

OBSERVATION OF A SECONDARY EXTINCTION DURING THE OCCULTATION OF
SAO 114159 BY (18) MELPOMENE

RICHARD M. WILLIAMON

Fernbank Science Center Observatory, Atlanta, Georgia 30307

Received 6 August 1979; revised 15 November 1979

ABSTRACT

A secondary occultation of the fainter component of SAO 114159 was observed from Fernbank Observatory on 11 December 1978, at 9^h11^m UT. An interpretation consistent with the data is that the event was caused by a satellite of (18) Melpomene with a minimum diameter of 48 km.

I. INTRODUCTION

The identification of the occultation of SAO 114159 = AGK3 + 6°778 ($m_v = 8.4$) by (18) Melpomene on 11 December, 1978, was initially presented by G. E. Taylor (1978). Later astrometry at Lowell Observatory reported by O. G. Franz, R. L. Millis, and L. H. Wasserman (1978) indicated a shift in the occultation path somewhat to the south of the initial track. Further communication with R. L. Millis (1978) indicated that the uncertainty in the predictions was such that the event could possibly be observed from Fernbank Observatory at a latitude of 33° 46' 43".5. The last prediction available to the author, supplied by D. Dunham (1978), predicted the event would be visible from a more northern latitude with enough uncertainty to warrant observations from Fernbank Observatory. Dunham also suggested that secondary events, possibly caused by satellites, might be detected even if the primary event could not be acquired. Other articles debating the plausibility of minor planet satellites as well as the observational evidence for the existence of such satellites have been presented by Reitsema (1979), Binzel and Van Flandern (1979), and Tedesco (1979).

The occultation of SAO 114159 by (18) Melpomene was successfully observed photoelectrically from three locations in the Washington, D.C. area (Dunham 1978). The tentative results of these observations as well as those obtained by four visual observers in the Washington, D.C.-Baltimore area have already been presented (Dunham 1979). A more complete discussion of the (18) Melpomene observations and its possible satellites will be presented elsewhere (Dunham *et al.* 1979).

II. OBSERVATIONS

The secondary occultation of SAO 114159 was photoelectrically observed with the 91-cm reflector at the Fernbank Science Center Observatory. A standard V filter of the Johnson-Morgan UBV system was used in combination with an unrefrigerated EMI 6256s photomultiplier and a dc amplifier with the time constant set

to zero seconds. The observations were recorded on a Honeywell strip chart recorder with the chart transport set at 10 in./min. The tracing of the secondary occultation is shown in Figure 1, and the timing measurements as read from the chart are given in Table I. The duration of the event was obtained by measuring from the front of the ingress ink line to the front of the egress ink line at the half depth level. This method of measurement eliminated any timing error due to either chart recorder response or absolute chart synchronization with WWV, and an uncertainty of only ± 0.01 seconds was estimated.

The sky conditions prior to the event were such that clouds prohibited the acquisition of the field until 8^h 55^m UT. By 9^h 03^m UT the sky was free of haze and stable in the region of SAO 114159. Sky conditions remained stable until 9^h 14^m UT at which time haze began to reappear, although it is felt that another event could have been detected until about 9^h 18^m UT. A portion of the strip chart record is reproduced in Figure 2 in order to demonstrate the sky stability during the critical time between 9^h 08^m UT and 9^h 14^m UT. Because of the

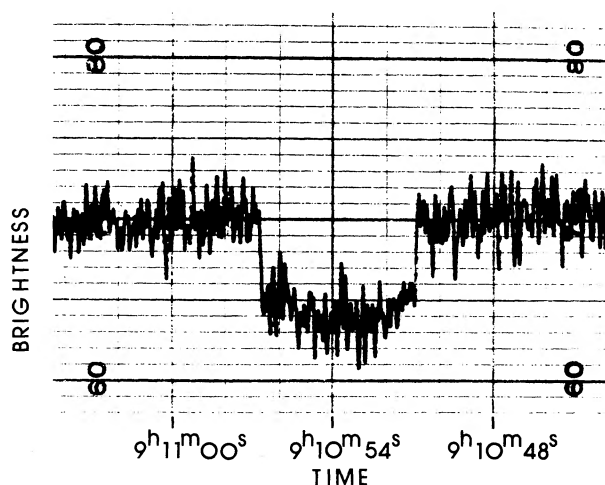


FIG. 1. The strip chart record of the secondary event observed at Fernbank Observatory.

TABLE 1. Timing measurements from the occultation of SAO 114159.

Event	Time	Estimated Error
Ingress occultation	9 ^h 10 ^m 50 ^s .9	±0 ^s .1
Egress occultation	9 ^h 10 ^m 56 ^s .7	±0 ^s .1
Duration of event = 5 ^s .77 ± 0 ^s .01		

rather short duration of stable sky, neither an accurate sky brightness nor the individual brightnesses of (18) Melpomene and SAO 114159 could be obtained. In turn, the actual magnitude loss during the secondary event could not be calculated. At 9^h 31^m UT, the haze thinned once again which allowed a measurement of a sky brightness level of 45% of full scale and of a (star + sky + asteroid) level of 72%. If a similar sky level had been present at the time of the event, then the corresponding magnitude loss would have been only 0^m.31. Since the sky was noticeably clearer at 9^h 11^m UT, the corresponding sky brightness at the time of the secondary event should have been significantly lower. The 0^m.31 can therefore be considered an upper limit for the magnitude loss during the secondary event.

