

Two Egyptian Kings, Shepseskaf and Userkaf, and a solar eclipse (2471 BC)

*Original*

Two Egyptian Kings, Shepseskaf and Userkaf, and a solar eclipse (2471 BC) / Sparavigna, Amelia Carolina. -  
ELETTRONICO. - (2024). [10.5281/zenodo.14541509]

*Availability:*

This version is available at: 11583/2995806.2 since: 2024-12-21T19:07:57Z

*Publisher:*

*Published*

DOI:10.5281/zenodo.14541509

*Terms of use:*

This article is made available under terms and conditions as specified in the corresponding bibliographic description in the repository

*Publisher copyright*

(Article begins on next page)

# Two Egyptian Kings, Shepseskaf and Userkaf, and a solar eclipse (2471 BC)

Amelia Carolina Sparavigna

*Dipartimento di Scienza Applicata e Tecnologia, Politecnico di Torino*

Recently, arXiv published a work by G. Magli about the eclipse of 1 April 2471 BC and a supposed influence of it on the end of the fourth Egyptian dynasty and the beginning of the fifth one. In Magli's arXiv/2412.13640 paper, the eclipse is defined as the 'Shepseskaf eclipse'. Magli considers that this eclipse happened during the reign of the 'last ruler of the 4th dynasty, Shepseskaf'. Some literature is giving the name of further members of this dynasty. Therefore, here we add some references, besides those given in arXiv. We will show that, in this literature, the same eclipse of 2471 BC is linked to king Userkaf of the fifth dynasty. Some observations about chronological data proposed by Magli are also necessary.

## Gautschy and coworkers' Egyptian chronology

Before starting a survey of literature, let us remember the chronology of Egyptian pharaohs as proposed by Gautschy et al., 2017. This is strictly necessary because in the arXiv's test, written by G. Magli, it is told the following: "The bulk of the chronology of ancient Egypt is based on registered astronomical observations of Lunar dates and Heliacal rising of Sirius. These observations ... actually furnish astronomical anchors on which specialists can rely in dating the regnal periods of each Pharaoh. Unfortunately, besides a controversial proposal (Gautschy et al. 2017) the first available registrations come from the Middle Kingdom, so no Sothic anchor is as yet available for the Old Kingdom". For what is regarding the Sothic cycle and the Egyptian calendar, see please Sparavigna, 2024, <https://arxiv.org/abs/2411.08061>, where the reader can find further literature, besides that given by Magli.

Regarding Gautschy and coworkers' article, Magli does not explain what their proposal is, and why is "controversial" (he does not provide any reference about this controversy). The burden of proof is with Magli, because he mentioned the existence of a problem. However, the reader's convenience allows me to tell that Gautschy and coworkers, 2017, are discussing a "recently discovered inscription on an ancient Egyptian ointment jar [which] mentions the heliacal rising of Sirius. In the time of the early Pharaohs, this specific astronomical event marked the beginning of the Egyptian New Year and originally the annual return of the Nile flood, making it of great ritual importance". The researchers discuss the lunar calendar and provide a detailed list of inscriptions related to the heliacal rising of Sirius. In Puchkov, 2024, the author tells that the "Sothic chronology of the Old Kingdom has not yet been securely established because of the small number of suitable dates from this period". Puchkov considers the same jar discussed by Gautschy and coworkers, adding that "Since key features of the artifact cause dating controversy, it is not possible to benefit from this Sothic date, at least until a photo of the object becomes available". Here, the "controversy" (to my best knowledge, Puchkov is the only author referring to it).

## Chronology

Let us propose here two chronological lists from Gautschy and coworkers' paper. The following Table is giving the content of Table 3 in Gautschy et al., 2017, proposing the “absolute dates and number of counted regnal years” in Gautschy and coworkers' Low Chronology (left) and High Chronology (right) of the Old Kingdom. Note Thamphitis after Shepseskaf. Shepseskaf was not the last king of the fourth dynasty, according to Gautschy et al.

	Low Chronology			High Chronology	
Year	Y1 Pharaoh	Regnal Years	Year	Y1 Pharaoh	Regnal Years
2503 BCE	Khufu	30	2636 BCE	Khufu	30
2473 BCE	Djedefre	9	2606 BCE	Djedefre	9
2464 BCE	Chefrem	24	2597 BCE	Chefrem	24
2440 BCE	Baka	3	2573 BCE	Baka	3
2437 BCE	Menkaure	19	2570 BCE	Menkaure	19
2418 BCE	Shepseskaf	6	2551 BCE	Shepseskaf	5
2412 BCE	Thamphitis	4	2546 BCE	Thamphitis	2
2407 BCE	Userkaf	10	2544 BCE	Userkaf	10
2398 BCE	Sahure	19	2543 BCE	Sahure	19
2379 BCE	Neferirkare	14	2515 BCE	Neferirkare	14

The following screenshot is proposing the Table 4 Gautschy and coworkers (reason to propose a screenshot exists). The caption tells that the Table 4 is giving the “Absolute accession dates of selected pharaohs in different chronological models. From left to right: [Gautschy and coworkers'] Low Chronology; dates given in Hornung, et al., Chronology; Shaw, Oxford History; von Beckerath, “Chronologie”; the modelled 95% probability C14 accession dates of Dee, et al., “Radiocarbon-based Chronology”; and [Gautschy and coworkers'] High Chronology

