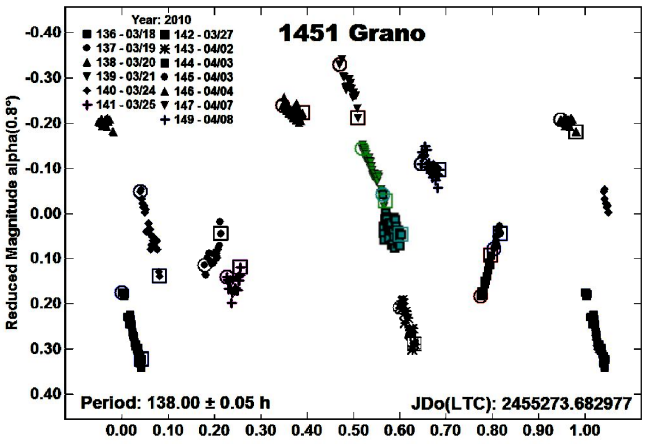

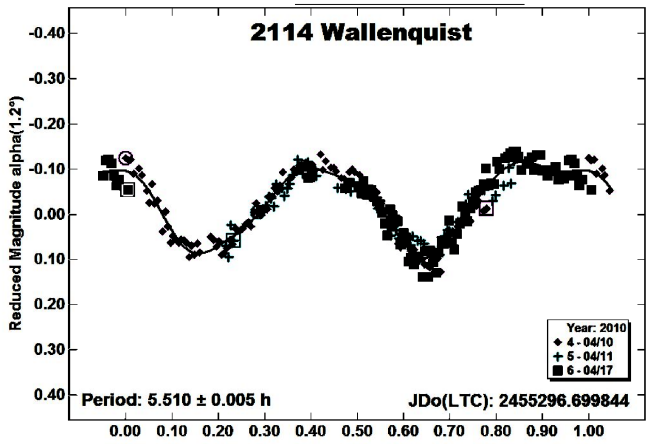

ASTEROID LIGHTCURVE ANALYSIS AT THE PALMER DIVIDE OBSERVATORY: 2010 MARCH – JUNE

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Lightcurves for 19 asteroids were obtained at the Palmer Divide Observatory (PDO) from 2010 March through June: 413 Edburga, 2204 Lyyli, 2449 Kenos, 3225 Hoag, 3416 Dorrit, 3483 Svetlov, 3800 Karayusuf, 4461 Sayama, 4713 Steel, 5081 Sanguin, 5427 Jensmartin, 5641 McCleese, 6249 Jennifer, 6635 Zuber, 6911 Nancygreen, (29147) 1988 GG, (30856) 1991 XE, (48147) 2001 FO160, and (103501) 2000 AT245.

CCD photometric observations of 19 asteroids were made at the Palmer Divide Observatory (PDO) from 2010 March through June. See the introduction in Warner (2010) for a discussion of equipment, analysis software and methods, and overview of the plot scaling. The "Reduced Magnitude" in the plots uses R magnitudes corrected to unity distance using -5 * log (Rr) with R and r being, respectively, the Sun-asteroid and Earth-asteroid distances in AU. The magnitudes were normalized to the phase angle given in parentheses, i.e., alpha(X°), using G = 0.15 unless otherwise stated.

413 Edburga. This asteroid was observed as a "full moon project" to resolve the ambiguity between two previously reported periods: 15 h (Hainaut-Rouelle et al., 1995) and 12.1 h (Behrend, 2010). The PDO data gave a convincing solution of P = 15.773 h and A = 0.36 mag.

2204 Lyyli. Mohamed et al. (1994) reported P = 10 h for this Mars-crosser while Gil-Hutton and Canada (2003) found P = 9.51 h. Neither of these could be fit to the PDO data, which gave P = 11.063 h with A = 0.40 mag.