The initial announcement of the secondary event (Williamon 1978) tentatively noted that the tracing showed a duplicity of SAO 114159. While SAO 114159 has been shown to be a binary (Dunham 1979), the rather symmetrical structure during the secondary event is now believed to be noise. This belief is primarily based on the measurement of a magnitude drop of significantly less than 0^m.3, which is consistent with an occultation of only the secondary component of SAO 114159 by a satellite. Since the V magnitudes of the primary and secondary components of SAO 114159 are 8^m.6 and 10^m.1, respectively, and the V magnitude of (18) Melpomene at the time of the event was 9^m.2 (Dunham *et al.* 1979), then the expected drop during a satellite occultation of the secondary component of SAO 114159 would have been 0^m.16. Furthermore, the scintillation noise was not reduced during the event as would have been expected during a deep event.

III. CONCLUSIONS

The possibility that the Fernbank secondary event was caused by the occultation of a third component of SAO 114159 by (18) Melpomene could not be eliminated with the Fernbank observations alone. Other observers along the secondary occultation track have eliminated the possibility of an occulting body the size of (18) Melpomene since no occultation was observed (Dunham *et al.* 1979). These same observers, unfortunately, were not

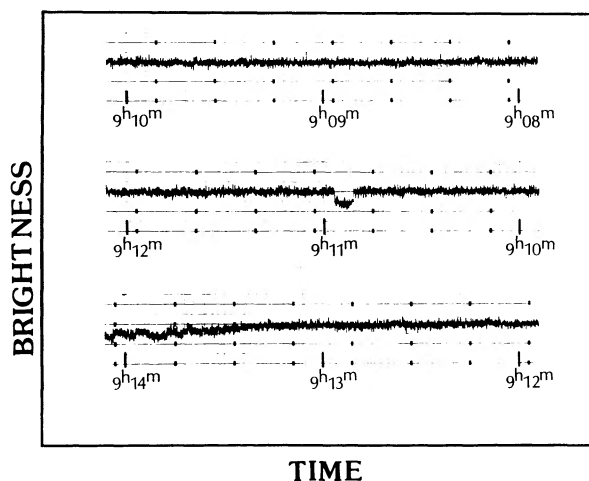


FIG. 2. A portion of the strip chart record showing sky stability just before and after the secondary event.

able to either confirm or deny the existence of an occulting body with a diameter of only 48 km.

An attempt was made to duplicate the chart record by non-astronomical means such as telescope movement or dark slide motion, but no situation could produce even a remotely similar record. Unlike cloud passages or atmospheric events, the ingress and egress slopes of the event are sharp and, in fact, are identical to the limiting slope constrained by the response time of the Honeywell recorder.

While some other interpretations are not excluded, the secondary event can be explained as the occultation of the secondary component of SAO 114159 by a satellite of (18) Melpomene. If the satellite hypothesis is adopted and if a spherical shape is assumed for the satellite, previously designated 1978 (18) 1 (Williamon 1978), then a minimum diameter of 48 ± 1 km follows from the duration of the occultation. At the time, the separation of the satellite from the asteroid was 0.86 (Dunham *et al.* 1979), corresponding to a distance projected onto the plane of the sky of 697 km. Since the mean diameter of (18) Melpomene is about 135 km (Dunham 1979) and therefore about three times larger in diameter than 1978 (18) 1, a difference of about 2 1/2 magnitudes is expected if similar albedos are assumed. Near opposition, (18) Melpomene and its satellite should be visually resolvable or perhaps reveal an elongated image with a large telescope.

The author gratefully acknowledges the helpful comments of R. L. Millis and D. Dunham in the preparation of this work.

REFERENCES

- Binzel, R. P., and Van Flandern, T. C. (1979). Minor planets: The discovery of minor satellites. *Science* **203**, 903.
- Dunham, D. W. (1978). Private communication, 8 December.
- Dunham, D. W. (1979). Duplicity of both (18) Melpomene and SAO 114159 discovered during occultation. *Occultation Newsletter* **2**: (2), p. 12.

- Dunham, D. W., Dunham, J. B., Van Flandern, T. C., Schmidt, R., Skillman, D. R., Espenak, F., A'Hearn, M. F., Bolster, R. N., Taylor, G. E., Klemola, A. R., Wasserman, L. H., Williamon, R. M., Poss, H. L. (1979). Occultation of SAO 114159 by (18) Melpomene and possible satellites. *Icarus*, in preparation.
- Franz, O. G., Millis, R. L., and Wasserman, L. H. (1978). Occultation of SAO 114159 by (18) Melpomene on 1978 December 11. *IAU Circular No. 3312*.
- Millis, R. L. (1978). Private communication, 30 November.
- Reitsema, H. J. (1979). Reliability of Minor Satellite Observations. *Science* **205**, 205.
- Taylor, G. E. (1978). IAU Commission 20 Working Group on Predictions of Occultations by Satellites and Minor Planets, *Bulletin* 3.
- Tedesco, E. F. (1979). Binary asteroids: Evidence for their existence from lightcurves. *Science* **203**, p. 905.
- Williamon, R. M. (1978). 1978 (18) 1. *IAU Circular No. 3315*.