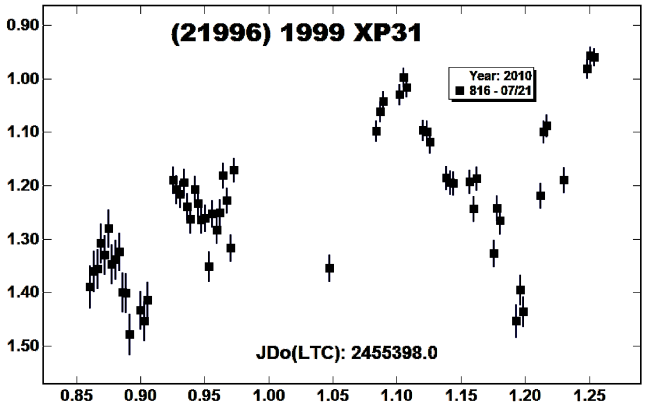

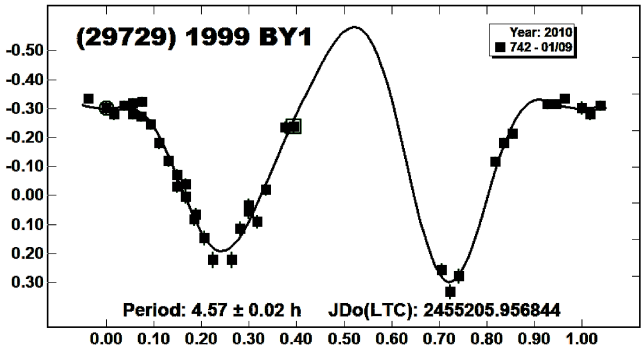

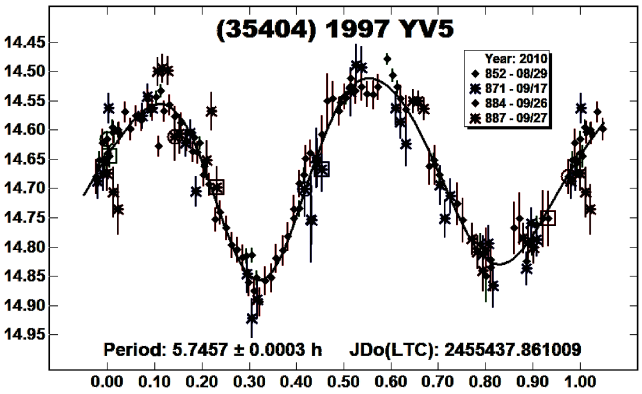

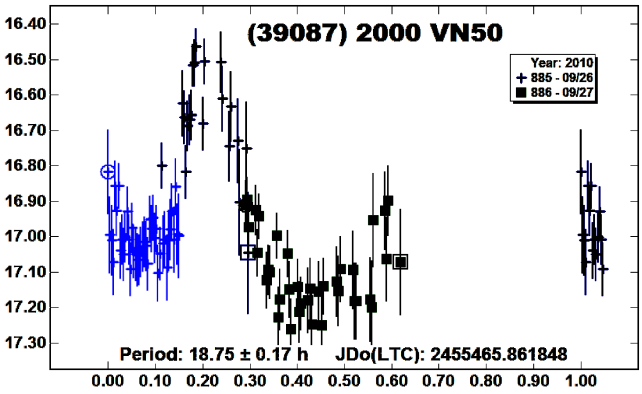

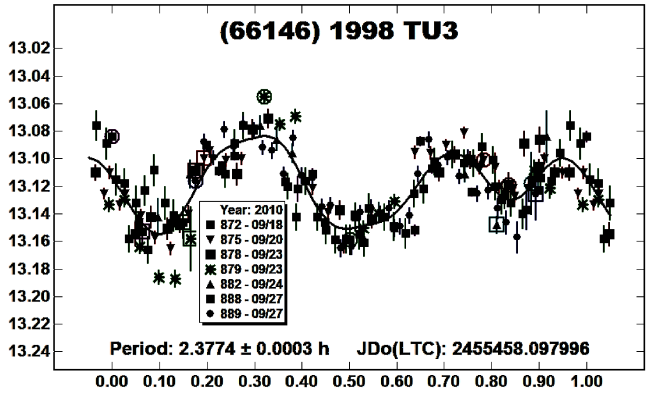

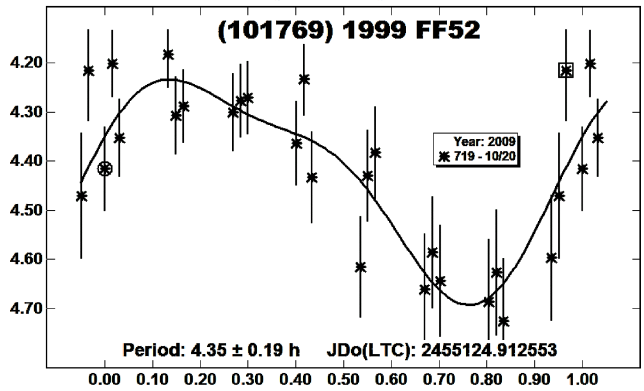

PERIOD DETERMINATION OF BINARY ASTEROID TARGETS OBSERVED AT HUNTERS HILL OBSERVATORY: MAY-SEPTEMBER 2009

David Higgins
Hunters Hill Observatory
7 Mawalan Street, Ngunnawal, ACT 2913, AUSTRALIA
higginsdj@bigpond.com

Julian Oey
Leura Observatory
Leura, NSW, AUSTRALIA

Petr Pravec
Astronomical Institute
CZ-25165 Ondrejov, CZECH REPUBLIC

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Lightcurves for seven confirmed or possible binary asteroids were obtained at the Hunters Hill Observatory (HHO) and Leura Observatory from 2009 May through 2010 September: 1453 Fennia, 2501 Lohja, 3076 Garber, 4029 Bridges, 5325 Silver, 6244 Okamoto, and (6265) 1985 TW3.

Observations of seven minor planets were obtained at Hunters Hill Observatory using a 0.36-m f/4 Meade LX200GPS S-C and SBIG ST-8E CCD camera. Exposures varied according to the brightness of the target. All were guided and taken through a clear filter. Observations at Leura Observatory were made using a 0.36-m f/4.6 Meade LX2000 Schmidt-Cassegrain and SBIG ST-9XE CCD

Camera. Image measurement and lightcurve analysis were done using the latest release or beta version of *MPO Canopus* at the time the target was observed. Analysis of the binary nature of these targets used the dual-period search function in *MPO Canopus* version 10.2.0.0. All data were sent to Petr Pravec, the principal investigator of the Binary Asteroid Photometric Survey (Pravec *et al.*, 2006), and analysed independently. His advice and guidance ensured that both sets of results were in agreement.