2449 Kenos. Wisniewski et al. (1997) found P = 4.188 h but with P = 3.862 h as a possible solution. Warner (2007) found P = 3.8492 h. The latest PDO data gave P = 3.846 h with A = 0.23 mag.

3225 Hoag. Warner (2007, 2009b) previously reported P ~ 2.372 h. The asteroid was observed in 2010 for additional modeling data and to check if it might be binary (see Warner et al., 2010, for a serendipitous story concerning 2131 Mayall and repeated follow-up). The 2010 PDO data gave P = 2.3722 and A = 0.12.

3416 Dorrit. Bennefeld (2009) found P = 2.714 h based on two consecutive nights but with data point errors of ~0.04 mag. Using the PDO data, which consisted of two consecutive nights and a third three days removed from the first two, there was a much weaker solution in the period spectrum around that value, but it was obviously not a good fit. Instead, the data gave P = 2.574 h with A = 0.21 mag.

3800 Karayusuf. Warner (2008) found P = 2.2319 h with some suspicious data that might have been attributed to a satellite. No evidence of such was found in the 2010 apparition. The latest data gave P = 2.232 h with A = 0.15 mag.

4713 Steel. The PDO data gave P = 5.199 h with A = 0.42 mag. The period is reasonable agreement with that from Behrend (2010) of P = 5.186 h.

5427 Jensmartin. Warner (2009a) found P = 5.810 h from observations in 2008. The 2010 follow-up observations gave P = 5.813 h with A = 0.55 mag.

5641 McCleese. Warner et al. (2006a) found P = 7.268 h with A = 0.06 mag. Behrend (2010), using data from 2005 and 2007, found P = 28.8 h. The 2010 PDO data set benefited from well-linked data over the nearly six weeks of observations. These gave P = 418 h with A = 1.3 mag, thus making this Hungaria asteroid a very slow rotator and demonstrating the need to provide accurate linking and prolonged observations when the data indicate only a small but steady change over each session. One must also avoid the temptation to find solutions based on what is mostly noise in the data.

6249 Jennifer. Both Warner et al. (2006b) and Behrend (2010) previously reported a period of approximately 4.6 h. In both cases, the amplitudes were $A \leq 0.11$ mag. Such low amplitude curves, especially if monomodal (as Behrend found), leave open the possibility that the true period solution is something other than what was found, often one-half. The 2010 PDO data produced a lightcurve amplitude of A = 0.32 mag, which almost assures that the lightcurve is bimodal and so a period solution featuring such a curve is very likely correct. The period of P = 4.961 h confirmed

the earlier findings.

6911 Nancygreen. In Warner (2006), the period for this asteroid was P = 5.3 h. Despite an amplitude of 0.52 mag, the period was uncertain. In Warner (2009a), the period was P = 4.33 h with A = 0.10 mag. It was hoped that the 2010 observations at PDO would resolve the ambiguity. Instead, they added a third, much different solution of P = 17.14 h with A = 0.22 mag to the puzzle.

(29147) 1988 GG. This asteroid appears to be in non-principal axis rotation (NPAR; see Pravec et al., 2005). The dominant period is P = 99 h but since the lightcurve did not repeat itself, this is only a suggested solution.

(30856) 1991 XE. This asteroid was observed as follow-up to work done by the author in 2007 (Warner, 2007) that produced P = 5.353 h and A = 0.70 mag. The 2010 data gave P = 5.355 h and A = 0.75 mag.

(48147) 2001 FO160. Two solutions are possible, P = 13.09 h and P = 26.17 h, both with A = 0.25 mag. Given the amplitude, the longer period, which has a bimodal solution, is usually favored. A period spectrum is also given to show that some other solutions cannot be formally excluded.

(103501) 2000 AT45. The period of P = 29.95 h presented in the plot is the most likely of several solutions with the double period, P = 59.85 h, being one of the alternatives.

