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NEW PERIOD DETERMINATION FOR 27 EUTERPE, A COLLABORATIVE PROJECT

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27 Euterpe has a previously published period of 8.5 hours. Because additional data indicated that this period could be incorrect, a collaborative effort was undertaken to remeasure the period. A revised rotational period of 10.410 ± .002 hours was determined from 12 nights of observations.

In mid July, Alan Harris of JPL posted a request to Brian Warner's CALL Web Page requesting measurement of 27 Euterpe. A published report by Chang in 1962 previously put the period at 8.5 hours. Lagerkvist et al, in 1988 could not determine a period. However, unpublished reports indicated that the period might be around 11 hours.

Four observatories specializing in asteroid photometry run by Brian Warner, Bob Stephens, Bob Koff and Stephen Brincat started a collaborative effort in July to measure the asteroid's rotational period. Warner was not able to get any observations due to equipment problems. Glenn Malcolm later contributed some observations to the effort. All of the images that were successfully obtained were flat fielded and dark subtracted. All of the images were taken in unfiltered light, through cameras of varying spectral responses. Data reduction and the resulting lightcurves were prepared using Brian Warner's Canopus program, portions of which were developed from Alan Harris' Fourier analysis program (Harris et al, 1989). The unfiltered images had to be calibrated against each other before being combined for analysis. This is accomplished by Canopus, which first measures the camera's response against a field of well-known reference stars, typically LONEOS Stars. This calibration is then applied against the data set obtained that night. Since these are still reported as instrumental magnitudes, only sessions containing a minimum or a maximum of the lightcurve were used. These provided a calibration point for adjusting the instrumental magnitudes reported by the various systems.

Early efforts to determine the period produced ambiguous results. Initially, it appeared that the 8.5 hour period was correct. However, that result did not hold up to subsequent observations. Midway through the observing runs, Warner analyzed the sessions and was

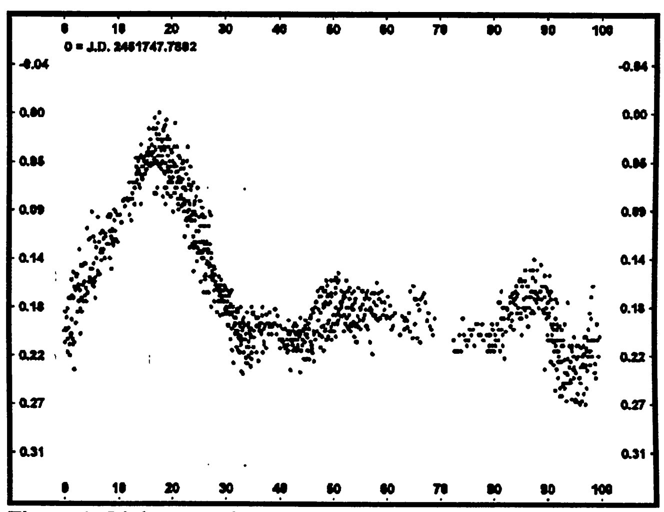

Figure 1. Lightcurve (instrumental magnitudes, unfiltered) for 27 Euterpe compiled using a period of 10.41 ± 0.002 hours.

Table 1 - Observers participating in 27 Euterpe rotational project

	R. Stephens	G. Malcolm	R. Koff	S. Brincat
Obser-vatory	Santana Observatory (MPC 646)	Roach Motel Observatory (MPC 856)	Thornton Observatory (MPC 713)	Flarestar Observatory (MPC 171)
Tele-scope	27cm (11") SCT	30cm (12") SCT	20cm (8") SCT	25 cm (10") SCT
F/ratio	F/7	F/6.3	F/10	F/2.6
CCD	SBIG ST9e	SBIG ST8	Cookbook Camera with Texas Instr 245	Starlight Express HX516
Filter	Unfiltered	Unfiltered	Unfiltered	Unfiltered
Exp.	30 seconds	60 seconds	120 seconds	60 seconds
# Obs	846	233	100	26
Nights	11	4	3	1

the first to identify the possible 10.4 hour period. Subsequent analysis of additional Stephens and Malcolm data showed that these data were consistent with the 10.41 hour period. Because of the somewhat unusual nature of the lightcurve, Stephens then explored every period between 5 hours and 18 hours in 0.01 hour increments. The Fourier analysis in Canopus identified a few possible periods for the data. All of these were quickly eliminated as candidates except for the 10.41 hour period. Adding the Koff and Brincat data further gave a good fit to the 10.41 hour period.

Asteroid 27 Euterpe has an interesting lightcurve with a single strong peak that was confirmed by multiple nights of observations. As shown in Figure 1, it also has a very weak secondary peak. That portion of the curve was also confirmed by four different sets of data. The resulting period is 10.410 ± .002 hours with an amplitude of 0.29 magnitudes, a result that comes from 1,205 observations from 19 different sessions on 12 nights spanning a period of 18 days.

Acknowledgements

The co-authors are grateful to Brian Warner for his continuing help and guidance, and for his continuing development of the software programs 'Connections 2000' and 'Canopus' which makes it possible for amateurs to automatically gather the data, measure and analyze the light the lightcurves. Also, many thanks to Alan Harris who suggested the 27 Euterpe project.

References

Chang, Y.C., Chang, C.-s.: 1962, Acta Astron. Sin. 10, 101-111.

Lagerkvist, C.I., Magnusson, P., Williams, I.P., Buontempo, M.E., Gibbs, P., Morrison, L.V.: Astron. Astrophys. Suppl. Ser. 73, 395-405.

Collaborative Asteroid Lightcurve Link (CALL) - http://www.minorplanetobserver. com/astlc/default.htm

ASTEROID-DEEPSKY APPULSES IN 2001

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A list of favorable appulses between asteroids and brighter deepsky objects during the year 2001 is presented.

The following list is a subset of the results of a search for asteroid-deepsky appulses meeting the following criteria:

1. The asteroid was brighter than 14.0.
2. The separation between the two was less than 360 arcseconds.
3. The phase of the moon was between mid-waning gibbous to mid-waxing gibbous
4. The event was at least 45° from the Sun.

The list below is not comprehensive by any means. However, it's a good first check. For a more complete check, the Minor Planet Center's web site at

http://cfaps8.harvard.edu/~cgi/CheckSN.COM

allows you to enter the location of a suspected asteroid or supernova and check if there are any known targets in the area.

The complete set from which the table below is a small subset can be found at the MPO web site:

http://www.MinorPlanetObserver.com/htms/dso.htm

The table gives the following data:

Date/Time	Universal Date and Time of closest approach
#/Asteroid	The number and name of the asteroid
RA/Dec	The J2000 position of the asteroid
Mag	The approximate visual magnitude of the asteroid
Sep/PA	The separation in arcseconds and the position angle from the DSO to the asteroid
DSO	The DSO name or catalog designation
Mag	The approximate total magnitude of the DSO
Type	The type of DSO: OC = Open Cluster; GC = Globular Cluster; G = Galaxy
SE/ME	The elongation in degrees from the sun and moon respectively
MP	The phase of the moon: 0 = New, 1.0 = Full. Positive = waxing; Negative = waning

Date	UT	#	Name	RA	Dec	AM	Sep	PA	DSO	Type	DM	SE	ME	MP
01 03	13:40	213	Lilaea	22 30.98	-13 59.2	14.0	51	338	NGC 7300	G	12.9	51	46	0.563
01 05	03:12	505	Cava	7 59.21	+26 58.5	11.2	260	220	NGC 2492	G	12.7	167	76	0.721
01 19	11:38	372	Palma	2 12.07	+44 31.2	11.5	186	214	NGC 846	G	12.1	105	143	-0.215
01 19	23:27	675	Ludmilla	23 01.86	+ 2 13.2	13.0	177	162	NGC 7460	G	13.0	48	97	-0.177
01 22	08:24	487	Venetia	12 29.82	+ 7 48.6	13.0	134	129	NGC 4470	G	12.1	118	95	-0.041
01 26	14:25	21	Lutetia	1 14.37	+ 5 57.1	12.2	73	335	NGC 437	G	12.8	73	51	0.038
01 26	19:07	533	Sara	9 26.53	+ 7 57.2	14.0	80	22	NGC 2882	G	12.6	164	166	0.045
01 29	01:35	597	Bandusia	9 39.08	+33 59.4	13.8	37	206	NGC 2942	G	12.6	160	136	0.175
02 12	17:51	372	Palma	2 52.75	+42 09.7	11.8	140	197	NGC 1122	G	12.1	90	139	-0.742
02 12	21:53	133	Cyrene	17 28.50	-29 28.6	13.4	27	7	Tr 26	OC	9.5	61	57	-0.725
02 15	21:41	1021	Flammario	12 04.33	+18 28.6	13.6	148	51	NGC 4064	G	11.4	149	73	-0.422
02 23	05:55	1388	Aphrodite	12 22.08	+12 44.4	13.9	43	211	NGC 4305	G	12.6	151	152	0.001
02 23	09:41	1388	Aphrodite	12 21.99	+12 45.2	13.8	198	211	NGC 4306	G	12.6	152	154	0.001
02 23	15:54	250	Bettina	17 40.22	-32 07.5	14.0	341	18	M6	OC	4.2	70	72	0.002
02 24	00:48	372	Palma	3 15.18	+41 21.0	11.9	63	193	NGC 1250	G	12.8	83	78	0.006
02 25	12:58	186	Celuta	10 44.34	+22 25.3	12.7	204	11	NGC 3352	G	12.6	166	152	0.046
02 26	17:23	604	Tekmessa	9 03.90	+21 57.6	13.9	24	187	NGC 2738	G	13.0	153	116	0.107
02 27	16:51	250	Bettina	17 44.37	-32 22.4	14.0	86	199	NGC 6416	OC	5.7	73	120	0.174
03 04	21:57	144	Vibilia	20 06.17	-22 00.7	13.2	348	170	M75	GC	8.6	45	159	0.700
03 15	15:59	1145	Robelmonte	11 58.18	- 2 06.8	13.8	110	191	NGC 4006	G	12.6	174	71	-0.616
03 19	21:03	110	Lydia	12 19.85	+ 6 00.2	11.8	118	200	NGC 4269	G	12.9	172	120	-0.228
03 20	15:03	6	Hebe	12 51.80	+12 01.3	9.9	286	219	NGC 4746	G	12.6	162	123	-0.172
04 14	07:34	238	Hypatia	11 20.26	+ 2 57.4	13.1	53	226	NGC 3630	G	11.9	145	110	-0.625
04 25	23:04	13	Egeria	12 23.35	+11 21.5	10.5	102	152	NGC 4330	G	12.4	143	116	0.062
04 26	05:51	145	Adeona	12 26.09	+16 14.1	12.0	209	332	NGC 4405	G	12.0	140	111	0.078
04 26	11:07	6	Hebe	12 22.91	+15 44.7	10.3	330	194	M100	G	9.4	140	107	0.091
04 28	12:52	356	Liguria	22 32.51	-14 11.1	14.0	267	157	NGC 7302	G	12.3	64	125	0.262
04 29	16:56	790	Pretoria	13 08.93	-28 42.3	12.9	293	231	NGC 4980	G	12.6	157	92	0.385
04 30	07:30	532	Herculina	14 28.30	+13 46.9	9.0	6	178	IC 1014	G	12.5	151	85	0.454
05 02	16:42	790	Pretoria	13 07.11	-28 15.1	13.0	197	233	NGC 4965	G	12.1	155	53	0.721
05 22	02:08	760	Massinga	13 37.05	-29 52.7	12.0	58	224	M83	G	7.5	147	154	-0.013
05 25	08:55	36	Atalante	0 28.13	- 1 52.2	13.3	226	148	NGC 124	G	13.0	59	88	0.065
05 27	09:19	13	Egeria	12 14.20	+ 7 12.9	11.2	273	79	NGC 4191	G	12.8	114	58	0.223
05 28	20:57	1667	Pels	18 02.18	-22 58.4	13.9	236	333	M20	CNB	6.3	157	127	0.380
06 15	06:08	145	Adeona	12 28.49	+ 9 29.4	13.0	222	51	NGC 4445	G	12.8	98	173	-0.392
06 16	20:34	929	Algunde	18 18.39	-18 26.1	14.0	66	191	NGC 6603	OC	11.1	170	113	-0.243
06 20	04:29	345	Tercidina	18 39.77	- 8 31.8	12.1	168	190	Tr 34	OC	8.6	162	149	-0.022
06 23	01:31	5559	1990 MV	17 53.01	-22 22.7	13.7	135	136	NGC 6469	OC	8.2	177	155	0.035
06 24	11:59	247	Eukrate	1 04.87	+ 2 05.7	12.9	99	142	IC 1613	G	9.2	77	119	0.124
06 28	17:21	1241	Dysona	16 59.10	-52 43.0	13.9	3	238	NGC 6253	OC	10.2	146	71	0.566
07 19	05:49	507	Laodica	22 52.29	+ 1 02.2	14.0	298	220	NGC 7396	G	12.9	131	110	-0.035
07 20	14:33	487	Venetia	12 23.70	+ 7 34.0	13.9	349	30	NGC 4334	G	13.0	65	68	-0.000
07 20	17:24	36	Atalante	1 52.75	+12 34.7	12.6	208	320	NGC 716	G	12.9	87	86	0.000
07 23	08:35	3103	Eger	23 01.69	+ 2 13.3	13.4	192	212	NGC 7460	G	13.0	133	163	0.096
07 25	17:15	1	Ceres	18 55.16	-30 32.1	7.7	192	164	M54	GC	7.7	158	92	0.314
07 26	21:26	234	Barbara	22 55.59	- 5 30.6	11.1	103	251	NGC 7416	G	12.4	141	135	0.443
08 19	03:14	89	Julia	2 33.92	+34 31.9	10.6	177	305	NGC 968	G	12.2	99	98	0.001
08 21	06:44	75	Eurydike	14 45.10	-20 51.9	13.8	4	19	NGC 5734	G	12.7	77	47	0.072
08 21	07:23	75	Eurydike	14 45.14	-20 52.1	13.8	121	15	NGC 5743	G	13.0	77	47	0.074
08 26	03:53	3	Juno	7 13.22	+12 17.1	9.8	126	10	NGC 2350	G	12.3	46	139	0.536
08 28	08:25	36	Atalante	2 34.73	+23 25.7	11.9	31	117	NGC 984	G	12.8	111	129	0.744
09 08	23:43	127	Johanna	7 59.42	+27 04.0	13.7	118	8	NGC 2492	G	12.7	50	63	-0.684
09 11	06:28	1467	Mashona	1 15.01	+33 21.4	13.7	116	220	NGC 443	G	13.0	133	58	-0.448
09 13	01:15	410	Chloris	17 59.86	-28 14.7	12.3	227	190	Tr 31	OC	9.8	100	161	-0.258
09 16	12:00	22	Kalliope	5 34.47	+22 01.4	11.5	85	343	M1	PN	8.4	90	76	-0.014
09 16	18:18	566	Stereoskopia	5 34.52	+21 57.0	13.9	181	174	M1	PN	8.4	90	80	-0.008
09 17	07:04	504	Cora	22 11.20	-30 33.6	12.4	222	336	NGC 7221	G	12.1	145	149	0.002
09 18	01:25	449	Hamburga	1 40.35	+ 5 39.2	13.6	318	154	NGC 645	G	12.6	150	159	0.008
09 20	11:42	783	Nora	2 54.03	+ 2 56.8	14.0	25	114	NGC 1137	G	12.4	134	171	0.130
09 22	04:07	89	Julia	2 50.73	+41 41.2	10.1	91	85	NGC 1106	G	12.3	123	152	0.278
09 22	10:19	675	Ludmilla	7 22.39	+21 58.4	12.7	351	197	NGC 2365	G	12.4	70	137	0.303
09 25	10:00	1310	Villigera	1 49.89	+27 35.5	13.6	291	242	NGC 684	G	12.4	144	111	0.601
10 11	02:26	4558	Janesick	22 06.25	+47 14.6	13.3	40	242	UGC 11909	G	12.3	125	105	-0.396
10 12	11:27	570	Kythera	1 53.00	+12 28.5	13.1	225	157	NGC 716	G	12.9	169	109	-0.248
10 23	01:16	80	Sappho	8 45.39	+ 9 39.8	12.8	16	207	NGC 2657	G	13.0	79	155	0.397
10 25	12:52	4324	1981 YA1	1 50.28	+27 09.8	14.0	344	153	Cr 21	OC	8.2	165	79	0.633
10 26	09:28	28	Bellona	9 34.81	+10 21.8	12.1	359	15	NGC 2919	G	12.9	70	170	0.709
11 12	19:11	483	Seppina	5 35.91	- 0 58.1	13.9	143	325	Cr 70	OC	0.4	140	114	-0.080
11 14	02:17	504	Cora	22 32.45	-25 27.7	13.5	347	142	NGC 7294	G	12.5	98	114	-0.018
11 16	14:33	247	Eukrate	0 22.43	+29 46.9	11.1	177	9	NGC 97	G	12.3	137	122	0.022
11 17	02:49	92	Undina	10 48.97	+14 18.8	13.0	352	10	NGC 3391	G	12.9	77	100	0.040
11 22	04:54	247	Eukrate	0 19.55	+29 52.5	11.2	211	192	NGC 76	G	13.0	132	61	0.428
12 07	06:11	388	Charybdis	2 34.76	+23 24.2	13.3	121	155	NGC 984	G	12.8	148	113	-0.564
12 16	12:11	22	Kalliope	5 24.13	+29 37.3	9.9	80	19	Berk 19	OC	11.4	173	158	0.029
12 18	05:02	89	Julia	1 52.98	+36 47.0	10.3	172	253	NGC 712	G	12.8	129	95	0.112
12 18	09:26	105	Artemis	9 26.53	-11 32.9	13.1	117	86	NGC 2884	G	13.0	116	145	0.123
12 24	23:50	125	Liberatrix	10 48.21	+ 4 55.4	14.0	27	20	NGC 3385	G	12.6	112	134	0.698

ASTEROID PHOTOMETRY AT THE PALMER DIVIDE OBSERVATORY: RESULTS FOR 706 HIRUNDO, 957 CAMELIA, AND 1719 JENS

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Lightcurves for three asteroids were measured in 2000 July and September at the Palmer Divide Observatory located near Colorado Springs, CO. For 706 Hirundo, a period of 22.072 ±0.005h and amplitude of 0.96m was found. The period for 957 Camelia was found to be 5.391 ±0.02h with an amplitude of 0.32m. The parameters for 1719 Jens were found to be 5.867 ± 0.02h and 0.54m maximum amplitude.

