

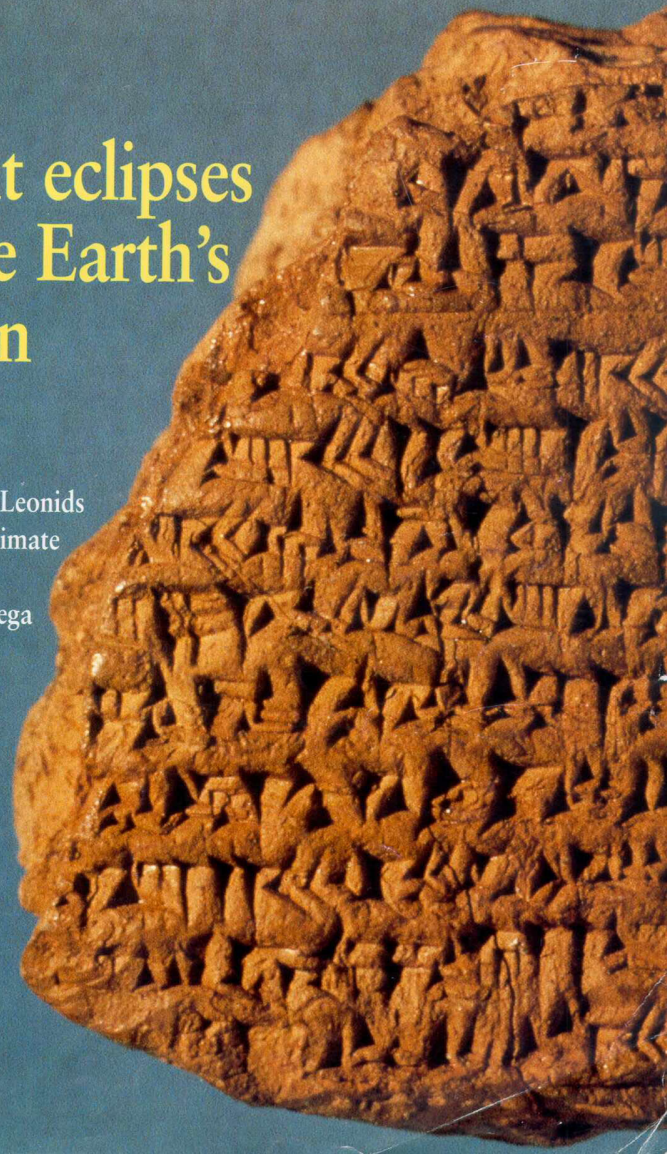
# ASTRONOMY & GEOPHYSICS

The Journal of the Royal Astronomical Society

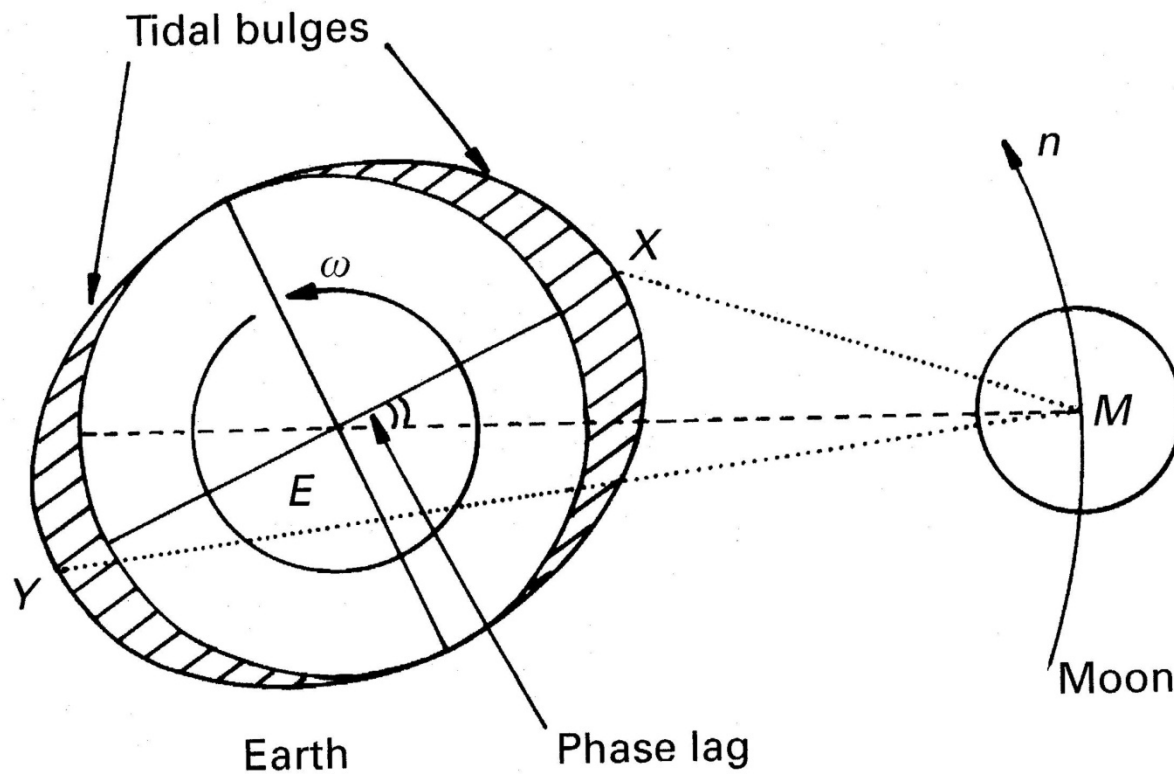
October 1998 Vol 39 Issue 5

