

Astron. Astrophys. Suppl. Ser. **41**, 335-338 (1980)**ROTATION PERIOD AND PHOTOELECTRIC LIGHTCURVES
OF ASTEROIDS 68 LETO AND 563 SULEIKA (*)**

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Summary. — Asteroids 68 Leto and 563 Suleika were observed photometrically during their 1978 opposition with the 50 cm telescope of the European Southern Observatory (Chile). Until August 1978, no rotation period had been determined for these minor planets.

The rotation lightcurve of 68 Leto displays three identifiable maxima and minima with a total amplitude $\Delta V = 0.19$ mag. and the synodic period of rotation is found to be $14^{\text{h}}50^{\text{m}}51^{\text{s}} \pm 52^{\text{s}}$.

For 563 Suleika the derived synodic period of rotation is $5^{\text{h}}41^{\text{m}}31^{\text{s}} \pm 3^{\text{m}}36^{\text{s}}$ and its lightcurve shows two nearly symmetric maxima and minima within an amplitude range $\Delta V = 0.21$ mag.

The color indices measured for 68 Leto and 563 Suleika are, respectively, $B-V = 0.839 \pm 0.022$ mag., $U-B = 0.472 \pm 0.025$ mag. and $B-V = 0.891 \pm 0.017$ mag., $U-B = 0.459 \pm 0.030$ mag. with no trends of variation exceeding the mean scatter of the observations.

Key words : Asteroids — Minor planets — Photoelectric photometry — 68 Leto, 563 Suleika.

1. Introduction. — The Ephemeris of Minor Planets for the year 1978 (I.T.A., 1978) predicted oppositions for 68 Leto and 563 Suleika occurring on August 27 and August 19 with $B = 10.3$ mag. and $B = 7.0$ mag. Photometric observations of the minor planets 68 Leto and 563 Suleika in the standard *UBV* system were carried out respectively on August 16-22, 1978 (the nights of August 16, 18 and 22 were rejected because of bad weather conditions) and on August 27, 1978 with the ESO 50 cm telescope at the observatory of La Silla (ESO, Chile).

Harris (1979) informed us that he and Young also observed 68 Leto at Table Mountain Observatory on August 24-29, 1978 and that they derived the following results from their measurements: $P = 14^{\text{h}}85$ and $\Delta V = 0.15$ mag. We also communicated to them our results. Morrison (1977) reported for 68 Leto the visual geometric albedo $p_v = 0.126$ and Bowell *et al.* (1978) classified it as an S-type asteroid with a diameter around 125 km.

Until today, no previous photometric observations have been reported in the literature for 563 Suleika. Morrison (1977) gave for this minor planet the visual geometric albedo $p_v = 0.156$ and Bowell *et al.* (1978)

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classified it as an S-type asteroid with a diameter roughly equal to 53 km.

Table I presents 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 time for both asteroids and the number of the figure corresponding to the given date. These ephemerides were computed and kindly put at our disposal by Batrakov (1979).

2. Observations. — A single-channel photometer equipped with an EMI 6256 photomultiplier, Schott standard filters for the *UBV* magnitudes and Pelletier cooling system was used for the photoelectric measurements. A basic integration time of 40 s was chosen when collecting the photons through a 15 arcsec diaphragm.

The observations were performed following the general observing routine which consisted in frequent measurements of the asteroid, sky, comparison stars and some standard E region stars (Cousins and Stoy, 1962). The comparison stars were selected close to the path of the asteroids and had similar colors and magnitudes (see table II). The data were reduced to the standard *UBV* system taking into account the first and second order extinction as well as a linear color transformation.

3. Lightcurves and rotation period for 68 Leto. — Figures 1 to 4 display the photometric measurements of 68 Leto obtained respectively on 17, 19, 20 and 21 August, 1978 in the *V* color. None of these lightcur-

ves has been corrected for the phase and distance effects and the abscissae are U.T. without correction for light time.

Figure 5 illustrates the mean composite lightcurve constructed from the four single ones when taking into account the distance (see table I) and phase effects ($\beta = 0.039$ mag./deg., see Gehrels and Tedesco, 1979). One sees that a full cycle of light variations consists of three distinguishable maxima M_1, M_2, M_3 and minima m_1, m_2, m_3 , with m_1 not being entirely recorded. The maximum amplitude derived for the V lightcurve is $\Delta V = 0.19$ mag.

Table III gives the epochs and time lapses between similar extrema appearing in the lightcurve of 68 Leto. Assigning weights proportional to the number of cycles elapsed between two similar extrema, we derived the following synodic period of rotation

$$P = 14^{\text{h}}50^{\text{m}}59^{\text{s}} \pm 3^{\text{m}}18^{\text{s}}.$$

This determination is in perfect agreement with the independent one Harris (1979) communicated to us

$$P = 14^{\text{h}}85 \text{ or } P = 14^{\text{h}}51^{\text{m}}.$$

We found that Harris' lightcurve recorded on August 27, 1978 showed that a maximum M_2 occurred at $3^{\text{h}}3 \pm 0^{\text{h}}2$. The combination of this result with our data (see table III, August 17 at $5^{\text{h}}74$) allowed us to refine the preceding period of rotation and chiefly the uncertainties to its value

$$P = 14^{\text{h}}50^{\text{m}}51^{\text{s}} \pm 52^{\text{s}} \text{ or } 0^{\text{d}}6186 \pm 0^{\text{d}}0006.$$

Out of 197 single measurements, the color indices for 68 Leto are found to be $B-V = 0.839 \pm 0.022$ mag. and $U-B = 0.472 \pm 0.025$ mag., with no trends of variation exceeding the mean scatter of the observations.