Y1 Pharaoh	Low chronology	Hornung <i>et al.</i>	Shaw	von Beckerath	Dee (C14: 95%)	High chronology
1 Khufu	2503 BCE	2509 BCE	2589 BCE	2604/2554 BCE	2629–2558 BCE	2636 BCE
1 Shepseskaf	2418 BCE	2441 BCE	2503 BCE	2511/2461 BCE	2556–2476 BCE	2551 BCE
1 Djedkare	2331 BCE	2365 BCE	2414 BCE	2405/2355 BCE	2486–2400 BCE	2468 BCE
1 Unas	2294 BCE	2321 BCE	2375 BCE	2367/2317 BCE	2450–2364 BCE	2432 BCE
1 Pepy I	2256 BCE	2276 BCE	2321 BCE	2335/2285 BCE	2399–2310 BCE	2392 BCE
1 Pepy II	2201 BCE	2216 BCE	2278 BCE	2279/2229 BCE	---	2334 BCE

In the Appendix 1 of Magli’s arXiv, 2024, we find that “in table 1, four among the most accepted chronologies for the Old Kingdom are reported: (1) Baines and Malek (1981), (2) von Beckerath (1997), (3) Shaw (2000), (4) Hornung, Krauss and Warburton (2006) (the asterisks signal a short reign attributed to “Bicheris” in (2) and (3)).” Then, Magli is giving the Table according to three references (von Beckerath (1997), (3) Shaw (2000), (4) Hornung, Krauss and Warburton (2006)), which are the same used for their Table 4 by Gautschy and coworkers.

Therefore, let us compare the two Tables, in the case of king Khufu.

Table 1 from Magli, arXiv, 2024:

(2) von Beckerath (1997), (3) Shaw (2000), (4) Hornung, Krauss and Warburton (2006)

King	1	2	3	4
Khufu	2551-2528	2554-2531	2509-2483	2589-2566

Table 4 from Gautschy et al., “Absolute accession dates of selected pharaohs in different chronological models. ...”. I referred to this Table in my <https://arxiv.org/pdf/2411.08061>

Y1 Pharaoh	Low chronology	Hornung <i>et al.</i>	Shaw	von Beckerath	Dee (C14: 95%)	High chronology
1 Khufu	2503 BCE	2509 BCE	2589 BCE	2604/2554 BCE	2629-2558 BCE	2636 BCE

Three references are the same, but the years are different.

The burden of controlling the proposed Tables is with Magli and Gautschy and coworkers.

Magli continues: “The length of each single regnal period is subject to some uncertainty on its own, and each regnal period has to be considered within a safety band which in itself is difficult to estimate but cannot be less than, say,  $\pm 25$  years. It is thus seen that 2471 b.C. can be accommodated practically in all Shepseskaf chronologies. Further, if the astronomical dating of the Khufu pyramid that points to **2550** with an uncertainty not greater than  **$\pm 10$  years** for the **first year of Khufu** is accepted, than the “low” and the “high” chronologies of columns (3) and (4) are excluded.” Magli is not considering the High and Low chronology given by Gautschy et al. (the jar is “controversial”).

What does it mean that the regnal period has a “safety band”, what is the “safety band”? in the case of Egyptian chronology Why, this band cannot be “less than, say,  $\pm 25$  years”?

### The last members of the fourth dynasty

In Gautschy et al. we find Thamphitis after Shepseskaf. Shepseskaf was not the last king of the fourth dynasty, according to Gautschy et al. Let us stress that controversy is regarding a jar (Puchkov, 2024), not the fact that a further member of the fourth dynasty has been mentioned.

<https://pharaoh.se> is a “website mostly about the kings of ancient Egypt. Information provided "as is". © 2011–2024 Peter Lundström | v. 4.5. Errors & omissions are possible. Always check the sources! Creative Commons Attribution 4.0 License.

In <https://pharaoh.se/ancient-egypt/pharaoh/hordjedef/> we find the last member of the fourth dynasty, Hordjedef. “The ninth pharaoh of the Fourth Dynasty, a.k.a. Djedefhor. Hordjedef was a son of Khufu and half-brother of pharaohs Radjedef and Khafra. His name is mentioned on an inscription in Wadi Hammamat, written after the names of Khufu, Radjedef and Khafra, preceding the name of another of his brothers, Baufra. There is no evidence that either Hordjedef or Baufra ruled as a pharaoh, even though only pharaohs' names were written in cartouches during the 4th dynasty. The name appears with an added Ra sign, which implies that the inscription was not contemporary, but inscribed later, likely during the Middle Kingdom.” Predecessor is Thamphthis, successor is Userkaf, of the fifth dynasty.


<https://pharaoh.se/ancient-egypt/pharaoh/thamphthis/> Thamphthis is the eighth pharaoh of the Fourth Dynasty, a.k.a. Djedefptah, Ptahdjedef. “Thamphthis is possibly a hellenized version of Djedefptah or Ptahdjedef. Most likely he never ruled the kingdom, but Middle Kingdom tradition seem to venerate his name and somewhere along the line, his name was included among the already then ancient kings. There are no attestations and no archaeological records whatsoever of this king, if he ever existed. The name is only mentioned as the last king in Africanus list of Manetho's fourth dynasty.” Predecessor Baufra, Successor Hordjedef.

<https://pharaoh.se/ancient-egypt/pharaoh/baufra/> Baufra is the seventh pharaoh of the Fourth Dynasty, a.k.a. Baefra, Baufre, Baka, Bicheris, Bikka. “According to Africanus, Manetho named Bicheres as the successor to Suphis (Khafra) but there is no archaeological evidence for a king by that name. Herodotus and Diodorus writes that after Khufu died, his brother's Chephren (Khafra) took the throne, but Diodorus correctly adds that it was Khufu's son Chabryen (Radjedef) who ascended the throne. Khafra and Radjedef were in fact brothers, which shows that Herodotus and Diodorus simply misunderstood the relation told by the Egyptian priests, or that there were inconsistencies in the traditions about the fourth dynasty even in ancient Egypt. Maybe the earlier records (on papyrus) were corrupted and only partially readable. ...”. Predecessor Shepseskaf, Successor Thamphthis.