In the tables below, D_2/D_1 indicates the size ratio of the secondary and primary. An asterisk indicates the year of discovery.

1453 Fennia. This target was discovered to be a binary system by B.D. Warner in 2007 (Warner *et al.*, 2007). The target was observed during the 2009 apparition, confirming its binary nature (see Table I). It should be noted that any small features outside the eclipsing events may be spurious.

Year	P_1 (h)	A (mag)	P_{orb} (h)	A_{orb} (mag)	D_2/D_1
2009	4.4124 ± 0.0004	0.13 ± 0.02	23.03	0.08	0.27
2007*	4.4121 ± 0.0001	0.18	22.99	0.09	0.28

Table I. Attributes of the 1453 Fennia binary system

2501 Lohja. This target was revealed as a possible binary or tumbler during its 2006 apparition when observed at HHO. The target was observed during its 2010 apparition at HHO and Leura Observatory in an effort to uncover anything new about the target. A dual-period search was undertaken and, like previous apparitions, an underlying period close to P_1 was indicated though not to sufficient precision to rule out an artifact of some sort. A synodic rotation period of 3.8086 ± 0.0001 h with an amplitude of 0.35 ± 0.01 mag was derived.

3076 Gaber. This target was observed by Oey at Leura Observatory and HHO. Oey determined a period of 2.6087 h with his own data However, combined with HHO data, a period of 2.7600 h is derived. The entire dataset could not be fit to the 2.6087 h period. Using the dual period search in *MPO Canopus*, the data revealed sufficient deviations to suggest a second period may be present but no obvious eclipsing events were seen. Table II gives the observed parameters.