## Ancient eclipses and the Earth's rotation

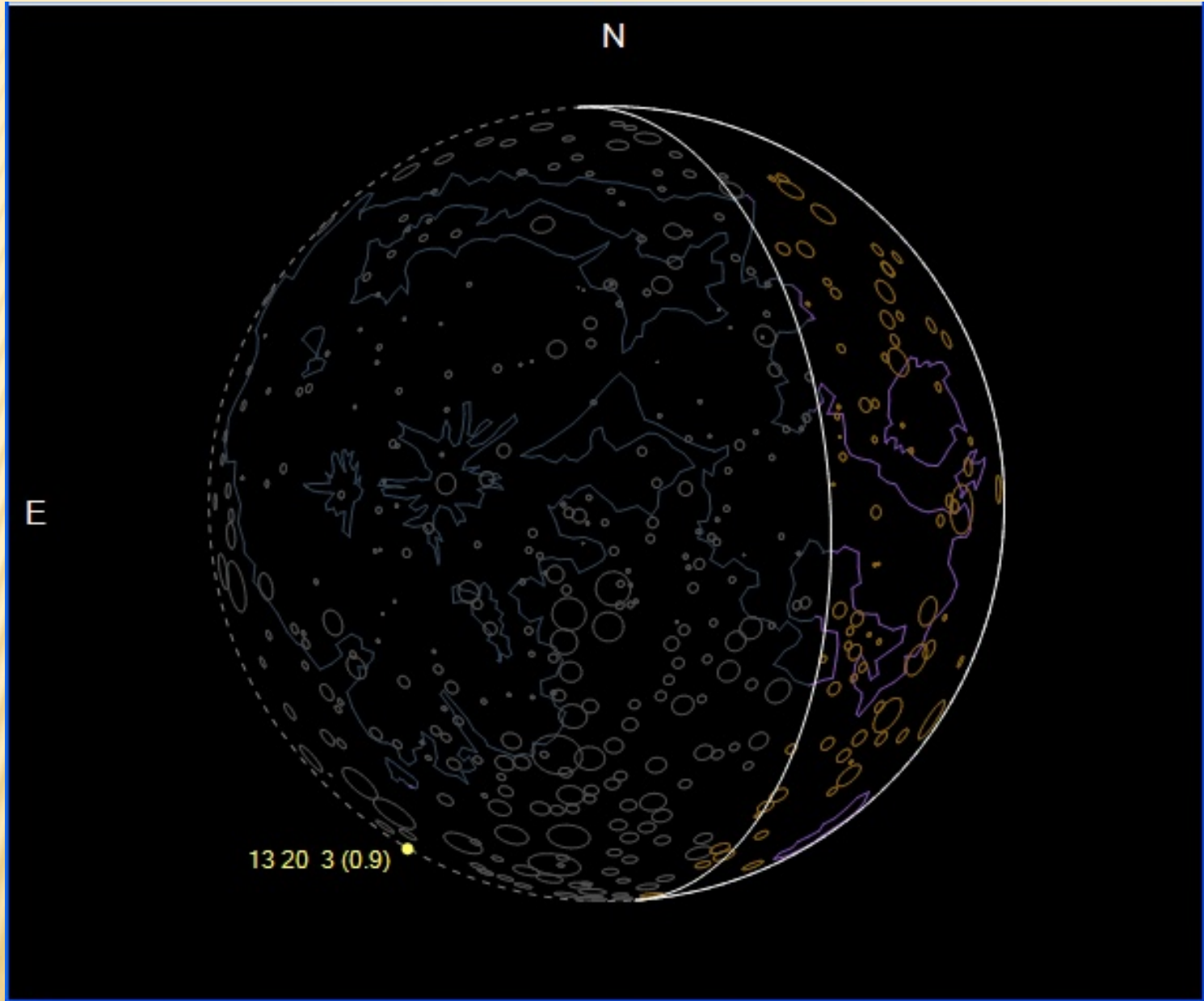
The nature of the Leonids  
Solar cycles and climate  
Planck Surveyor  
The quest for Omega