68 Leto is one more asteroid to add to the list of the seven known ones (see Schober, 1979) which present triple maxima and minima in their lightcurves. We allow the reader to imagine this object as being a sophisticated spinning *boomerang* (Tedesco *et al.*, 1978), a tumbling Pharaon-like *triangular Pyramide* (Surdej and Surdej, 1977) or even... ?

4. Lightcurve and rotation period for 563 Suleika. — The V lightcurve recorded for 563 Suleika on August 27, 1978 is shown in figure 6. It is not corrected for phase and distance effects. The abscissae are U.T. without correction for light time.

Over one cycle of rotation, the light variations display two nearly symmetric maxima M_1, M_2 and minima m_1, m_2 with a total amplitude $\Delta V = 0.21$ mag. We exclude the possibility of a third maximum M_3 and minimum m_3 because the ascending branch of the lightcurve observed between $1^{\text{h}}5$ and 3^{h} U.T. coincides perfectly with the one at $7^{\text{h}}-8^{\text{h}}5$ U.T.

Table IV gives the epochs for different extrema appearing in the V lightcurve of 563 Suleika. As the extremum m_1 is the only one recorded twice during that night, the synodic period of rotation is straightforwardly found to be

$$P = 5^{\text{h}}41^{\text{m}}31^{\text{s}} \pm 3^{\text{m}}36^{\text{s}} \text{ or } 0^{\text{d}}2372 \pm 0^{\text{d}}0025.$$

It was also possible to derive by planimetry a mean magnitude \bar{V} for the lightcurve of 563 Suleika, which when corrected for distance effects, leads to a determination of the mean absolute magnitude

$$\bar{V}(1, \alpha) = 9.05 \pm 0.02 \text{ mag.}$$

From 69 single measurements, we derived the color indices of 563 Suleika : $B-V = 0.891 \pm 0.017$ mag. and $U-B = 0.459 \pm 0.030$ mag. These indices do not show any variation during the rotation of the minor planet, which exceeds the mean scatter of the observations.

The lightcurve and rotation period of 563 Suleika are normal when compared to most of the asteroids (see Schober, 1978). One can interpret the light variations of 563 Suleika as due to its changing shape over a cycle of rotation, quite similar to those recorded for a three-axes ellipsoid model (cf. Surdej and Surdej, 1978).

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TABLE I. — *Aspect data, light times and figure numbers for 68 Leto and 563 Suleika.*

Date of observations (0h U.T.)	R.A. (1950.0)	Decl. (1950.0)	λ (1950.0)	β (1950.0)	Δ (A.U.)	r (A.U.)	α	Light time	Figure
68 Leto									
Aug. 17, 1978	22 ^h 29 ^m 46 ^s	-24 ^o 18'	330 ^o 07	-13 ^o 80	1.292	2.284	6 ^o 7	0 ^d 00747	1
19	22 28 06	-24 27	329.65	-13.79	1.289	2.283	6.4	0.00745	2
20	22 27 15	-24 31	329.44	-13.78	1.288	2.282	6.2	0.00744	3
21	22 26 24	-24 35	329.23	-13.77	1.287	2.282	6.1	0.00743	4
563 Suleika									
Aug. 27, 1978	22 ^h 42 ^m 42 ^s	-28 ^o 33'	318 ^o 38	-13 ^o 97	1.664	2.636	7 ^o 6	0 ^d 00961	6

TABLE II. — *Identification, V magnitude, B-V and U-B colors of comparison stars.*

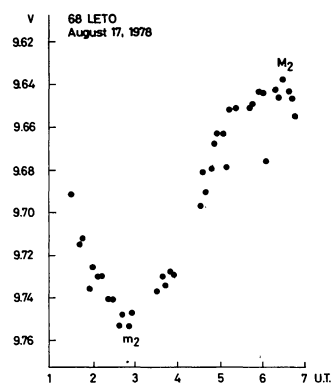
	Identification	V	B-V	U-B
Comp. star (68 Leto)	HD 213072	9.511 +0.008	1.058 +0.020	0.889 +0.025
Comp. star (563 Suleika)	21 ^h 41 ^m 3 -28 ^o 42' (1950.0)	11.897 +0.008	0.775 +0.012	0.330 +0.020

TABLE IV. — *Epochs for the different extrema appearing in the V lightcurve of 563 Suleika.*

Epoch (U.T., 1978)	Extremum
August 27 1 ^h 808 ^m +0 ^h 030	m ₁
3.200	M ₁
4.463	m ₂
5.910	M ₂
7.500	m ₁

