

23 New Variable Stars

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Abstract I report the discovery of 23 new variable stars: ten W UMa eclipsing (USNO 1070-0023351, USNO 1023-0051547, USNO 1024-0049987, USNO 1023-0051277, USNO 1289-0181948, USNO1287-0180792, USNO12870-0177514, GSC 01965:01128, USNO 1395-0370184, USNO 1395-0370731); four which may be W UMa eclipsing (USNO 0943-0001247, GSC 05581:00450, USNO 0820-0342790, USNO 1026-0049630); four other eclipsing (GSC 00008:00428, USNO1287-0181263, 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 1287-0181515, USNO 1288-0184031, USNO 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, W UMa 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 , 24μ 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, it was simply a hot pixel. These comprise the majority of the detections.

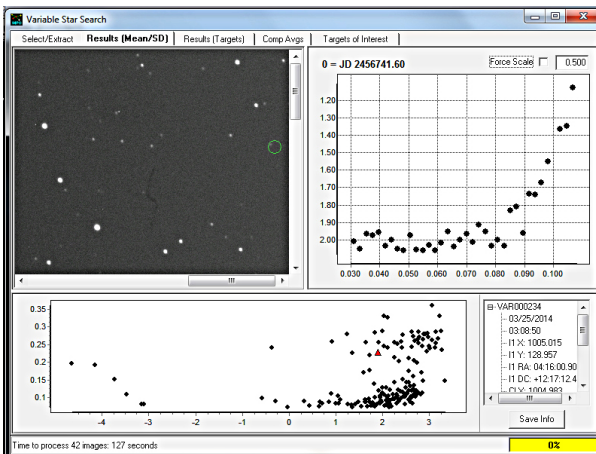


Figure 1. Plot of possible variable objects. X-axis is brightness arbitrary magnitude units. Y-axis is magnitudes RMS.

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

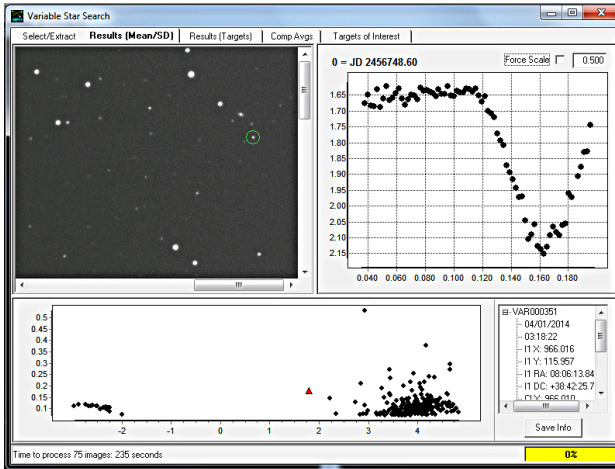


Figure 2. Plot of eclipsing variable star as detected by the “Variable Star Search” utility.

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.

<i>Star Name and cross-identification</i>	<i>Position USNO B1 (J2000) R.A. h m s</i>	<i>Dec. o ' "</i>	<i>Discovery Date (by image)</i>	<i>Type</i>	<i>Magnitude</i>	<i>Period</i>	<i>Amplitude</i>	<i>Epoch (HJD)</i>
USNO 0943-0001247 2MASS 00095378+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 0954-0002869	00 18 45.791	05 27 35.87	2012 10 14	Eclipsing	14.1 R	?	0.4	2456214.646277
2MASS 00184579+0527357 UCAC4 478-000501								
USNO 1070-0023351 2MASS 0 2130384+1704255 UCAC4 536-003923 SDSS J021303.84+170425.4	02 13 03.840	17 04 25.71	2012 10 09	WUMa	15.39 R	6.917h	0.92	2456684.566031
USNO 1026-0049630 2MASS 04142099+1236292	04 14 20.980	12 36 29.27	2012 12 12	WUMa?	16.3 R	6h+?	0.3?	2456727.619196
USNO 1023-0051547 2MASS 04154996+1223131	04 15 49.945	12 23 13.17	2012 12 12	WUMa	18.4 R	6.704h	0.54	2456273.718834