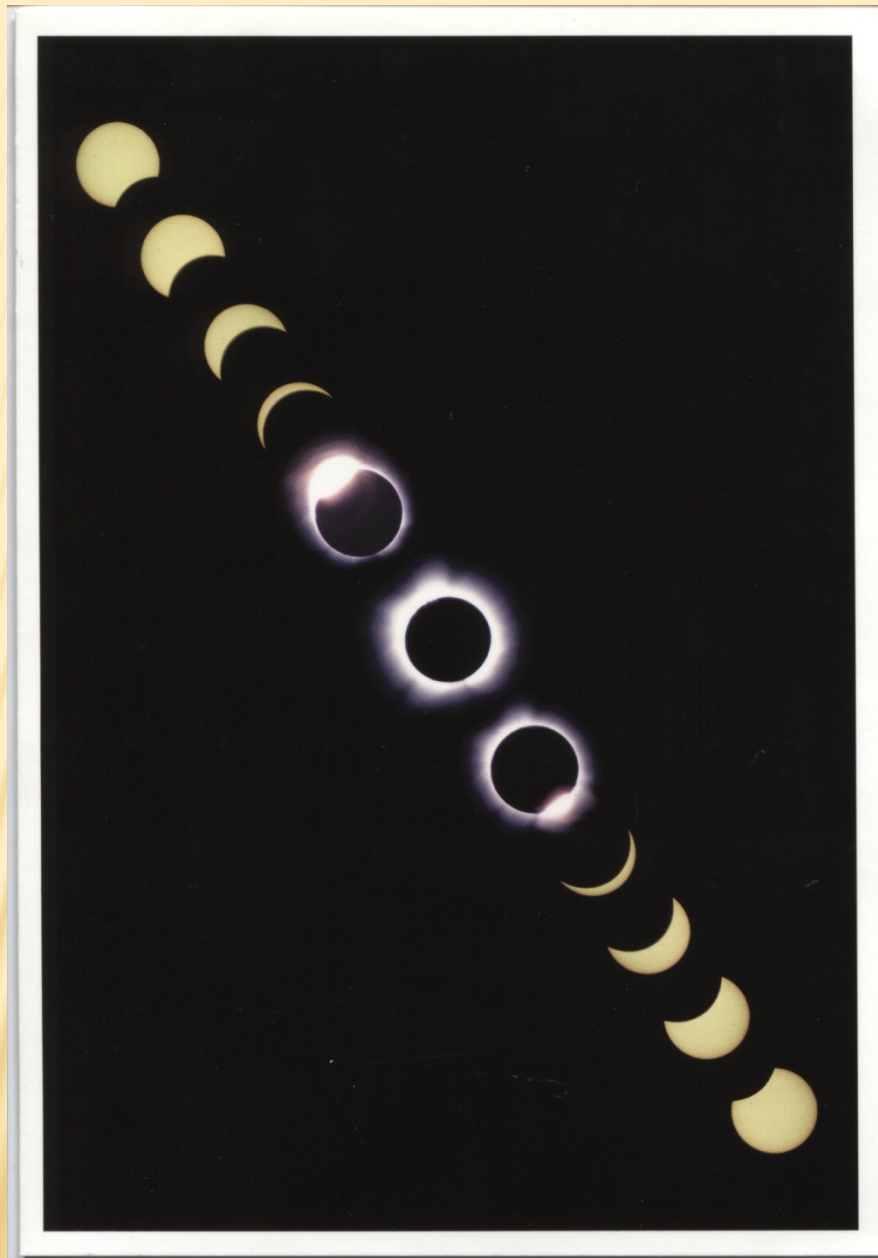






Tidal interaction between the Moon and the Earth.









