

frames. MPO *Canopus* v10.7.7.0 was used for differential photometry and period analysis (see Ruthroff 2010, for technique details).

Data reduction reveals a probable rotation period of $5.69 \text{ h} \pm 0.03$ h. A search of the Asteroid Lightcurve Database (LCDB; Warner et al., 2009) and the Astrophysics Data System did not find any previously reported results concerning the rotation period of 10041 Parkinson.

Acknowledgments

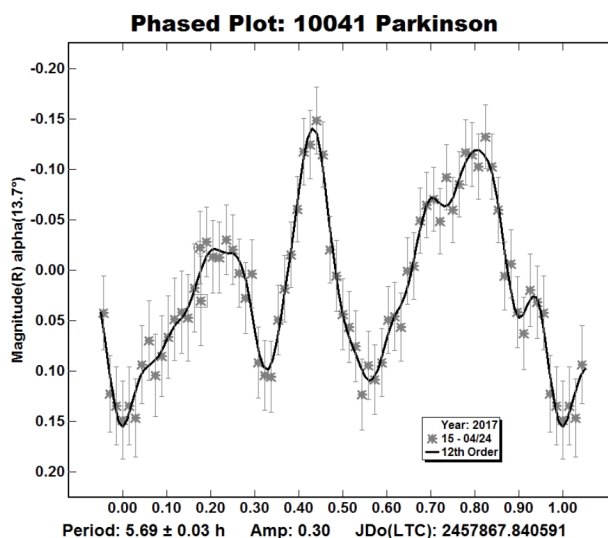
This paper makes use of data products from the Third U.S. Naval Observatory CCD Astrograph Catalog (UCAC3).

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Number	Name	2017 mm/dd	Pts	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
10041	Parkinson	04/24	69	13.7	206	18	5.69	0.03	0.30	0.02	MBA

Table I. Observing circumstances and results. Pts is the number of data points used in the analysis. The phase angle values are for the first and last date, unless a minimum (second value) was reached. LPAB and BPAB are the average phase angle bisector longitude and latitude. Period is in hours. Amp is peak-to-peak amplitude. LPAB and BPAB are the average phase angle bisector longitude and latitude (see Harris et al., 1984). Grp is the asteroid family/group (Warner et al., 2009).

ASTEROID LIGHTCURVE ANALYSIS AT CS3-PALMER DIVIDE STATION: 2017 APRIL THRU JUNE

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Lightcurves for 16 main-belt asteroids were obtained at the Center for Solar System Studies-Palmer Divide Station (CS3-PDS) from 2017 April thru June. Many of the asteroids were "strays" in the field of planned targets, demonstrating a good reason for data mining images. Analysis shows that the Hungaria asteroid (45878) 2000 WX29 may be binary.

CCD photometric observations of 16 main-belt asteroids were made at the Center for Solar System Studies-Palmer Divide Station (CS3-PDS) from 2017 April thru June. Table I lists the telescope/CCD camera combinations used for the observations. All the cameras use CCD chips from the KAF blue-enhanced family and so have essentially the same response. The pixel scales for the combinations range from 1.24-1.60 arcsec/pixel.

All lightcurve observations were unfiltered since a clear filter can result in a 0.1-0.3 magnitude loss. The exposure duration varied

depending on the asteroid's brightness and sky motion. Guiding on a field star sometimes resulted in a trailed image for the asteroid.

Measurements were made using *MPO Canopus*. The Comp Star Selector utility in *MPO Canopus* found up to five comparison stars of near solar-color for differential photometry. Catalog magnitudes were usually taken from the CMC-15 (<http://svo2.cab.inta-csic.es/vocats/cmc15/>) or APASS (Henden et al., 2009) catalogs. The MPOSC3 catalog was used as a last resort. This catalog is based on the 2MASS catalog (<http://www.ipac.caltech.edu/2mass>) with magnitudes converted from J-K to BVRI (Warner, 2007). The nightly zero points for the catalogs are generally consistent to about ± 0.05 mag or better, but on occasion reach 0.1 mag and more. There is a systematic offset among the catalogs so, whenever possible, the same catalog is used throughout the observations for a given asteroid. Period analysis is also done with *MPO Canopus*, which implements the FALC algorithm developed by Harris (Harris et al., 1989).

