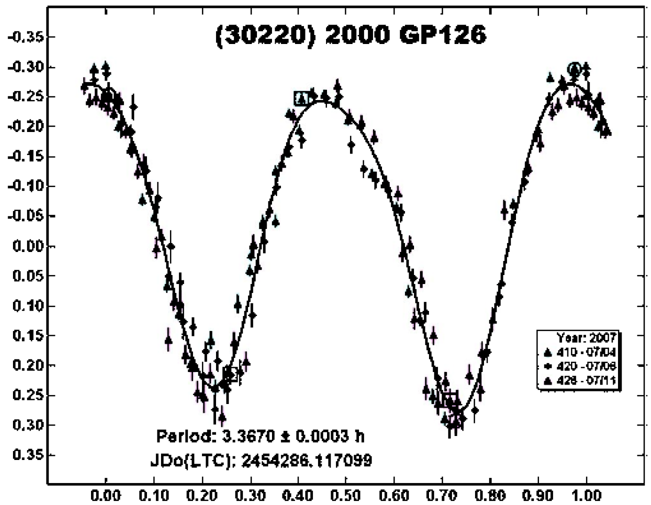

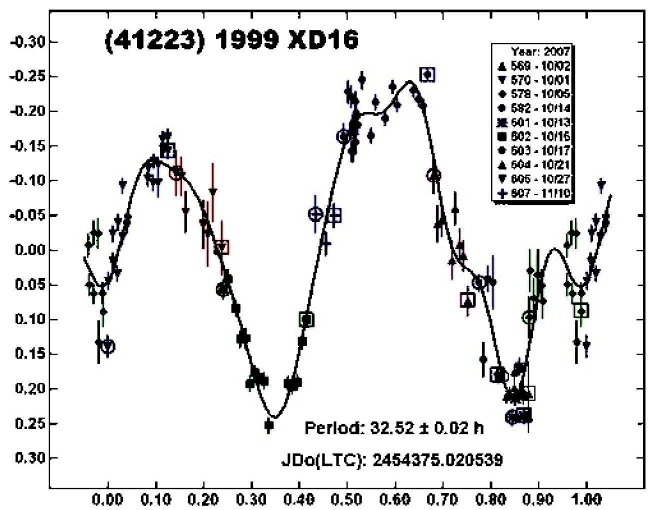

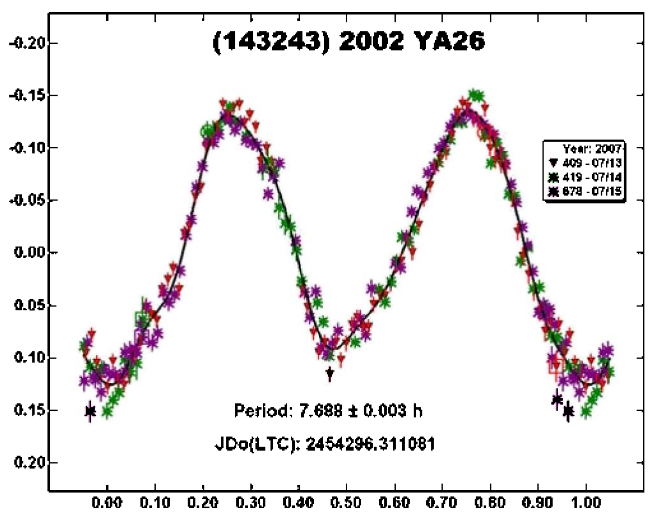

PERIOD DETERMINATIONS FOR 26 PROSERPINA, 34 CIRCE, 74 GALATEA, 143 ADRIA, 272 ANTONIA, 419 AURELIA, AND 557 VIOLETTA

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Synodic lightcurve periods and amplitudes were determined for seven aseroids: 26 Proserpina, 13.110 ± 0.001 h, 0.14 ± 0.02 mag; 34 Circe, 12.176 ± 0.002 h, 0.17 ± 0.02 mag; 74 Galatea, 17.270 ± 0.001 h, 0.08 ± 0.01 mag with four maxima and minima per cycle; 143 Adria, 22.005 ± 0.001 h, 0.08 ± 0.02 mag with an irregular lightcurve; 272 Antonia, 3.8548 ± 0.0001 h, 0.43 ± 0.04 mag; 419 Aurelia, 16.784 ± 0.001 h, 0.07 ± 0.01 mag; 557 Violetta 5.0887 ± 0.0001 h, 0.25 ± 0.03 mag.