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

Star Name and cross-identification	Position USNO B1 (J2000)			Discovery Date (by image)	Type	Magnitude	Period	Amplitude	Epoch (HJD)
	R.A. h m s	Dec. ° ' "	Par. "						
USNO 1024-0049987	04 14 34.932	12 29 01.50		2012 12 12	WUMa	16.23 R	7.145h	0.66	2456273.718834
2MASS 04143495+1229014									
UCAC4 063.6455698									
USNO 1023-0051277	04 14 36.778	12 21 45.03		2012 12 12	WUMa	15.94 R	6.274	0.38	2456273.718834
2MASS 04143679+1221448									
UCAC4 063.6533998									
USNO 1295-0192642	08 00 51.195	39 33 18.79		2012 01 03	?	17.0 R	45.22h	0.7	2455929.660188
2MASS 08005119+3933183									
SDSS J080051.19+393318.3									
USNO 1289-0181948	08 04 24.402	38 54 36.50		2011 12 29	WUMa	14.8 R	6.1099h	0.20	2455924.635036
2MASS 08042441+3854362									
UCAC4 645-045175									
SDSS J080424.40+385436.2									
USNO 1287-0180792	08 04 24.345	38 45 43.29		2011 12 29	WUMa	16.7 R	5.3487h	0.19	2455924.637193
2MASS 08042435+3845428									
SDSS J080424.34+384542.9									

Table continued on following pages

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

Star Name and cross-identification	Position USNO B1 (J2000)			Discovery Date (by image)	Type	Magnitude	Period	Amplitude	Epoch (HJD)
	R.A. h m s	Dec. ° ' "	z						
USNO1287-0181263 UCAC4 6444-044338	08 06 13.818	38 42 25.83		2011 12 29	Eclipsing	16.0 R	19.537h?	0.55	2455923.626735
2MASS 08061380+3842255 SDSS J080613.81+384225.5									
USNO12870-0177514 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
USNO1287-0181515 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 1288-0184031 UCAC4 645-045277	08 06 30.521	38 43 43.62		2014 04 08	?	16.2 R	4.31h?	0.09?	2456755.643176
2MASS 08063051+3848435 SDSS J080630.51+384843.4									
GSC 00814:00461 USNO 1023-0198594	08 53 46.669	12 18 23.01		2014 03 25	Eclipsing	15.6 R	5.013h?	0.54	2456741.721395
UCAC4 512-046328 2MASS 08042435+3845428 SDSS J085346.66+121822.8									

Table continued on following pages

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

Star Name and cross-identification	Position USNO BI (J2000)			Discovery Date (by image)	Type	Magnitude	Period	Amplitude	Epoch (HJD)
	R.A. h m s	Dec. ° ' "	z						
GSC 01965:01128	09 30 16.580	27 34 52.26		2011 01 02	W UMa	13.7 R	6.110h	0.09	2455563.719881
USNO 1175-0215277									
UCAC4 588-046057									
2MASS 09301659+2734517									
SDSS J093016.58+273451.7									
GSC 05568:00529	14 37 00.198	-10 48 53.35		2011 05 12	RR Lyr?	14.3 R	12.46h?	0.9?	2455693.648030
USNO 0791-0263951									
UCAC4 396-058141									
2MASS 14370018-1048533									
SDSS J093016.58+273451.7									
GSC 05581:00450	15 16 25.848	-07 52 27.07		2014 03 30	W UMa?	13.8 R	8.4h?	0.4	2456746.817471
USNO 0821-0348315									
UCAC4 411-060065									
2MASS 15162584-0752270									
USNO 0820-0342790	15 16 29.403	--07 54 00.26		2014 03 30	W UMa?	16.3 R	8h+	0.4	2456746.817471
UCAC4 698-084455									
2MASS 20471515+4931378									

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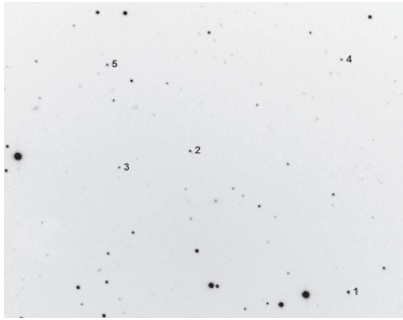


Figure 3. Finder chart for USNO 0943-001247.

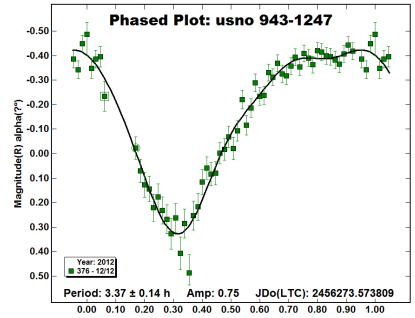


Figure 4. Light curve for USNO 0943-001247.