In the plots below, the "Reduced Magnitude" is Johnson V as indicated in the Y-axis title. These are values that have been converted from sky magnitudes to unity distance by applying $-5 \cdot \log(r\Delta)$ to the measured sky magnitudes with r and Δ being, respectively, the Sun-asteroid and Earth-asteroid distances in AU. The magnitudes were normalized to the given phase angle, e.g., $\alpha(6.5^\circ)$, using $G = 0.15$, unless otherwise stated. The X-axis is the rotational phase ranging from -0.05 to 1.05 .

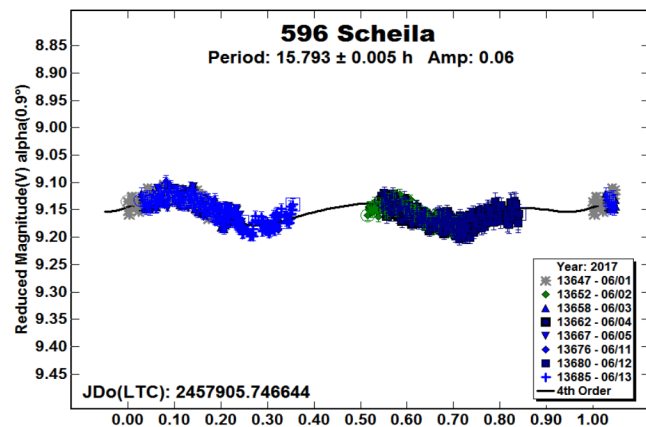
Desig	Telescope	Camera
Squirt	0.30-m f/6.3 Schmidt-Cass	ML-1001E
Borealis	0.35-m f/9.1 Schmidt-Cass	FLI-1001E
Eclipticalis	0.35-m f/9.1 Schmidt-Cass	STL-1001E
Australius	0.35-m f/9.1 Schmidt-Cass	STL-1001E
Zephyr	0.50-m f/8.1 R-C	FLI-1001E

Table I. List of CS3-PDS telescope/CCD camera combinations.

If the plot includes an amplitude, *e.g.*, “Amp: 0.65”, this is the amplitude of the Fourier model curve and *not necessarily the adopted amplitude for the lightcurve*.

For the sake of brevity, only some of the previously reported results may be referenced in the discussions on specific asteroids. For a more complete listing, the reader is directed to the asteroid lightcurve database (LCDB; Warner et al., 2009). The on-line version at <http://www.minorplanet.info/lightcurvedatabase.html> allows direct queries that can be filtered a number of ways and the results saved to a text file. A set of text files of the main LCDB tables, including the references with bibcodes, is also available for download. Readers are strongly encouraged to obtain, when possible, the original references listed in the LCDB for their work.

596 Scheila. When observed in 2006 (Warner, 2006), this main-belt object was found to have a period of 15.848 h. There were no signs of unusual activity. On 2010 Dec 11, Steve Larson at the Catalina Sky Survey detected a “coma” around the asteroid, suggesting that it might be a cometary outburst. Follow-up observations eventually determined that the asteroid had been hit by a smaller object of about 35-m size (Jewitt et al., 2011; Bodewits et al., 2011). When observed in 2011 (Warner, 2011a) and again in 2017, there were no signs of cometary activity. The 2017 observations led to a period of 15.793 h, but only by assuming previous results were correct.