The goal of the Palmer Divide Observatory asteroid photometry program is to measure the lightcurves of as many asteroids as possible given the limitations of the equipment. The current instrumentation is a 0.5m Ritchey-Chretien working at f/4.7 instead of the usual f/8.1. This is achieved by using a commercial focal reducer in a modified cell so that the distance from the lens to the CCD chip is closer to the designed specifications. An SBIG ST-8 camera using a non anti-blooming non-enhanced chip was used. The temperature was kept at approximately −10°C, as it is at all times of the year to help maintain some consistency of results. Initial targets are selected by referring to the list of lightcurves maintained by Alan Harris (Harris 1997, 1999). At least two nights are dedicated to the initial run for every target. Depending on the preliminary analysis of the lightcurve data from those two nights, additional runs are allocated as necessary to assure full coverage of the lightcurve with no significant gaps, if possible. For asteroids with periods approaching and exceeding 24 hours, this becomes difficult.

Custom software written by the author, Canopus, is used to measure the images since it allows automatic storage of the measured magnitudes of the comparison stars and targets. It uses aperture photometry with magnitudes determined by calibrating images against field or, preferably, standard stars. The package includes a Fourier analysis routine, the original FORTRAN code for which was supplied by Alan Harris (Harris et al, 1989) and converted to Delphi Pascal. If the data from a single night appears to cover at least half a period or more, then an estimate based on a plot of the raw data is used to help narrow the possibilities when using data from two or more nights.

706 Hirundo

Hirundo is a unclassified main-belt asteroid of about 24km size. It was discovered by J. Helffrich in Heidelberg on 1920 October 9. It is named after a bird in the swallow family. 352 observations of Hirundo were made during runs on 2000 September 13, 15-17, 19, and 25. The period was found to be 22.072 ± 0.005h with an amplitude of 0.98m. The first maximum is well rounded with the following minimum being very sharp. This might suggest that the asteroid is fairly elongated and that the viewing angle was close to a right angle with the axis of rotation. Despite the gap between second maximum and second minimum, there was enough overlap of data at other inflection points to determine the period with a fair degree of precision. The period being almost 24 hours made this a difficult target for which to get a complete lightcurve. It would have been a perfect case for a collaborative effort. Unfortunately, the several amateurs contacted were already involved with other collaborations or working other targets. This is quite a reversal from years past when the trouble was finding anyone at all interested in asteroid lightcurves let alone willing to take time to work a given target.

957 Camelia

About 180 data points were measured for this 39km unclassified asteroid during runs on 2000 July 30 and August 9. The derived period is 5.391 ± 0.02h and the amplitude 0.32m. Camelia was discovered by K. Reinmuth on 1921 September 7 and is named after a group of plants in the tea family that has glossy evergreen leaves and rose-like flowers. There is a decided asymmetry to the descending branch following the first maximum while the second maximum is much sharper than the first.

1719 Jens

Discovered by K. Reinmuth in 1950 February, Jens is named after Reinmuth's grandson. It is an unclassified asteroid of about 24km size and a member of the main-belt with a slightly larger than usual orbital inclination of just over 14 degrees. This makes it very similar to the orbit of 706 Hirundo (see above). 166 data points were obtained during runs on 2000 September 26 and 27. The derived period is 5.867 ± 0.02h with a maximum amplitude of 0.54m occurring between second minimum and the following maximum. The minimum between first and second maximum is about 0.14m shallower, i.e., about 0.40m amplitude. Each of the runs was more than 6 hours in length and so covered more than one full revolution of the asteroid. This allowed for a fair amount of overlap at the inflection points, making the determination of the period easier. This was a rare treat as often many of the selected targets, e.g. 706 Hirundo above, have periods exceeding what can be done in a single night and, to make matters worse, have periods closely commensurate with 24 hours.

Acknowledgments.

Thanks go to Alan Harris of the Jet Propulsion Laboratory for making available the source code to his Fourier Analysis program.

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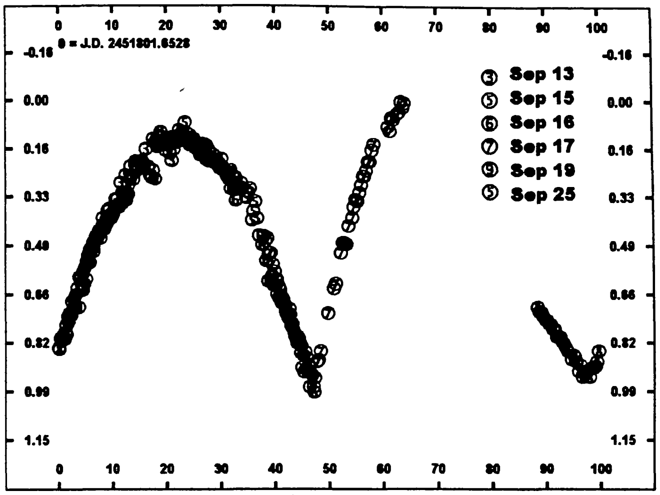

Fig. 1 – The lightcurve plot for 706 Hirudo. The period is 22.072 ± 0.02h with an amplitude of 0.98m. Note the sharp inflection point at first minimum versus the very rounded first maximum.

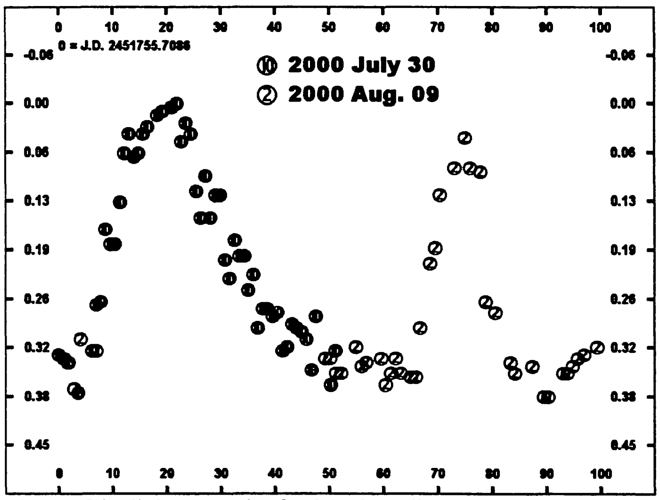

Fig. 2 – The lightcurve plot for 957 Camelia. The derived period is 5.391 ±0.02h; the amplitude is 0.32m. The shape of the two maximums is distinctly different with the first showing a curved shape on the descending slope.

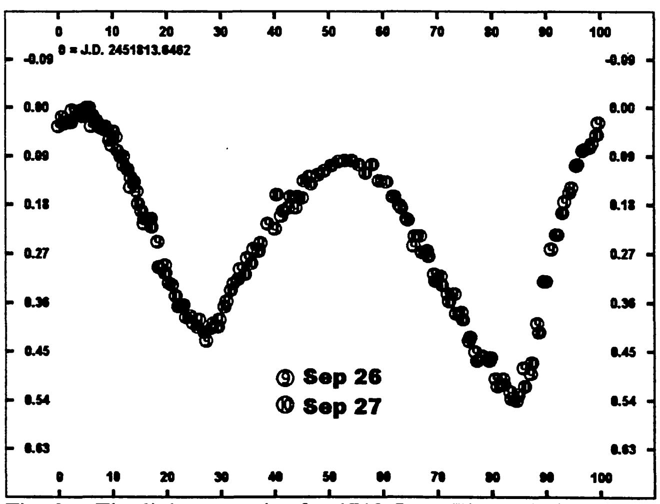

Fig. 3 – The lightcurve plot for 1719 Jens. The period is 5.867 ±0.02h and the maximum amplitude is 0.54m. The first, shallower minimum has an amplitude of about 0.40m.

COMBINING COLLABORATIVE WORK

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Many amateur photometric observations are not converted to the Standard System. Combining results from collaborative work is difficult when using instrumental observations. Canopus software by BW Publishing can be used to combine instrumental observations from different systems.

Thanks to recent publicity, in publications and at conferences, there is a growing community of amateur astronomers desiring to do photometry of asteroids in order to determine rotational periods. It is only natural, that with the growth of the Internet, many of these amateur astronomers would wish to collaborate on projects. The benefits are obvious; (1) more complete coverage can be obtained on lightcurves from observatories stationed around the globe and, (2) the collaborative work can be used to verify each other and reduce errors.

However, on the downside, there are problems in trying to combine work from remote observatories. Most important is that most amateur observatories tend to make instrumental measurements as opposed to absolute magnitude determinations. In calculating these instrumental measurements, the amateur observatories typically calculate the slopes, but not the zero points. This is simply because they often use comparison stars in the same field of view without transforming to a standard system. So the problem becomes how to combine data from different observatories that are not adjusted to the standards system. One approach is to calibrate each observatories data by determining a minimum or maximum, for the lightcurve in comparison with data from the other observatories. In order to do this, start with an observing session whose length of time covers at least 25 percent of the asteroid's rotational period. This will typically contain at least one minimum or maximum of the curve. Having both, or other identifiable features is an extra advantage. I use Brian Warner's Canopus software to measure and analyze the data. This software has the ability to import data from other observatories, if measured using the same software.

As stated in the accompanying article on 27 Euterpe, four observatories contributed observations to an observing campaign on the asteroid. This was a very difficult target for which to find a solution, as it turned out not have the traditional two-peaked curve. My first step was to identify which sessions had the longest continuous amount of data, typically at least four hours long. I selected the six best sessions, all of which had at least a minimum or a maximum. Several had other identifying features. The Canopus program has the ability to adjust the zero point with what it calls a 'DeltaComp' adjustment. This adjustment is used to correct differences resulting from different comparison stars used on different nights, different cameras used, or the asteroid being at a different distance from Earth during different sessions. The six sessions were roughly adjusted with the DeltaComp adjustment. Then, using the Fourier Analysis portion of Canopus, every period between 5 and 18 hours was checked at 0.01 hour increments. A few possibilities were found for the six sessions used. One of which was the previously published 8.5-hour period. However, by far the best fit was a 10.41-hour period with the data from various nights. Fine tuning of the DeltaComp adjustment provided significant overlap along 75 percent of the curve. In essence a zero point adjustment was simulated by matching curve features.

Later sessions and previously obtained shorter sessions were added and served to confirm the 10.41-hour period. One of the issues in combining these sessions was that, from time to time, the amplitudes of a few sessions were a poor match. This was likely due to the spectral response of the various cameras and the comparison stars used. In future campaigns the comparison stars used need to be checked to see that they are similar in color to the asteroid. Taking an image of the field during the session through Visual and Red filters could determine color indexes for the comparison stars.

Acknowledgements

Many thanks to Brian Warner for his continuing help and guidance, and for his continuing development of the software programs 'Connections 2000' and 'Canopus' which makes it possible for amateurs to automatically gather the data, measure and analyze the light the lightcurves.

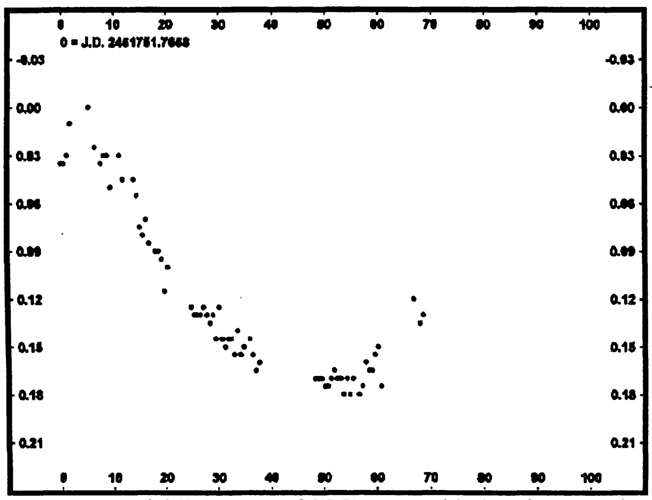

Figure 1. Partial lightcurve of 27 Euterpe with data from Session 6.

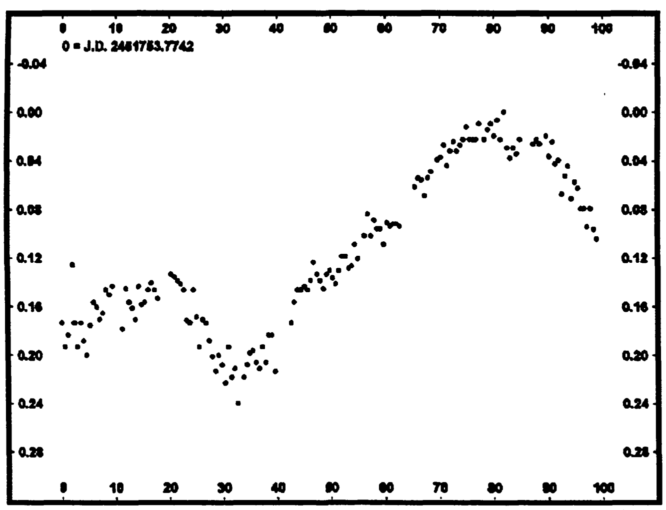

Figure 2. Partial lightcurve of 27 Euterpe with data from Session 9.

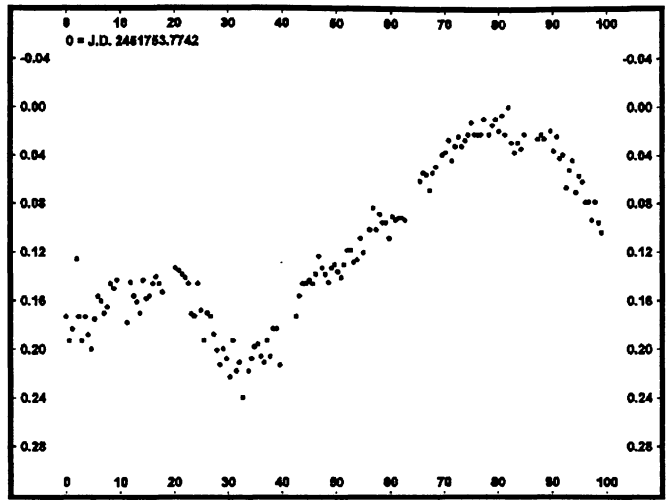

Figure 3. Partial lightcurve of 27 Euterpe with data from Session 11.

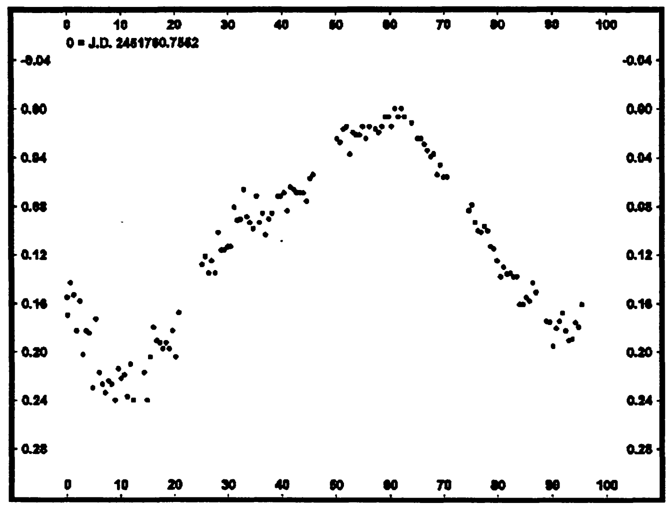

Figure 4. Partial lightcurve of 27 Euterpe with data from Session 13.

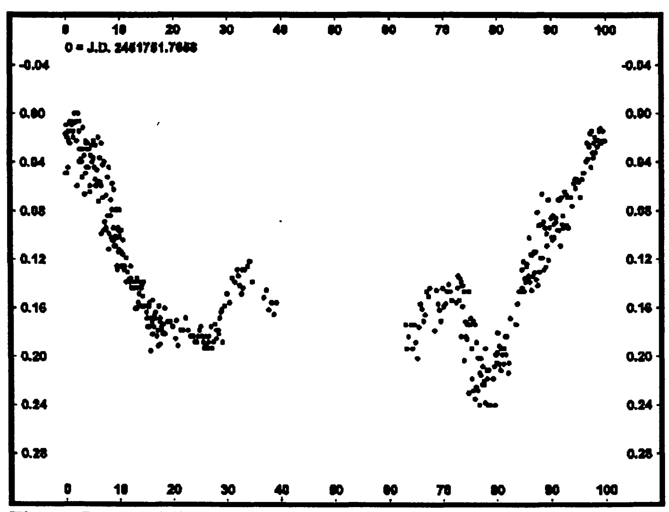

Figure 5. Partial lightcurve of 27 Euterpe combining Sessions 6, 9, 11 and 13.

CLOSE MUTUAL APPROACHES OF MINOR PLANETS IN 2001

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The table below lists 31 cases where one minor planet comes to within 120" of another and both are of magnitude 16 or brighter. A challenge for minor planet observers!

Here I present a list of close approaches between numbered minor planets larger than 40 km during 2001 where:

- the elongation of the Sun is more than 30°.
- both minor planets are brighter than visual magnitude 16.
- and the minimum geocentric separation is less than 120".

The table gives the following data:

1. Date: date and time of closest geocentric approach (in U.T.). All other information is given for this instant.

2. Closest approach: gives the minimum geocentric distance (in seconds of arc) and the position angle (in degrees) of the *nearest* minor planet with respect to the *farthest* one.

3. Minor planet 1: contains information about the *nearest* minor planet:
   - number and name
   - visual magnitude
   - parallax in seconds of arc
   - apparent motion in seconds of arc per hour
   - position angle of the direction of motion in degrees

4. Minor planet 2: information about the *farthest* minor planet. The same data as for the nearest one are given. In addition the right ascension and declination (2000.0) are printed.

5. Sun and Moon:
   - elongation of the Sun in degrees
   - elongation of the Moon (degrees)
   - illuminated fraction of the Moon in %

The author wants to acknowledge the Computer Center of Agfa-Gevaert N.V. (Mortsel, Belgium), where the computations were executed.