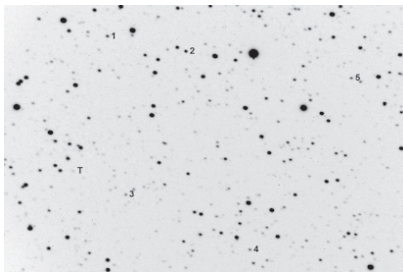


Figure 5. Finder chart for GSC 00008:00428.

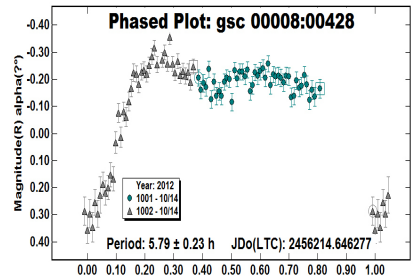


Figure 6. Light curve for GSC 00008:00428.



Figure 7. Finder chart for USNO 1070-0023351.

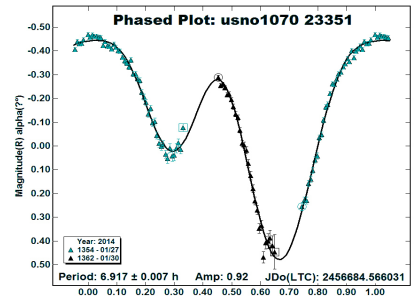


Figure 8. Light curve for USNO 1070-0023351.

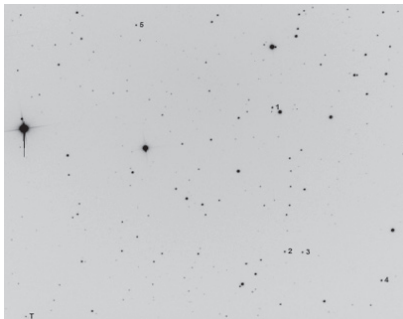


Figure 9. Finder chart for USNO 1026-0049630.

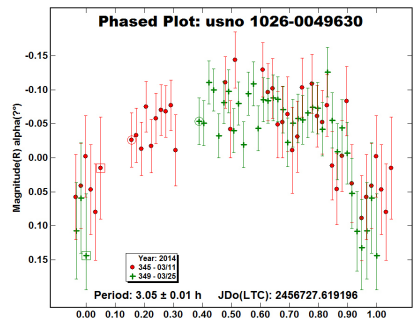


Figure 10. Light curve for USNO 1026-0049630.

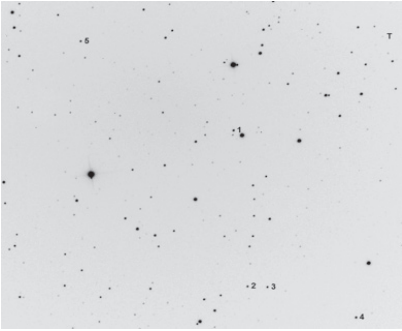


Figure 11. Finder chart for USNO 1023-0051547.

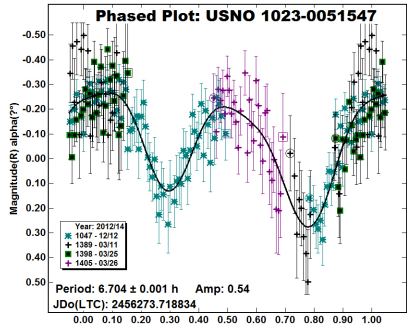


Figure 12. Light curve for USNO 1023-0051547.



Figure 13. Finder chart for USNO 1024-0049987.

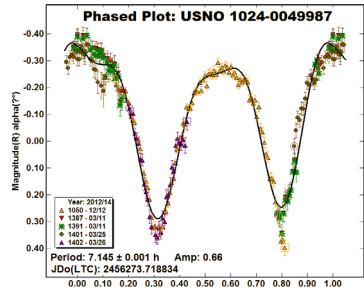


Figure 14. Light curve for USNO 1024-0049987.