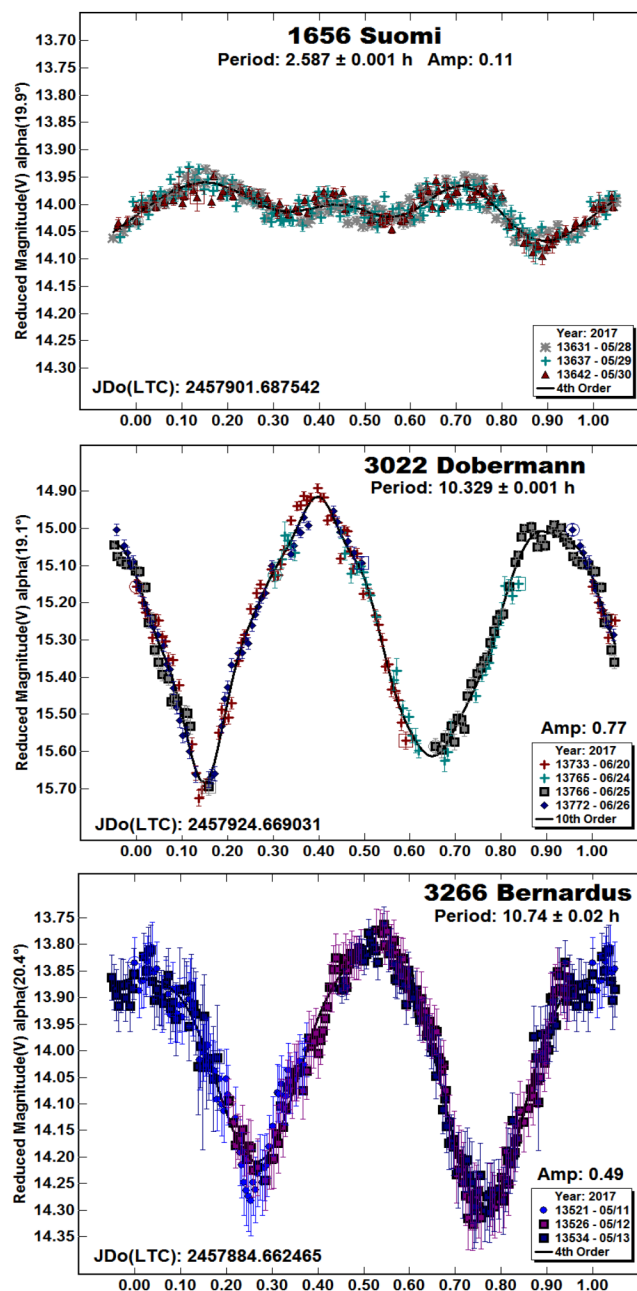


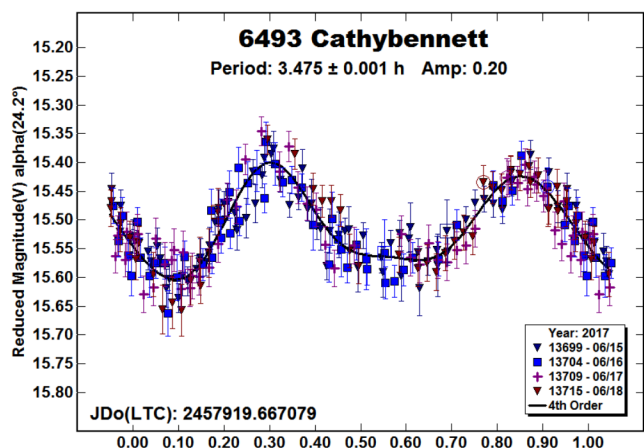
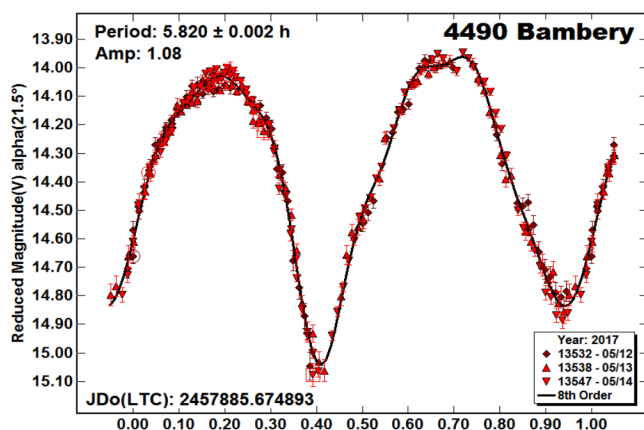
1656 Suomi, 3022 Dobermann, 3266 Bernardus, 4490 Bamberg, and 6493 Cathybennett. All of these Hungarias are “repeats” that were observed to provide additional data for spin axis modeling. The periods reported from the analysis of the most recent data are all in good agreement with previous results obtained by the author.

Observations in 2015 (Warner, 2016) suggested that 1656 Suomi might be binary, a secondary period of 12.6 hours with an amplitude of 0.11 mag being found. However, this was based on data from a single night that appeared to show an attenuation due to a satellite occultation/eclipse. Observations at previous apparitions as well as in 2017 found no similar “events.”