Close mutual approaches of minor planets

(Dist. < 120" ; El. Sun > 30° ; magn. < 16.0)

	Date (U.T.)		Min. dist.	Pos. ang.	Minor planet 1 Name	Vis. mag.	Hor. par.	Motion per hour	pos. ang.	Minor planet 2 Name	Vis. mag.	Hor. par.	Motion per hour	pos. ang.	Right ascens. (2000.0)	Declination (2000.0)	Elongation Sun	Elongation Moon	Ill. frac. Moon
		h m	"	0			"	"/h	0			"	"/h	0	h m	0 '	0	0	%
	2001 jan 6	3 33.9	55.88	336	455 Bruchsalia	13.22	3.78	88.97	62	528 Rezia	15.47	2.28	45.10	59	22 52.02	-17 26.5	52	73	78
	jan 11	8 20.7	65.05	176	30 Urania	11.48	5.33	40.56	75	99 Dike	15.13	3.10	13.88	52	2 00.48	+14 54.3	102	101	95
	jan 20	18 38.2	70.25	163	202 Chryse's	13.07	3.00	37.52	96	866 Fatme	15.28	2.66	31.50	101	14 43.52	- 7 29.2	80	39	15
	feb 5	21 22.2	43.53	239	1687 Glarona	14.86	4.05	28.47	295	911 Agamemnon	14.97	2.05	19.96	277	10 31.45	+12 39.8	162	55	89
?	mar 4	10 13.4	4.33	158	1771 Makover	15.10	3.88	2.55	115	769 Tatjana	15.00	2.81	6.70	231	7 15.43	+31 05.7	121	33	64
	mar 6	0 34.6	13.53	348	126 Velleda	14.38	3.19	63.15	84	121 Hermione	13.70	2.30	41.93	88	19 16.34	-24 33.7	58	159	80
	apr 6	13 36.5	111.78	342	144 Vibilia	12.98	3.29	62.16	77	351 Yrsa	15.09	2.52	40.11	80	21 04.92	-19 17.0	63	139	96
	may 1	16 59.8	119.73	185	287 Nephthys	13.14	3.50	58.61	74	10 Hygiea	11.34	2.69	42.31	65	22 22.27	- 8 05.8	66	169	62
	jun 17	0 19.1	77.94	5	83 Beatrix	13.59	3.37	64.43	113	328 Gudrun	14.47	2.63	48.48	120	9 50.80	+15 59.8	58	118	26
	jun 21	8 7.7	19.46	336	4 Vesta	8.37	2.83	60.52	75	213 Lilaea	14.38	2.57	53.65	76	2 56.90	+11 01.1	45	44	3
	jul 8	18 0.4	103.56	179	201 Penelope	13.08	4.18	12.23	135	521 Brixia	14.52	2.95	8.76	179	14 34.90	- 7 32.9	111	102	90
	jul 14	6 29.9	62.19	166	116 Sirona	13.56	2.54	56.06	80	90 Antiope	14.51	2.25	46.73	81	4 30.27	+21 23.3	42	46	48
	jul 15	16 43.8	99.78	242	785 Zwetana	13.19	5.79	27.27	138	1596 Itzigsohn	15.94	3.33	7.54	31	15 10.46	-18 36.6	117	160	34
	jul 16	23 25.8	16.13	48	1369 Ostanina	15.62	3.91	29.21	85	366 Vincentina	14.05	3.24	23.24	49	0 59.16	+ 8 37.7	97	49	22
	jul 24	7 46.3	58.86	16	397 Vienna	13.93	3.63	72.41	87	578 Happelia	15.03	2.64	46.04	75	4 08.73	+22 37.6	56	105	17
	aug 13	13 59.4	7.27	210	59 Elpis	13.95	2.37	50.31	111	107 Camilla	13.54	2.17	46.72	111	12 15.14	+ 1 41.1	42	118	39
	aug 24	15 37.8	69.49	75	37 Fides	10.90	5.62	17.76	254	601 Nerthus	14.04	4.54	24.21	212	0 17.50	+ 0 26.1	147	137	36
?	sep 8	6 24.3	11.48	114	519 Sylvania	13.55	4.62	22.68	58	526 Jena	15.69	3.31	14.21	86	3 47.43	+17 22.5	107	21	76
	sep 11	20 36.3	27.99	83	702 Alauda	12.63	3.47	8.26	24	1069 Planckia	14.92	3.24	11.45	151	19 07.32	-16 37.6	116	161	39
	sep 18	7 38.7	7.51	148	289 Nenetta	15.40	2.45	51.34	107	179 Klytaemnestra	14.26	2.32	48.79	111	8 57.11	+12 12.6	42	54	1
	oct 1	15 38.7	38.69	185	788 Hohensteina	14.31	2.31	53.39	108	737 Arequipa	15.01	2.21	47.53	110	10 11.84	+ 3 57.0	35	154	99
	oct 23	3 49.1	31.46	220	125 Liberatrix	14.66	2.69	45.80	110	924 Toni	15.42	2.53	40.94	107	9 58.92	+ 9 35.8	61	140	42
	oct 26	20 19.5	49.62	347	45 Eugenia	12.83	3.41	39.46	85	558 Carmen	14.78	3.02	32.10	87	20 02.45	-19 32.2	85	35	75
	oct 27	22 42.7	102.14	265	547 Praxedis	11.95	7.65	43.88	215	318 Magdalena	13.83	4.20	30.44	242	2 45.39	+ 2 18.1	166	55	83
	nov 3	5 10.6	58.99	57	246 Asporina	13.74	3.49	48.28	94	170 Maria	14.69	3.31	40.05	72	20 07.45	-14 49.9	80	122	94
	nov 4	8 55.1	81.16	356	269 Justitia	13.95	4.46	43.32	78	1074 Beljawskya	15.56	3.20	22.77	70	21 23.66	-16 06.2	96	118	88
?	nov 4	17 59.1	11.16	95	397 Vienna	13.00	5.80	21.15	192	48 Doris	11.74	4.06	8.00	203	6 17.72	+14 58.0	127	15	85
	nov 19	16 30.7	56.80	212	111 Ate	12.56	4.32	38.48	114	300 Geraldina	15.49	2.91	20.88	107	9 42.59	+14 35.0	94	145	22
	nov 20	0 33.6	105.12	67	1015 Christa	14.99	2.69	38.40	76	385 Ilmatar	13.50	2.65	37.77	62	20 53.82	-21 42.0	72	24	25
	nov 27	10 23.4	43.84	14	131 Vala	15.02	2.88	73.42	111	118 Peitho	14.55	2.61	62.11	112	14 07.47	-10 04.6	32	165	85
	dec 31	17 14.4	42.24	316	126 Velleda	14.08	3.41	70.80	66	163 Erigone	14.85	3.15	59.72	70	22 32.10	-10 23.4	55	139	96

CLOSE APPROACHES OF MINOR PLANETS TO NAKED EYE STARS IN 2001

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A list is presented of approaches of minor planets brighter than magnitude 14 to naked eye stars. This may be helpful in finding some faint minor planets.

The accompanying table lists close approaches of minor planets to stars during 2001 where:

- The event takes place more than 30° from the Sun.
- The minor planet is brighter than visual magnitude 14.
- The star is brighter than magnitude 6.
- The minimum angular separation is smaller than 120".

This list can be helpful in locating some otherwise faint minor planets. By carefully drawing the star field around the predicted position down to the magnitude of the minor planet and comparing it to the situation some time later, one can detect the intruder by its apparent motion.

The information contained in the list is divided into 5 groups:

1. Date: gives the date and time in U.T. of the closest geocentric approach. All subsequent data pertain to this instant.

2. Closest approach: the two columns give the position of the minor planet with respect to the star:
   - the minimum geocentric distance in seconds of arc
   - the position angle in degrees, measured from north over east

3. Minor planet: gives information about the minor planet:
   - number and name
   - visual magnitude
   - apparent motion in seconds of arc per hour
   - parallax in seconds of arc

4. Star: the following data of the star are given:
   - Hipparcos star number
   - visual magnitude
   - right ascension for the equinox 2000.0
   - declination (2000.0)

5. Sun and Moon:
   - elongation of the Sun in degrees
   - elongation of the Moon (degrees)
   - illuminated fraction of the Moon in %

The *observed* minimum distance depends on the location of the observer on the Earth's surface but is always comprised between the minimum *geocentric* distance plus and minus the parallax. An occultation will be visible somewhere on the Earth when the parallax is greater than the geocentric separation.

The close approaches in this article were computed at the Computer Center of Agfa-Gevaert N.V., Mortsel, Belgium.

Close approaches of minor planets to stars

(Dist. < 120" ; El. Sun > 53°
Star < 6.0 ; Min. pl. < 14.0)

Date (U.T.)	h m	Minim. dist. "	Pos. ang. 0	Minor planet Name	Vis. mag.	App. mot. "/h	Hor. par. "	Star Designation	Vis. mag.	Right ascens. (2000.0) h m	Declination (2000.0) 0 '	Elongation Sun 0	Elongation Moon 0	Ill. frac Moon %
2000 dec 22	17 52.3	29.91	15	410 Chloris	13.4	71.71	3.05	HIP 73473	4.9	15 0.97	- 8 31.1	46	13	8
dec 27	9 26.0	64.70	156	135 Hertha	12.7	70.07	4.11	HIP 114822	5.6	23 15.57	- 3 29.8	72	54	2
dec 28	15 16.4	14.85	230	1963 Bezovec	12.8	68.62	9.18	HIP 27280	5.9	5 46.87	+ 9 31.3	162	135	7
2001 jan 2	23 12.3	103.10	349	539 Pamina	13.1	34.21	5.55	HIP 28734	4.3	6 4.12	+23 15.8	168	78	50
jan 5	6 4.7	78.75	191	13 Egeria	11.4	34.75	4.17	HIP 63608	3.0	13 2.18	+10 57.5	94	146	73
jan 6	4 57.9	3.66	180	914 Palisana	13.5	64.06	3.85	HIP 116611	5.5	23 37.95	+18 24.0	77	57	82
jan 6	11 48.5	27.53	10	409 Aspasia	12.6	65.61	3.00	HIP 76532	6.0	15 37.80	-23 8.5	48	172	85
jan 10	13 47.3	58.08	172	96 Aegle	11.6	35.19	4.77	HIP 37265	5.0	7 39.17	+34 35.1	167	15	99
jan 12	9 20.6	88.79	198	58 Concordia	13.3	12.93	4.50	HIP 20873	6.0	4 28.39	+14 44.5	135	81	90
jan 13	0 38.3	19.69	147	471 Papagena	11.4	68.25	3.41	HIP 117567	5.8	23 50.55	-14 24.1	59	164	85
jan 14	10 19.4	71.52	356	258 Tyche	13.9	63.58	2.54	HIP 86263	3.6	17 37.59	-15 23.9	30	86	72
jan 15	15 48.6	96.06	190	308 Polyxo	13.7	52.56	2.87	HIP 76126	5.5	15 32.92	-16 51.2	60	40	59
jan 17	6 42.4	26.89	336	27 Euterpe	11.8	66.23	3.52	HIP 117375	5.6	23 47.94	- 2 45.7	58	140	42
jan 18	22 0.5	46.28	27	579 Sidonia	12.6	31.76	3.85	HIP 43103	4.2	8 46.70	+28 45.6	167	110	26
jan 21	20 37.1	43.81	202	348 May	13.2	32.98	4.89	HIP 37826	1.3	7 45.32	+28 1.6	169	158	6
jan 23	17 3.4	41.96	159	71 Niobe	11.4	39.82	4.56	HIP 35710	5.3	7 22.04	+36 45.6	157	164	1
jan 25	16 48.9	40.32	6	328 Gudrun	12.7	32.19	4.72	HIP 47168	5.7	9 36.71	+31 9.7	160	167	1
jan 27	20 58.9	117.22	357	246 Asporina	13.8	68.89	2.93	HIP 86313	5.9	17 38.16	-10 55.6	44	81	10
jan 28	7 32.5	3.61	149	22 Kalliope	12.0	58.73	2.63	HIP 117314	5.9	23 47.27	-11 54.7	44	6	12
jan 30	19 33.3	109.31	352	702 Alauda	13.3	52.23	2.28	HIP 90260	5.7	18 25.02	-30 45.4	36	104	32
feb 3	0 45.3	59.95	16	674 Rachele	13.5	37.21	2.53	HIP 80343	4.6	16 24.10	-20 2.2	66	174	65
feb 3	22 21.1	110.14	329	360 Carlova	13.5	51.59	3.57	HIP 10723	5.7	2 18.02	+ 1 45.5	77	42	75
feb 5	17 9.8	67.60	126	145 Adeona	12.2	14.89	5.13	HIP 64445	5.9	13 12.55	+11 33.4	122	92	90
feb 8	6 19.4	79.78	1	444 Gyptis	13.5	34.16	2.92	HIP 77060	5.5	15 44.07	-15 40.4	82	98	100
feb 13	12 26.4	30.22	3	68 Leto	12.5	58.46	2.75	HIP 89678	4.8	18 18.05	-27 2.6	50	59	67
feb 13	15 33.1	55.97	335	55 Pandora	12.9	66.85	3.03	HIP 3786	4.6	0 48.68	+ 7 35.1	49	156	65
feb 19	17 45.3	118.74	328	387 Aquitania	13.3	47.41	2.65	HIP 10826	5.0	2 19.35	- 2 58.7	61	99	11
feb 27	18 20.8	109.34	238	354 Eleonora	9.8	39.52	5.69	HIP 58159	5.6	11 55.68	+15 38.8	160	143	18
mar 1	5 17.2	64.08	29	377 Campania	12.8	32.02	4.97	HIP 47310	4.8	9 38.45	+ 4 39.0	162	97	31
mar 1	23 24.9	58.88	137	2 Pallas	9.6	43.31	3.29	HIP 83000	3.4	16 57.67	+ 9 22.5	89	149	38

