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PHOTOELECTRIC LIGHTCURVES OF THE MINOR PLANETS 29 AMPHITRITE, 121 HERMIONE AND 185 EUNIKE

H. DEBEHOGNE
Observatoire Royal de Belgique
A. SURDEJ and J. SURDEJ
European Southern Observatory, La Silla, Chile

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Asteroids 29 Amphitrite, 121 Hermione and 185 Eunike were observed with a photoelectric photometer attached to the 50 cm telescope at the European Southern Observatory. The lightcurve of 29 Amphitrite presents a triple maximum and minimum as remarkable features and a total amplitude of 0.11 mag. The synodic rotation period derived for this asteroid is found to be $5^h23^m24^s \pm 4^s$. The minor planet 121 Hermione only displayed very smooth light variations (~ 0.03 mag) during 16 hours of observation. No rotation period could be deduced from our measurements. Finally, asteroid 185 Eunike appeared with light variations greater than 0.12 mag and with a very probable synodic rotation period of $10^h50^m \pm 2^m$.

Key words: asteroid – rotation period – lightcurve – 29 Amphitrite, 121 Hermione and 185 Eunike

1. INTRODUCTION

The opposition dates of the minor planets 29 Amphitrite, 121 Hermione and 185 Eunike were respectively predicted on May 28, 1977 with $B = 10.6$ mag, on September 16, 1976 with $B = 12.2$ mag and on December 27, 1976 with $B = 11.8$ mag (I.T.A. 1976, I.T.A. 1977).

Because of bad weather conditions each of these asteroids could only be followed during two nights among five allocated to us. We observed 29 Amphitrite on May 29 and 30, 1977, 121 Hermione on September 11 and 15, 1976 and 185 Eunike on January 5 and 6, 1977.

No previous observations for asteroids 121 Hermione and 185 Eunike are reported in the literature (Taylor 1971). All references concerning 29 Amphitrite are condensed in Taylor's paper with the following known results:

$B(1,0) = 7.21$ mag, $B(a,0) = 10.25$ mag, $B-V = 0.87$ mag, $P_{syn} = 5.589^h$ and the maximum light amplitude $\Delta V = 0.13$ mag.

2. OBSERVATIONS

The equipment used was a photoelectric photometer (single channel and pulse counting) attached to the 50 cm telescope at the European Southern Observatory. The measurements were performed by this photometer equipped with an EMI 9789 QB photomultiplier and Schott standard filters U.G. 1, BG 12, GG 14, respectively for the *UBV* magnitudes.

As usual the general observing routine included very frequent measurements of the asteroid, sky and comparison stars in order to bring details in the shape of the lightcurve. The comparison stars (respectively DM−30°13007, $23^h38^m38^s$ −14°51′51″ (1950) and $6^h16^m27^s$ −06°44′20″ (1950)) were chosen for their proximity to the asteroid (respectively 29 Amphitrite, 121 Hermione and 185 Eunike) and their similarity in colours and magnitude. Some standard stars were measured in the U, B, V system (Blanco *et al.* 1968) to determine the magnitudes of asteroid 29 Amphitrite. The V lightcurves for this asteroid are presented in figures 1 and 2. Concerning 121 Hermione and 185 Eunike no transformations from the instrumental system $(UBV)'$ to the standard one were performed. The differences $\Delta V'$, in the sense asteroid minus comparison star, are plotted against U.T. without correction for light time in figures 4 and 5 (121 Hermione) and figures 6 and 7 (185 Eunike). In those lightcurves, not corrected for the phase and distance effects, the integration time for each single measurement was 20 sec (figures 1 and 2), 40 sec (figures 4 and 5) and 30 sec (figures 6 and 7).

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 different asteroids and the number of the figure relative to the corresponding date. These improved ephemeris were determined by one of us (H.D.) at the Royal Observatory of Belgium (Debehogne *et al.* 1976).

