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PHOTOELECTRIC LIGHTCURVES AND ROTATION PERIOD OF THE MINOR PLANET 59 ELPIS

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The minor planet 59 Elpis was observed photoelectrically with the ESO 50 cm telescope at La Silla (Chile) during the 1976 opposition. The lightcurve appears fairly continuous with two nearly symmetric maxima and minima. The synodic rotation period is found to be $13^h41^m24^s \pm 18^s$ and the maximum amplitude about 0.1 mag.

Key words: asteroid – rotation period – lightcurve – 59 Elpis

1. INTRODUCTION

Ephemeris of Minor Planets for 1976 predicted the opposition for 59 Elpis on August 27, 1976 with $B = 11.6$ mag (I.T.A. 1976). We observed this asteroid during five consecutive nights since August 31, 1976. The measurements were performed by using a photoelectric photometer equipped with an EMI 6256 photomultiplier attached to the 50 cm telescope at the European Southern Observatory. No previous observations for 59 Elpis are reported in the literature (Gehrels 1970).

The general observing routine included frequent observations of the asteroid, sky and comparison stars (DM − 6°5971 (Go) and DM − 7°5755 (Ko)) chosen close to the path of 59 Elpis and of similar colours and magnitude. The integration time for each single measurement was 40 sec.

Parts of the obtained lightcurves were rejected because of poor meteorological conditions. Furthermore, no transformations from the instrumental system $(UBV)'$ to the standard one (UBV) were performed.

The differences $\Delta V'$ between the instrumental magnitudes V' of the asteroid and of the comparison star DM − 6°5971 are plotted against U.T. in figures 1 to 5.

Table 1 contains the date of observations, the right ascension and declination, the ecliptic longitude and latitude, the geocentric distance Δ, the heliocentric distance r, the phase angle α, the light times for the asteroid and the number of the figure relative to the corresponding date.

A few photographic plates of 59 Elpis were taken with the 40 cm double refractor of the European Southern Observatory in order to improve the ephemeris of the minor planet. The final results presented in table 1 were determined by one of us (H.D.) at the Royal Observatory of Belgium (Debehogne *et al.* 1976).

2. LIGHTCURVES AND PERIOD

The $\Delta V'$ lightcurves for 59 Elpis presented in figures 1 to 5 are not corrected for the phase and distance effects, the abscissae are U.T. without correction for light time.

In figure 6 we superpose all preceding night curves in order to display the full light variation of the minor planet 59 Elpis. In that figure the ordinates are referred to the mean magnitude line constructed so that the areas enclosed by the curve above and below this line are equal.

The rotational lightcurve of 59 Elpis appears fairly continuous with two nearly symmetric maxima (M_1, M_2) and minima (m_1, m_2) and with a maximum amplitude of 0.1 mag. The magnitude difference between both maxima and both minima are almost negligible *i.e.* comparable to the mean scatter. The phase differences between the positions of the extrema M_1 and M_2 and between those of m_1 and m_2 are respectively about 0.52 and 0.51.

Different superpositions of the lightcurves obtained during the five observing nights allow to derive straight away the lapse of time separating two similar features in the asteroid's lightcurve. Location on time scale of such a feature (maximum, minimum) is determined within a precision of 30 sec. Table 2 encloses the epochs and lapses of time derived when comparing the extrema from all individual lightcurves. Finally, assigning weights proportional to the number of cycles we deduce the following mean rotational synodic period P:

$$P = 13^h41^m24^s \pm 18^s = 0^d.57042 \pm 0.00021$$

3. DISCUSSION

Because of the continuous light variations observed for 59 Elpis and the presence of two very symmetric maxima and minima, it is very probable that the irregular shape of the asteroid's body accounts mainly for the rotational lightcurve displayed in figure 6. It is very likely too that a symmetric shape (ellipsoid, etc.) for 59 Elpis could fit the general pattern of the observed lightcurve. This is to be expected because at the time the two maxima (minima) occur, the projected area corresponding to opposite sides of the asteroid's surface will appear with the same light and at equal phase intervals.