Acknowledgements

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#	Name	mm/dd 2010	Data Pts	α	L_{PAB}	B_{PAB}	Per (h)	PE	Amp (mag)	AE
413	Edburga	05/24-06/20	307	10.2,16.9	225	18	15.773	0.005	0.36	0.02
2204	Lyyli	05/05-06/07	220	12.8,18.8	199	18	11.063	0.001	0.40	0.02
2449	Kenos (H)	06/08-06/18	176	33.7,33.2	278	40	3.846	0.001	0.23	0.02
3225	Hoag (H)	04/25-05/03	189	22.4,21.1	239	26	2.3722	0.0005	0.12	0.01
3416	Dorrit (H)	03/21-03/25	179	6.3,6.0	182	10	2.574	0.002	0.21	0.01
3483	Svetlov (H)	05/01-05/04	169	15.1,15.2	216	25	6.790	0.005	0.23	0.02
3800	Karayusuf (H)	03/17-03/22	266	27.3,27.0	186	28	2.232	0.002	0.15	0.01
4461	Sayama	06/21-07/02	232	12.4,15.3	250	17	40.75	0.20	0.60	0.03
4713	Steel (H)	05/01-05/04	203	22.1,22.2	217	31	5.199	0.002	0.42	0.02
5081	Sanguin	03/25-04/10	239	12.5,17.7	170	18	10.262	0.003	0.53	0.02
5427	Jensmartin (H)	04/25-05/04	134	7.7,12.6	205	-5	5.813	0.003	0.55	0.02
5641	McCleese (H)	05/16-07/01	938	32.1,24.3	268	32	418.	5.	1.30	0.10
6249	Jennifer (H)	06/11-06/18	127	18.8,19.5	265	29	4.961	0.005	0.32	0.03
6635	Zuber (H)	06/19-06/22	92	22.1,21.6	292	33	5.546	0.005	0.63	0.03
6911	Nancygreen (H)	05/05-06/08	297	8.9,18.7	230	15	17.14	0.01	0.22	0.02
29147	1988 GG	03/12-04/11	663	15.7,20.6	172	19	99. (NPAR?)	3.	0.80	0.05
30856	1991 XE (H)	05/04-05/09	160	15.8,15.1	228	23	5.355	0.002	0.75	0.02
48147	2001 FO160	05/04-06/07	284	13.6,17.6	229	23	26.17/13.09	0.02	0.25	0.02
103501	2000 AT245	03/17-04/09	298	12.2,21.6	165	7	29.95/59.85	0.10	0.16	0.02

Table I. Observing circumstances. Asteroids with "(H)" after the name are members of the Hungaria group. The phase angle (α) is given at the start and end of each date range, unless it reached a minimum, which is then the second of three values. If a single value is given, the phase angle did not change significantly and the average value is given. L_{PAB} and B_{PAB} are each the average phase angle bisector longitude and latitude, unless two values are given (first/last date in range).

24-27.

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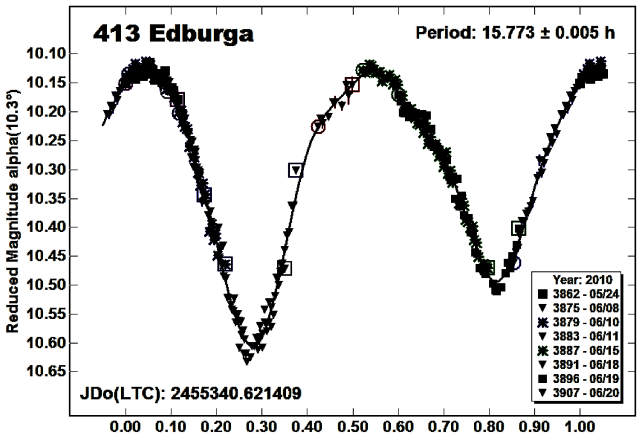

