23 New Variable Stars

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Received May 20, 2014, accepted June 30, 2014

Abstract I report the discovery of 23 new variable stars: ten W UMa eclipsing (USNO-B1.0 1070-0023351, USNO-B1.0 1023-0051547, USNO-B1.0 1024-0049987, USNO-B1.0 1023-0051277, USNO-B1.0 1289-0181948, USNO-B1.0 1287-0180792, USNO-B1.0 1287-0177514, GSC 01965:01128, USNO-B1.0 1395-0370184, USNO-B1.0 1395-0370731); four which may be W UMa eclipsing (USNO-B1.0 0943-0001247, GSC 05581:00450, USNO-B1.0 0820-0342790, USNO-B1.0 1026-0049630); four other eclipsing (GSC 00008:00428, USNO-B1.0 1287-0181263, GSC 00814:00461, GSC 01665:01505); one RR Lyr ((GSC 00540:00848); one that might be an RR Lyr ((GSC 05568:00529); and three others for which the type could not be determined (USNO-B1.0 1287-0181515, USNO-B1.0 1288-0184031, USNO-B1.0 1295-0192642).

1. Introduction

As a long-time observer of asteroid light curves, I have accumulated a considerable amount of data of various areas of the sky. Typically, the observations are around 4–7 hours on a single field. Recently I decided to go back and examine all of these images with the aim of seeing if there was anything else of interest in these fields. While the observations were made continuously for many hours on a single field, that field was almost always covered only for one night. This meant that any new variables found would be short-period—mostly, although not exclusively, WUMa eclipsing binaries. The search has proved more successful than I expected, and a lot of fun. However it has resulted in one problem: how to fit time for follow-up observations in between all the asteroid work. As a result of this, several of the variable stars reported here are in need of follow-up observations to better refine the periods and in two cases, to determine the type of variable.

2. Instrumentation used

The data were obtained with two PlaneWave 20-inch f/6.8 cassegrain telescopes operating at prime focus. One of these telescopes is the personal property of the author while the other is the main instrument at the Preston Gott Observatory run by the Physics Department of Texas Tech University. Both telescopes are located at the Preston Gott Observatory, situated at

coordinates 33° 44' 53" N 101° 57' 30" W, about 25 km north of Lubbock, Texas. Both telescopes are equipped with SBIG STL 1001E CCD cameras. These cameras use a Kodak Enhanced KAF-1001E monochrome sensor equipped with an array of 1024 × 1024, 24 µ pixels, for a resulting sampling of 1.43 arcsec/pixel. Skies at the observatory are relatively dark with zenith limiting magnitudes typically around 6.7. Under these conditions, it is possible to reach 20th magnitude with unfiltered three-minute integrations.

3. Data collection

All images were unfiltered. This is normal for asteroid photometry since the spectrum is basically solar in the visible and near infra-red. The spectral response of the CCD chip means that the photometry approximates Johnson-Cousins R.

Normal exposure times were 180 seconds with an average download time of about three seconds per frame. The CCD control program was CCDSOFT v5 (Software Bisque 2012). The images were calibrated using darks and sky flats.

4. Data analysis

The images were initially examined using the "Variable Star Search" routine in MPO CANOPUS (Warner 2012). This routine scans a set of images and looks for objects that vary in brightness, compared to a number of comparison stars selected by the observer. The results are then displayed as a Magnitude-RMS diagram for the observer to check. As shown in Figure 1, numerous possible variable objects are located by the software. These need to be examined to sort out real variables from the false positives. In the case of the object displayed in

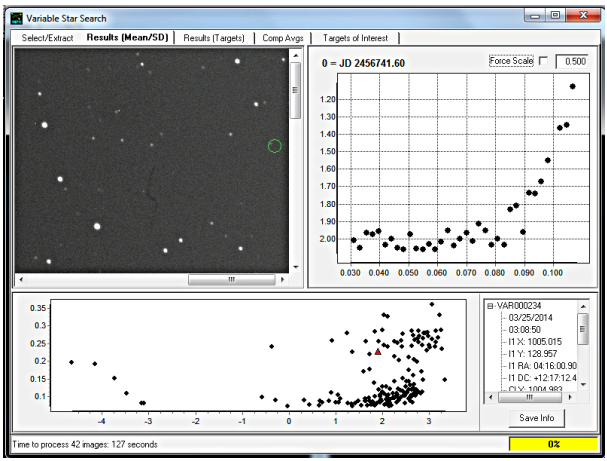

Figure 1. Plot of possible variable objects. X-axis is brightness arbitrary magnitude units. Y-axis is magnitudes RMS.

