly in order to determine the precise timing of the religious feasts and funerary rites. [53], (Figs.1, 2; 7-8)

3.5. EHwty Hill Observatory

There is a Mountain summit located in the west of Thebes (Fig.13), which was known as Hill or Highland of EHwty/Thoth. In this area of El-Dir Elbahari was initiated the building of the temple of the king Mentuhotep II. The temple buildings were completed by the king Mentuhotep III [*]. This temple was dedicated to the falcon god Or. [54], (Fig. 13)



Fig. 13. Thoth hill area that was the highest summit of the Theban hills.

Source: Belmonte, J., & Shaltout, M., "On the Orientation Of ancient Egyptian Temples, I", JHA.36, No.3, 2005, Figs.7, 8.16.

The EHwty Hill area was known as one of the most important archaeological sites not only from the archaeological perspective, but also in the astronomical and celestial spheres. Moreover, it was related to the god EHwty, which is the god of writing and astronomy and the inventor of the Epagomenal days in ancient Egypt [55].

These days were added as a supplement of the solar calendar in order to balance the civil year. Astronomically, these days were added in order to correct the errors of the calendrical year. Had these corrections not been made to correct astronomical gaps in the ancient Egyptian calendar, oscillating errors and imbalance in the calendar would have been incurred [56]. It is clear from the foregoing that EHwty Hill Observatory was one of the most important observatories of that period and in that archaeological area. Therefore, it would have been used for observing and exploring the northern and southern hemispheres in order to determine the approximate moon phases or star paths. Also, it would have been used for monitoring astronomical events such as the solstices [*] and equinoxes [*] and for scheduling religious and funerary practices [57]. Summer and Winter solstices were two astronomical phenomena which were associated with a specific set of stars in each hemisphere [58]. Therefore, the temple of Mentuhotep III at El-Deir El-Bahari is the most obvious evidence which proves the aforementioned idea (Fig. 13). It is a temple constructed approximately 2000 B.C. and was dedicated to the falcon god Or. The Hungarian expedition has conducted excavations at the temple and this mission discovered the foundational remains of a much larger temple of a much older epoch dating almost to the year 3000 B.C. Noteworthy, the two axes of the temple are different by 2.5 ° of azimuth[*]angle range. [59], (Figs. 14-15)

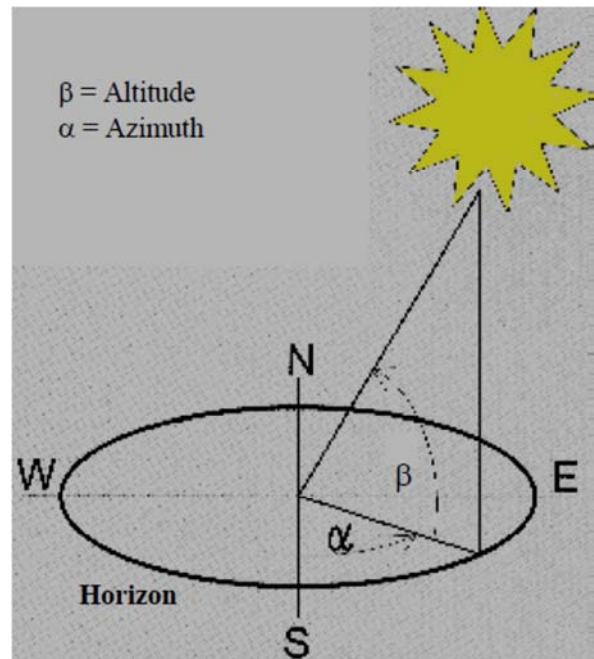


Fig. 14. The azimuth is symbolized by α which starts from the South Pole and moves clockwise. Whilst the altitude is symbolized by β which starts from the Northern hemisphere/Northern horizon.

Source: Roger, L. & Others, "Heavenly Mathematics", Fig. 2.1C.