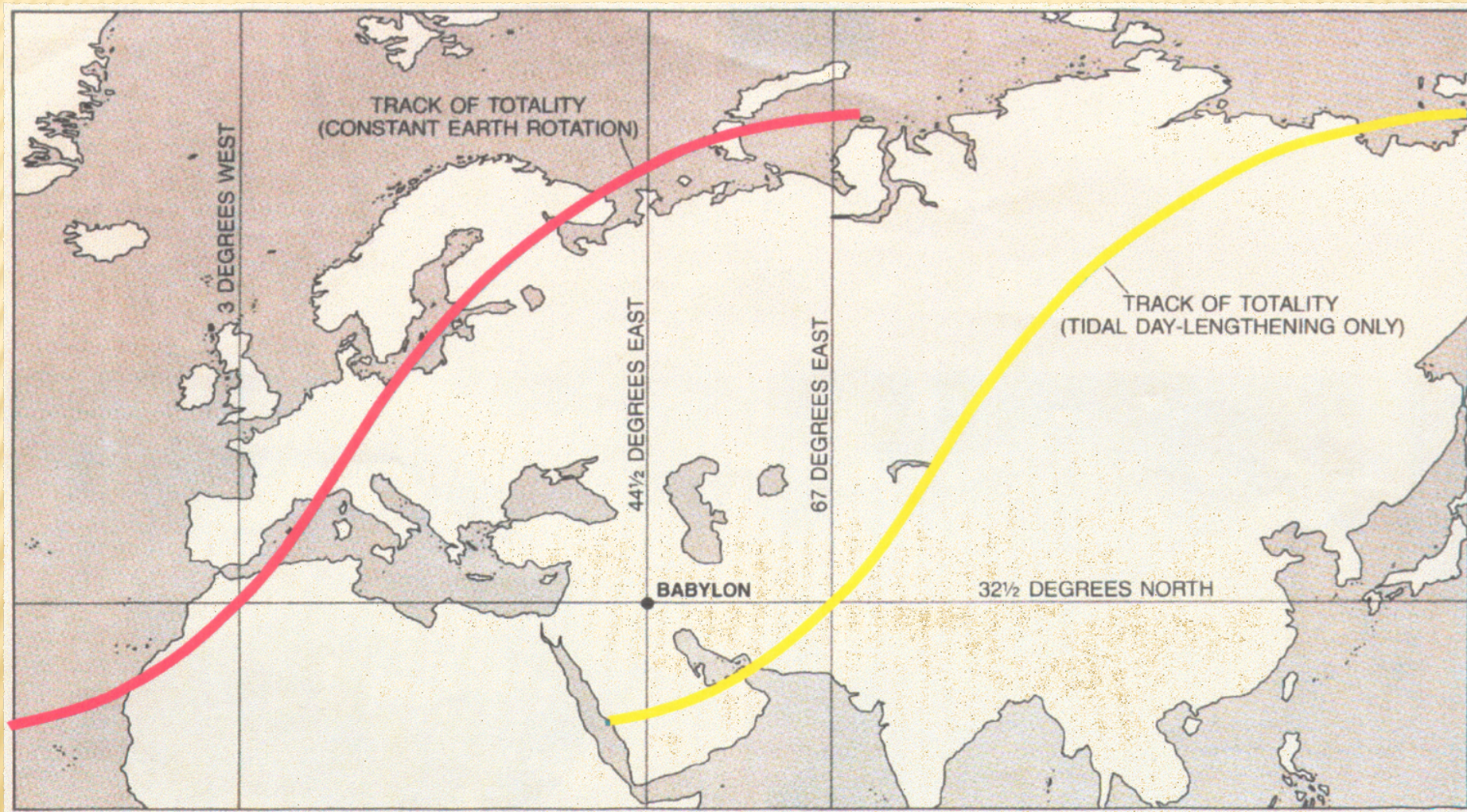
## ***BC 136 Apr 15 (total): Babylon***

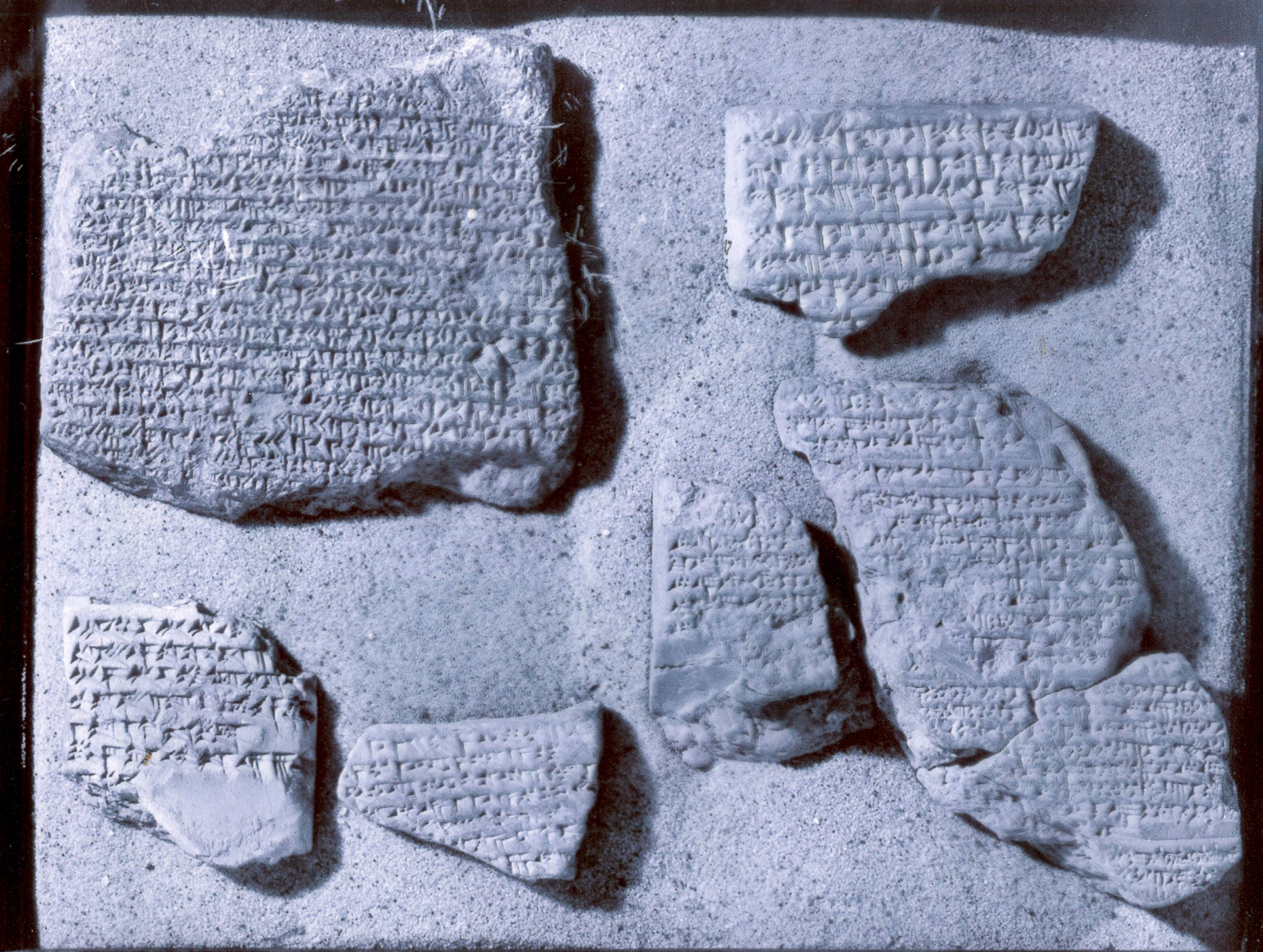
**SE 175, month XII<sub>2</sub>. The 29<sup>th</sup>, solar eclipse. When it began on the south-west side, in 18 deg daytime in the morning it became entirely total (TIL *ma* TIL *ti gar* AN). (It began) at 24 deg after sunrise.**