Figure 1, it was simply a hot pixel. These comprise the majority of the detections.

Most times an actual variable star will show up clearly in the data as shown in Figure 2. Several times more than one variable star would be visible in a set of images. Any variable stars found were then checked against the AAVSO Variable Star Index (http://www.aavso.org/vsx/) to see if they were already

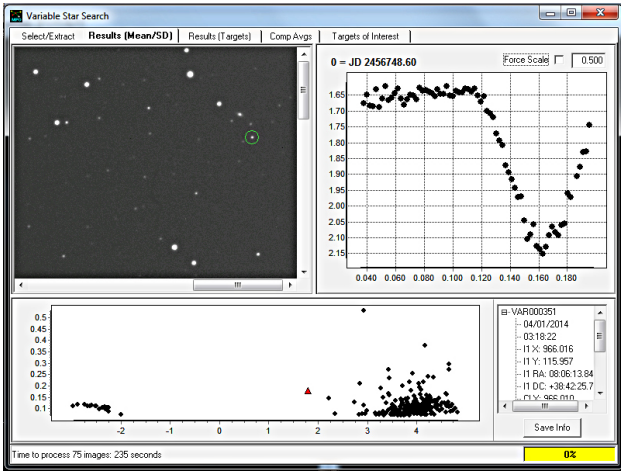

Figure 2. Plot of eclipsing variable star as detected by the "Variable Star Search" utility.

known. For the most part, no variables were listed near the location in question.

Once any likely variable stars were found, they were then analysed using the photometry routines within CANOPUS to yield more precise light curves and, where possible, periods. Comparison stars were chosen from those in the images that had solar-type spectra. Five such comparison stars were used for each variable.

5. Results

To date, I have found 27 new variable stars in my asteroid images, and one that I suspect to be variable. Of those that are confirmed as variable, 23 are reported here. Three of the 27 stars are not discussed as they are the subject of a separate paper to be presented at a conference in June 2014. The details of each of the 23 new variable stars are given in Table 1 in order of increasing Right Ascension. Finder charts, phase plots, and light curves for these 23 stars are shown in Figures 3 through 46.

Acknowledgements

This work has made use of the VizieR catalogue access tool, CDS, Strasbourg, France, and the International Variable Star Index (VSX) operated by the AAVSO.

Table 1. Information about 23 new variable stars.

Star Name and cross-identification	*Position USNO-B1.0 (J2000) R.A.* h m s	*Dec.* ° ′ ″	*Discovery Date (by image)*	*Type*	*Magnitude*	*Period*	*Amplitude*	*Epoch (HJD)*
USNO-B1.0 0943-0001247 2MASS J00095378+0420182	00 09 53.754	04 20 18.18	2012 12 12	WUMa?	16.9 R	8h?	0.4	2456214.596362
GSC 00008:00428 USNO-B1.0 0954-0002869 2MASS J00184579+0527357 UCAC4 478-000501	00 18 45.791	05 27 35.87	2012 10 14	Eclipsing	14.1 R	?	0.4	2456214.646277
USNO-B1.0 1070-0023351 2MASS J02130384+1704255 UCAC4 536-003923 SDSS J021303.84+170425.4	02 13 03.840	17 04 25.71	2012 10 09	W UMa	15.39 R	6.917h	0.92	2456684.566031
USNO-B1.0 1026-0049630 2MASS J04142099+1236292	04 14 20.980	12 36 29.27	2012 12 12	W UMa?	16.3 R	6h+?	0.3?	2456727.619196
USNO-B1.0 1023-0051547 2MASS J04154996+1223131	04 15 49.945	12 23 13.17	2012 12 12	WUMa	18.4 R	6.704h	0.54	2456273.718834
USNO-B1.0 1024-0049987 2MASS J04143495+1229014 UCAC4 063.6455698	04 14 34.932	12 29 01.50	2012 12 12	WUMa	16.23 R	7.145h	0.66	2456273.718834

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Table 1. Information about 23 new variable stars, cont.

