ISSN 0236-2457

ASTRONOMICHESKII TSIRKULYAR

Published by the Eurasian Astronomical Society
and Sternberg Astronomical Institute

No. 1575, 2012 March 13

PHOTOMETRY AND POLARIMETRY OF THE LARGEST NEA 1036 GANYMED

Фотометрия и поляриметрия самого большого АСЗ 1036 Ганимед

Abstract. Представлены результаты $BVRI$-фотометрии и V-поляриметрии астероида 1036 Ганимед – самого большого из астероидов, приближающихся к Земле (АСЗ). Наблюдения выполнены в мае–июне и августе 2011 г. Были получены: кривая блеска с амплитудой $0\overset{m}{.}25$ при $\alpha = 36\overset{\circ}{.}5$; показатели цвета $B-V = 0\overset{m}{.}85 \pm 0\overset{m}{.}02$, $V-R = 0\overset{m}{.}53 \pm 0\overset{m}{.}01$ и $R-I = 0\overset{m}{.}36 \pm 0\overset{m}{.}01$; координаты полюса $\lambda_0 = 130^\circ \pm 10^\circ$, $\beta_0 = -70^\circ \pm 10^\circ$ и сидерический период $10\overset{h}{.}3096 \pm 0\overset{h}{.}0001$; степень линейной поляризации при $\alpha \approx 52^\circ$.

New photometry and polarimetry of the largest near-Earth asteroid 1036 Ganymed ($D \approx$ 40 km, S-type) were carried out on six nights in 2011 May–June and August with the 70-cm reflector of the Chuguev Observation Station (Institute of Astronomy, Kharkiv Karazin University). The telescope was equipped with a ML 47-10 CCD camera with a set of $BVRI$ filters of the Johnson–Cousins photometric system. The polarimetry data were obtained by using an upgraded single-channel AFM-6 photoelectric polarimeter with a V-band filter of the Johnson–Morgan system. As an analyser a fast rotating quarter wavelength achromatic retarded plate with a linear polaroid was used (Velichko S. Polarimetric and photometric characteristics of the dust in the atmosphere of splitting comets. PhD thesis, Kyiv, Ukraine, 2010).

We have obtained a composite light curve that covers the full period of the asteroid rotation. The light curve has an amplitude of $0\overset{m}{.}25$ at a phase angle $\alpha = 36\overset{\circ}{.}5$ and is presented in Fig. 1. At the present asteroid apparition the observed light curve shows a fairly normal double periodic form with two maxima and two minima per rotation cycle. Both levels of the light curve maxima and minima differ by $0\overset{m}{.}12$ and $0\overset{m}{.}07$, respectively.

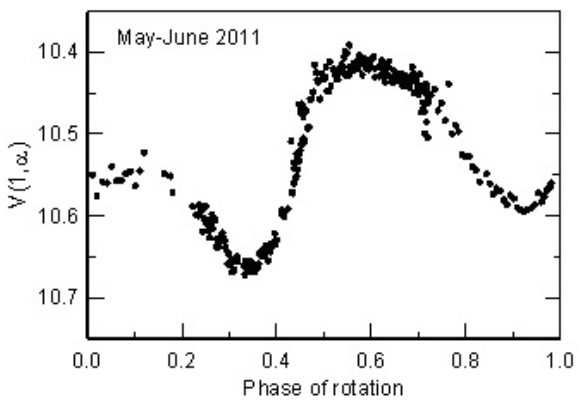

Figure 1: Composite light curve of Ganymed.

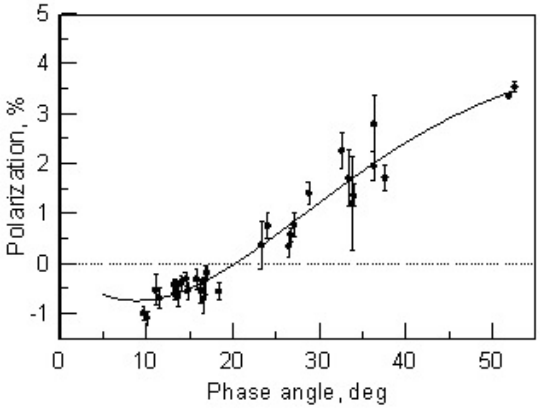

Figure 2: Phase dependence of linear polarization of Ganymed.

