OCCULTATION STUDIES AT
THE DOMINION ASTROPHYSICAL OBSERVATORY

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During the last year studies of lunar occultations have begun at the Dominion Astrophysical Observatory. Since the acquisition of a Fabri-Tek (model FT 1074) signal averager and analyser, twelve occultations have been observed but only one has been reduced and a comparison made with a theoretical model. The observed diffraction pattern for this occultation was found to correspond with an almost point source model.

The exposure meter photomultiplier (EMI type 6094) on the 48 in. telescope has been used for all observations to date. A preamplifier mounted close to the photomultiplier housing directs the amplified signal to a circuit which controls the D.C. level of the signal before being applied to the signal averager. The same circuit can deliver a variably delayed stopping pulse to the signal averager upon receipt of a

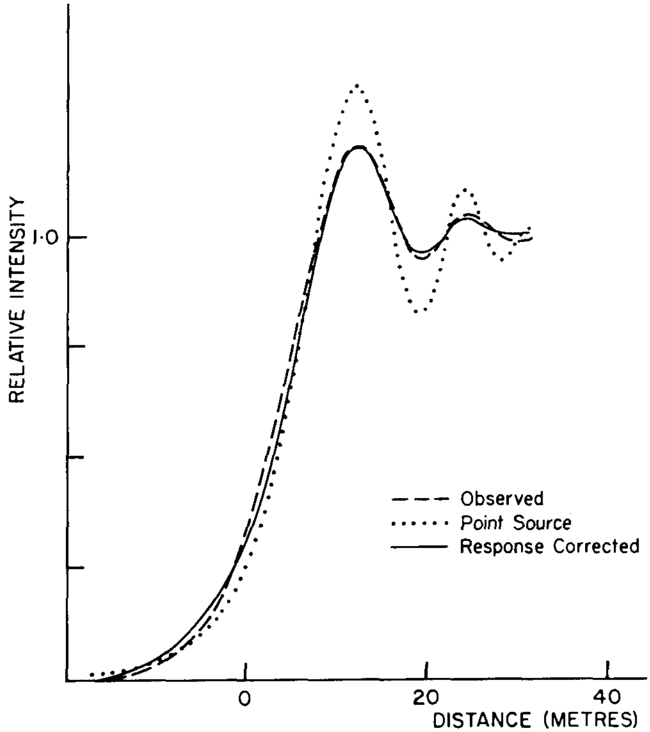

Fig. 1. Diffraction curves for SAO 79805: -- observed, ... point source model, —— response adjusted model.

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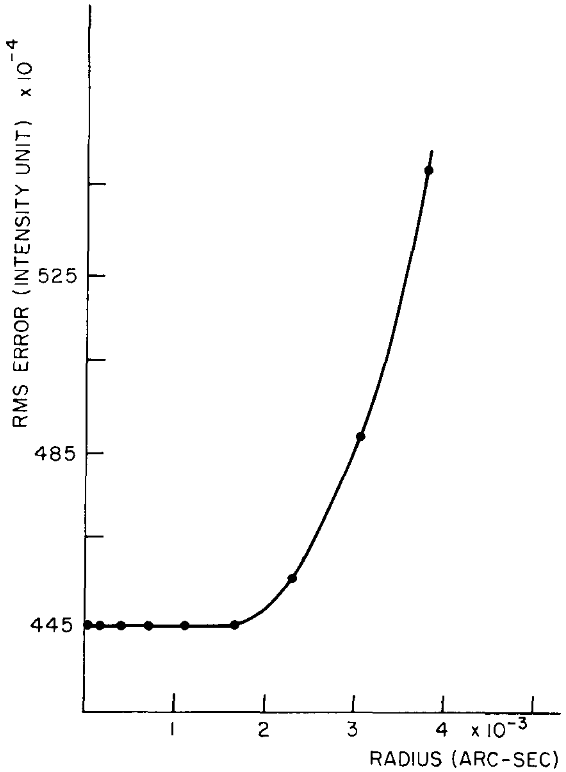

Fig. 2. RMS differences between model and data for various model radii for SAO 79805.