<https://pharaoh.se/ancient-egypt/pharaoh/shepseskaf/> Shepseskaf was the sixth pharaoh of the Fourth Dynasty. “According to the archaeological record. Shepseskaf was the last pharaoh of the fourth dynasty. The Turin papyrus and the Saqqara king list is damaged where the last rulers of the dynasty would be placed, and to make matters worse, they detail a different number of pharaohs between Khafra and Userkaf, the first ruler of the fifth dynasty. According to Africanus, Sebercheres was the seventh of eight kings in Manetho's fourth dynasty.”

Reign of <b>Shepseskaf</b>	
AE Chronology	2441–2436
v. Beckerath	2486–2479
Shaw	2503–2498
Dodson	2396–2392
Allen	2472–2467
Arnold	2454–2450
Malek	2460–2456
Redford	2523–2519
Turin King List	4 years
Manetho (Africanus)	7 years

Bicheris has his pyramid (Cagnino, 2021). In Budge, 1902, 2013, we find the following:

6.  SHEPSES-KA-F, Σεβερχέρης  
(Herodotus, *Ἀσυχίς*).

According to the Tablet of Abydos, Men-kau-Rā was followed by SHEPSES-KA-F, but Manetho names one Bicheris as his successor, and says that he reigned twenty-two years; Bicheris may be either a corruption of the name Shepses-ka-f, or another name of the king, but in any case it is perfectly certain from the evidence of the monuments<sup>1</sup> that Shepses-ka-f followed Men-kau-Rā in the rule of Egypt. According to Herodotus ...

The burden to prove that Shepseskaf was the last king of the fourth dynasty is with Magli. In Budge, 1902, new edition 2013, we find also what Herodotus reports about the Shepseskaf tomb. “The pyramid here mentioned was undoubtedly built of mud bricks, but that it is to be identified with the Pyramid of Shepses-ka-f, which was called “Qebh” is very unlikely.” (Budge, 1902).



**Shepseskaf**

**Coordinates**  29°50'20"N 31°12'55"E

**Ancient name**   
[a]  
  
Qebh Shepseskaf  
Qbh Špss k3=f  
"Shepseskaf is cool" or "cool place of Shepseskaf"<sup>[1]</sup>

**Constructed** c. 2500 BC

Screenshot from [Wikipedia](#). “Instead of the last sign, which depicts a pyramid, a similar sign without a point signifying 'mastaba' must have actually been used, which cannot be shown for technical reasons.” Ref.[1] is Gundacker, 2009.

The mastaba of mud bricks is also shown in <https://egyptphoto.ncf.ca>: “The riddle of why Shepseskaf built his tomb here, and why he chooses a mastaba like structure is not yet resolved by Egyptologist. Certainly, it has something to do with the transition from the 4th to the 5th dynasties.” No reference given. “Certainly”, why “certainly”?

<https://www.britannica.com/place/Saqqarah#ref633419>; “Shepseskaf of the 4th dynasty (c. 2575–c. 2465 bce) built Maṣṭabat Fir'awn, a coffin-shaped tomb, and several kings of the 5th dynasty (c.

2465–c. 2325 bce) also constructed their pyramids at Saqqārah. Unas, the last king of the 5th dynasty, was the first to inscribe on the walls of his pyramid chambers the Pyramid Texts, ... Succeeding kings of the 6th dynasty (c. 2325–c. 2150 bce) continued the practice of inscribing Pyramid Texts in the underground chambers. With the exception of Teti, the 6th-dynasty kings built their pyramids to the south of Unas's pyramid, and the most southerly is that of a 13th-dynasty (c. 1756–c. 1630 bce) king”.

### The Userkaf tomb (pyramid)

“The pyramid complex of Userkaf was built c. 2490 BC[1] for the king Userkaf, founder of the 5th Dynasty of Egypt (c. 2494–2345 BC). It is located in the pyramid field at Saqqara, on the north-east of the step pyramid of Djoser. Constructed in dressed stone with a core of rubble, the pyramid is now ruined and resembles a conical hill in the sands of Saqqara.[1] For this reason, it is known locally as El-Haram el-Maharbish, the "Heap of Stone",[2] and was recognized as a royal pyramid by western archaeologists in the 19th century” ([Wikipedia](#), mentioning [1] Lenher, 1997, and [2] Lauer, 1988).

“The complex is markedly different from those built during the 4th Dynasty (c. 2613–2494 BC) in its size, architecture and location, being at Saqqara rather than the Giza Plateau. As such, Userkaf's pyramid complex could be a manifestation of the profound changes in the ideology of kingship that took place between the 4th and 5th dynasties,[1] changes that may have started during the reign of Userkaf's likely immediate predecessor, Shepseskaf.[5]” (Wikipedia, mentioning [1] Lehner, 1997, and [5] Shaw (Ed.), 2000).

### Dating the pyramids

In Magli's arXiv, we find: “Unfortunately, besides a controversial proposal (Gautschy et al. 2017) the first available registrations come from the Middle Kingdom, so no Sothic anchor is as yet available for the Old Kingdom. *However*, astronomy in Egypt can be measured also in architecture. In particular, *strong hints* pointing to the planning of the Khufu pyramid – **and thus to Khufu's first year - in 2550 bC. with the impressive uncertainty of only 10 years** come from the alignment of this pyramid to the cardinal points” (Magli mentioning Belmonte, 2001).

Magli does not propose dates for the other kings from Belmonte. For further references, see Puchkov, 2023.

In Belmonte, 2001, we find the following (screenshot from the copy of the article at <https://adsabs.harvard.edu/pdf/2001JHAS...32....1B>)

According to my proposal, the pyramid of Khufu would have been aligned between 2571 and 2565 B.C., at a time when Phecda and Megrez were at upper culmination, since, as we shall see below, with the pair of stars at lower culmination, the dates (2559 to 2553 B.C.) do not fit the chronological pattern accurately. If we assume, following Spence, that the alignment was carried out in the first years of

... (see the further discussion in Belmonte, 2001).