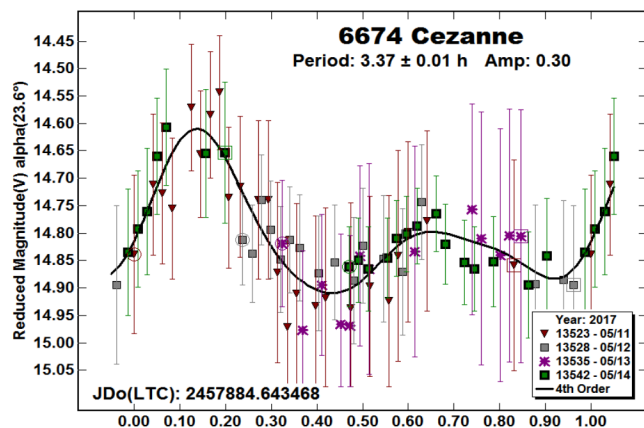
3022 Doberman and 4490 Bamberg have always shown large amplitude lightcurves. The 0.49 mag amplitude for 3266

Bernardus in 2017 is a mid-range value between the reported extremes of 0.27-1.14 mag. The 0.20 mag amplitude for 6493 Cathybennett in 2017 fits within the reported range 0.19-0.23 mag.





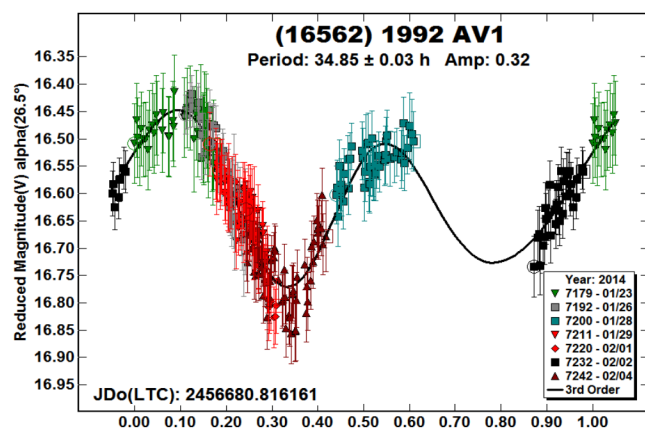
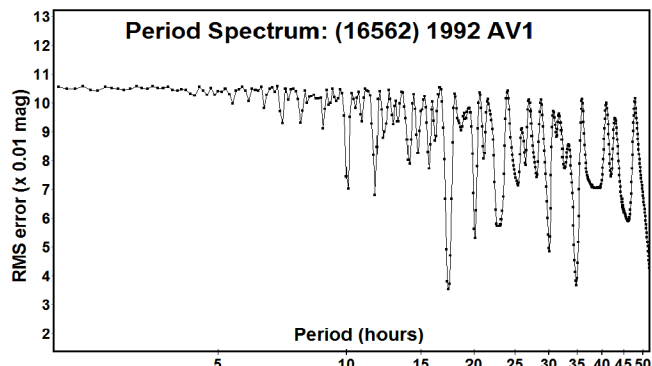
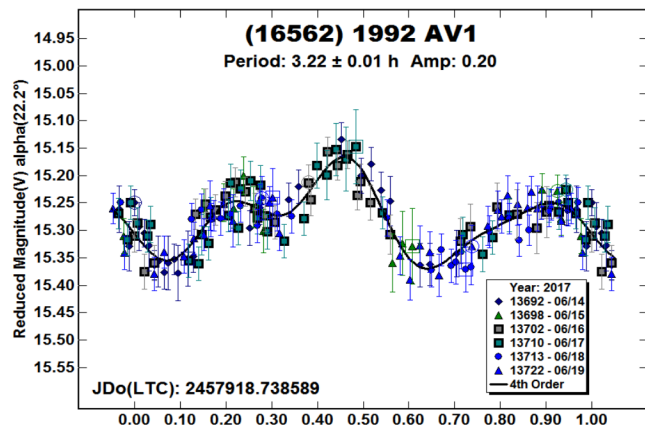
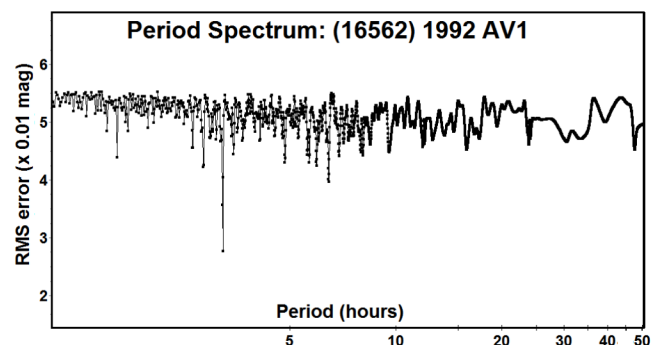
6674 Cezanne. There were no previously reported periods in the LCDB for this Nysa group member. The period of 3.37 h is reasonably secure, but additional observations are needed to confirm this result.