P_1 (h)	A (mag)	P_2 or P_{orb} (h)	A_2 (mag)	D_2/D_1
2.7600 ± 0.0002	0.18 ± 0.02	NA	NA	NA

Table II. Attributes of the 3076 Garber, possible binary system

4029 Bridges. This target was discovered to be a binary by Higgins in 2006 (Higgins *et al.*, 2006a). The target was observed during its 2010 apparition, when its binary nature was confirmed (see Table III).

Year	P_1 (h)	A (mag)	P_2 (h)	A_2 (mag)	D_2/D_1
2010	3.5748 ± 0.0002	0.25 ± 0.02	16.30	0.07	0.25
2006*	3.5746 ± 0.0001	0.20	16.31	0.06	0.24

Table III. Attributes of the 4029 Bridges Binary system

5325 Silver. This was a new target for the BAPS team. The data revealed some possible attenuations but nothing concrete enough to warrant anything other than possible binary status. Table IV gives the observed parameters.

P_1 (h)	A (mag)	P_2 (h)	A_2 (mag)	D_2/D_1
4.02361 ± 0.00006	0.27 ± 0.02	NA	NA	NA

Table IV. Attributes of the 5325 Silver, possible binary system

6244 Okamoto. This target was discovered to be binary by Higgins in 2006 (Higgins *et al.*, 2006b). The target was observed in its 2009 apparition, when mutual events confirmed the binary nature (see Table V). The data set was not sufficient to find a unique period for the orbit (P_{orb}). Equal quality fits were found at 20.04 h and 20.60 h but the period of 20.32 h was chosen since it matched the previous apparition, when the data set allowed a unique solution for P_{orb}.

Year	P_1 (h)	A (mag)	P_{orb} (h)	A_{orb} (mag)	D_2/D_1
2009	2.89585 ± 0.00009	0.15 ± 0.02	20.32	0.06	0.23
2006*	2.8958 ± 0.0001	0.11	20.32	0.07	0.25

Table V. Attributes of the 6244 Okamoto Binary system

(6265) 1985 TW3. This target was discovered to be binary by Higgins in 2007 (Higgins *et al.*, 2007). The 2010 observations confirmed the discovery and refined the system parameters (see Table VI).

Year	P1 (h)	A (mag)	P_{orb} (h)	A_{orb} (mag)	D_2/D_1
2010	2.70932 ± 0.00008	0.35 ± 0.01	15.845	0.1	0.30
2007*	2.7091 ± 0.0001	0.28	15.86	0.06	0.24

Table VI. Attributes of the (6265) 1985 TW3 Binary system

References

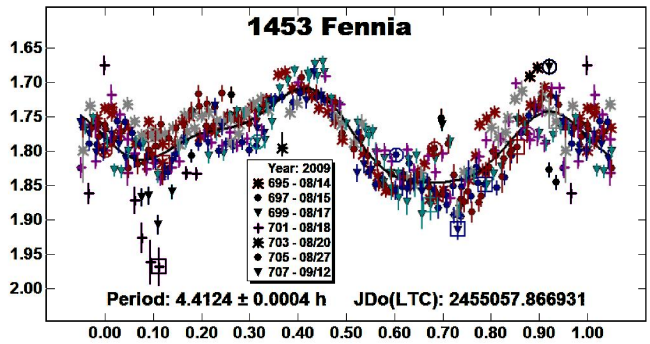
Pravec, P., Scheirich, P., Kušnirák, P., Šarounová, L., Mottola, S., Hahn, G., Brown, P., Esquerdo, G., Kaiser, N., Krzeminski, Z., Pray, D. P., Warner, B. D., Harris, A. W., Nolan, M. C., Howell, E. S., Benner, L. A. M., Margot, J.-L., Galád, A., Holliday, W., Hicks, M. D., Krugly, Yu. N., Tholen, D., Whiteley, R., Marchis, F., Degraff, D. R., Grauer, A., Larson, S., Velichko, F. P., Cooney, W. R., Stephens, R., Zhu, J., Kirsch, K., Dyvig, R., Snyder, L., Reddy, V., Moore, S., Gajdoš, Š., Világi, J., Masi, G., Higgins, D., Funkhouser, G., Knight, B., Slivan, S., Behrend, R., Grenon, M., Burki, G., Roy, R., Demeautis, C., Matter, D., Waelchli, N., Revaz, Y., Klotz, A., Rieugné, M., Thierry, P., Cotrez, V., Brunetto, L., and Kober, G. (2006) "Photometric Survey of Binary Near-Earth Asteroids". *Icarus* **181**, 63-93.