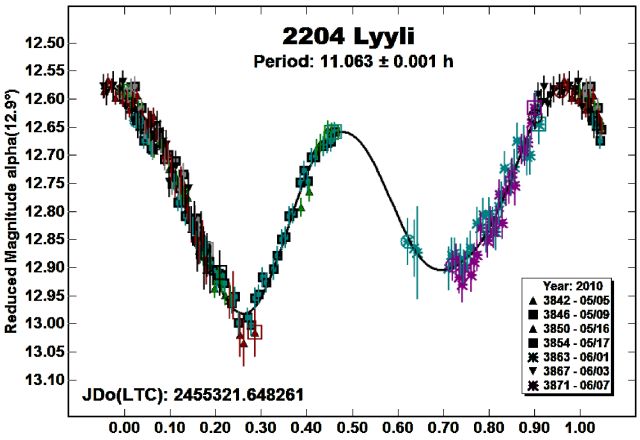

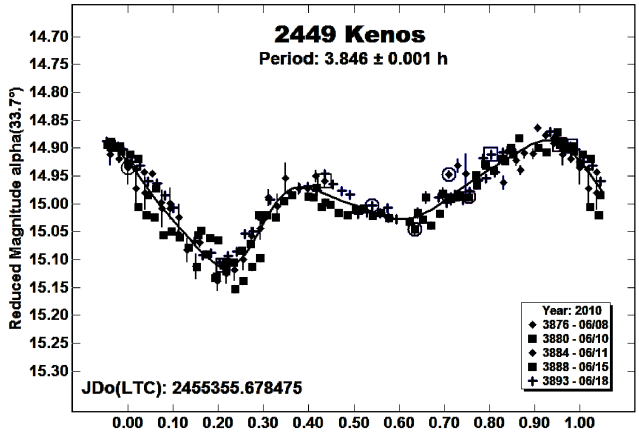

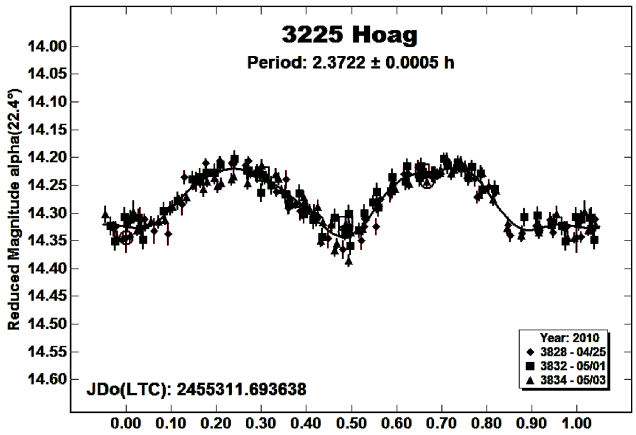

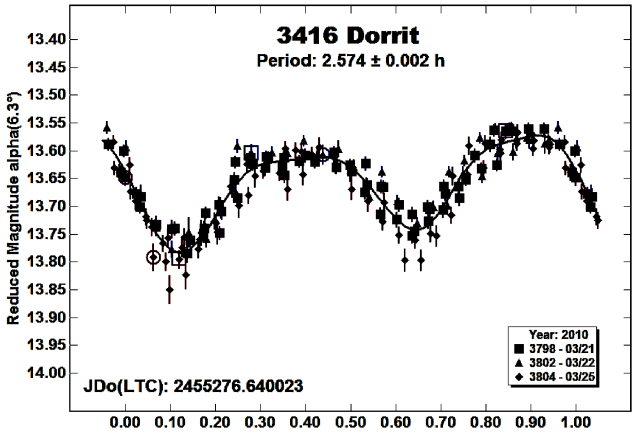

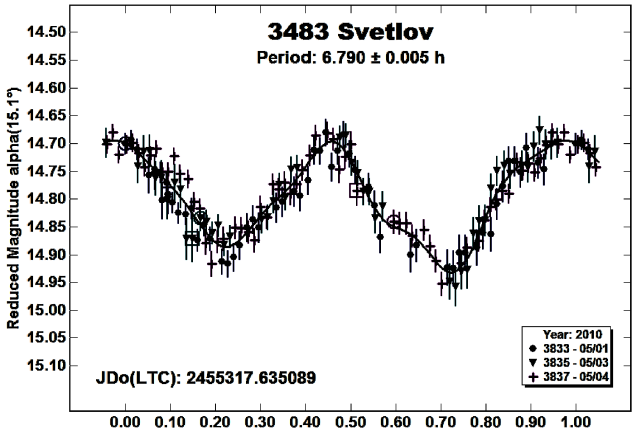

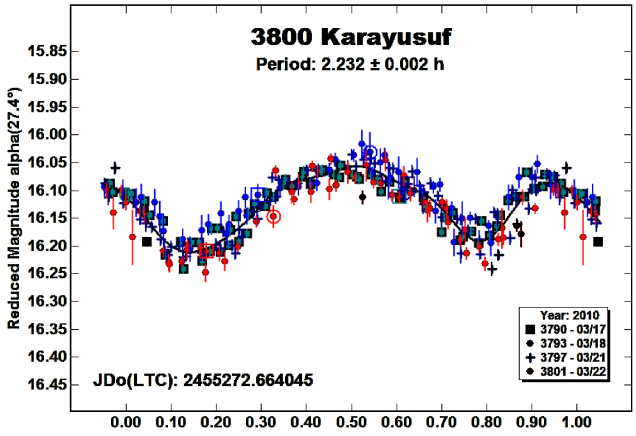

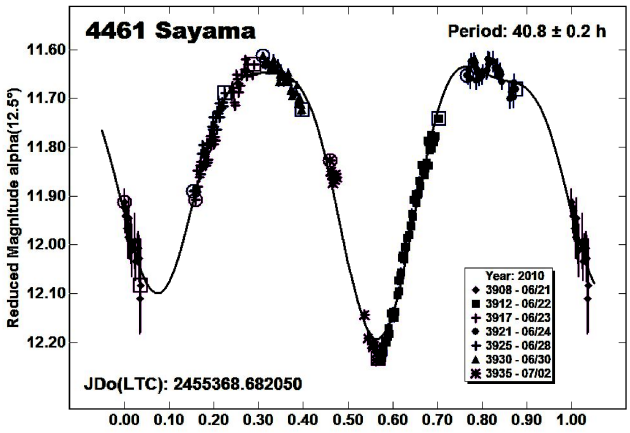

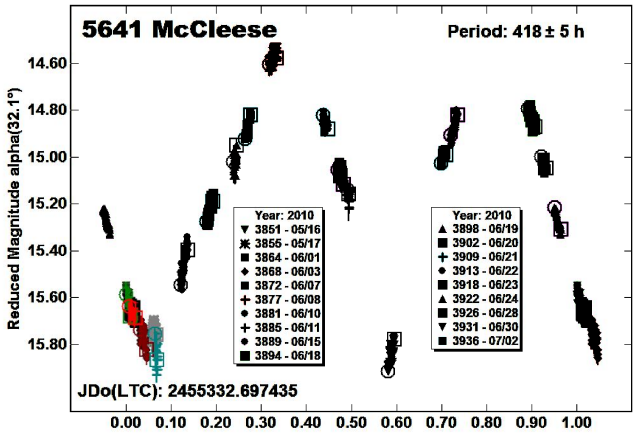

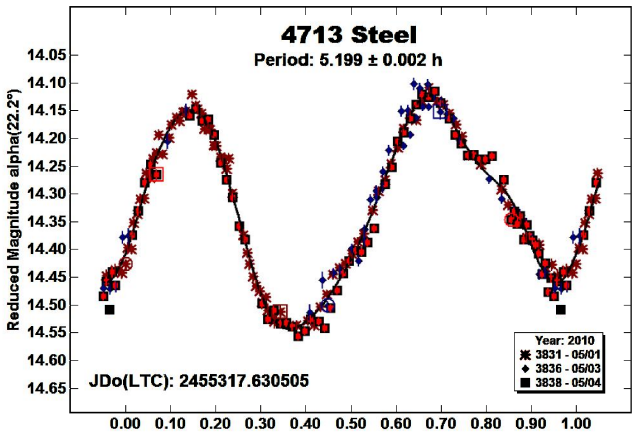

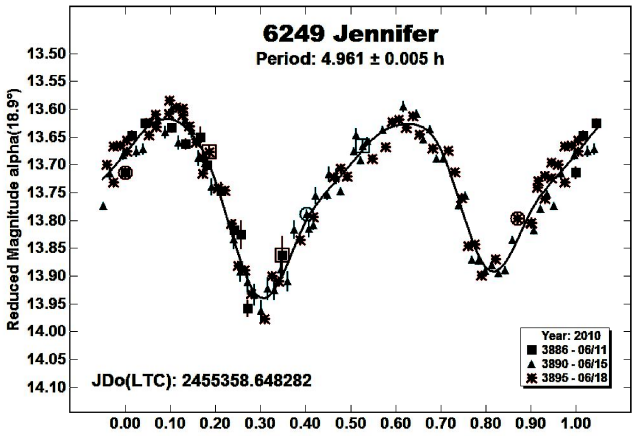

