



A NEW ASTRONOMICAL DATING OF THE TROJAN WAR'S END

Papamarinopoulos S.¹, Preka-Papadema P.², Mitropetros P.³, Antonopoulos P.⁴,
Mitropetrou E.³, Saranditis G.⁵

¹*University of Patras, Department of Geology, 26504 Rio Patras, Greece*

²*University of Athens, Department of Astrophysics, Astronomy and Mechanism, Faculty of Physics, 15784 Athens, Greece*

³*Keratsini, Piraeus, Greece*

⁴*University of Patras, Department of Physics, 26504 Rio Patras, Greece*

⁵*Byron, Athens, Greece*

Received: 12/04/2013

Accepted: 27/06/2013

Corresponding author: ppreka@phys.uoa.gr

ABSTRACT

A solar eclipse's evolution was described in the Iliad *in a stepwise* mode manifested in *increasing* gradual darkness, during a warm day at late noon; from Sarpedon's death time to few later from Patroclus' death time. We examined the solar eclipses within the time span 1400-1130 B.C. and we found that only the annular solar eclipse on 6th June 1218 yr B.C. observable in Troy with significant obscuration 75.2 % fits fully with the Homeric descriptions.

KEYWORDS: Homer, Iliad, solar eclipse, Trojan War, Achilles shield, Patroclus

1. INTRODUCTION

The Mycenaean civilization started within the 16th century B.C. peaked at the middle of 13th century B.C. and ended during a period of 50 years due to fires and seismic activity within 1130 yr B.C. The excavations have already discovered nine layers of the town of Troy. Archaeologists proposed various dates corresponding in the layers VI and VII as well VIIa or VII correspond to the Υ E III B 2 (Late Mycenaean B Age or Late Bronze Age) whether or not they accept the Trojan War's reality (Table 1). Also, the ancient writers have given various dates of the Trojan War (see Table 2 in Papamarinopoulos *et al* (2012)).

It is known that some astronomical events are described in the Homeric epics (Theodossiou *et al.*, (2011)). Among them, a solar eclipse mentioned by Heraclitus of Pontus (*Allegories*, 75, 1, 1-9, 3), is described in the *Odyssey* during the suitors killing (Od. 20. 356-357). Schoch (1931), Papamarinopoulos (2008) and Baikouzis and Magnasco (2008) indicated that the so referred solar eclipse was a total one, that of the 16th April 1178 yr B.C. However, Papamarinopoulos *et al* (2012) studied the Homeric text's details (climate, plants, fruits, agricultural and bucolic scenes, the long lasting nights, the constellations description etc.) and concluded that Odysseus' arrival was *autumn* and not spring. The authors justified that the annular solar eclipse of the 30th October 1207 yr B.C. observable from the Ionian Islands as a partial one with significant obscuration of 75% is that mentioned by Homer.

Henriksson (2012) indicated the occurrence of another solar eclipse described in the *Iliad* (Il.17.366-377) and proposed the total solar eclipse of the 11th June 1312 yr B.C. (Gregorian calendar) based on his own calculations, whereas in accordance with the NASA's site Xavier Jubier "*Five Millennium (-1999 to +3000) Canon of Solar Eclipses Database*" the corresponding date of this solar eclipse is the 24th June 1312 yr B.C. (Julian calendar). In this paper the above reference will be called *NASA catalog* (Stephenson and Houlden (1986), Stephenson and Morrison (1984), Stephenson (1997), Espenak and Meeus (2006) and (2009a, b, c), Morrison and Stephenson (2004)). However, Henriksson *ignored to connect his proposed date with the solar*

eclipse's date described in Odyssey after 10 years (because the Homeric epics clearly mention that Odysseus was absent for 20 years from Ithaca and the Trojan War duration was 10 years). Indeed, a solar eclipse of the 17th November of 1301 yr B.C. (based on NASA catalog) was visible in the Ionian Islands as a partial one with obscuration 46%. However, the timing was early in the morning (start at 6.53 LT, peak at 7:39 LT and end at 10.03 LT). It is not associated with the suitors killing time, at late noon. Moreover, the planet Venus was visible in the eastward direction five days before this solar eclipse in accordance with Homeric text (Od.13.93-95). On the contrary, planet Venus on the 12th of November 1301 yr B.C. was not visible in the east horizon because Venus rose at 8:31 LT, when sunrise was at 7:11 LT. Venus was visible in the westward direction and set at 18:24 LT whereas the sunset was at 17:42 LT, according to *Starry Night 6 Pro Plus* software calculations (2006). In other words no other solar eclipse has been found in the Ionian Islands *ten years after* the Trojan War's end and the same being *in accordance* with the Homeric descriptions.