	Date (U.T.)		Minim. dist.	Pos. ang.	Minor planet Name	Minor planet Vis. mag.	Minor planet App. mot.	Minor planet Hor. par.	Star Designation	Star Vis. mag.	Star Right ascens. (2000.0)	Star Declination (2000.0)	Elongation Sun	Elongation Moon	Ill. frac Moon
		h m	"	0			"/h	"			h m	0 '	0	0	%
	mar 2	5 16.2	81.90	221	423 Diotima	12.2	13.59	3.90	HIP 66936	5.5	13 43.06	+ 3 32.3	137	141	41
	mar 3	7 6.0	75.53	151	387 Aquitania	13.4	49.68	2.53	HIP 11791	5.5	2 32.16	- 1 2.1	54	42	52
	mar 6	5 10.2	23.99	50	660 Crescentia	13.2	28.43	4.96	HIP 43121	5.9	8 46.93	+12 6.6	144	16	83
	mar 12	8 13.9	16.71	167	345 Tercidina	13.8	48.29	3.55	HIP 89609	5.9	18 17.19	-17 22.4	77	66	91
	mar 13	6 57.0	76.52	165	270 Anahita	13.3	83.52	3.54	HIP 100881	5.1	20 27.32	-18 12.7	48	84	84
	mar 15	13 29.3	3.89	339	54 Alexandra	12.5	76.71	3.14	HIP 104019	4.9	21 4.40	-19 51.3	42	63	63
	mar 24	1 24.1	110.62	203	785 Zwetana	12.7	14.73	6.67	HIP 78436	5.6	16 0.79	- 8 24.7	122	113	1
	mar 24	13 55.5	99.08	64	161 Athor	13.2	16.89	5.31	HIP 77909	5.9	15 54.66	-25 14.6	122	116	0
	mar 25	8 19.1	15.53	347	103 Hera	13.0	59.98	3.00	HIP 102026	6.0	20 40.54	-16 7.4	56	60	0
	mar 28	8 55.1	87.63	5	196 Philomela	12.2	29.24	3.06	HIP 91004	5.6	18 33.89	-24 1.9	89	129	11
	mar 31	9 29.7	9.71	11	145 Adeona	11.6	34.08	5.84	HIP 62356	5.3	12 46.65	+16 34.7	159	97	38
X	apr 3	1 39.0	2.80	201	487 Venetia	12.4	28.93	4.59	HIP 58159	5.6	11 55.68	+15 38.8	155	49	68
	apr 6	17 35.1	14.80	38	489 Comacina	12.6	31.83	4.29	HIP 65198	5.7	13 21.69	+ 2 5.2	170	21	97
	apr 15	14 1.6	6.96	163	626 Notburga	13.6	86.00	3.10	HIP 13328	4.7	2 51.51	+35 3.6	30	115	51
	apr 16	0 0.8	78.93	85	326 Tamara	13.9	35.71	4.48	HIP 47300	5.3	9 38.36	+40 14.4	105	154	47
	apr 17	1 0.4	76.81	164	360 Carlova	13.8	68.45	2.75	HIP 19376	6.0	4 9.03	+13 23.9	36	110	37
	apr 17	11 8.1	13.96	51	218 Bianca	11.7	35.80	6.24	HIP 73620	4.6	15 2.90	+ 2 5.5	156	95	33
	apr 21	8 8.1	27.92	346	173 Ino	13.1	68.47	2.82	HIP 21735	5.4	4 40.06	+12 11.9	39	66	6
	apr 22	4 18.5	41.12	11	372 Palma	12.3	71.23	3.13	HIP 25292	5.1	5 24.65	+37 23.1	52	70	2
	apr 23	15 4.0	66.93	343	751 Fa'na	13.8	71.61	2.85	HIP 20186	5.3	4 19.61	+21 46.4	33	34	0
	apr 25	16 30.4	92.98	335	233 Asterope	13.2	47.74	3.61	HIP 103401	5.6	20 56.90	- 9 41.9	81	107	5
	apr 28	6 26.8	77.10	346	234 Barbara	13.1	69.54	4.81	HIP 103981	5.7	21 4.08	- 5 49.4	81	138	24
	apr 29	16 43.2	106.03	307	345 Tercidina	13.2	19.72	4.69	HIP 93225	5.5	18 59.40	-12 50.4	114	164	38
	may 7	9 44.9	47.38	191	38 Leda	13.4	61.52	3.32	HIP 35699	5.2	7 21.95	+20 26.6	62	116	100
	may 10	1 55.1	88.23	359	30 Urania	12.5	74.43	2.97	HIP 26248	5.4	5 35.45	+24 2.4	34	175	93
	may 11	2 0.5	87.91	22	7 Iris	9.5	36.91	4.57	HIP 73184	5.9	14 57.47	-21 25.0	175	45	87
	may 15	4 23.0	18.39	213	472 Roma	13.9	25.89	3.87	HIP 52457	5.1	10 43.42	+23 11.3	98	164	52
	may 16	4 21.9	98.43	347	234 Barbara	12.8	63.92	5.44	HIP 106592	6.0	21 35.29	- 3 59.0	90	17	43
	may 17	0 7.4	84.75	197	762 Pulcova	13.0	28.88	3.92	HIP 76939	5.4	15 42.64	-37 25.5	161	99	35
	may 18	1 27.7	28.81	206	747 Winchester	13.6	23.70	2.88	HIP 50384	5.9	10 17.24	+23 6.4	90	151	26
	may 21	1 56.0	110.99	160	11 Parthenope	11.6	71.16	2.93	HIP 7007	5.0	1 30.19	+ 6 8.6	37	12	5
	may 26	1 35.4	80.57	157	785 Zwetana	11.8	38.89	7.99	HIP 75352	5.9	15 23.87	-12 22.2	165	128	11
	may 30	17 20.0	107.94	183	57 Mnemosyne	13.1	50.32	2.45	HIP 38712	5.9	7 55.52	+ 8 51.8	50	53	59
	jun 4	20 24.1	48.19	15	38 Leda	13.5	66.60	2.98	HIP 40167	4.8	8 12.21	+17 38.9	47	118	98
	jun 12	18 48.5	11.98	339	98 Ianthe	13.3	27.66	4.43	HIP 95294	4.4	19 23.22	-44 48.0	147	52	63
	jun 19	1 12.0	105.65	328	101 Helena	12.7	54.26	4.11	HIP 2006	5.9	0 25.40	+ 1 56.4	81	49	8
	jun 21	1 11.2	31.03	183	69 Hesperia	12.0	26.80	3.71	HIP 82369	4.7	16 49.83	-10 47.0	159	165	0
	jun 21	17 11.9	103.82	185	229 Adelinda	13.9	26.32	3.89	HIP 83176	5.9	16 59.96	-25 5.5	165	163	0
	jun 23	6 21.3	100.03	126	564 Dudu	12.5	47.38	8.73	HIP 91875	5.1	18 43.78	-38 19.4	163	158	4
X	jun 24	20 32.8	1.23	38	1241 Dysona	13.9	31.21	4.49	HIP 83431	5.4	17 3.15	-53 14.2	147	118	15
	jun 27	4 34.2	42.18	346	451 Patientia	12.4	57.18	2.44	HIP 18724	3.4	4 0.68	+12 29.4	35	113	39
	jun 30	3 8.0	97.74	346	4 Vesta	8.4	58.57	2.90	HIP 14764	6.0	3 10.65	+11 52.4	50	165	71
	jul 1	13 21.8	95.96	227	1241 Dysona	13.9	30.95	4.45	HIP 82902	5.9	16 56.48	-52 17.0	144	42	84
	jul 5	8 16.7	66.64	31	106 Dione	13.9	20.99	2.42	HIP 61941	2.8	12 41.66	- 1 27.0	86	90	100
	jul 8	4 45.6	6.75	192	133 Cyrene	11.6	29.16	5.27	HIP 90260	5:7	18 25.02	-30 45.4	167	39	94
	jul 8	14 14.1	108.33	177	674 Rachele	12.9	12.95	3.37	HIP 77909	5.9	15 54.66	-25 14.6	135	77	92
	jul 11	21 43.3	40.11	210	912 Maritima	14.0	63.34	2.62	HIP 50384	5.9	10 17.24	+23 6.4	39	149	68
	jul 17	1 37.1	100.49	167	11 Parthenope	11.5	57.11	3.47	HIP 14439	5.8	3 6.39	+13 11.2	66	16	18
	jul 18	0 46.5	70.58	37	145 Adeona	13.4	47.95	3.29	HIP 63090	3.4	12 55.60	+ 3 23.8	76	114	11
	jul 18	17 19.0	114.11	175	397 Vienna	13.9	74.00	3.57	HIP 18471	5.7	3 56.87	+22 28.7	54	26	6
	jul 26	11 52.6	81.51	170	24 Themis	13.1	45.76	2.49	HIP 20087	5.7	4 18.39	+21 34.8	57	135	40
	aug 1	21 37.4	87.28	179	397 Vienna	13.9	69.75	3.74	HIP 20711	4.4	4 26.31	+22 48.8	61	145	95
	aug 4	10 54.3	16.19	355	471 Papagena	11.6	69.42	2.88	HIP 30343	2.9	6 22.96	+22 30.8	36	141	100
	aug 8	12 33.4	95.59	343	203 Pompeja	13.1	20.14	5.00	HIP 114724	4.3	23 14.32	- 6 2.9	148	16	84
	aug 11	0 37.6	3.19	202	65 Cybele	12.8	37.79	2.72	HIP 68940	5.6	14 6.71	- 9 18.8	74	179	63
	aug 14	20 57.4	51.43	169	164 Eva	13.6	68.33	3.28	HIP 30343	2.9	6 22.96	+22 30.8	46	12	24
	aug 21	16 32.8	103.58	15	674 Rachele	13.5	18.58	2.74	HIP 78265	2.8	15 58.85	-26 6.8	94	59	10
	aug 22	11 57.2	103.48	357	159 Aemilia	13.7	35.41	3.07	HIP 20261	5.3	4 20.61	+15 5.7	83	131	16
	aug 23	8 55.7	79.94	3	48 Doris	12.6	44.80	2.83	HIP 25499	5.4	5 27.17	+17 57.7	68	127	24
	aug 27	3 29.9	23.06	8	8 Flora	11.0	78.74	3.23	HIP 38722	5.4	7 55.66	+19 53.0	36	142	63
	aug 29	23 59.1	69.46	189	28 Bellona	12.3	68.55	2.84	HIP 38848	6.0	7 56.99	+15 47.4	38	172	87
	aug 30	11 4.1	48.83	188	397 Vienna	13.8	58.15	4.17	HIP 24822	5.1	5 19.28	+22 5.8	76	141	90
	sep 5	2 36.6	83.61	11	675 Ludmilla	12.8	65.07	3.46	HIP 32968	5.8	6 52.00	+23 36.1	60	95	95
	sep 5	6 14.6	33.53	349	164 Eva	13.6	60.69	3.45	HIP 33927	5.4	7 2.41	+24 12.9	58	96	95
	sep 17	10 19.7	113.02	358	196 Philomela	12.1	23.49	3.20	HIP 88839	4.7	18 8.08	-28 27.4	97	98	0
	sep 18	17 47.1	79.88	186	410 Chloris	12.4	49.82	4.93	HIP 88839	4.7	18 8.08	-28 27.4	95	78	3
	sep 26	6 20.4	33.63	184	55 Pandora	13.1	47.09	3.16	HIP 37826	1.3	7 45.31	+28 1.6	70	175	68
	sep 29	9 41.8	45.90	255	117 Lomia	12.9	17.43	3.91	HIP 17460	5.6	3 44.52	+36 27.6	122	92	91
	oct 1	21 59.8	4.85	199	18 Melpomene	11.8	59.21	2.76	HIP 75379	5.0	15 24.20	-10 19.3	43	130	99
	oct 3	1 45.8	65.97	183	42 Isis	11.6	68.38	4.84	HIP 88012	6,0	17 58.65	-28 45.5	79	105	100
	oct 5	8 8.5	67.13	190	148 Gallia	13.3	54.07	2.61	HIP 49029	4.8	10 0.21	+ 8 2.7	42	105	93
	oct 10	6 10.3	5.55	225	117 Lomia	12.7	19.71	4.10	HIP 17203	5.5	3 41.13	+37 34.8	132	48	49
	oct 11	4 19.7	89.17	201	57 Mnemosyne	13.2	50.74	2.19	HIP 53907	4.8	11 1.83	- 2 29.1	31	48	39
	oct 14	23 59.0	105.56	19	3 Juno	9.7	62.23	3.92	HIP 43109	3.5	8 46.77	+ 6 25.1	69	47	5
	oct 15	5 35.7	10.49	160	740 Cantabia	14.0	28.00	3.66	HIP 3909	5.3	0 50.13	-10 38.7	159	168	4

Date (U.T.)		Minim. dist.	Pos. ang.	Minor planet Name	Vis. mag.	App. mot.	Hor. par.	Star Designation	Vis. mag.	Right ascens. (2000.0)	Decli- nation (2000.0)	Elon- gation Sun	Moon	Ill. frac Moon
	h m	"	0			"/h	"			h m	0 '	0	0	%
oct 19	10 35.5	55.22	18	182 Elsa	13.8	64.45	3.64	HIP 47723	5.4	9 43.73	+14 1.3	62	97	9
oct 25	9 23.8	78.89	345	334 Chicago	13.7	15.72	2.78	HIP 21029	4.8	4 30.56	+16 11.6	143	112	62
oct 29	15 15.1	48.91	192	498 Tokio	11.9	25.21	7.03	HIP 5364	3.6	1 8.59	-10 10.9	150	12	93
oct 30	0 11.1	114.29	188	72 Feronia	13.6	80.62	3.09	HIP 80569	4.3	16 27.02	-18 27.4	31	123	95
oct 30	3 47.6	68.85	178	409 Aspasia	12.7	58.47	3.14	HIP 90913	5.6	18 32.72	-14 51.9	61	96	96
oct 30	13 39.6	61.14	173	388 Charybdis	12.9	30.19	4.38	HIP 14376	5.4	3 5.44	+25 15.3	164	35	97
oct 30	14 33.4	91.81	177	43 Ariadne	12.2	87.07	3.99	HIP 89369	5.6	18 14.26	-21 42.8	56	105	97
oct 30	17 36.3	82.12	178	409 Aspasia	12.7	58.62	3.13	HIP 90991	5.8	18 33.65	-14 51.2	61	102	98
nov 2	20 24.5	37.55	176	23 Thalia	10.1	38.90	5.98	HIP 12114	5.9	2 36.09	+ 6 53.3	171	21	97
nov 5	9 59.7	79.37	167	113 Amalthea	12.2	32.65	5.51	HIP 19376	6.0	4 9.03	+13 23.9	158	32	82
nov 5	13 50.7	68.08	309	547 Praxedis	12.0	40.73	7.59	HIP 12387	4.0	2 39.48	+ 0 19.7	164	59	80
nov 11	13 31.6	111.75	4	519 Sylvania	12.3	37.84	5.80	HIP 15737	5.3	3 22.75	+20 44.5	175	126	18
nov 13	22 45.5	109.22	350	334 Chicago	13.4	23.98	2.88	HIP 20205	3.8	4 19.79	+15 37.7	164	148	2
nov 14	19 39.4	48.00	155	234 Barbara	12.3	46.68	6.58	HIP 114375	4.8	23 9.92	-22 27.5	106	113	0
nov 19	5 17.2	49.89	169	117 Lomia	12.3	31.81	4.47	HIP 14354	3.3	3 5.18	+38 50.4	159	127	17
nov 20	5 15.4	58.56	359	46 Hestia	13.5	71.01	2.89	HIP 89369	5.6	18 14.26	-21 42.8	35	25	25
nov 21	2 58.8	24.57	328	144 Vibilia	11.7	47.92	5.41	HIP 112716	4.1	22 49.59	-13 35.6	99	30	33
nov 23	15 59.6	70.57	297	686 Gersuind	12.7	36.93	6.65	HIP 10306	5.3	2 12.80	+21 12.7	155	60	57
nov 25	23 7.4	44.38	102	1467 Mashona	13.9	13.81	3.51	HIP 1630	5.9	0 20.41	+30 56.1	128	33	77
nov 26	23 57.7	114.29	333	234 Barbara	12.6	55.54	5.97	HIP 115669	4.5	23 26.05	-20 38.5	98	36	85
nov 29	20 25.5	17.84	188	2 Pallas	10.5	52.03	2.16	HIP 89065	5.7	18 10.67	+ 3 19.5	36	137	99
dec 5	4 15.3	30.84	333	287 Nephthys	12.8	38.71	4.15	HIP 115126	5.3	23 19.11	-13 27.5	92	143	79
dec 7	18 5.1	23.66	19	788 Hohensteina	14.0	35.57	2.98	HIP 56127	4.9	11 30.31	- 3 0.2	81	15	51
dec 10	14 47.1	88.36	75	154 Bertha	12.7	23.12	3.69	HIP 42604	5.5	8 41.02	+45 50.0	131	83	20
dec 14	1 1.5	28.11	163	60 Echo	11.5	10.90	6.23	HIP 7007	5.0	1 30.19	+ 6 8.6	121	131	1
dec 19	8 59.7	72.73	162	702 Alauda	13.4	50.82	2.31	HIP 101345	5.8	20 32.40	- 9 51.2	41	17	19
dec 23	5 40.0	39.13	131	654 Zelinda	10.2	52.82	10.16	HIP 37908	5.0	7 46.12	+18 30.6	156	109	53
dec 26	9 41.5	80.54	345	233 Asterope	13.3	61.73	3.25	HIP 110578	5.8	22 24.11	- 4 50.2	61	69	82
dec 28	5 0.4	109.29	343	410 Chloris	13.4	73.17	2.94	HIP 105576	5.7	21 23.01	-22 40.1	40	111	94
dec 30	16 32.8	86.39	339	77 Frigga	13.9	60.20	2.80	HIP 108036	5.2	21 53.30	-13 33.1	46	136	100
2002 jan 1	11 4.2	118.91	165	403 Cyane	12.8	30.58	5.27	HIP 25278	5.1	5 24.42	+17 23.0	159	47	94

HIGH PRECISION LIGHTCURVES FOR 762 PULCOVA

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The minor planet 762 Pulcova was observed over an interval of 62 days. The period of variation in the lightcurve was determined by the method of Harris to be 5.83923 hours with a formal error of ±0.00004 hours. The amplitude of the lightcurve variation ranged from 0.27 to 0.31 magnitudes. The effect of changing phase of illumination on the lightcurves was observed.

Introduction

The minor planet 762 Pulcova was selected for detailed study after a survey of minor planets was surveyed. The criteria for selection were: (1) Observable in the morning sky that allowed the object to be followed for at least 60 days. (2) No previous published determinations of lightcurve period of variation. (3) An apparent magnitude that would provide a signal to noise ratio greater than 100:1 in the CCD camera images. (4) A clear and noteworthy variation in magnitude during a survey session of 90 minutes.

The program of observation for 762 Pulcova was planned to obtain multiple instances in which there were two successive nights of observation under roughly identical conditions. Thus, there could be reliable determinations of the period of variation at different degrees of phase illumination.

Following the work reported here, Pulcova has been recognized as a binary system (Merline et al, 2000) based on observations that began on February 22, 2000. The companion was reported to be 4 mag fainter and in a 4.0 day orbit around Pulcova. The system has a semi-major axis of 800 km. The orbit of the companion was observed to be inclined at approximately 60 degrees to the line of sight. That Pulcova has a companion increases interest in lightcurves for Pulcova that are of the highest precision possible.

Observations

The Granville Observatory (#825) is equipped with a Meade LX-200 0.2 meter f/10 telescope. Imaging is performed with an Apogee AP-1 CCD camera with a Kodak KAF-400 sensor using an Optec f 3.3 focal reducer and a yellow #12 filter. This system configuration produces a field of view of approximately 33 by 22 arc minutes. The pixel scale for this system is 2.6 arc seconds per 9-micron square pixel.

All observations were based on the same exposure duration of 300 seconds. All images within each night were obtained without any delay between images other than what is required by the CCD camera system to capture the previous image and save it to disk storage. Therefore, the interval between the start of successive images was 318 seconds.

The schedule of observations and parameters of the observing sessions are presented in Table I. Given a period of variation of about 5.839 hours the percentage of a period observed in session 1 to 6 was 27%, 83%, 83%, 100%, 100% respectively.

Table I. Parameters of Observing Sessions.

Ses[1] Num	Date	Time[2] Start	Time[2] End	Exp[3]	Phase Angle
1	Dec 9, 1999	9:09:26	10:39:28	18	19.82
2	Dec 19, 1999	6:43:49	11:24:43	54	19.00
3	Dec 20, 1999	6:23:24	11:14:37	56	18.89
4	Jan 29, 2000	3:03:58	8:53:40	67	9.68
5	Jan 30, 2000	3:03:21	8:47:21	66	9.35
6	Feb 9, 2000	2:20:33	8:04:55	66	5.83

[1]Session Number

[2]Times are the beginning of the first and last exposures at UT.

[3]Number of exposures (duration 300 sec) in the session

This schedule shows that there are two cases in which sessions were obtained on consecutive nights, December 19-20 and January 29-30. These two cases will permit independent determinations of the period of variation in the light curves based on nearly identical conditions of observation. These short interval determinations can be compared to the period determined based on all observations combined and that span a change in phase angle of 14 degrees.

Analysis and Results

The photometry analysis of these images was performed by the software package MIRA version 6.03 manufactured by Axiom Inc. The signal to noise ratio for Pulcova over the six sessions was in the range of 400 to 450. Many reference stars within all sessions were measured. These comparison stars had instrumental magnitudes that did not vary systematically within any session. The period of variation was determined by two methods, an analysis by the Fourier method in a program provided by Harris, et al (1989), and by visual alignment of the lightcurve plots. The Fourier analysis was applied to three sets of data, the entire set of observations from all six sessions, and the two sessions 2 and 3, and the two sessions 4 and 5. The results include formal error ranges as determined by the method of Harris. Among these determinations, the result based on all of the data acquired over the 62-day interval of observation has a very small error range due to the abundance of data. Thus, this result of 5.93923 hours is the most reliable of these determinations with an error interval of ±0.00004 hours. These results are summarized in Table II.

