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EIGHT MONTHS OF LIGHTCURVES OF 1036 GANYMED

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Minor Planet 1036 Ganymed, the largest Mars crosser, made its closest approach to Earth in the 21st century in 2011 October, and was continuously observed over a path length exceeding 100 degrees from 2011 May to 2012 January. The shape of the lightcurve changed greatly during this interval, with a mean synodic period 10.3031 hours over the interval 2011 May to October and amplitude varying from 0.10 mag to 0.30 mag and increasing roughly linearly with increasing phase angle.

Minor planet 1036 Ganymed is the largest and brightest Amor type object with approximate orbital elements a = 2.665, e = 0.534, i = 26.7 deg. Closest approach to Earth was 2011 Oct. 13 at 0.359 AU, smaller than on any other date in the 21st century, and brightest magnitude was 8.3 on 2011 Oct. 28, again brighter than on any other date in the 21st century. The path in the sky, shown in Fig. 1, enabled observation from 2011 May 16 - 2012 Jan. 18 at phase angles ranging from 52 degrees in late August to 1 degree Oct. 28. Fig. 2 graphs the distance and the phase angle versus time for the interval of observation. Six observers, Vladimir Benishek, John Briggs, Andrea Ferrero, Daniel Klinglesmith, Frederick Pilcher, and Curtis Warren all contributed lightcurves with R or V filters. Their telescopes and CCDs are: Benishek, Meade 40 cm Schmidt-Cassegrain, SBIG ST-10 XME; Briggs, DFM Engineering 40 cm f/8 Ritchey-Chretien, Apogee Alta U47; Ferrero, 30 cm Ritchey-Chretien, SBIG ST9; Klinglesmith and Warren, Celestron 35 cm f/11 Schmidt-Cassegrain, SBIG STL-1001E; Pilcher, 35 cm Meade Schmidt-Cassegrain, SBIG STL-1001E.

Several previous studies all show a period near 10.3 hours. Synodic periods have been found by Harris and Young (1985), 12 h; Lupishko et al. (1987), 10.308 h; Lupishko et al. (1988), 10.304 h; Hahn et al. (1989), 10.31h; Gaftonyuk and Krugly (2004), 10.31 h; Behrend (2011), 10.2936 h. Kaasalainen et al. (2002) obtain a sidereal period of 10.313 h from a partial lightcurve inversion model, which is also shown by Durech (2011).

It is not productive with such large changes in phase angle and lightcurve shape to draw a single lightcurve representing all observations. We present 15 separate lightcurves, Figures 3 - 17, each over a fairly small time interval, which show the evolution of lightcurve shape. The synodic period for each of these intervals ranged from 10.280 to 10.345 hours, and the amplitude from a maximum of 0.30 magnitudes at phase angle 52 degrees to 0.10 magnitudes at phase angle 1 degree. To obtain a single mean synodic period for the entire interval, we proceeded as follows. The JD of highest maximum was obtained on dates separated by not more than two weeks. The interval between successive maxima was divided by an approximate period 10.3 hours, and in all cases yielded a result close to an integer. The integer then represents the number of cycles between dates. The time interval between successive maxima was then divided by this interval to obtain the synodic period over this interval, and the results are on the table below. Between Oct. 14 and Oct. 23 the position in the sky, phase angle, and appearance of the lightcurve were changing too rapidly for a particular feature of the lightcurve to be sufficiently stable for this technique to be applied. With the much sparser observations in 2011 Nov. and 2012 Jan. changes in the lightcurve likewise rendered the phases of readily identifiable features unstable. The technique could be applied only to the interval 2011 May 16 - Oct. 14.

Columns headers: A = JD of first maximum + 2455000.00, B = JD of second maximum + 2455000.00, C = time interval in days between maxima, D = number of cycles between maxima, E = mean synodic period in hours.

