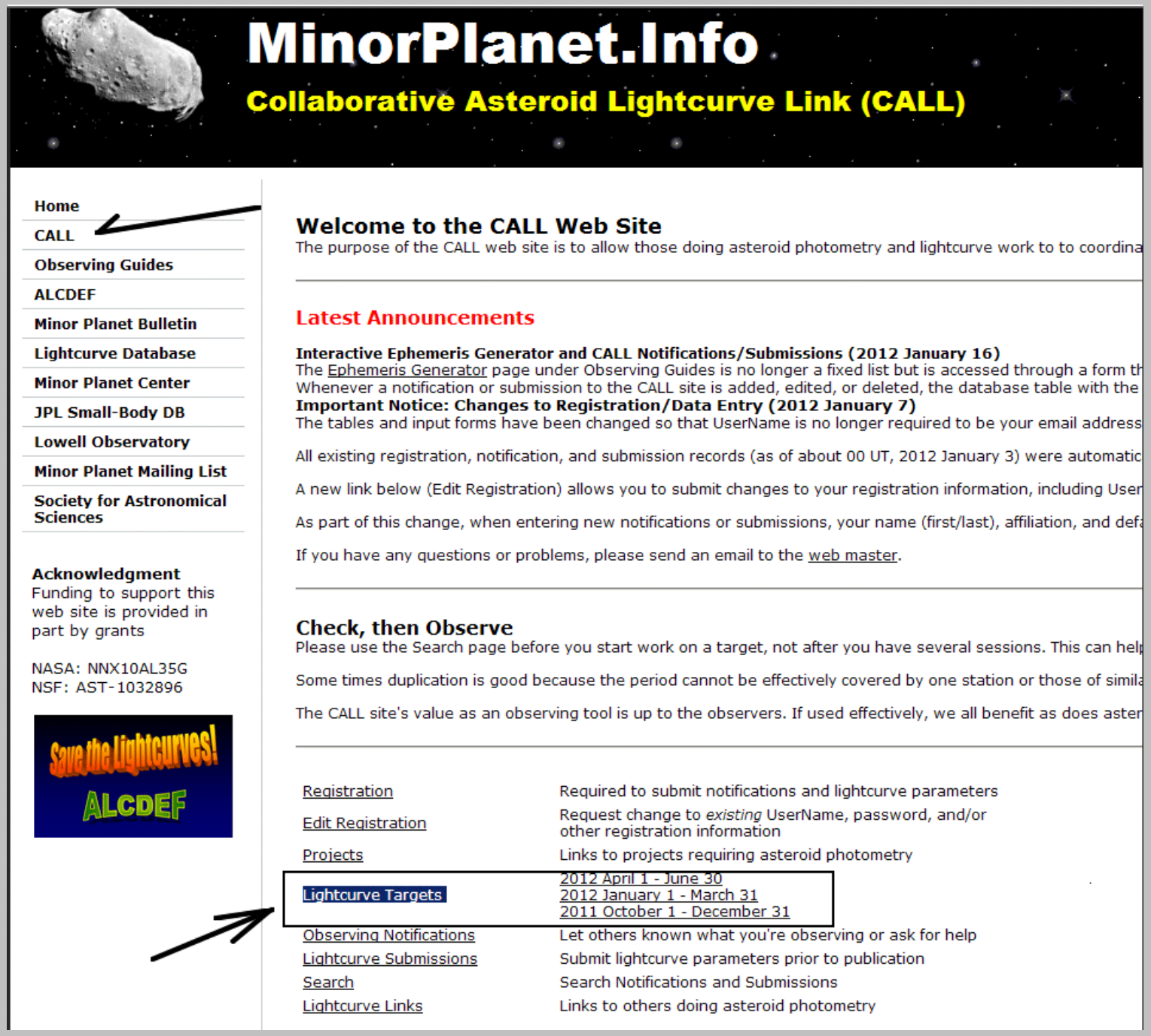
Measuring Asteroid Rotation Periods

- ✘ Getting data
- ✘ Measure a moving target
- ✘ Interpret the data
  - Getting it right
  - Getting it wrong
- ✘ Analysis & Some Results
- ✘ Problem Light Curves
- ✘ Support Resources

Possible targets



Select a target

Potential Lightcurve Targets 2012 January-March

This is list is by no means all inclusive. Some of the criteria for building were:

The asteroid had to be 15.0 or brighter at brightest (V as computed using H/G parameters)

The asteroid had to have either no or a poorly established lightcurve

This list was prepared by Brian D. Warner in support of the "Lightcurve Opportunities" article that appears in each issue of *The Minor Planet Bulletin*.

The 'U' (last) column indicates the uncertainty flag as assigned by Harris, Warner, and Pravec their Asteroid Lightcurve Data Base.

0 No lightcurve parameters reported
1 Very preliminary parameters reported. Very likely incorrect
2 Parameters reported. Error could be up to 30% or an ambiguous solution
? Parameters reported but not published so a value is not reported.

It's important to note that a flag of '2' by no means indicates the asteroid is not worth working. There can still be considerable error in the reported parameters. Also, additional work on any asteroid on this list can contribute towards determining the pole position or shape of the asteroid, information that is known for very few asteroids.

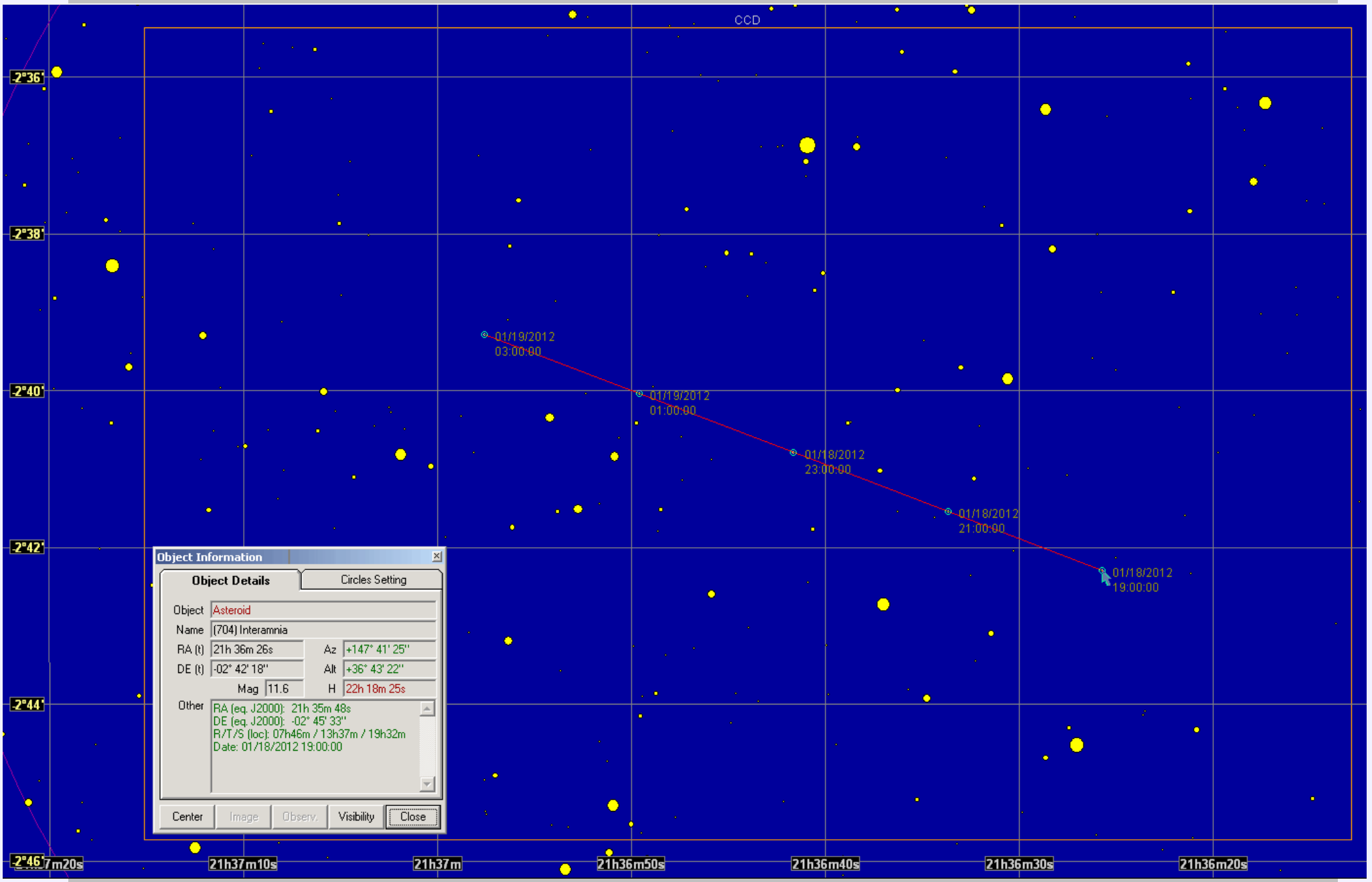
Asteroids with a '(F)' after the name are those reaching a particularly favorable opposition.

Click here to download a list that includes all asteroids reaching 16m or brighter in the three month period.

		Opposition		Closest		Brightest				LCDB Data	
#	Name	Date	Mag	Date	AU	Date	Mag	Dec	U	Period	Amplitude
621	Werdandi	1 03.1	13.9	1 02.6	1.707	1 02.9	13.9	+25	2	9.39	0.58
5435	Kameoka	1 05.2	14.9	1 05.9	1.768	1 05.7	14.9	+20			
8882	Sakaetamura	1 02.1	15.0	1 05.5	0.992	1 07.4	15.0	-10	2	2.83	0.66
3115	Baily	1 08.6	13.6	1 05.5	1.297	1 08.5	13.6	+13	2+	16.22	0.08-0.14
555	Norma	1 09.2	14.1	1 11.1	1.742	1 09.5	14.1	+21	2	30.6	0.20
3063	Makhaon	1 12.0	15.0	1 12.6	3.921	1 12.0	15.0	+21	2	8.64	0.03-0.15
3017	Petrovic	1 12.9	14.1	1 13.9	1.304	1 13.7	14.1	+ 9	2	4.06	0.40
4801	Ohre	1 15.3	14.8	1 14.8	1.234	1 14.8	14.8	+24			
1373	Cincinnati	1 15.7	15.0	1 06.7	1.869	1 15.1	15.0	+25	2	5.28	0.14
9780	Bandersnatch	1 16.9	14.6	1 18.8	1.007	1 16.8	14.6	+21	2+	8.23	0.16
5297	Schinkel	1 15.8	15.0	1 15.8	1.008	1 16.9	15.0	+14			
1311	Knopfia	1 20.0	15.0	1 21.1	1.339	1 20.6	15.0	+16	1+	9.65	1.3
2464	Nordenskiold	1 22.0	14.7	1 18.0	1.619	1 21.7	14.7	+21			
2026	Cottrell	1 22.5	15.0	1 25.8	1.237	1 22.3	15.0	+21			
6972	Helvetius	1 24.1	14.9	1 27.8	1.271	1 26.5	14.8	+ 8			
1660	Wood	1 18.0	13.7	1 31.3	0.826	1 30.6	13.7	-25			
4700	Carusi	2 02.0	14.7	1 25.7	1.163	1 30.2	14.7	+25			
47035	1998 WS	2 13.9	14.7	1 29.0	0.851	1 31.7	14.6	+69			
4874	Burke	2 02.3	14.7	1 30.2	1.355	2 01.6	14.7	+19			

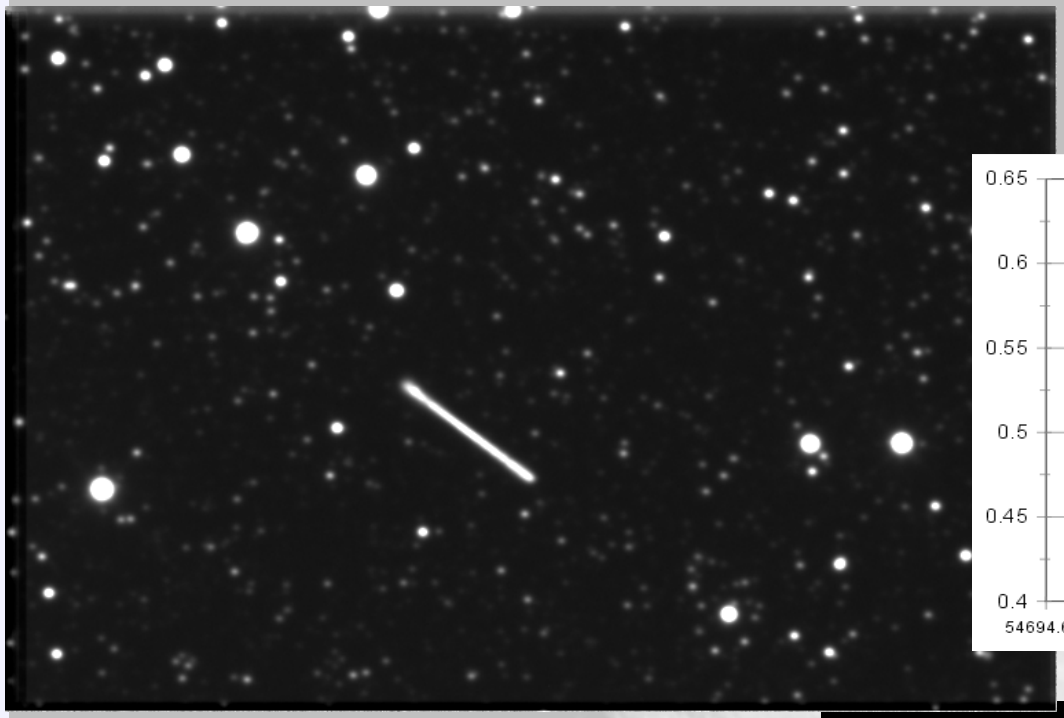
Locate the target

Position the target considering its motion **Note any near-miss stars along the asteroid path**