The very small humps located in the bottom of both minima m_1 and m_2 (see figure 6) can be due to spottedness over the asteroid's surface. Van Houten (1965) proposed that such features could result from near-specular reflection from rather small flat areas.

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Table 1 Aspect data, light times and figure numbers for 59 Elpis

Date of observation (0h U.T.)	R.A. (1950.0)	Dec. (1950.0)	λ (1950.0)	β (1950.0)	Δ (A.U.)	r (A.U.)	α	Light time	Figure
Aug. 31,1976	$22^h20^m.04$	-06°28!7	334°48	3°64	1.51694	2.52434	1°85	$0^d.00876$	1
Sept.01,1976	22 19.29	-06 37.4	334.25	3.57	1.51795	2.52439	2.16	0.00877	2
Sept.02,1976	22 18.54	-06 46.0	334.02	3.50	1.51923	2.52444	2.52	0.00877	3
Sept.03,1976	22 17.79	-06 54.7	333.80	3.44	1.52078	2.52449	2.91	0.00878	4
Sept.04,1976	22 17.06	-07 03.3	333.58	3.37	1.52260	2.52455	3.32	0.00879	5

Table 2 Epochs and lapse of time between two similar extrema appearing in a pair of lightcurves (see text)

Epoch (U.T.,1976)	Extremum	Lapse of time	Deduced N° of cycles
Aug. 31, 4.445h±0.008h Sept.01, 7.825	m_2	27.380h	2
Aug. 31, 4.445 Sept.04, 4.273	m_2	95.828	7
Aug. 31, 8.078 Sept.02, 1.165	M_1	41.087	3
Aug. 31, 8.078 Sept.03, 4.528	M_1	68.450	5
Sept.01, 0.860 Sept.02, 4.258	m_1	27.398	2
Sept.01, 0.860 Sept.03, 7.615	m_1	54.755	4
Sept.01, 7.825 Sept.04, 4.273	m_2	68.448	5
Sept.01, 4.942 Sept.04, 1.385	M_2	68.443	5
Sept.02, 1.165 Sept.03, 4.528	M_1	27.363	2