A	B	C	D	E
702.89	723.94	21.05	49	10.310
723.94	739.83	15.89	37	10.307
739.83	753.55	13.72	32	10.290
753.55	763.43	9.88	23	10.310
763.43	777.60	14.17	33	10.305
777.60	788.74	11.14	26	10.283
788.74	799.49	10.75	25	10.320
799.49	817.51	18.02	42	10.297
817.51	831.66	14.15	33	10.291
831.66	848.85	17.19	40	10.314

For the entire interval JD 2455702.89 to 2455848.85 there are 340 cycles for a mean synodic period 10.3031 hours. Examination of the table shows individual values which appear to vary randomly with no systematic trend.

Acknowledgements

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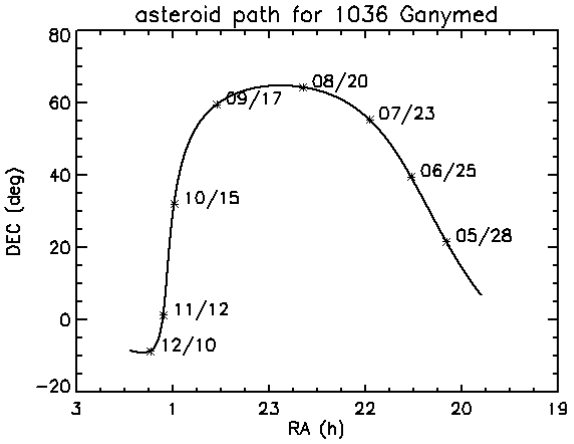

Figure 1. Path of 1036 Ganymed in sky, 2011 May - December.

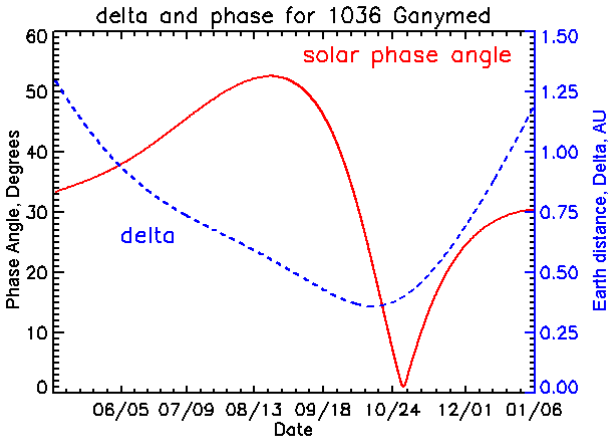

Figure 2. Phase angle and Earth distance Delta for 1036 Ganymed, 2011 May - 2012 January.

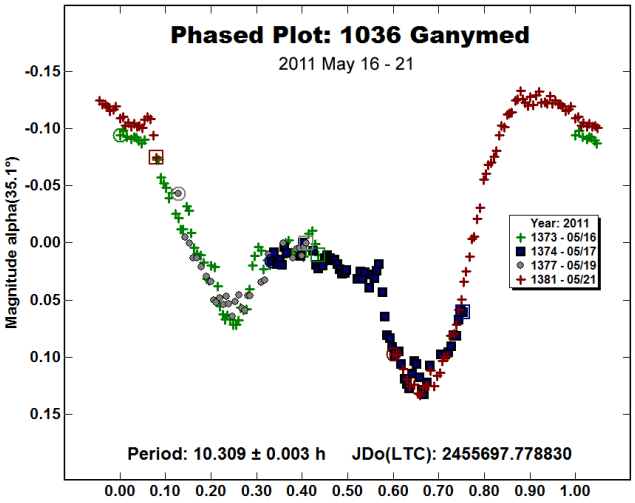

Figure 3. Lightcurve of 1036 Ganymed 2011 May 16 - 21.