## ***BC 136 Apr 15 (total): Babylon***

**SE 175, [king] Arsaces, [month XII<sub>2</sub>]. The 29<sup>th</sup>, at 24 deg after sunrise, solar eclipse; when it began on the south and west side, [...] [Ven]us, Mercury and the Normal stars were visible; Jupiter and Mars, which were in their period of invisibility, were visible in its eclipse [...] it threw off (the shadow) from west and south to north and east; 35 deg onset, maximal phase and clearing; in its eclipse, the north wind which was set [to the west side blew...].**







1	2	3	4	5	6	7	8	9	10
Centimetres									
BRITISH MUSEUM			2	3	4	Inches			

45745 32286  
 41129 41565 35787+34658

***BC 120 Jun 1/2 (mag. = 1.02)***

**Year 128 (Arsacid), that is year 192 (SE), king Arsaces.**

**Month II 14. Moonrise to sunset 6,30 (= 6½) deg, measured.**

**5 deg after  $\alpha$  Her culminated, lunar eclipse beginning on the north-east side. After 24 deg, 1 UD lacked to totality. 6 deg duration of maximal phase, until it began to become bright.**

**In 24 deg, it became bright from north-east to south-west.**

**54(?) deg total duration... (Began) at 66 deg after sunset.**

**[BM 45845 (=LBAT 1442), Obv. and Rev.]**



## RECENTLY IDENTIFIED BABYLONIAN RECORDS OF LUNAR ECLIPSES

(a) *Records prior to 400 BC: all dates BC*

603 Oct 27: Began 45 deg after sunset; duration 45 deg.

594 May 23: Began 20 deg after sunset.

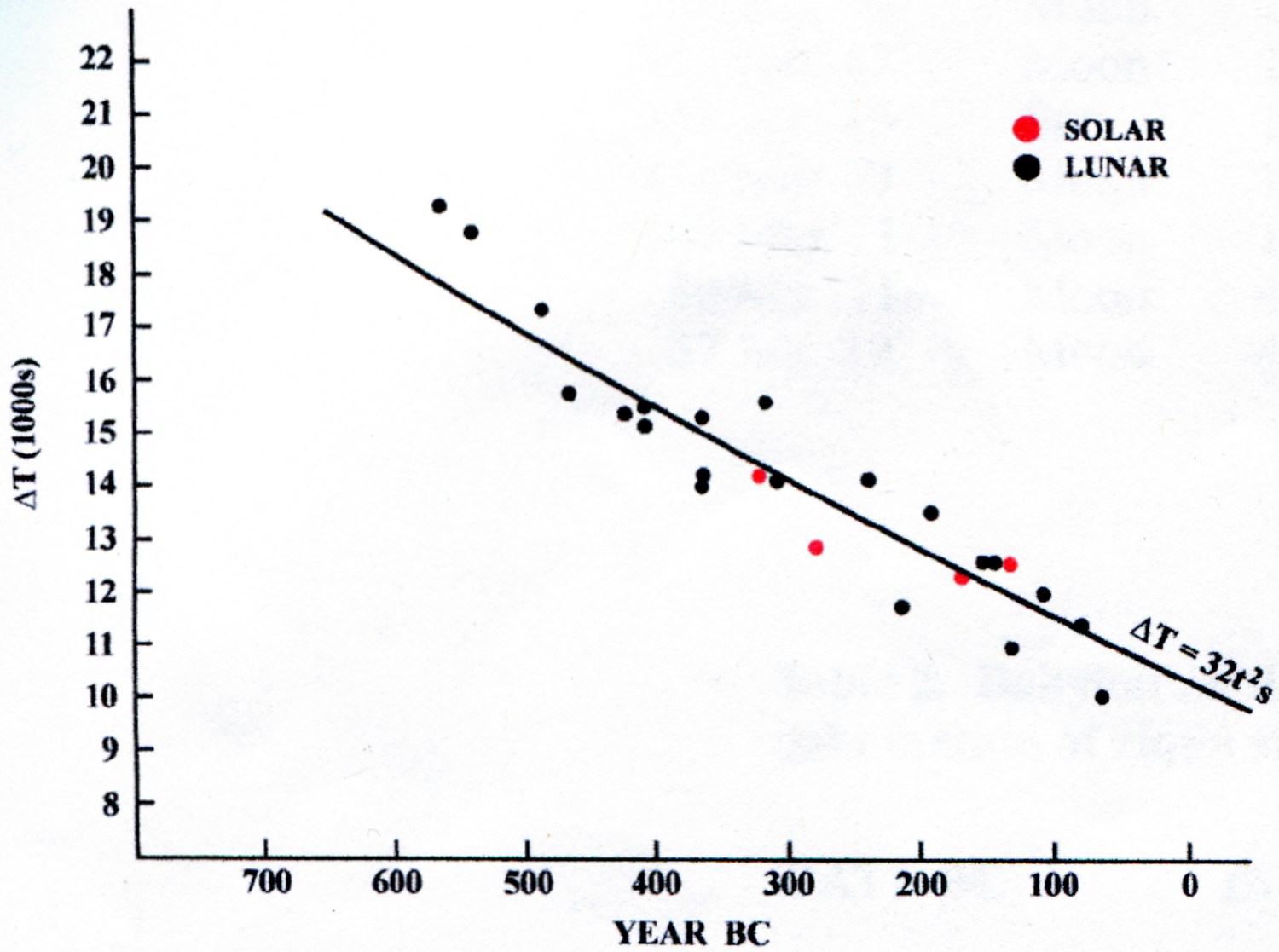
588 Jan 19: Began 20 deg before sunrise.

577 Dec 08: Began 105 deg after sunset.

576 Jun 04: Began 40 deg before sunrise.

555 Oct 07: Began 55 deg after sunset; total in 17 deg; duration of totality 28 deg; cleared in 20 deg.

526 Sep 17: Began 60 deg after sunset; total in 18 deg; duration of totality 14 deg.



$\Delta T$  results obtained from Babylonian sunrise/sunset and moonrise/moonset measurements less than 25 degrees

秋七月有星孛入于北斗

春王正月戊申朔隕石于宋五

夏四月辛卯夜恒星不見夜中星隕如雨

秋七月壬辰朔日有食之既

**AD 434 Sep 5**

**“Emperor Wen of Liu-Song, 11th year of the Yuanjia reign period, 7th month, 16th day, full Moon; the Moon was eclipsed. The calculated time was the hour of *mao* (LT = 5-7h). The Moon began to be eclipsed at the second call of the fourth watch of the 15th day, in the initial half of the hour of *chou* (LT = 1-3h). By the fourth call the eclipse was total at the end of 15 *du* of YINGSHI [LM 13]”**