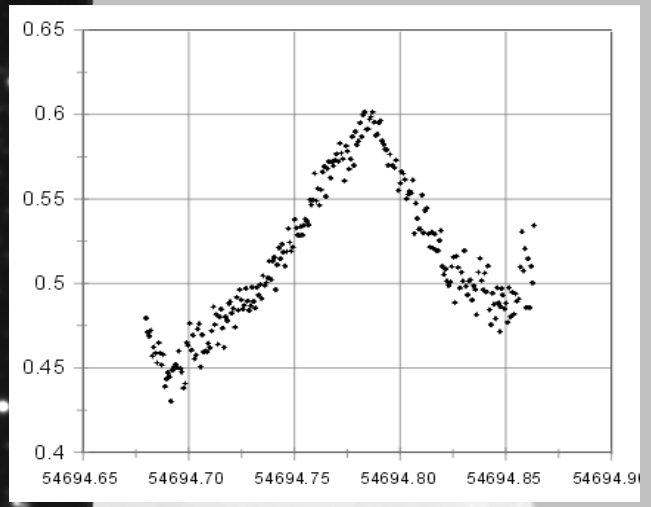


Getting data

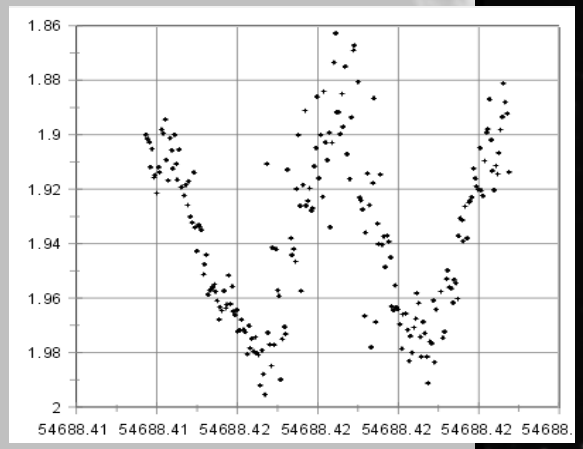
Take a series of images



Stacked Images for a period of 4.5 hrs



Stacked images for a Period of 4.0 hrs

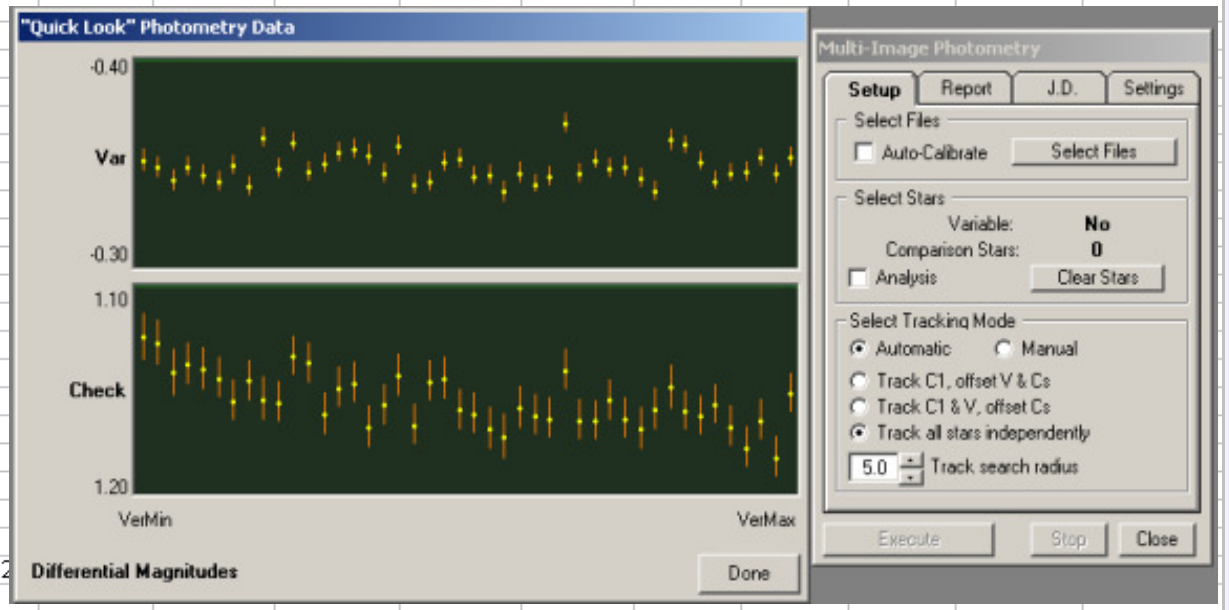


Tools to Use

AIP4Win Multi-Image Photometry Tool - MIPT

Easily tracks past nearby stars

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	AIP4Win Multiple-Image Photometry Tool													
2	Differential (w/ Extra Decimals) Photometry Report													
3	AIP4Win Licensed to:		F.Joseph Garlitz											
4	AIP4Win v.		2.2.24											
5	Folder containing files:		G:\D___DATA\ASTEROID\(51)Nemausa\08-15-08											
6	Filename of first image:		Data001.FIT											
7	Number of files selected:		254											
8	Star aperture radius:		10											
9	Sky annulus inner radius:		12											
10	Sky annulus outer radius:		20											
11	Star aperture pixels:		316											
12	Sky annulus pixels:		485											
13	Default integration time:		60.0											
14	Zero point:		25.0											
15	Gain [e/ADU]:		1.0											
16	Readout noise [e rms]:		10.0											
17	Dark current [e/sec/pix]:		1.0											
18	Time of observation:													
19	Date, time, exposure from		FITS header											
20	First Image Date:		2008-08-16											
21	First Image Time:		04:18:37.000											
22	First Exposure Time:		60 seconds											
23	Filter:		Clear											
24	Clock time zone:		0 hours											
25	Offset (true-clock):		0 seconds											
26	Heliocentric correction:		0 seconds											
27	Julian Day (midexposure):		ImageTime + (Exposure / 2											
28	First Mid-exposure Date:		2008-08-16											
29	First Mid-exposure Time:		04:19:07.000											
30	Stars selected in the first image													
31	Star	Star_X	Star_Y	Integr	Max_PV	Sky_ADU	Star_ADU	Mag	±Sigma					
32	Var	155.685	225.217	60.000	19462.96	1860.86	389850	15.468	0.0033					
33	C1	627.041	391.312	60.000	30429.0	1852.843	606303	14.989	0.0023					
34	C2	470.622	371.160	60.000	28257.0	1864.142	557389	15.080	0.0024					
35	C3	309.775	400.100	60.000	63418.3	1911.435	1989059	13.699	0.0009					
36	C4	418.034	93.485	60.000	24876.7	1854.458	483106	15.235	0.0028					
37	C5	620.148	195.223	60.000	23293.2	1844.319	435403	15.348	0.0030					
38	C6	149.238	55.521	60.000	9368.78	1838.947	162171.5	16.420	0.0073					
39	----------													
40	Seq_#	YYYY-MM-DD	HH:MM:SS	Julian_Day	Integr	Filt	(V-C1)	±Sigma	(C2-C1)	±Sigma	(V-Ens)	±Sigma	Sky_ADU	File_Name
41	00001	2008-08-16	04:19:07	54694.6799421	60.00	clear	0.4795	0.0040	0.0914	0.0033	2.5895	0.0034	1860.86	Data001.FIT
42	00002	2008-08-16	04:20:11	54694.6806829	60.00	clear	0.4713	0.0040	0.0763	0.0033	2.6075	0.0034	1854.608	Data002.FIT
43	00003	2008-08-16	04:21:15	54694.6814236	60.00	clear	0.4688	0.0040	0.0853	0.0033	2.5942	0.0033	1851.177	Data003.FIT
44	00004	2008-08-16	04:22:19	54694.6821644	60.00	clear	0.4723	0.0040	0.0907	0.0033	2.5814	0.0034	1851.465	Data004.FIT
45	00005	2008-08-16	04:23:23	54694.6829051	60.00	clear	0.4569	0.0040	0.0730	0.0033	2.5938	0.0034	1861.39	Data005.FIT