3. LIGHTCURVES AND ROTATION PERIOD

3.1. 29 Amphitrite

A full cycle of light variation for the minor planet 29 Amphitrite displays within a total amplitude of 0.11 mag three well shaped maxima (M_1, M_2, M_2') and minima (m_1, m_2, m_2'). These appear very distinctly in figure 3 which illustrates a mean lightcurve constructed from the two single night curves (figures 1 and 2) of the asteroid. The horizontal line in figure 3 indicates a mean magnitude reference, the areas enclosed by the mean curve above and below that line being equal. An additional smallscale feature around the phase 0.43 can be noticed as well in that figure.

The magnitude differences between the maxima M_2', M_2 and M_1 are respectively about 0.01 mag and 0.04 mag. Similarly, the magnitude differences between the minima m_2', m_2 and m_1 are 0.005 mag and 0.02 mag. The positions of these different extrema, not always defined precisely, are distributed on the phase abscissa without any evident symmetry (figure 3). Table 2 summarizes the epochs at which occured all maxima and minima. We indicated in the same table the lapses of time separating distinct epochs relative to a same extremum. Assigning weights proportional to the number of cycles we deduced the following mean rotational synodic period P:

$$P = 5^h23^m24^s \pm 4^s = 0^d.224583 \pm 0^d.000046.$$

We present below the observed mean magnitudes $\bar{V}(1,\alpha)$ at unit distances for the two observing nights. We found for May 29, 1977: $\bar{V}(1,\alpha) = 6.166$ mag and for May 30, 1977: $\bar{V}(1,\alpha) = 6.177$ mag. The mean magnitude $\bar{V}$ was computed by planimetry.

3.2. 121 Hermione

The big scatter (~ 0.015 mag) appearing in the $\Delta V'$ lightcurves of 121 Hermione (figures 4 and 5) imposes a real lack of definition in the light variations (~ 0.03 mag) of the asteroid. It is very likely that the light maximum located around 3^h U.T. on September 11, 1976 is identical to the one occuring at around $1^h.5$ U.T. on September 15, 1976. A good superposition of these maxima yields a time interval of $97.60^h \pm 0^h.10$. We can conclude that the rotation period for 121 Hermione is greater than 9^h (figure 5) and enters very probably an integer number of times the times interval $97^h.60$.

3.3 185 Eunike

With a maximum amplitude exceeding 0.12 mag the lightcurves (figures 6 and 7) obtained for 185 Eunike enable us to determine its rotation period. Indeed, we recorded a same part of the lightcurve, namely the minimum m_1 on two consecutive nights. The lapse of time separating these minima (cf. table 2) is found to be $21^h.660$. Because the time interval between the two minima m_1 and m_2 is around 5^h (see figure 7) and under the reasonable assumption that the full lightcurve of 185 Eunike contains only two maxima and minima, the rotation period P adopted as the most probable is

$$P = 10^h50^m \pm 2^m = 0^d.4514 \pm 0^d.0014.$$

4. DISCUSSION

Because of the presence of three well-defined maxima (M_2', M_2, M_1) and minima (m_2', m_2, m_1) the lightcurve of 29 Amphitrite appears very similar to the one of 471 Papagena (Surdej and Surdej 1977). Both an irregular shape of the asteroid and albedo variations over its surface can account for the observed lightcurve. It is not possible from our measurements to determine which are the contributions of these two distinct factors.

The $B-V$ and $U-B$ colours of 29 Amphitrite did not show any real variation during the run of our observations, they were found to be respectively 0.82 and 0.38. These numbers are typical values among the known colours of various asteroids (see figure 10, Gehrels 1970). However, let us notice the deviation between our $B-V$ value and the one appearing in Taylor's paper: $B-V = 0.87$. A variation of this colour index between different oppositions of the asteroid is not excluded.

The synodic rotation period we derived for 29 Amphitrite does not differ, within the precision of our measurements, from the one determined previously (Taylor 1971) $P = 5.389^h$.

