read standard stars, by reversing the order and reading, for one cycle after the standard set, the asteroid first and then the comparison star. Moreover, by reading the standards when the telescope is already near a target asteroid, we reduce the time lost between asteroid readings. The standards are important because they provide a constant check on the consistency of our data at various airmasses.

History and Plans

During the past year, our nights at the telescope were generally productive with the number of photometric hours somewhat higher than 1982. During one particularly "cost effective" two night run in December 1982, we obtained 8 full light curves and in 4 nights in April 1983 we managed to obtain 10 full and 3 partial lightcurves.

The project has another 18-24 months to proceed, depending to a large extent on the weather. Following that, we will likely need more time to fill in gaps in our data. As our reductions and analysis proceed, we are discovering ways to refine our observing process. We expect that when this project is concluded, we will know much more about both these asteroids and how scientists can best observe them photometrically.

Asteroid	Period (hours)	Diameter (km)	Type	Amplitude (mag)
16 Psyche	4.196	249	M	0.34
22 Kalliope	4.15	175	M	0.30
29 Amphitrite	5.39	199	S	0.13
39 Laetitia	5.14	158	S	0.54
45 Eugenia	5.70	250	UC	0.33
87 Sylvia	5.19	251	P	0.42
107 Camilla	4.85	252	C	0.53
125 Liberatrix	3.969	103	M	0.32
129 Antigone	4.96	113	M	0.32
130 Elektra	5.25	143	U	0.30
201 Penelope	3.75	144	M	0.56
216 Kleopatra	5.39	219	M	1.2
337 Devosa	4.61	100	CSM	0.2
349 Dembowska	4.70	145	R	0.40
354 Eleonora	4.28	156	UR	0.30
511 Davida	5.17	335	C	0.25

Table I
Priority 1 Target Asteroids

PHOTOELECTRIC PHOTOMETRY OF ASTEROID 60 ECHO

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Photoelectric observations of asteroid 60 Echo were made from Gila Observatory on 13 nights between January 29 and February 20, 1984. A synodic rotational period for Echo of 25.208 $\pm$ 0.048 hours was determined. The observed amplitude of the lightcurve was 0.22 $\pm$ 0.02 magnitudes.

During 1984 the asteroid 60 Echo had a very favorable opposition with a predicted B magnitude at opposition of 11.4. Photometric observations of Echo were undertaken by the authors as part of a program to determine the rotational periods for asteroids with no published lightcurve or whose rotational period is not accurately known, as was the case for Echo.

The observations reported here were made with the 28 cm (11 inch) Schmidt-Cassegrain telescope at Gila Observatory. All photometric observations were made using an uncooled Optec SSP-3 solid state photometer interfaced to a TRS-80 model 3 micro-computer with 16 K of RAM memory. The photometric observations were made using no filters and no transformation of the data to B or V was attempted. However, the unfiltered response of the SSP-3 photometer is most similar to R with a peak response near 8000 angstroms. During the course of the observations described here, the stars SAO 117836, 2 Leo, and SAO 98495 with spectral types G5, F9, and KO, respectively, were used as comparison stars. These comparison stars were never further than 1.5 degrees away from the target asteroid. Differential atmospheric extinction corrections were applied to all data. The choice of near solar-type comparison stars minimized color-dependent variations in atmospheric extinction between the asteroid and comparison star.

Photometric integration times of 90 seconds were used for both the comparison star and the asteroid. Each 90 second integration was composed of three separate 30 second integrations of comparison star or asteroid and four 15 second integrations of the sky background. The sequence of these integrations was sky, asteroid, sky, asteroid, sky, asteroid, sky and sky, comp, sky, comp, sky, comp, sky. Each differential magnitude was derived from a set of three 90 second integrations in the sequence: comparison, asteroid, comparison. An average of six photometric readings of the asteroid were recorded every hour during an observing run. The computer recorded the photometric readings as well as the time of each reading and stored this data in RAM memory for later data reduction. At the completion of a photometric data run, the computer calculated the differential magnitudes taking into account the differential atmospheric extinction between asteroid and comparison star. Atmospheric extinction coefficients were estimated at the beginning of each photometric observing session. The obtained photoelectric data could then be displayed on either the computer CRT or the line printer.