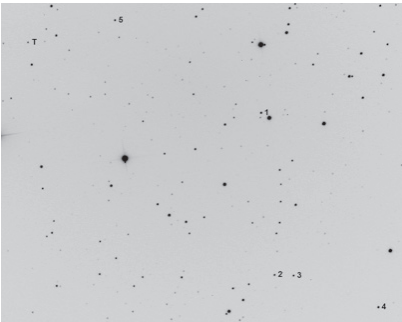


Figure 15. Finder chart for USNO 1023-0051277.

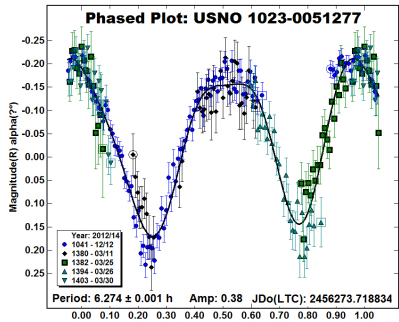


Figure 16. Light curve for USNO 1023-0051277.

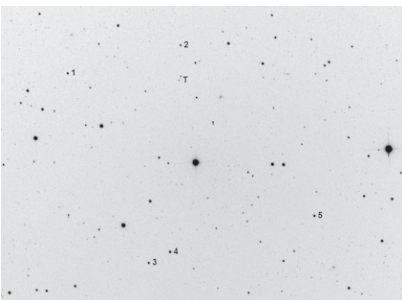


Figure 17. Finder chart for USNO 1295-0192642.

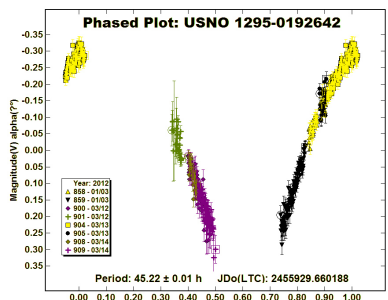


Figure 18. Light curve for USNO 1295-0192642.



Figure 19. Finder chart for USNO 1289-0181948.

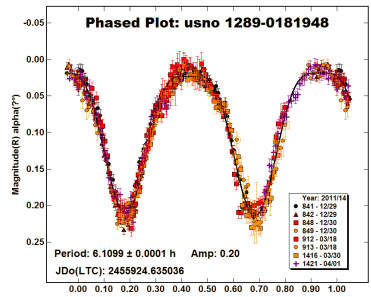


Figure 20. Light curve for USNO 1289-0181948.

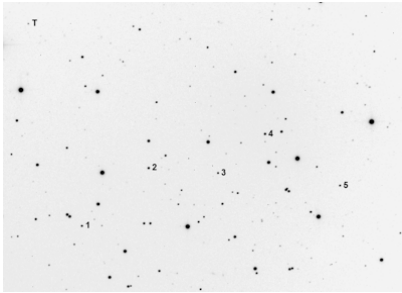


Figure 21. Finder chart for USNO 1287-0180792.

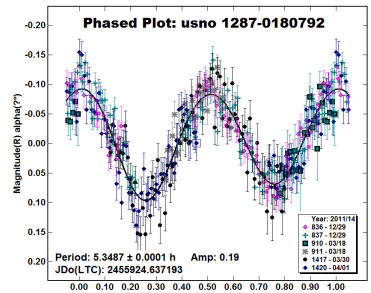


Figure 22. Light curve for USNO 1287-0180792.

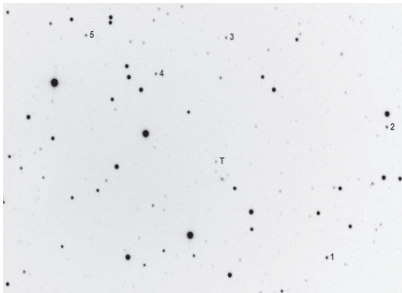


Figure 23. Finder chart for USNO 1287-0181263.

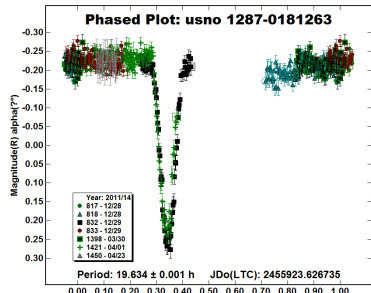


Figure 24. Light curve for USNO 1287-0181263.



Figure 25. Finder chart for USNO 1284-0177514.