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Table 1 Aspect data, light times and figure numbers for 29 Amphitrite, 121 Hermione and 185 Eunike

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
a) 29 Amphitrite									
May 29,1977	$16^h14^m.18$	-30°31'.7	247°.13	-09°.16	1.76696	2.77228	3°.34	$0^d.01021$	1
May 30,1977	16 13.12	-30 29.9	246.89	-09.17	1.76580	2.77112	3.37	0.01020	2
b) 121 Hermione									
Sept.11,1976	23 39.20	-14 38.0	349.36	-11.36	1.75637	2.75023	4.16	0.01014	4
Sept.15,1976	23 36.32	-14 55.0	348.60	-11.33	1.75302	2.74503	4.30	0.01012	5
c) 185 Eunike									
Jan.05,1977	06 16.02	-06 48.1	94.60	-30.18	1.66441	2.55484	11.61	0.00961	6
Jan.06,1977	06 15.15	-06 40.2	94.35	-30.06	1.66690	2.55581	11.69	0.00963	7

Table 2 Epochs and lapse of time between two similar extrema (see text)

Epoch (U.T. 1977)	Extremum	Lapse of time	Deduced N° of cycles
A. 185 Eunike			
Jan.05, 5.580h±0.070h Jan.06, 3.240	m_1	21.660h	2
B. 29 Amphitrite			
May 29, 3.540h±0.004h 29, 1.102	m_1	21.562h	4
29, 3.540 30, 6.490	m_1	26.950	5
30, 1.102 30, 6.490	m_1	5.388	1
29, 4.558 30, 2.120	M_2'	21.562	4
29, 4.558 30, 7.506	M_2'	26.948	5
30, 2.120 30, 7.506	M_2'	5.386	1
29, 5.056 30, 2.618	m_2'	21.562	4
29, 5.056 30, 8.004	m_2'	26.948	5
30, 2.618 30, 8.004	m_2'	5.386	1
29, 5.837 30, 3.400	M_2	21.563	4
29, 6.772 30, 4.335	m_2	21.563	4
29, 7.870 30, 5.430	M_1	21.560	4

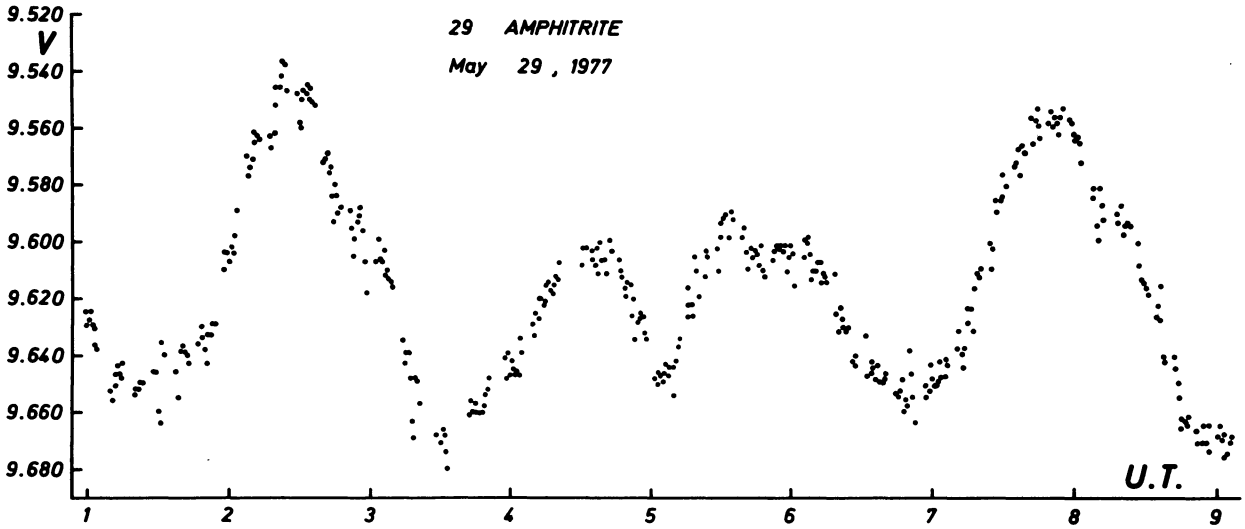

Figure 1 *V* lightcurve of 29 Amphitrite on May 29, 1977.