Star Name and cross-identification	*Position USNO-B1.0 (J2000) R.A.* h m s	*Dec.* ° ′ ″	*Discovery Date (by image)*	*Type*	*Magnitude*	*Period*	*Amplitude*	*Epoch (HJD)*
USNO-B1.0 1023-0051277 2MASS J04143679+1221448 UCAC4 063.6533998	04 14 36.778	12 21 45.03	2012 12 12	W UMa	15.94 R	6.274	0.38	2456273.718834
USNO-B1.0 1295-0192642 2MASS J08005119+3933183 SDSS J080051.19+393318.3	08 00 51.195	39 33 18.79	2012 01 03	?	17.0 R	45.22h	0.7	2455929.660188
USNO-B1.0 1289-0181948 2MASS J08042441+3854362 UCAC4 645-045175 SDSS J080424.40+385436.2	08 04 24.402	38 54 36.50	2011 12 29	WUMa	14.8 R	6.1099h	0.20	2455924.635036
USNO-B1.0 1287-0180792 2MASS J08042435+3845428 SDSS J080424.34+384542.9	08 04 24.345	38 45 43.29	2011 12 29	WUMa	16.7 R	5.3487h	0.19	2455924.637193
USNO-B1.0 1287-0181263 UCAC4 644-044338 2MASS J08061380+3842255 SDSS J080613.81+384225.5	08 06 13.818	38 42 25.83	2011 12 29	Eclipsing	16.0 R	19.537h?	0.55	2455923.626735

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Table 1. Information about 23 new variable stars, cont.

Star Name and cross-identification	*Position USNO-B1.0 (J2000) R.A.* h m s	*Dec.* ° ′ ″	*Discovery Date (by image)*	*Type*	*Magnitude*	*Period*	*Amplitude*	*Epoch (HJD)*
USNO-B1.0 1287-0177514 SDSS J080706.96+382856.7	08 07 06.969	38 28 57.49	2011 12 27	WUMa	18.7 R	5.5548h	0.52	2455922.691446
USNO-B1.0 1287-0181515 SDSS J080714.27+384304.2	08 07 14.273	38 43 04.85	2011 12 28	?	15.3 R	12.8h??	0.25	2455923.626735
USNO-B1.0 1288-0184031 UCAC4 645-045277 2MASS J08063051+3848435 SDSS J080630.51+384843.4	08 06 30.521	38 43 43.62	2014 04 08	?	16.2 R	4.31h?	0.09?	2456755.643176
GSC 00814:00461 USNO-B1.0 1023-0198594 UCAC4 512-046328 2MASS J08042435+3845428 SDSS J085346.66+121822.8	08 53 46.669	12 18 23.01	2014 03 25	Eclipsing	15.6 R	5.013h?	0.54	2456741.721395
GSC 01965:01128 USNO-B1.0 1175-0215277 UCAC4 588-046057 2MASS J09301659+2734517 SDSS J093016.58+273451.7	09 30 16.580	27 34 52.26	2011 01 02	W UMa	13.7 R	6.110h	0.09	2455563.719881

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Table 1. Information about 23 new variable stars, cont.

Star Name and cross-identification	*Position USNO-B1.0 (J2000) R.A. h m s*	*Dec. ° ' "*	*Discovery Date (by image)*	*Type*	*Magnitude*	*Period*	*Amplitude*	*Epoch (HJD)*
GSC 05568:00529 USNO-B1.0 0791-0263951 UCAC4 396-058141 2MASS J14370018-1048533 SDSS J093016.58+273451.7	14 37 00.198	-10 48 53.35	2011 05 12	RR Lyr?	14.3 R	12.46h?	0.9?	2455693.648030
GSC 05581:00450 USNO-B1.0 0821-0348315 UCAC4 411-060065 2MASS J15162584-0752270	15 16 25.848	-07 52 27.07	2014 03 30	W UMa?	13.8 R	8.4h?	0.4	2456746.817471
USNO-B1.0 0820-0342790 UCAC4 698-084455 2MASS J20471515+4931378	15 16 29.403	--07 54 00.26	2014 03 30	W UMa?	16.3 R	8h+	0.4	2456746.817471
USNO-B1.0 1395-0370184 UCAC4 698-084455 2MASS J20471515+4931378	20 47 15.147	49 31 38.12	2010 10 22	W UMa	14.7 R	4.718h	0.35	2455494.572038

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Table 1. Information about 23 new variable stars, cont.