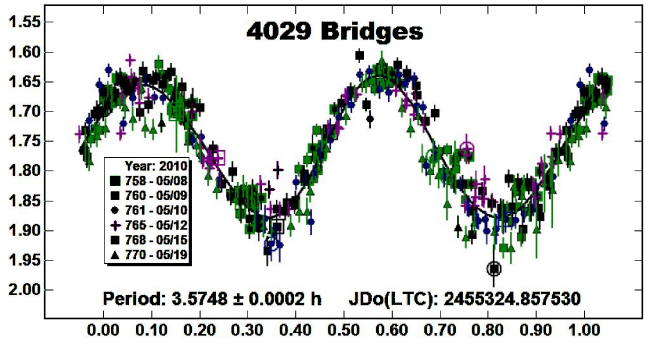
Higgins, D., Pravec, P., Kušnirák, P., Cooney Jr., W., Gross, J., Terrell, D., and Stephens, R.D. (2006a). CBET 570.

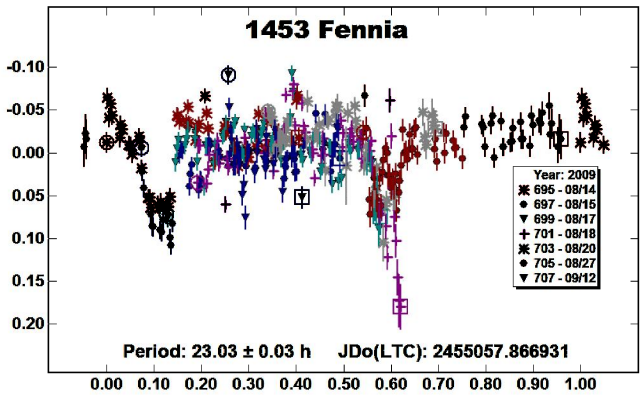
Higgins, D., Pray, D., Kušnirák, P., and Pravec, P. (2006). CBET 681.

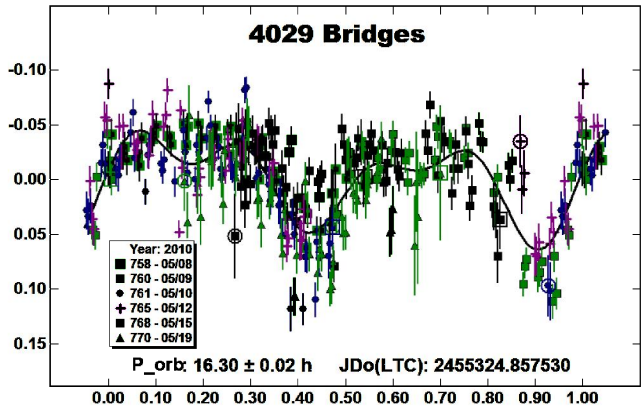
Higgins, D., Pravec, P. and Kušnirák, P. (2007). CBET 1015.

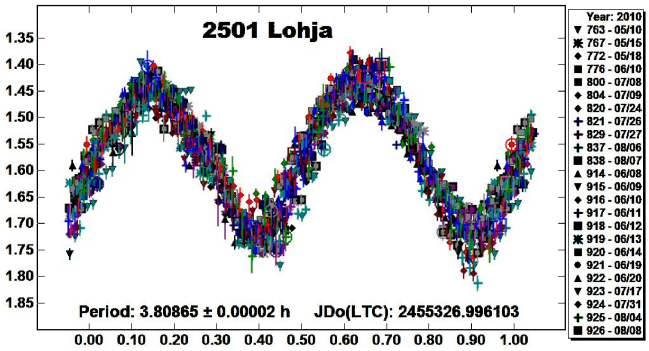
Warner, B.D., Harris, A.W., Pravec, P., Stephens, R.D., Pray, D., Cooney Jr., W., Gross, J., Terrell, D., Gajdoš, Š., Galád, A., and Krugly, Yu. (2007). CBET 1150.

