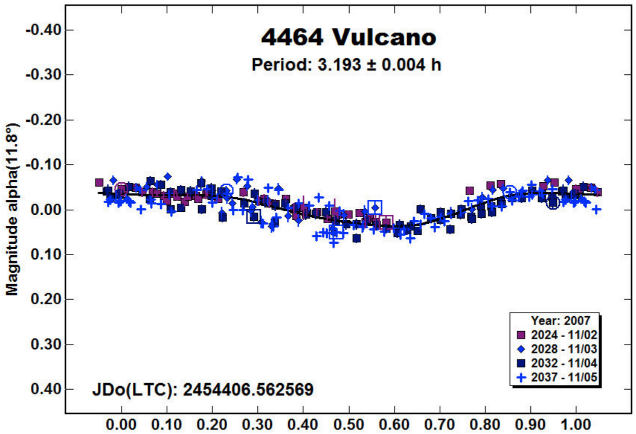

Figure 2. Lightcurve of 4464 Vulcano, 2007 data set forced to monomodal solution.

Acknowledgements

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MINOR PLANET LIGHTCURVE ANALYSIS AT BASSANO BRESCIANO OBSERVATORY 2010 OCTOBER - 2011 MARCH

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Lightcurves for eight minor planets were obtained at Bassano Bresciano Observatory from 2010 October to 2011 March: 283 Emma, 334 Chicago, 933 Susi, 948 Jucunda, 1080 Orchis, 1318 Nerina, 1342 Brabantia, and 4452 Ullacharles.

Photometric measurements of eight minor planets were made using the Schmidt 0.32-m f/3.1 telescope at Bassano Bresciano Observatory (565). The images were taken with Starlight CCD camera HX-516 located at prime focus. 120 sec exposure times and 2x2 binning were used for all images as was a Johnson V filter until 2010 December. Afterward, the filter was removed in order to increase the S/N ratio. All exposures were unguided. *Polypus* software (Bassano Bresciano Observatory, 2010) was used to control the telescope and camera, allowing us to work without an operator on more than one minor planet for up to 7 hours each night. Flat field and dark frame calibration images were captured each night. All exposures were taken when the target's altitude was more than 30°.

All images were corrected with dark and flat field. *MPO Canopus* (BDW Publishing, 2010) was used to perform differential photometry on the reduced images. Period analysis was also done with *MPO Canopus*, which incorporates the Fourier analysis algorithm developed by Harris (Harris *et al.*, 1989). Comparison stars were selected with a colour index as near as possible to V-R = 0.45 in order to minimize colour error from different sessions. All periods were found as the solution with lowest RMS error. Sessions were linked to a common zero point by adjusting the DeltaComp value in *MPO Canopus.* The values were adjusted such that the final period solution had the the lowest RMS error.

<u>283 Emma.</u> The Asteroid Lightcurve Database (Warner *et al.*, 2009) reports a period of 6.888 h and amplitude 0.11-0.57 mag with quality code 3. We observed the asteroid for 5 nights covering 18 days span. All measurements had a good S/N ratio. The longest session shows almost all of a bimodal rotation. The period corresponding to a bimodal lightcurve is P = 6.896 ± 0.001 h and amplitude A = 0.22 ± 0.02 mag.

<u>334 Chicago.</u> Warner *et al*. (2009) give a period 7.371 h and amplitude 0.15-0.67 mag with quality code 3. We observed for 4 nights covering a 17 day span. All measurements had a good S/N ratio. At least one maximum and one minimum were captured in all sessions. Our analysis for a bimodal lightcurve gives P = 7.359 ± 0.001 h and amplitude A = 0.35 ± 0.02 mag.

<u>933 Susi.</u> We selected this asteroid from a list in the *Minor Planet Bulletin* (Warner *et al.*, 2011) that gave a period 2.08 h and amplitude 0.08 mag with quality code 1. We observed for 3 nights covering a 2 day span. All sessions showed more than one complete rotation and a clear bimodal shape. Our analysis gives P = 4.623 ± 0.003 h and amplitude A = 0.32 ± 0.02 mag.

948 Jucunda. Selected from the *Minor Planet Bulletin* lists (Warner *et al.*, 2011), no previous period was reported for this asteroid. The initial observations showed only a slow change over an entire night and so many nights were needed in order to catch the complete lightcurve. Our observations included 8 nights over a 19 day span. Due to little overlapping of individual sessions, the DeltaComp (nightly zero point) was adjusted by inspection. The result of our analysis was a bimodal lightcurve with $P = 28.64 \pm 0.012$ h and amplitude $A = 0.35 \pm 0.03$ mag.

