VARIATION OF ΔT BETWEEN AD 800 AND AD 1200 DERIVED FROM ANCIENT SOLAR ECLIPSE RECORDS

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ABSTRACT. In our recent series of work (Tanikawa and Sôma 2002, 2004a,b, Sôma et al. 2003, 2004, Kawabata et al. 2004) we have applied our own method using nearly contemporary observations of eclipses and occultations to derive simultaneously the values of $\Delta T = \mathrm{TT} - \mathrm{UT}$ and the tidal acceleration $\dot{n}$ of the lunar motion. Here we apply our method to the total and annular solar eclipses recorded between the years 800 and 1200, and show that the ΔT values were decreased abruptly between the years 873 and 912 by more than 600 sec.

1. ΔT VALUES BETWEEN AD 968 AND AD 1140

The following records are found for the deep solar eclipses between AD 968 and 1004:

Total eclipse at Constantinople (Istanbul) in Turkey and Farfa in Italy on 968 Dec. 22,

Total eclipse at Kyoto in Japan on 975 Aug. 10, and

Very large partial eclipse at Cairo in Egypt on 1004 Jan. 24.

By applying our own method of obtaining simultaneously the ΔT values and the correction to the coefficient of the lunar tidal term (Fig. 1 of Sôma et al. 2004), we can obtain that the correction to the coefficient of the tidal term was larger than or equal to -1.4 arcsec/cy^2. If we accept the present tidal acceleration of the Moon, the derived ΔT values are:

$$1513 \text{ sec} - 2654 \text{ sec} \qquad \text{for} \quad 968, \qquad (1)$$
$$1167 \text{ sec} - 4452 \text{ sec} \qquad \text{for} \quad 975, \qquad (2) \text{ and}$$
$$<1520 \text{ sec} \quad \text{or} \quad >1917 \text{ sec} \qquad \text{for } 1004. \qquad (3)$$

The solar eclipse of 1133 Aug. 2 was recorded at several places as total (Ausburg and Heilsbronn in Germany, Reichersburg and Saltzburg in Austria, and Kerkrade in the Netherlands; see Stephenson 1997), and they give the consistent parameter area, and therefore they can be regarded as very reliable. The solar eclipse of 1153 Jan. 26 was recorded at Erfurt in Germany, and several recorded sketches showed that the Sun was seen as a crescent, but there were no words indicating that the eclipse was annular, and therefore Stephenson (1997) regarded it as partial at Erfurt. However, this contradicts the 1133 Aug. 2 total solar eclipse mentioned above, i.e. the solar eclipse of 1153 Jan. 26 at Erfurt should have been annular based on the 1133 Aug. 2 total solar eclipse at several places. The 1140 Mar. 20 solar eclipse was recorded at Malmesbury in England as "they saw stars around the Sun", and therefore we can see that the eclipse was total there. By combining this eclipse with the 1133 Aug. 2 eclipse, we see that the correction to the coefficient of the lunar tidal term was less than or equal to 0.0 arcsec/cy^2.

If we accept the present tidal acceleration of the Moon, we can obtain the ΔT values as:

433 sec – 1117 sec   for 1133,   (4)

and

1111 sec – 3330 sec   for 1140.   (5)

2. ΔT VALUES OF AROUND AD 900

The solar eclipse on 873 July 28 was recorded as annular both at Nishapur in Iran and at Kyoto in Japan (see Tanikawa and Sôma 2004). The solar eclipse on 912 June 17 was recorded as total at Cordoba in Spain. If we apply our method to these eclipses, we cannot obtain the ΔT value and the tidal acceleration of the Moon common to these eclipses. This means that either record was spurious or the ΔT value changed largely between the two eclipses. We show that the latter is correct, i.e. the ΔT value was decreased between the years 873 and 912 by more than 600 sec.

If we accept the present tidal acceleration of the Moon, the ΔT value derived from the 873 July 28 annular eclipse at Nishapur and Kyoto is:

3237 sec – 3760 sec   for 873,   (6)

and the value derived from the 912 June 17 total eclipse at Cordoba is:

1296 sec – 2593 sec   for 912.   (7)

On 891 Aug. 8 there was an annular eclipse in Europe, and at Constantinople in Turkey it is written that stars were seen (Stephenson 1997, p. 382). It is not written that the eclipse was annular, but it can be considered that the eclipse was at least very close to annular. Accepting the present tidal acceleration of the Moon, the condition that the eclipse was annular at Constantinople is:

2863 sec – 3908 sec   for 891.   (8)

This fact supports the value given in (6).

The 939 July 19 eclipse was recorded as total in Olmos or Cueva del la Mora in Spain. But as Stephenson points out, there were two inconsistent expressions, "the Sun was eclipsed totally", and "its disk became dark except for a slight portion as seen by eye". In any case the eclipse was at least very close to total. Accepting the present tidal acceleration of the Moon, the conditions that the eclipse was total at Olmos and at Cueva del la Mora are, respectively:

328 sec – 2283 sec,   (9)

186 sec – 2164 sec   for 939.   (10)

This fact supports the value given in (7).

These considerations show that it is most likely that the values of ΔT given by (6) and (7) are correct.

Details about the present researches will be published elsewhere.

3. REFERENCES

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