Star Name and cross-identification	*Position USNO-B1.0 (J2000) R.A.* *h m s*	*Dec.* *° ′ ″*	*Discovery Date (by image)*	*Type*	*Magnitude*	*Period*	*Amplitude*	*Epoch (HJD)*
USNO-B1.0 1395-0370731 UCAC4 698-084559 2MASS J20474625+4932024	20 47 46.209	49 32 02.88	2010 10 22	W UMa	14.9 R	8.0269h	0.31	2455494.572038
GSC 00540:00848 USNO-B1.0 0962-056701 UCAC4 482-128284 2MASS J21221863+0615034 SDSS J212218.63+061503.3	21 22 18.631	06 15 03.69	2011 07 6	RR Lyr	14.5 R	24.360h	1.2	2455748.702837
GSC 01665:01505 USNO-B1.0 1050-0607272 UCAC4 526-146088 2MASS J21400677+1503109	21 40 06.775	15 03 11.05	2010 10 22	Eclipsing	13.9 R	4.66h??	0.15	2455494.703877

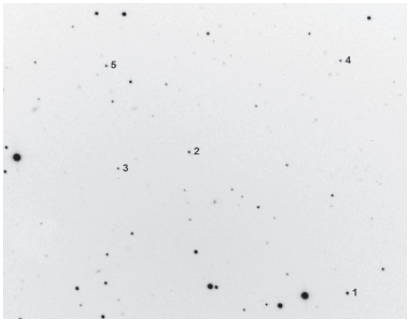


Figure 3. Finder for USNO-B1.0 0943-0001247.

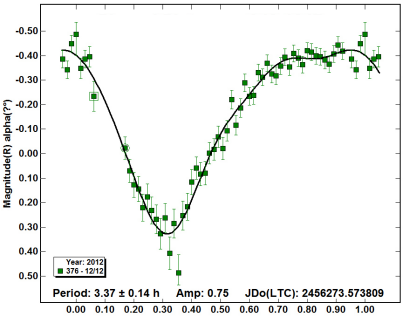


Figure 4. USNO-B1.00943-0001247 phase plot.

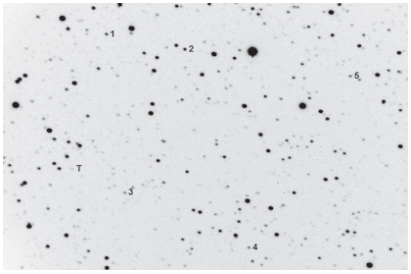


Figure 5. Finder for GSC 00008:00428.

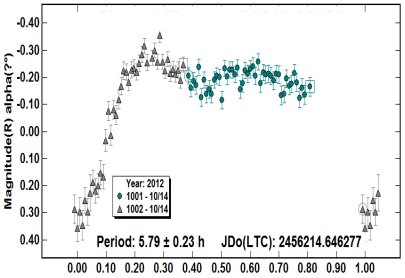


Figure 6. GSC 00008:00428 phase plot.

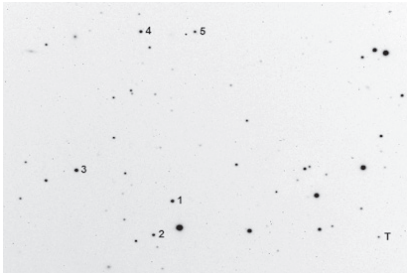


Figure 7. Finder for USNO-B1.0 1070-0023351.

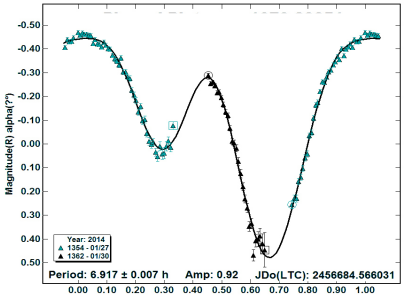
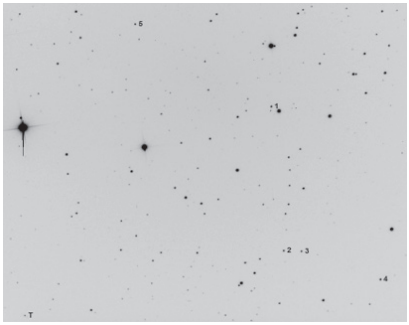


Figure 8. USNO-B1.01070-0023351 phase plot.



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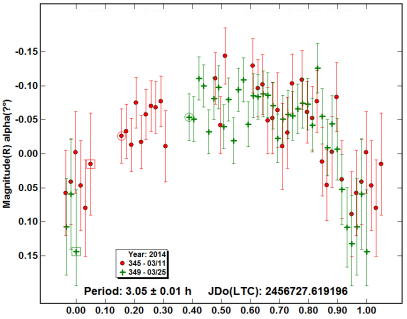


Figure 10. USNO-B1.01026-0049630 phase plot.