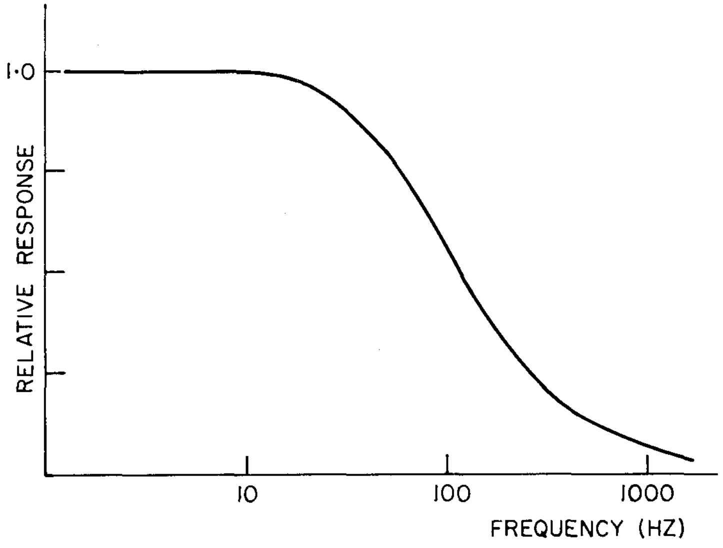

Fig. 3. The recording system response.

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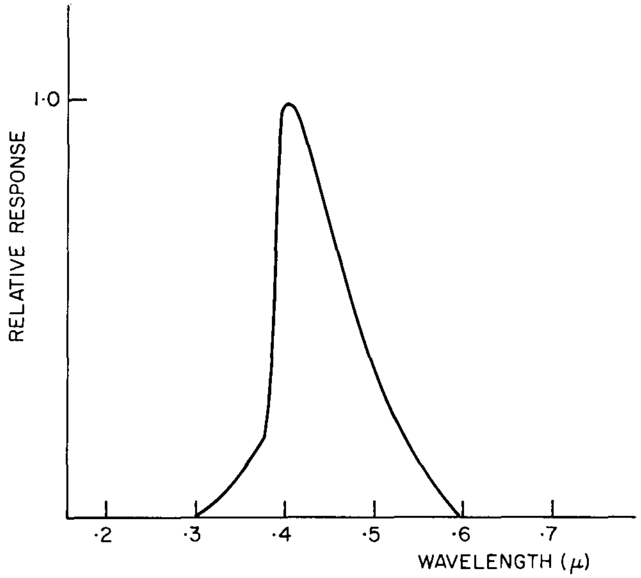

Fig. 4. SAO 79805 observed bandpass.

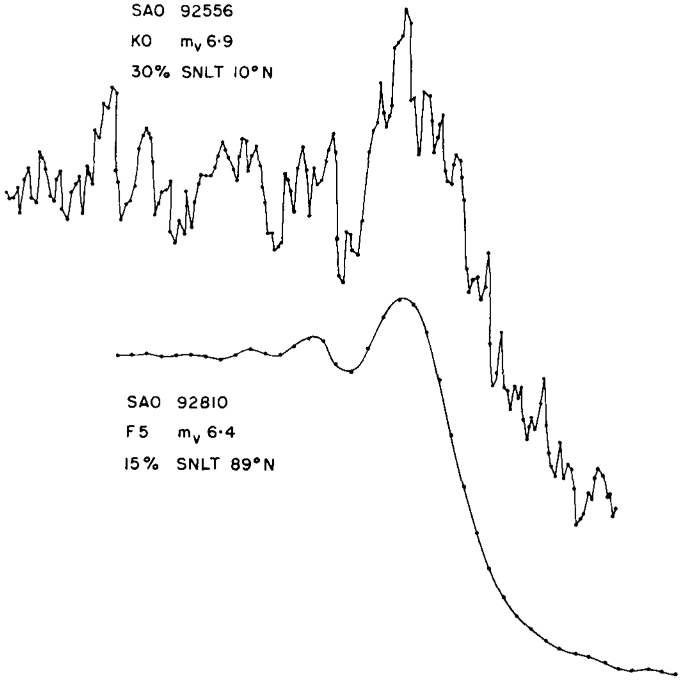

Fig. 5. Observed occultation of SAO 92556 and SAO 92810.