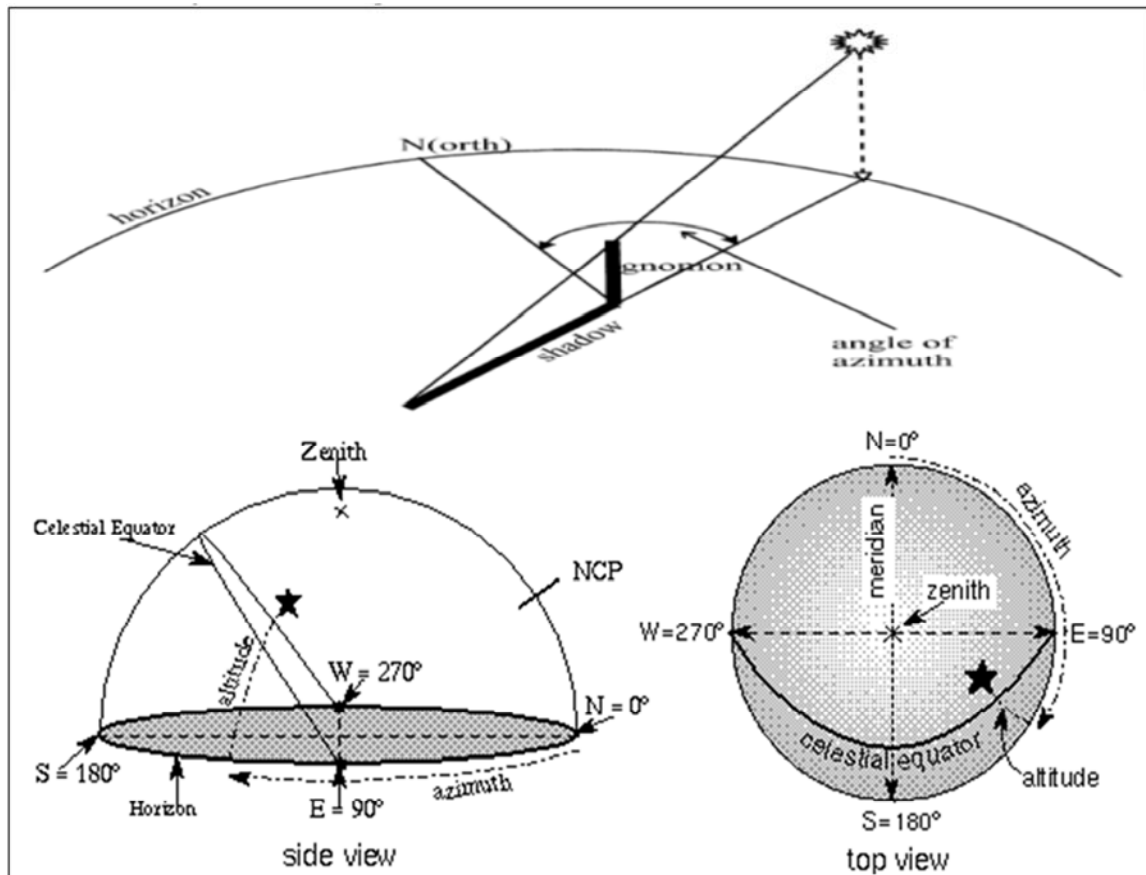


Fig. 15. The azimuth is the angle formed between specific directions from true north and a sight line of the observer to a specific point measured in the same scale as the provisional orthogonal direction to zenith as the highest point of the azimuth. The true north on the stereographic diagram is the positive Y axis "straight up" and is marked with N.

Source: Couprie, D. L., "Heaven, Fig.2.15. cf. Magli, G., "Architecture, Astronomy and Sacred landscape in Ancient Egypt", Cambridge, 2013, p.26, Box.1, 1.

