

BRIGHTNESS VARIATION OF THE ASTEROID (35690) 1999 CT21

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(Received: 15 May)

The asteroid (35690) 1999 CT21 was incidentally recorded on 29 and 30 July 2000 UT during the observations of the globular cluster M22. These data have allowed determination of the synodic rotation period to be 9.06 ± 0.02 hours. On 29 July 2000 the reduced V magnitude, the amplitude of the light variation and color index B-V were 14.82 ± 0.01 , 0.60 ± 0.02 and 0.7 ± 0.1 mag, respectively. Dimensions and the biaxial ellipsoid models of this asteroid have been obtained for two assumed taxonomic classes (C and S).

Galactic globular clusters are target objects for the Cluster AgeS Experiment (CASE). One of the aims of the project is the search for possible “outbursting” stars (Kaluzny et al. 2005, Pietrukowicz et al. 2005a). The cluster M22 was monitored in the seasons 2000 and 2001 at Las Campanas using the 1.0-m Swope telescope equipped with a 2048×3150 pixel SITE3 CCD camera. The photometry was extracted with the *Difference Image Analysis Package* written by Wozniak (2000) and recently modified by W. Pych. This package is an implementation of the method developed by Alard and Lupton (1998).

The asteroid 1999 CT21 was incidentally detected as a straight sequence of residuals on subtracted images representing two consecutive nights 28/29 and 29/30 July 2000 UT. The total number of frames on which the asteroid was present amounts to 64 and 21 in the V and B bands, respectively. The SkyCat tool and USNO-A2.0 catalog were used to obtain an astrometric solution. The obtained positions were sent to the Minor Planet Center where the asteroid was identified (Pietrukowicz et al. 2005b).

Period of Rotation

The observations from 29 July 2000 did not cover the whole rotational cycle but displayed two maxima and one minimum of a large amplitude of 0.60 ± 0.02 mag. The maximum brightness reduced to the unit distances asteroid-Sun and asteroid-Earth was $V = 14.82 \pm 0.01$ mag. The run from 30 July covered only part of the cycle with one visible maximum.

These observational data allow us to determine the synodic rotation period that can take two possible values: 11.44 and 9.06

hours. We have been able to construct the composite lightcurve with these two values. The lightcurve obtained with the longer period covered about 70% rotational cycle. The maximum from 30 July coincided with the second maximum from 29 July. The difference between two maxima was about 0.4 rotational phase. Moreover, the shape of the composite lightcurve suggested the existence of the third pair of extrema not recorded in our observations. We can conclude that the lightcurve with three pairs of extrema is not likely for a such small body (see below).

The synodic period of 9.06 ± 0.02 hours suggests a more classical quasi-sinusoidal lightcurve. The maximum from the second night coincided with the first maximum from 29 July. The data covered about 80% of the cycle and the maxima are in 0.5 rotational phase apart. We have assumed that this period is more probable and the composite lightcurve is presented on the top panel of Fig.1.

The B, V observations indicate that the mean color index B-V is 0.7 ± 0.1 mag. The B-V showed small changes with the rotational cycle. The asteroid seemed to be a little bluer in the first minimum of light as shown in the bottom panel of Fig.1. The lack of data did not allow us to check this behavior for the second minimum.

Dimension and shape model of the asteroid

The photometric data presented above do not allow a determination of the dimension and shape of this asteroid. However, if we assume some parameters, we can obtain provisional values. The maximum brightness ($V = 14.82$ mag) and the amplitude observed (0.60 mag) are related to the size and shape of the asteroid. However, these values should be corrected to the zero phase angle: brightness by using the so-called HG-magnitude system (Bowell et al. 1989) and the amplitude by the method developed by Zappala et al. (1990). Such reductions are important as the phase angle was $\alpha = 11.9$ deg on 29 July.

Unfortunately, the observations from two consecutive nights did not allow us to make correction for the zero solar phase angle. It can be approximately performed assuming typical values obtained for asteroids. Most of them belong to one of the two taxonomic classes: C and S (Tholen 1989). We can calculate physical parameters of the asteroid 1999 CT21 assuming that it belongs to one of these two classes. The mean values of slope parameter G and geometric albedo p_v for these taxonomic classes have been taken from Harris (1989) while m parameters for reducing the amplitude from Zappala et al. (1990). These assumed values are shown in Table I. They allow us to obtain the absolute magnitude (H) and reduced amplitude (A(0)) for C and S classes and also shown in the same table.