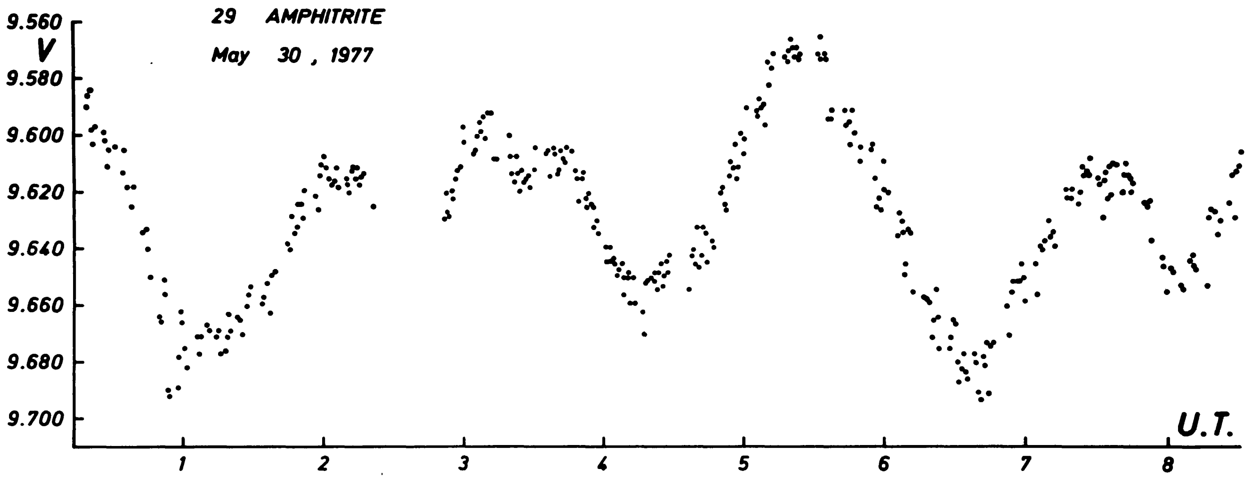

Figure 2 *V* lightcurve of 29 Amphitrie on May 30, 1977.

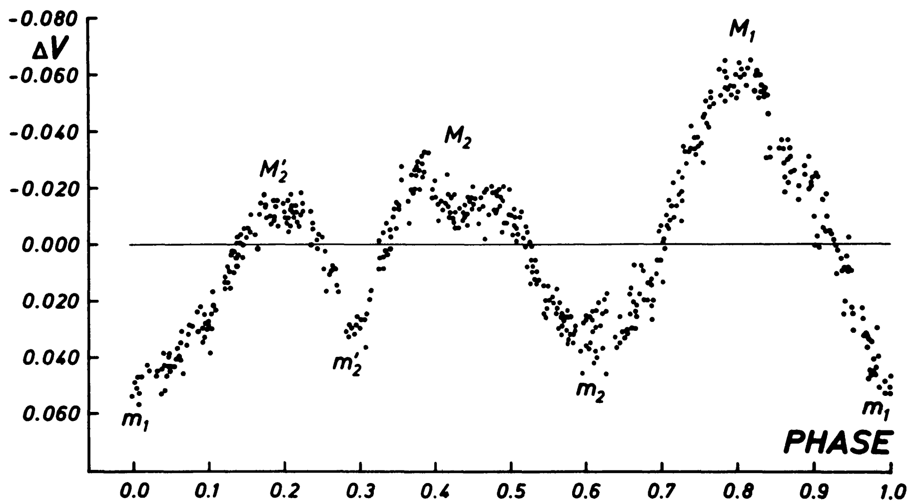

Figure 3 Mean lightcurve of 29 Amphitrite. The ordinates are refered to the mean magnitude line (see text).

