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PHOTOELECTRIC OBSERVATIONS OF TWO UNUSUAL ASTEROIDS: 1978 CA AND 1978 DA

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The two fast-moving asteroids 1978 CA and 1978 DA discovered on February 1978 with the ESO Schmidt telescope at La Silla (Chile) were observed with a photoelectric photometer attached to the 1m ESO telescope. The lightcurve of 1978 CA displays two fairly symmetric maxima and minima with a total amplitude of 0.8 mag. in the *V* colour. The synodic period of rotation found is 3 h 45 m and places 1978 CA as the third fastest rotator among all known solar objects. Concerning the minor planet 1978 DA we were not able to monitor light variations covering one full cycle of rotation. Nevertheless, the rotation period exceeds 5 h and the total amplitude is greater than 0.35 mag.

Key words: Asteroid – Minor Planet – Lightcurve – 1978 CA and 1978 DA

1. INTRODUCTION

Two fast-moving asteroids were recently discovered on photographic plates obtained with the 1 m Schmidt telescope of the European Southern Observatory by H.E. Schuster assisted with G. Pizarro and O. Pizarro. The first asteroid, 1978 CA, belonging to the family of Apollo was found on February 8, 1978 and the second one, 1978 DA, an Amor-type object on February 15, 1978.

Because the closest encounters of these two small planets with the earth took place exactly one month after their discovery, various astronomers were able to prepare observations in order to study their physical conditions and chemical compositions. Two reserved nights at the ESO 1 m telescope were alloted to us on March 1 and 2, 1978 for *UBV* photometric observations of 1978 CA and 1978 DA. Preliminary results from these observations were announced in a IAU circular on March 7, 1978 (Surdej and Surdej 1978a). Soon after, J. Degewij from the Lunar and Planetary Laboratory confirmed and reported additional data (Degewij 1978).

2. OBSERVATIONS

The measurements were performed by a photoelectric photometer equipped with an EMI 6256 photomultiplier, Schott standard filters for the *UBV* magnitudes and a dry ice cooling system.

When observing the lightcurves of 1978 CA and 1978 DA we measured regularly one comparison star chosen close to the path of the asteroid and of similar brightness (see table 1). In this way we could easily remove the small extinction effects from the lightcurve of the minor planets as well as judging the quality of the nights, good during our observing run. The general observing routine included frequent observations of the asteroid, sky, comparison star and some standard E region stars (Cousins and Stoy 1962) to determine *UBV* standard magnitudes. Basic integration times in each filter were 15 s and 20 s respectively for 1978 CA and 1978 DA because of their fast motions within a diaphragm of 22 arcsec.

Table 2 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 and the number of the figure relative to the observed asteroid.

These ephemerides were computed by using the POS program complex designed and kindly put at our disposal by R.M. West.

3. LIGHTCURVE AND ROTATION PERIOD

A. 1978 CA

On March 1, while the minor planet 1978 CA was crossing the sky at such a high speed rate as 3.5° per day, a complete lightcurve could be recorded. Figure 1 displays these photometric observations in the V filter, uncorrected for the phase and distance effects and where the abscissae are U.T. without correction for light time. The lightcurve appears to be periodic with a maximum amplitude of 0.8 mag. and shows two maxima and minima fairly symmetric. The V magnitude averaged over one period of rotation was determined to be $\overline{V}=13.26\pm0.02$. The colour indexes are $B-V=0.90\pm0.05$ and $U-B=0.48\pm0.15$ without evident variations during the light changes.

Comparison between the epochs of two successive similar extrema (see table 3) in figure 1 sets the synodic period of rotation

$$P=3\text{ h }45\text{ m}\pm3\text{ m}.$$

J. Degewij was very kind to send us his data obtained on March 8, 1978 and by combining his and our results over 45 rotations for 1978 CA we could refine the determination of the period

$$P=3\text{ h }45\text{ m }21\text{ s}\pm20\text{ s}.$$

Finally, one may still notice the three small humps located at around 3.3 h, 4.0 h and 7.1 h U.T. in the V lightcurve of 1978 CA. These are associated with the frequent encounters of field stars distributed within a radius of 11 arcsec along the trajectory of the asteroid. Incredible was that the second encounter at 4.000 h$\pm$0.006 h U.T. with the star α (1950)=10 h 9 m 47.73 s, δ (1950)=+4° 7′ 48.7″ turned out to be a true occultation.

B. 1978 DA

Observations performed on March 2, 1978 resulted in the V lightcurve of 1978 DA (see figure 2). Because almost three hours were lost when identifying this fast-moving asteroid and because 1978 DA turns around its axis much slower than does 1978 CA, we were not able to monitor light changes covering one full cycle of rotation. However, the lightcurve in figure 2 includes one clear symmetric maximum M_1 centered at 6.00 h U.T. with $V=14.28$ and one clear minimum m_1 at 7.83 h U.T. with $V=14.63$. The range of light variations thus exceeds 0.35 mag. in V and the rotation period 5 h in time. The colour indexes $B-V$ and $U-B$ were respectively found to be 0.83 ± 0.05 and 0.41 ± 0.15.