Spence is Spence, 2000.

In the Table 1 from Belmonte, 2001, we have the dates of other kings. Please consider the following Table adapted from a screenshot of the Belmonte's work.

King	Regnal Years	High <sup>1</sup> Chronology	Low <sup>1</sup> Chronology	Pyramid	Dates New Proposal
Huni	24	2637–2613	2600–2575	<i>Meidum</i>	Sometime between 2649 and 2601
Snofru	24 to 48 30 <sup>6</sup>	2613–2589	2575–2551	<i>Meidum</i> <i>Shining South</i> <i>Shining (Red)</i>	2601–2577 <i>If 30: 2607–2577</i> <i>If 48: 2625–2577</i>
Khufu (Cheops)	23	2589–2566	2551–2528	Horizon's	2577–2554
Djedefre	8	2566–2558	2528–2520	Sehedu Star	2554–2547
Khafre (Chephren)	25	2558–2532	2520–2494	Great	2547–2522

Note the new proposal of dates by Belmonte. The high chronology is from Malek, and the low chronology from Baines and Malek. According to Table 1 from Belmonte, the reign of Khufu lasted from 2577 BC to 2554 BC. The first year was 2577 BC.

We can find in Belmonte's text the note 30.

30. The most widely accepted chronology for the Old Kingdom, according to Spence (private comm.) is that from von Beckerath, *op. cit.* (ref. 13). However, earlier dates have been proposed, for example by J. Malek, "The Old Kingdom" in *The Oxford history of Egypt*, ed. by I. Shaw (Oxford, 2000), 89–117, and by P. A. Clayton, "Crónica de los Faraones" (Madrid, 1996), 30. The lowest dates in the literature can be found in the outdated "Egipto: Dioses, templos y faraones", *Atlas culturales del mundo*, by J. Baines and J. Malek (Barcelona, 1988), 36.

Regarding Khufu, Robinson, 2022. "Without a doubt, the Great Pyramid was commissioned by the Old Kingdom pharaoh Khufu (Cheops). The British Museum and Cairo's Egyptian Museum give his regnal dates as 2589 to 2566 BCE. Egyptologists Mark Lehner, who has conducted fieldwork at Giza for four decades, and Zahi Hawass, a former Egyptian government official in charge of Giza, argued for the later range of 2509 to 2483 BCE in their massive 2017 book, *Giza and the Pyramids*. But another high-profile Egyptologist, Pierre Tallet, whose pioneering fieldwork on the Red Sea coast of Egypt began in 2011, favors the earlier range of 2633 to 2605 BCE, derived from a recent astronomically based chronological model for the Old Kingdom" (Robinson, 2022).

### Seller's Table

Regarding the eclipse of 2471 BC, Magli is mentioning Sellers, 1992, in the following manner: "So, we are led to search if a total solar eclipse occurred on Lower Egypt in a date compatible with Shepseskaf first year. This eclipse actually exists and occurred in the morning of April 1, 2471 b.C. (this fact has been noticed before but without deepen the investigation by Sellers (1992) and Magli (2013))." The book by Sellers is available thanks to archive.org.

Page 132: "In 2471 BC a total solar eclipse is predicted to have taken place over the sacred city of Pe, north on the Delta."

Page 277: Pe 1 April 2471 Userkaf c. 2480 (Dyn. 5).



Page 286: On 1 April 2471 BC at 7:23 a.m., with the sun large on the horizon, a total eclipse is predicted to have been witnessed by the inhabitants of the sacred city of Pe, a city North in the Delta. At Memphis and Heliopolis this eclipse of 2471 BC would have been seen as near total”.

In Sellers’ book, we do not find Shepseskaf, but we find Userkaf. At page 277 of the book, we find the following Table, and we have the King Userkaf.

City	Date (BC)	King	Conjectured accession date (BC)
Nekhen	5 Feb 3109	Menes	c. 3110 (Dyn. 1 – Parker)
Thinis	28 Feb 3046	Aha	c. 3048 (Dyn. 1 – Manetho)
Pe	1 April 2471	Userkaf	c. 2480 (Dyn. 5 – Gardiner)
Nekhen	23 March 2340	Teti	c. 2341 (Dyn. 6 – Parker)
Memphis	29 June 2159	Akhtoy	c. 2154 (Dyn. 9 – Parker) <sup>3</sup>
Iwnw	11 Sept 2079	Unknown	c. 2100 (Dyn. 9)
Memphis	9 May 1533	Amosis	c. 1540 (Dyn. 18) <sup>4</sup>
Akhetaten	14 May 1338	Tutankhamun	c. 1334 (Dyn. 18 – Wente) <sup>5</sup>
Thebes	31 July 1063	Amenemnisu	c. 1063 (Dyn. 21 – Kitchen, his alternative dates) <sup>6</sup>

In Kelley and Milone, 2011, we find also Userkaf.

TABLE 8.3. Egyptian dynastic eclipses.\*

	Chronology		Egyptian capitals	Total solar eclipse dates over capitals
	Gardiner (dates)	Clayton (dates)		
I	Narmer/Menes (3100 ± 150)	0 Scorpion (3150) 0 Narmer (3050)	Nekhen Thinis	3109 Feb. 5 3046 Feb. 28
V	(2480)	I Aha/Menes (3050) V Userkaf (2498)	Pe	2471 Apr. 1
VI	(2340)	VI Teti (2345) IX Meryibre (2160) Intef III (2069)	Nekhen Memphis Heliopolis	2340 Mar. 23 2159 June 29 2079 Sept. 11
XVIII	(1575) Smenkare (1350) Tutankhamen (1347)	XVIII Ahmose I (1570) Smenkare (1336) Tutankhamen (1334)	Memphis Akhetaten	1533 May 9 1338 May 14
XXI	(1087) (1061)	XXI Nesbanebjed (1069) Amenemnisu (1043)	Thebes	1063 July 31
XXII	(945)  Wahibre (589–570)	XXII Shoshenq I (945) Shoshenq III (825) Wahibre (589–570)	Thebes Tanis Sais	948 May 22 831 Aug. 15 582 Sept. 21

\* Dynasties are indicated by Roman numerals (see Table 8.1). All dates are B.C.