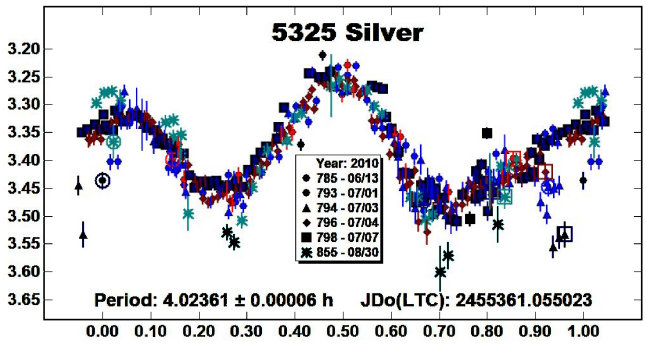


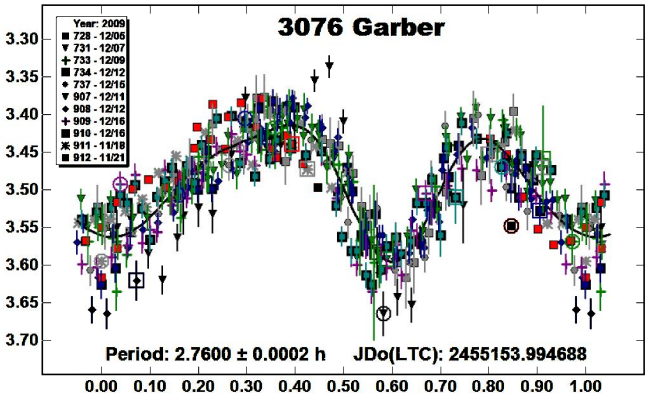


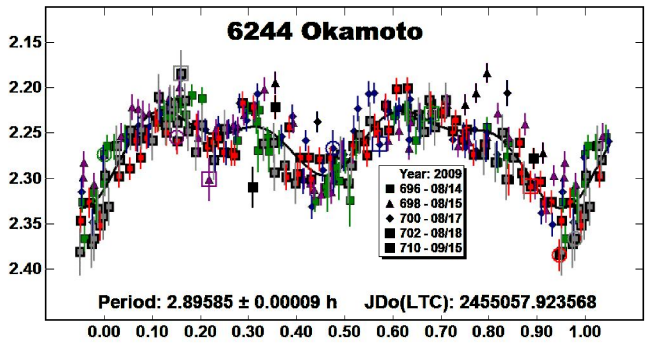


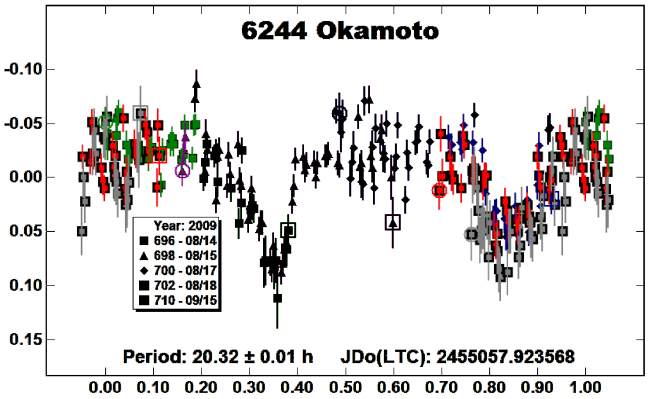


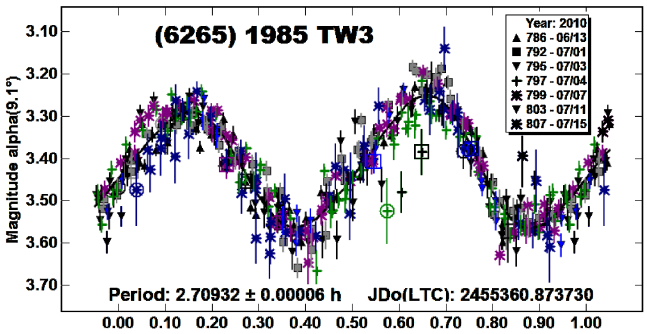


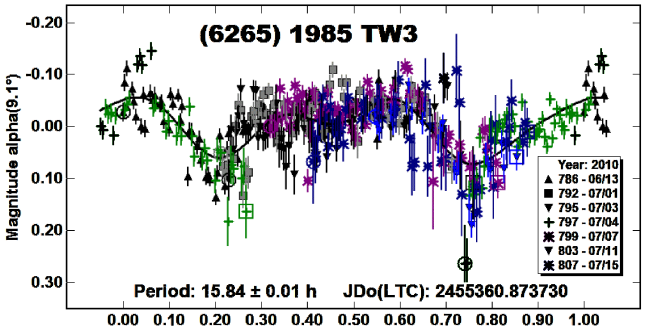












PERIOD ANALISYS OF 996 HILARITAS, 3387 GREENBERG, AND 3870 MAYRE

Andrea Ferrero
Bigmuskie Observatory (B88)
via Italo Aresca 12, 14047 Mombercelli–Asti ITALY
bigmuskie@alice.it

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The lightcurves for three asteroids were obtained at Bigmuskie Observatory, Italy, from 2010 March to June: 996 Hilaritas, 3387 Greenberg, and 3870 Mayre.

The rotation periods of three asteroids were found at the Bigmuskie Observatory from observations in 2010 March to June. 996 Hilaritas was chosen from among the list of photometry targets for 2010 January-March (Warner *et al.*, 2010a). The other two targets, 3387 Greenberg and 3870 Mayre, were chosen from the lists of photometry opportunities for 2010 April-June (Warner *et al.*, 2010b) and 2010 July-September (Warner *et al.*, 2010c) because there was no reported set of lightcurve parameters for the pair and they were favorably placed for observations.

A 0.3-m f/8 Ritchey-Chretien with a Finger Lakes Max Cam CM-9 CCD camera under the control of *MaximDL* was used to acquire the unfiltered images. Data reduction was performed with *MPO Canopus* (Warner, 2010). For all the asteroids, every session of the curve was produced using 3 to 5 comparison stars that were chosen using the comparison star selector routine in *MPO Canopus.* This feature typically allows linking multiple sessions to ±0.05 mag. Every observing session started about 3.5 hours east of the meridian and ended about 4 hours west. Exposure times were 120 seconds for 996 Hilaritas and 180 seconds for 3387 Greenberg and 3870 Mayre.