4. DISCUSSION

The smooth lightcurve observed for the minor planet 1978 CA, nearly symmetric, and with large light variations ($\Delta V\simeq0.8$ mag.) can be easily interpreted as due to the scatter of sunlight by a spinning elongated object (three-axes ellipsoid model?) around a fixed axis in space (cf. Surdej and Surdej 1978b). The extreme short period of rotation $P=3$ h 45 m places 1978 CA as the third fastest rotator known among all solar bodies, 1566 Icarus being the first one with $P=2$ h 16 m and 321 Florentina the second one with $P=2$ h 52 m.

J. Degewij (1978) also communicated radiometric observations by L. and M. Lebofsky giving a geometric visual albedo $p_v=0.068$ and a diameter $d=1.86$ km for 1978 CA and $p_v=0.17$ and $d=0.90$ km for 1978 DA (see Lebofsky *et al.* 1978 for these updated values) and added that the combination of reddish colour and low albedo for 1978 CA is quite unique. Though the colour indexes range 1978 CA and 1978 DA among the S-type asteroids, it is very difficult to conciliate the low albedo found for 1978 CA.

More generally, the origin as well as the physical and chemical properties of Apollo type minor planets are poorly known. Could, for instance, 1978 CA be associated with the rest of an inactive cometary nucleus remains very questionable. It is our wish to collect new data in order to depict the more true nature of these unusual asteroids.

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Table 1 Coordinates, V magnitude, $B-V$ and $U-B$ colours of comparison stars

	α(1950)	δ(1950)	V	B-V	U-B
comp.star (1978 CA)	$10^h10^m02^s.49$	$+03^\circ57'30''.6$	13.11	1.30	1.34
comp.star (1978 DA)	$11^h39^m35^s.55$	$-14^\circ16'51''.0$	13.08	1.34	1.48

Table 2 Aspect data, light times and figure numbers for 1978 CA and 1978 DA

Date of observation (Oh 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
March 1.000, 1978	$10^h10^m00^s$	03°38'27"	153°.155	- 7°.186	0.1431	1.1322	8°.5	$0^d.00083$	1, 1978 CA
1.375,	10 09 24	04 45 36	152.614	- 6.193	0.1417	1.1309	8.4	0.00082	
March 2.000, 1978	11 38 31	-14 27 48	180.964	-15.379	0.1396	1.1189	22.2	0.00081	2, 1978 DA
2.375,	11 41 28	-14 07 09	181.493	-14.772	0.1373	1.1171	22.1	0.00079	

Table 3 Epochs and lapses of time referring to the extrema in figure 1

Extremum	Epoch (U.T.)	Lapse of time (U.T.)
m_1	$2^h.47 \pm 0^h.08$	$3^h.75$
m_1	6.22	
M_1	3.47	3.76
M_1	7.23	
m_2	4.37	
M_2	5.30	

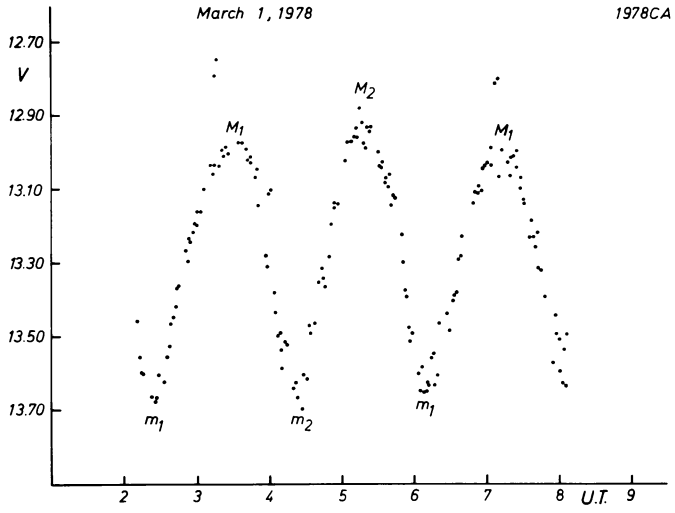

Figure 1 *V* Lightcurve of 1978 CA on March 1, 1978.

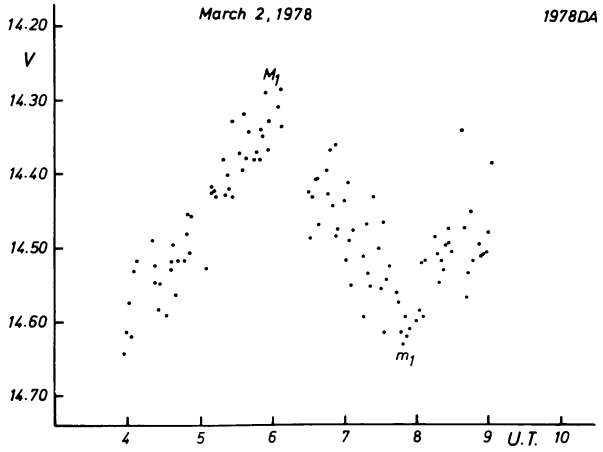

Figure 2 *V* Lightcurve of 1978 DA on March 2, 1978.