Measure a moving target

Another Tool

AIP4 Win Magnitude Measurement Tool - MMT

Provides access to comp star data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	AIP4Win v2.4.0 Magnitude Measurement Tool																						
2	Instrumental Magnitudes Report																						
3	Format: One line per image. Stars in columns.																						
4	Date: JD = Geocentric Julian Day.																						
5	Airmass: Computed for entire image.																						
6	Decimal places normal: Three for magnitude, five for date.																						
7	Delimiting Character:																						
8	Aperture = 5.00 Inner/Outer Annulus = 9.00/15.000																						
9	Observer name = J.GARLITZ at LON=-117.92100 LAT=45.57287																						
10	Target name = TARGET VAR at RA=344.6708 DEC=31.55417																						
11	Results computed on the basis of user input.																						
12	Now = 9/17/2011 6:44:28 AM																						
13																							
14	Seq_#	JulianDay	Expos	Filtr	Airmas	TARGETVAR		COMP1		COMP2		COMP3		COMP4		COMP5		COMP6		COMP7	Sky	Name of Image	T-Ave7
15	1	2455822	60	Clear	1.0804	11.659	0.006	11.331	0.004	12.577	0.012	11.874	0.007	11.411	0.005	13.084	0.019	13.434	0.026	13.235	0.022	WD2309+105__001.FIT	-0.762
16	2	2455822	60	Clear	1.0792	11.622	0.005	11.306	0.004	12.552	0.012	11.833	0.006	11.381	0.004	13.078	0.019	13.374	0.025	13.206	0.021	WD2309+105__002.FIT	-0.768
17	3	2455822	60	Clear	1.078	11.59	0.005	11.264	0.004	12.518	0.012	11.793	0.006	11.349	0.004	13.043	0.019	13.327	0.024	13.183	0.021	WD2309+105__003.FIT	-0.764
18	4	2455822	60	Clear	1.0769	11.591	0.005	11.27	0.004	12.508	0.012	11.813	0.006	11.353	0.004	13.047	0.019	13.35	0.024	13.206	0.021	WD2309+105__004.FIT	-0.773
19	5																						
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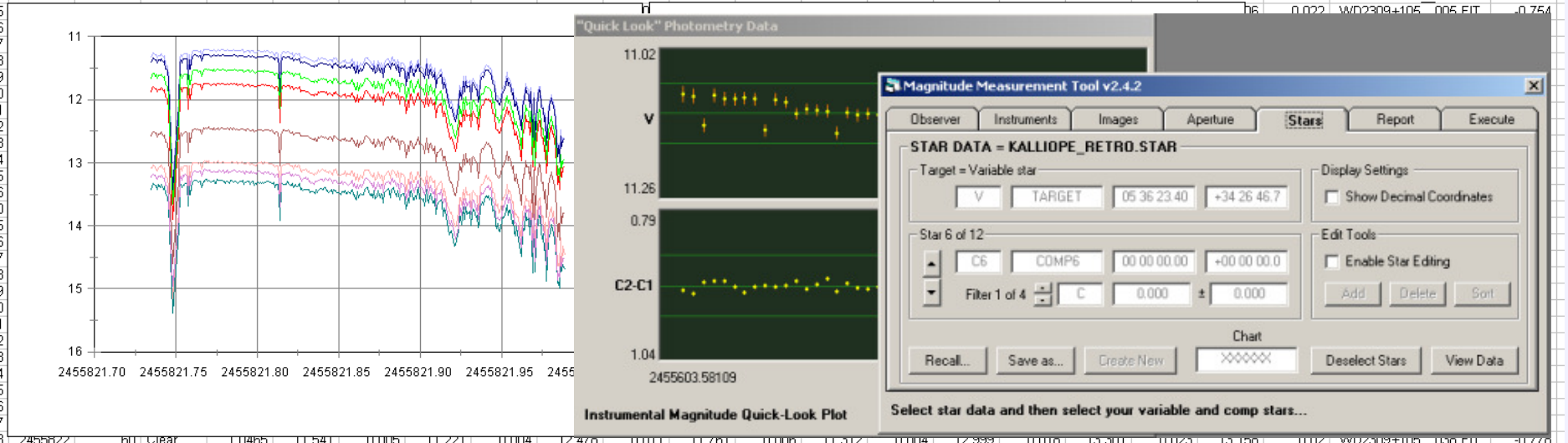
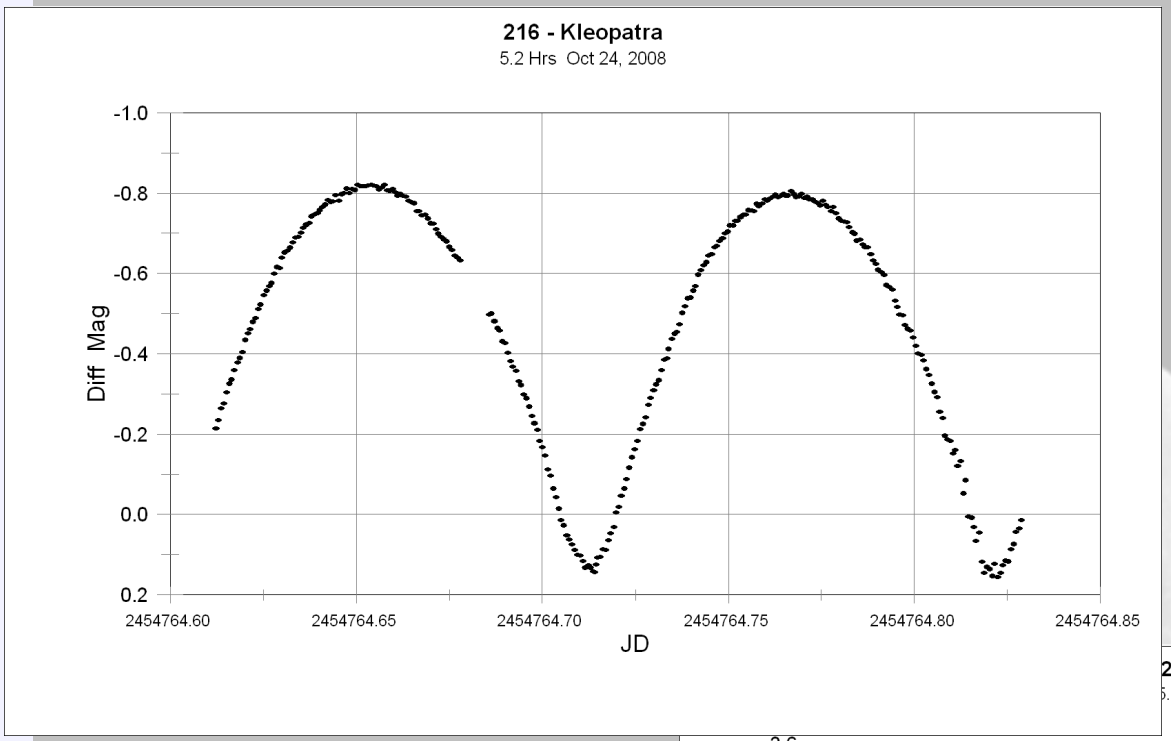
39	32																						
40	33																						
41	34																						
42	35																						
43	36																						
44	37																						
45	38	2455822	60	Clear	1.0465	11.541	0.005	11.221	0.004	12.478	0.011	11.761	0.006	11.312	0.004	12.999	0.018	13.301	0.023	13.156	0.02	WD2309+105__038.FIT	-0.778
46	39	2455822	60	Clear	1.0459	11.541	0.005	11.217	0.004	12.463	0.011	11.752	0.006	11.298	0.004	12.999	0.018	13.289	0.023	13.131	0.02	WD2309+105__039.FIT	-0.766
47	40	2455822	60	Clear	1.0453	11.537	0.005	11.219	0.004	12.474	0.011	11.752	0.006	11.306	0.004	13.001	0.018	13.274	0.023	13.153	0.02	WD2309+105__040.FIT	-0.774
48	41	2455822	60	Clear	1.0447	11.541	0.005	11.224	0.004	12.468	0.011	11.761	0.006	11.307	0.004	13	0.018	13.292	0.023	13.149	0.02	WD2309+105__041.FIT	-0.773
49	42	2455822	60	Clear	1.0441	11.561	0.005	11.244	0.004	12.488	0.011	11.771	0.006	11.327	0.004	13.016	0.018	13.309	0.023	13.156	0.02	WD2309+105__042.FIT	-0.769
50	43	2455822	60	Clear	1.0435	11.545	0.005	11.235	0.004	12.479	0.011	11.771	0.006	11.314	0.004	13.01	0.018	13.291	0.023	13.132	0.02	WD2309+105__043.FIT	-0.774
51	44	2455822	60	Clear	1.0429	11.546	0.005	11.223	0.004	12.482	0.011	11.761	0.006	11.299	0.004	13.015	0.018	13.302	0.023	13.141	0.02	WD2309+105__044.FIT	-0.772
52	45	2455822	60	Clear	1.0423	11.625	0.006	11.305	0.004	12.553	0.012	11.845	0.007	11.388	0.005	13.1	0.02	13.4	0.026	13.216	0.022	WD2309+105__045.FIT	-0.776
53	46	2455822	60	Clear	1.0418	11.529	0.005	11.209	0.004	12.453	0.011	11.747	0.006	11.294	0.004	12.99	0.018	13.3	0.023	13.127	0.02	WD2309+105__046.FIT	-0.774



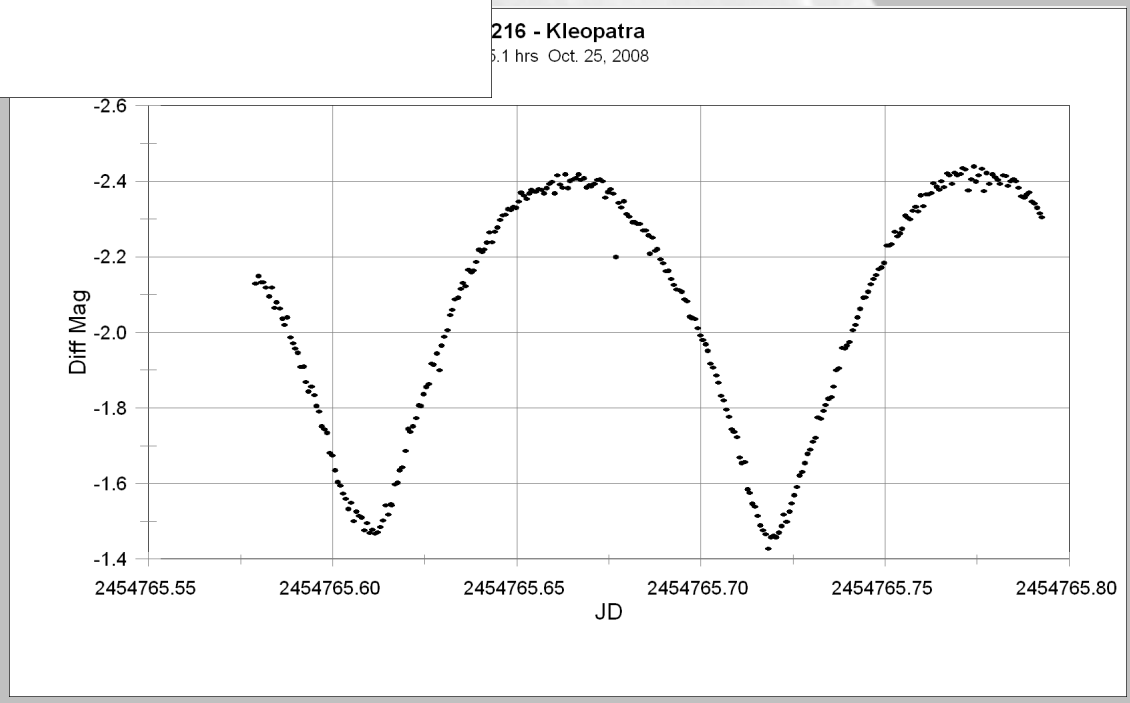
Getting it Right



Easy for well behaved, short (less than 6 hr) rotation periods.

One night session is adequate, to get a full rotation, with a second night to confirm.

Two "humps" is common for most asteroids, but few are as symmetric as this.

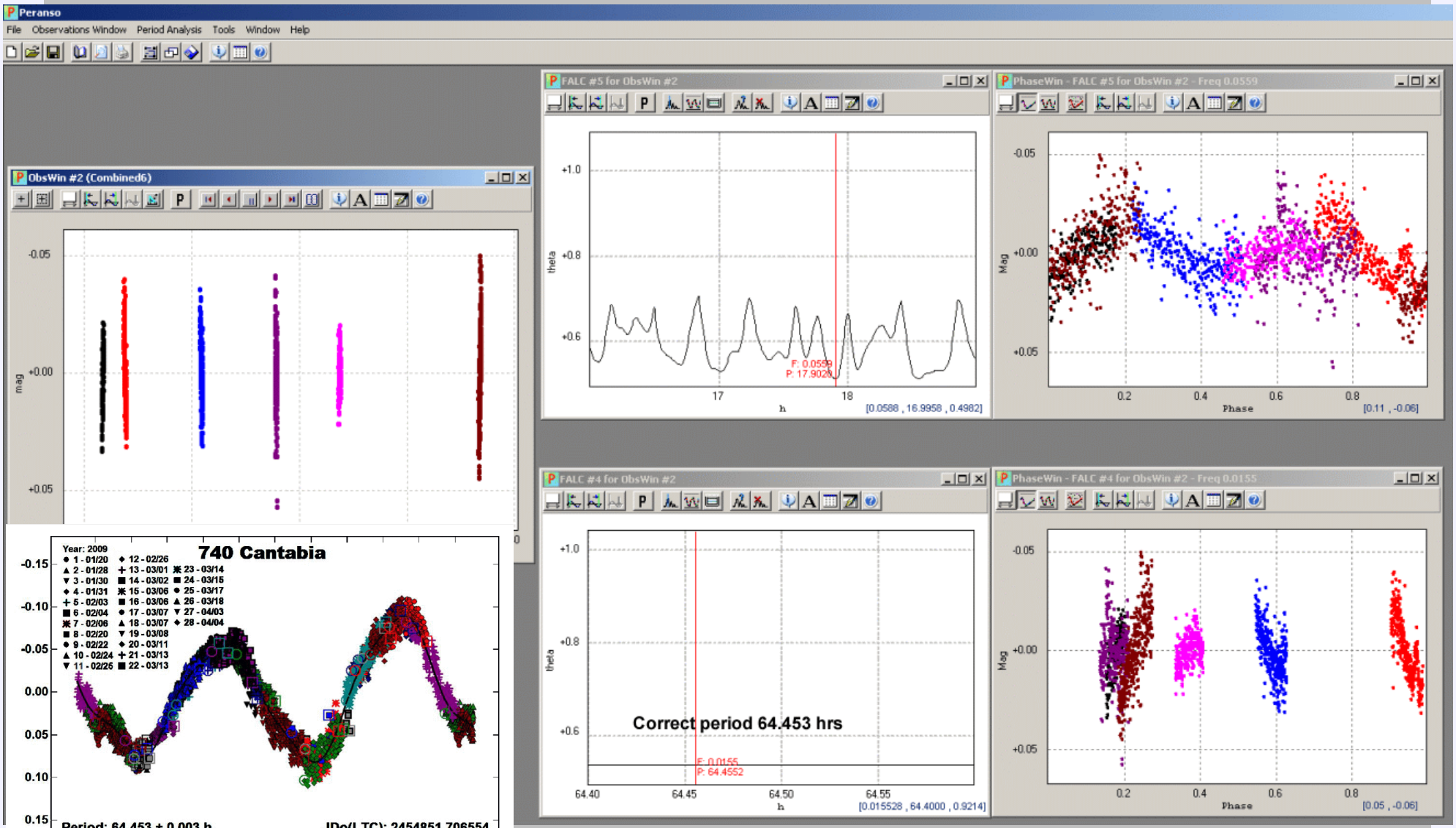


Getting it Wrong

740 Cantabia

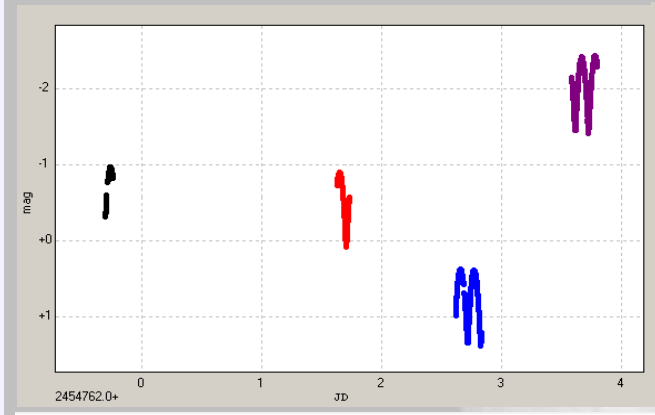
This asteroid has a very long rotation period

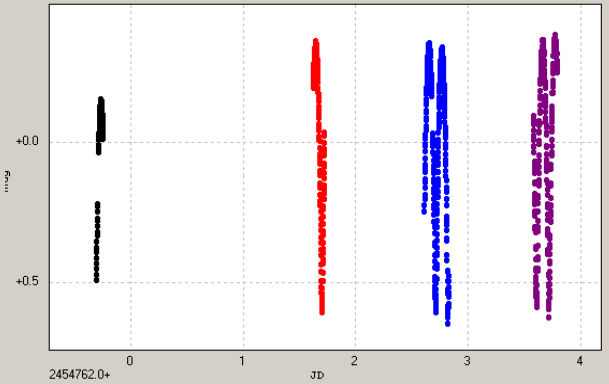
Shortcuts are not allowed; only very good photometry will work here