***(Song shu)***

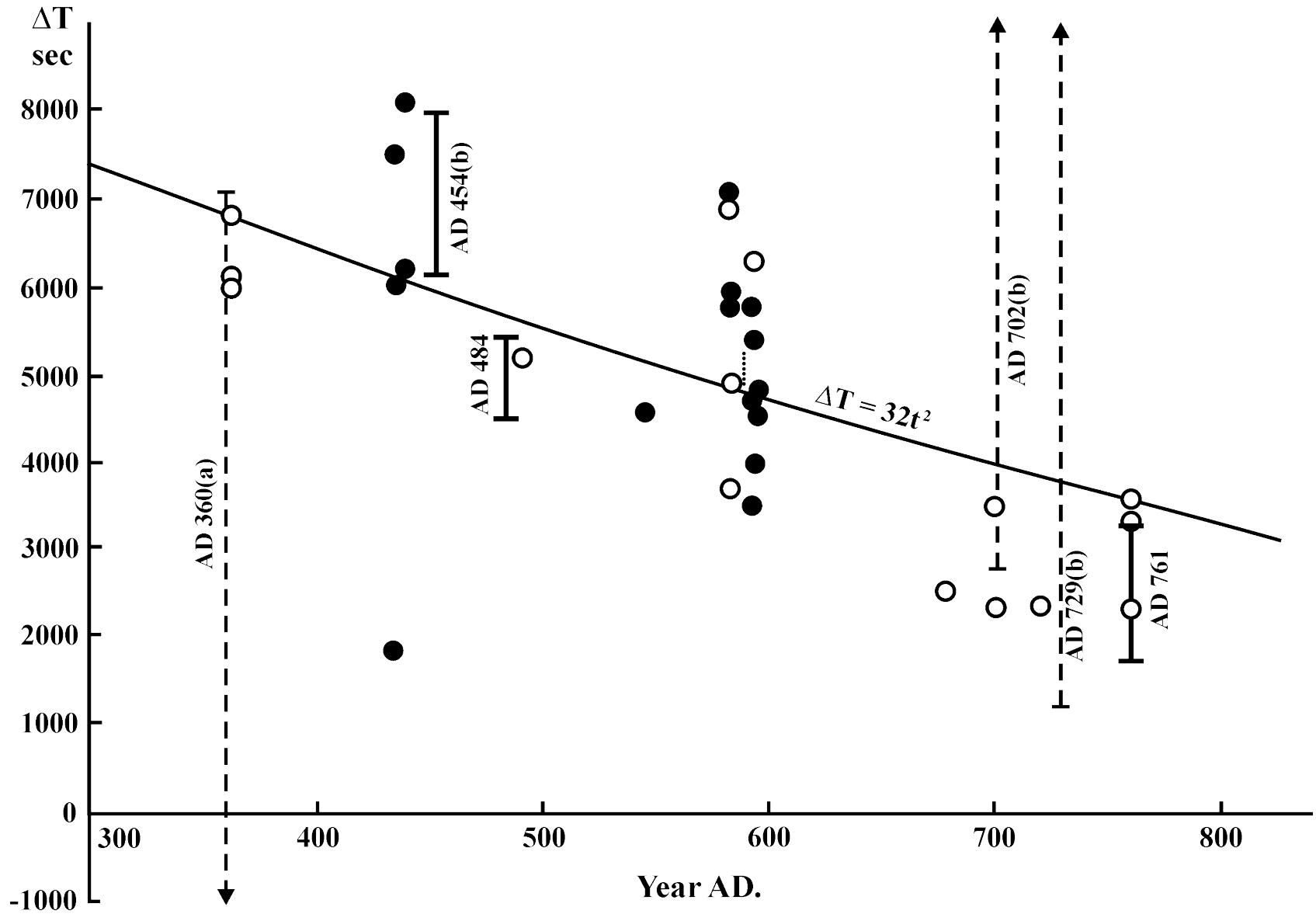


## AD 761 Aug 5: China (Chang'an)

“Shangyuan reign period, 2nd year, 7th month, day *guiwei* [20], the first day of the month. The Sun was eclipsed; the large stars were all seen. The Astronomer Royal, Chu Dan, reported: ‘On day *guiwei* the Sun diminished. Precisely after 6 *ke* in the hour of *chen*, the loss began.

Precisely after 1 ke in the hour of *si* it was total. At 1 *ke* before the hour of *wu* it was restored to fullness’.” (*Jiu Tangshu*, 36).

N.B. Each *ke* was equal to 0.24 h.