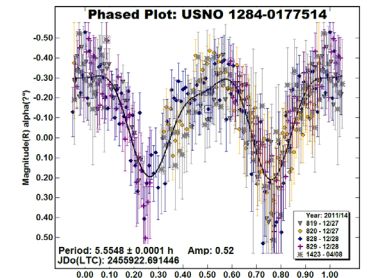


Figure 26. Light curve for USNO 1284-0177514.

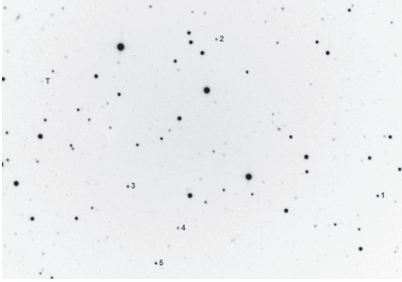


Figure 27. Finder chart for USNO1287-0181515.

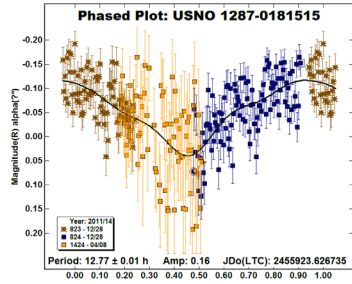


Figure 28. Light curve for USNO1287-0181515.



Figure 29. Finder chart for USNO 1288-0184031.

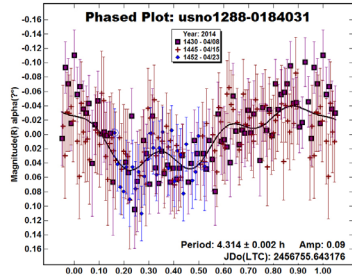


Figure 30. Light curve for USNO 1288-0184031.



Figure 31. Finder chart for GSC 00814:00461.

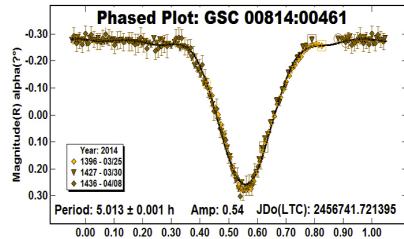


Figure 32. Light curve for GSC 00814:00461.



Figure 33. Finder chart for GSC 01965:01128.

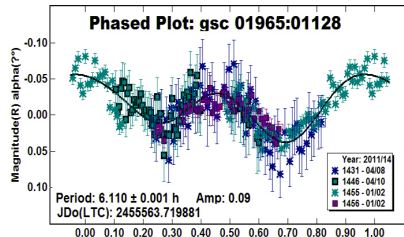


Figure 34. Light curve for GSC 01965:01128.

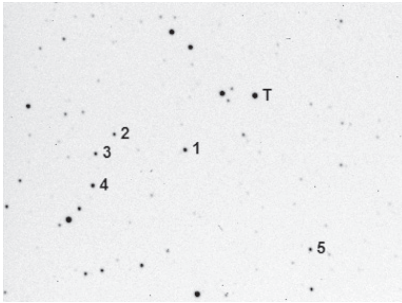


Figure 35. Finder chart for GSC 05568:00529.

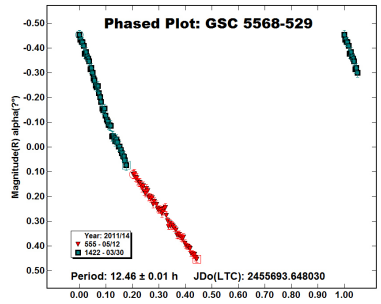


Figure 36. Light curve for GSC 05568:00529.

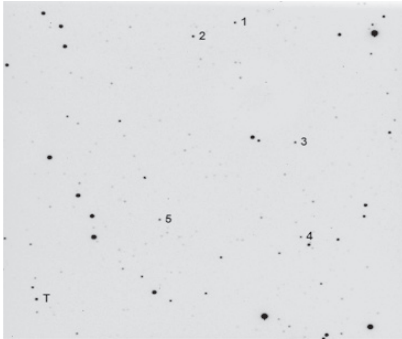


Figure 37. Finder chart for GSC 05581:00450.

