# THE TOTAL SOLAR ECLIPSE PHOTOELECTRIC OBSERVATIONS FOR THE SUN'S DIAMETER DETERMINATION

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The solar eclipse observations allow to trace the solar diameter in time scales of years to hundreds of years. There are solar diameter values obtained near edges of the path of the total eclipses from visual and videotapes observations. However, it is necessary to use the model of the solar atmosphere with the solar optical diameter measurement in order to obtain correct diameter values. Visual eclipse observations technique does not allow to do it, whereas photoelectric total solar eclipse observations allow to do it by the use of the solar limb intensity model. The 1991 and 1999 total solar eclipses were observed by photoelectric method. An estimation of the solar visible disk semidiameter was done from the data 1991 eclipse observations, and for distance 1 AU it was equal to (959.70 ± 0.12) arcs. The data of the August 11, 1999 eclipse observations are in processing and there is a hope to obtain the solar disk semidiameter with error less than ±0.1 arcs.

The solar eclipse observations allow to trace the solar diameter in a time scale of years to hundreds of years. It is important both for estimations of the effect of the possible variations in a solar luminosity on the earth climatic changes and for computations of solar convective zone models. There are data obtained near edges of the path of a total eclipse from visual and videotapes observations [6]. These data series cover about three centuries but contain 10 values of the solar semidiameter only (9 of them were obtained in 20th century). These data as well as some new published results obtained by other techniques show a possibility of the solar diameter variations, and separately, these variations may be associated with the cycle of the solar activity [10, 14]. But the atmospherical effects such as seeing and blurring have an influence on the ground-based solar diameter measurements, whereas the solar diameter values obtained from the solar eclipse observations do not depend on these atmospherical effects. Besides, these results are especially important because their accuracy may be increased if the Sun's and Moon's ephemeris and lunar limb profile data are improved. However, as it was shown in [1] it is necessary to use the model of the solar atmosphere (as a model of the solar limb intensity distribution) with the solar optical diameter measurement in order to obtain correct diameter values. But the visual eclipse observations technique does not allow to model the solar limb intensity distribution.

Photoelectric observations of the total solar eclipses were performed earlier for determining some geodetic parameters and solar limb brightening [7, 11, 12]. These observations consisted in the registering of the photometer signals, which are proportional to solar crescent light, together with respective instants of a time. Also it has been shown how the observed solar crescent luminosity at any instant depends on the semidiameters and angular separations of the centres of the Sun's and Moon's visible disks at that instant and solar limb brightening function as well [7, 9, 11].

For the first time, the photoelectric observations of the July 11, 1991 total solar eclipse were performed in Baia California Sur, Mexico, by Ukrainian scientists [8] to determine the Sun's angular diameter. Special photometers, designed in the Astronomical Observatory of the Taras Shevchenko National University of Kyiv, were used [2]. The observations were performed at three sites within the path of the total eclipse near its northern edge and at one site near centre of the path of the total eclipse. At the northern edge the observers were located along the line approximately normal to the edge with intervals of about 1.5–2 km. Analysis of the observational data [3] showed that the chromosphere light and the lunar limb shape irregularities influenced significantly on the light curves of the eclipses. To determine the solar disk semidiameter from these observational data, a theoretical light curve was described by an integral equation similar to the Kopal's equation and fitted with the least squares method to each observational light curve, and the solar disk semidiameter was one of the best-fit parameters. The theoretical light curve includes the Moon's limb irregularities corrections, but it is supposed that the solar limb is sharply delineated and the intensity function at the limb is linear, and the chromosphere light was taken into account partially only. Nevertheless, the solar angular semidiameter averaged from four values is equal to (959.70 ± 0.12) arcs and it is in a good agreement with the standard value and with data obtained visually and with video techniques near the edges of the path of the total eclipses [4, 5].

For the second time, the photoelectric observations of the total solar eclipse were performed on August 11, 1999 in Romania by the expedition of the Taras Shevchenko National University in Kyiv [13]. The observations were completed at six sites: at three sites near northern edge and at three sites near southern edge of the path of the total eclipse within its. The observers were located along the line approximately normal to the edges with intervals from of about 2 km to about 5 km. These observations consisted in registration of the photometer signals from the full Sun's disk before the 1st and after the 4th contacts, and signals from the solar crescent light including a total phase, together with respective instants of a time. To perform these observations the photometers were improved. Specifically, they were upgraded to measure the brightness of the sky near the Sun's apparent disk (the solar aureole brightness). The measurements of a solar light and sky brightness are necessary to reduce an influence of both individual parameters of photometer and atmospheric extinction at the observational sites on the observational light curves. Unfortunately, this kind of a measurement was not performed during 1991 eclipse observations. Besides, photometer's time scale was adjusted to UTC scale. The time interval was equal to 1/1024 s and errors of timing the data were not more than 0.5 s in UTC scale.

It was necessary to determine coordinates of the observational sites with errors not more than of about $\pm 1$ arcs. During 1999 eclipse they were determined by GPS personal navigator with adequate accuracy, but during 1991 eclipse they were determined with errors of about 0.1 arcmin [8]. The data of the August 11, 1999 eclipse observations are in processing and we hope to obtain the solar disk semidiameter with error less than $\pm 0.1$ arcs.

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