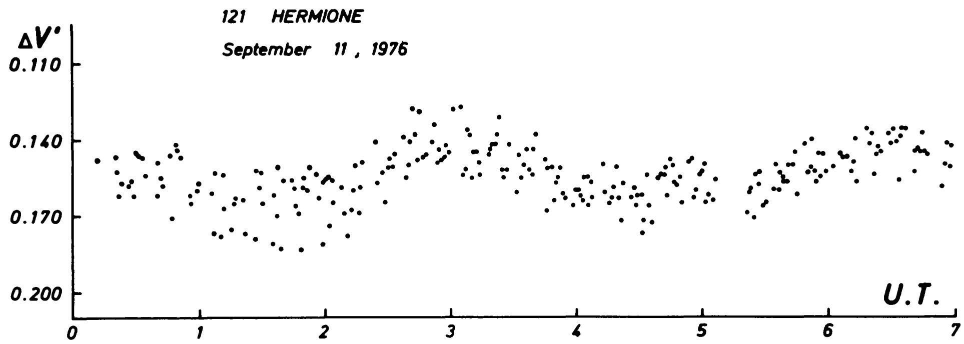

Figure 4 $\Delta V'$ lightcurve of 121 Hermione on September 11, 1976.

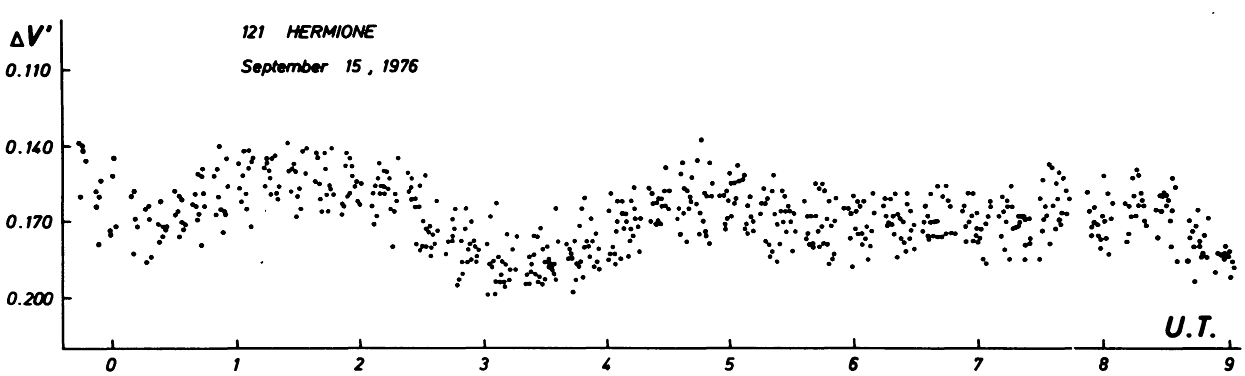

Figure 5 $\Delta V'$ lightcurve of 121 Hermione on September 15, 1976.