The Hungarian exploratory expedition in collaboration with a group of astronomers linked the variation present in each of the temple axes to the variation in rising locations of the stars during astronomical cycles. It is noteworthy that by monitoring the emergence location of the star path at the time when the temple was built, it was clear that its path had been changed from a specific location used in the construction of the first temple to another alternative location. This may be deduced as being due to the Equinox initiative process [*] over the duration of time from 2000-3000 B.C [60]. Accordingly, this research deduces that it is probable that the differences in the temple's axes accord with the difference in the star appearance location across the duration of the period from 2000 to 3000 B.C. Almost a thousand years passed between the constructing of the two temples. Thereupon, EHWty Hill Observatory has been used to determine the axes direction for constructing temples by the kings across these sequential epochs [61]. During the day-time, the sky is usually clear, thus ancient Egyptians measured the passing of the hours using a sundial. At night-

time the passing of hours was determined by the rise and fall of stars and because different stars rise at different times depending on seasons. The night hours could be determined by the rising of specific stars which were called Decans. By Decans or sometimes by one star the night hours could be divided. Ancient Egyptians adopted the determination of temple axes based on the Decans, which were monitored in the form of a set of visible stars or one visible star, which would appear at a certain hour of night and be calculated through thirty-six hours duration. Thus, each period is divided into ten days, likewise, the determination of each of these periods was through the star rise on the eastern horizon directly before sunrise [62]. It is noteworthy that one of the results of the Hungarian expedition was to confirm that the temple axes were aligned to the star "cpdt/Sothis" [63] at the moment of sunrise. Therefore, we can conclude that EHWty Hill served as an astronomical observatory designed to determine the dawn angle of that star [64]. Furthermore, some inscriptions have been discovered on the interior walls of Thoth Hill dating

back to the seventeenth dynasty [65]. These inscriptions mention the rising process of the star cpdt [66]. This can be called "Heliacal rising of star Sothis". Thereupon, the so-called Thoth Hill Observatory was used in monitoring and directing processes in order to observe and measure the dawn angle of cpdt heliacal rising in order to declare the oncoming flood [67]. Accordingly, it is supposed that EHwty Hill [68] was one of the most important astronomical observatories in Thebes, and probably the best place to observe and monitor winter and summer solstices as well as Moon phases and star paths. [69], (Figs. 13, 14, 15)

4. Discussion of Probability Hypothesis and Evidence of the Study Results

- The observation process was of great importance in ancient Egypt, particularly in relation to Ancient Egyptians beliefs and the need to determine the precise timing of religious feasts and funerary rites.
 - It can be seen through study that there are evidences affirming the existence of Nabta Playa observatory, where there are compelling examples of various astronomical structures. These include a complex building which aligns with the spring moderation of the heliacal rising of Orion's zone and Orion's Transfiguration on the meridian before the rising of the summer solstice, and the Megalith lines zone may be in order to coordinate with the spring moderation heliacal rising of some stars with a time span of 6400 BC for the rising of the first star from the Orion zone until 5200 BC. Moreover, the northerly features of the Megaliths are considered to have a relationship with movements of the brightest star located in the northern part of the sky, which is today called Vega. It is believed that the first rise of Vega over the Calendar Circle occurred in about 6400BC.
 - It has become clear through study that there evidence to prove that there was a guard tower present in Letopolis city which was used as a celestial Observatory, probably built on a high hill far from the dangers of the Nile flood. Furthermore, it is believed that the shiny metal sign created by architects in the reign of "Khufu" was used to facilitate the direction of true North, which was determined accurately by observation of the Polar group or Ursa Major group. Accordingly, it is believed that the King Khufu established a facility used as an astronomical observatory in the city of Letopolis/Ausim to determine and monitor geographical or true North in order to complete his pyramid building process. The same approach was used by the Kings of the fifth dynasty who
- were from the city of caXbw located in the zone of Letopolis. Likewise, they also established astronomical observatories in Heliopolis on the same pattern as Letopolis Observatory with the same characteristics and in addition some technical developments. An equilateral triangle could be drawn so that the top of the triangle is located in Xm/Ausim /Letopolis, while one side of the triangle in the zone of Khufu pyramid and the last triangle point is located in the city of Heliopolis.
- There is a supposition on the existence of an astronomical observatory in the Panorama area located in south of Menkaure pyramid or in the surroundings of the Giza plateau, because the pyramids were aligned in directions based on previous older buildings and also depended on religious features of that archaeological site. Moreover, it is noted that the south-north axes of Djedkare-isesi pyramid are aligned in parallel to the pyramid of King Teti, and the axis of the pyramid of King Pipe is aligned parallel to the axis of the pyramid of King Unas. The Khafre and Menkaure pyramids were aligned to be parallel to Khufu pyramid. Thereupon, the researcher supposes the existence of an astronomical observatory in the surroundings of the Giza plateau for the purpose of conducting the monitoring process with extreme accuracy.
 - The city of Heliopolis is considered one of the most important cultural centers in Egypt both in astronomy and engineering. Therefore, it probably possessed an important role in monitoring and studying stars, so it is necessary to have an astronomical observatory for observing and monitoring stars. Moreover, the high priest in Iwnw was titled "greatest of the observers of sky secrets", metaphorically is "greatest of the observers of movements of planets and stars". He is the greatest of astronomers in Heliopolis. Moreover, the astronomical orientation used by Ancient Egyptians was based on monitoring, observing, testing and analysis, so it is most precise.
 - EHwty Hill area is known as one of the most important archaeological sites, not only from an archaeological perspective, but also in astronomical and celestial spheres. It is connected with the god EHwty, the god of writing and astronomy and the inventor of Epagomenal days used to correct the calendar in ancient Egypt. Thereupon, the so-called Thoth Hill Observatory was used in monitoring and directing processes in order to observe and measure the dawn angle of cpdt/Sothis heliacal rising that declares the oncoming flood. Accordingly, it is supposed that EHwty Hill was one of the most important astronomical observatories in Thebes, and probably the best place to observe and monitor winter and summer solstices as well as Moon phases and star paths.