We note further, that there was not a visible solar eclipse in Troy, ten years *before* the proposed by Baikouzis and Magnasco (2008) solar eclipse in April 1178 yr B.C., in other words in 1188-1189 yr B.C. in accordance with NASA's catalog. However, the annular solar eclipse of the 6th June 1218 yr B.C. observed in Troy with significant obscuration of 75.2 %, occurred *10 years before* the solar eclipse's occurrence in the Ionian Islands on the 30th October 1207 B.C. as proposed by Papamarinopoulos *et al.* (2012). It started at 14.10 LT, peaked at 15.45 LT and ended at 17.07 LT and fits exactly with the Patroclus' death at noon, as it is described in the *Iliad*. Moreover, the planet *Venus'* appearance in the *east horizon* three days after Patroclus' death is indicated by the Homeric text in Il.23,226-228 ("Ἦμος δ' εὐσφόρος εἰσι φῶως ἐρέων ἐπὶ γαίαν, ὄν τε μέτα κροκόπεπλος ὑπεῖρ ἄλα κίδναται ἠῶς, τήμος πυρκαϊή εμαραίνετο, παύσατο δε φλόξ.-But at the hour when *the star of morning* goeth forth to herald light over the face of the earth—the *star after* which followeth saffron-robed *Dawn* and spreadeth over the sea—even then grew the burning faint, and the flame the-

reof died down). Indeed, Planet Venus was visible in the Trojan sky *before dawn* on the 9th June 1218 yr B.C. because it rose at 3:12 LT when the sunrise was at 4:48 LT according to Starry Night program. In contradiction to the Homeric text,

on the 27th of June 1312 year B.C. (three days after the proposed by Henriksson date) the sunrise is approximately *the same* with Venus rise (4:42 LT and 4:30 LT respectively).

Table 1: Archaeologists' and historians' references on the Homeric Troy (Papamarinopoulos et al., 2012 and references therein).

Author's name	Layer*	Years B.C.
Dorpfeld W. (Zengel, 1990)	Troy VI	ca 1250 but <i>after</i> Kadesh's battle.
Blegen C. (Zengel, 1990)	Troy VIIa	1270-1240
Mylonas G. (1964)	Troy VIIa	ca 1200
Desborough V. R. d'A (1966)	Troy VIIa	1230-1250
Nylander C. (1963)	Troy VI	Not historic Trojan War.
Finley M. et al. (1964)	-	Not historic Trojan War.
Wood M. (1998)	Troy VI	1250-1260
Hiller S. (1991)	Troy VIh Troy VIIa	In the middle of the 13 th century End of the 13 th /start of 12 th century
Hood S. (1998)	Troy VII b2	10 th century
Mountzoy P. (1999a)	-	ca 1300 for VIh
Mountzoy P. (1999b)	-	ca 1210 for VIIa
Korfmann M. (2004a)	Troy VI/VIIa	1200- 1180**
* <i>The layers in Latin numbers illustrate the archaeologists' stratigraphic differences in dating Homeric Troy.</i>		
** <i>He proposes, the ratio VI/VIIa as being the Troy's catastrophe layer VI. He does that by equating VIIa=VII (Korfmann 2004b).</i>		

Furthermore, we examined fully the solar eclipses' occurrence (partial, annular, total) based on NASA catalog; within the time span 1400-1130 yr B.C. We did not find another pair of solar eclipses, *separated by ten years*, which would be visible in Troy and in the Ionian Islands respectively satisfying fully *all* the Homeric descriptions, both in the Ionian Islands *in the autumn* (with Venus observable at eastward sky) and Troy's environments *within the spring and summer* respectively.

According to Papamarinopoulos et al (2012), Odysseus departed from Ithaca after the autumn equinox (4th October) of 1227 yr B.C. and he returned home after the autumn equinox of 1207 yr B.C., marking 20 years of absence. Consequently the first year of the Trojan War was 1227-1226 yr B.C. *because battles were not conducted during the winter*. The 10th year of the war was between spring equinoxes (1st April) of the years 1218 and 1217 yr B.C. respectively. Moreover, we read in the Iliad (Il.2.134-138) that a wise man, called Calchas (Κάλχας) said that 'so shall we fight *nine years* at Troy, but in the *tenth* shall take the town'. Also, Agamemnon in

Il.2.134-138 said that '*nine* of Jove years are gone...' and Odysseus said in Il.2.295-296 that 'it is now *nine long years* that we have been kept here'. Consequently, we can say that the Iliad's events happened *at the beginning* of the 10th year, in the spring and summer of 1218 yr B.C. Taking into account, all these analyses, we reached a *new* date for the Trojan War's end based on the solar eclipse of the 6th June of 1218 yr B.C. visible in Troy.

2. THE SOLAR ECLIPSE OF 1312 yr B.C. AND ALAKSANDU, WILUSA'S KING

Henriksson (2012) mentioned that Alaksandu was Wilusa's King in accordance with the Hittite archives as Starke (2001) published. Henriksson suggested that Wilusa's 'Alaksandu' and Alexander (Paris) of Ilium, King Priam's son, is one and the same person. However, Alaksandu was the successor of Wilusa's King Kukunni (Kelder (2004/5)) and he is not mentioned by the Hittites' archives as Priam's son. The '*Alaksandu treaty*', which was issued between Hattusa's King *Muwatalli II* and Wilusa's King *Alaksandu*, is written in first singular person by the Hittite King him-

self. The text is as follows: 'And when the country of Arzawa started war for one more time, and my grandfather, Suppiluliuma came and attacked the country of Arzawa, Kukuni the King of Wilusa had peaceful relations with him...' (Beckman, *Hittite Diplomatic texts*, Atlanta 1999, page 82). Consequently, Alaksandu who is mentioned in the Hittite treaty, he had nothing to do with Alexander (Paris) mentioned by Homer.