At the primary light-curve maximum the color indices are: $B-V = 0\overset{m}{.}85 \pm 0\overset{m}{.}02$, $V-R = 0\overset{m}{.}53 \pm 0\overset{m}{.}01$, and $R-I = 0\overset{m}{.}36 \pm 0\overset{m}{.}01$. The obtained values coincide with or are close to the earlier observed ones (Hahn G. *et al.*, Icarus **78**, 363, 1989; Chernova G. *et al.*, AJ **110**, 1875, 1995). Only $V-R$ differs by $0\overset{m}{.}05$ between the present opposition and 1985. According to our observations, the asteroid is redder in $V-R$ than in the above-mentioned ones. However, it should be noted that the observation aspects are considerably different for the 2011 and 1985 oppositions. On the part of the asteroid surface that defines the light curve in a rotation phase interval of 0.0–0.3 (see Fig. 1) the $B-V$ color variations with an amplitude of $0\overset{m}{.}03$–$0\overset{m}{.}04$ were recorded. It is the range of the secondary light curve maximum. Earlier some authors indicated a variation of colors and a minor albedo variation (Hahn G. *et al.*, Icarus **78**, 363, 1989; Kaasalainen M. *et al.*, Icarus **159**, 369, 2002), while in the opposition of 1989 the $B-V$ variations were not detected or did not exceed $0\overset{m}{.}02$ (Chernova G. *et al.*, AJ **110**, 1875, 1995).

Considering all available photometric data (Lagerkvist C.-I. *et al.*, Asteroid Photometric Catalogue, 5th update. Uppsala, Sweden, 2001), we can conclude that the asteroid 1036 Ganymed has a large pole flattening. An ellipsoidal model is not useful for modeling Ganymed as evidenced by radar results (Ostro S.J. *et al.*, Icarus **75**, 30, 1988) and by anvil-like shape proposed earlier (Kaasalainen M. et al., Icarus **159**, 369, 2002). The calculated pole coordinates of the asteroid are $\lambda_0 = 130^\circ \pm 10^\circ$, $\beta_0 = -70^\circ \pm 10^\circ$, and the sidereal period is $10\overset{h}{.}3096 \pm 0\overset{h}{.}0001$. A rough scaling yields $a/b = 1.05$ and $b/c = 1.5$. The ecliptic-pole longitude and sidereal period are somewhat different from the published ones, and the pole latitude and dimensions coincide with the known values (Kaasalainen M. *et al.*, Icarus **159**, 369, 2002).

Polarimetry of the asteroid 1036 Ganymed was carried out in August 2011 and is presented in the table. This is the range of phase angles where the asteroid had not been observed before. Figure 2 shows the phase dependence of the linear polarization of Ganymed, which has been plotted using the Asteroid Polarimetry Database (Lupishko D. and Vasilyev S. Kinemat. Fiz. Nebesn. Tel **13**, 17, 1997) and our points. It is interesting to note that when using our data the polarimetric slope tends to be slightly less than that obtained by Kiselev N. *et al.* (Kinemat. Fis. Nebesn. Tel **10**, 35, 1994) and the surface albedo to be greater.

The measured circular polarization of the asteroid 1036 Ganymed goes to zero in the V-band at a phase angle $\alpha \approx 52^\circ$.

Table: Aspect data and results of polarimetry of the asteroid Ganymed

Date, August 2011 UT	λ_{2000} (deg)	β_{2000} (deg)	r (a.u.)	Δ (a.u.)	α (deg)	P (%)	σ (%)
21.002	34.48	58.87	1.248	0.554	52.6	3.53	0.11
30.834	40.05	55.90	1.241	0.510	51.9	3.35	0.04

Institute of Astronomy F.P.Velichko
Kharkiv Karazin National University Ф.П.Величко
Sums'ka str., 35
61022 Kharkiv, Ukraine
fvelichko@ukr.net
Swedish National Space Broad P.Magnusson
Stockholm, Sweden П.Магнуссон

Received August 31, 2011