Seven asteroids were observed in late 2007 and early 2008 at the Organ Mesa Observatory where the equipment consists of a Meade 35 cm LX200 GPS S-C, and SBIG STL-1001E CCD camera. Exposures were 60s, unguided, and used a clear filter, except for 26 Proserpina and 419 Aurelia whose brightness required 20- and 40-second exposures, respectively. Differential photometry and lightcurve analysis were done by *MPO Canopus*. Because of their large number, the data points for all lightcurve were binned in sets of three with no more than 5 minutes time separation.

26 Proserpina. Harris et al. (2007) list four different periods of 6.668, 10.60, 13.06, and 13.13 h, each with reliability 2. It was the intent of this investigation to determine a unique and correct period as well as search for and eliminate all alias periods. Observations on eight nights from 2007 Dec. 24–2008 Feb. 22 achieved all of these goals. Full-phase coverage with overlap found an asymmetric bimodal lightcurve with a period of 13.110 ± 0.001 h and maximum amplitude 0.14 ± 0.02 magnitudes. No alias periods in the range from 6 to 30 hours could be found except for a quadrimodal lightcurve with full phase coverage of twice this period for which the two halves looked essentially identical, and for which the RMS residual was slightly larger. One could artificially construct a shape model greatly variant over a 90 degree rotation but almost invariant over a 180 degree rotation. The probability of this symmetry for a real asteroid is so small that it may be safely rejected. Hence I claim the 13.110 hour period is the correct one.

After this study was completed and the paper was being prepared for publication, a new lightcurve for 26 Proserpina was published by Fauerbach et al. (2008a). They found a period of 13.106 ± 0.001 h, in excellent agreement with this study, based on observations six nights from 2007 Nov. 9–Dec. 7. At the larger phase angles encountered in this pre-opposition data set, the amplitude was 0.17 ± 0.02 magnitudes. Fauerbach (2008b) kindly prepared a lightcurve that includes both his (2008a) data and those of the present study, a total of fourteen sessions 2007 Nov. 7–2008 Feb. 22, with a period of 13.110 ± 0.001 hours. Lightcurves of the Organ Mesa observations 2007 Dec. 24–2008 Feb. 22 and of the combined sessions 2007 Nov.–2008 Feb. 22 are included separately in this paper.

34 Circe. Harris et al. (2007) list a period of 12.15 h, reliability 3 (secure). The purpose of this investigation was to provide additional data for spin/shape modeling. Observations on three nights, 2007 Dec. 7, 25, and 30, provided full-phase coverage for an asymmetric bimodal lightcurve of period 12.176 ± 0.002 h, amplitude 0.17 ± 0.02 magnitudes. The synodic period of any asteroid with fixed spin vector varies by small amounts with mean motion, aspect and obliquity angles, and the shadowing by surface irregularities. Hence this period is not only consistent with Harris et al. (2007) but its small deviation provides information useful to the stated goal of spin/shape modeling.

74 Galatea. Harris et al. (2007) list a period of 8.629 h, reliability 2, based on Behrend (2008) who assumed 2 maxima and minima per cycle. Observations on eleven nights from 2008 Feb. 1–Mar. 23 show a period of 17.270 ± 0.002 h with a maximum amplitude 0.08 ± 0.01 magnitudes. Unlike the case for 26 Proserpina previously described, the lightcurve phased to 17.270 hours with four maxima and minima per cycle fit the data better than that phased to a bimodal 8.635 h period in three criteria: by visual inspection alternate maxima and minima looked distinctly different; the fit to the longer period had much smaller scatter of individual data points; and the RMS residual to the Fourier series analysis was considerably smaller for the longer period. Particularly for small amplitude lightcurves, this example shows the importance of always examining lightcurves with periods of twice (and 1.5 times) the bimodal value.