How deep was the investigation made by Sellers? Here, in the following screenshot the discussion by In Kelley and Milone, 2011.

Sellers also found some suggestive evidence that dynastic changes in Egypt sometimes occurred following an eclipse that was total at the capital of the particular dynasty that lost power. Given uncertainties in the backcalculation of eclipses and other uncertainties in the calculation of ancient Egyptian chronology, it would be rash to consider this more than a reasonable hypothesis, but given the identification of the Pharaoh as the son of the Sun, one would expect solar eclipses to be regarded as extremely bad omens. The coincidences of dynastic changes with eclipse dates as calculated by Sellers (1992, p. 277), shown in Table 8.3, are more than we would have expected. We should make it clear that Sellers is proposing a causal connection based in the emotional reactions of the Egyptian people in terms of their mythology. If there was such a correlation, later people might have interpreted it as astrological causation, but nothing indicates that this was an idea present in Egypt earlier than, perhaps, the time of the Assyrian invasions.

In fact, Sellers, 1992, was the first researcher that linked eclipses to dynastic changes.

### **The magnitude of an eclipse**

Smith, 2012, part 2: “Research has suggested that eclipses at a particular place tend to occur in clusters especially if they occur at sunrise or sunset. Such eclipses, as will be seen later, may allow the obscuration of the solar disk to be much more obvious and therefore more likely than normal to have been noticed. Brewer (1991, p.70) illustrates the flavour of the apparently random nature of the recurrence interval by quoting a table of examples ranging from 837 years for London (from 29 Oct 878 AD to 22 Apr 1715 AD) to 1½ years in Southern New Guinea (from 11 Jun 1983 AD to 22 Nov 1984 AD), listing two for places in Egypt – 312 years for Giza (1 Apr 2471 BC to 29 June 2159 BC) and 9 years for Thebes (31 May 957 BC to 22 May 948 BC). Although total eclipses are rare, near total eclipses are more common but can be almost as dramatic. The precise degree of darkness achieved during a solar eclipse will depend on many factors, including the time of day, weather conditions and the cloudiness of the sky, but the major factor in determining this will be how much of the solar disk is covered by the moon. Astronomers call this the magnitude of the eclipse, measured simply by the linear fraction of the solar disk obscured by the moon ... . In practice this magnitude ( $\mu$ ) can range from 0, when the moon’s disk is about to touch the sun’s disk, up to 1.08, when the moon’s disk appears slightly larger than the sun.”

Smith, 2012, part 1: “Solar eclipses in Egypt have been discussed by several researchers in recent years. *Sellers* (1992) considered that there may have been a link between such events and Pharaonic accession, while *Ibrahem* studied possible correlations of solar eclipses with key events or inscriptions, although the eclipse predictions he used are no longer accurate. *Aubourg* (1995), using the motions of the planets to study the dating of the Zodiac of Dendera, ... . This research, however, has been disputed recently and a different dating ... *McMurray* (2003 & 2004), using the latest predictions, notes the possible influence of a solar eclipse on Akhenaten and has also been attempting to correlate lunar and solar eclipse dates with dateable inscriptions to try to develop an absolute chronology. *Ryholt* (2011) has concluded that the association with astrology of Necho II (who gained the epithet ‘the wise’) may have been due to an historical eclipse marking the beginning of his reign – the same eclipse mentioned in the Neue demotische Erzählung but which was associated there with the earlier death of Necho II’s predecessor Psammetichus. However, more recently *Park* (2012) has

argued that Ryholt's analysis does not put forward sufficient evidence ... Although this [Smith's] paper concerns work on eclipses in Ancient Egypt, it is worth noting in passing the related work on the Asiatic Campaigning of Horemheb (*Redford 1973*) which has implications for Egyptian chronology because of the political relationship and interaction between the Egyptian and the Hittite empires. Redford draws attention to the annals of Mursilis II's tenth year which mention an "omen of the sun", generally accepted as a solar eclipse. Drawing upon his earlier work in this area, he argues that this is likely to have been the eclipse of March 13th 1335 BC and proceeds to use this date to determine an absolute chronology of Thutmose III to Horemheb. Recent research has suggested that this date is too early and that there are other more likely candidates for this eclipse. The first is that of 24th June 1312 BC, which passed over Northern Anatolia close to Hattusa where Mursilis II and his men were likely to have been based (*Bryce 1998*). An alternative view has been put forward that the eclipse was instead that of 13th April 1308 BC (*Åström, 1993*)" (Smith, 2012).

Smith is mentioning Gaultschy, 2012.

### **$\Delta T$ and its uncertainty**

Gaultschy, 2012: "For many centuries, the fundamental unit of time was the rotational period of the Earth with respect to the Sun. Universal Time (UT), also called Greenwich Mean Time (GMT), is based on the mean solar time at Greenwich. Unfortunately, UT is not a uniform time scale over historical times because Earth's rotational period gradually decreases. Therefore, the calculation of local circumstances of solar eclipses in the far past is subject to uncertainties. As the Earth rotates, tidal friction, inflicted by the gravitational attraction of the Moon and the Sun is at work. The result is a transfer of angular momentum from the Earth to the Moon. The Earth loses energy and slows down, the Moon gains energy and its distance from the Earth increases. Today, atomic clocks are used for accurate timekeeping. Terrestrial Dynamical Time (TDT) is such an atomic time scale. Solar eclipse calculations are based on TDT, the position of the visibility area of an eclipse depends however on UT. Calculations from TDT have to be converted into UT; therefore the time difference between TDT and UT must be known. This time difference, called  $\Delta T$ , which adds up to about 12 hours around 2000 BC and the uncertainty of  $\Delta T$  - about 2 hours in 2000 BC - has to be taken into account in the calculations. For more information about  $\Delta T$  see e.g. the webpage of Robert van Gent" (Gaultschy, 2012). <https://www.gaultschy.ch/~rita/archast/solec/solec.html>

### **A controversy**

Here a "controversy" about Egyptian eclipses.