The asteroid showed the large amplitude which indicated an elongated shape of the body or/and the aspect angle close to 90° . If we assume such an aspect angle and the triaxial ellipsoid model (see e.g. Michalowski 1993), we can easily estimate the a/b axes ratio from the formula: $A(0) = 2.5 \log(a/b)$.

We have obtained a/b equal to 1.60 or 1.50 for the assumed C, S parameters, respectively (see Table I). If the aspect angle was lower than 90° , the a/b ratio would be greater than the above mentioned values.

The absolute H magnitude is connected with the diameter D of a spherical body via the relation (e.g. Harris and Harris 1997):

$$\log D = 3.1236 - 0.5 \log p_v - 0.2 H$$

where p_v is the geometric albedo and D diameter in kilometers. The albedo is also unknown for 1999 CT21 and we have assumed the mean values for a given taxonomic class (Table I). These assumptions yield the diameter of 8.4 or 4.6 km for C or S classes, respectively. These values of the diameter have been calculated for spherical body but we know that asteroid is elongated. With the assumptions of the aspect angle equals to 90° and biaxial ellipsoid model ($b = c$) we can write the relation:

$$\pi (D/2)^2 = \pi ab,$$

and using a/b ratios from Table I we have obtained the dimensions 2a and 2b in kilometers (last two columns in Table I).

All calculated values shown in Table I are only the first approximation of the real parameters describing the asteroid. However, from the orbital semi-major axis (2.55 AU) and low inclination and eccentricity, we would like to pointed out that this asteroid is more likely S-like than C-like.

Planned future observations are expected to verify calculated parameters (Table I) when one is able to determine the G, m values, estimate the geometric albedo and check if the assumptions about the 90° aspect angle in the 2000 apparition and the biaxial ellipsoid model are valid for this asteroid. Anyway, at present we have only some preliminary results shown in the present paper.

Acknowledgments

This work was supported by two Polish grants: 1 P03D 024 26 (to PP) and 1 P03D 020 27 (to TM).

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Table I. Assumed and calculated parameters of the asteroid (35690) 1999 CT21 for C and S taxonomic classes (G and p_v are taken from Harris (1989), while m from Zappala et al. (1990)).

Class	G	p_v	m	H [mag]	A(0) [mag]	D [km]	a/b	2a [km]	2b [km]
C	0.09	0.06	0.015	14.04	0.51	8.4	1.60	10.7	6.7
S	0.23	0.18	0.030	14.16	0.44	4.6	1.50	5.6	3.8

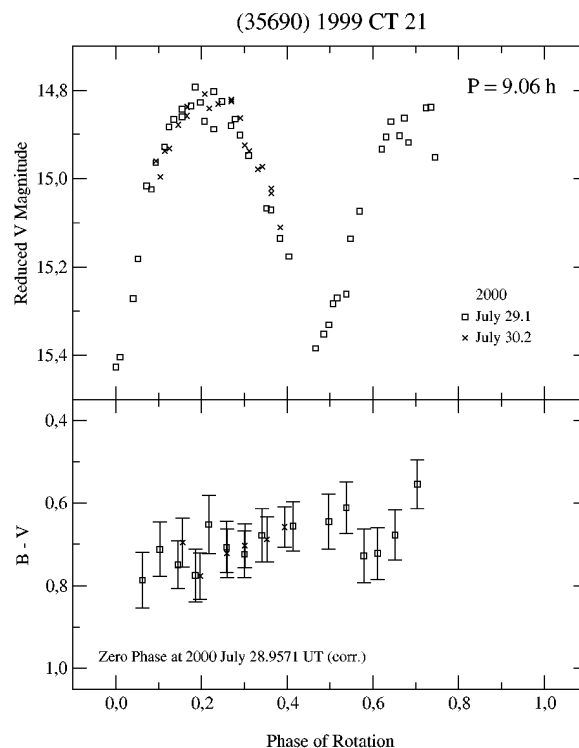


Fig. 1. Composite lightcurve of the asteroid (35690) 1999 CT21 in V band (top panel) and B-V color index (bottom panel).