143 Adria. Harris et al. (2007) list a period of 21.89 h, reliability 2. This is based on the most comprehensive data set preceding this investigation by Warner (2007), who published a lightcurve with three irregularly spaced and unequal maxima and minima with a maximum amplitude of 0.10 magnitudes based on observations on five nights 2006 Dec. 4–10. Behrend (2008) phased observations beginning 2005 Aug. 8 with an amplitude 0.04 magnitudes to the same period. In the current investigation observations on nine nights 2008 Jan. 11-Mar. 2 show an irregular lightcurve of one very shallow and two narrow deep minima with a period of 22.005 ± 0.001 h and maximum amplitude of 0.08 ± 0.02 magnitudes. The shape of the lightcurve is very different from December 2006, and, considering that the synodic period varies with aspect, the period is consistent. For objects with irregular lightcurves and small amplitudes, it is important to search diligently for alias periods. All local minima on the *MPO Canopus* period spectrum diagram between 10 and 44 hours were examined and none except 22.005 h produced a good fit on all nights. A lightcurve phased to 44 hours showed nearly complete phase coverage with the two halves nearly identical to each other and to the 22.005 h lightcurve. This is rejected for the same reason as previously explained for 26 Proserpina.

272 Antonia. Harris et al. (2007) list no previous period determinations. Observations on five nights from 2007 Dec. 26–2008 Jan. 22 show a period of 3.8548 ± 0.0001 h, amplitude 0.43 ± 0.04 magnitudes.

419 Aurelia. Harris and Young (1989) obtained a period of 16.709 h and amplitude 0.05 ± 0.02 magnitudes. Riccioli et al. (1995) reported a period of 16.63 ± 0.01 h and amplitude 0.18 ± 0.02 magnitudes. Riccioli et. al (2001), on the basis of full phase coverage of an asymmetric bimodal lightcurve, found a period of 16.63 ± 0.006 h and maximum amplitude 0.27 magnitudes. The current study is the densest data set published to date. Observations on nine nights 2008 Feb.17–Mar. 25 show a somewhat irregular lightcurve with a period of 16.784 ± 0.001 h and amplitude of 0.07 ± 0.01 magnitudes. Recognizing that the synodic period varies somewhat with changing mean motion and at different aspect angles, I consider all of these determinations consistent.

557 Violetta. Harris et al. (2007) list no previous period determinations. Observations on six nights from 2007 Dec. 20–2008 Jan. 20 show a period of 5.0887 ± 0.0001 h and amplitude 0.25 ± 0.03 magnitudes.

Acknowledgments

The author thanks Michael Fauerbach for constructing a combined lightcurve of his and this author's data for 26 Proserpina and encouraging its publication in this paper.