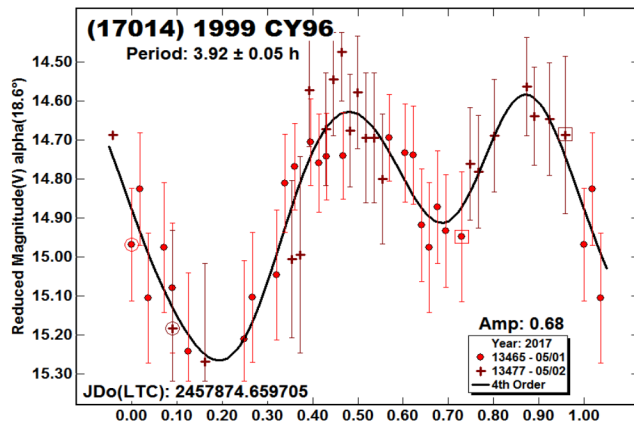
(16562) 1992 AV1. Finding a period for this Hungaria has been difficult. Previous results include Warner (2011b, 12.251 h or 6.51 h; 2014, 20.18 h). The data from 2017 led to entirely different result: 3.22 ± 0.01 h, which is close to the half-period of the alternate solution from 2011, when the amplitude was only 0.04 mag

Such divergent results prompted reviewing images from the previous apparitions to be sure that the same asteroid had been worked each time. After confirming that this was the case, the images from 2014 were measured anew. The revised data set led to a period of 34.85 h with a weak solution near the original period

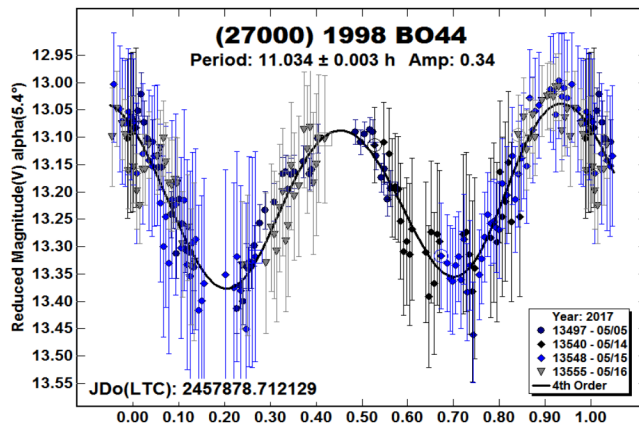
of 20.18 h. There seems to be no reconciliation among the various results. A final solution awaits more data from future apparitions.



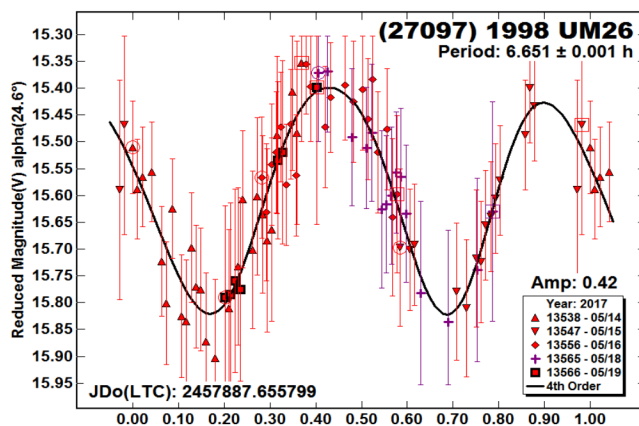
(17014) 1999 CY96. This outer main-belt asteroid was a target of opportunity in the field of a planned target. There were no reported periods in the LCDB.