TABLE III. — *Epochs and lapses of time between two similar extrema appearing in the lightcurves of 68 Leto (see text).*

Epoch (U.T., 1978)	Extremum	Lapse of time	Deduced number of cycles
August 17 2 ^h 875 ^m +0 ^h 030	m ₂	74 ^h 215 ^m +0 ^h 060	5
20 5.090	m ₂		
19 5.740	m ₃	44.430	3
21 2.170	m ₃		
20 3.025	M ₁		
17 5.740	M ₂	44.825	3
19 2.565	M ₂		
17 5.740	M ₂	74.325	5
20 8.065	M ₂		
19 2.565	M ₂	29.500	2
20 8.065	M ₂		
19 7.740	M ₃		

FIGURE 1. — *V lightcurve of 68 Leto on August 17, 1978.*

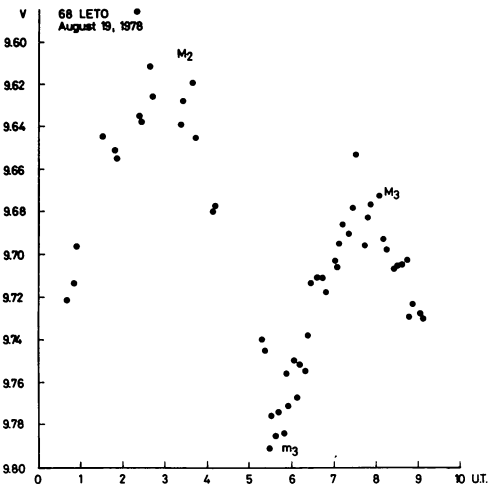


FIGURE 2. — V lightcurve of 68 Leto on August 19, 1978.

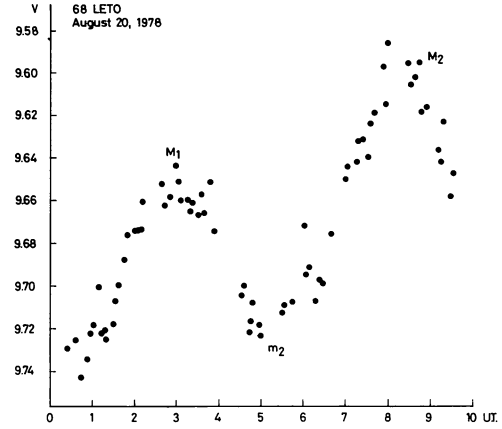


FIGURE 3. — V lightcurve of 68 Leto on August 20, 1978.

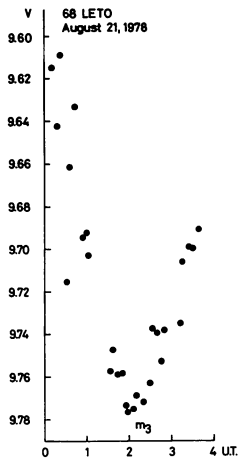


FIGURE 4. — V lightcurve of 68 Leto on August 21, 1978.

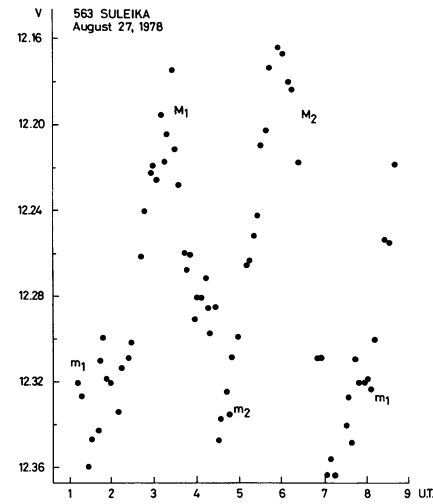


FIGURE 6. — V lightcurve of 563 Suleika on August 27, 1978.

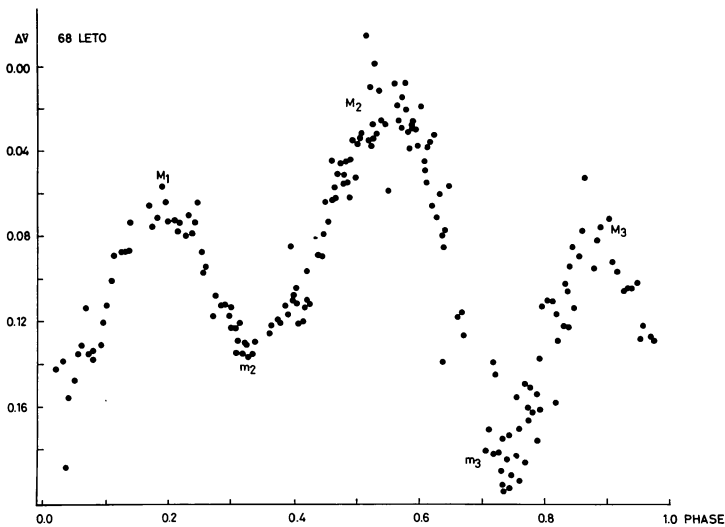


FIGURE 5. — Mean lightcurve of 68 Leto in the V color. The ordinates are referred to $\Delta V = 0$ for M_2 .