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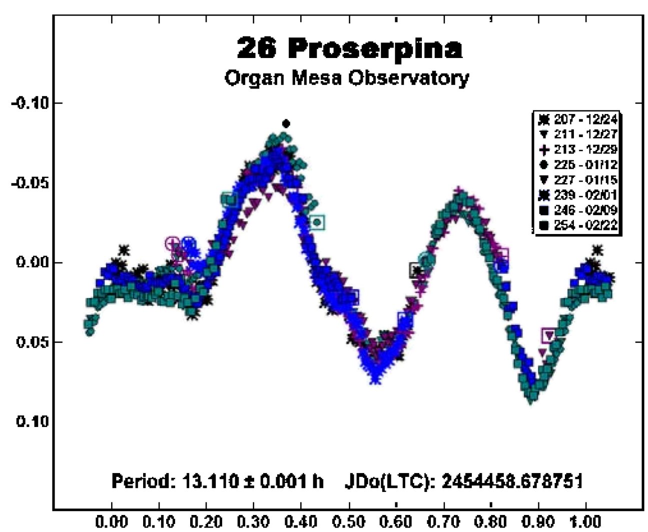
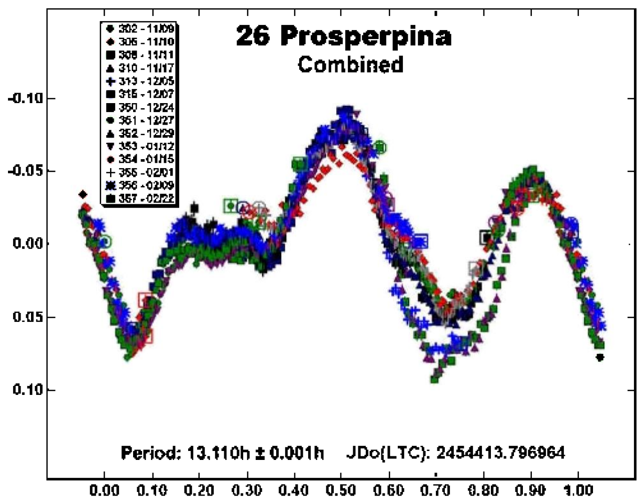
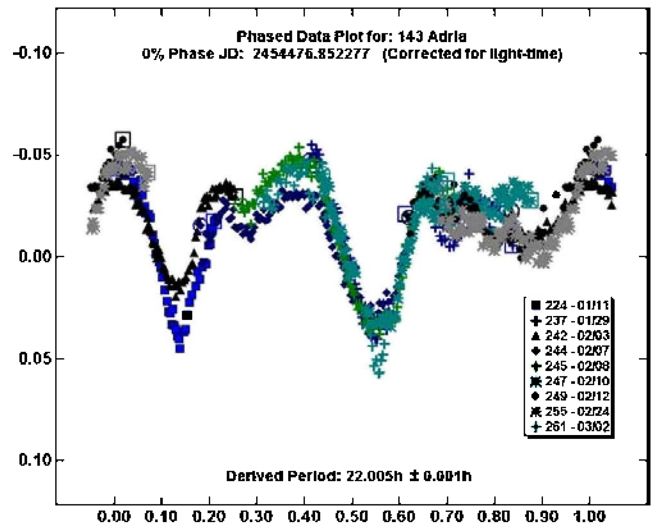
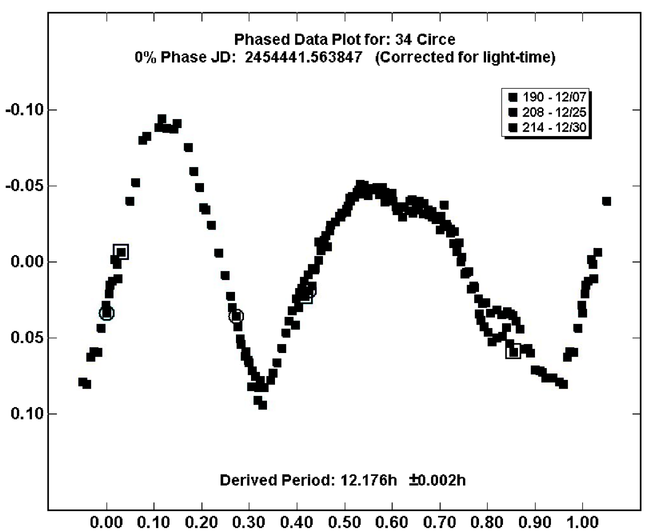
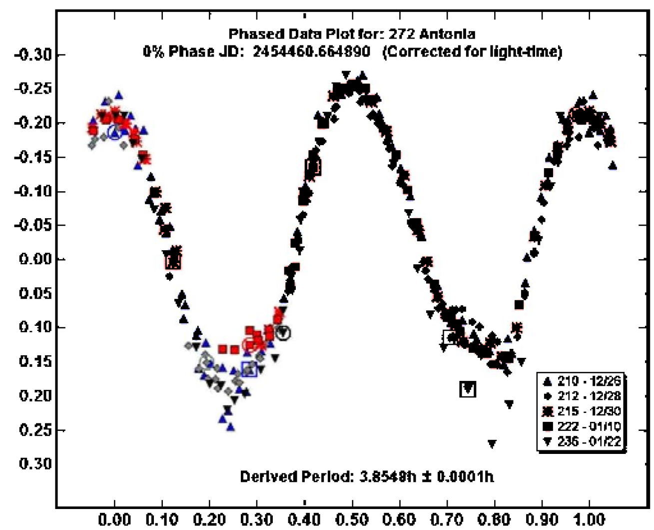
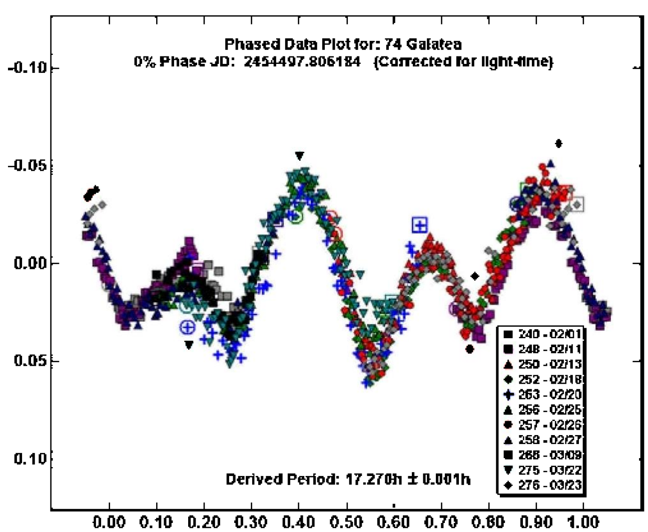