sharp change in input signal. This feature has not been used since there is plenty of time to stop the signal averager manually after the diffraction pattern is displayed on the oscilloscope. An alteration to the channel advance circuitry of the signal averager allows only the most recent data to be stored in memory. The appropriate quarter or half of the memory containing the observation is then transferred to punched tape for reduction.

Most occultations have been observed using the 2 msec filter on the input to the signal averager. This will not be used in the future because all smoothing can be done with the reduction program. Several of the occultations have been timed absolutely with makeshift equipment, but it is planned to time each occultation to several milliseconds in the future.

A computer program has been developed which generates diffraction pattern models resulting from occultations of a range of stellar radii. The method outlined by Whitford (1939) sums the effects from component strips of the source. Limb darkening effects are computed by summing the patterns from several sources of different size according to weights determined by the assumed limb darkening law. The smearing caused by the telescope diameter is computed by shifting the source and summing the patterns. The time scale of the event is determined from the apparent relative star/Moon velocity and the cusp angle on the Moon at the occultation point. The observed bandpass (Figure 4) is derived from the star colour, the reflection of the flats in the telescope's coudé system, and the response of the photomultiplier. The resulting models are further modified by calculating their Fourier transforms and correcting the inverse transform coefficients according to the response of the instrumentation (Figure 3). The reconstituted models therefore are corrected for the R.C. time constant at the photomultiplier preamplifier input and the filter constant selected on the signal averager.

A least squares best fit is obtained after the models are stretched or shrunk according to the time scale of the observed data points. This modification to the theoretical models determines the angle on the lunar limb at the point of occultation.

The occultation of SAO 79805 on May 10–11, 1970 provided data which fitted very closely to the theoretical model for a point source. The star has a magnitude of 6.7 and is of spectral class B8. From these parameters one would expect a radius of 0.00005 sec of arc. Figure 2 shows that models below about 0.002 sec of arc radius have equivalent diffraction patterns and are in fact representative of a point source. When the source is this small, limb darkening has no effect on the model fit but only slightly displaces the model/data error curve. The best fit indicated an angle on the lunar surface of 13.9 ± 6.0 deg at the point of occultation which was 85 deg from the north pole.

Figure 1 (Table I) shows the diffraction curve for a model of SAO 79805 with radius 0.00005 sec of arc. The corrected curve has allowed for the response of the system which is almost equivalent to a 3.5 msec RC filter. This smoothing of the input slightly shifts the $\frac{1}{4}$ intensity point of the data from the geometrical shadow point. The unsmoothed observed points are shown to fit very closely to the corrected curve.

TABLE I

Occultation of SAO-79805

Date	May 10–11, 1970
Mag.	6.7
Special type	B8
PCT. Moon Sunlit	30 +
Cusp-angle	85°
Star-Moon angle	$-14^{\circ}.83$
Hour angle	1.265
Latitude	0.846
Tel. diameter	48″
Speed (Earth–Moon)	87.2 cm/msec
Observed speed (Earth–Moon)	81.4 cm/msec
Distance (Earth–Moon)	0.399×10^{11} cm
Best fit	point source

Figure 5 shows the diffraction curve resulting from the occultation of SAO 92556 on February 11, 1970. Although a definite diffraction effect is evident, noise with frequency components close to the frequency components of the diffraction makes any reduction all but impossible.

We hope to obtain more observations from various types and sizes of stars in the near future and of course would welcome any binary system. Although we have only observed disappearances we will soon be able to observe reappearances when a new drive system has been installed on the 48 in. telescope. Ultimately the occultation equipment will become a permanent fixture for the 48 in. and the observing procedures routine.

Acknowledgements

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