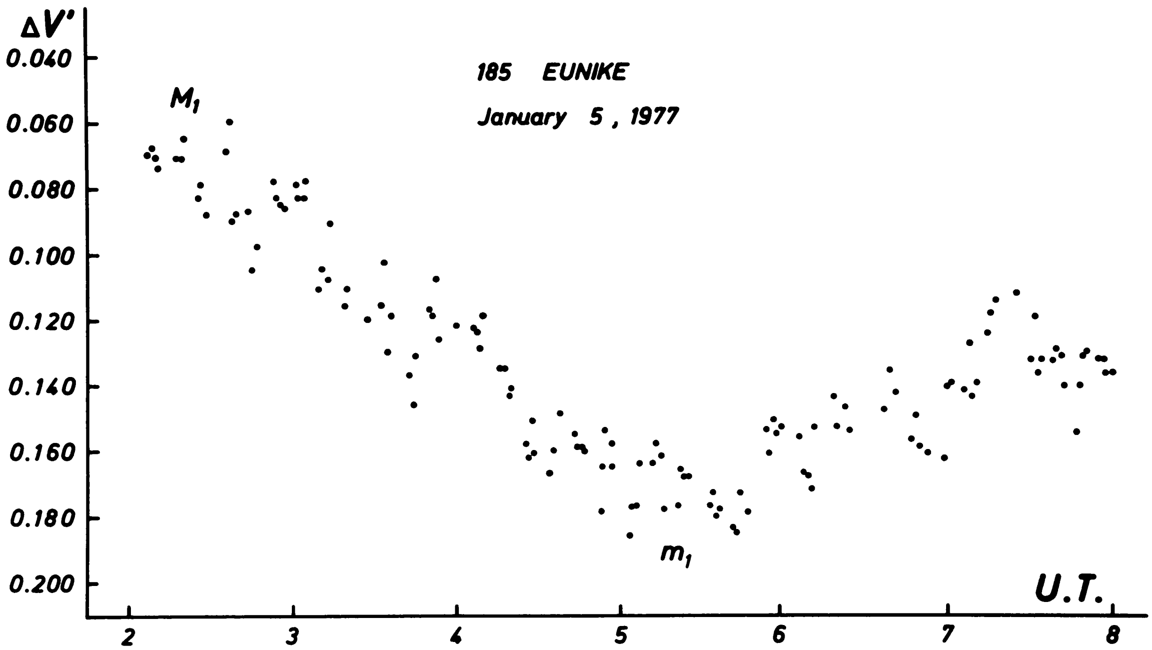

Figure 6 $\Delta V'$ lightcurve of 185 Eunike on January 5, 1977.

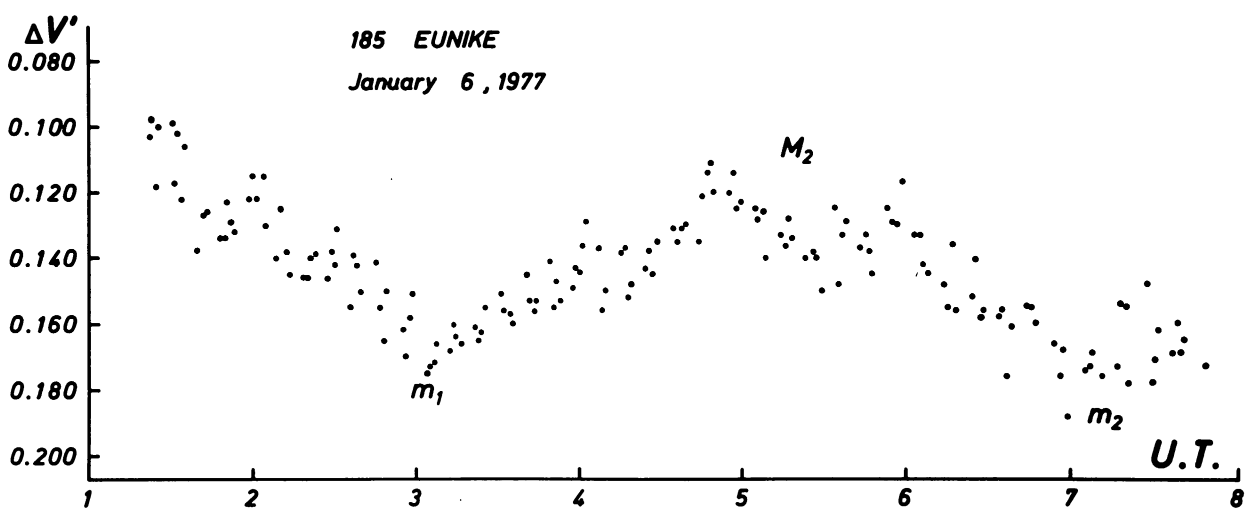

Figure 7 $\Delta V'$ lightcurve of 185 Eunike on January 6, 1977.