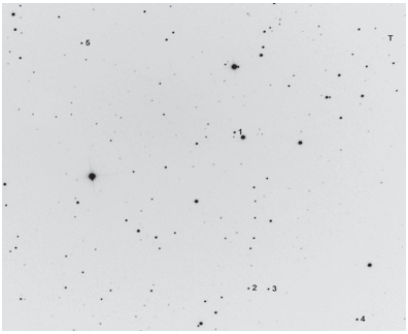


Figure 11. Finder for USNO-B1.0 1023-0051547.

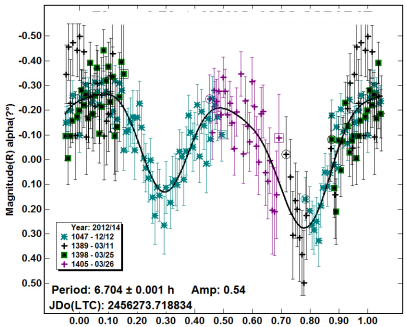


Figure 12. USNO-B1.0 1023-0051547 phase plot.

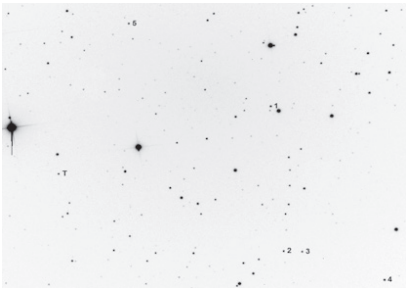


Figure 13. Finder for USNO-B1.0 1024-0049987.

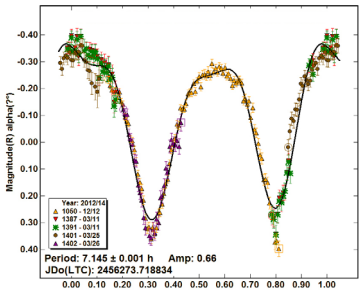
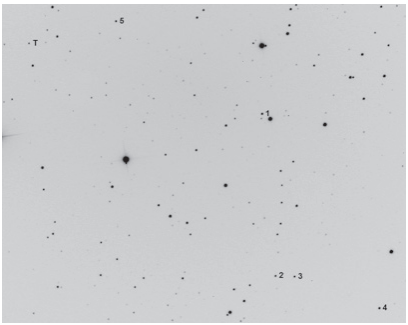


Figure 14. USNO-B1.0 1024-0049987 phase plot.



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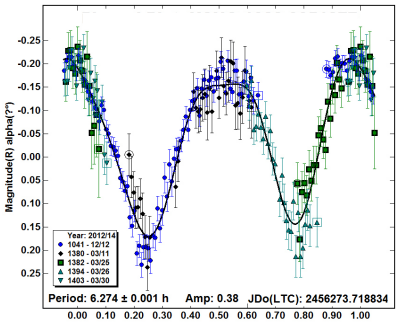

Figure 16. USNO-B1.0 1023-0051277 phase plot.

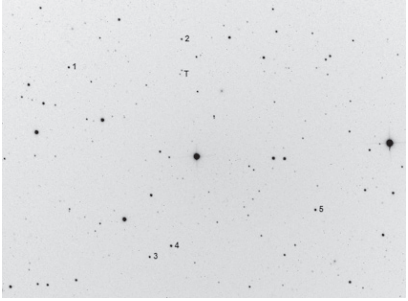

Figure 17. Finder for USNO-B1.0 1295-0192642.

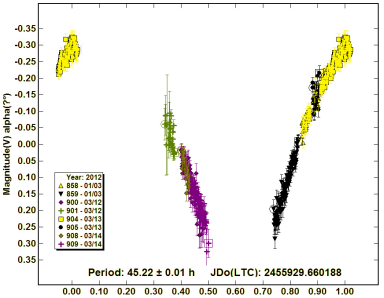

Figure 18. USNO-B1.0 1295-0192642 phase plot.

Figure19.FinderforUSNO-B1.0 1289-0181948.