996 Hilaritas. A period of 7.20 h had been previously reported by Angeli *et al.* (2001). It was evident from analysis of the first session's data with *MPO Canopus* that a different period would emerge. After three sessions, we found a period of P = 10.05 ± 0.01 h, the same period reported by Stephens (2010).

3387 Greenberg. With a short period of P = 2.70 ± 0.02 h, the solution was evident from inspection of the raw plot, where more than two complete cycles were recorded . With two sessions, four complete rotations of the asteroid were covered, giving the result a high degree of reliability.

3870 Mayre. Using data from three sessions, a secure bimodal curve with a period of P = 3.99 ± 0.01 h was obtained.

References

Angeli, C.A., Guimaraes, T.A., Lazzaro, D., Duffard, R., Fernandez, S., Florczak, M., Monthé-Diniz, T., Carvano, J.M., and Betzler, A.S. (2001). "Rotation Periods for Small Main-Belt Asteroids from CCD Photometry." *Astron. J.* **121**, 2245-2252

Stephens, R.D. (2010). "Asteroids Observed from GMARS and Santana Observatories: 2010 April - June." *Minor Planet Bulletin* **37**, 159-161.

Warner, B. D. (2010). *MPO Canopus* version 10.1.0.6. Bdw Publishing, Colorado Springs, CO.

Warner, B.D., Harris A. W., Pravec, P., Durech J., and Benner L. A.M. (2010a). "Lightcurve Photometry Opportunities: 2010 January – March." *Minor Planet Bulletin* **37**, 37-39.

Warner, B.D., Harris A. W., Pravec, P., Durech J., and Benner L. A.M. (2010b). "Lightcurve Photometry Opportunities: 2010 April July." *Minor Planet Bulletin* **37**, 77-79.

Warner, B.D., Harris A. W., Pravec, P., Durech J., and Benner L. A.M. (2010c). "Lightcurve Photometry Opportunities: 2010 July-September." *Minor Planet Bulletin* **37**, 130-133.