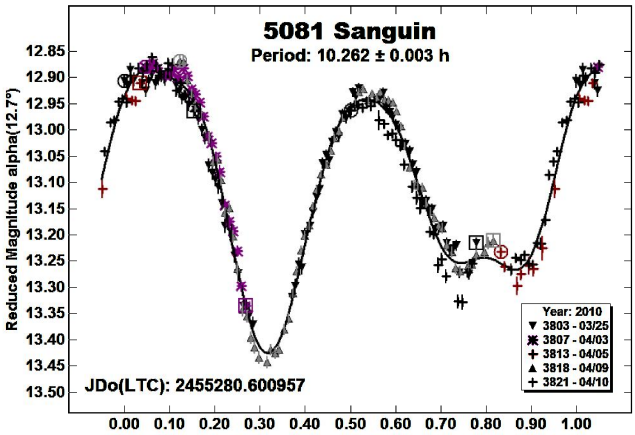

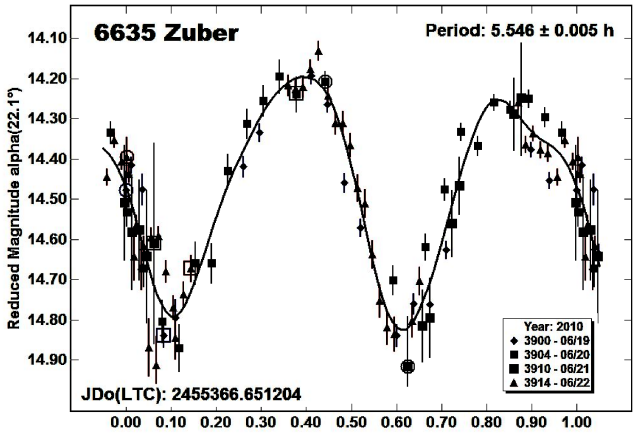

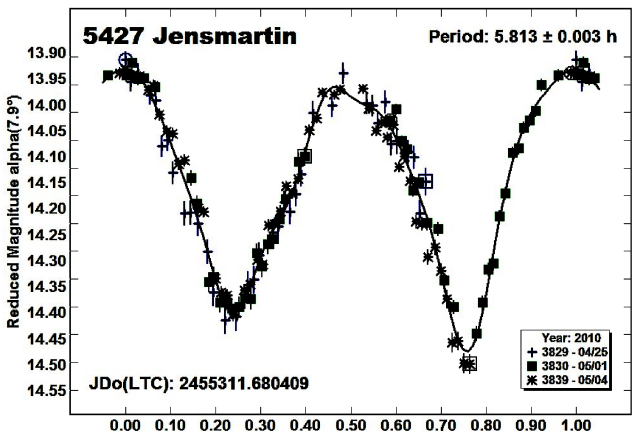

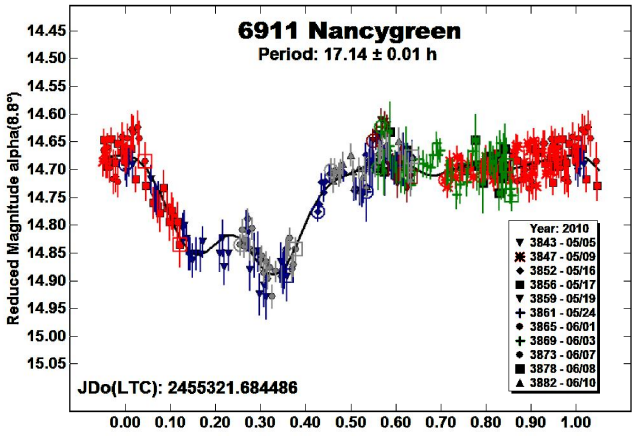

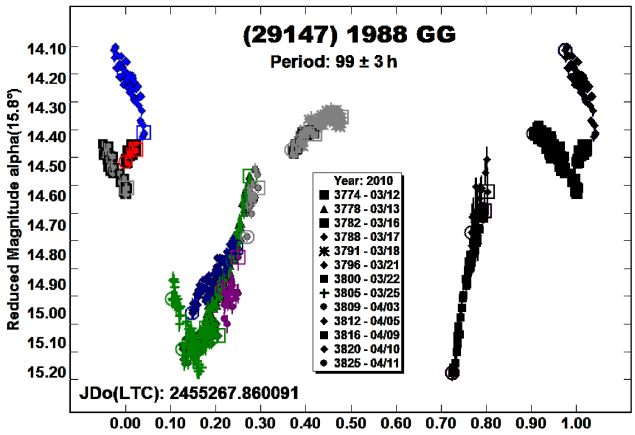

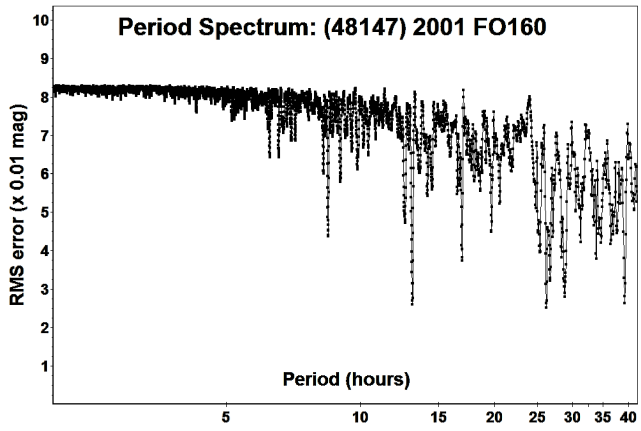

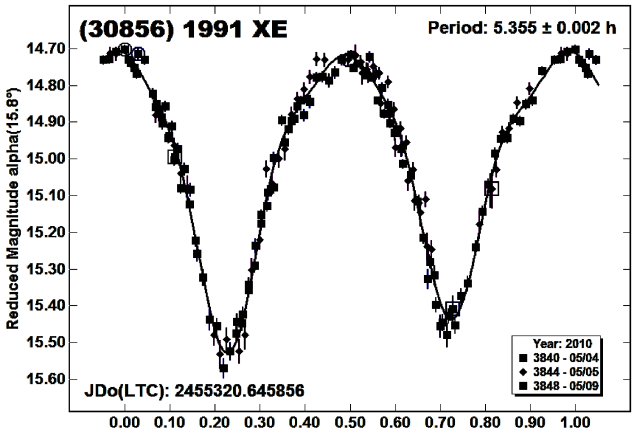

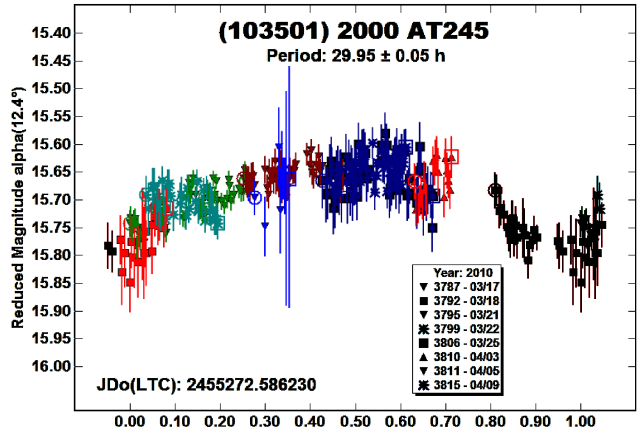

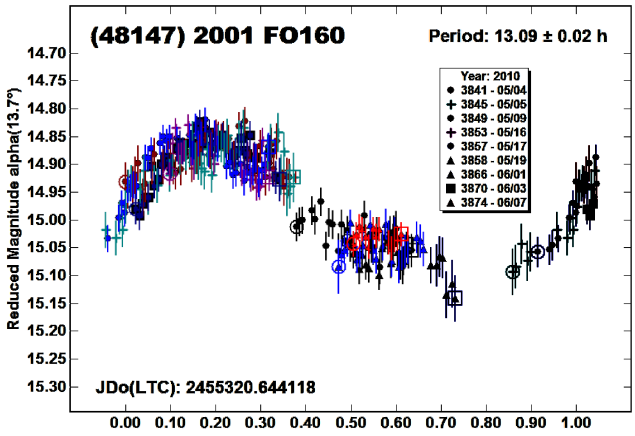