Also, Henriksson (2012) described a military operation in which Prince Pijamaradu was involved in 1315 yr B.C. He writes exactly: 'It is known from Hittite texts that in 1315 yr B.C. Prince Pijamaradu ...in military operations...After that, when Pijamaradu attacked the coast of Seha...the king of Wilusa, Alaksandu, was ordered by the Hittite king to send military help. But king Muwatalli II did not sent military help...'. However, in accordance with Henriksson's way of thinking, in 1315 yr B.C. Troy's King was Priam and not Alaksandu because Troy was sacked in 1312 yr B.C. We have noticed a disharmony in Henriksson's data, between the simultaneous existence of the two Kings, Wilusa's Alaksandu and Hattusa's Muwatalli II in 1315 yr B.C., respectively, and Troy's occupation in 1312 yr B.C.

Additionally Henriksson (2012) writes: 'According to the Iliad, King Priam of Troy had two sons, Hector and Paris (Alexander). Priam and Hector were killed at the end of the war but Paris (Alexander) survived and became King in Troy after the war'. However, Priam had 50 sons and 12 daughters (Il. 6.242-250). After Hector's death, Priam's sons were reduced to nine (Il.24.247-252). Why Priam would have preferred Paris (Alexander) as his successor and not any of the others? Moreover, in the Iliad is mentioned that *Priam was the last King of his generation* (Il. 20.306-308). The next generation of Kings in Troy originated from the Aeneas' House. Furthermore, according to Apollodorus, Malalas (2006), Cedrenus (1889) and Howatson (1996), Paris (Alexander) never became King's Troy, because Philoktetes killed him in a duel with bows in a battle, a little time before the Trojan War's end and *after* Hector's death. The latter are a post-Homeric tradition but they agree very well with the Homer's statement about Aeneas'

kingship taking control in a ruined Troy after Priam's death. Thus, Henriksson (2012) incorrectly identifies Wilusa's King Alaksandu as Alexandros (Paris) who never became Ilion's King in accordance with Homer's text and the post-Homeric tradition.

3. ACHILLES' SHIELD AND THE MARKED SKY DURING A SOLAR ECLIPSE

The annular solar eclipse of the 6th of June 1218 yr B.C. was visible as a partial one with significant obscuration *over* 75 % in Troy (Fig. 1). It occurred in *Gemini* constellation between planets Venus and Mercury. Its view was in NW direction between the well known in antiquity constellations of Ursa Major and Orion, eastward to Pleiades and Hyades clusters of Taurus constellation. The proposed by Henriksson (2012) total solar eclipse of the 11th of June 1312 yr B.C. (24th of June 1312 yr B.C. in NASA catalog), occurred near to Cancer constellation, eastwards from Gemini, and it is surrounded by the same constellations as that of the 6th of June 1218 yr B.C. (see Henriksson's (2012), Fig. 2). According to the Homeric epic, Hephaestus built a new shield for Achilles decorated by nine scenes because the previous was taken by Hector when he killed his friend Patroclus. The last scene offered to the 'Ocean' and the first scene is described in Il.18.483-489: 'Εν μὲν γαίαν ἔτευξ', ἐν δ' οὐρανόν, ἐν δὲ θάλασσαν, ἠέλιόν τ' ἀκάμαντα σελήνην τε πλήθουσαν, ἐν δὲ τὰ τεῖρεα πάντα, τὰ τ' οὐρανός εστεφάνωται, Πληιάδας θ' Ἰάδαυς τε, τὸ τε σθένοϋ Ὠρίωνος Ἀρκτονθ', ἦν καὶ Ἀμαξάν ἐπὶ κλησὶν καλέουσιν, ἢ τ' αὐτοῦ στρέφεται καὶ τ' Ὠρίωνα δοκεῖ, οἴη δ' ἄμμορός ἐστι λοετρῶν Ὠκεανοῖο'. 'Therein he wrought the earth, therein the heavens therein the sea, and the unwearied sun, and the moon at the mighty Orion, and the Bear, that men call also the Wain, that circleth ever in her place, and watcheth Orion, and alone hath no part in the baths of Ocean.' In that, Hephaestus presents the world's creation the Earth, the Sea, the Sky with the Sun, the Full Moon and many stars. From all these stars, he preferred to present the following well known constellations: The *Pleiades* and the *Hyades* which belong to the Taurus' nebulae, the *Orion* and the *Ursa Major* (*Bear*). The latter is

characterized as *circumpolar* constellation! We note that the constellations mentioned by Homer define peripherally the sky's region in which the solar eclipse occurred with the *most known* and *shining* stars, in both cases of 1218 and of 1312 yr B.C. solar eclipses. The very *first* and the *last* from *the thematic concentric scenes* show

where that shield was devoted: a) To Patroclus' memory. It showed the sky view at the time of his death. His friend Achilles was holding always this shield in the battles. b) For gratitude to *Thetis, Achilles' mother*, who helped, once, the builder of the shield, Hephaestus and protected him in the *Ocean's* caves (Il.18.394-409).