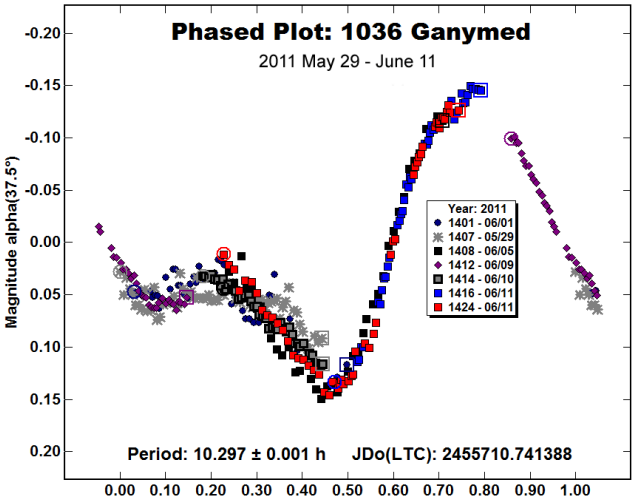

Figure 4. Lightcurve of 1036 Ganymed 2011 May 29 - June 11.

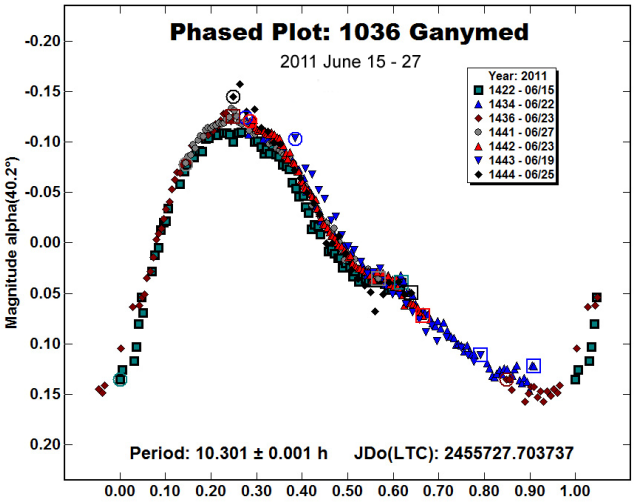

Figure 5. Lightcurve of 1036 Ganymed 2011 June 15 - 27.

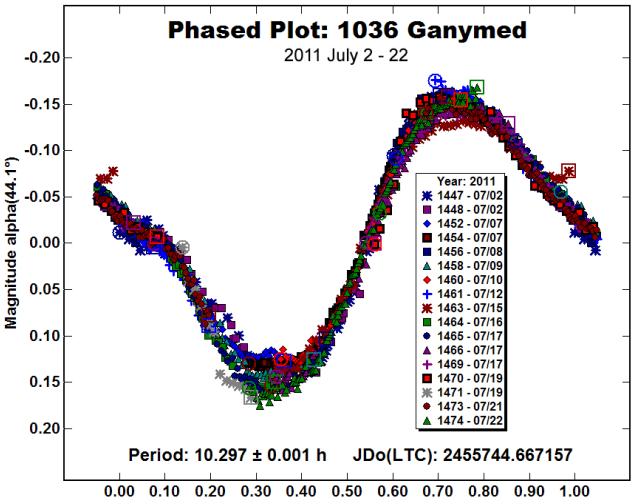

Figure 6. Lightcurve of 1036 Ganymed 2011 July 2 - 22.

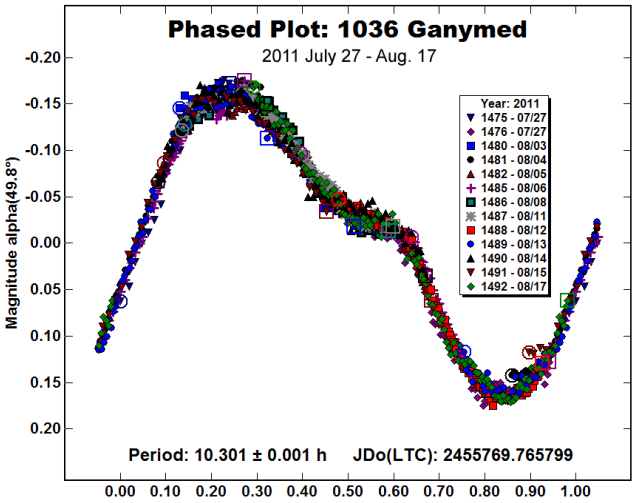

Figure 7. Lightcurve of 1036 Ganymed 2011 July 27 - Aug. 17.