1080 Orchis. Warner *et al.* (2010) gave no previous period in their regular lightcurve opportunities article in the *Minor Planet Bulletin*. Observations covered a 20 day span with 5 nights. The period spectrum in *MPO Canopus* favored solutions that were simple ratios of an Earth day. A careful analysis of slopes from minimum to maximum determined that the most probable solution was near 2/3 day. Our final analysis found $P = 16.06 \pm 0.004$ h and amplitude $A = 0.35 \pm 0.03$ mag.

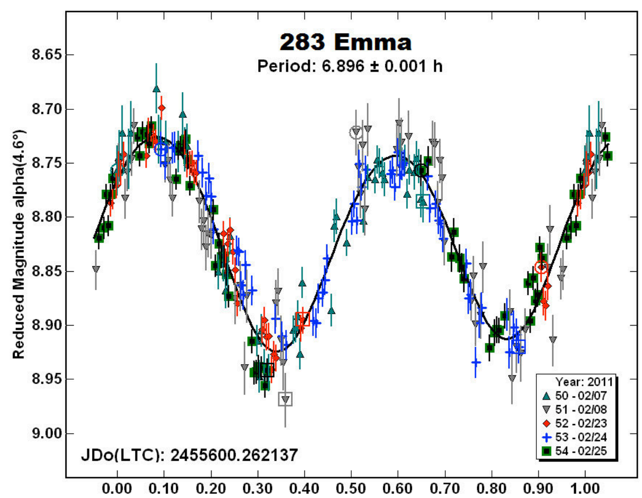
1318 Nerina. Warner *et al.* (2009) report a period of 2.53 h and amplitude 0.16 mag with quality code 2. Our observations covered a 2 day span with 3 nights. The high S/N ratio made it possible to evaluate the low amplitude lightcurve of this asteroid. All sessions show more than one complete rotation. We found $P = 2.528 \pm 0.003$ h and amplitude $A = 0.08 \pm 0.02$ mag.

1342 Brabantia. No previous period was reported in the lists in the *Minor Planet Bulletin* (Warner *et al.*, 2011). Our observations covered a 13 day span with 4 nights. All sessions showed at least one maximum and one minimum and a clear bimodal shape. Our analysis gives $P = 8.345 \pm 0.002$ h and amplitude $A = 0.20 \pm 0.02$ mag.

4452 Ullacharles. A period of 9.36 hours and amplitude 0.43 with quality code 2 are given in the Lightcurve Database (Warner *et al.*, 2009). We found a period of $P = 9.138 \pm 0.011$ h and amplitude $A = 0.42 \pm 0.04$ mag.

Asteroid	Date	Phase Angle	Time h.	Num. Obs	Filter
283 Emma	2011-02-07	4.6	4.5	50	C
283 Emma	2011-02-08	5.0	6.0	56	C
283 Emma	2011-02-23	9.7	3.5	38	C
283 Emma	2011-02-24	10.0	5.3	56	C
283 Emma	2011-02-25	10.3	4.5	52	C
334 Chicago	2011-02-08	3.0	4.7	56	C
334 Chicago	2011-02-23	7.1	3.8	40	C
334 Chicago	2011-02-24	7.3	5.3	51	C
334 Chicago	2011-02-25	7.6	4.5	46	C
933 Susi	2011-03-22	3.6	6.3	44	C
933 Susi	2011-03-23	3.8	5.3	53	C
933 Susi	2011-03-24	4.0	5.2	57	C
948 Jucunda	2011-03-06	3.5	4.2	44	C
948 Jucunda	2011-03-07	2.6	5.8	49	C
948 Jucunda	2011-03-08	2.1	6.2	56	C
948 Jucunda	2011-03-09	1.7	6.2	45	C
948 Jucunda	2011-03-22	4.5	4.8	29	C
948 Jucunda	2011-03-23	4.9	5.3	38	C
948 Jucunda	2011-03-24	5.3	4.0	25	C
948 Jucunda	2011-03-25	5.8	5.3	33	C
1080 Orchis	2010-10-09	6.1	5.3	79	V
1080 Orchis	2010-10-14	3.4	6.3	128	V
1080 Orchis	2010-10-27	6.2	4.5	66	V
1080 Orchis	2010-10-28	6.9	5.7	119	V
1080 Orchis	2010-10-29	7.5	3.0	64	V
1318 Nerina	2011-03-06	5.4	4.3	60	C
1318 Nerina	2011-03-07	4.9	4.7	35	C
1318 Nerina	2011-03-08	4.5	6.5	47	C
1342 Brabantia	2011-01-24	8.2	2.5	32	C
1342 Brabantia	2011-02-04	13.7	5.3	45	C
1342 Brabantia	2011-02-05	14.2	6.5	63	C
1342 Brabantia	2011-02-06	14.7	6.0	39	C
4452 Ullacharles	2011-01-24	6.8	3.0	36	C
4452 Ullacharles	2011-02-04	11.3	7.0	60	C
4452 Ullacharles	2011-02-05	11.7	6.7	28	C

Table I. Observing circumstances for eight asteroids.