Table II. Period of Lightcurve Variation

Method of Analysis	Sessions Included	Period (hours)	Error (hours)
Harris Fourier	2,3	5.8380	±0.0030
Harris Fourier	4,5	5.8377	±0.0017
Harris Fourier	All	5.83923	±0.00004
Graph Alignment	All	5.83915	±0.0002
Stephens	----	5.839	±0.011

The observations are graphically presented here in Figure 1. The zero point of the phase scale is the time of starting the first exposure in session1 (refer to Table I.). This time base of the phase plot in Figure 1 places the brightness minimum that shows the most noteworthy differences in the center of the graph. The constant used as an estimate of the period of variation for plotting the results in Figure 1 is 5.83875 hours. This constant was selected to reveal some characteristics in the lightcurves that will be discussed later.

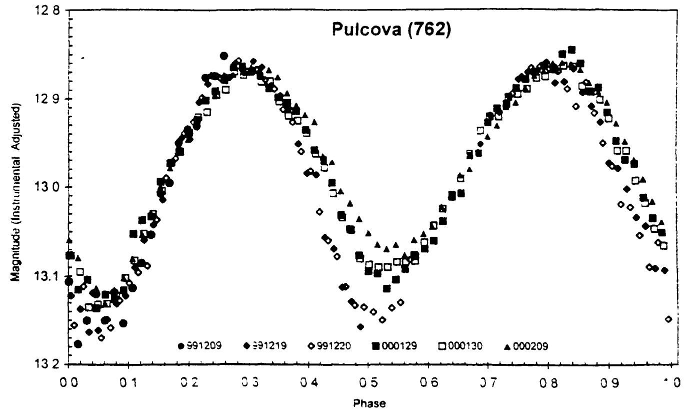

Figure 1. 762 Pulcova lightcurves aligned in time by superimposing the fast rising parts of the curves in the phase intervals 0.12-0.21 and 0.62-0.71. Magnitudes are instrumental values. An additive constant has been used to adjust all brightest magnitudes to approximately the same level. The zero point for phase time is December 9 at 09:06:26 UT. The period used was 5.8385 hours.

Alignment of semi-synchronous variations in a time series of data is best accomplished by alignment of parts of the data that are changing most rapidly. The period value used to plot Figure 1 was adjusted until the ascending segments of the lightcurves show minimum scatter. These parts of the light curves in Figure 1 are in the phase interval of 0.12-0.21 and 0.62-0.71.

Figure 1 shows a characteristic feature in the lightcurves that appears in all 6 sessions. This feature can be seen in the phase interval between 0.1 and 0.2. There is a 'cluster' of points in this interval that are separated by a small interval in which there are not any observed points. This cluster of points can serve as an alignment feature that increases confidence in the conclusion that the period of variation of about 5.839 hours is correct.

However, the number 5.8385 ±0.0001 hours used to plot Figure 1 underestimates the period of variation. The curves in Figure 1 change in shape as the phase angle of sun illumination changes. Therefore, in relation to some external fixed reference point, the time at which this characteristic feature appears will change as illumination phase angle changes. A second graph, similar to Figure 1, was plotted in which the dispersion of data around a descending portion of the light curve is minimized. This graphic solution was performed to reduce the scatter in the plot in a region centered on the 0.9 phase point. The period of variation necessary to minimize the scatter of points in this region was 5.8398 ±0.0001 hours. Again, due to the change in light curve shape as phase of illumination changes, this second analysis over estimates period. The best estimate of the period of variation is the midpoint between these two estimates. The midpoint value determined by this graphic analysis is 5.83915 ±0.0002 hours. It is this midpoint of the two estimates based on graphic alignment of ascending and descending segments of the light curves that is presented in Table II above.

Given the high signal to noise ratio of the data presented here, the amplitudes of variation in these light curves can provide important reference points for observations made at subsequent oppositions. Future oppositions may present different geometrical orientations of this asteroid in relation to its axis of rotation, and the line of sight in relation to the plane of rotation for Pulcova. As a result these differences, future lightcurve results may systematically differ from the present data. Therefore, some amplitude measurements are presented in Table III. Session 1 was much shorter than the rest, and covered only 27% of a fully cycle of variation. Therefore, data from session 1 did not contribute to the information presented in Table III.

Table III. Light Curve Measurements

Session Number	Plot Symbol	Maximum[1] Amplitude	Minimum[2] Amplitude	Phase Angle
2	◆	0.306	0.296	19.00
3	◇	0.313	0.285	18.89
4	■	0.291	0.262	9.68
5	□	0.272	0.226	9.35
6	▲	0.272	0.208	5.83

[1]Difference in magnitude between the brightest point and the darkest point in the session light curve.

[2]Difference in magnitude between the phase interval at 0,45-0.50 (the second minimum magnitude in Figure 1.) and phase interval 0.75-0.80 (the second maximum magnitude in Figure 1.) for each session.

Discussion

Another observer (Stephens, 2000) has reported lightcurve observations on 762 Pulcova. The analysis of Stephens in that report determined a period of variation of 6.65 ±0.01 hours, which is 8/7 times longer than the present findings. The results of the observations being reported here were furnished to Stephens, who re-analyzed the data in the earlier report (Stephens, 2000) and found a consistent match with 5.839 ±0.011 hours. Thus, not only has Stephens been able to fit this period with independent data, his data give an independent determination of the value closely matching the results reported here. The new determination by Stephens is also included in Table II for direct comparison with the determinations made using the present data.

There is a noteworthy feature in the lightcurves shown in Figure 1. In the phase interval 0.11-0.125 there is a small "cluster" of points that include data from all six sessions. This cluster of points is distinctly separated along the magnitude scale from the earlier and later parts of the nearby observations. This feature represents a "shoulder" in the lightcurves where the rate of increase in brightness accelerates then pauses briefly, and accelerates a second time. This characteristic feature is present in all six sessions to varying degrees. It is a "land mark" in the six light curves that confirms the alignment presented in Figure 1 is correct, and that the minimum selected from the method of Harris is the correct one.

The method of Harris involves choosing a minimum dispersion of data from among numerous minimum points in the analysis. This fact coupled with the uncertainty arising from noisy data and fragmentary coverage of the period of variation can lead to difficult decisions about periods of variation in lightcurve data. The findings of Stephens (2000) are an example of this point. The graphic alignment analysis reported here accomplished two things that strengthened the main finding obtained by the analytic method of Harris. First, the unusual characteristics in the light curves of successive observing sessions could be used to align the lightcurves, thereby providing a specifically unique estimate of the period to be used as a starting point in the method of Harris. Second, the determination of "rising" and "setting" periods by graphic analysis, and then finding the midpoint of these two estimates, provides an independent estimate of the period of variation that confirms the result obtained by the method of Harris.

The changes in the lightcurve as the phase angle decreases for this opposition of Pulcova are suggestive of a particular class of shape for this body. First, the overall light curve is consistent with a shape of Pulcova that is approximately ellipsoid. However, the degree of change in the amplitude of the two halves of the curve is not symmetrical. Thus, as presented in Table III, one minimum brightness point grew brighter as the asteroid approached the point of opposition. The other brightness minimum did not exhibit a similar change (refer to Figure 1.). This finding suggests that the shape of Pulcova may be asymmetric along the longer axis of its ellipsoid shape.

The sessions numbered 2 and 3 were successive nights. Likewise, sessions 4 and 5 were on successive nights. Thus, these two cases are close to exact replications of the same set of observations. Moreover, the change in phase angle between the two adjacent nights was 0.11 degrees and 0.33 degrees respectively (refer to Table I.). Consequently, the effects of illumination differences are at a minimum for these two cases, and may be so small as to be negligible. The periods of variation for these two pairs of successive nights were essentially identical, being 5.838 and 5.8377 respectively. Thus, while the individual formal error intervals for these two independent determinations are large (see Table II), this agreement suggests these estimates are reliable.

However, these estimates based on consecutive nights do not generalize to the entire set of observations. In fact they are systematically less than the other three estimates presented in Table II by about 0.0013 hours. The discrepancy of 0.0013 hours could be discounted since it is within the interval of uncertainty that includes all of the findings in Table II.. However, there were 254 revolutions of Pulcova between the first observing session and the last one. This difference in period estimates leads to a difference of 19.8 minutes in predicting the timing of the last session in relation to the first session. Therefore, the difference between the two 'successive' night estimates, and the 'all data' estimate is significant.

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PHOTOMETRY OF ASTEROIDS 191 KOLGA AND 1200 IMPERATRIX

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River Oaks Observatory began operating in the spring of 2000. The first asteroids studied for lightcurves prior to incorporating photometric filters were 191 Kolga and 1200 Imperatrix. Kolga was found to have a long period lightcurve with a most likely period of 27.80 ± 0.05 hours and amplitude of approximately 0.5 magnitudes. Imperatrix was found to rotate in 13.34 ± 0.11 hours with an amplitude of 0.23 magnitudes.

The River Oaks Observatory was built to replace a smaller one in which was located in more light polluted skies. The site and equipment were chosen to produce lightcurves with much lower noise than those done from the former site. The two asteroids present here were chosen from the "CALL" web site List of Potential Lightcurve Targets (Warner 2000). Kolga was observed first on the dates 5/23, 5/24, 6/7, 6/8, and 7/6/2000 Universal time through phase angles of 5.4 to 14.5 degrees. After observing only one inflection point in five nights the asteroid was dropped from study. A best fit of the data which was calibrated only with Hubble Guide Star magnitudes and without filtration is a period of 27.848 hours. By shifting the calibration slightly a fit can also be made for 27.76 hours, yielding an estimate of 27.80 ± 0.05 hours. Other solutions could be made but this general range seems the most likely with the limited portion of the curve observed and assuming two peaks and two troughs per period. Single night lightcurves were converted to reduced magnitudes at zero phase angle using a phase coefficient of 0.20 which worked reasonably well in constructing the composite curve.

Asteroid 1200 Imperatrix was observed on the dates 8/4, 8/5, and 8/6/2000 Universal time. As with asteroid 191 no filtration was done and calibration was only to Hubble Guide Stars. The observations spanning phase angles of 2.5 to 2.9 degrees were converted to reduced magnitudes at zero phase angle with a phase coefficient of 0.20. The composite curve has a best fit for a 13.34 hour period with an uncertainty of 0.11 hours for this period solution. The full amplitude of the lightcurve was observed to be 0.23 magnitudes this opposition.

Acknowledgments:

The submission of 191 Kolga was partly a response to a suggestion that incomplete light curves are better than no lightcurves. Magnitude conversions to reduced magnitude at zero phase angle were done with math contained in Batrakov (1992) which referenced the Minor Planet Circulars #10193 and 10194.

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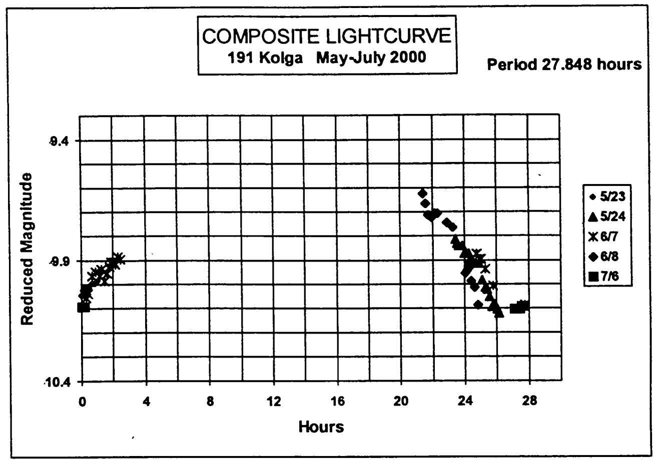

Figure 1 191 Kolga Lightcurve

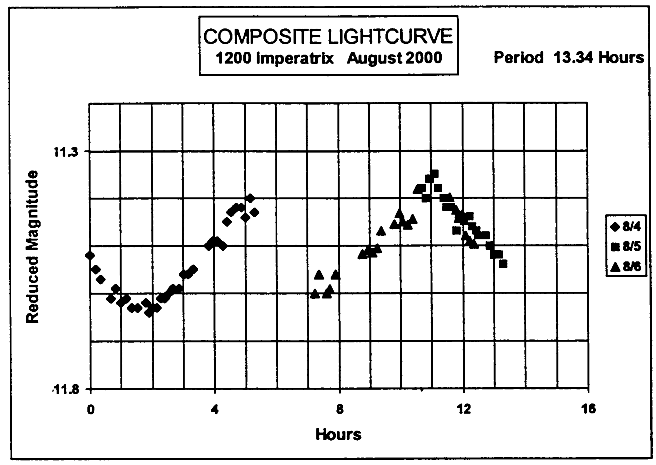

Figure 2 1200 Imperatrix Lightcurve

MINOR PLANETS AT UNUSUALLY FAVORABLE ELONGATIONS IN 2001

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A list is presented of minor planets which are much brighter than usual at their 2001 apparitions. Moderately close approaches within 0.356 A. U. of planets 719 Albert, 1916 Boreas, and two of (5587) 1990 SB, are especially noteworthy.

The minor planets in the lists which follow will be much brighter at their 2001 apparitions than at their average distances at maximum elongation. Many years may pass before these planets will be again as bright as in 2001. Observers are encouraged to give special attention to those which lie near the limit of their equipment.

Minor planet 719 Albert, missing from the time of its discovery in 1911 until the year 2000, will experience maximum elongation from the Sun on Oct. 26. Brightest magnitude of 15.0 occurs Sept. 24. This is fainter than the usual limit for this column, but the occasion of its recent recovery and its being brighter in 2001 than at any other time in the 21st century merit its inclusion here. Minor planet 1916 Boreas also reaches its brightest magnitude in the entire century, 14.5 on Sept. 11 preceding maximum elongation Sept. 29. Minor planet (5587) 1990 SB has two close approaches, to 0.298 AU on May 16 with brightest magnitude 13.0 on April 30, inbound toward the Sun; and again to 0.349 AU on Aug. 2, brightest magnitude 13.3 on Sept. 1, outbound from the Sun.

These lists have been prepared by an examination of the maximum elongation circumstances of minor planets computed by the author for all years through 2060 with a full perturbation program written by Dr. John Reed, and to whom he expresses his thanks. Elements are from EMP 1992, except that for all planets for which new or improved elements have been published subsequently in the Minor Planet Ciculars through 1998 Oct. 6, the newer elements have been used. Planetary positions are from the JPL DE-200 ephemeris, courtesy of Dr. E. Myles Standish. Dr. Reed's ephemeris generating program, a list of minor planet elements, and the JPL planetary ephemeris are freeware which may be obtained from the author by sending a 100 Megabyte zip disk and stamped, addressed return mailer. They cannot be downloaded directly over the Internet.

Any minor planets whose brightest magnitudes near the time of maximum elongation vary by at least 2.0 in this interval and in 2001 will be within 0.3 of the brightest occurring, or vary by at least 3.0 and in 2001 will be within 0.5 of the brightest occurring; and which are visual magnitude 14.5 or brighter, are included. For minor planets brighter than visual magnitude 13.5, which are within the range of a large number of observers, these standards have been relaxed somewhat to include a larger number of objects. Magnitudes have been computed from the updated magnitude parameters published in MPC28104-28116, on 1996 Nov. 25.

Oppositions may be in right ascension or in celestial longitude. Here we use still a third representation, maximum elongation from the Sun, instead of opposition. Though unconventional, it has the advantage that many close approaches do not involve actual opposition to the Sun near the time of minimum distance and greatest brightness and are missed by an opposition-based program. Other data are also provided according to the following tabular listings: Minor planet number, date of maximum elongation from the Sun in format yyyy/mm/dd, maximum elongation in degrees, right ascension on date of maximum elongation, declination (in degrees) on date of maximum elongation, both in J2000 coordinates, date of minimum or brightest magnitude in format yyyy/mm/dd, minimum magnitude, date of minimum distance in format yyyy/mm/dd, and minimum distance in AU.

Users should note that when the maximum elongation is about 177 deg or greater, the minimum magnitude is sharply peaked due to enhanced brightening near zero phase angle. Even as near as 10 days before or after minimum magnitude the magnitude is generally about 0.4 greater. This effect takes place in greater time interval for smaller maximum elongations. There is some interest in very small minimum phase angles. For maximum elongations E near 180° at Earth distance Δ, an approximate formula for the minimum phase angle ϕ is $\phi = (180° - E)/(\Delta + 1)$.

