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Occultation of 2UCAC 42376428 by (423) Diotima on 2005 March 06

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Abstract. Observations of the occultation of the star 2UCAC 42376428 by (423) Diotima on 2005 March 06 at the Vainu Bappu Observatory are reported. The observed mid time of the event at 15:12:25.1 UT occurred 3.4 s later than the predicted time but within the 1 σ uncertainty of 4.3 s of the predictions by IOTA. The duration of the event of 4.2 s was found to be shorter than the predictions even allowing for a one sigma uncertainty in the impact parameter. This implies a narrower projected width of the asteroid along the occultation track at the time of the event.

Keywords : Occultation: Stellar – Asteroid : Diotima – Star:2UCAC 42376428

1. Introduction

Odd properties of the rotational light-curve of the asteroid (423) Diotima obtained during 1980-1982 were noted by Schober(1983). He pointed out that presence of an additional feature of 0.10 magnitude in the light curve might suggest that this asteroid may have a satellite. The rotation period of Diotima was first determined by Di Martino and Cacciatori (1984) as $4^h.62 \pm 0^h.03$ and an amplitude of $0^m.18 \pm 0^m.01$. Prokof'eva and Karachkina (2004) from their analysis of their observations in 1993 and 1998-1999 derived a rotation period of $4^h.54 \pm 0^h.01$ for the primary component. Using a more extensive data set from 1982 through 2000, they find the period of forced precession of 113 days or 226 days. Another direct evidence of the binary component may come through stellar

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Table 1. Details of the occultation event, star and the asteroid.

The occultation path	
Predicted time of event at VBO	15h 12 21.7s ± 4.3s
Estimated maximum duration	19.7 s
Approx speed of asteroid's shadow	10.5853 km s^{-1}
One σ error in relative position of star and asteroid	$\pm 0.''025$ in α & $\pm 0.''023$ in δ
Data for the target star	
Star	2UCAC 42376428
α(J2000)	05 32 47.1585
δ(J2000)	+30 01 14.298
V mag [mag]	12.5
Data for the asteroid	
(Number) Name	(423) Diotima
Approx. diameter	209 km or $0''.099$ (Bowell et al. 1979, Tedesco, 1989)
Distance from Earth [AU]	2.89800 at event time
Type	C type (Zellner et al. 1985)

occultations provided the occultation chord intercepts both the primary and the satellite. Occultation of the star HIP 66446 by (423) Diotima on 2001, 15 March from India, Greece and France were successful in delineating the outline of the asteroid (Lecacheux 2001, Vasundhara et al. 2001). Fit using five chords by Vasundhara et al. (2001) yielded a preliminary estimate of the projected size of the asteroid as 186 km × 149 km. Dunham (2002) used 15 chords and obtained an estimate of 171 km × 138 km. We report here the results of the occultation of star 2UCAC 42376428 by the same asteroid from the Vainu Bappu observatory four years later. The circumstances of the event are given in Table 1.

2. Observations

The observations were carried out at the cassegrain focus of the 102 cm reflector using a dry ice cooled Ge As Hamamatsu R943-02 photomultiplier tube. A locally built PC based pulse counting unit (Srinivasan, Nagaraja Naidu, Vasundhara, 1993) was used for the intensity measurements. The sky conditions were generally poor, hence no filter was used in order to improve S/N. The PC clock was corrected using a GPS clock.

3. Results and discussions

The observed light curve is shown in Fig.1. The sharp drop in the light level at 15:12:23.0 UT and its abrupt recovery at 15:12:27.2 UT is as expected in case of an occultation by

