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Professional paper

THE ANALYSIS OF TOTAL SOLAR ECLIPSE OBSERVATIONS ON AUGUST 11th, 1999 IN KIKINDA

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SUMMARY: Because of poor meteorological conditions, the obtained observational material has not an even distribution in time. Therefore a special method was devised for treating this material. Using this method the durations of total and partial phases of this eclipse were established.

1. INTRODUCTION

At the location of the sport and recreation center "Jezero" in Kikinda with the geographical coordinates $\varphi = 44^o50'N$, $\lambda = 20^o55'E$ and altitude h=81 m, the authors carried out solar eclipse photographing in poor meteorological conditions. The beginning of the eclipse could not be registered because of a totally overcast sky at the mentioned location. Strong rain which started at the sport and recreation center "Jezero" just before the beginning of the eclipse, prevented the team not only to start photographing but also to prepare in time the instrument and necessary equipment. During eclipse, the sky cleared so the team succeeded in making 31 shots. Unfortunately the distribution of the shots according to time was not very favorable because the photographs were taken at moments when conditions allowed it. However material permitted to obtain certain results. The totality was registered by two shots.

2. EQUIPMENT

The equatorial 80/800 mm was ceded by People's Observatory in Belgrade. This small instrument by original construction did not have a driving clock so the authors mounted a simple slit through which the Solar image could be registered at the screen. This device proved very practical during photographing. "Zenit" camera has been used with black and white film FORTEPAN 100 ISO 100/210. On the instrument objective a set of red, green and yellow filters plus foil filter was placed. A short time before the eclipse, the computer clock was synchronized with a quartz clock which received time signals from Frankfurt. On R. Pavlović suggestion, time registration was performed so that the camera shooter activated at the same time the flashbulb, whose blaze together with time was registered at the computer screen by all the time active video camera.

Responsible for camera shootings were: G. Popović and D. Olević and for time registering: R. Pavlović and P. Jovanović.

3. THE OBSERVATIONAL MATERIAL

The first photograph of the event was taken after app. 50 minutes after the I contact, when the phase was already about 0.6. A total of 31 photographs was made, 3 of them during the totality. From the total of 20 analyzed shots (Fig.1) only 5 were taken in the period before the totality. The majority of the other shots are grouped over the decreasing branch when the phase was already between 0.3 and 0.1. Only one shot was made immediately after III contact. Such a poor distribution of the shots by time very much directed the treatment of the observational material.

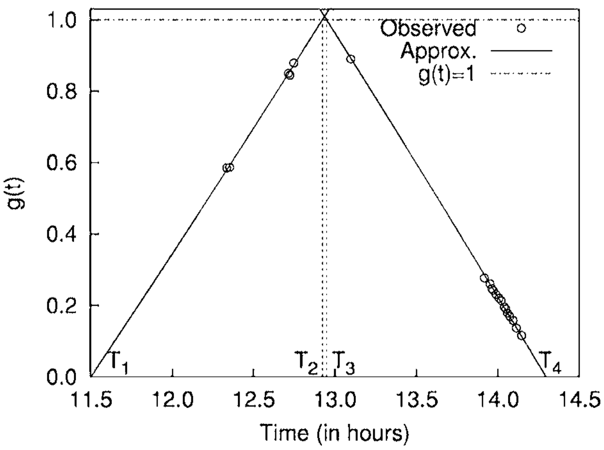

Fig. 1. *The progressing of the eclipse phase $g(t)$.*

4. THE METHOD OF ELABORATION

The eclipse photographs were measured by the staff of the People's Observatory. The measurements were carried out at the blink microscope of the Belgrade Observatory. From these measurements eclipse phase was determined for each photograph (the relation of the eclipsed part of solar diameter to the whole diameter) in the form of function of time $g(t)$. As the moments of I and IV contacts correspond to $g(t) = 0$, and II and III to $g(t) = 1$, for the purpose of their determination it was necessary to approximate the observed phase with certain function. As the approximation of the ascending and descending phase branches was not adequate, it was necessary to apply some transformations of the phase function. These transformations were elaborated by G. Popović and P. Jovanović.