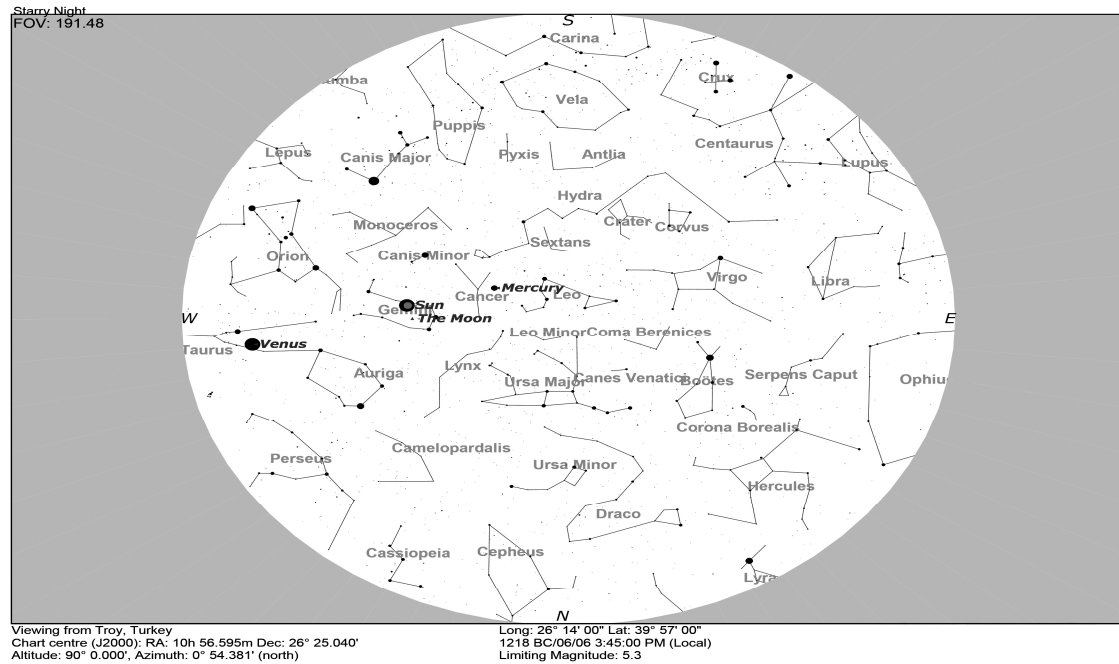


Figure 1. Troy's sky ($39^{\circ} 57' 0''$ N, $26^{\circ} 14' 0''$ E) at the maximum obscuration (75.2%) of the solar eclipse (13:45 UT or 15:45 LT) in the June of the 6th 1218 yr B.C. (JD 1276705) is shown. $\Delta T = 29356$ sec. Limiting magnitude of visible stars and planets: 5.3, Sun altitude at maximum: 40° , $\Delta T: \pm 1105$ sec, $\pm 4.6^{\circ}$.

4. A MOONLESS WARM NIGHT

We examined Homer's text in order to see if a *new moon phase* has occurred because it is an *absolute necessity* for the appearance of a solar eclipse. We also examined in which season, the facts in connection with the Iliad, are involved because *both dates* (Henriksson's (2012) and ours in the current paper) indicate *June*.

The night before Patroclus' death, the Trojans were compelled to make many fires in order to watch better the Achaeans' possible maneuvers (Il.8.500-511) because the *night was black* ('*νυκτί μελαίνῃ*'). In Il.10.220-253, the Achaeans take *advantage of the black night* ('*νυκτα μέλαιναν*') and decide to send two spies towards the Trojans' camp. Also, the Trojans thought alike in connection with the *black night* ('*νυκτα μέλαιναν*') and sent Dolon to spy the Achaeans (Il.10.357-395). Diomedes and Odysseus killed Dolon, they removed his weapons and placed

them under a tamarisk bush in order to find them because of the *black night* ('*νύκτα μέλαιναν*'). Also, in Il.10.275-277 indicated: '*τοι δ' ουκ ιδον οφθαλμοίσι νύκτα δι' ορφναίην...*' and though they saw it not through the *darkness of night...*'. The above mentioned Homeric *characteristic* descriptions denote *categorically* a *moonless night*. It can be interpreted firstly either with the moon's setting before the night comes or that is going to rise in the next day's dawn and secondly there is a minute moon crescent near or in the phase of the new moon. Both cases lead to a *dark night*. If indeed the solar eclipse occurred, then the phase of the *new moon* is a rigid fact.

Moreover, Diomedes and Odysseus heard the cry of a *migratory bird*; a heron-ερωδιός (Il.10.274). The latter arrives to the North Aegean Sea in the spring and stays there until the summer's end (Vougioukalou (2009)). Also,

when the two heroes returned to the Achaeans' camp, they went straight into the sea ('θαλάσση εσβάντες- they entered the sea') in order to wash away the abundant sweat ('ιδρώ πολλόν νίψεν- had washed the abundant sweat') as described in Il.10 572-575. Similar scenes as above are described in the next morning in Il.11.621-622 (τοι δ' ιδρώ απεψύχοντο χιτώνων, σταντε ποτί πνοιήν παρὰ θίν' αλός - And the twain dried the sweat from their tunics standing in the breeze by the shore of the sea), Il.11.642-643 (Τω δ' επει ουν πίνοντ' αφέτην πολυκαγκέα δίψαν μύθοισιν τέρποντο προς αλλήλους ενέποντες- Then when the twain had drunk, and sent from them parching thirst, they took delight in tales) and Il.11.811-812 (κατά δε νότιος ρέεν ιδρώς ώμων και κεφαλής- And in streams down from his head and shoulders flowed the sweat). From all the above, it is concluded that the Patroclus' death day was a warm day. We note that the summer solstice was on the 4th July of 1218 yr B.C. according to Starry Night program. Our proposed date on the 6th of June 1218 yr B.C. fits with the seasonal detail of an early summer's warm day fully.