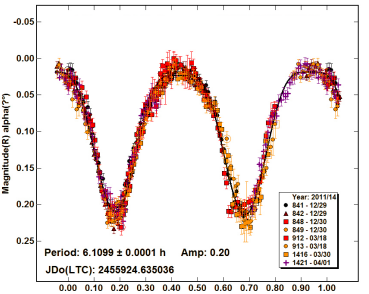

Figure20.USNO-B1.0 1289-0181948phaseplot.

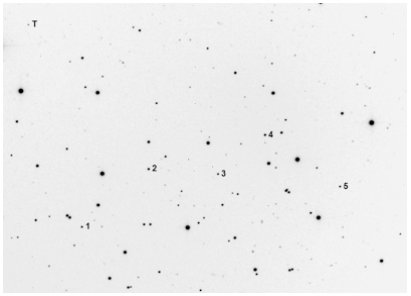

Figure21.FinderforUSNO-B1.01287-0180792.

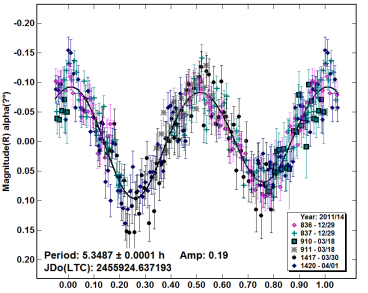

Figure22.USNO-B1.01287-0180792phaseplot.

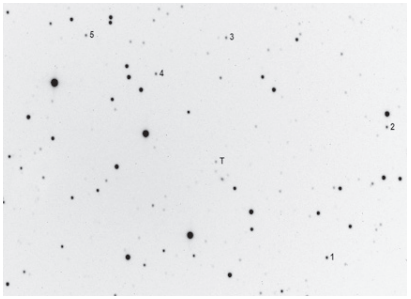

Figure23.FinderforUSNO-B1.01287-0181263.

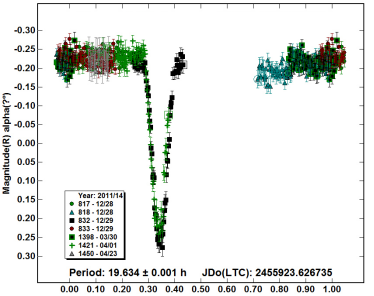

Figure24.USNO-B1.01287-0181263phaseplot.

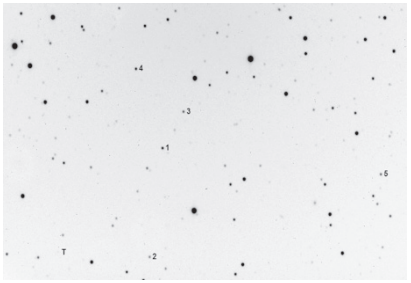

Figure25.FinderforUSNO-B1.01284-0177514.

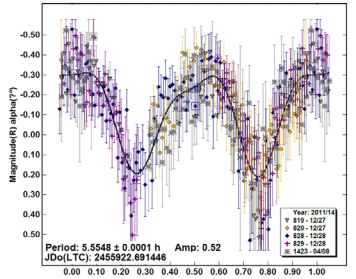

Figure26.USNO-B1.01284-0177514phaseplot.

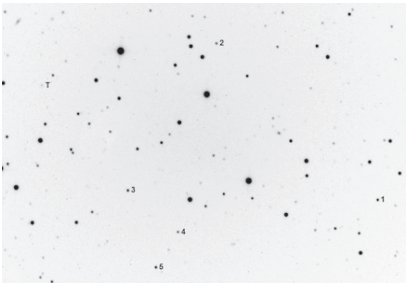

Figure 27. Finder for USNO-B1.0 1287-0181515.

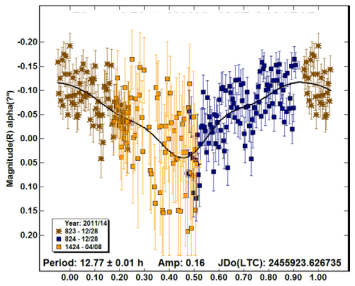

Figure 28. USNO-B1.0 1287-0181515 phase plot.

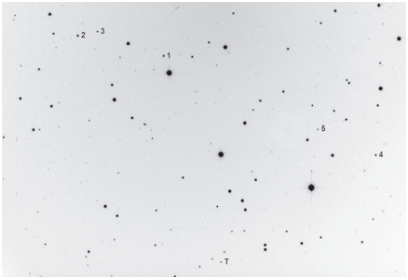

Figure 29. Finder for USNO-B1.0 1288-0184031.