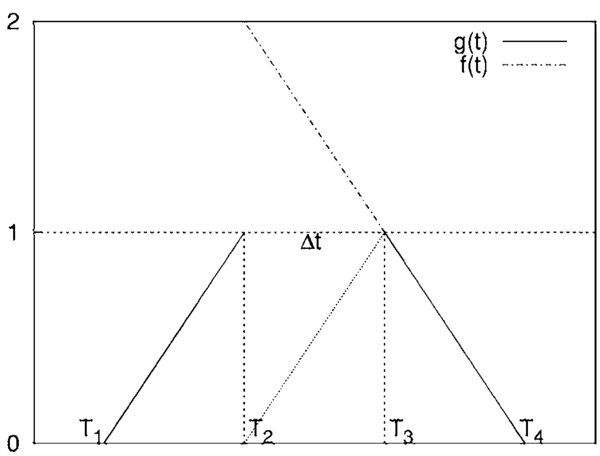

Fig. 2. *Scheme of the applied method.*

Let us assume for a moment that the totality duration $\Delta t = T_3 - T_2$ is known. Then it is possible to shift by Δt (or $-\Delta t$) one of the branches $g(t)$, so that II and III contacts overlap. Thereupon, if we mirror the corresponding phase branch with respect to the axis of symmetry $g(t) = 1$, we will obtain a continuous function (Fig. 2). If these transformations are applied to the increasing phase branch, and the decreasing branch is not changed, then the resulting function $f(t)$ has the following form:

$$f(t) = \begin{cases} 2 - g(t - \Delta t), & t \leq T_3 \\ g(t), & t > T_3. \end{cases} \tag{1}$$

It is possible to approximate the function $f(t)$ using the method of least squares also with a continuous and smooth curve:

$$f'(t) = a + b\,t^{\frac{3}{2}}, \tag{2}$$

as shown at Fig. 3. This curve approximates better the observational material than a straight line. This method gives good results also in the cases of an uneven distribution of observations in time. From the relations (1) and (2) the following relation for fitted phase $g'(t)$ is obtained:

$$g'(t) = \begin{cases} 2 - a - b\,(t + \Delta t)^{\frac{3}{2}}, & T_1 \leq t \leq T_2 \\ a + b\,t^{\frac{3}{2}}, & T_3 \leq t \leq T_4. \end{cases} \tag{3}$$

From the relation (3) the contact moments are as follows:

$$\begin{aligned} T_1 &= \left(\frac{2-a}{b}\right)^{\frac{2}{3}} - \Delta t \\ T_2 &= \left(\frac{1-a}{b}\right)^{\frac{2}{3}} - \Delta t \\ T_3 &= \left(\frac{1-a}{b}\right)^{\frac{2}{3}} \\ T_4 &= \left(\frac{a}{b}\right)^{\frac{2}{3}}. \end{aligned} \tag{4}$$

As Δt is initially unknown, it is possible to obtain it by its variation, taking the value for which the mean square deviations between the fitted ($g'(t)$) and observed phase functions are minimal.

5. RESULTS

In the case of total Solar eclipse observed in Kikinda on August 11^{th}, 1999 for parameters a and b of the function $f'(t)$ the following values are obtained: $a = 7.24440104$ $b = -0.13400892$. Using the relations (4) for the duration of the partial and total eclipse the obtained results are given in Table 1 together with calculated values for Kikinda published in *NASA Reference Publication 1398, March 1997.* and the corresponding differences (O-C).

Table 1. The 1999 solar eclipse duration

Duration	Kikinda	NASA R. P.	(O - C)
total eclipse:	$0^h01^m34^s.0$	$0^h01^m31^s.4$	$+2^s.6$
partial eclipse:	$2^h47^m46^s.9$	$2^h47^m46^s.4$	$+0^s.5$

The contact moments are not registered due to unexpected problems with the clock.

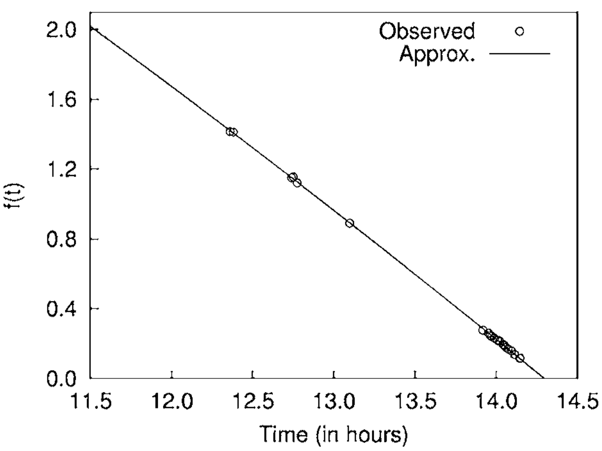

Fig. 3. *The eclipse phase variation after time shift and mirroring of the increasing phase branch.*

REFERENCES

Espenak, F., Anderson, J.: 1997, *Total Solar Eclipse of 1999 August 11*, NASA Reference Publication 1398.

АНАЛИЗА ПОСМАТРАЊА ПОТПУНОГ ПОМРАЧЕЊА СУНЦА У КИКИНДИ 11. 8. 1999. ГОДИНЕ

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Стручни чланак

Због лоших метеоролошких услова добијен је посматрачки материјал који нема равномерну расподелу по времену. Због тога је за редукцију овог материјала разрађен један специфичан поступак обраде. Овим поступком су изведена трајања потпуне и делимичне фазе овог помрачења.