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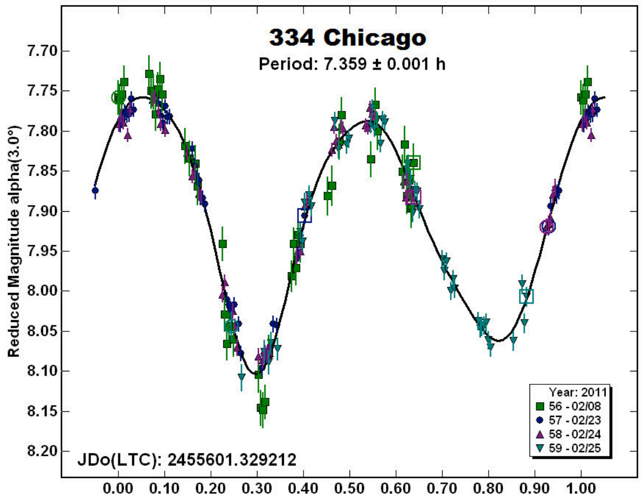
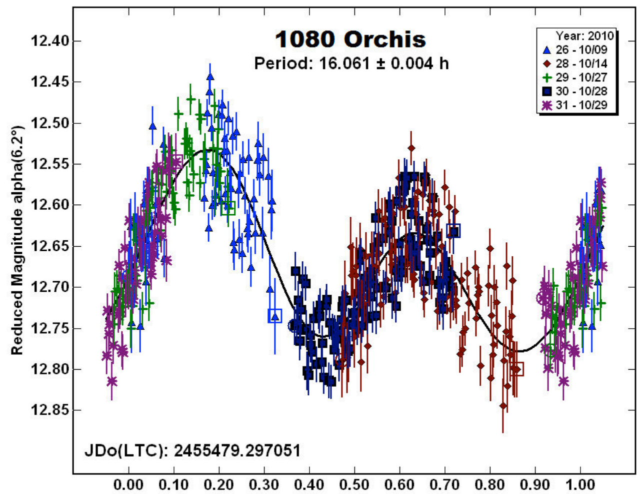
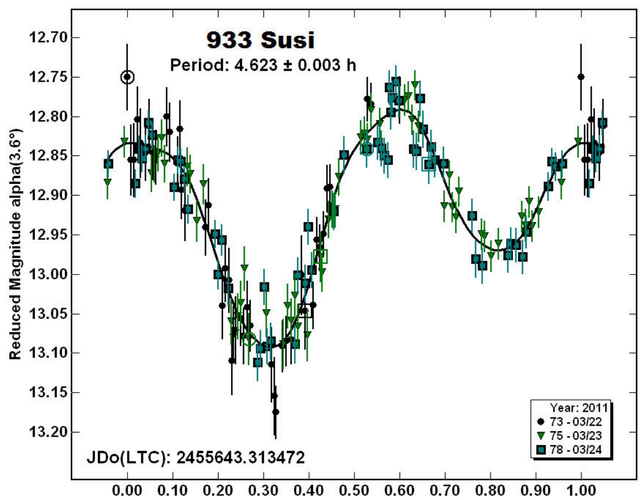
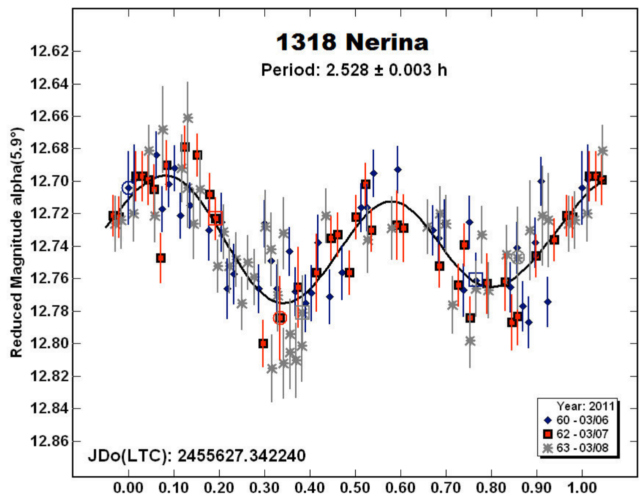
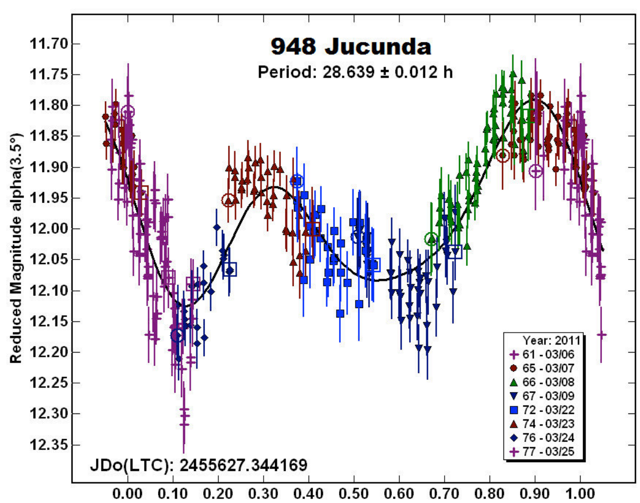
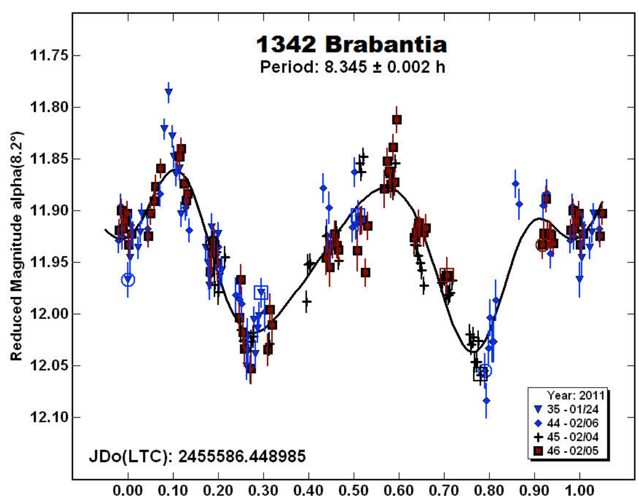