## TIMED REPORT OF LUNAR ECLIPSE FROM BAGHDAD

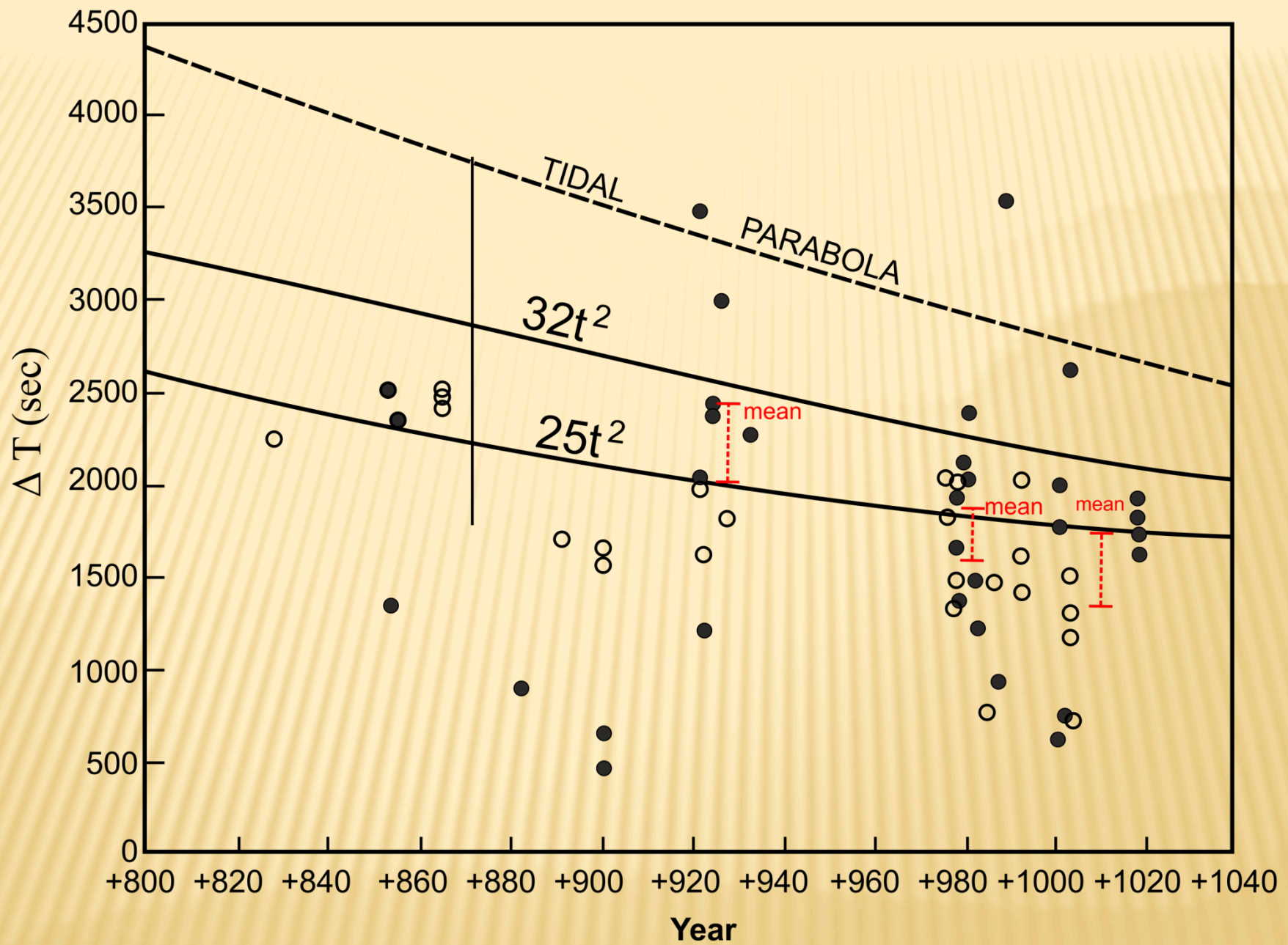
AD 925 APR 11/12

“This eclipse was on the night of Tuesday, the 15th of (the lunar month) Muharram, year 313 of *al-Hijrah*. I (Abu al-Hasan ibn Amajur) observed this eclipse. The beginning was when the altitude of (the star) *al-simak al-ramih* (= Arcturus) was 11 deg in the east. The end of the clearance was when the altitude of (the star) *al-nasr al-waqi* (= Vega) was 24 deg.” (Ibn Yunus: *al-Zij al-Kabir al-Hakima*).

## TIMED REPORT OF SOLAR ECLIPSE FROM CAIRO

AD 985 JUL 20

“This solar eclipse was in the late afternoon of Monday at the end of (the lunar month) Safar in the year 373 of *al-Hijrah*. The altitude of the Sun when I (Ibn Yunus) perceived its eclipse by eye was 23 deg approximately. The altitude was 6 deg when nothing of its eclipse remained to be perceived by the eye. A maximum of  $1/4$  of the Sun’s diameter was eclipsed.” (Ibn Yunus: *al-Zij al-Kabir Qal-Hakima*).



$\Delta T$  values and limits derived from medieval Arab eclipse observations.

## STARS SEEN AT AN ANNULAR ECLIPSE (ENGLAND: AD 1191)

“1191. In the month of June, on Sunday, the 9th day before the Kalends of July (= Jun 23), at the 9th hour of the day, the Sun was eclipsed and it lasted for three hours. The Sun was so obscured that darkness arose over the Earth and stars appeared in the sky. And when the eclipse withdrew, the Sun returned to its original beauty” (*Gesta Regis Henrici II et Ricardi I*).

N.B. Computation reveals that even where the ring phase was visible, no more than 95 per cent of the solar diameter (= 90 per cent of the solar area) would be obscured by the Moon. Stars were seen at several other annular eclipses in Europe between AD 891 and 1310.

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UNTIMED REPORT OF TOTAL SOLAR ECLIPSE FROM  
CONSTANTINOPLE

AD 968 DEC 22

“At the winter solstice there was an eclipse of the Sun such as never happened before...The eclipse was such a spectacle. It occurred on the 22nd of Decembder at the 4th hour of the day, the air being calm. Darkness fell upon the Earth and all the brighter stars revealed themselves. Everyone could see the disc of the Sun, deprived of light, and a certain dull and feeble glow, like a narrow headband, shining round the extreme parts of the edge of the disc. However, the Sun gradually going past the Moon (for this appeared covering it directly), sent out its original rays and light filled the Earth again.” (*Leonis Deaconis Historiae*).

# $\Delta T$ limits from Medieval Central Solar Eclipses