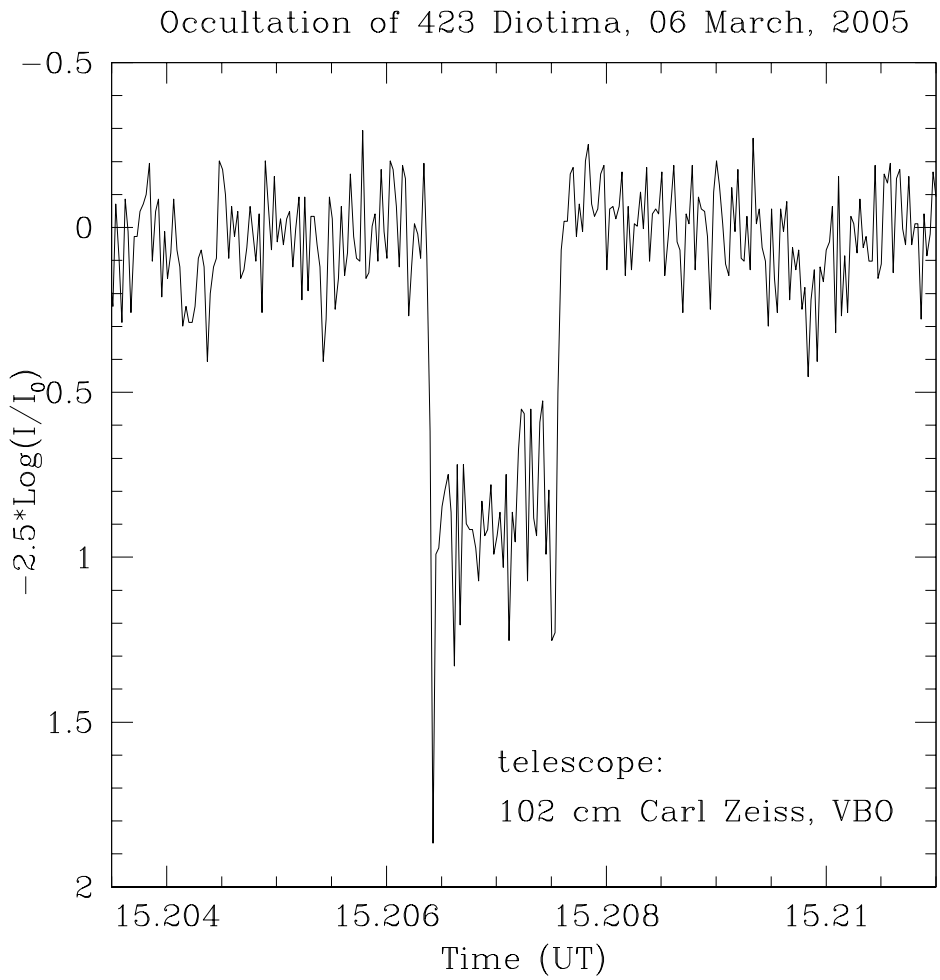

Figure 1. The observed light curve.

Table 2. Observed event timings.

Disappearance of the star (Immersion)	15:12:23.0 UT
Reappearance of the star (Emersion)	15:12:27.2 UT
Observed magnitude drop	0.9 ± 0.15
Predicted magnitude drop	1.0
Mid Event	15:12:25.1 UT ± 0.1 s
Observed duration	4.2 s
Observed length of intercept across the asteroid	44.5 km
(O-C) in mid event time	+3.4s or 0.0"16