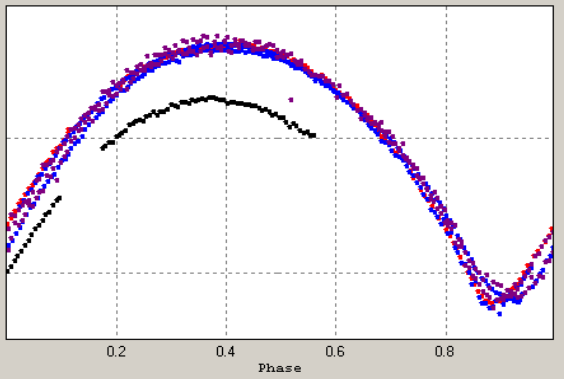


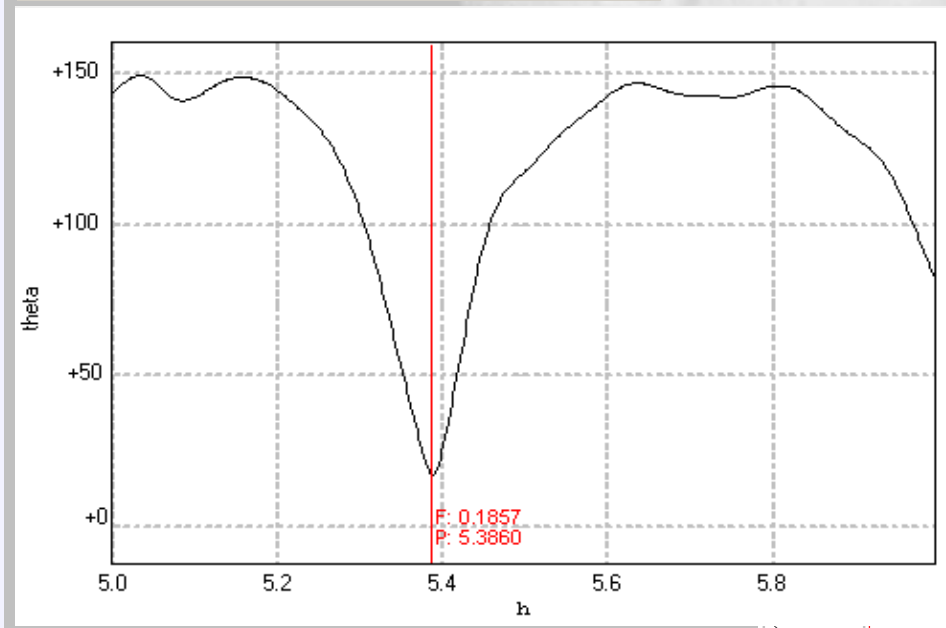
Analysis & Some Results

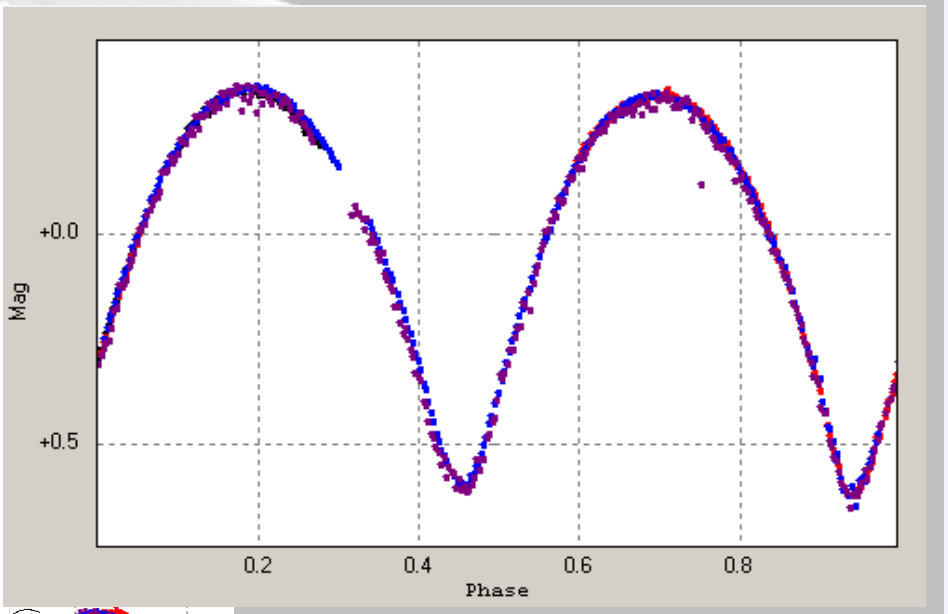
Peranso - Light Curve and Period Analysis Software