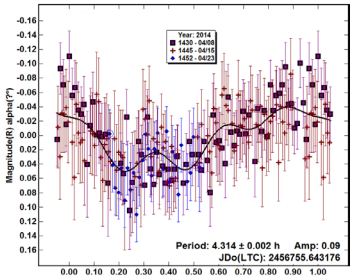

Figure 30. USNO-B1.0 1288-0184031 phase plot.

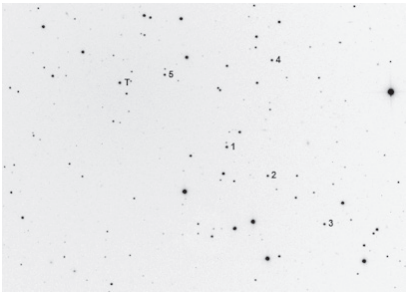

Figure 31. Finder for GSC 00814:00461.

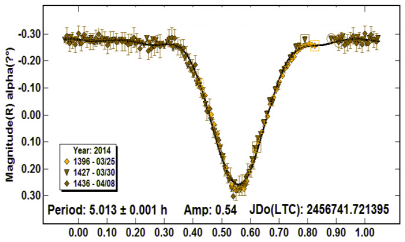

Figure 32. GSC 00814:00461 phase plot.

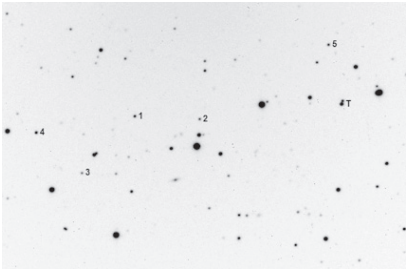

Figure 33. Finder for GSC 01965:01128.

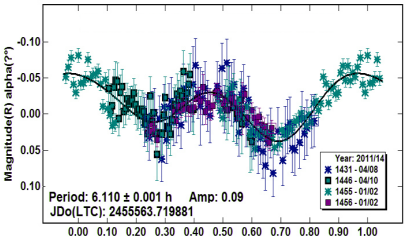

Figure 34. GSC 01965:01128 phase plot.

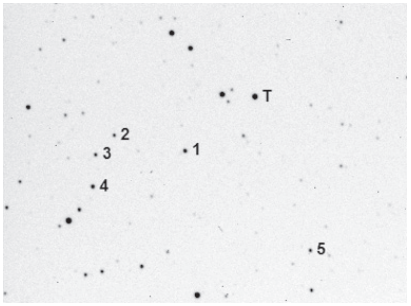

Figure 35. Finder for GSC 05568:00529.

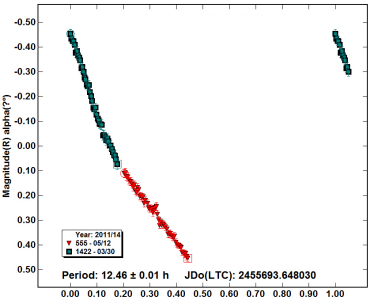

Figure 36. GSC 05568:00529 phase plot.

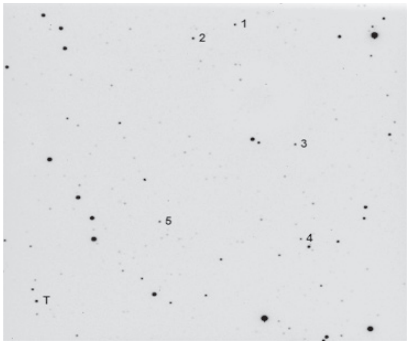

Figure 37. Finder for GSC 05581:00450.

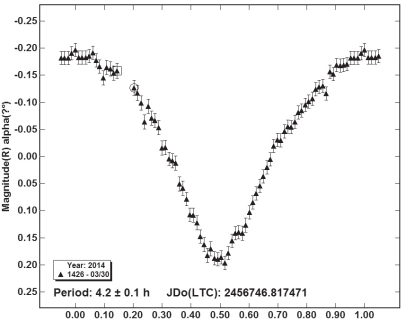

Figure 38. GSC 05581:00450 phase plot.

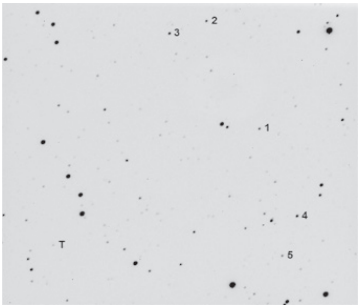

Figure39. Finder for USNO-B1.0 0820-0342790.