Table I. Numerical Sequence of Favorable Elongations

Planet	Max Elon D	Max E	RA	Dec	Min Mag D	Mag	Min Dist D	Min Dist
14	2001/06/10	178.1	17h16m	-21	2001/06/10	9.2	2001/06/04	1.400
19	2001/09/27	178.6	0h14m	+ 3	2001/09/27	9.0	2001/09/30	1.089
36	2001/11/01	153.8	2h 7m	+40	2001/11/01	10.6	2001/11/01	0.976
42	2001/06/07	177.8	17h 4m	-20	2001/06/08	9.5	2001/06/17	1.083
66	2001/11/13	176.2	3h10m	+21	2001/11/13	11.7	2001/11/12	1.201
67	2001/09/29	176.7	0h17m	+ 5	2001/09/29	10.4	2001/09/21	1.119
70	2001/07/24	159.1	20h41m	-39	2001/07/24	10.7	2001/07/24	1.156
74	2001/09/10	176.1	23h 7m	- 1	2001/09/10	10.9	2001/09/13	1.154
103	2001/08/20	178.2	21h59m	-14	2001/08/20	10.6	2001/08/19	1.474
114	2001/03/13	178.7	11h37m	+ 3	2001/03/13	10.8	2001/03/13	1.329
144	2001/08/29	170.9	22h47m	-17	2001/08/30	10.1	2001/09/03	1.098
211	2001/11/12	176.5	3h 6m	+21	2001/11/12	11.2	2001/11/14	1.607
225	2001/08/28	155.6	21h41m	+11	2001/08/25	12.4	2001/08/21	1.582
234	2001/08/29	172.2	22h50m	-15	2001/08/29	10.2	2001/08/28	0.801
247	2001/10/14	160.3	1h 3m	+27	2001/10/16	10.6	2001/10/18	1.161
253	2001/09/12	177.6	23h17m	- 1	2001/09/12	11.7	2001/09/08	0.949
266	2001/10/21	168.7	1h23m	+20	2001/10/21	11.8	2001/10/20	1.386
269	2001/08/08	176.2	21h 7m	-12	2001/08/08	11.6	2001/08/01	1.121
270	2001/09/24	175.2	23h56m	+ 4	2001/09/23	10.2	2001/09/19	0.891
354	2001/03/09	164.8	11h49m	+17	2001/03/08	9.7	2001/03/08	1.535
368	2001/07/26	167.2	20h10m	- 6	2001/07/26	13.1	2001/07/27	1.448
380	2001/06/28	179.7	18h30m	-23	2001/06/28	12.3	2001/07/02	1.472
402	2001/01/19	176.3	8h 2m	+16	2001/01/19	11.6	2001/01/21	1.316
409	2001/06/12	173.4	17h28m	-16	2001/06/12	10.5	2001/06/11	1.398
410	2001/06/18	176.2	17h47m	-19	2001/06/18	10.3	2001/06/19	1.065
418	2001/12/09	178.3	5h 6m	+21	2001/12/09	12.6	2001/12/05	1.436
431	2001/07/27	179.6	20h28m	-19	2001/07/27	11.9	2001/07/30	1.594
434	2001/09/15	176.7	23h23m	- 0	2001/09/14	12.4	2001/09/11	0.844
445	2001/08/22	158.2	21h45m	+ 9	2001/08/24	13.2	2001/08/26	1.716
451	2001/12/16	178.0	5h37m	+21	2001/12/16	10.4	2001/12/15	1.849
492	2001/10/07	178.6	0h55m	+ 4	2001/10/07	13.1	2001/10/03	1.655
498	2001/10/09	162.5	1h24m	- 9	2001/10/07	11.5	2001/10/01	1.160
504	2001/08/20	163.3	22h29m	-27	2001/08/21	12.0	2001/08/23	1.176
505	2001/01/13	172.8	7h51m	+28	2001/01/13	11.0	2001/01/06	1.174
519	2001/11/14	177.5	3h19m	+20	2001/11/14	12.2	2001/11/08	1.513
523	2001/01/18	175.6	8h 0m	+16	2001/01/18	12.7	2001/01/15	1.500
532	2001/04/22	152.7	14h35m	+13	2001/04/20	9.0	2001/04/19	1.377
543	2001/12/11	172.1	5h11m	+30	2001/12/11	12.9	2001/12/08	1.671
547	2001/10/30	166.4	2h43m	+ 1	2001/10/29	11.9	2001/10/27	1.140
555	2001/02/23	178.3	10h30m	+11	2001/02/23	14.1	2001/02/21	1.753
563	2001/11/29	173.8	4h25m	+15	2001/11/29	10.6	2001/11/28	1.089
564	2001/06/26	163.7	18h40m	-39	2001/06/27	12.5	2001/06/28	1.005
569	2001/12/10	178.3	5h 7m	+24	2001/12/10	12.3	2001/12/10	1.186
601	2001/09/21	176.0	0h 2m	- 4	2001/09/21	13.5	2001/09/18	1.851
602	2001/08/18	177.1	21h55m	-15	2001/08/18	11.4	2001/08/24	1.521
612	2001/10/17	179.7	1h28m	+ 9	2001/10/17	14.3	2001/10/08	1.590
629	2001/02/05	168.6	9h35m	+26	2001/02/05	13.5	2001/02/04	1.677
704	2001/10/11	152.7	0h18m	+31	2001/10/11	10.0	2001/10/10	1.688
713	2001/09/16	168.6	23h16m	+ 7	2001/09/16	12.9	2001/09/15	1.808
719	2001/10/26	161.1	2h41m	- 3	2001/09/24	15.0	2001/09/05	0.285
767	2001/09/12	176.0	23h28m	- 7	2001/09/12	13.2	2001/09/10	1.567
785	2001/05/15	172.3	15h34m	-11	2001/05/15	11.6	2001/05/11	1.076
882	2001/12/03	178.8	4h36m	+23	2001/12/03	13.5	2001/11/25	1.500
886	2001/09/19	153.8	0h24m	-25	2001/09/19	12.0	2001/09/18	1.406
901	2001/09/29	172.3	0h11m	+ 9	2001/09/28	12.5	2001/09/21	0.783
908	2001/01/12	168.2	7h53m	+32	2001/01/12	13.0	2001/01/12	1.138
915	2001/11/24	170.9	3h54m	+29	2001/11/24	13.4	2001/11/22	0.942
956	2001/07/23	167.4	19h58m	- 7	2001/07/23	14.1	2001/07/26	0.837
959	2001/10/02	174.4	0h44m	- 1	2001/10/03	13.5	2001/10/04	1.566
968	2001/03/31	173.9	12h28m	- 9	2001/03/31	13.3	2001/03/29	1.568
972	2001/11/19	170.2	3h29m	+29	2001/11/18	12.7	2001/11/13	1.501
1006	2001/08/20	169.5	21h47m	- 2	2001/08/22	14.0	2001/08/30	1.295
1047	2001/09/18	167.6	0h 4m	-13	2001/09/19	13.3	2001/09/21	0.838
1097	2001/08/22	179.0	22h 9m	-12	2001/08/22	12.9	2001/08/16	0.865
1108	2001/07/08	134.5	19h31m	+22	2001/07/14	14.2	2001/07/15	0.952
1123	2001/10/05	167.5	1h 1m	- 6	2001/10/05	13.4	2001/10/07	0.913
1126	2001/01/14	168.0	7h52m	+33	2001/01/14	14.0	2001/01/17	0.984
1147	2001/08/06	173.3	20h58m	-10	2001/08/05	13.1	2001/07/29	0.782
1170	2001/10/04	168.0	0h39m	+16	2001/10/06	13.5	2001/10/14	0.749
1196	2001/09/15	149.6	0h31m	-29	2001/09/15	13.2	2001/09/15	1.257
1264	2001/05/22	174.4	16h 7m	-15	2001/05/23	12.1	2001/05/25	1.425
1310	2001/10/16	154.6	1h19m	+34	2001/10/24	12.9	2001/11/01	0.773
1319	2001/03/08	175.4	11h 8m	+ 0	2001/03/08	14.2	2001/03/14	1.506
1320	2001/05/19	171.1	15h49m	-11	2001/05/20	13.4	2001/05/26	1.382
1335	2001/09/04	178.9	22h54m	- 5	2001/09/05	14.3	2001/09/07	0.919
1358	2001/06/15	176.3	17h33m	-26	2001/06/15	14.3	2001/06/21	1.127
1369	2001/10/05	175.4	0h54m	+ 0	2001/10/05	14.3	2001/09/27	1.730
1381	2001/11/11	172.5	2h58m	+24	2001/11/10	14.4	2001/11/06	1.088
1427	2001/06/22	176.3	18h 6m	-27	2001/06/22	13.3	2001/06/29	1.282
1450	2001/01/03	175.7	7h 1m	+26	2001/01/03	14.2	2001/01/01	1.199
1506	2001/07/21	156.4	19h51m	+ 3	2001/07/19	13.7	2001/07/16	0.947
1539	2001/08/29	179.4	22h33m	- 9	2001/08/29	14.1	2001/09/02	1.770
1593	2001/08/29	164.6	23h 4m	-22	2001/08/26	14.0	2001/08/18	0.648
1609	2001/08/23	151.7	23h15m	-35	2001/08/22	12.8	2001/08/22	0.988
1650	2001/07/20	174.8	19h55m	-15	2001/07/20	13.6	2001/07/15	1.089
1660	2001/03/19	151.0	10h40m	-22	2001/03/13	13.6	2001/03/08	0.835
1665	2001/01/09	173.2	7h29m	+28	2001/01/08	13.5	2001/01/07	0.941
1667	2001/06/17	179.0	17h44m	-24	2001/06/17	13.2	2001/06/19	0.835
1680	2001/05/13	176.0	15h24m	-14	2001/05/13	13.6	2001/05/15	1.219
1693	2001/08/16	157.9	22h19m	-34	2001/08/14	13.4	2001/08/10	1.081
1730	2001/10/26	168.3	2h20m	+ 1	2001/10/26	14.0	2001/10/25	1.183
1738	2001/09/14	170.9	23h41m	-11	2001/09/13	13.4	2001/09/08	0.761
1750	2001/11/18	147.4	2h 5m	+46	2001/11/14	14.4	2001/11/11	0.695
1807	2001/10/12	175.3	1h 2m	+11	2001/10/12	13.3	2001/10/10	0.834
1820	2001/07/03	171.9	18h45m	-14	2001/07/04	14.1	2001/07/10	0.768

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Planet	Max Elon D	Max E	RA	Dec	Min Mag D	Mag	Min Dist D	Min Dist
1916	2001/09/29	159.9	0h10m	+22	2001/09/11	14.5	2001/08/24	0.356
1991	2001/08/14	178.3	21h37m	-15	2001/08/14	13.8	2001/08/11	0.772
2017	2001/09/10	179.2	23h15m	- 4	2001/09/10	14.0	2001/09/03	0.894
2023	2001/10/02	175.0	0h28m	+ 8	2001/10/01	13.7	2001/09/29	1.096
2139	2001/08/15	175.9	21h33m	-10	2001/08/15	14.5	2001/08/14	0.987
2156	2001/10/18	178.3	1h32m	+11	2001/10/18	13.6	2001/10/16	0.796
2253	2001/07/18	175.3	19h45m	-16	2001/07/18	13.4	2001/07/24	0.663
2348	2001/12/21	171.0	5h58m	+14	2001/12/22	14.4	2001/12/25	1.055
2479	2001/01/16	178.1	7h56m	+22	2001/01/16	14.5	2001/01/16	0.935
2651	2001/12/04	152.1	4h44m	- 5	2001/11/30	13.7	2001/11/26	1.130
3103	2001/07/22	132.6	22h55m	+ 3	2001/08/02	12.9	2001/08/06	0.116
3107	2001/08/14	177.1	21h31m	-11	2001/08/14	14.5	2001/08/13	0.733
3116	2001/08/04	170.5	21h12m	-26	2001/08/05	13.9	2001/08/10	0.838
3156	2001/02/16	162.1	10h21m	+29	2001/02/15	14.4	2001/02/14	1.369
3182	2001/11/30	179.4	4h24m	+21	2001/11/30	14.5	2001/11/27	1.264
3184	2001/06/30	179.7	18h37m	-23	2001/06/30	14.1	2001/07/10	1.128
3248	2001/09/26	177.2	0h15m	- 1	2001/09/26	14.4	2001/09/21	1.766
3300	2001/05/13	166.5	15h10m	-31	2001/05/14	14.2	2001/05/20	1.716
3322	2001/12/18	164.3	6h 1m	+ 8	2001/12/19	14.2	2001/12/22	0.941
3443	2001/08/10	155.7	20h33m	+ 5	2001/08/06	14.4	2001/08/02	0.692
3879	2001/08/02	175.8	20h52m	-21	2001/08/02	14.5	2001/08/11	0.838
4201	2001/06/07	174.9	17h 7m	-17	2001/06/07	14.0	2001/06/07	1.420
4222	2001/10/09	178.3	0h55m	+ 7	2001/10/09	13.4	2001/10/19	0.793
4324	2001/10/28	165.3	1h47m	+26	2001/10/28	14.0	2001/10/28	1.064
4378	2001/06/28	179.3	18h31m	-22	2001/06/28	13.8	2001/06/20	1.162
4440	2001/01/12	171.1	7h40m	+12	2001/01/13	13.7	2001/01/14	0.816
4451	2001/10/17	154.3	0h 8m	+26	2001/10/10	13.7	2001/10/02	0.778
4520	2001/09/07	170.8	23h20m	-14	2001/09/07	14.1	2001/09/08	0.777
4558	2001/10/31	127.1	22h48m	+38	2001/10/07	13.3	2001/09/28	0.600
5002	2001/07/15	179.5	19h37m	-21	2001/07/15	14.4	2001/07/12	0.835
5216	2001/08/23	174.3	22h21m	-16	2001/08/23	13.9	2001/08/22	1.181
5222	2001/04/30	178.8	14h27m	-15	2001/04/30	13.7	2001/04/28	1.399
5559	2001/06/20	178.4	17h55m	-21	2001/06/20	13.6	2001/06/21	0.814
5587	2001/04/12	152.4	15h 4m	+ 2	2001/04/30	13.0	2001/05/16	0.298
5587	2001/09/19	159.4	22h38m	+10	2001/09/01	13.3	2001/08/02	0.349
5847	2001/10/17	165.8	1h 5m	+22	2001/10/16	14.0	2001/10/14	0.797
5964	2001/10/14	177.1	1h22m	+ 5	2001/10/14	14.2	2001/10/14	1.154
5970	2001/07/29	179.4	20h34m	-19	2001/07/29	14.5	2001/07/26	0.838
5980	2001/10/03	177.2	0h33m	+ 6	2001/10/03	14.5	2001/10/02	0.914
6146	2001/08/09	171.8	21h28m	-23	2001/08/08	13.9	2001/08/02	0.712
6193	2001/07/28	179.2	20h30m	-19	2001/07/28	14.1	2001/07/19	0.999
6669	2001/08/14	165.3	21h58m	-28	2001/08/13	14.0	2001/08/09	0.744
7000	2001/11/17	178.0	3h32m	+17	2001/11/17	14.4	2001/11/07	0.959
7043	2001/06/19	167.3	17h53m	-10	2001/06/20	14.3	2001/06/24	0.846
7353	2001/08/08	179.4	21h16m	-16	2001/08/08	13.9	2001/08/10	1.114
7808	2001/06/24	179.5	18h10m	-23	2001/06/24	14.4	2001/06/23	1.144
7898	2001/09/07	164.0	23h31m	-20	2001/09/06	14.2	2001/09/05	0.734
8021	2001/11/14	174.6	3h 7m	+23	2001/11/14	14.1	2001/11/11	0.854
10094	2001/09/18	179.1	23h44m	- 2	2001/09/18	14.1	2001/09/19	1.226
10565	2001/10/28	169.9	2h17m	+ 3	2001/10/27	14.4	2001/10/25	1.076
14790	2001/08/14	179.5	21h34m	-14	2001/08/14	14.5	2001/08/21	0.901
15166	2001/09/11	179.2	23h18m	- 3	2001/09/11	14.3	2001/09/08	1.209

Table II. Temporal Sequence of Favorable Elongations

Planet	Max Elon D	Max E	RA	Dec	Min Mag E	Mag	Min Dist D	Min Dist
1450	2001/01/03	175.7	7h 1m	+26	2001/01/03	14.2	2001/01/01	1.199
1665	2001/01/09	173.2	7h29m	+28	2001/01/08	13.5	2001/01/07	0.941
908	2001/01/12	168.2	7h53m	+32	2001/01/12	13.0	2001/01/12	1.138
4440	2001/01/12	171.1	7h40m	+12	2001/01/13	13.7	2001/01/14	0.816
505	2001/01/13	172.8	7h51m	+28	2001/01/13	11.0	2001/01/06	1.174
1126	2001/01/14	168.0	7h52m	+33	2001/01/14	14.0	2001/01/17	0.984
2479	2001/01/16	178.1	7h56m	+22	2001/01/16	14.5	2001/01/16	0.935
523	2001/01/18	175.6	8h 0m	+16	2001/01/18	12.7	2001/01/15	1.500
402	2001/01/19	176.3	8h 2m	+16	2001/01/19	11.6	2001/01/21	1.316
629	2001/02/05	168.6	9h35m	+26	2001/02/05	13.5	2001/02/04	1.677
3156	2001/02/16	162.1	10h21m	+29	2001/02/15	14.4	2001/02/14	1.369
555	2001/02/23	178.3	10h30m	+11	2001/02/23	14.1	2001/02/21	1.753
1319	2001/03/08	175.4	11h 8m	+ 0	2001/03/08	14.2	2001/03/14	1.506
354	2001/03/09	164.8	11h49m	+17	2001/03/08	9.7	2001/03/08	1.535
114	2001/03/13	178.7	11h37m	+ 3	2001/03/13	10.8	2001/03/13	1.329
1660	2001/03/19	151.0	10h40m	-22	2001/03/13	13.6	2001/03/08	0.835
968	2001/03/31	173.9	12h28m	- 9	2001/03/31	13.3	2001/03/29	1.568
5587	2001/04/12	152.4	15h 4m	+ 2	2001/04/30	13.0	2001/05/16	0.298
532	2001/04/22	152.7	14h35m	+13	2001/04/20	9.0	2001/04/19	1.377
5222	2001/04/30	178.8	14h27m	-15	2001/04/30	13.7	2001/04/28	1.399
1680	2001/05/13	176.0	15h24m	-14	2001/05/13	13.6	2001/05/15	1.219
3300	2001/05/13	166.5	15h10m	-31	2001/05/14	14.2	2001/05/20	1.716
785	2001/05/15	172.3	15h34m	-11	2001/05/15	11.6	2001/05/11	1.076
1320	2001/05/19	171.1	15h49m	-11	2001/05/20	13.4	2001/05/26	1.382
1264	2001/05/22	174.4	16h 7m	-15	2001/05/23	12.1	2001/05/25	1.425
42	2001/06/07	177.8	17h 4m	-20	2001/06/08	9.5	2001/06/17	1.083
4201	2001/06/07	174.9	17h 7m	-17	2001/06/07	14.0	2001/06/07	1.420
14	2001/06/10	178.1	17h16m	-21	2001/06/10	9.2	2001/06/04	1.400
409	2001/06/12	173.4	17h28m	-16	2001/06/12	10.5	2001/06/11	1.398
1358	2001/06/15	176.3	17h33m	-26	2001/06/15	14.3	2001/06/21	1.127
1667	2001/06/17	179.0	17h44m	-24	2001/06/17	13.2	2001/06/19	0.835
410	2001/06/18	176.2	17h47m	-19	2001/06/18	10.3	2001/06/19	1.065
7043	2001/06/19	167.3	17h53m	-10	2001/06/20	14.3	2001/06/24	0.846
5559	2001/06/20	178.4	17h55m	-21	2001/06/20	13.6	2001/06/21	0.814
1427	2001/06/22	176.3	18h 6m	-27	2001/06/22	13.3	2001/06/29	1.282
7808	2001/06/24	179.5	18h10m	-23	2001/06/24	14.4	2001/06/23	1.144
564	2001/06/26	163.7	18h40m	-39	2001/06/27	12.5	2001/06/28	1.005
380	2001/06/28	179.7	18h30m	-23	2001/06/28	12.3	2001/07/02	1.472
4378	2001/06/28	179.3	18h31m	-22	2001/06/28	13.8	2001/06/20	1.162
3184	2001/06/30	179.7	18h37m	-23	2001/06/30	14.1	2001/07/10	1.128