5. THE ILIAD'S SOLAR ECLIPSE IN DETAIL

Homer in Il.11.84-90 describes the battle, indicated that the time has reached at noon, as connecting it with the time in which the woodman has his meal. During this period, Patroclus was engaged in fighting with Sarpedon whom he eventually killed. Zeus after Sarpedon's death (Il.16.567-568) covered the battlefield by a destructive night ('ολοήν νύκτα'): 'Ζευς δ' επί νυκτ' ολοήν τάνυσσε κρατερή υσμίνη όφρα φίλω περι παιδί μάχης ολοός πόνος είν- and Zeus drew destructive darkness over the mighty combat so that around his dear son might be waged the destructive toil of war'. The solar eclipse of the 6th of June 1218 yr B.C. starting time was at 14.10 LT. This means that indeed a slight kind of darkness is occurred characterized, by Homer, as 'night-νύκτα' at noon and not 'darkness' as the interpreter translates. We note that this 'night' did not prevent the battle's continuation. Patroclus tried four times to overtake the wall of Troy (Il.16.702-709). Also, from the sun's behavior in Il.16.777-782, it is indicated that the time

has been advanced toward late noon: 'Όφρα μεν ήλιος μέσον ουρανόν αμφιβεβήκει... πίπτε δε λαός ήμος δ' Ηέλιος μετενίσετο βουλυτόν δε...υπέρ αίσαν Αχαιοί φέρτεροι ήσαν. -Now as long as the sun bestrode mid-heaven, ...and the folk kept falling; but when he turned to the time for the unyoking of oxen, ...the Achaeans proved the better'. At that time, Patroclus was killed by Hector (Il.16.786-810). Zeus covered everything with thick darkness-'ήέρα πολλήν' (Il.17.269-270): 'λαμπρήσιν κορούθεσσι Κρονίων ήέρα πολλήν χεύε-And the son of Cronos shed thick darkness over their bright helmets'.

We note that Homer described a gradual increase in darkness during late noon. Indeed the solar eclipse of the 6th of June 1218 yr B.C. maximum obscuration (over 75%) occurred at 15.45 LT. After Sarpedon's death, a destructive night ('ολοήν νύκτα') occurred. As the time advanced, after Patroclus' death, the destructive night became much darker ('ήέρα πολλήν'), which is translated by interpreter as thick darkness. It is a very careful and detailed description of a progressing partial solar eclipse. It is well known that an absolute darkness is exhibited when a total solar eclipse occurs. However, the latter did not occur because the battle continued. In other words the increasing darkness never reached its maximum.

In Il.17.366-376, a complete description of the partial solar eclipse is showed: 'Ως οι μεν μάρναντο δέμας πυρός, ουδέ κε φάιης ούτέ ποτ' ήλιον σων έμμεναι ουτε σελήνην. ήερι γαρ κατέχοντο μάχης επί θ' όσσοι άριστοι έστασαν αμφί Μενοιτιάδη κατατεθνηώτι. Οι δ' άλλοι Τρώες και εύκνήμιδες Αχαιοί Εύκηλοι πολέμιζον υπ' αιθέρι, πέπτατο δ' αυγή ηελίου οξειά, νέφος δ' ου φαίνετοο πάσης γαιης ουδ' ορέων. Μεταπαυόμενοι δε μάχοντο αλλήλων αλεινοντες βέλεα στονόεντα πολλόν αφεσταότες. Τοι δ' εν μέσω αλγε' έπασχον ήερι και πολέμω-So they fought like blazing fire, nor would you say that sun or moon still remained intact, for with darkness were shrouded in the fight all the chief men who stood around the slain son of Menoetius. But the rest of the Trojans and the well-greaved Achaeans fought unimpeded under clear air, and over them was spread the piercing brightness of the sun, and on all the earth and the mountains was no cloud seen; and they fought rest-

ing themselves at times, avoiding one another's shafts laden with groans, and standing far apart. But those *in the middle* suffered woes because of the darkness and the war'. For the above mentioned text we note the following:

a) There is a clear reference of the solar eclipse in connection with *the sun's and the moon's existence*. It looks strange to be able to see in a late hot noon with ample sun light both, the *sun* and the *moon* in the sky! The only case which would allow the co-existence of these two bodies is the case of a *partial solar eclipse*. In reality the *moon's shadow* would have covered partially the *sun's disk*. If the solar eclipse was *total*, the *moon could not be seen at all* because the two heavenly bodies would be placed *one upon the other*. In reality the *moon's shadow* would have covered all the *sun's disk*.