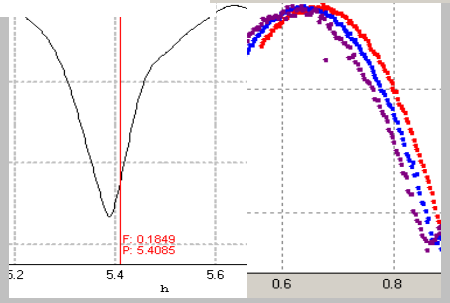




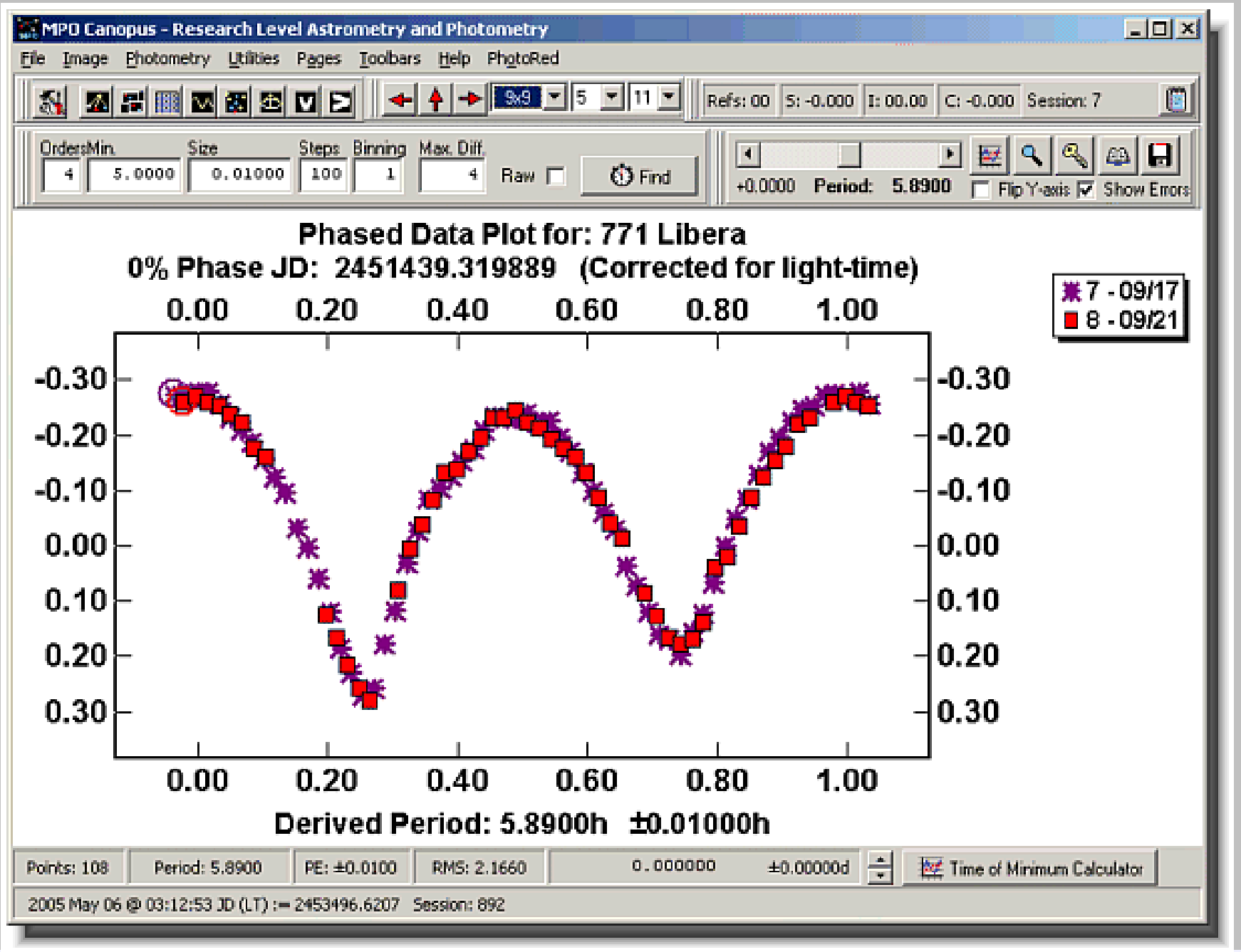




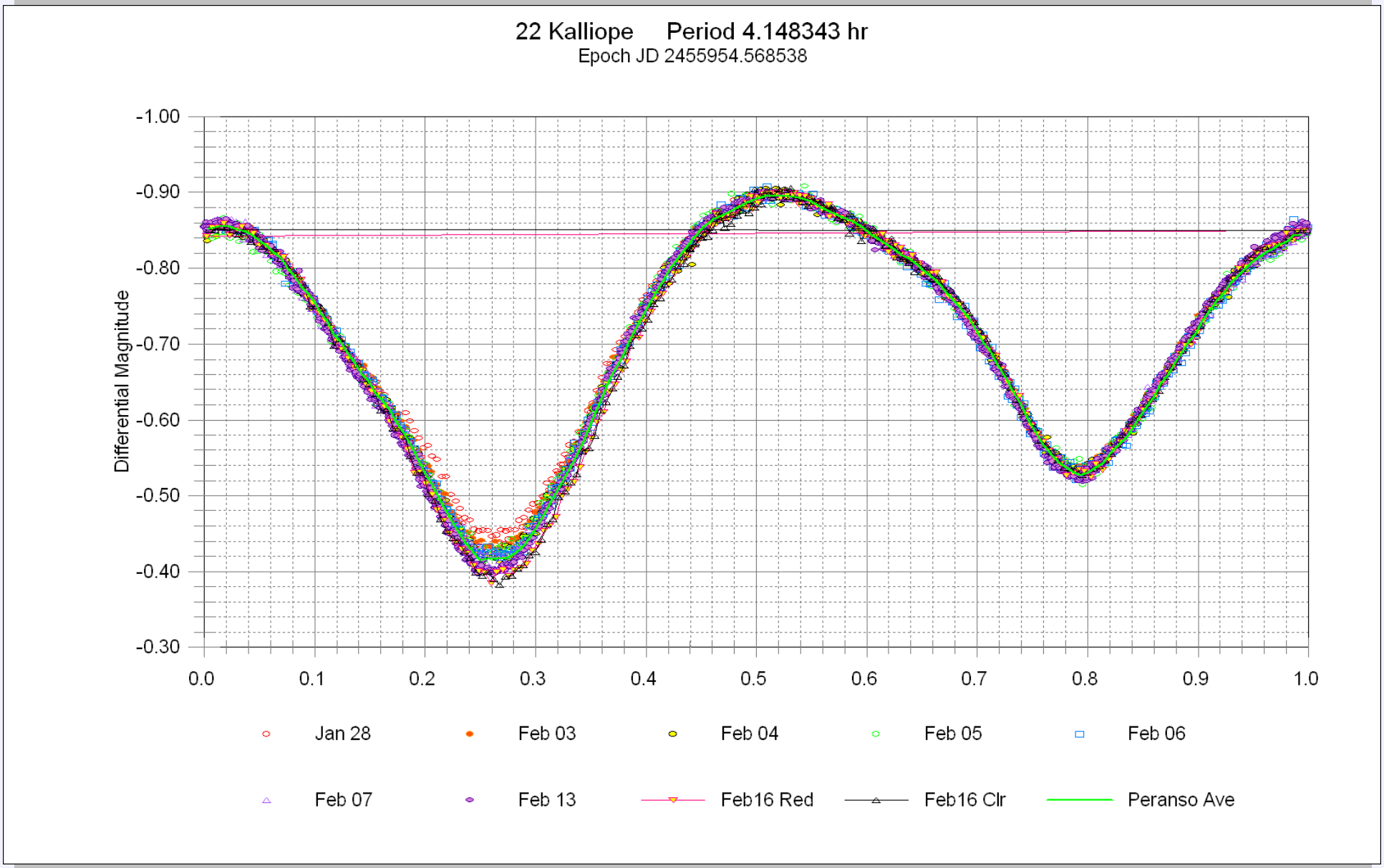




Another analysis tool
MPO Canopus Analysis Software

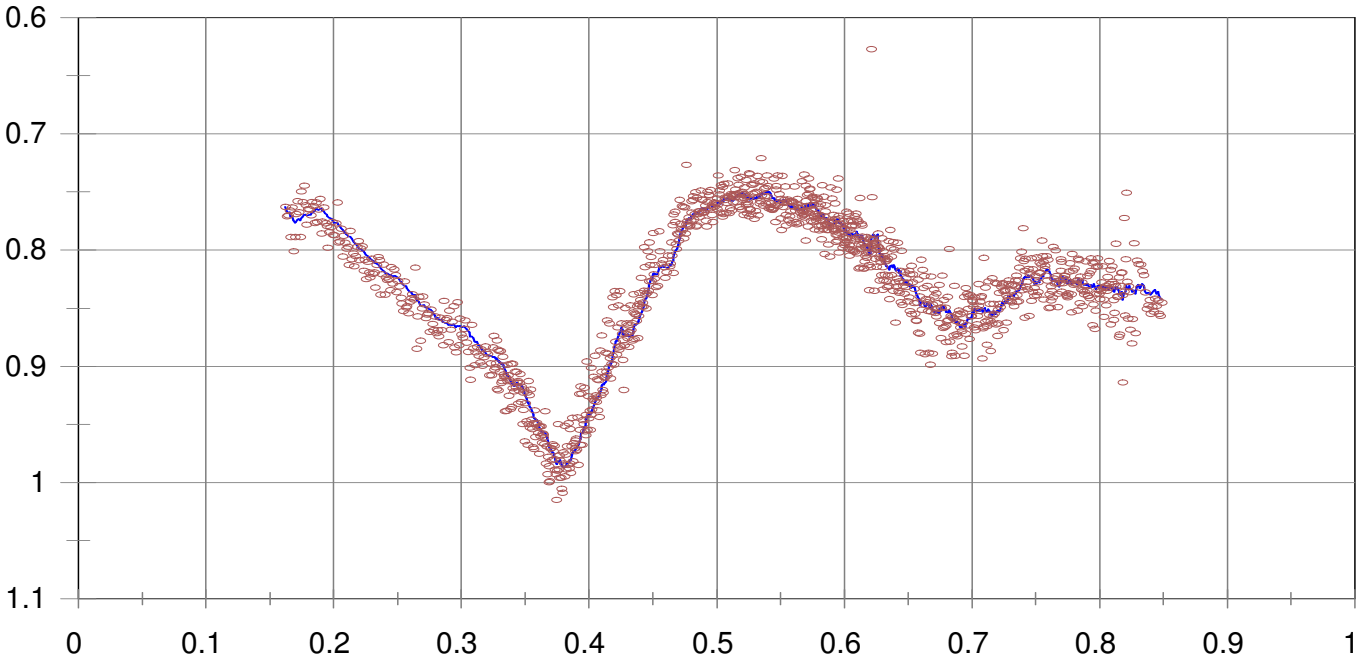


Analysis & Some Results

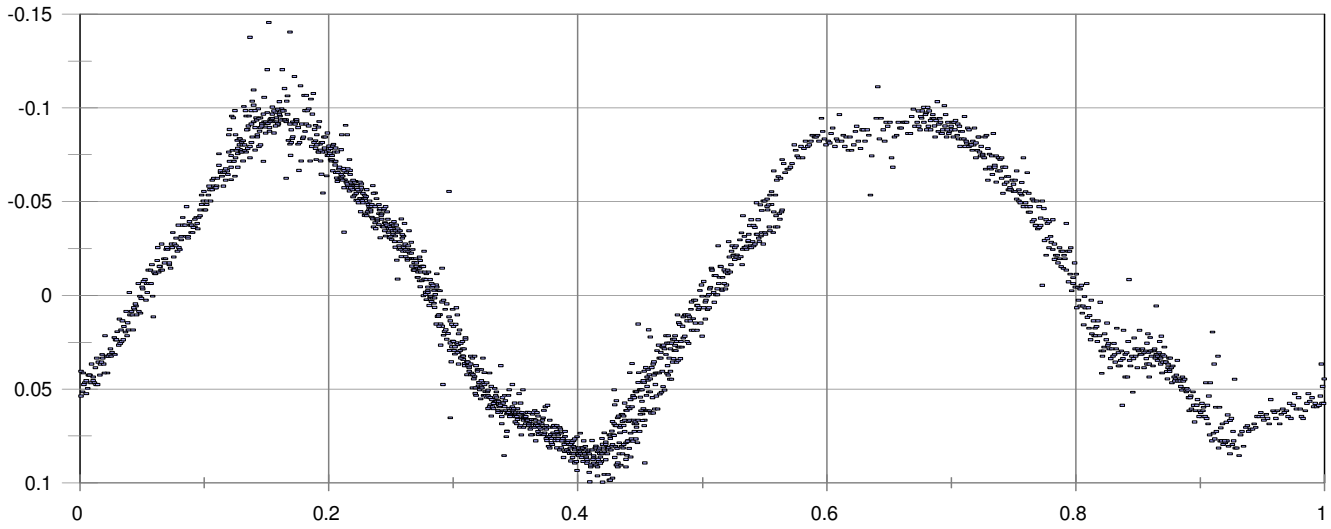


Analysis & Some Results

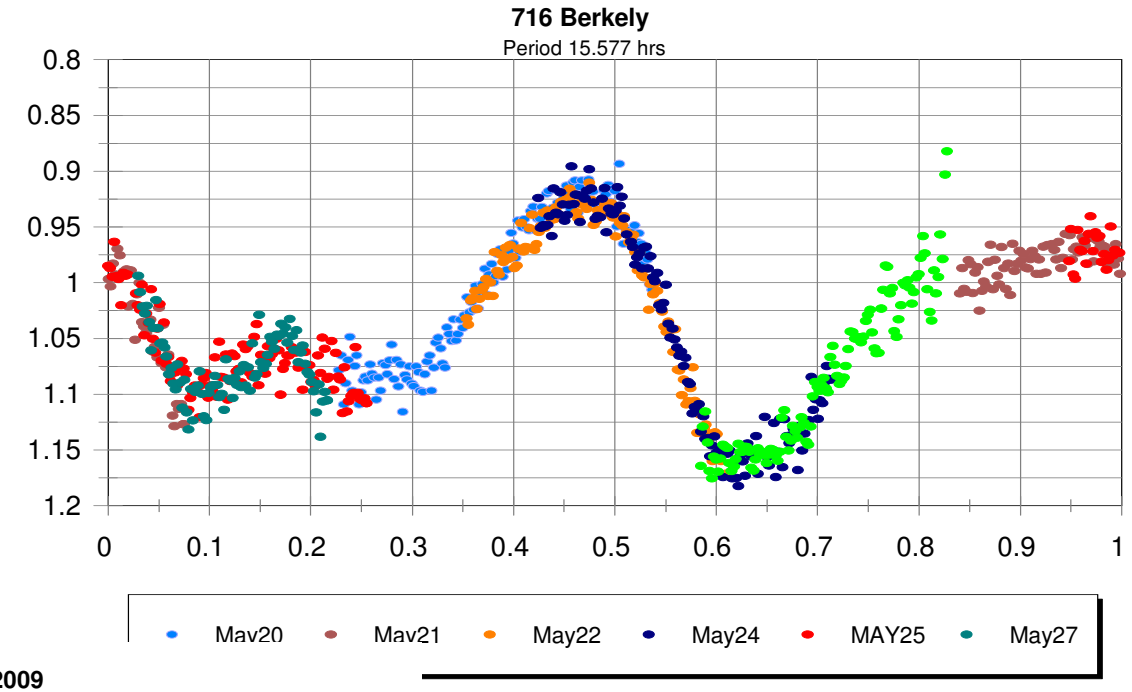
195 Eurykleia
Period 16.5213 hrs

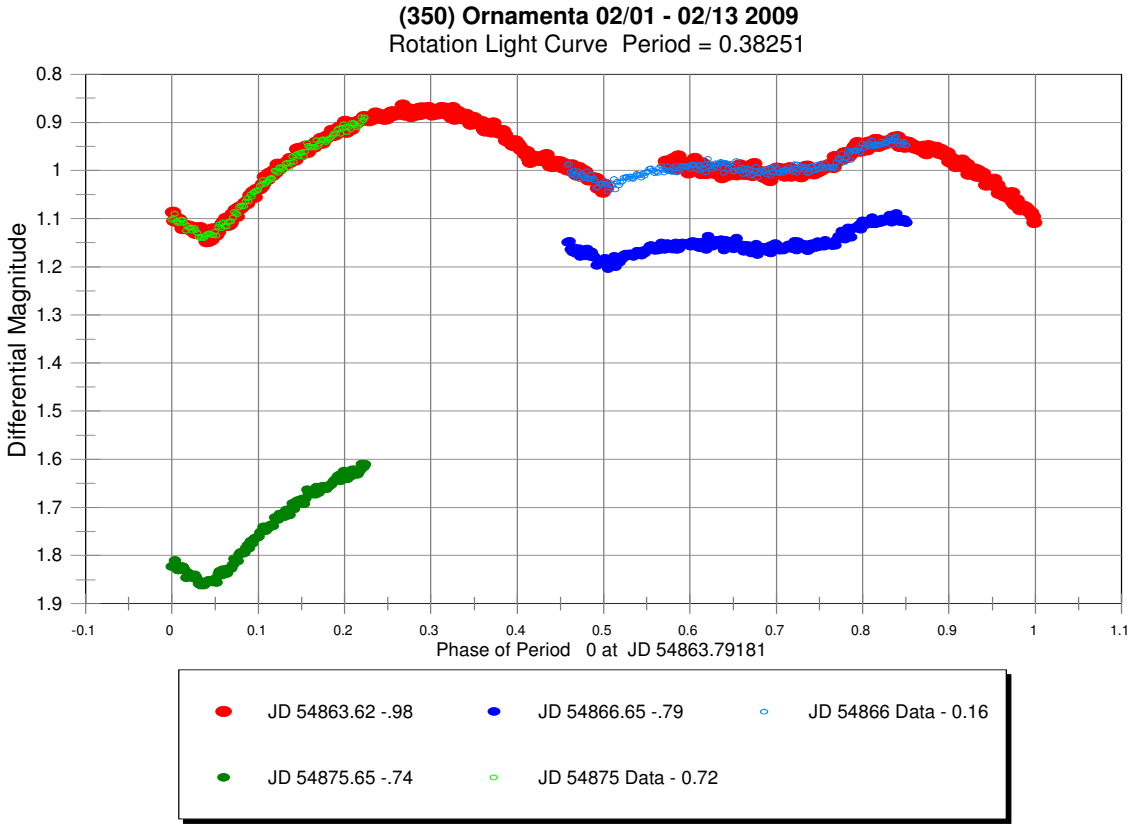


247 Eukrate
JD 55504 - 55548 Period 12.087 hrs

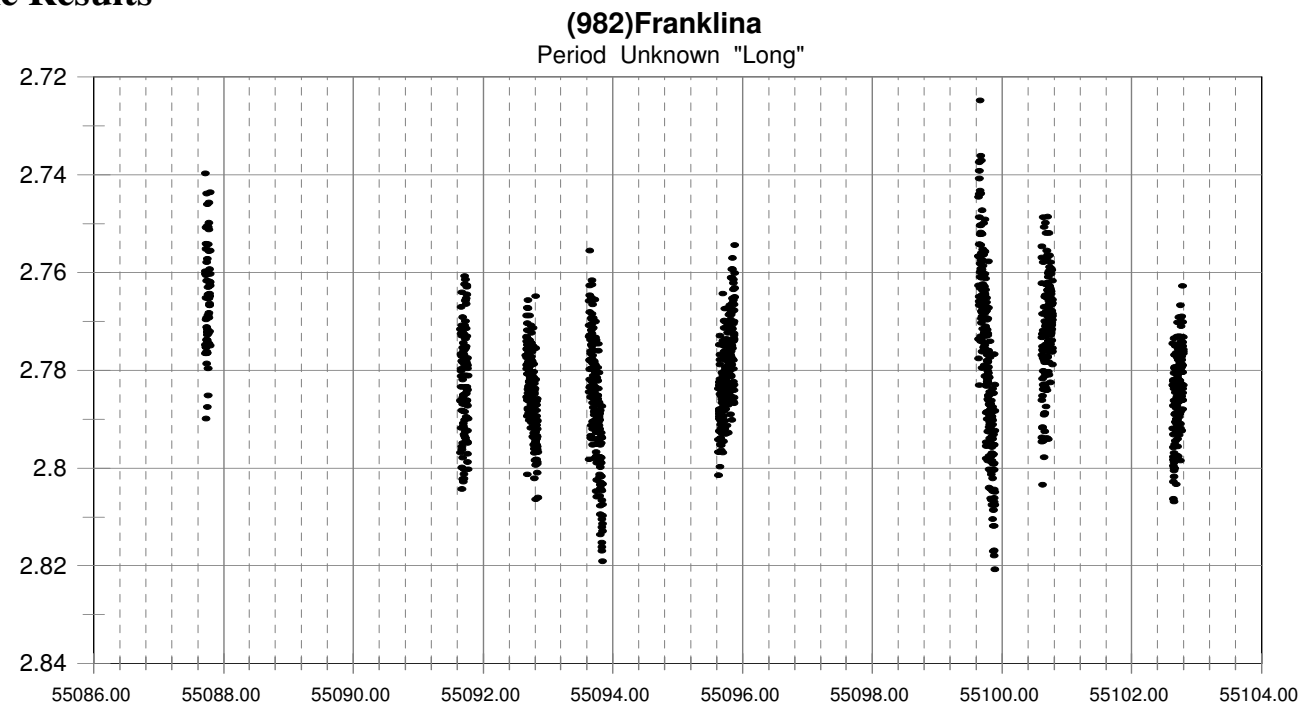


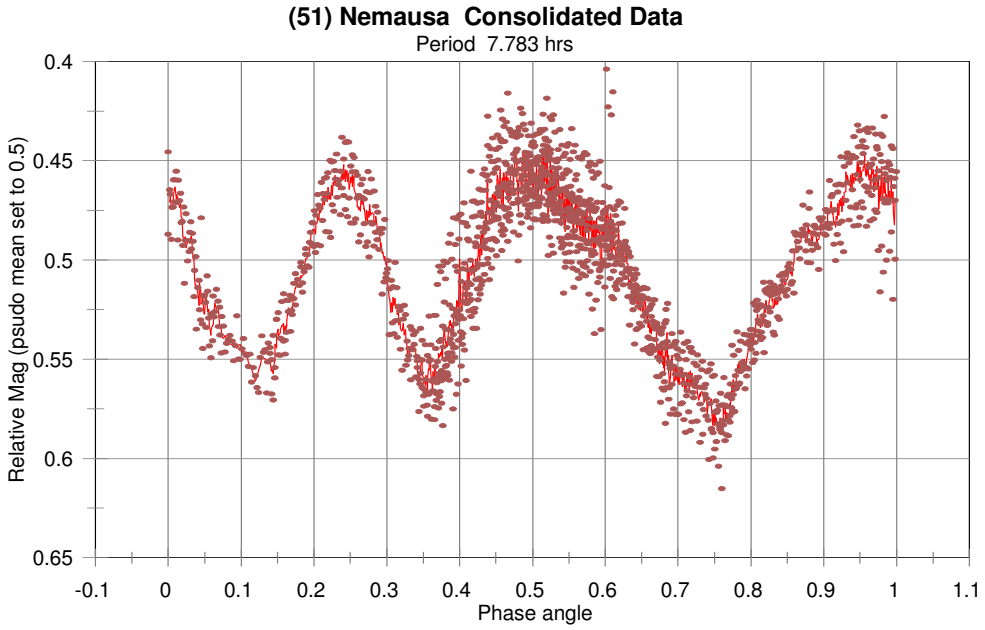
Analysis & Some Results

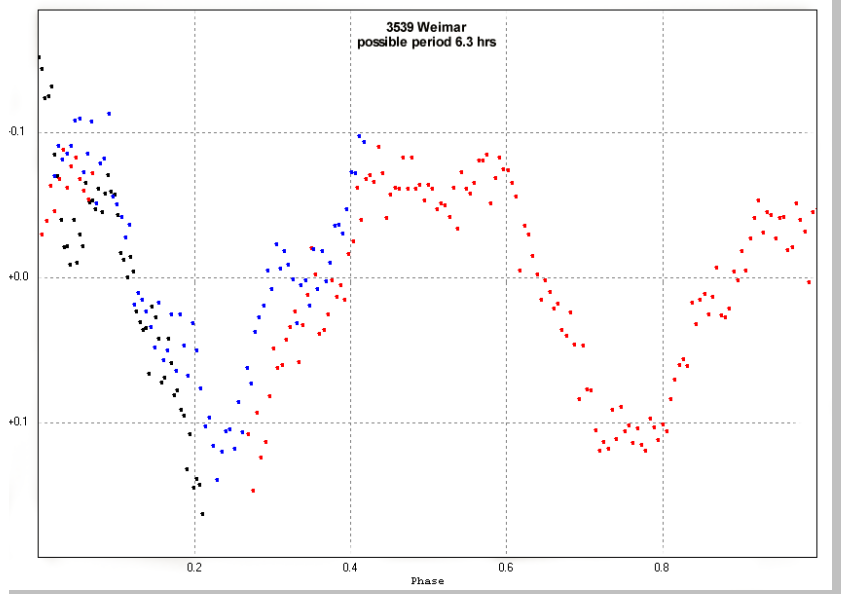