We can find a proposal from Andis Kaulins <AKaulins@AOL.COM>, Tuesday, July 10, 2001 2:59 PM Subject: Solar Eclipses - Absolute Chronology of Egypt. The title is THE ABSOLUTE CHRONOLOGY of the PHARAOHS by SOLAR ECLIPSES IN EGYPT". <https://eclipse.gsfc.nasa.gov/SENL/SENL200108A.pdf>

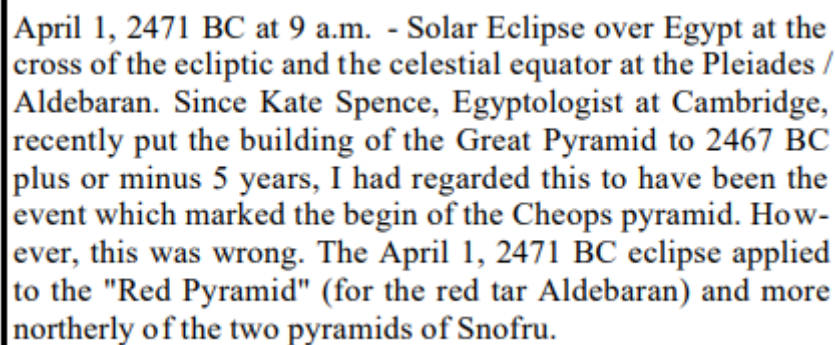
"The first original hypothesis presented [by Kaulins] is that Pharaohs put their pyramids and tombs on the paths of solar eclipses and that this can be calculated to a day. A second original hypothesis is that the causeways to the pyramids may mark the path of the eclipse in question. A third hypothesis is that these eclipses are "archived" in the hieroglyphs of the Pharaohs as their "name" - e.g. the "shaded" or "eclipsed" object in the hieroglyph of Cheops. Fourth, there is the original hypothesis that the RA or "Sun Name" of a pharaoh in the cartouche gives the position of the Sun in the heavens

and the "AMUN-name" of a pharaoh shows the position of the Moon. Possibly, the analysis below may also permit astronomers to get an absolutely accurate T-Delta value regarding the change in the rate of the spin of the earth in the last 5000 years (there is dispute about this value among astronomers). To obtain the correct value, I would suggest a combination of approaches to get a properly calibrated Delta T value ...” (Kaulins, 2001). See further discussion in the Newsletter.

<https://eclipse.gsfc.nasa.gov/SENL/SENL200108A.pdf>

“The idea of eclipses as being of such great importance came from a posting to me by ChasInca on Shalmaneser (Solomon-Nezer) and from the internet page of Amir Bey ... who used the following sources -Solar Eclipses of the Ancient Near East, by M. Kudlek and E.H. Mickler. ---The Canon of Solar Eclipses, by J. Meeus and H. Mucke -Solar Fire 4.07, a software program developed by Esoteric Technologies -Lunar Eclipses of the Ancient Near East by M. Kudlek and E. H. Mickler Bey's data of course is subject to verification but - he provides a great graph of the path of the eclipses - and I think that his data will in general be confirmed” (Kaulins, 2001).

The Amir Bey discussion is in [web.archive.org](http://web.archive.org).

A screenshot of text from a newsletter, enclosed in a black rectangular border. The text discusses a solar eclipse on April 1, 2471 BC, and its connection to the Great Pyramid of Giza. It mentions that the eclipse occurred at the cross of the ecliptic and the celestial equator at the Pleiades / Aldebaran. The text also notes that Kate Spence, an Egyptologist at Cambridge, recently dated the building of the Great Pyramid to 2467 BC, plus or minus 5 years. The author states that they had previously regarded this as the event marking the beginning of the Cheops pyramid, but that this was incorrect. The correct event, according to the author, is the April 1, 2471 BC eclipse, which applied to the "Red Pyramid" (for the red star Aldebaran) and was more northerly than the two pyramids of Snofru.

April 1, 2471 BC at 9 a.m. - Solar Eclipse over Egypt at the cross of the ecliptic and the celestial equator at the Pleiades / Aldebaran. Since Kate Spence, Egyptologist at Cambridge, recently put the building of the Great Pyramid to 2467 BC plus or minus 5 years, I had regarded this to have been the event which marked the begin of the Cheops pyramid. However, this was wrong. The April 1, 2471 BC eclipse applied to the "Red Pyramid" (for the red star Aldebaran) and more northerly of the two pyramids of Snofru.

This is the screenshot from Kaulins, regarding the eclipse of 2471.

The newsletter was open to comment. And then we find the following from R.H. van Gent [r.h.vangent@PHYS.UU.NL](mailto:r.h.vangent@PHYS.UU.NL). Van Gent criticized Kaulins.