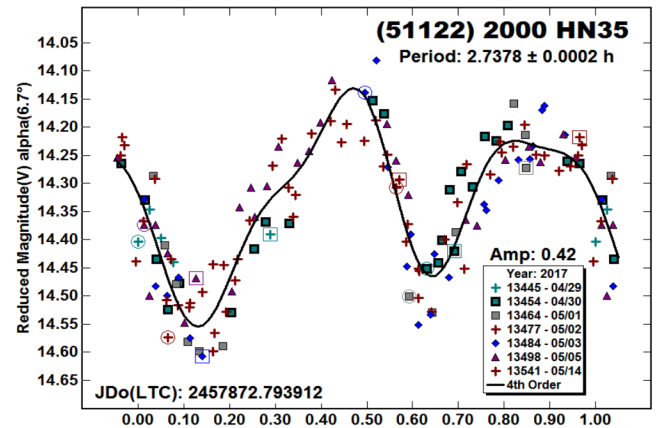
(27000) 1998 BO44. This appears to be the first reported period for this outer main-belt asteroid. The first night's observations were the result of the asteroid being in the same field as a planned target. The subsequent nights were follow-up after work on the planned target was finished.



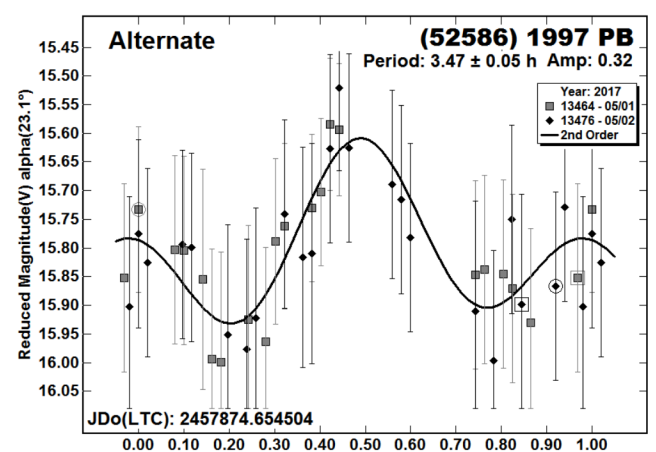
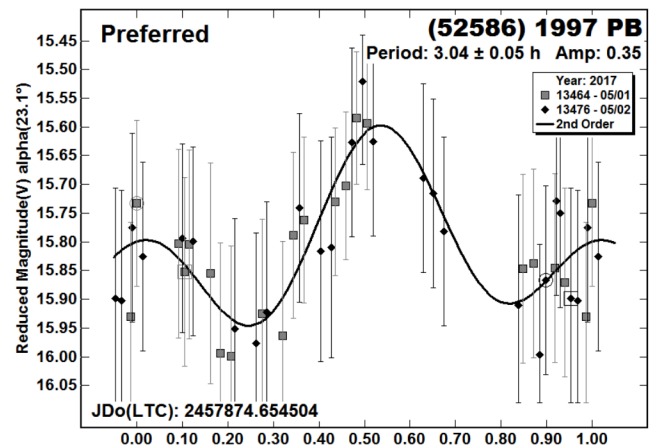
(27097) 1998 UM26. Polishook et al. (2012) using data from four nights obtained by the Palomar Transient Factory reported a period of $P > 8.7$ h and amplitude of $A > 0.07$ mag. The CS3-PDS data from 2017 led to $P = 6.651$ h and $A = 0.42$ mag. This result is considered sufficiently secure to supplant the earlier result.



(51122) 2000 HN35. The error bars were very large for these observations (low SNR) and so are not shown in the lightcurve. Despite the larger errors, the result is considered reasonably secure because of the amplitude.



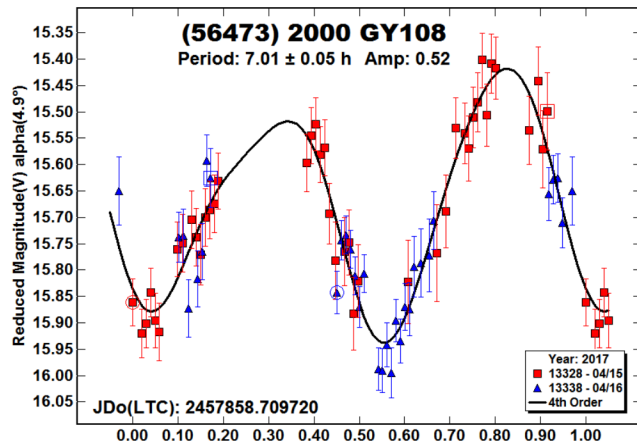
(52586) 1997 PB. This Flora group member was a target of opportunity on two nights. The data set was sparse and noisy, leading to several possible solutions, two of which are shown below. The two periods differ by one rotation over a 24-hour period. There were no other periods given in the LCDB.