Analysis & Some Results



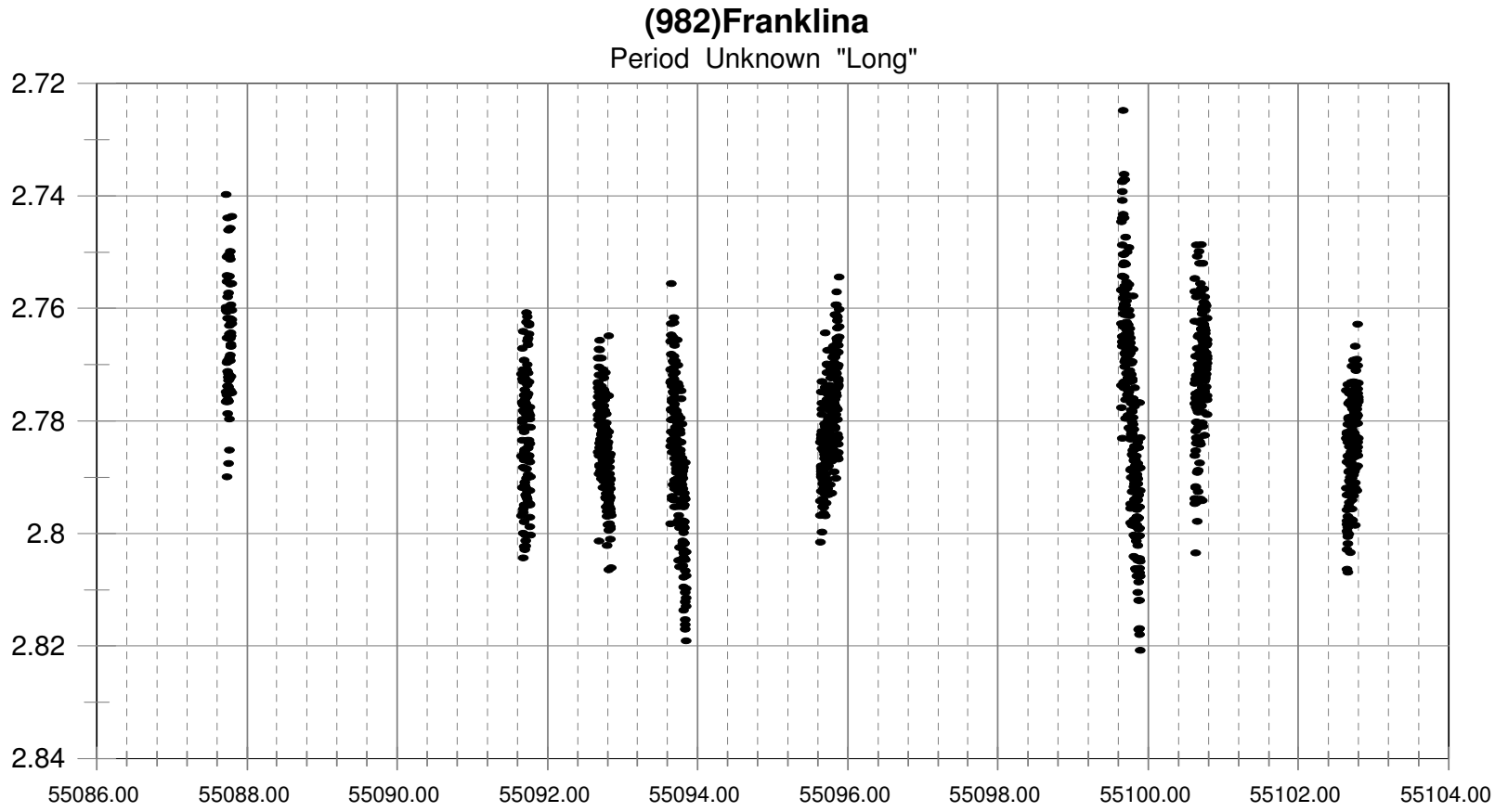




Problem Light Curves

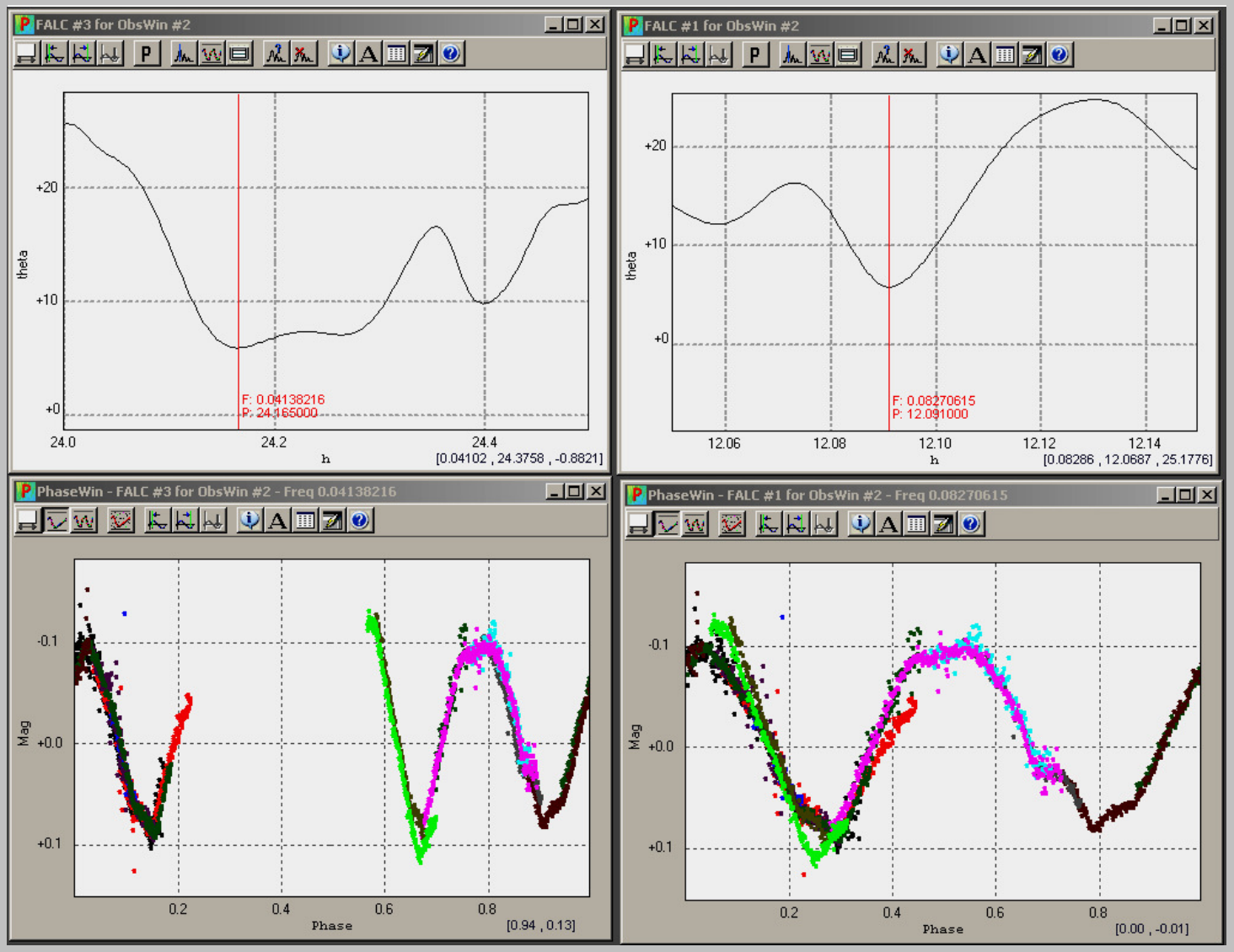
- ✓ Long Periods + 24 hrs
- ✓ Periods w/ whole fractions or multiples of 24 hours
- ✓ Tumbling Asteroids (rotation about multiple axes)
- ✓ Multiple Bodies (Asteroids with satellites)
- ✓ Asteroids that are smooth, round, w/ rotation axis head on

Long Periods + 24 hrs



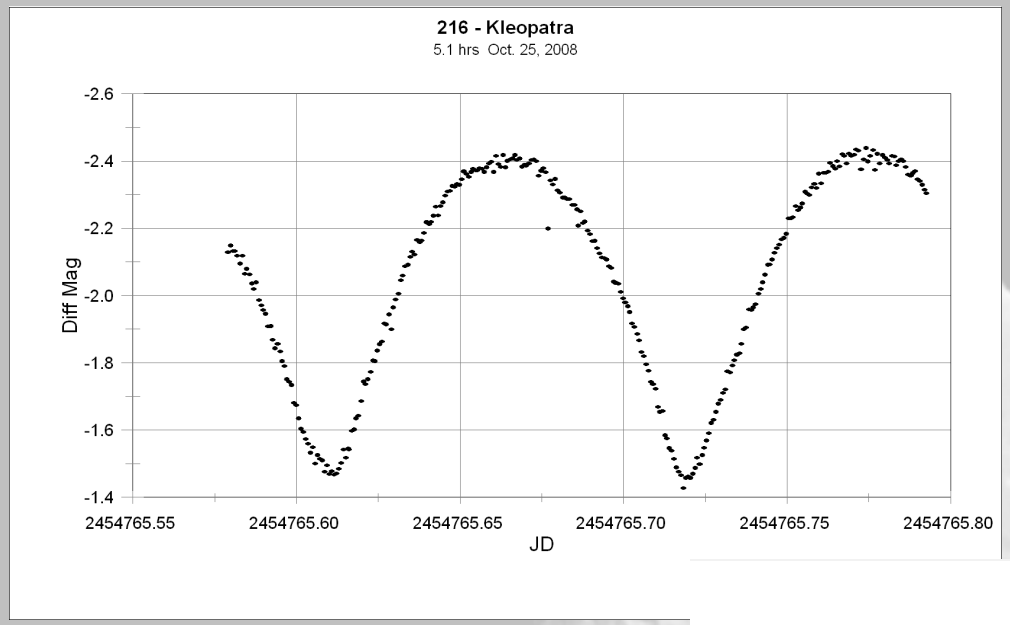
Determining the periods for these objects requires long term observations and “standard” (all sky) photometry.
Having multiple observers is a big plus.