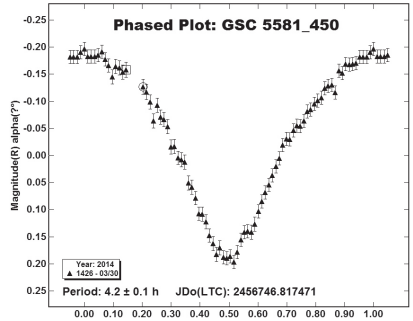


Figure 38. Light curve for GSC 05581:00450.



Figure 39. Finder chart for USNO 0820-0342790.

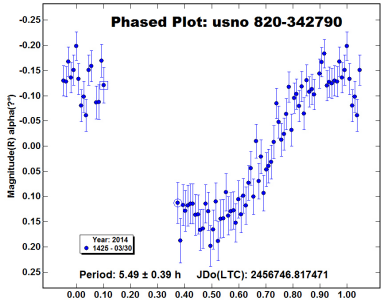


Figure 40. Light curve for USNO 0820-0342790.

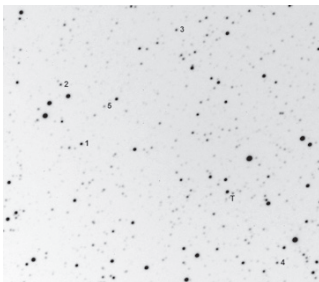


Figure 41. Finder chart for USNO 1395-0370184.

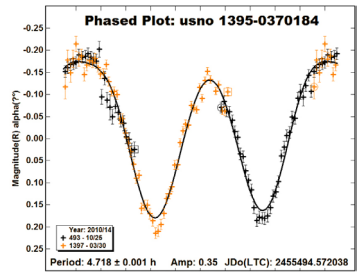


Figure 42. Light curve for USNO 1395-0370184.

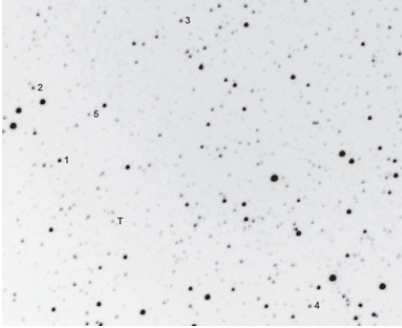


Figure 43. Finder chart for USNO 1395-037031.

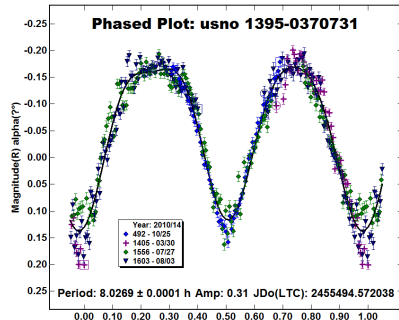


Figure 44. Light curve for USNO 1395-037031.

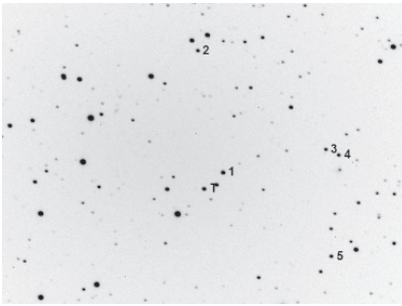


Figure 45. Finder chart for GSC 00540:00848.

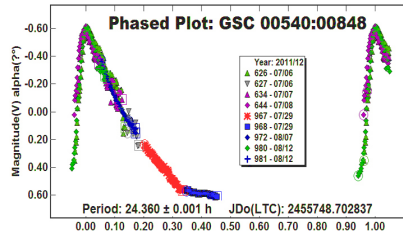


Figure 46. Light curve for GSC 00540:00848.

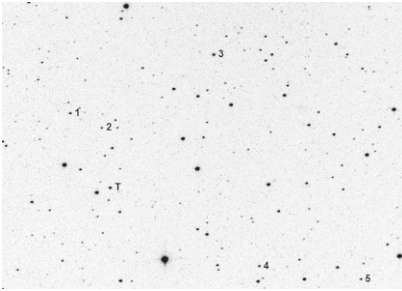


Figure 47. Finder chart for GSC 01665:01505.

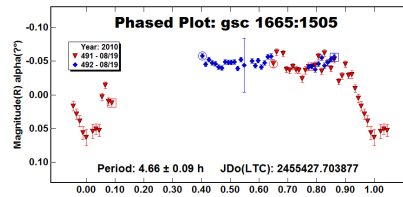


Figure 48. Light curve for GSC 01665:01505.

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>).