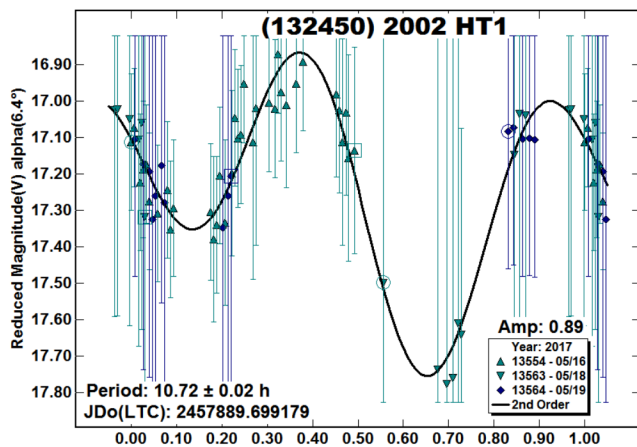
(56473) 2000 GY108. This is also a Flora group member that was a target of opportunity on two nights and had no previously-reported periods in the LCDB. Since each night covered most of the assumed lightcurve, and given the amplitude, the result is considered secure but not definitive.

Number	Name	2017 mm/dd	Pts	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.	Group
596	Scheila	06/01–06/13	922	0.9, 6.6	249	0	15.793	0.005	0.06	0.01	MB-O
1656	Suomi	05/28–05/30	317	19.9, 20.0	247	34	2.587	0.001	0.11	0.01	H
3022	Dobermann	06/20–06/26	211	19.1, 19.8	261	33	10.329	0.001	0.77	0.02	H
3266	Bernardus	05/11–05/13	317	20.4, 20.6	221	34	10.74	0.02	0.5	0.03	H
4490	Bamberg	05/12–05/14	246	21.5, 21.8	214	36	5.82	0.002	1.08	0.02	H
6493	Cathybennett	06/15–06/18	218	24.2, 24.7	232	32	3.475	0.001	0.2	0.02	H
6674	Cezanne	05/11–05/14	75	23.6, 23.8	160	4	3.37	0.01	0.3	0.03	NYSA
16562	1992 AV1	06/14–06/19	161	22.2, 23.2	233	26	3.219	0.001	0.2	0.02	H
17014	1999 CY96	05/01–05/02	43	18.6, 18.7	157	4	3.92	0.05	0.66	0.05	MB-O
27000	1998 BO44	05/05–05/16	217	5.4, 4.7, 4.8	232	13	11.034	0.003	0.34	0.03	MB-O
27097	1998 UM26	05/14–05/19	85	24.6, 24.9	161	4	6.651	0.004	0.42	0.03	BAP
51122	2000 HN35	04/29–05/14	140	6.7, 4.9	232	13	2.7378	0.0002	0.42	0.04	MB-O
52586	1997 PB	05/01–05/02	43	23.1, 23.3	159	4	3.04	0.05	0.38	0.03	FLOR
56473	2000 GY108	04/16–04/16	73	4.6, 4.6	210	6	7.01	0.05	0.52	0.03	FLOR
132450	2002 HT1	05/16–05/19	65	6.4, 6.6	236	11	10.7	0.1	0.89	0.05	MB-I
247259	2001 RT98	05/03–05/05	68	11.2, 10.8	241	20	6.69	0.01	0.75	0.05	MB-O

Table II. Observing circumstances and results. The phase angle (α) is given at the start and end of each date range. If three values are given, the middle one is the minimum phase angle during the range of observations. L_{PAB} and B_{PAB} are, respectively, the average phase angle bisector longitude and latitude (see Harris *et al.*, 1984). The Group column gives the orbital group to which the asteroid belongs. The definitions and values are those used in the LCDB (Warner *et al.*, 2009a). BAP = Baptistina; FLOR = Flora; H = Hungaria; MB-I/O = main-belt inner/outer.