Periods w/ whole fractions or multiples of 24 hours



Twelve nights of observations over 60 days:
Is it 12.09 or 24.16 hours?

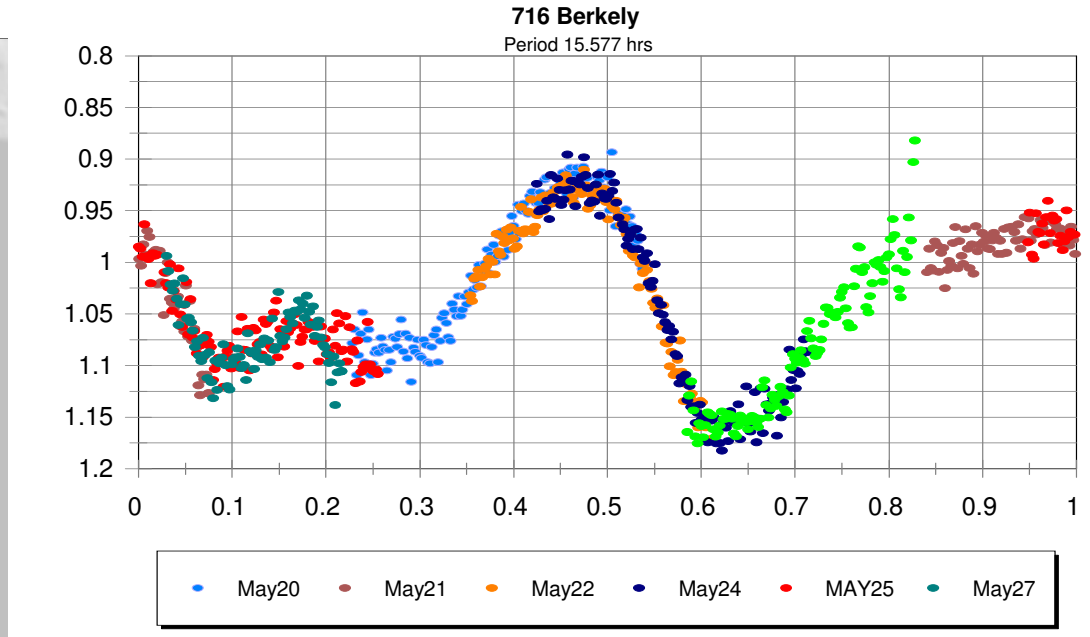
Tumbling Asteroids (rotation about multiple axes)



This smooth curve

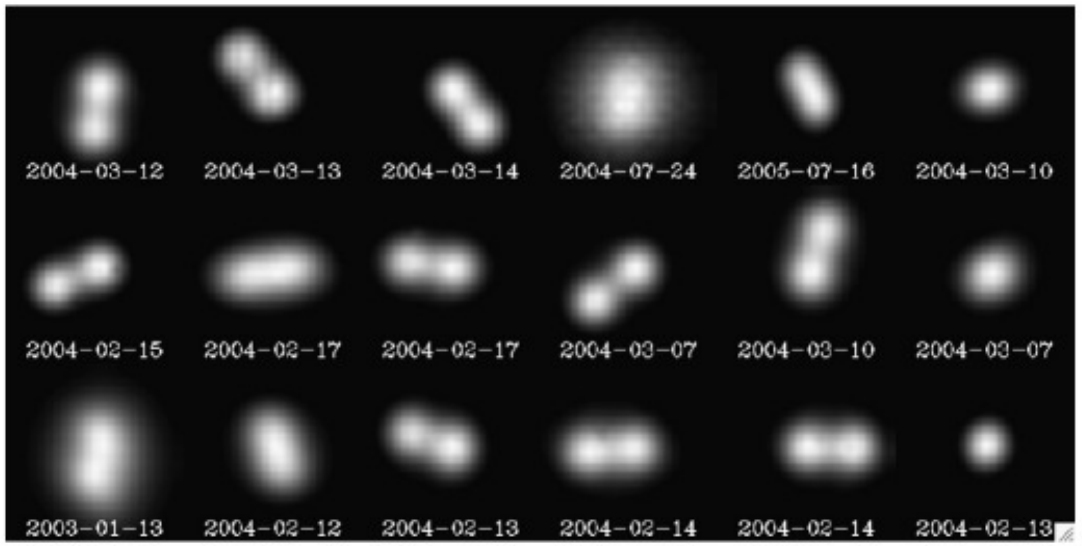
vs.

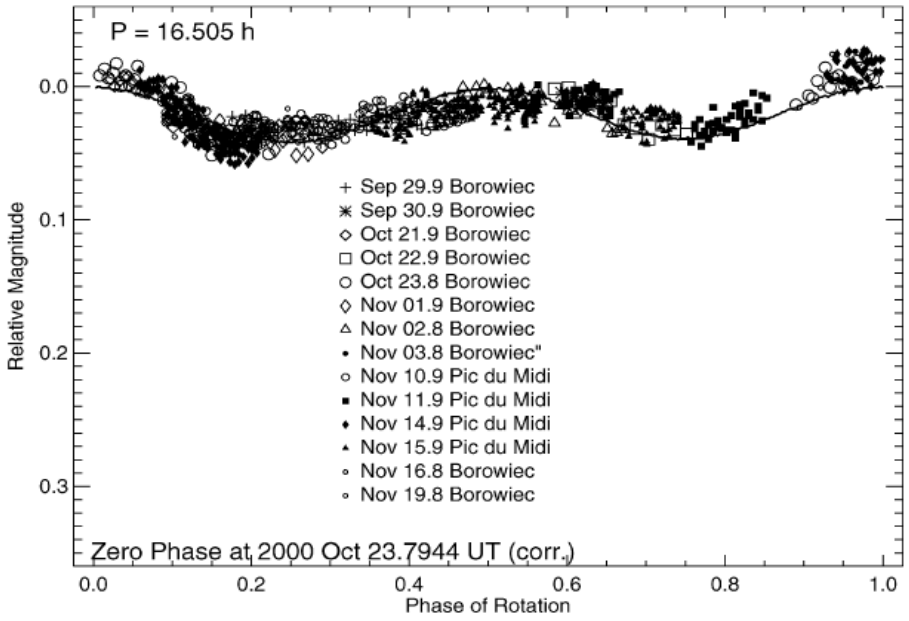
this more complex curve.

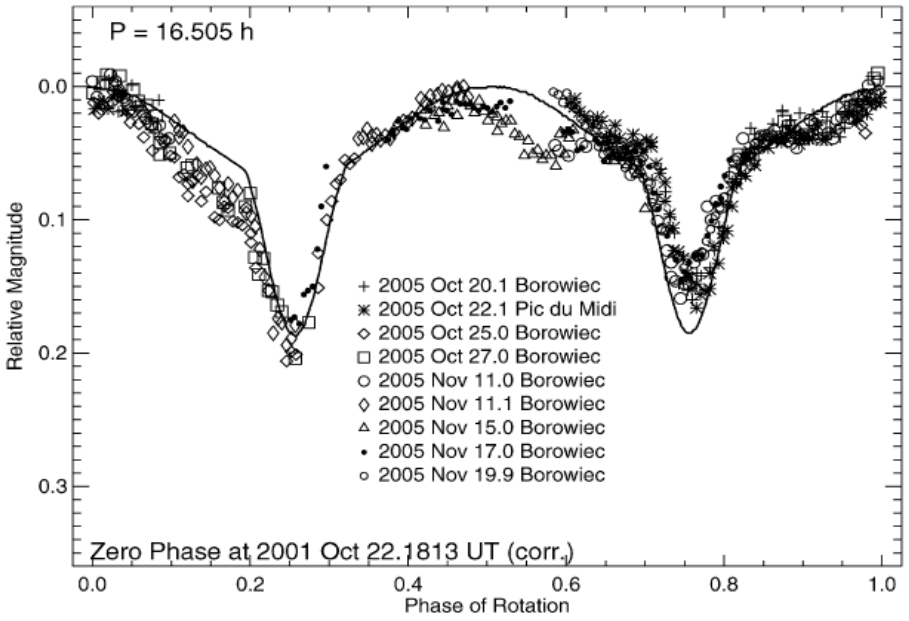


Multiple bodies (asteroids with satellites)

P. Descamps et al. / Icarus 187 (2007) 482–499

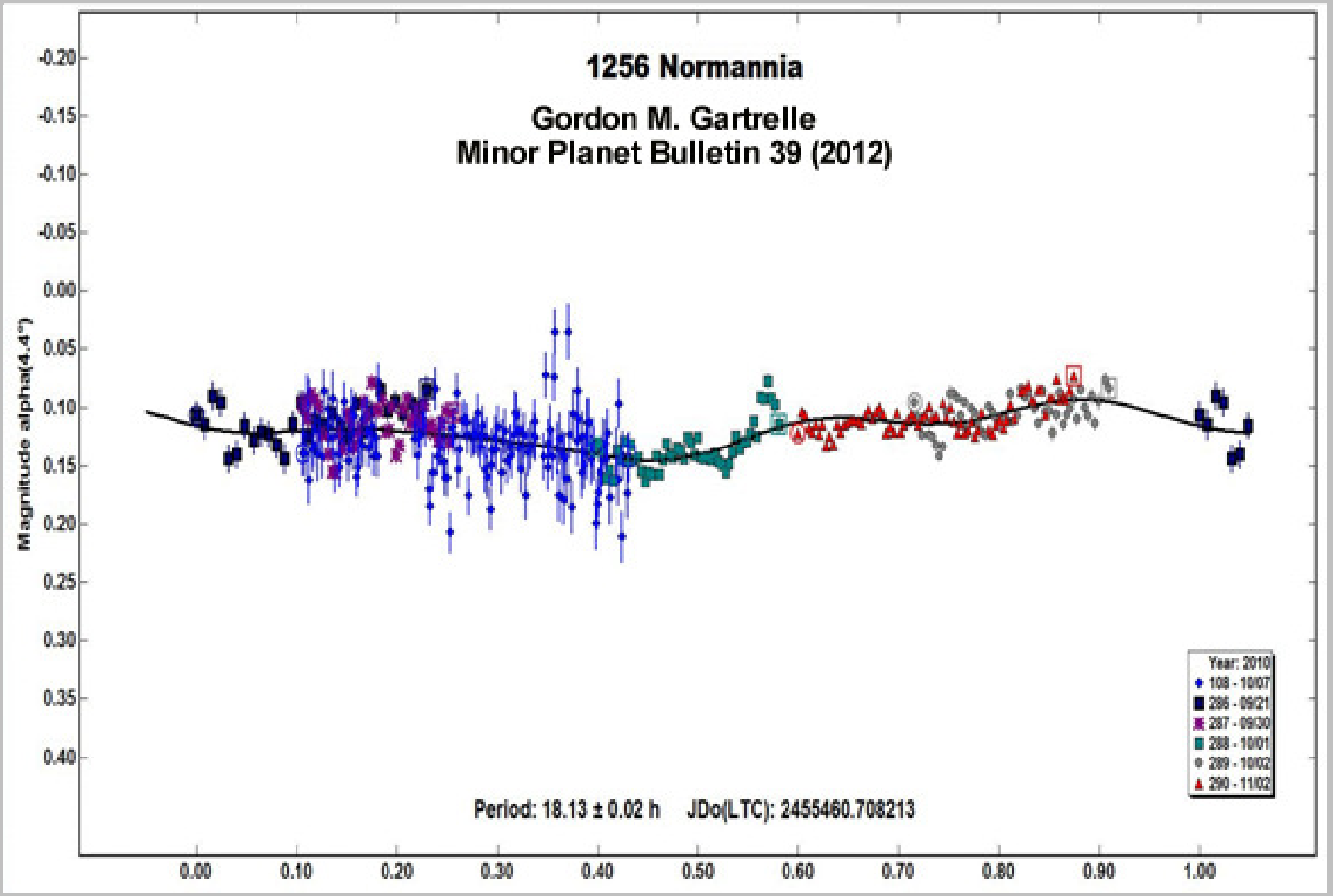






Problem Light Curves

Asteroids that are smooth, round, or w/ rotation axis head on



Requesting collaboration

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Lowell Observatory
Minor Planet Mailing List
Society for Astronomical Sciences