60 Echo has been observed on two previous occasions by Gehrels and Owing (1962) and by Harris and Young (1982). Gehrels and Owing estimated a rotational period of greater than or equal to 30 hours based on a single lightcurve of approximately 8 hours duration. Harris and Young gave a tentative value of 52 hours, based on extensive observations, but noted that interpretation was confused by the fact that one of the comparison stars used was later determined to be a variable star with a period very nearly equal to the rotational period of the asteroid.

Observations of 60 Echo made by the authors on 13 nights between January 29 and February 20, 1984 indicate that a synodic rotational period of 25.208 $\pm$ 0.048 hours best fit the observed data. The composite lightcurve shown in Figure 1 is based on this rotational period. The lightcurve shows two broad maxima and minima per rotation with an amplitude of 0.22 $\pm$ 0.02 magnitudes.

Radar observations of 60 Echo in the 13 cm wavelength conducted by S. Ostro at the Arecibo Radio Observatory returned no detectable echo from the asteroid. This effect may be explained by a greater than expected Doppler broadening caused by the rotational period for Echo being considerably shorter than the anticipated 52 hours. This evidence lends further support to the assertion by the authors that the rotational period of this asteroid is approximately one-half of the previously assumed value.

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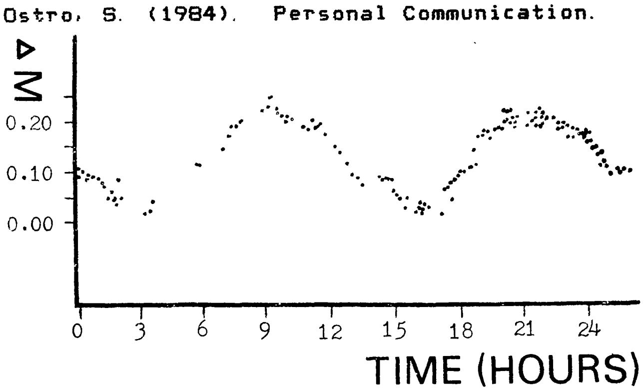

Figure 1. Composite Lightcurve of Asteroid 60 Echo.

THE PHASE COEFFICIENT OF 18 MELPOMENE AS DETERMINED BY VISUAL OBSERVATIONS

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Visual magnitude estimates of 18 Melpomene were made throughout its 1981 apparition. Analysis of the observations made at phase angles > 7 degrees yield a linear phase coefficient of 0.028 $\pm$ 0.002 mag/deg, in excellent agreement with the mean value for S-type asteroids. Linear extrapolation to zero degrees phase angle implies a V(1,0) magnitude of 6.88.

The interest generated in this visual observing project was entirely due to Dr. J. U. Gunter's admirable bi-monthly publication Tonight's Asteroids. In the July-August 1981 edition came an appeal by R. P. Binzel encouraging lightcurve observations of asteroid 18 Melpomene during its very favorable opposition in Aquarius.

All observations reported here were made by the first author using a 25 x 105 mm binocular telescope, field 3 degrees, mounted on a portable tripod. Also, a pair of hand-held 15 x 80 mm binoculars, field 4 degrees, was used by the observer comfortably seated in a reclining deck chair with arm rests. Experience has been gained over a number of years in visual magnitude observations of comets and variable stars using various classes of instruments. Particular attention has also been given to monitoring light fluctuations of new and old novae.

The comparison stars were taken from the AAVSO Variable Star Atlas. The magnitude determinations were obtained by the usual variable star techniques by selecting suitable standard comparison stars near the minor planet at the time.

The observations are listed in Table I which gives the UT date, visual magnitude estimate, and the (earth-asteroid-sun) phase angle, α. r and Δ are the sun-asteroid and earth-asteroid distances in AU. $V(1,\alpha)$ is the magnitude of the asteroid corrected to a distance 1 AU from the earth and sun, where

$$V(1,\alpha) = V - 5 \operatorname{Log}(r\Delta)$$

Figure 1 shows a "phase curve", a plot of $V(1,\alpha)$ versus phase angle. The data show the typical features of a phase curve: a linear portion for α > 7 degrees and a non-linear increase for α < 7 degrees called "the opposition effect." The opposition brightening is due to the microscopic