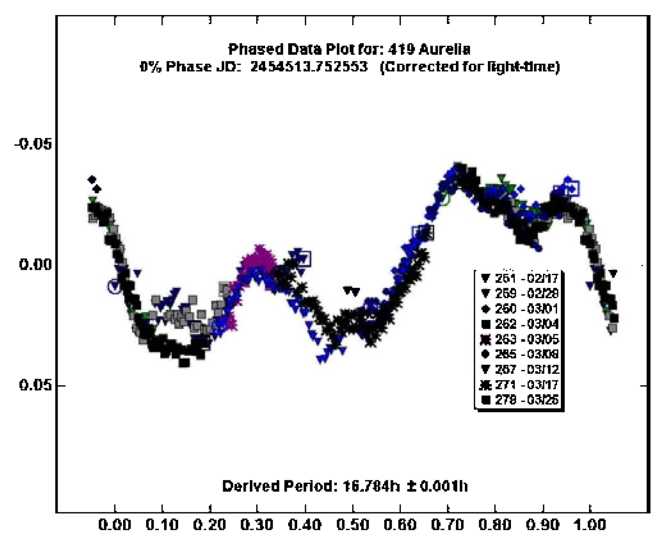

26 Prosperpina
Combined
302 - 11/09
305 - 11/10
308 - 11/11
310 - 11/17
313 - 12/05
315 - 12/07
350 - 12/24
351 - 12/27
352 - 12/29
353 - 01/12
354 - 01/15
355 - 02/01
356 - 02/09
357 - 02/22
Period: 13.110h ± 0.001h JDo(LTC): 2454413.796964
-0.10
-0.05
0.00
0.05
0.10
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00

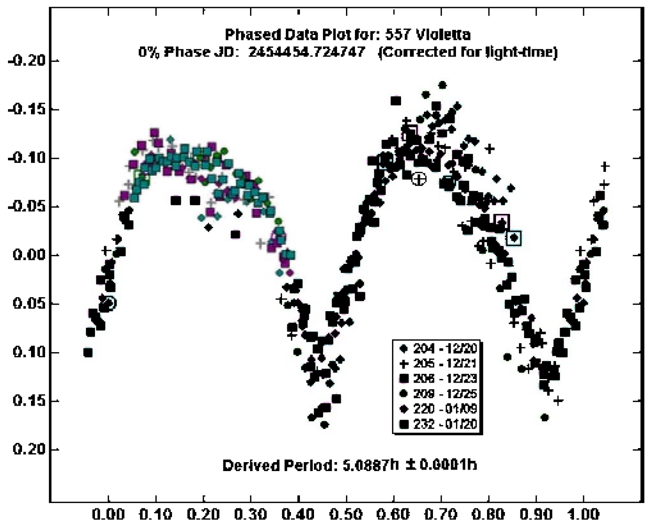

Phased Data Plot for: 143 Adria
0% Phase JD: 2454476.852277 (Corrected for light-time)
224 - 01/11
237 - 01/29
242 - 02/03
244 - 02/07
245 - 02/08
247 - 02/10
249 - 02/12
255 - 02/24
261 - 03/02
Derived Period: 22.005h ± 0.001h
-0.10
-0.05
0.00
0.05
0.10
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


Phased Data Plot for: 34 Circe
0% Phase JD: 2454441.563847 (Corrected for light-time)
190 - 12/07
208 - 12/25
214 - 12/30
Derived Period: 12.176h ±0.002h
-0.10
-0.05
0.00
0.05
0.10
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


Phased Data Plot for: 272 Antonia
0% Phase JD: 2454460.664890 (Corrected for light-time)
210 - 12/26
212 - 12/28
215 - 12/30
222 - 01/10
236 - 01/22
Derived Period: 3.8548h ± 0.0001h
-0.30
-0.25
-0.20
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