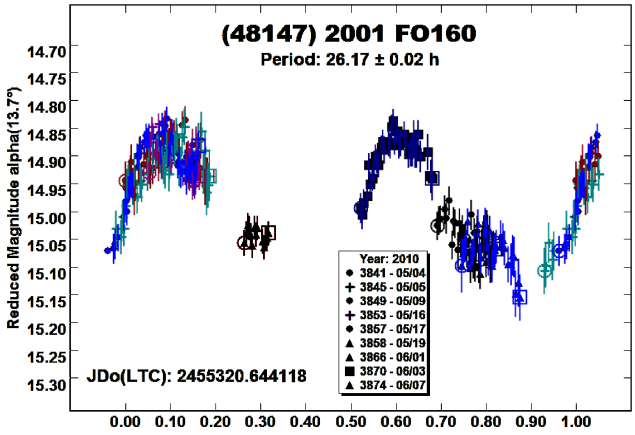

THE LIGHTCURVE OF NEAR-EARTH ASTEROID 2010 NR1

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A lightcurve for the newly-discovered Near-Earth asteroid 2010 NR1, was obtained from Tzec Maun Observatory in Moorook, South Australia (MPC Code D96) from a single night's observations on 2010 July 10. An approximate period of 0.89 h was found along with an amplitude of 1.8 mag, indicating a very-elongated body.

Observations of the near-Earth asteroid 2010 NR1 were obtained by utilizing a 0.15-m TOA-150 refractor and a SBIG STL-6303 CCD imager. All images were with a clear filter, unguided, and using three-minute exposures. The camera was binned 2x2 giving 3.4 arc-second pixels. Measurements were made using *MPO Canopus* (Warner, 2010a). This particular near-Earth asteroid had no published lightcurve since it had only just been discovered. As well as generating a lightcurve, confirmation astrometry was also submitted to the Minor Planet Center. At the time of imaging this object, it was temporarily designated as RN4AF02. A second night of follow-up observations was impossible due to poor sky conditions over a period of several nights. These appear to be the