Acknowledgment
Funding to support this web site is provided in part by grants

NASA: NNX10AL35G
NSF: AST-1032896

Return

Use Return to return to the Search page *and reset to defaults* OR
Use the Back button on your browser *and keep previous settings*

Notifications: 1 Submissions: 0
Records found: 1 (display limit: none)

The results are available for download as a text file

Search Results from NOTIFICATIONS

```
Submitted:          2012-02-11 11:00:59
Object:             621 Werlandi
Observer:           Luca Pietro Strabla
EMail:              lstrabla@moog.com
Request Type:       Collaboration
Urgency:            Medium
Unfiltered OK:      YES
Comments:           We obserbed this asteroid from Gen 22th to Gen 30th. its
curvelight is very similar in all sessions. Period should be
round about 12 hours. Someone have lightcurve from different
longitude?
Web Site:           www.osservatoriobassano.tk
```

Edit Delete **(UserName/Password required and must match those on the record)**

Search Results from SUBMISSIONS

No matching records

Return

Use Return to return to the Search page *and reset to defaults* OR
Use the Back button on your browser *and keep previous settings*

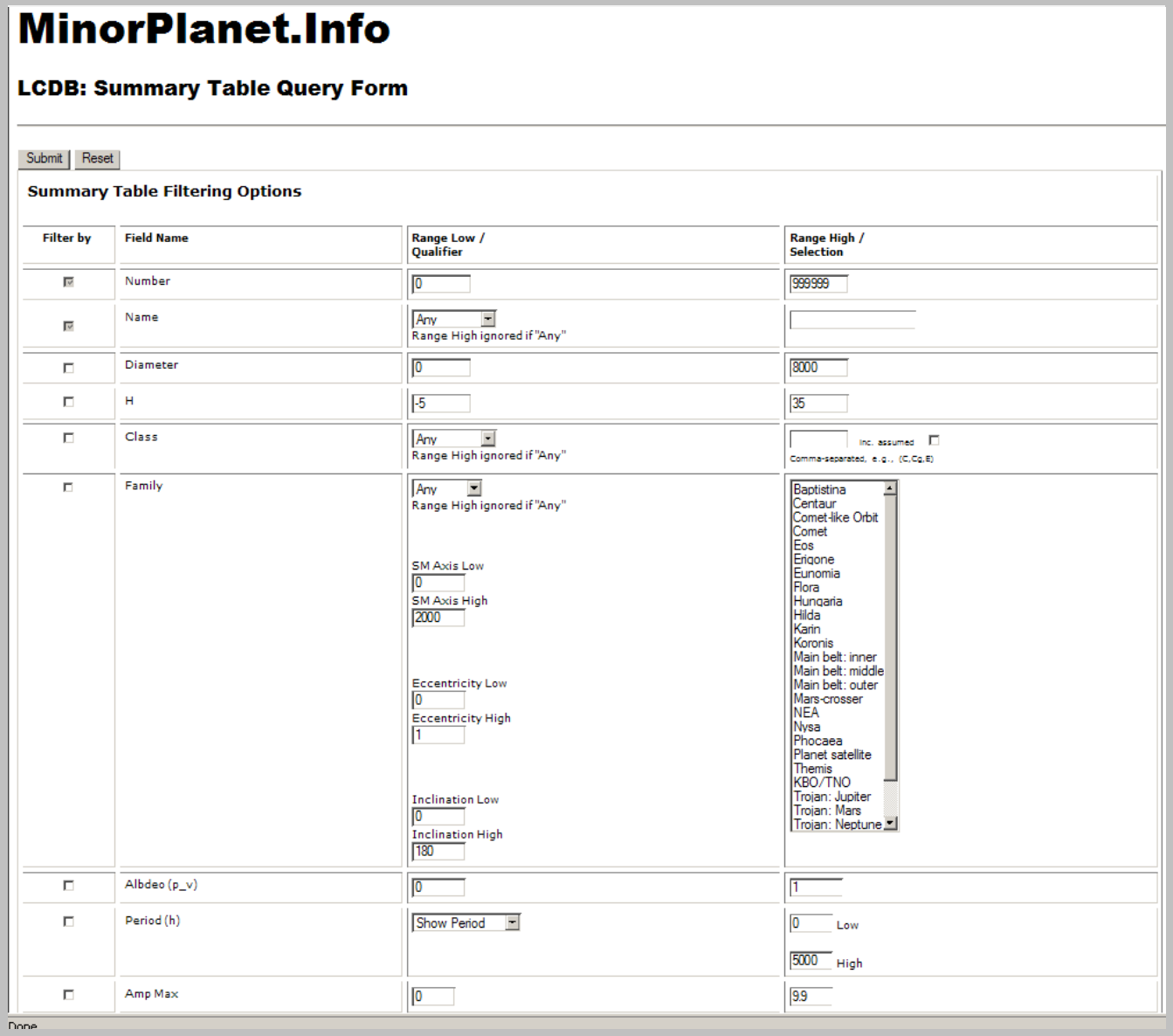
Support Resources

Getting Collaboration

Submitted: 2009-03-18 15:38:46
Object: 740 Cantabia
Observer: Robert Stephens
EMail: rstephens@foxandstephens.com
Code/Location: 646 Rancho Cucamonga, California
Equipment: 0.30m SCT and 0.35m SCT with STL-1001e CCD Camera
Start/End Date: 2009-02-24 / 2009-03-18
Sessions/Points: 12 /
Period / Err: **64.55 ± 0.02 hr**
Amplitude / Err: 0.12 ± 0.03
Comments:
Web Site: members.dslextreme.com/users/rstephens/

Observer	Data points	Dates Observed mm/dd/2009
Stephens 0.30-m SCT, SBIG STL-1001E	1899	02/24, 02/25, 03/06, 03/07, 03/08, 03/11, 03/13, 03/14, 03/17, 03/18
Stephens 0.35-m SCT, SBIG STL-1001E	228	03/01
Pilcher 0.35-m SCT, SBIG STL-1001E	2506	01/20, 01/28, 01/30, 01/31, 02/22, 02/26, 03/02, 03/13
Buchheim 0.28-m SCT, SBIG ST-8XE	101	02/03, 02/04, 02/20, 03/06, 03/07
Benishek 0.40-m SCT, Apogee AP47p	304	02/07, 04/03, 04/04
Warner 0.35-m SCT, SBIG STL-1001E	87	03/15

Check database for prior work



MinorPlanet.Info

LCDB: Summary Table Query Form

Submit | Reset

Summary Table Filtering Options

Filter by	Field Name	Range Low / Qualifier	Range High / Selection
☑	Number	0	999999
☑	Name	Any Range High ignored if "Any"	
☐	Diameter	0	8000
☐	H	-5	35
☐	Class	Any Range High ignored if "Any"	Inc. assumed ☐ Comma-separated, e.g., (C,Cg,E)
☐	Family	Any Range High ignored if "Any" SM Axis Low 0 SM Axis High 2000 Eccentricity Low 0 Eccentricity High 1 Inclination Low 0 Inclination High 180	Baptistina Centaur Comet-like Orbit Comet Eos Erigone Eunomia Flora Hungaria Hilda Karin Koronis Main belt: inner Main belt: middle Main belt: outer Mars-crosser NEA Nysa Phocaea Planet satellite Themis KBO/TNO Trojan: Jupiter Trojan: Mars Trojan: Neptune
☐	Albdeo (p_v)	0	1
☐	Period (h)	Show Period	0 Low 5000 High
☐	Amp Max	0	9.9

Done

Getting database records & references

Records found: 4 (display limit: 50)

Show LCDB Entries

	Number	Name	Desig	Family	CS	Class	DS	DF	Diameter	HS	HBand	H	GS	G	AS	AF	Albedo	PF	Period	PDescrip	AmpF	AmpMin	AmpMax	U	Pole	BIN	Notes
◉	247	Eukrate		MB-O	S	Xc	S		134.43	M		8.04	M	0.15	S		0.0595		12.10				0.12	2+			
○	248	Lameia		MB-I	A	S	C		48.62	L		10.26	M	0.15	D		0.0588		12.00				0.10	2			
○	249	Ilse		MB-I	A	S	D		34.82	L		11.39	M	0.15	D		0.0405		85.24				0.33	1			A
○	250	Bettina		MB-O	S	Xk	S		79.75	M		7.58	M	0.15	S		0.2581		5.0545			0.11	0.60	3	TRUE		

Summary Data

Number	Name	Desig	Family	CS	Class	DS	DF	Diameter	HS	HBand	GS	H	G	AS	AF	Albedo	PF	Period	PDescrip	AmpF	AmpMin	AmpMax	U	Pole	BIN	Notes	NotesEx
247	Eukrate		MB-O	S	Xc	S		134.43	M		M	8.04	0.15	S		0.0595		12.10				0.12	2+				

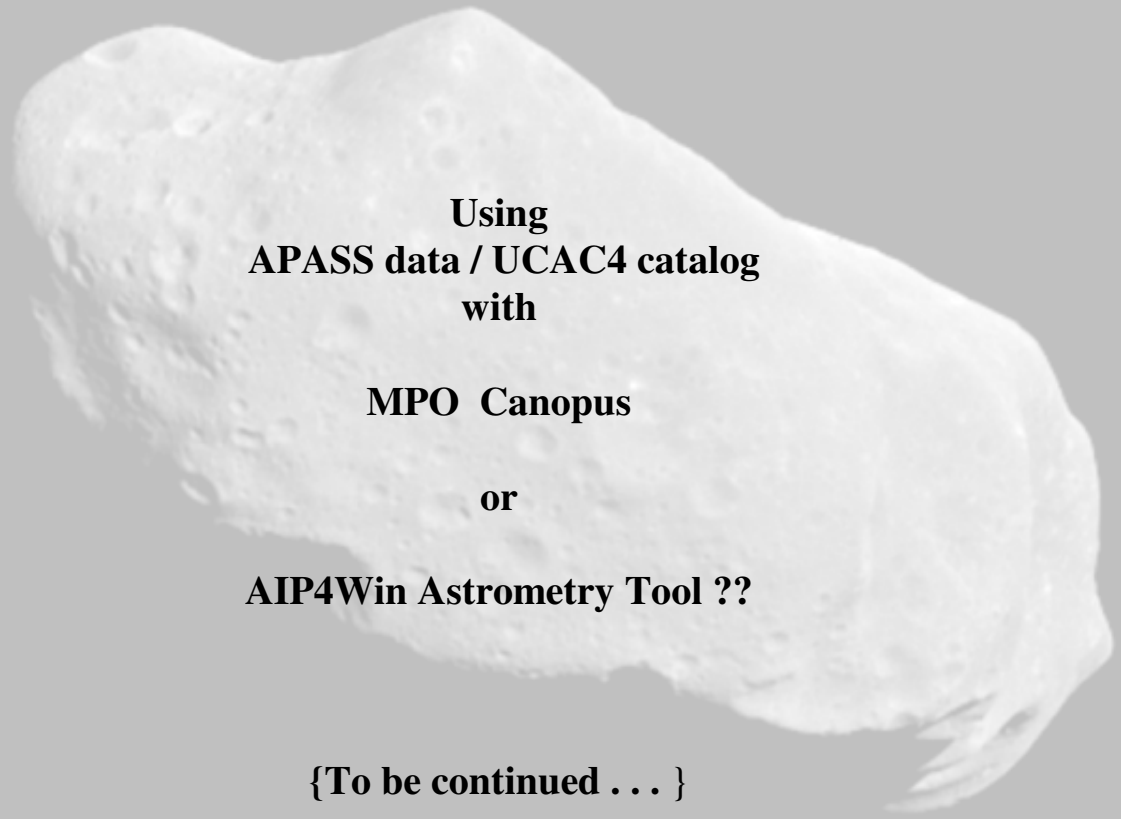
Details

Reference	BibCode	Worked as	DateObs	PABL	PABB	Phase	Family	Class	DMethod	DF	Diameter	DErr	HS	HBand	H	HErr	GS	G	GErr	AS	AF	Albedo	AErr	PF
Schober 1979e	1979A&AS...38..269S																							
Harris 1980b	1980Icar...43...20H	Eukrate	1978-09-02	340.5	-12.4	6.4																		
SIMPS	2004PDSS...12.....T										134.43	2.5			8.04							0.0595	0.002	
AKARI	2011PASJ...63.1117U	Eukrate									150.24	1.66			8.04			0.15		D		0.048	0.001	
WISE	2011ApJ...741...90M	Eukrate									134.000	13.42	A		8.04		A	0.15				0.060	0.011	

http://www.minorplanet.info/PHP/lcdbsummaryquery.php

Getting “standard” Magnitudes

With suitable accuracy and without extended effort



Using
APASS data / UCAC4 catalog
with

MPO Canopus

or

AIP4Win Astrometry Tool ??

{To be continued . . . }