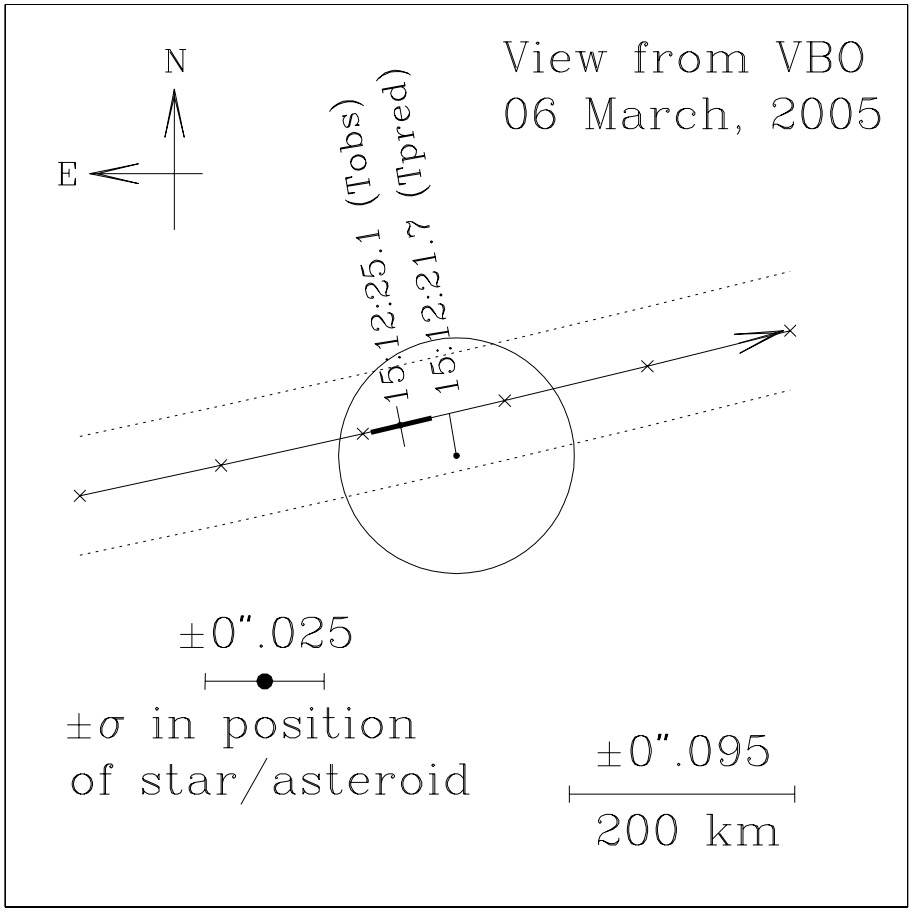

Figure 2. Geometry of the event on the sky plane as viewed from the Vainu Bappu Observatory. The circle at the center represents the outline of the asteroid of diameter 209 km. The predicted path of the star across the asteroid is shown as the arrow. The crosses indicate positions at intervals of 10s. The event (thick segment of line on the occultation track) centered at 15:12:25.1 was delayed by 3.4 s. The dotted lines above and below the track indicate the one sigma error in the predictions

an atmosphere-less body such as an asteroid. The event timings and magnitude drop are given in Table 2. The mid event occurred 3.4 s later but within the 1 σ uncertainty of 4.3 s of the predicted time of 15:12:21.7 UT by Preston (2005). He derived the orbit from 868 observations of the asteroid during 1904 Mar 12 - 2005 Feb 14. One sigma uncertainty in position was $\sim \pm 0".025$ in α and $\sim \pm 0".023$ in δ. Geometry of the event on the sky plane as viewed from the Vainu Bappu Observatory is shown in Fig. 2. The circle at the center represents the outline of the asteroid of diameter 209 km (Bowell, 1979). The

predicted path of the star across the asteroid is shown as the arrow. The crosses indicate positions at intervals of 10s. The (O-C) in the event time of 3.4s in time corresponds to 33.9 km or 0.$''$016 at the distance of Diotima at the time of event. The observed relative separation between the star and the asteroid along the occultation track is thus found to be within the predicted accuracy (Table 1). The duration of the event is illustrated by the thick line on the track in Fig. 2. This is much less than the predicted width. Considering that the event occurred within one sigma of the predicted time, a northward shift of the track by one sigma of 0$''$.025 (dotted line above the predicted track) will reduce the predicted event duration but will still be longer than the observed duration of 4.2 s or a projected width of 44 km. The fitted projected dimensions of the same asteroid during the occultation on 2001, March 15, were 171 km $\times$138 km by Dunham (2002) and 186 km $\times$149 km by Vasundhara et al. (2001). The difference in the projected dimensions of the rotating asteroid does not come as a surprise as the two events took place at different rotational phases. In absence of at least a minimum of 3 chords, no further investigations regarding the projected shape of the asteroid are possible. No secondary event by a possible satellite was noticed. However, occultation by a companion can occur only if it crosses the occultation track precisely at the instant the star-observer line cuts the occultation track at the same point, taking into account the light time corrections from the asteroid to the Earth. Such rare events can best be detected when simultaneously observed from a large number of closely spaced locations. Further, the sky conditions being poor, a secondary even to have taken place behind the passing clouds cannot be ruled out. Absence of a secondary effect does not therefore dispute the possible binary nature of the asteroid (Schober, 1983; Prokof'eva and Karachkina, 2004).

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