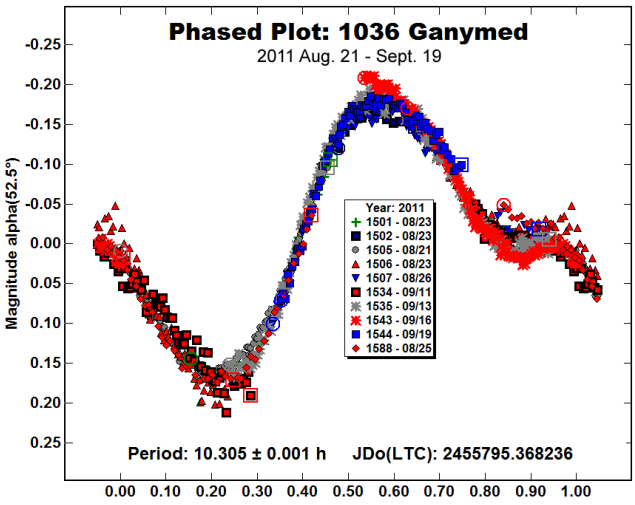

Figure 8. Lightcurve of 1036 Ganymed 2011 Aug. 21 - Sept. 19.

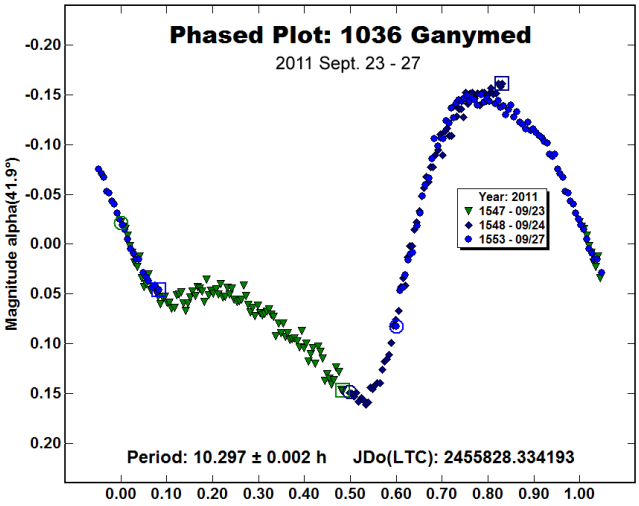

Figure 9. Lightcurve of 1036 Ganymed 2011 Sept. 23 - 27.