b) The men who were fighting around Patroclus' body were occupied by the 'ἥρι μάχη'- 'with darkness'. The interpreter did not realize the subtle difference between the single word 'ἥρι' and the same word combined with the word 'battle' as 'ἥρι μάχη'. We note that the passage says the following: 'ἥρι γὰρ κατέχοντο μάχης ἐπὶ δ' ὅσον ἀριστοί'- "for with darkness of the battle were shrouded in the fight all the chief men". Consequently this means a *synecdoche*, the mayhem, the dense dust of the mist of the battle and not a 'remarkable darkness' during day light itself.

c) The passage continues as follows: 'but the rest of the Trojans and the well-greaved Achaeans fought unimpeded under *clear air*, and over them was spread the *piercing brightness of the sun* and on all the earth and the mountains was *no cloud* seen'. The latter condition is given deliberately by Homer in order to explain that the *gradual darkness* mentioned in previous passages is *not due to the clouds*. The *piercing sun light* is emanated intensively from the *sun's remaining uncovered part*. Homer described with exceptional clarity a partial solar eclipse. We offer to the reader a real example of what a partial solar eclipse with 75% obscuration produces both in the sky and in the ground (Fig. 2). The *piercing sun light* in a *cloudless sky* together with the impressive *darkness on the ground* can be seen and consequently understood.

Henriksson (2012) accepted the phrase 'ἥρι μάχη' as meaning 'remarkable darkness'. It was an attempt to explain the *simultaneous* differentiation between 'dark' and 'light' in the *same battlefield* in the *same day*. Thus, he wrote: 'the information that the piercing brightness of the sun was spread over the Achaeans who fought in the outer parts of the battlefields can easily explained if the outer parts of the battlefield lay just outside the zone of totality'. However, Homer described: 'τοὶ δ' ἐν μέσῳ ἀλγεῖ ἔπασχον'- 'but those in the *middle* suffered woes'. All fighting men's position, around dead Patroclus' body, is located only in the *middle of both armies*. Furthermore, in the passage Il.6.1-4 is mentioned that the battle was taking place 'μεσσηγύς Σιμόεντος ἰδέ Ξάνθοιο ροάων.- *between the Simois and the streams of Xanthus*'. This region is *north of the southern limit of totality's zone* as Henriksson (2012) has plotted in his own Fig.1. Consequently it is impossible for 'some' soldiers to fight and being located out of the zone of totality.

In addition, it is well known that if an observer is *just* out of the zone of totality, he can observe a solar eclipse, as a partial one, with significant obscuration (p) of 99-98%. The light's intensity just outside of this zone, which has a width of 250-300 km, is only ~1% of its nominal value according to $L/L_{max}=1-p$ (Mollmann and Vollmer (2006)), where L is the Sun's illuminance corresponding to p (the obscuration of the solar disk) and L_{max} is the Sun's Illuminance. In Fig. 3, we can see that in the eclipse proposed by Henriksson's date, the solar disk's obscuration varies from 100 up to 99% in NW Turkey.

The *sun's set is still far away* from the time of Patroclus' death because in Il.17.455 the *time* of the events is mentioned by Homer allowing Hector to say 'εἰς ὅ...δύτ' ἥλιος καὶ ἐπὶ κνέφας ἱερὸν ἔλθη'- until...and the sun sets and holy darkness comes on'. However, Ajax saying in Il.17.643-647: 'ἀλλ' οὐ πῆ δύναμαι ἰδέειν τοιοῦτον Ἀχαιῶν· ἥρι γὰρ κατέχονται οὐδ' αὐτοὶ τε καὶ ἵπποι. Ζεὺ πάτερ ἀλλὰ σὺ ρύσαι νηῖ ἥερος ὑίας Ἀχαιῶν, ποίησον δὲ αἶθρην, δὸς δὲ οφθαλμοῖσιν ἰδέσθαι· ἐν δὲ φάει καὶ ὀλεσσον, ἐπεὶ νῦ τοι εὐάδεν οὕτως-Howbeit, nowhere can I see such a one among the Achaeans, for in *darkness* are they all enwrapped, themselves and

their horses withal. Father Zeus, *deliver thou from the darkness* the sons of the Achaeans, and *make clear sky*, and grant us to see with our eyes. *In the light* do thou e'en slay us, seeing such is thy good pleasure'. This *deep darkness* can be explained because a *lurid cloud* came from the sky and landed among the fighting men in the battlefield as described in Il.17.548-552: 'Ζεὺς ἐξ ουρανóθενὡς ἡ πορφυρέη νεφέλη πυκάσασα ἐ αὐτὴν δύσετ' Ἀχαιῶν ἔθνος, ἐγειρε δε φῶτα ἕκαστον.-Zeus stretches forth for mortals ...enwrapping herself in a *lurid cloud*, entered the throng of the Danaans, and urged on each

man'. This cloud, which is red (*πορφυρέη*) was added on the mist of the battle ('*ἡέρι μάχης*') and on the darkness ('*ἡέρα πολλήν χεύε Κρονίων*') of the solar eclipse resulting in *zero visibility* for every fighter in the field. This obvious darkness resulted from both phenomena; the partial solar eclipse with significant obscuration of $\frac{3}{4}$ of the solar disc and the semi-transparent red cloud which appeared in front of the sun. This double condition from one hand allowed observers to see it and from the other hand caused the battle to stop, as mentioned by Homer.