In Ancient Egypt, summer and winter solstices were two astronomical phenomena which were associated with specific set of stars of the northern and southern hemispheres. Therefore, the temple of Mentuhotep III at El-Deir El-Bahari is the most obvious evidence which proves the aforementioned idea.

5. Conclusion of the Study

The Nile inundation was an important reason for looking toward the sky in order to monitor and control knowledge about the stars. Therefore, the process of star monitoring has since ancient times been a major function assumed by senior figures in the state. Specifically, the Minister or the High priest had the important title "greatest of the observers". Ancient Egyptians insisted on precise orientation of temples and tombs to a specific astronomical point or geographic locality and in relation to the four cardinal directions. Design improvements of temples and tombs confirmed the importance of this belief. Thus, the researcher believes this can be called "Astronomical improvements of design". Moreover, when Ancient Egyptians initiated the building of a temple, it was necessary to accurately identify the northern and southern axes by monitoring the Polar stars located in the northern hemisphere, and likewise the Non-polar stars located in the southern hemisphere. It is clear that there must have been observatories to monitor these zones and directions accurately. It can be said that the monitoring process and looking upward to the world of the sky started through the observation of simple harbingers in order to note an expectation of some astronomical phenomena and predict the movement of the stars in the sky. Therefore, there is a belief that the first Astronomical Observatory to monitor stars is situated in Nabta Playa. Furthermore, it is noted that the directions of the Khufu pyramid had been identified in a way that makes the northern side centered and oriented towards the city of Ausim/Letopolis. Similarly, the pyramids of the Kings "Menkaure, Shepsekaf, Sahure, Userkaf, Neferirkare" have been identified as also pointing towards that city. Accordingly, it is believed that there was a guard tower in Letopolis which was used as a celestial Observatory. Likewise, in order to identify and orient the directions of pyramids to a specific point, there must be an astronomical observatory in the Panorama area located to the south of the Menkaure pyramid or in the surroundings of the Giza plateau. There must also have been an observatory in the city of Heliopolis, which is considered one of the most important cultural centers in Egypt both for astronomy and engineering. Therefore, it probably possessed an important role in monitoring and studying stars, so it would have been necessary to possess an astronomical observatory for observing and monitoring stars. Similarly, EHwty Hill area is

known as one of the most important archaeological sites not only from an archaeological perspective, but also in the astronomical and celestial spheres. Therefore, it is believed that EHwty Hill Observatory was one of the most important astronomical observatories in Thebes, and probably the best place to observe and monitor Winter and Summer Solstices as well as Moon phases and Star paths.

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