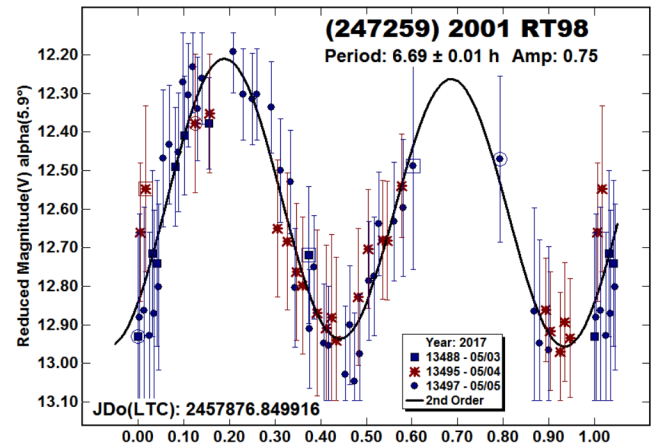


(132450) 2002 HT1. The period spectrum for this 1.4 km inner main-belt asteroid shows several secondary solutions and one primary. However, this is likely a “fit by exclusion,” which is where the Fourier analysis finds a minimum RMS by minimizing the number of overlapping data points.



(247259) 2001 RT98. The estimated size of this outer main-belt asteroid is 5.6 km. The period spectrum favored two solutions, a monomodal and bimodal lightcurve. The latter, with a period of

6.69 h, is adopted here. Given the amplitude and low phase angle, this seems a reasonable assumption (Harris *et al.*, 2014).



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ROTATION PERIOD DETERMINATIONS FOR 46 HESTIA, 118 PEITHO, 333 BADENIA, 356 LIGURIA, AND 431 NEPHELE

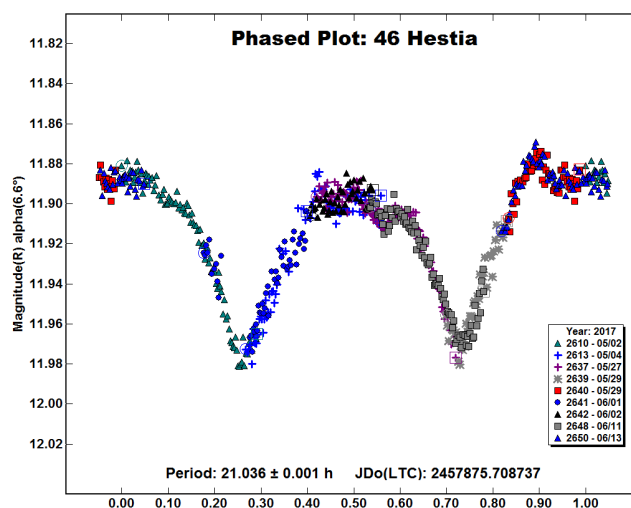
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(Received: 2017 June 13)

Synodic rotation periods and amplitudes are found for
46 Hestia: 21.036 ± 0.001 h, 0.09 ± 0.01 mag; 118
Peitho: 7.805 ± 0.001 h, 0.14 ± 0.01 mag; 333 Badenia:
 9.862 ± 0.001 h, 0.24 ± 0.01 mag; 356 Liguria: $31.701 \pm$
 0.001 h or 63.395 ± 0.002 h, 0.14 ± 0.01 mag; 431
Nephele: 13.530 ± 0.001 h, 0.13 ± 0.01 mag.

Observations to obtain the data used in this paper were made at the Organ Mesa Observatory with a 0.35-meter Meade LX200 GPS Schmidt-Cassegrain (SCT) and SBIG STL-1001E CCD. Exposures were 60 seconds, unguided, with a clear filter. Photometric measurement and lightcurve construction is with *MPO Canopus* software. To reduce the number of points on the lightcurves and make them easier to read, data points have been binned in sets of 3 with a maximum time difference of 5 minutes.

46 Hestia. Previously published rotation periods are by Scaltriti et al. (1981), 21.04 hours at celestial longitude 57 degrees; and by Pilcher (2012), 21.040 hours at celestial longitude 160 degrees. The lightcurves look almost identical with one deep minimum and one shallow minimum and amplitude 0.13 magnitudes.



New observations were obtained on eight nights from 2017 May 2 to June 13 near celestial longitude 235 degrees. They provide a good fit to a lightcurve with an almost identical period 21.036 ± 0.001 h, but with smaller amplitude 0.09 ± 0.01 mag and two minima of nearly the same depth.

118 Peitho. The Asteroid Lightcurve Data Base (Warner et al., 2009) lists five independent published periods all between 7.78 hours and 7.823 hours, with the best value considered as 7.8055 hours.