Phased Data Plot for: 74 Galatea
0% Phase JD: 2454497.806184 (Corrected for light-time)
240 - 02/01
248 - 02/11
250 - 02/13
252 - 02/18
253 - 02/20
256 - 02/25
257 - 02/26
258 - 02/27
268 - 03/09
275 - 03/22
276 - 03/23
Derived Period: 17.270h ± 0.001h
-0.10
-0.05
0.00
0.05
0.10
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


Phased Data Plot for: 419 Aurelia
0% Phase JD: 2454513.752553 (Corrected for light-time)
251 - 02/17
259 - 02/28
260 - 03/01
262 - 03/04
263 - 03/05
265 - 03/08
267 - 03/12
271 - 03/17
278 - 03/25
Derived Period: 16.784h ± 0.001h
-0.05
0.00
0.05
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00



MINOR PLANET 6411 TAMAGA

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The synodic rotation period of the Mars crossing minor planet 6411 Tamaga (1993 TA) was found to be 8.352 ± 0.007 h. The peak to peak variation of the bi-modal light curve is 0.34 mag implying an axial ratio a/b of 1.37.

Minor planet 6411 Tamaga (1993 TA) was discovered by Rob McNaught at Siding Spring on 8 October, 1993. It is a Mars-crossing asteroid with a quoted diameter of 16.6 km (Guide v8, 2002). It was named in MPC 29671 (April, 1997) after the British magazine, *The Astronomer*, which now features the name and number of this asteroid on its cover. No rotation period data were found in the latest available lists (Harris and Warner, 2007).

Observations in 2008 were conducted from four sites: one in New Zealand and three in Australia. The locations of these sites are listed in Bembrick et al (2004). All observations were made using unfiltered differential photometry and exposures were adjusted so that 1% precision was achieved in most cases. All data were light-time corrected. The aspect data (Table I) also shows the percentage of the lightcurve observed each night. PAB is the Phase Angle Bisector. Period analyses were carried out using the Peranso software (Vanmunster, 2006), utilising a variety of period search routines, including the FALC routine (Harris et al 1989). Following a visual inspection of the data, periods between 5 and 10 hours were searched and several routines gave identical or near identical results with a prominent peak in the power spectrum.

The composite lightcurve for 6411 Tamaga appears to be a "normal" bi-modal curve with a synodic period of 8.352 ± 0.007 h. The peak-to-peak amplitude variation is some 0.34 mag, implying an axial ratio (assuming an equatorial observing aspect) a/b of 1.37. The lightcurve has full phase coverage and is considered a secure result. We note that this result is slightly different to that quoted by Higgins (2008), who obtained a value of 8.383 h for the synodic rotation period in December 2007 from a lightcurve (at solar phase angle 27 degrees) with two distinctly different maxima.

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UT Date	PAB Long	PAB Lat	Phase Angle	%Phase Coverage
2008 Jan 09	113.3	-33.6	24.4	69
2008 Jan 10	113.4	-33.4	24.2	132
2008 Jan 11	113.5	-33.2	23.9	135
2008 Jan 13	113.7	-32.6	23.5	86
2008 Jan 15	113.9	-32.1	23.0	72
2008 Jan 19	114.3	-30.9	22.3	43

Table I. Aspect data for Tamaga in 2008.

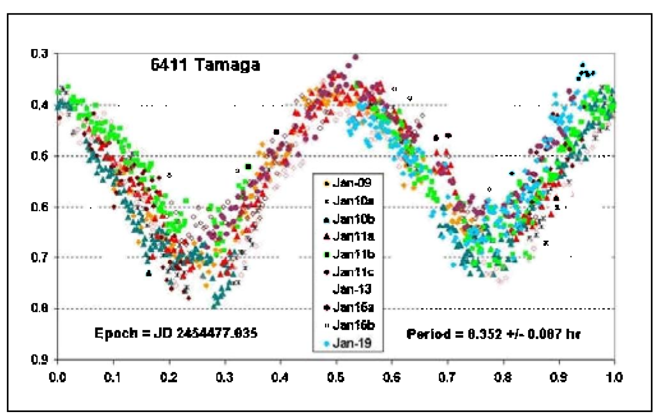

Figure 1. Composite phased lightcurve for 6411 Tamaga.