334 Chicago
Period: 7.359 ± 0.001 h
Reduced Magnitude alpha(3.0°)
Year: 2011
56 - 02/08
57 - 02/23
58 - 02/24
59 - 02/25
JDo(LTC): 2455601.329212

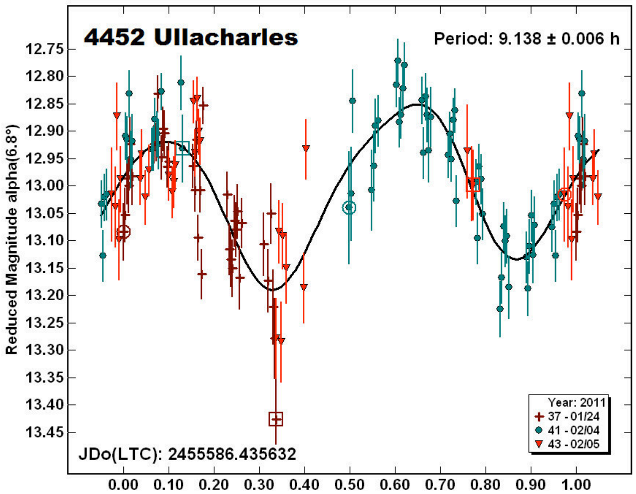

1080 Orchis
Period: 16.061 ± 0.004 h
Reduced Magnitude alpha(6.2°)
Year: 2010
26 - 10/09
28 - 10/14
29 - 10/27
30 - 10/28
31 - 10/29
JDo(LTC): 2455479.297051


933 Susi
Period: 4.623 ± 0.003 h
Reduced Magnitude alpha(3.6°)
Year: 2011
73 - 03/22
75 - 03/23
78 - 03/24
JDo(LTC): 2455643.313472


1318 Nerina
Period: 2.528 ± 0.003 h
Reduced Magnitude alpha(5.9°)
Year: 2011
60 - 03/06
62 - 03/07
63 - 03/08
JDo(LTC): 2455627.342240


948 Jucunda
Period: 28.639 ± 0.012 h
Reduced Magnitude alpha(3.5°)
Year: 2011
61 - 03/06
65 - 03/07
66 - 03/08
67 - 03/09
72 - 03/22
74 - 03/23
76 - 03/24
77 - 03/25
JDo(LTC): 2455627.344169


1342 Brabantia
Period: 8.345 ± 0.002 h
Reduced Magnitude alpha(8.2°)
Year: 2011
35 - 01/24
44 - 02/06
45 - 02/04
46 - 02/05
JDo(LTC): 2455586.448985



SAVE THE LIGHTCURVES!