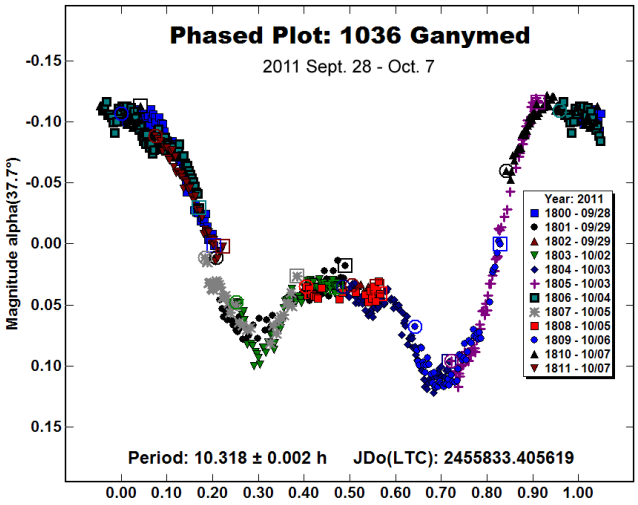

Figure 10. Lightcurve of 1036 Ganymed 2011 Sept. 28 - Oct. 7

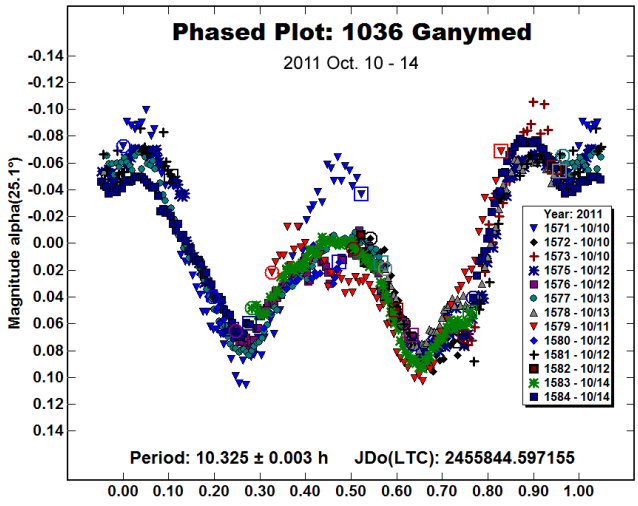

Figure 11. Lightcurve of 1036 Ganymed 2011 Oct. 10 - 14.

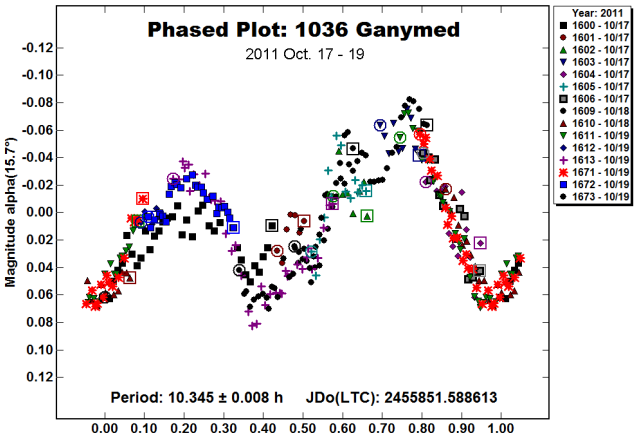

Figure 12. Lightcurve of 1036 Ganymed 2011 Oct. 17 - 19.

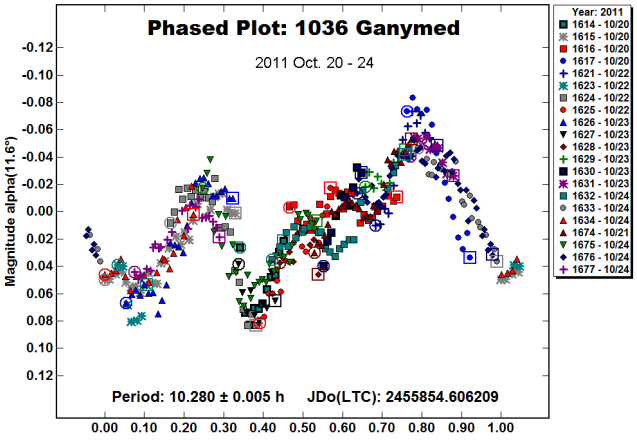

Figure 13. Lightcurve of 1036 Ganymed 2011 Oct. 20 - 24.