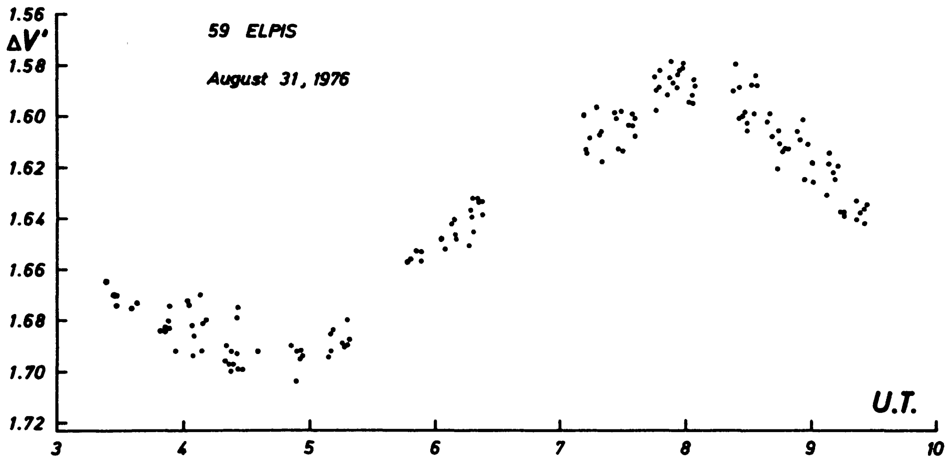

Figure 1 Lightcurve of 59 Elpis on August 31, 1976

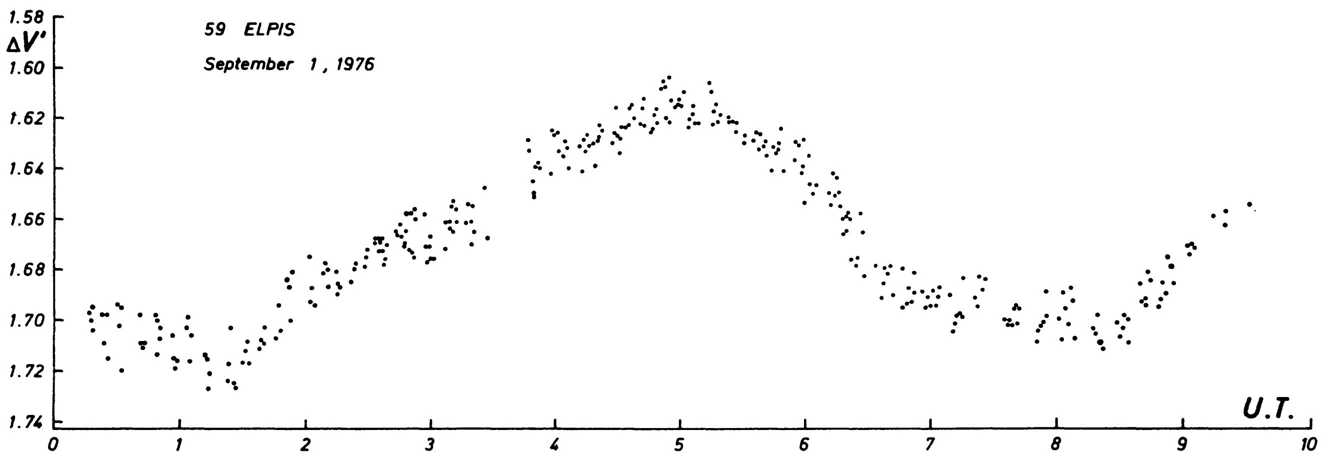

Figure 2 Lightcurve of 59 Elpis on September 1, 1976

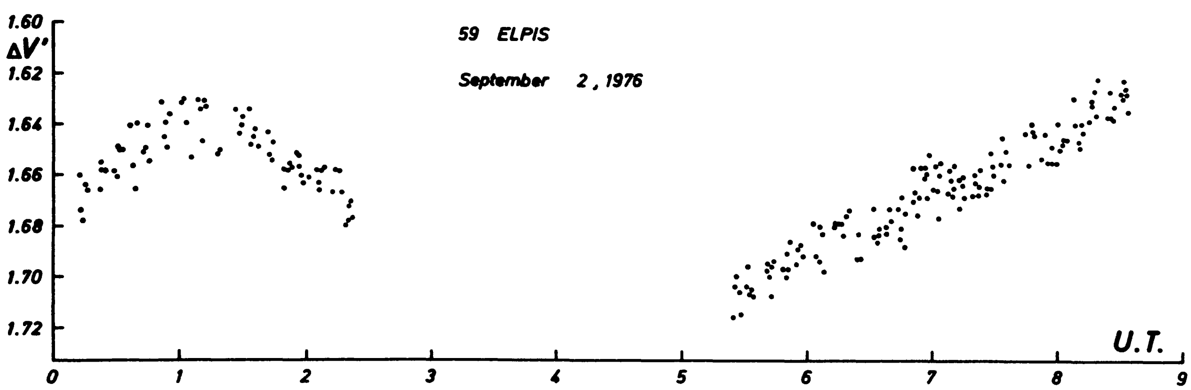

Figure 3 Lightcurve of 59 Elpis on September 2, 1976

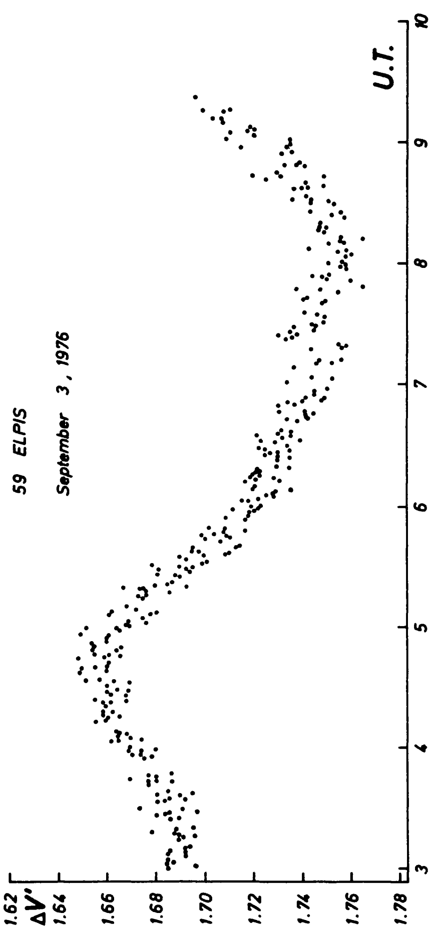