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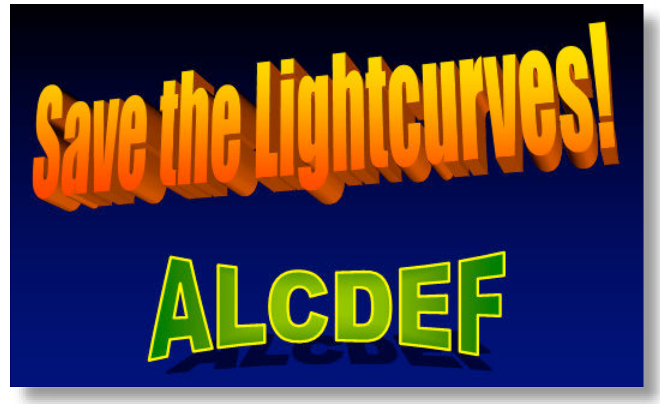
The lack of a central repository for asteroid time-series (lightcurve) photometry has put large amounts of data at risk of being forever lost as computers crash and the original researchers pass on. These data are vital to critical current work on theories regarding the origin and evolution of the asteroid population as a whole and of specific families/groups or types of asteroids. A first step toward creating such a repository is defining a minimum set of data and format for submitting current and future observations. The Asteroid Lightcurve Data Exchange Format (ALCDEF) has been proposed by the authors for this first step. In a recent development, the Minor Planet Center, long the recognized central repository for asteroid astrometry data, has agreed to host a site where researchers can upload and download asteroid photometry using the ALCDEF standard. We outline other steps that have been taken to have the ALCDEF standard generally accepted as well as describe a new gateway web site that leads to the ALCDEF pages as well as the Collaborative Asteroid Lightcurve Link (CALL) site commonly used by many asteroid photometrists.



For many years, the asteroid photometry community has sought what the astrometry community has long-enjoyed: a central repository for observations to which all researchers can have access to data vital for any number of topics. These include studies on rotational statistics, defining the role and limits of thermal effects such as Yarkovsky and YORP (Yakovsky-O'Keef-Radzievskii-Paddack) on orbital migration, binary asteroid formation, and spin axis alignments, to name just a few. Unfortunately, the vast majority of legacy asteroid photometry can be found only in "dusty filing cabinets" (paper or the computer equivalent), where it remains unavailable to most researchers and is at risk of being lost forever when the original observer passes on, a computer crashes, or some other disaster strikes. Handling the problems of legacy data is just one of the issues to be addressed. More important, however, we believed it was time to do something that would prevent unabated growth of legacy data. Toward this end, we proposed a new standard format for asteroid photometry data (Stephens *et al.*, 2010) at the Division of Planetary Sciences meeting in Pasadena, CA. The proposal was well-received and minor revisions to the standard were made as a result of conversations at that meeting. Instead of providing a lengthy description of the format here, we suggest that you download the most recent PDF document defining the standard from

http://www.minorplanet.info/alcdef.html

In brief, the format calls for simple text files that, for each individual lightcurve (usually meaning the data from a single night for a single object) there are two "blocks" of information. One ("metadata") gives observation details such as the object observed, a mid-date/time for the data, phase angle, filter used, type of data (differential or absolute values), and so on. The second ("data") gives the actual data, which consists of a minimum of the Julian Date and a magnitude. The estimated error and air mass are optional. A single file can contain any number of lightcurves for any number of objects, though usually a file will have data for only one object.

While the standard does allow corrected data to be submitted, it's important to note that the database is intended to store "raw" data. For example, the Julian Dates for the observations should be the actual date of observation and not forced to coincide with a JD that is an offset from a fixed value based an assumed rotation period. In this "light", the data should not include any corrections such as for light-time travel or to unity distances using –5log(RΔ). If any corrections are applied, they should be of such a nature that the uncorrected data can be easily reconstructed and the correction value that was used given in the metadata block(s). The point is to allow the researcher to do his own analysis with as pure of data as possible.