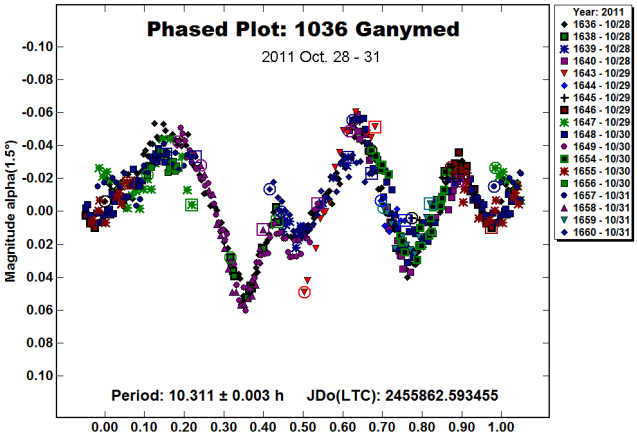

Figure 14. Lightcurve of 1036 Ganymed 2011 Oct. 28 - 31.

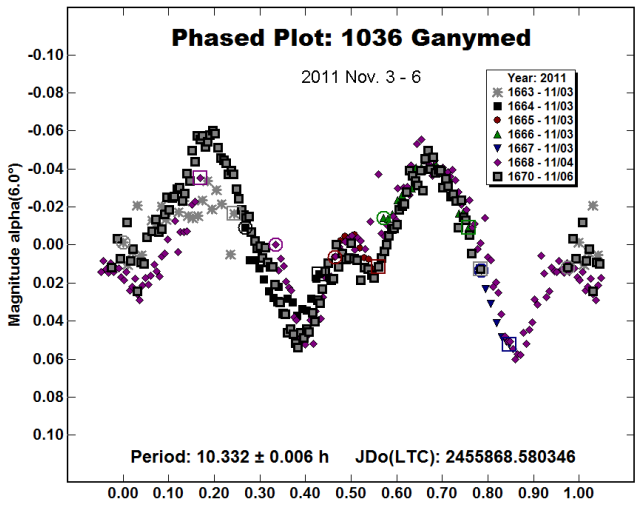

Figure 15. Lightcurve of 1036 Ganymed 2011 Nov. 3 - 6.

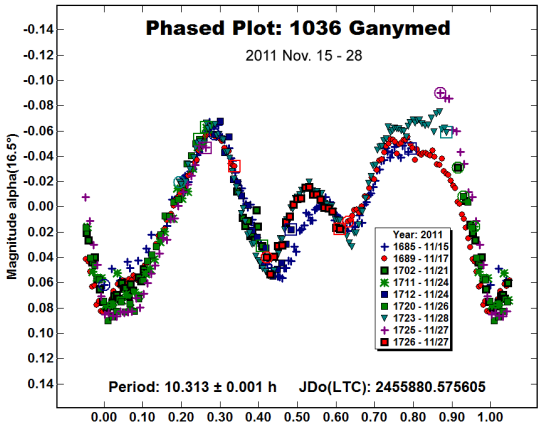

Figure 16. Lightcurve of 1036 Ganymed 2011 Nov. 15 - 28.

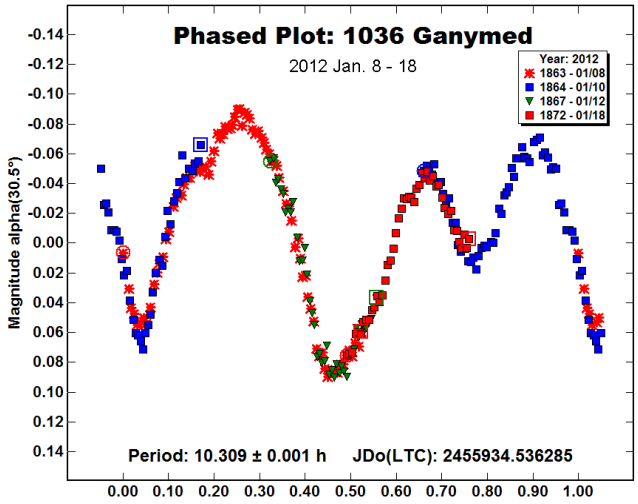

Figure 17. Lightcurve of 1036 Ganymed 2012 Jan. 8 - 18.