R. van Gent observes: “The recent attempt of Andis Kaulins to re-date the ancient history of Egypt by means of solar eclipses provides a nice example of the various pitfalls one can fall into. ... Andis Kaulins is probably unaware that he is here following a process that in the past Robert R. Newton has aptly named the 'eclipse game'. These are the rules:

- a) Find an ambiguously stated historical record and convince yourself that it can only refer to a total solar eclipse and nothing else.
- b) Make sure that the record cannot be dated chronologically within the nearest half century or so.
- c) Find the nearest solar eclipse in time from a calculated list of eclipses that satisfies your interpretation of the record. Preferably pick an eclipse list that is not too specific as to how it was calculated.
- d) Date the record with the help of this eclipse and convince historians that the record has now been dated firmly with the help of precise astronomical techniques.


e) Some years later, astronomers will stumble across this record in a historical publication (probably several removes away from the original publication), believe that it has been dated firmly by historical means and determine an improved value of Delta T for that epoch. This Delta T value can then be used to calculate 'improved' eclipse tables for the aid of historians.”(Van Gent, 2001)

“It cannot be stressed too much that historical dates inferred in this way are completely meaningless unless they can be corroborated by other means.” (Van Gent, 2001).

“Concluding, I cannot say that I am in the least convinced by Andis Kaulin's astronomical re -dating of the ancient history of Egypt by means of his suggested eclipse records. For me his theory already fails in step (a) of the above mentioned 'eclipse game'. I see no reason why every ancient Sun symbol (or even round symbol) should have to refer to a solar eclipse. There may certainly be hidden eclipse records in Egyptian texts and inscriptions but I do not believe them to be found in the names and cartouches of the Egyptian pharaohs. Sun symbols can mean a lot of things, not all necessarily related to astronomy. The University of Utrecht also uses a solar image in its logo but there is definitely no link with any solar eclipse visible from Utrecht around the date of its founding (though I am sure there will be people in a far distant future who will be tempted to interpret it as such)” (Van Gent, 2001).

## Akhet Khufu

In Magli, 2024, we find: “Khufu will indeed build his pyramid on the Giza plateau, in plain view from Heliopolis (the main theological centre of the cult of Ra), and will make an explicit reference to the sun cult with the spectacular hierophany occurring at Giza at the summer solstice re-creating the “solarized” version of the double mountain sign, Akhet (Lehner 1985, Shaltout et al. 2007, Magli 2008)”.

double mountain sign, Akhet 

The Fig.13 in Shaltout et al., 2007, shows the “hierophany”, corresponding to the “solarized” horizon.

I do not repeat what I wrote in <https://arxiv.org/pdf/2411.08061>. The reader can find the discussion at Page 11 of this work. I stress reading my article, to understand the fundamental importance of the Wadi al-Jarf papyri, discovered by Pierre Tallet, 2017. **The papyri are of Khufu’s time: SEE PLEASE THE POPYRUS at [the-past.com](http://the-past.com)** and note the AKHET below the Khufu’s cartouche.

Here Fig.2, in <https://arxiv.org/pdf/2411.08061>



*Fig.2: On the left: Hieratic version of the crested ibis (adapted from the image courtesy of Wionvard, [Wikipedia](https://en.wikipedia.org/wiki/File:Wionvard_-_Crested_Ibis_-_Hieratic.png), CC BY-SA 4.0). On the right: See again the Merer’s papyrus, day 22, [second part of the day](https://www.egyptology.com/egyptology/egyptology-2017-07-22-merer-papyrus-day-22/), below the Khufu’s cartouche.*



This is the AKHET that KHUFU knew, AKHET the CRESTED IBIS; not the horizon with a disk between two hills. Magli must show a text of Khufu’s time where AKHET is written with a disk and two hills, not a picture of two pyramids and the sun setting between them. The burden of proof is with Magli.

## References

1. Aubourg, É. (1995). La date de conception du zodiaque du temple d'Hathor à Dendera. *Bulletin de l'Institut Français d'Archéologie Orientale du Caire*, (95), 1-10.
2. Åström, P. (1993). The Horizons of the Sun in the Tenth Year of the Reign of Mursilis II, in *Horizons and Styles: Studies in Early Art and Archaeology in Honour of Professor Homer L. Thomas*.
3. Baker, D. D. (2008). *The Encyclopedia of the Pharaohs: Volume I*. London: 80
4. Bauval, R. (2013). The "Giza Diagonal" and the "Horizon of Khufu": True or False?. In *Imhotep the African*, Bauval & Brophy, Academia.edu
5. Bauval, R., & Brophy, T. (2013). *Imhotep the African: Architect of the cosmos*. Red Wheel Weiser.
6. Belmonte, J. A. (2001). On the orientation of old kingdom Egyptian pyramids. *Journal for the History of Astronomy*, 32(26), S1-S20.
7. Beckerath, J. (1997). *Chronologie des Pharaonischen Ägypten*. Mainz am Rhein: Philipp von Zabern.
8. Beckerath, J. (1999). *Handbuch der ägyptischen Königsnamen*, Second edition, MÄS 49: 53–54
9. Brewer, B. (1991). *Eclipse*, Seattle, Washington, Earth View
10. Bryce, T.R. (1998). *The Kingdom of the Hittites*, Clarendon Oxford University Press
11. Budge, E. A. (2013). *A History of Egypt from the End of the Neolithic Period to the Death of Cleopatra VII BC 30 (Routledge Revivals): Vol. II: Egypt Under the Great Pyramid Builders*. Routledge.
12. Cargnino, P. (2021). La Piramide di Baka o Bicheris. *La Civiltà Egizia*. <https://laciviltaeegizia.org/2021/01/27/la-piramide-di-baka/>
13. Dee, M.W. (2013). A Radiocarbon-based Chronology for the Old Kingdom. In *Radiocarbon and the Chronologies of Ancient Egypt*, A.J. Shortland and C. Bronk Ramsey, eds. 209–217. Oxford: Oxbow Books.
14. Gautschy, R. (2012). Canon of solar eclipses from 2501 to 1000 AD dated Jan 2011, <http://www.gautschy.ch/~rita/archast/solec/solec.html>
15. Gautschy, R. (2012). Sonnenfinsternisse und ihre chronologische Bedeutung: Ein neuer Sonnenfinsterniskanon für Altertumswissenschaftler. *Klio*: Vol. 94, No. 1, pp.7-17.
16. Gautschy, R., Habicht, M. E., Galassi, F. M., Rutica, D., Rühli, F. J., & Hannig, R. (2017). A new astronomically based chronological model for the Egyptian Old Kingdom. *Journal of Egyptian History*, 10(2), 69-108.
17. Gundacker, R. (2009). Zur Struktur der Pyramidennamen der 4. Dynastie. In: *Sokar*, Nr. 18, 2009, S. 26–30.
18. Hawass, Z. (2024). *Mountains of the Pharaohs: The Untold Story of the Pyramid Builders*. American University in Cairo Press.
19. Hawass, Z. A., & Lehner, M. (2017). *Giza and the Pyramids. The Definitive Account of the Greatest Archaeological Site by the World's Leading Experts*. Thames & Hudson Limited.
20. Hornung, E., R. Krauss, & D.A. Warburton, eds. (2006). *Ancient Egyptian Chronology*. HdO I/83. Leiden: Brill.
21. Ibrahim, A. (2011). Egyptian Cosmology, <http://www.eclipsechasers.com/Akhet.html>,
22. Ibrahim, A. (2011). The Philosopher Pharaoh and the Total Solar eclipse, <http://www.jas.org.jo/pharo.html>