Planet	Max Elon D	Max E	RA	Dec	Min Mag E	Mag	Min Dist D	Min Dist
1820	2001/07/03	171.9	18h45m	-14	2001/07/04	14.1	2001/07/10	0.768
1108	2001/07/08	134.5	19h31m	+22	2001/07/14	14.2	2001/07/15	0.952
5002	2001/07/15	179.5	19h37m	-21	2001/07/15	14.4	2001/07/12	0.835
2253	2001/07/18	175.3	19h45m	-16	2001/07/18	13.4	2001/07/24	0.663
1650	2001/07/20	174.8	19h55m	-15	2001/07/20	13.6	2001/07/15	1.089
1506	2001/07/21	156.4	19h51m	+ 3	2001/07/19	13.7	2001/07/16	0.947
3103	2001/07/22	132.6	22h55m	+ 3	2001/08/02	12.9	2001/08/06	0.116
956	2001/07/23	167.4	19h58m	- 7	2001/07/23	14.1	2001/07/26	0.837
70	2001/07/24	159.1	20h41m	-39	2001/07/24	10.7	2001/07/24	1.156
368	2001/07/26	167.2	20h10m	- 6	2001/07/26	13.1	2001/07/27	1.448
431	2001/07/27	179.6	20h28m	-19	2001/07/27	11.9	2001/07/30	1.594
6193	2001/07/28	179.2	20h30m	-19	2001/07/28	14.1	2001/07/19	0.999
5970	2001/07/29	179.4	20h34m	-19	2001/07/29	14.5	2001/07/26	0.838
3879	2001/08/02	175.8	20h52m	-21	2001/08/02	14.5	2001/08/11	0.838
3116	2001/08/04	170.5	21h12m	-26	2001/08/05	13.9	2001/08/10	0.838
1147	2001/08/06	173.3	20h58m	-10	2001/08/05	13.1	2001/07/29	0.782
269	2001/08/08	176.2	21h 7m	-12	2001/08/08	11.6	2001/08/01	1.121
7353	2001/08/08	179.4	21h16m	-16	2001/08/08	13.9	2001/08/10	1.114
6146	2001/08/09	171.8	21h28m	-23	2001/08/08	13.9	2001/08/02	0.712
3443	2001/08/10	155.7	20h33m	+ 5	2001/08/06	14.4	2001/08/02	0.692
1991	2001/08/14	178.3	21h37m	-15	2001/08/14	13.8	2001/08/11	0.772
3107	2001/08/14	177.1	21h31m	-11	2001/08/14	14.5	2001/08/13	0.733
6669	2001/08/14	165.3	21h58m	-28	2001/08/13	14.0	2001/08/09	0.744
14790	2001/08/14	179.5	21h34m	-14	2001/08/14	14.5	2001/08/21	0.901
2139	2001/08/15	175.9	21h33m	-10	2001/08/15	14.5	2001/08/14	0.987
1693	2001/08/16	157.9	22h19m	-34	2001/08/14	13.4	2001/08/10	1.081
602	2001/08/18	177.1	21h55m	-15	2001/08/18	11.4	2001/08/24	1.521
103	2001/08/20	178.2	21h59m	-14	2001/08/20	10.6	2001/08/19	1.474
504	2001/08/20	163.3	22h29m	-27	2001/08/21	12.0	2001/08/23	1.176
1006	2001/08/20	169.5	21h47m	- 2	2001/08/22	14.0	2001/08/30	1.295
445	2001/08/22	158.2	21h45m	+ 9	2001/08/24	13.2	2001/08/26	1.716
1097	2001/08/22	179.0	22h 9m	-12	2001/08/22	12.9	2001/08/16	0.865
1609	2001/08/23	151.7	23h15m	-35	2001/08/22	12.8	2001/08/22	0.988
5216	2001/08/23	174.3	22h21m	-16	2001/08/23	13.9	2001/08/22	1.181
225	2001/08/28	155.6	21h41m	+11	2001/08/25	12.4	2001/08/21	1.582
144	2001/08/29	170.9	22h47m	-17	2001/08/30	10.1	2001/09/03	1.098
234	2001/08/29	172.2	22h50m	-15	2001/08/29	10.2	2001/08/28	0.801
1539	2001/08/29	179.4	22h33m	- 9	2001/08/29	14.1	2001/09/02	1.770
1593	2001/08/29	164.6	23h 4m	-22	2001/08/26	14.0	2001/08/18	0.648
1335	2001/09/04	178.9	22h54m	- 5	2001/09/05	14.3	2001/09/07	0.919
4520	2001/09/07	170.8	23h20m	-14	2001/09/07	14.1	2001/09/08	0.777
7898	2001/09/07	164.0	23h31m	-20	2001/09/06	14.2	2001/09/05	0.734
74	2001/09/10	176.1	23h 7m	- 1	2001/09/10	10.9	2001/09/13	1.154
2017	2001/09/10	179.2	23h15m	- 4	2001/09/10	14.0	2001/09/03	0.894
15166	2001/09/11	179.2	23h18m	- 3	2001/09/11	14.3	2001/09/08	1.209
253	2001/09/12	177.6	23h17m	- 1	2001/09/12	11.7	2001/09/08	0.949
767	2001/09/12	176.0	23h28m	- 7	2001/09/12	13.2	2001/09/10	1.567
1738	2001/09/14	170.9	23h41m	-11	2001/09/13	13.4	2001/09/08	0.761
434	2001/09/15	176.7	23h23m	- 0	2001/09/14	12.4	2001/09/11	0.844
1196	2001/09/15	149.6	0h31m	-29	2001/09/15	13.2	2001/09/15	1.257
713	2001/09/16	168.6	23h16m	+ 7	2001/09/16	12.9	2001/09/15	1.808
1047	2001/09/18	167.6	0h 4m	-13	2001/09/19	13.3	2001/09/21	0.838
10094	2001/09/18	179.1	23h44m	- 2	2001/09/18	14.1	2001/09/19	1.226
886	2001/09/19	153.8	0h24m	-25	2001/09/19	12.0	2001/09/18	1.406
5587	2001/09/19	159.4	22h38m	+10	2001/09/01	13.3	2001/08/02	0.349
601	2001/09/21	176.0	0h 2m	- 4	2001/09/21	13.5	2001/09/18	1.851
270	2001/09/24	175.2	23h56m	+ 4	2001/09/23	10.2	2001/09/19	0.891
3248	2001/09/26	177.2	0h15m	- 1	2001/09/26	14.4	2001/09/21	1.766
19	2001/09/27	178.6	0h14m	+ 3	2001/09/27	9.0	2001/09/30	1.089
67	2001/09/29	176.7	0h17m	+ 5	2001/09/29	10.4	2001/09/21	1.119
901	2001/09/29	172.3	0h11m	+ 9	2001/09/28	12.5	2001/09/21	0.783
1916	2001/09/29	159.9	0h10m	+22	2001/09/11	14.5	2001/08/24	0.356
959	2001/10/02	174.4	0h44m	- 1	2001/10/03	13.5	2001/10/04	1.566
2023	2001/10/02	175.0	0h28m	+ 8	2001/10/01	13.7	2001/09/29	1.096
5980	2001/10/03	177.2	0h33m	+ 6	2001/10/03	14.5	2001/10/02	0.914
1170	2001/10/04	168.0	0h39m	+16	2001/10/06	13.5	2001/10/14	0.749
1123	2001/10/05	167.5	1h 1m	- 6	2001/10/05	13.4	2001/10/07	0.913
1369	2001/10/05	175.4	0h54m	+ 0	2001/10/05	14.3	2001/09/27	1.730
492	2001/10/07	178.6	0h55m	+ 4	2001/10/07	13.1	2001/10/03	1.655
498	2001/10/09	162.5	1h24m	- 9	2001/10/07	11.5	2001/10/01	1.160
4222	2001/10/09	178.3	0h55m	+ 7	2001/10/09	13.4	2001/10/19	0.793
704	2001/10/11	152.7	0h18m	+31	2001/10/11	10.0	2001/10/10	1.688
1807	2001/10/12	175.3	1h 2m	+11	2001/10/12	13.3	2001/10/10	0.834
247	2001/10/14	160.3	1h 3m	+27	2001/10/16	10.6	2001/10/18	1.161
5964	2001/10/14	177.1	1h22m	+ 5	2001/10/14	14.2	2001/10/14	1.154
1310	2001/10/16	154.6	1h19m	+34	2001/10/24	12.9	2001/11/01	0.773
612	2001/10/17	179.7	1h28m	+ 9	2001/10/17	14.3	2001/10/08	1.590
4451	2001/10/17	154.3	0h 8m	+26	2001/10/10	13.7	2001/10/02	0.778
5847	2001/10/17	165.8	1h 5m	+22	2001/10/16	14.0	2001/10/14	0.797
2156	2001/10/18	178.3	1h32m	+11	2001/10/18	13.6	2001/10/16	0.796
266	2001/10/21	168.7	1h23m	+20	2001/10/21	11.8	2001/10/20	1.386
719	2001/10/26	161.1	2h41m	- 3	2001/09/24	15.0	2001/09/05	0.285
1730	2001/10/26	168.3	2h20m	+ 1	2001/10/26	14.0	2001/10/25	1.183
4324	2001/10/28	165.3	1h47m	+26	2001/10/28	14.0	2001/10/28	1.064
10565	2001/10/28	169.9	2h17m	+ 3	2001/10/27	14.4	2001/10/25	1.076
547	2001/10/30	166.4	2h43m	+ 1	2001/10/29	11.9	2001/10/27	1.149
4558	2001/10/31	127.1	22h48m	+38	2001/10/07	13.3	2001/09/28	0.600
36	2001/11/01	153.8	2h 7m	+40	2001/11/01	10.6	2001/11/01	0.976
1381	2001/11/11	172.5	2h58m	+24	2001/11/10	14.4	2001/11/06	1.088
211	2001/11/12	176.5	3h 6m	+21	2001/11/12	11.2	2001/11/14	1.607
66	2001/11/13	176.2	3h10m	+21	2001/11/13	11.7	2001/11/12	1.201
519	2001/11/14	177.5	3h19m	+20	2001/11/14	12.2	2001/11/08	1.513
8021	2001/11/14	174.6	3h 7m	+23	2001/11/14	14.1	2001/11/11	0.854
7000	2001/11/17	178.0	3h32m	+17	2001/11/17	14.4	2001/11/07	0.959
1750	2001/11/18	147.4	2h 5m	+46	2001/11/14	14.4	2001/11/11	0.695
972	2001/11/19	170.2	3h29m	+29	2001/11/18	12.7	2001/11/13	1.501
915	2001/11/24	170.9	3h54m	+29	2001/11/24	13.4	2001/11/22	0.942
563	2001/11/29	173.8	4h25m	+15	2001/11/29	10.6	2001/11/28	1.089
3182	2001/11/30	179.4	4h24m	+21	2001/11/30	14.5	2001/11/27	1.264
882	2001/12/03	178.8	4h36m	+23	2001/12/03	13.5	2001/11/25	1.500
2651	2001/12/04	152.1	4h44m	- 5	2001/11/30	13.7	2001/11/26	1.130
418	2001/12/09	178.3	5h 6m	+21	2001/12/09	12.6	2001/12/05	1.436
569	2001/12/10	178.3	5h 7m	+24	2001/12/10	12.3	2001/12/10	1.186
543	2001/12/11	172.1	5h11m	+30	2001/12/11	12.9	2001/12/08	1.671
451	2001/12/16	178.0	5h37m	+21	2001/12/16	10.4	2001/12/15	1.849
3322	2001/12/18	164.3	6h 1m	+ 8	2001/12/19	14.2	2001/12/22	0.941
2348	2001/12/21	171.0	5h58m	+14	2001/12/22	14.4	2001/12/25	1.05

THE MINOR PLANET OBSERVER: WORKING TOGETHER

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The summer months of 2000 were quite busy for me. I managed a second asteroid discovery, determined another lightcurve, and took part in a joint effort towards finding another lightcurve. The first and third adventures provide excellent examples of how teamwork and coordinated efforts can lead to success for many, not just one, with the ultimate winner being science.

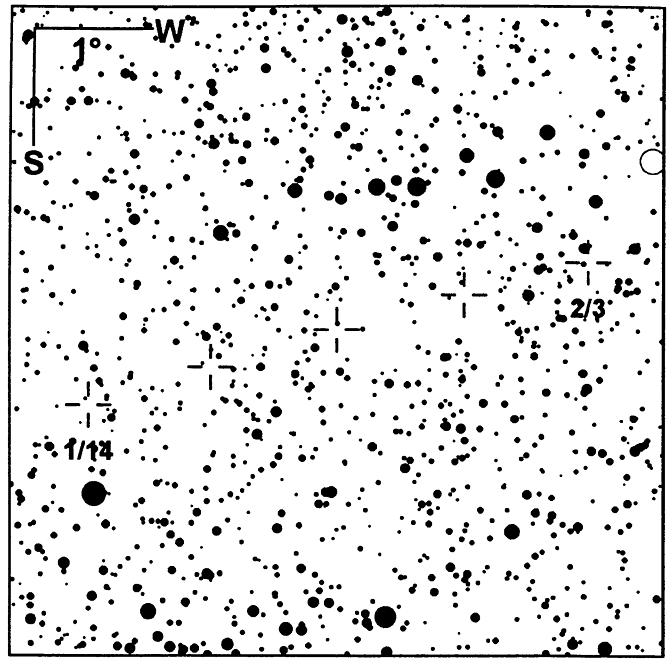
One evening, after getting a part for the 0.5m scope back from repairs, I decided to see if the fix would allow me to take 90 to 120-second unguided exposures. Beforehand, a 30-second exposure was often badly trailed. After taking shots of random star fields and a few "pretty pictures" of the summer Milky Way Messier highlights, I went after some asteroids needing follow-up observations.

While measuring one of the images, I found what appeared to be another asteroid. A check with the Minor Planet Center web site didn't show any known asteroids in the immediate vicinity. The chase began. Bad weather was settling in for a day, so I contacted Paul Comba to ask if he could get second night images. He did and, while doing so, found a new asteroid of his own.

Paul was not able to follow up on his discovery the next night so he asked me to return the favor, which I was glad to do while following up my discovery. In that process, I found what I thought at the time was *another* new asteroid. It later turned out that it wasn't but, again, Paul was in on trying to confirm the latest find and added at least one more to his "little herd." It seemed it might go on forever but the moon came in to stop the show.

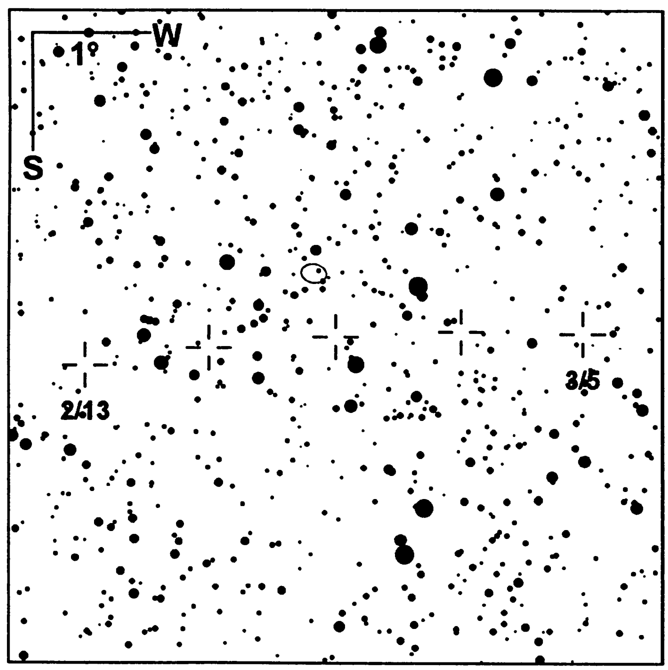
The other collaborative effort started with an e-mail message from Dr. Alan Harris of JPL, saying that the lightcurve for 27 Euterpe had been reported with several different periods. Since the period was nearly a multiple of 24 hours, this seemed an ideal situation to put together a team of observers from around the world. In the end, the team consisted of Stephen Brincat in Malta, Robert Koff in Colorado, and Robert Stephens and Glenn Malcolm in California (USA). I wasn't able to observe but was able to help to reduce the data. The effort produced more than 1200 observations and a period that was *none* of the previously published values. Details of this effort and the derived period will likely appear in a future *Minor Planet Bulletin* article and possibly as a sidebar in one of the leading astronomy magazines.

Those who regularly take part in asteroid astrometry are familiar with collaborative relationships, many of which had the same type of leap-frogging discoveries as I described. The fun part and the most important point are that there are many opportunities for amateurs to work with other amateurs and even professionals to produce a sum of data greater than the individual parts. At times the process can be difficult and frustrating, especially if you're an old dog like me. However, when the result is a new lightcurve or a new asteroid discovery for one or more of those taking part, then these "new tricks" are worth learning. Clear Skies!



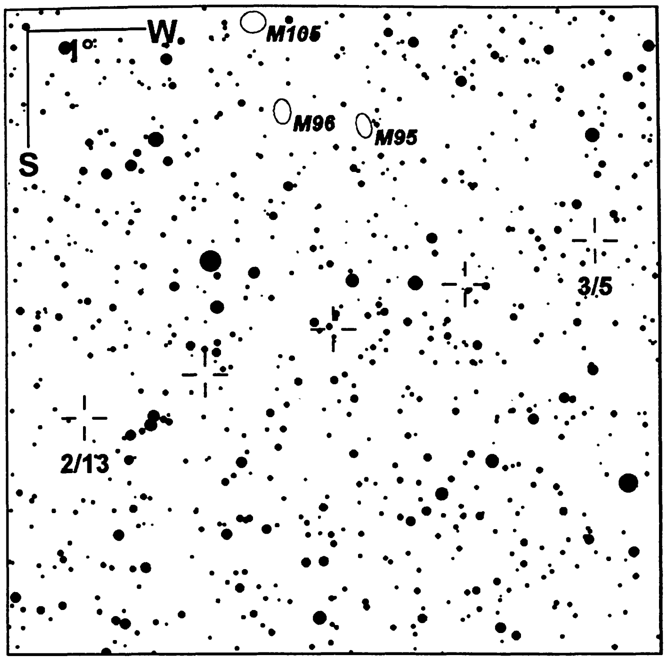
1423 Jose (F). Jose is an unclassified asteroid of about 15km size. It was discovered by J. Hunaerts in 1936 August and is named after the daughter of an Italian astronomer. The field is in Cancer with Gamma at lower left.

