RevMexAA (Serie de Conferencias), **46**, 93–94 (2015)

OBSERVATIONS OF THE OCCULTATION OF MARS BY THE MOON ON JULY 6, 2014

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RESUMEN

Se presentan los resultados de la observación de la ocultación de Marte por la Luna del 6 de julio de 2014. Las observaciones fueron realizadas desde el Observatorio Astronómico AFARI, en la ciudad de Tarma, Perú. Se utilizó un telescopio Celestron 8 con una cámara WATEC 120N (con tiempo GPS insertado). Las medidas de tiempo para el primer y segundo contacto se obtuvieron mediante el análisis de la variación del flujo de Marte usando el software LiMovie y dos métodos diferentes de cálculo. Las mediciones obtenidas se reportaron a la International Occultation Timing Association (IOTA).

ABSTRACT

We present the results of the observation of the occultation of Mars by the Moon on July 6, 2014. Observations were made from the AFARI Astronomical Observatory, in the town of Tarma, Peru. A Celestron 8 telescope with a camera WATEC 120N (GPS time inserted) were used. Time measurements for the first and second contact were obtained by analyzing the variation of the flux of Mars using the software LiMovie and two different methods of calculation. The measurements obtained were reported to the International Occultation Timing Association (IOTA).

Key Words: Mars — occultations

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1. INTRODUCTION

Lunar occultation observations are of great importance because they allow us to know with great precision the orbit and size of the occulted objects from the analysis of the disappearance and reappearance times. By comparing these two measurements with the predictions, we can improve the theoretical models that give us other predictions about positions in time of these objects. In the case of planets in the Solar System, their trajectory is well known, nevertheless, this kind of observations let us polish our predictions in the long run.

The Mars occultation by the Moon on July 6th of 2014 was an event visible from a large part of South America, Perú being one of the most favorable locations to observe such event. The data presented in this work is part of a ongoing project of occultation observations that has started to take place in Perú.

2. OBSERVATIONAL DATA

The observations were done at the AFARI Observatory (Lat. 11°24'53" S, Long. 75°41'00" W, 3056 m above sea level) located in Tarma, Junín-Perú, in the night of July 5th 2014 (local time). An 8 inch Schmidt-Cassegrain telescope was used (Celestron Celestar 8), with a focal ratio f/10, installed on an equatorial mount, and a WATEC 120N camera with UT inserted via GPS without a photometric filter. The resultant field of view according to the telescope-camera configuration was 8.3 arcmin×11 arcmin.

Predictions of the event were obtained using the Occult 4.1[4] software (see Table 1). The four contacts were recorded at a rate of 29 frames/second, but the best measures were the first and second contact. The observation was made with partly cloudy sky, with a temperature of 11°C and a humidity percentage of approximately 60%.

3. DATA PROCESSING

To obtain the contact times we analyzed the flux variation curve of Mars from measurements in each frame, this process was done using LiMovie[5]. This

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[4]Occult 4.1 is a program dedicated to the prediction and analysis of occultations of astronomical objects, it was created by Dave Herald and is available at: *www.lunar-occultations.com/iota/occult4.htm*.

[5]LiMovie is a software for automated photometry of video occultations, it is developed by Japanese amateur Kazuhisa Miyashita and is available at: *www005.upp.so-net.ne.jp/k_miyash/occ02/limovie_en.html*.

TABLE 1

CONTACT TIMES PREDICTION

	Event	Date	Time (UT)
Disappearance	First contact	06/Jul/14	02h14m54.6s
	Second contact	06/Jul/14	02h15m21.4s
Reappearance	Third contact	06/Jul/14	03h33m02.6s
	Fourth contact	06/Jul/14	03h33m24.5s

TABLE 2

MEASUREMENTS OBTAINED

Method	Event	Time (UT)	$O - C$
Method 1	First contact	02h14m50.78s±4s	8.05
	Second contact	02h15m13.54s±4s	0.84
Method 2	First contact	02h14m53.29s±4s	7.27
	Second contact	02h15m11.09s±4s	1.62

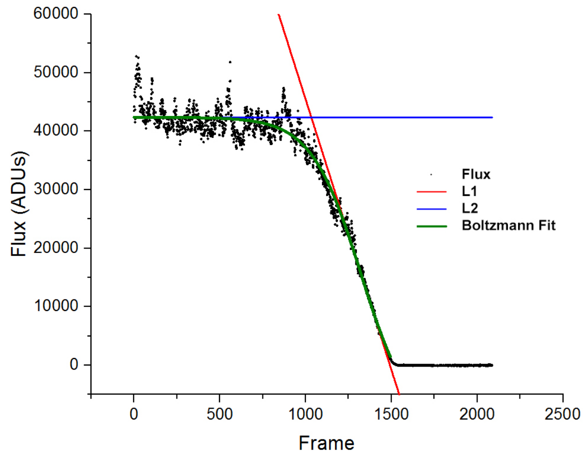

Fig. 1. Fit for the first contact, the intersection of L1 and L2 indicates the time of first contact, the fit is performed with $R^2 = 0.96794$.

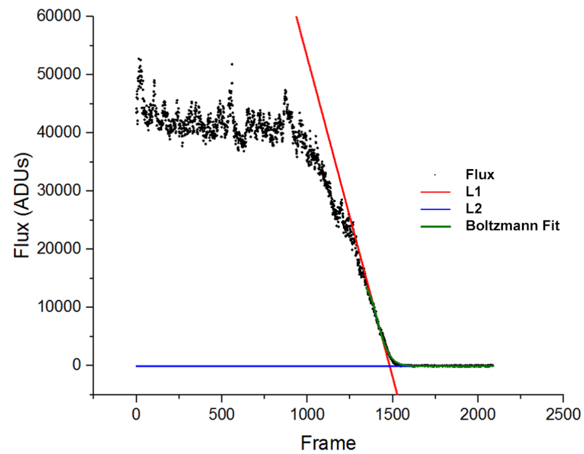

Fig. 2. Fit for the second contact, the intersection of L1 and L2 indicates the time of second contact, the fit is performed with $R^2 = 0.99575$.

flux variation showed a greater noise level at the moment of reappearance, due to the contrast generated between the brightened lunar limbo and the planet. Because of this, the analysis was focused on the first and second contact (disappearance). Mars is a large angular size object, the flux intensity drop was fairly gradual. That is why two methods were used for determining the contact times.

3.1. *First method: First estimative*

To determine the first contact time, we chose the first point that was below the minimum noise level from the constant region, before the decrease in flux. We used the same procedure to determine the second contact time in the corresponding disappearance frame. The method is somewhat subjective, but allows for a first approach to the contact times.

3.2. *Second method: Fit to a Boltzmann function*

Many natural processes exhibit a progression from small beginnings that accelerates and approaches a climax over time. When a detailed description is lacking, a sigmoid function is often used. In this case, the Boltzmann sigmoid function was used separately for adjusting the first and second contact time.

In Figures 1 and 2, L1 represents the tangent line to the point of inflection of the sigmoid function and L2 is the asymptote of the same function; higher in the first contact and lower in the second contact. Contact times were taken from the intersection of L1 and L2, in both cases.

4. RESULTS

The measurements obtained with both methods were reported to the IOTA, in Table 2 the measured time is displayed along with the $O - C$ differences.

5. CONCLUSIONS

Time was obtained for the first and second contact using two different methods. The results are quite similar; however, the method that uses a fit to the Boltzmann sigmoid function corresponds to a more formal procedure, which can be used by other observers as a standard procedure for occultations with gradual variation of flux.

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