Figure 2: A partial solar eclipse with obscuration 75%. (Left): Il.17.366-376 '*πέπτατο δ' αὐγὴ ἡελίου οὐξεία, νέφος δ' οὐ φαίνεται πάσης γαίης οὐδ' ὀρέων*'-'the piercing brightness of the sun, and on all the earth and the mountains was no cloud seen') and Il.17.269-270 '*ἡέρα πολλήν χεύε*'-'shed thick darkness' The '*piercing sun light*' in a cloudless sky is present in spite of the impressive imposed darkness on the ground by the partial solar eclipse. This is exactly what Homer described. (Right): The moon's shadow has covered *only partly* the sun's disk. Consequently in any non astronomer observer's view seem to be that *the two bodies, the moon and sun coexist close-by*. (After, Dr. K. Gazeas. Date: 1 August 2008. Location: Gobi-Altai Desert, Mongolia).

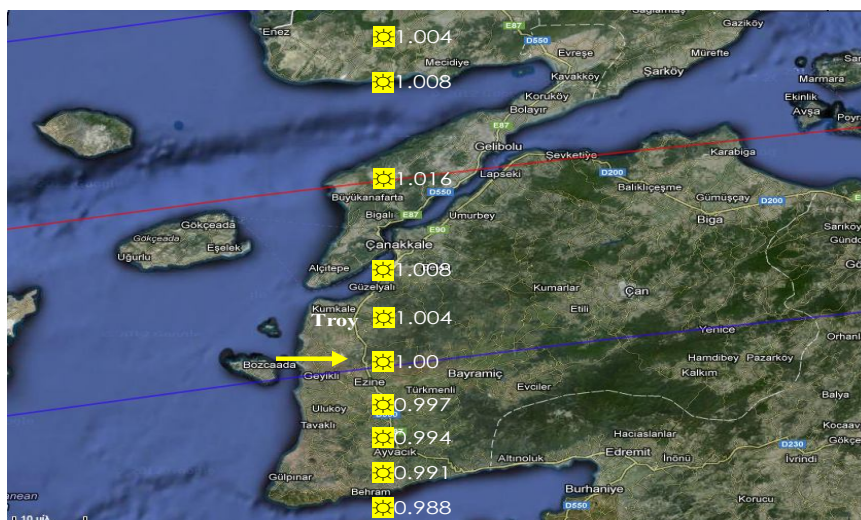


Figure 3. Troy's area. The central line depicts the central path of the total eclipse on the 24th of June 1312 yr B.C. reaching the maximum magnitude (<http://eclipse.gsfc.nasa.gov>). The symmetric lines, with respect the central, are totality's northern and southern limits respectively. The longitude is the same for all positions. The arrow to the south of the totality's southern limit shows a region in which Herrinkson (2012) sets a part of the fighting armies.

Ajax requested from Zeus to allow the *light to come again* and *die in the light*. Zeus “responded” in Ajax’s request, as described in Il.17.649-650:

‘αυτικά ήερα μεν σκέδασεν και άπωσεν ομίχλην, ήέλιος δ’ επέλαμψε, μάχη δε επί πάσα φαάνθη-And forthwith scattered the darkness and drove away the mist, and *the sun shone* forth upon them and all the battle was made plain to view’. The word ‘αυτικά’-‘*immediately*’ is compatible with the timing of the solar eclipse’s maximum which is always last only few minutes. Zeus ‘removed’ two phenomena: a) He drove away the mist and b) made the sun to shine *again*. The latter is justified because the verb ‘επέλαμψε’ means ‘re-shone’, which shows literally that the sun’s light has vanished, due to the eclipse, and then ‘*shone again*’. This solar eclipse’ maximum occurrence happened at 15.45 LT and the eclipse ended at 17.07 LT, while the sunset was taken place at 19.25 LT (Starry Night program). Achilles stay near the camp’s wall, in order the Trojans *to see him* and to be scared (Il.18. 197-201). This means that during that scene *the sun light still existed*. Additionally in Il.18.241 (‘ήέλιος μεν έδν’-‘so the sun set’) the sunset comes after the above described scene.

This denotes full compatibility between the progress of the solar eclipse and the sunset.

6. CONCLUSIONS

There is a unique pair of solar eclipses which are described in the Homeric Epics exhibiting a *ten years time span* between them. We examined the solar eclipses for the time period from 1400 to 1130 years B.C. taking into account that *battles were not conducted in the winter*. We also took into account the battles’ specific *warm conditions* in the Iliad and the autumn conditions in Odysseus’ return, respectively, as described by Homer analytically. Within *both* those corresponding conditions mentioned above, the planet *Venus was in the east sky* before sunrise a) five days before Odysseus’ arrival and b) three days after Patroclus death’s day. We found only one pair of two solar eclipses which satisfies fully the Homeric text: a) the annular solar eclipse on the 6th of June 1218 yr B.C. for the Trojan War’s end and b) the annular solar eclipse on the 30th of October 1207 yr B.C. for Odysseus’ return, observed as partial solar eclipses in Troy and the Ionian Islands respectively, with almost the same significant obscuration of 75%.

