ON A POSSIBLE USE OF TOTAL SOLAR ECLIPSE BELOW THE HORIZON FOR OBSERVATIONS OF THE INNER ZODIACAL LIGHT (AS APPLIED TO THE ECLIPSE OF 30 JUNE, 1992)

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Abstract. The Moon's umbral shadow, tangentially penetrating the Earth's atmosphere, appreciably reduces the brightness of the twilight sky at points located under the shadow axis. This should yield favourable conditions for observation of the zodiacal light for small altitudes of the Sun below the horizon. The location of the projection of the Moon's shadow axis at the Earth's surface under the above conditions is calculated for the case of the total solar eclipse of 30 June, 1992.

Ground-based observations of the zodiacal light which present an extension of the F-corona may be carried out after the end of the evening astronomical twilight or before the beginning of the morning twilight when the Sun's altitude below the horizon is no less than 18°. This allows us to study reliably the zodiacal light only in the elongation range $> 25°$. At a lower altitude of the Sun, the twilight prevents observations of the zodiacal light.

Meanwhile there is in principle a possibility of observing the zodiacal light under essentially a lower altitude of the Sun and consequently at lower elongations. Such an opportunity is provided by a total solar eclipse below the horizon.

Let us consider the following pattern (Figure 1): at some time T_0, the umbra of the Moon's shadow touches the Earth's surface at the point A. It is evident that such a case occurs at the beginning (or the end) of a total solar eclipse. For an observer at the point A the total solar eclipse would occur at the horizon. The observer moving from point A in the direction opposite to the Sun would be found beneath the umbra, while the Sun would be below the horizon for him.

The diameter of the Moon's umbral shadow is usually several times greater than the thickness of the lower layers of the atmosphere (≈ 80 km), contributing to the twilight scattering of solar light. Hence the Moon's umbral shadow, penetrating the Earth's atmosphere above the observer at point B, should greatly reduce the brightness of the twilight sky. One could say that in such a case a kind of double solar eclipse occurs: by the Moon and by the Earth's horizon simultaneously. Such conditions should evidently make

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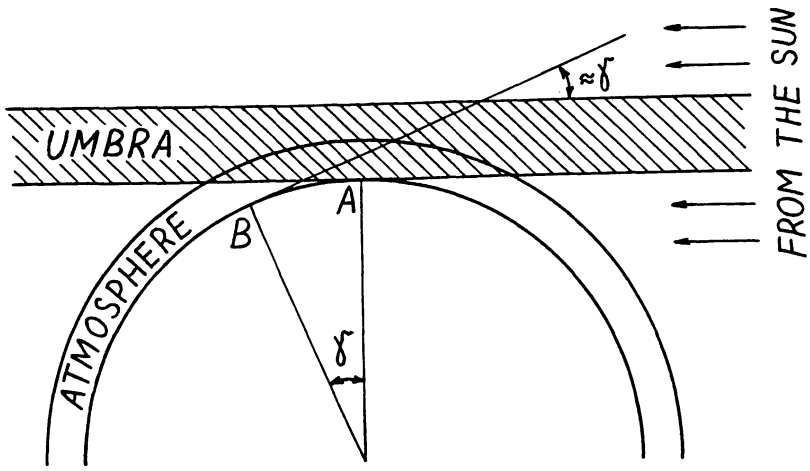

Fig. 1. Pattern of the total solar eclipse under the horizon.

TABLE I

Central line of the total solar eclipse below the horizon of 30 June, 1992

Points	Altitude of the Sun	Latitude	Longitude
1	− 2°	−36°46′	−58°44′
2	− 4	−37 41	−60 58
3	− 6	−38 33	−63 15
4	− 8	−39 22	−65 36
5	−10	−40 08	−68 00
6	−12	−40 51	−70 27
7	−14	−41 31	−72 58
8	−16	−42 08	−75 31

more easy the observations of inner zodiacal light or the far F-corona. The importance of observations of "double" solar eclipses was pointed out earlier by Prof. G.M. Nikolsky who unfortunately did not have the opportunity to make such observations.

The location of the projection of the Moon's shadow axis on the Earth's surface can easily be obtained as a first approximation using formulae from spherical trigonometry, if the time T_0 and coordinates of the point A are available. We have carried out such calculations for conditions of the total solar eclipse of 30 June, 1992, using the necessary data from the relevant *Circular of the U.S. Naval Observatory* (Bangert *et al.*, 1991). The results concerned with the morning eclipse are presented in Table I: the geographic coordinates φ and λ for eight points located under the Moon's shadow axis

are given as a function of the Sun's altitude γ at the time $T_0 = 11^h01.7^m$ UT. Note that refraction has been ignored in these calculations.

The projection of the Moon's shadow axis at the time T_0 is located in Argentina and Chili. The best conditions for observations should be in the region between points 5 and 7, located in mountainous areas of Patagonia and the Southern Andes as well as (to a lesser extent) between points 2 and 3 (Sierra-de-la-Ventana with elevations of 1200 m above sea level). The duration of the phenomenon considered is not large ($\approx$ 2 min), so light detectors should be highly sensitive.

Calculations for the evening eclipse are omitted since the relevant path is located over the ocean.

Reference

Bangert, J. A., Fiala, A. D., and Harris, W. T.: 1991, 'Central Solar Eclipse of 1992', *U.S. Naval Observatory Circular*, No. 176.