Figure 4 Lightcurve of 59 Elpis on September 3, 1976

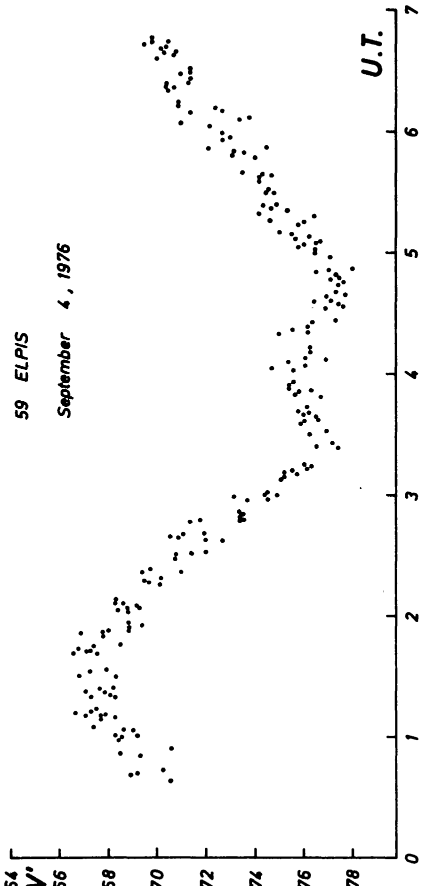

Figure 5 Lightcurve of 59 Elpis on September 4, 1976

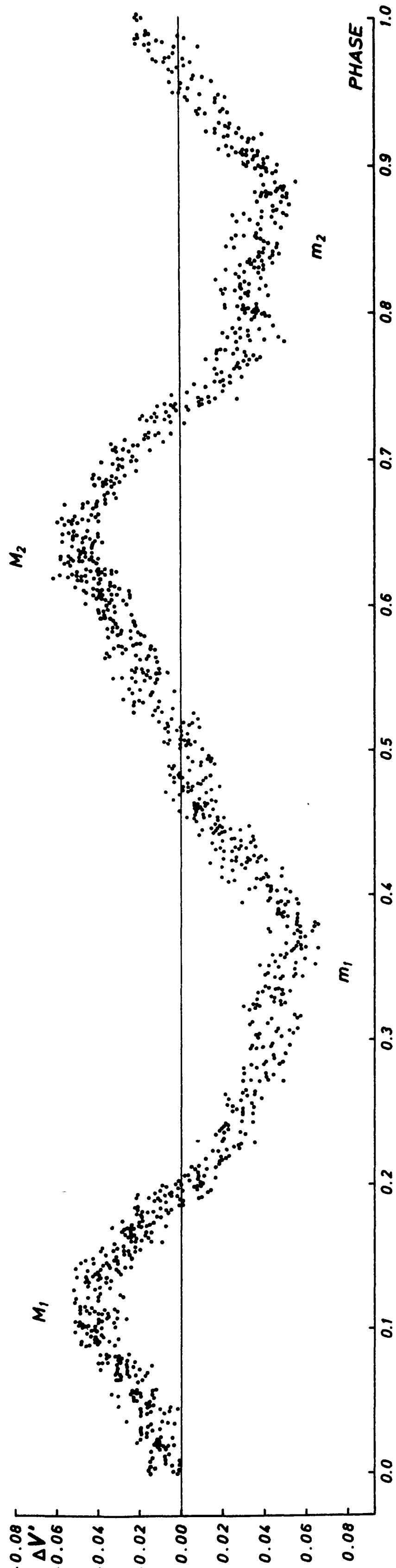

Figure 6 Mean lightcurve of 59 Elpis. The ordinates are referred to the mean magnitude line (see text)