ACKNOWLEDGEMENTS

To Dr. K. Gazeas, Lecturer of Astrophysics, of the University of Athens for his kindness to offer the astronomical photographs which will facilitate the non astronomer readers to visualize what Homer described.

To the anonymous reviewer for his in depth constructive criticism.

DEDICATION

This paper is devoted to the Academician Professor Christos Zerefos of the University of Athens.

REFERENCES

- Apollodorus (1921) *The Library*, with an English Translation by Sir James George Frazer, F.B.A., F.R.S. in 2 Volumes. Cambridge, MA, Harvard University Press; London, William Heinemann Ltd.
- Baikouzis C., Magnasco M.O., (2008) “Is an eclipse described in the Odyssey?”, *Proc. Natl. Acad. Sci. U.S.A.*, vol. 105(26), 8823-8828.
- Beckman G. (1999) *Hittite Diplomatic Texts*, Atlanta.
- Espenak F., Meeus J. (2006) *Five Millennium Canon of Solar Eclipses: -1999 to +3000*, NASA Technical Publication TP-2006-214141.
- Espenak F., Meeus J. (2009a) *Five Millennium Canon of Lunar Eclipses: -1999 to +3000*, NASA Technical Publication TP-2009-214172.
- Espenak F., Meeus J. (2009b) *Five Millennium Catalog of Lunar Eclipses: -1999 to +3000*, NASA Technical Publication TP-2009-214173.

- Espenak F., Meeus J. (2009c) *Five Millennium Catalog of Solar Eclipses: -1999 to +3000*, NASA Technical Publication TP-2009-214174.
- Cedrenus G. (1889) *Compendium Historiarum*, 1, 228, J.P.Migne, *Patrologia Graeca*, vol. 121, Paris.
- Henriksson G., (2012) The Trojan War dated by two solar eclipses, *Mediterranean Arhaeology and Archaeometry*, vol. 12(1), 63-76.
- Heraclitus of Pontus (1962) *Allégories d'Homère, Les Belles Lettres*, Paris.
- Homer (1924) *The Iliad*, translated by Murray A T., *Loeb Classical Library*, Cambridge, MA, Harvard University Press; London, William Heinemann Ltd.
- Howatson, M.C. (1996) *The Oxford Companion to Classical Literature*, s.v. Paris.
- John Malalas (2006) *Chronicle*, translated by Brian Croke, Elizabeth Jeffreys, Michael Jeffreys, Roger Scott et al., Sydney.
- Kelder Jorrit M., (2004/5) "Mycenaeans in Western Anatolia", *Talanta* 36-37, 49-86.
- Mollmann K.-P., Vollmer M. (2006) "Measurements and predictions of the illuminance during a solar eclipse", *Eur. J. Phys.*, 27, 1299-1314.
- Morrison, L.V., Stephenson, F.R. (2004) Historical values of the Earth's clock error Delta T and the calculation of eclipses. *Journal for the History of Astronomy*, vol. 35(3), No. 120, 327-336.
- Papamarinopoulos, St.P. (2008) "A comet during the Trojan War?", *Science and Technology in Homeric Epics*, Paipetis S.A. (Ed.), Springer Science, pp. 341-356.
- Papamarinopoulos St.P., Preka-Papadema P., Antonopoulos P., Mitropetrou H., Tsironi A., Mitropetros P., (2012) A new astronomical dating of Odysseus' return to Ithaca, *Mediterranean Arhaeology and Archaeometry*, vol. 12(1), 117-128.
- Schoch, C. (1931) Die säkulare Accelaration des Mondes und der Sonne, *Astronomische Abhandlungen, Ergänzungshefte zu den Astronomischen Nachrichten*, Band 8, B2, Kiel.
- Starke, F. (2001) Troia im Machtfüge des zweiten Jahrtausends vor Christus, *Die Geschichte des Landes Wilusa, Troia, Traum und Wirklichkeit*, Konrad Theiss Verlag GmbH., Stuttgart.
- Starry Night User's Guide (2006) Imaginova Corp. Toronto, Canada.
- Stephenson F.R., Morrison L.V. (1984) Long-term changes in the rotation of the Earth: 700 B.C, to A.D. 1980. *Philosophical Transactions of the Royal Society*. Vol. A313, pp. 47-70.
- Stephenson F.R., Houlden M.A. (1986) *Atlas of historical eclipse maps: East Asia 1500 BC - AD 1900*, Cambridge University Press, Cambridge.
- Stephenson, F.R. (1997) *Historical Eclipses and Earth's Rotation*, Cambridge University Press, Cambridge.
- Theodosiou E., Manimanis V.N., Mantarakis P., Dimitrijevic M.S., (2011) Astronomy and Constellations in the Iliad and Odyssey, *Journal of Astronomical History and Heritage*, 14/1.
- Vougioukalou M., (2009) *Αποκατάσταση Υγροτόπων: Μελέτη για την αποκατάσταση ενδιαιτημάτων της ορνιθοπανίδας για τη Χορταρόλιμνη Λήμνου*, MS.c Aegean University, Greece, (in Greek).