23. Ibrahem, A. (2011), Wonders of the Sun, <http://www.jas.org.jo/wsun.html>
24. Kaulins, A. (2001). The Absolute Chronology of the Pharaohs by Solar Eclipses in Egypt, *Solar Eclipse Newsletter*, August 2001. Volume 6, Issue 8, Page 8.
25. Kelley, D. H., & Milone, E. F. (2011). *Exploring ancient skies: A survey of ancient and cultural astronomy* (p. 82). New York: Springer.
26. Kudlek, M., & Mickler, E. H. (1971). *Solar and Lunar Eclipses of the Ancient Near East from 3000 b. c. to 0 with Maps* (Vol. 1). Butzon & Bercker.
27. Lauer, J.-P. (1988). *Saqqarah, Une vie, Entretiens avec Phillippe Flandrin*, Petite Bibliotheque Payot 107, 1988, ISBN 2-86930-136-7
28. Lehner, M. (1985). Giza. A Contextual Approach to the Pyramids. *Archiv für Orientforschung* 32, 136-158.
29. Lehner, M. (1997). *The Complete Pyramids*. Thames and Hudson, New York.
30. Lehner, M. (2009). Capital zone walk-about 2006: spot heights on the third millennium landscape. *Giza Occasional Papers*, 3, 97-151.
31. Lehner, M. (2020). Merer and the Sphinx, in *Guardian of Ancient Egypt, Studies in Honor of Zahi Hawass*. ISBN: 978-80-7308-980-1, [https://www.academia.edu/87151707/Merer\\_and\\_the\\_Sphinx](https://www.academia.edu/87151707/Merer_and_the_Sphinx)
32. Lehner, M., & Tallet, P. (2022). *The Red Sea scrolls: how ancient papyri reveal the secrets of the pyramids*. Thames & Hudson.
33. McMurray, W. (2003). Dating the Amarna Period in Egypt: Did a Solar eclipse Inspire Akhenaten? <http://www.egiptomania.com/EEF/EEFLibrary4.html>
34. McMurray, W. (2004). Towards an Absolute Chronology for Ancient Egypt <http://www.egiptomania.com/EEF/EEFLibrary5.html>
35. Magli, G. (2024). The April 1, 2471 b.C. eclipse and the end of 4th Egyptian dynasty. arXiv preprint arXiv:2412.13640.
36. Mucke, H., & Meeus, J. (1992). *Canon of solar eclipses:-2003 to+ 2526*.
37. Park, R. (2012). The Recorded Solar Eclipse of Nectanebo I. Read in Birmingham at CRExiii, 30 March 2012
38. Puchkov, A. (2023). Multi-star Target Model for Astronomical Orientation of the Old Kingdom Egyptian Pyramids, *The Oriental Studies*, 2023, 91.
39. Puchkov, A. (2024). Sothic Dating of the Egyptian Old Kingdom, *The World of the Orient*, 1, 43.
40. Redford, D.B. (1973). New Light on the Asiatic Campaigning of Horemheb, *Bulletin of the American Schools of Oriental research*, No 211, pp. 36-49
41. Robinson, A. (2022). Deciphering Egypt's Great Pyramid. *Science*, 375(6576), 34-34
42. Ryholt, K. (2011). New Light on the Legendary King Nechepsos of Egypt, *JEA* 97, pp. 61-72
43. Sellers, J. (1992) *The Death of Gods in Ancient Egypt* Penguin, London.
44. Shaltout, M., Belmonte, J. A., & Fekri, M. (2007). On the orientation of ancient Egyptian temples:(3) Key points at lower Egypt and Siwa Oasis, Part II. *Journal for the History of Astronomy*, 38(4), 413-442.
45. Shaw, I., ed. (2000). *The Oxford History of Ancient Egypt*. Oxford: Oxford University Press.
46. Smith, D. G. (2012). Solar Eclipse Events in the New Kingdom. Part 1— Texts and Funerary Material. *Egyptological Journal, Articles*, 5.
47. Smith, D. G. (2012). Solar Eclipse Events in the New Kingdom. Part 2—Astronomical Analysis. *Egyptological Journal, Articles*, 6.

48. Sparavigna, A. C. (2024). Timekeeping at Akhet Khufu, as shown by the Diary of Merer. arXiv preprint arXiv:2411.08061.
49. Spence, K. (2000). Ancient Egyptian chronology and the astronomical orientation of pyramids. *Nature*, 408(6810), 320-324.
50. Tallet, P. (2017). *Les Papyrus de la Mer Rouge I: Le Journal de Merer*. Institut français d'archéologie orientale. ISBN 978-2724707069.