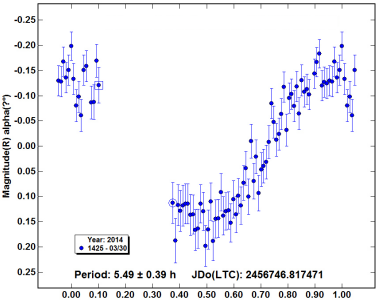

Figure40. USNO-B1.0 0820-0342790 phase plot.

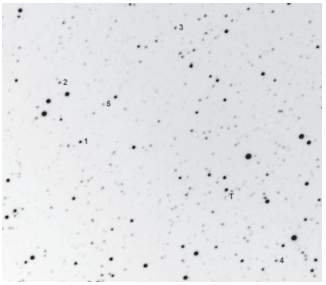

Figure41. Finder for USNO-B1.0 1395-0370184.

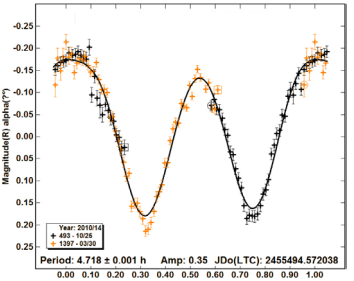

Figure42. USNO-B1.0 1395-0370184 phase plot.

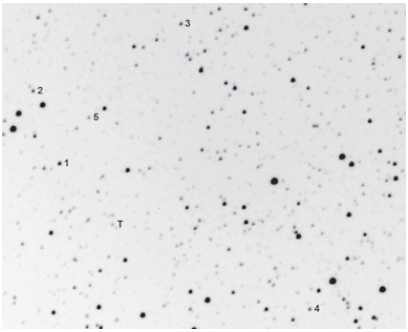

Figure43. FinderforUSNO-B1.0 1395-0370731.

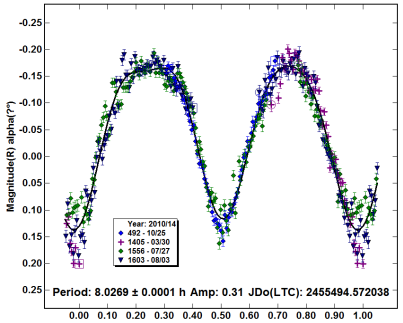

Figure44. USNO-B1.0 1395-0370731 phaseplot.

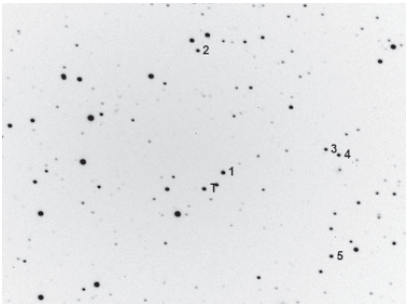

Figure 45. Finder for GSC 00540:00848.

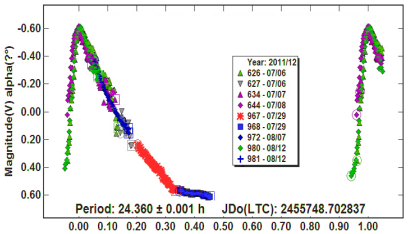

Figure 46. GSC 00540:00848 phase plot.

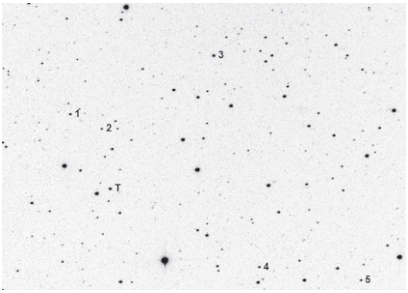

Figure 47. Finder for GSC 01665:01505.

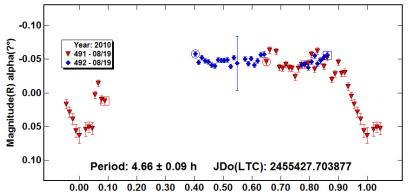

Figure 48. GSC 01665:01505 phase plot.

References

Software Bisque. 2012, CCDSOFT CCD control software (http://www.bisque.com).

Warner, B. D. 2012, MPO CANOPUS, version 10.4.3.17, BDW Publishing, Colorado Springs, CO (http://minorplanetobserver.com).