Date	RA2000	Dec2000	RA1950	Dec1950	M	PA	E
01/14	8 43.53	+22 13.0	8 40.62	+22 23.8	14.7	4.7	166
01/19	8 39.09	+22 32.9	8 36.17	+22 43.5	14.5	2.8	172
01/24	8 34.47	+22 52.0	8 31.54	+23 02.4	14.4	1.4	176
01/29	8 29.81	+23 09.8	8 26.86	+23 19.9	14.5	2.2	174
02/03	8 25.23	+23 25.7	8 22.28	+23 35.5	14.6	4.0	168



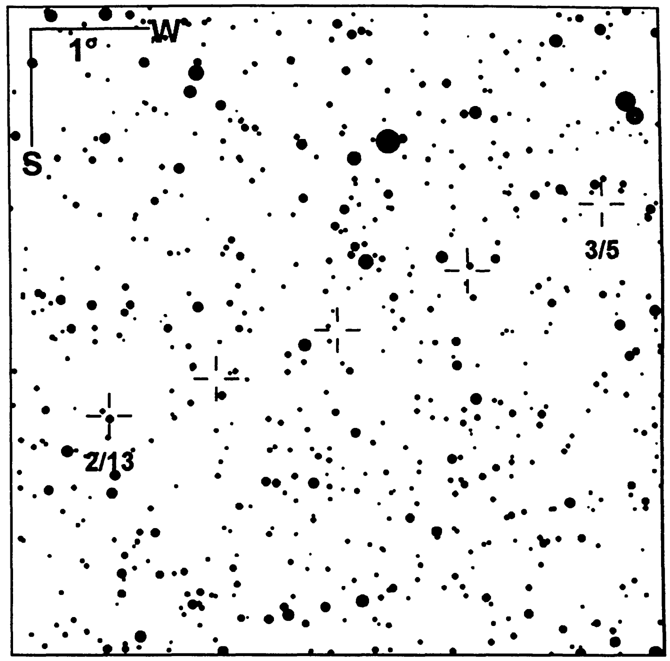
927 Ratisbona. This 74km type C asteroid wends its way through Leo in February. Discovery by M. Wolf was in 1920 February. The name is from the Latin for Regensburg, Germany, where Kepler died in 1629. The galaxy just above the asteroid's path is NGC 3209.

Date	RA2000	Dec2000	RA1950	Dec1950	M	PA	E
02/13	10 29.11	+24 41.6	10 26.34	+24 57.0	13.9	4.9	165
02/18	10 24.49	+24 51.0	10 21.72	+25 06.2	13.8	4.5	166
02/23	10 19.78	+24 57.0	10 17.00	+25 12.1	13.9	5.0	165
02/28	10 15.11	+24 59.3	10 12.31	+25 14.2	13.9	6.0	162
03/05	10 10.61	+24 57.4	10 07.80	+25 12.2	14.0	7.3	157



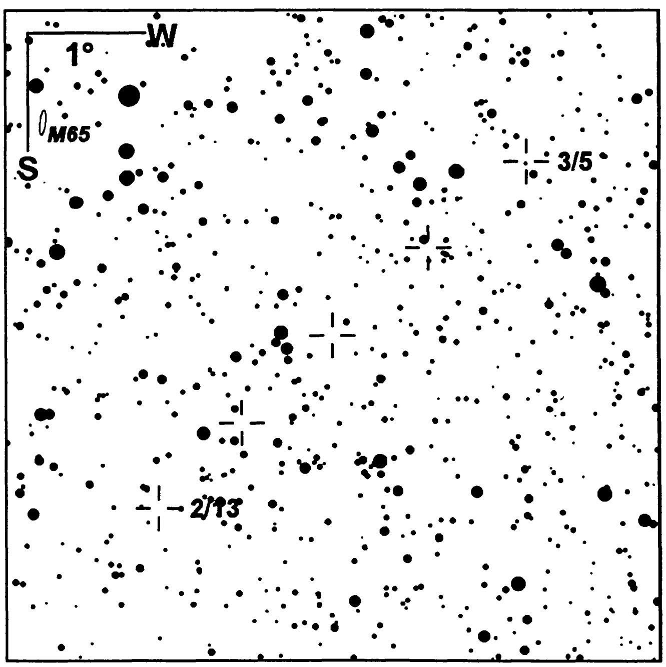
73 Klytia. A famous trio of galaxies in Leo offers some diversion while working Klytia, a 56km unclassified asteroid that was discovered in 1862 April by H.P. Tutle. In mythology, Klytia was nymph who was loved and then rejected by Apollo.

Date	RA2000	Dec2000	RA1950	Dec1950	M	PA	E
02/13	11 00.00	+ 9 12.4	10 50.98	+ 9 28.4	12.8	6.2	163
02/18	10 49.47	+ 9 34.8	10 46.85	+ 9 50.6	12.6	4.0	169
02/23	10 45.08	+ 9 57.8	10 42.46	+10 13.6	12.5	1.8	175
02/28	10 40.58	+10 20.7	10 37.95	+10 36.4	12.4	0.9	178
03/05	10 36.11	+10 42.7	10 33.47	+10 58.3	12.6	3.0	172



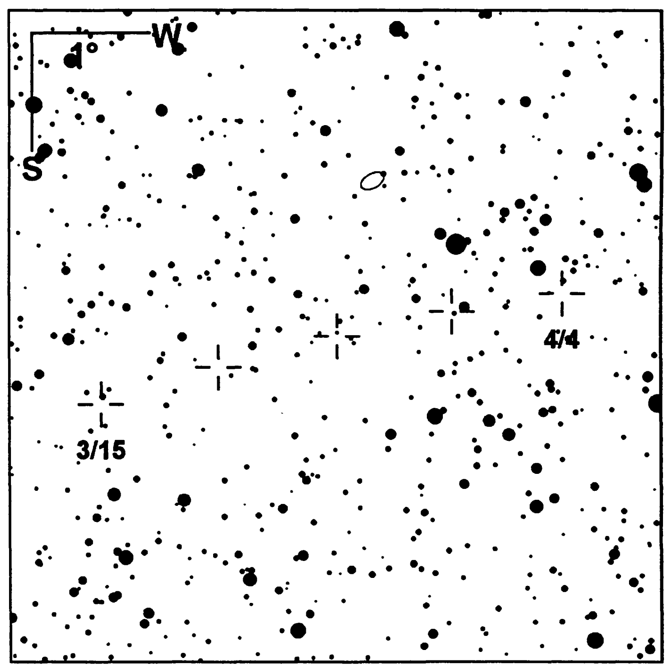
5858 Borovitskia (F). In reality, there's little difference among opposition appearances for Borovitskia, which was discovered by L.I. Chernykh 1978 September. The bright star at upper center is 51 Leonis. There is no established lightcurve for the asteroid. Its usual faintness is probably why.

Date	RA2000	Dec2000	RA1950	Dec1950	M	PA	E
02/13	11 11.34	- 4 48.9	11 08.80	- 4 32.6	15.5	12.0	152
02/18	11 07.70	- 4 30.2	11 05.16	- 4 13.9	15.4	9.8	158
02/23	11 03.59	- 4 05.4	11 01.05	- 3 49.3	15.2	7.5	163
02/28	10 59.17	- 3 35.3	10 56.63	- 3 19.2	15.1	5.4	168
03/05	10 54.61	- 3 00.8	10 52.06	- 2 44.8	15.0	4.2	171



286 Iclea. Discovered by J. Palisia in 1889 August, Iclea is a type CX asteroid of about 92km size. Flammarion used the name for the heroine in his astronomical romance, Uranie. The field is in Leo. At upper left is M66, with M65 just off to the left.

Date	RA2000	Dec2000	RA1950	Dec1950	M	PA	E
02/13	11 14.82	+ 9 48.8	11 12.22	+10 05.2	13.9	6.4	158
02/18	11 11.98	+10 32.3	11 09.37	+10 48.7	13.8	4.8	164
02/23	11 08.86	+11 16.8	11 06.25	+11 33.1	13.7	3.2	169
02/28	11 05.55	+12 01.3	11 02.93	+12 17.5	13.6	2.0	173
03/05	11 02.15	+12 45.1	10 59.52	+13 01.3	13.6	2.0	173



1388 Aphrodite. Those with a 20-25cm scope should be able to work this 22km type SM asteroid. Aphrodite is named after the Greek goddess of love and affection. E. Delporte discovered it in 1935 September. Chart center is about 3° due east of Beta Leonis (Denebola).

Date	RA2000	Dec2000	RA1950	Dec1950	M	PA	E
03/15	12 08.08	+14 16.8	12 05.53	+14 33.5	13.6	4.3	166
03/20	12 04.00	+14 35.9	12 01.44	+14 52.6	13.6	4.4	166
03/25	11 59.87	+14 52.0	11 57.31	+15 08.7	13.6	5.2	163
03/30	11 55.83	+15 04.5	11 53.26	+15 21.2	13.7	6.4	159
04/04	11 51.95	+15 13.1	11 49.38	+15 29.8	13.8	7.8	154

APPEAL FOR OBSERVATIONS OF 1915 QUETZALCOATL

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(Received: 30 October)

Can anyone in the Minor Planets Section do astrometry at magnitude 21? Minor Planet 1915 Quetzalcoatl has not been observed since the year 1985, a longer interval of non-observation than for any other numbered minor planet. During the years 1953-1981 Quetzalcoatl had a period very near 4.00 years and reached the perihelion point of its orbit near 1.1 AU at about the same time as the Earth passed this location, causing a series of very close approaches. Since that time planetary perturbations have increased the period to about 4.05 years, with the result that the Earth is now passing Quetzalcoatl's perihelion successively farther ahead of the minor planet. Each subsequent approach is farther away and fainter than the one four years earlier. Through most of the first half of the twenty-first century Quetzalcoatl will become no brighter than magnitude 23. The author therefore appeals for astrometric observations at the forthcoming apparition in order to better refine the orbit before it becomes completely unobservable for several decades. The ephemeris below is to assist observers in planning for this event.

EDITOR'S QUERY: SHOULD "ASTEROID NEWS NOTES" CONTINUE?

For more than 15 years, "Asteroid News Notes" written by David J. Tholen of the University of Hawaii has been a regular feature in the Minor Planet Bulletin. These notes have kept readers informed on minor planet research news fronts, kept tallies of new discoveries – especially those in planet crossing orbits, and provided comments on new and interesting asteroid names. Compiling these News Notes has been a labor of love for Dr. Tholen, one of the world's foremost experts in the physical study of minor planets.

A question arises whether "Asteroid News Notes" and the expenditure of effort in creating it (within Dr. Tholen's extremely busy schedule) are necessary in the new era of the World Wide Web. The modern internet provides easy access to keeping track of discoveries via the IAU Minor Planet Center web page. Numerous other web sites pertain to asteroid research. What's more, there is now instantaneous distribution of news through electronic mail lists.

Should "Asteroid News Notes" continue as a regular feature in the Minor Planet Bulletin? Please email your responses to Dr. Tholen at tholen@hale.IfA.Hawaii.Edu with a copy to the Editor at rpb@mit.edu.

Richard P. Binzel

DATE	ET	RA(2000)	DEC(2000)	Mv	Sun	Earth	Phase	Elon
2001-Feb- 5	.0	2h 41.08m	- 9° 10.0'	22.0	1.443	1.250	42.2	79.5
2001-Feb-10	.0	2h 48.90m	- 7° 39.3'	22.0	1.408	1.249	43.1	77.1
2001-Feb-15	.0	2h 57.54m	- 6° 4.9'	21.9	1.374	1.247	43.9	74.8
2001-Feb-20	.0	3h 7.01m	- 4° 26.9'	21.9	1.340	1.243	44.8	72.8
2001-Feb-25	.0	3h 17.31m	- 2° 45.4'	21.9	1.308	1.237	45.7	70.9
2001-Mar- 2	.0	3h 28.44m	- 1° .7'	21.8	1.277	1.230	46.5	69.3
2001-Mar- 7	.0	3h 40.40m	+ 0° 46.9'	21.8	1.248	1.221	47.4	67.7
2001-Mar-12	.0	3h 53.22m	+ 2° 37.1'	21.7	1.220	1.210	48.3	66.4
2001-Mar-17	.0	4h 6.91m	+ 4° 29.5'	21.7	1.194	1.199	49.1	65.2
2001-Mar-22	.0	4h 21.49m	+ 6° 23.7'	21.7	1.171	1.187	50.0	64.2
2001-Mar-27	.0	4h 37.01m	+ 8° 18.9'	21.6	1.150	1.174	50.8	63.3
2001-Apr- 1	.0	4h 53.47m	+10° 14.3'	21.6	1.132	1.162	51.6	62.6
2001-Apr- 6	.0	5h 10.91m	+12° 8.8'	21.6	1.117	1.150	52.4	62.1
2001-Apr-11	.0	5h 29.32m	+14° 1.2'	21.5	1.105	1.139	53.0	61.7
2001-Apr-16	.0	5h 48.72m	+15° 49.8'	21.5	1.096	1.130	53.6	61.5
2001-Apr-21	.0	6h 9.09m	+17° 33.1'	21.5	1.091	1.122	54.0	61.4
2001-Apr-26	.0	6h 30.40m	+19° 9.1'	21.5	1.089	1.116	54.3	61.5
2001-May- 1	.0	6h 52.58m	+20° 35.9'	21.5	1.091	1.113	54.4	61.6
2001-May- 6	.0	7h 15.50m	+21° 51.4'	21.5	1.096	1.113	54.3	62.0
2001-May-11	.0	7h 39.04m	+22° 53.9'	21.5	1.105	1.117	54.1	62.4
2001-May-16	.0	8h 3.01m	+23° 42.0'	21.5	1.117	1.124	53.6	62.8
2001-May-21	.0	8h 27.22m	+24° 14.6'	21.6	1.132	1.134	53.0	63.4
2001-May-26	.0	8h 51.45m	+24° 31.1'	21.6	1.150	1.149	52.3	63.9
2001-May-31	.0	9h 15.48m	+24° 31.6'	21.7	1.171	1.168	51.4	64.5
2001-Jun- 5	.0	9h 39.10m	+24° 16.9'	21.7	1.195	1.190	50.4	65.1
2001-Jun-10	.0	10h 2.13m	+23° 47.8'	21.8	1.220	1.217	49.2	65.6
2001-Jun-15	.0	10h 24.44m	+23° 5.9'	21.8	1.248	1.247	48.0	66.0
2001-Jun-20	.0	10h 45.94m	+22° 12.8'	21.9	1.277	1.282	46.8	66.4
2001-Jun-25	.0	11h 6.57m	+21° 10.3'	22.0	1.308	1.320	45.5	66.7

ASTEROID PHOTOMETRY OPPORTUNITIES JANUARY-MARCH 2001

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Lightcurve observations made from amateur and small professional stations during last summer and early autumn contributed significantly to understanding of rotations and other characteristics of several asteroids. There was a quite successful campaign on observations of the binary near-Earth asteroid 2000 DP107 (see, e.g., IAU Circular 7504); the gathered data were being reduced and analysed at the time of writing of this article (October 2000) and they shall result in a model of the binary system. Two other very successful collaborative projects concentrated on 27 Euterpe (see the article by R. Stephens et al. published elsewhere in this issue) and 391 Ingeborg (observed by a group of several observers led by R. Koff) allowed to establish correct rotation periods for the two asteroids with unusual lightcurves. We encourage observers to take part in collaborative efforts like those mentioned above which would allow to resolve uncertain rotation periods and lightcurves as well as to gather more experience by all involved. Even in cases of individual observing efforts, we recommend observers to coordinate via the Collaborative Asteroid Lightcurve Link (CALL; http://www.MinorPlanetObserver.com/astlc/default.htm) to avoid unnecessary duplication of coverage of some asteroids.

In the Table below, we present a list of suitable photometric targets for the January-March 2001 period. Most of the objects have been selected from a more extensive list prepared by Brian Warner. We selected objects with the predicted V<13.5 in opposition and unknown or not reliably established periods. We present preliminary uncertain period estimates for some of them to give you an idea what can be expected in them. The period of 108 Hecuba is ambiguous, a value twice as large is possible. The period of 112 Iphigenia is likely quite reliable, but the observations by Imhoff made at Lowell Observatory were never published, and now appear to be lost; a re-observation would be worthwhile to confirm the result. The Apollo asteroid 5131 1990 BG has been added to the list because it is observable in favorable conditions in January (it was in opposition in November 2000) and may be a suitable target for experienced photometrists. Also added have been asteroids 83, 174, 238 and 432 for which favorable occultation events are predicted to occur on February 16, February 16, March 6 and February 13, respectively. Since their periods are already established, lightcurve observations would be of value to establish the rotation phase at the instant of occultation. Observers interested in fainter asteroids are encouraged to check the full list on the CALL.

Asteroid	Opp'n Date	Opp'n V	Per	Ampl	Rem.
	2001		[h]		
259 Aletheia	Jan 02	12.6	~15	0.19	PER
108 Hecuba	Jan 19	12.5	14.46	0.05-0.2	PER
303 Josephina	Jan 20	12.9			PER
83 Beatrix	Jan 25	11.5	10.16	0.18-0.27	OCC
5131 1990 BG	(Jan 25	14.8)			PER, NEA
112 Iphigenia	Jan 28	13.2	15.78	0.50	PER
141 Lumen	Feb 01	11.8	19.67	0.13	PER
174 Phaedra	Feb 09	12.5	5.75	0.53	OCC
490 Veritas	Feb 14	13.1			PER
432 Pythia	Mar 10	12.0	8.25	0.14	OCC
238 Hypatia	Mar 16	12.4	8.88	0.12-0.15	OCC
774 Armor	Mar 16	12.9			PER
611 Valeria	Mar 16	13.2			PER

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* * * * *

The deadline for the next issue (28-2) is February 1, 2001. The deadline for issue 28-3 is May 1, 2001.