

CCD PHOTOMETRIC SURVEY FOR VARIABLE STARS IN CYGNUS AND GEMINI: THIRTY-NINE NEW DISCOVERIES FROM THE OSSERVATORIO ASTRONOMICCO NASTRO VERDE (MPC C82)

N. RUOCCO

*Osservatorio Astronomico "Nastro Verde", MPC Code C82, Sorrento (NA), Italy
nello_ruocco@hotmail.com | osservatorionastroverde@gmail.com*

Abstract: I present the results of a long-term CCD photometric monitoring programme carried out at the Osservatorio Astronomico "Nastro Verde" (MPC Code C82), Sorrento, Italy, targeting known variable stars in two constellations: Cygnus (nine fields plus one adjacent field in Lacerta, 2012–2018) and Gemini (four fields, 2017–2019). For four previously catalogued variables – OO Cyg (EW), V1111 Cyg (RRAB/BL), V2884 Cyg (EB) and GR Gem (EA) – I provide revised periods and epochs. In addition, thirty-nine new variable stars were discovered and submitted to the AAVSO International Variable Star Index (VSX): in Cygnus, 32 new variables of types EW, EB, EA, RRAB, RRC, DSCT, DSCTC and HADS; in Gemini, 7 new EW-type eclipsing binaries. All 43 programme objects are listed in Tables 1 and 2. A colour-magnitude diagram based on Gaia DR3 photometry, with individual Bailer-Jones (2021) distances and individual Gaia DR3 GSP-Phot reddening for each star, is presented for both samples.

1 Introduction

Systematic monitoring of known variable stars is a productive strategy for discovering new variables through serendipitous detection in the same CCD field. This technique, sometimes called field-mining (or ensemble photometry), has been particularly effective at small amateur observatories equipped with sensitive CCD cameras and automated period-analysis software. In this paper I report the combined results of two such campaigns conducted at the Osservatorio Astronomico "Nastro Verde" (MPC Code C82) in Sorrento, Italy.

The first campaign targeted nine fields in the constellation Cygnus and one adjacent field in Lacerta, spanning 2012 to 2018. The ten fields are centred on the known variables: (1) OO Cyg; (2) QX Cyg; (3) QT Cyg; (4) V1870 Cyg; (5) CM Lac; (6) V947 Cyg; (7) V1457 Cyg; (8) V789 Cyg; (9) V1437 Cyg; and (10) V1416 Cyg. The second campaign targeted four fields in Gemini – centred on GR Gem, BS Gem, SX Gem, and V351 Gem – observed in January–February 2017 and January–February 2019. Together, the two campaigns yielded revised elements for four known variables and the discovery of thirty-nine new variables, all submitted to and approved in the AAVSO Variable Star Index (VSX).

2 Instrumentation and Data Reduction

All observations were carried out with a Meade LX200 Schmidt-Cassegrain telescope of 254 mm aperture at effective focal ratio $f/6.3$ (Cygnus campaign) or $f/10$ (Gemini campaign),

equipped with SBIG ST-8 and SBIG ST-7 CCD cameras. The detector provides a field of view of approximately $11' \times 7'$ to $12' \times 9'$ with an image scale of $\sim 0.5''/\text{pixel}$. Most observations were unfiltered (clear passband, effective response close to Cousins Rc); some Cygnus runs used a V filter. Image calibration (bias, dark and flat-field correction) and differential aperture photometry were performed with MaxIm DL (Diffraction Limited) and MuniWin (Hroch 1998). Period searches were carried out with Peranso (Paunzen & Vanmunster 2016), implementing Lomb–Scargle, phase dispersion minimisation (PDM) and analysis of variance (AoV). For one Gemini object, UCAC4 525-032522, archival ASAS-SN photometry (Shappee et al. 2014; Kochanek et al. 2017) was combined with my own data to obtain a better-constrained period.

3 Results

Tables 1 and 2 summarise the photometric parameters of all 43 programme stars, for Cygnus and Gemini respectively. Revised objects are listed first in each table (in italics). For each star I provide the catalogue designation, AAVSO Unique Identifier (AUID), J2000 coordinates, variability type, epoch (HJD), period, magnitude range (amplitude in parentheses), and monitored field. Phase-folded light curves and DSS2 finding charts are presented in Section 4.

Table 1: Programme stars in Cygnus and adjacent Lacerta. Revised objects (rows 1–3, in italics) are listed first, followed by the 32 new discoveries grouped by field.

Name	AUID	Coordinates (J2000)	Type	Epoch (HJD)	Period (d)	Mag. range	Field
<i>OO Cyg</i>	<i>000-BDN-390</i>	<i>19 52 44.91 +37 58 48.3</i>	<i>EW</i>	<i>2456499.571</i>	<i>0.26890536</i>	<i>13.18–13.65 V</i>	<i>OO Cyg</i>
<i>V1111 Cyg</i>	<i>000-BDP-031</i>	<i>19 23 09.15 +30 10 53.2</i>	<i>RRAB/BL</i>	<i>2457573.5021</i>	<i>0.55820</i>	<i>14.7–16.1 p</i>	<i>V789/V1111</i>
<i>V2884 Cyg</i>	<i>000-BKQ-254</i>	<i>19 58 35.78 +38 10 42.9</i>	<i>EB</i>	<i>2458010.898</i>	<i>0.7053073</i>	<i>11.86–12.16 Ic</i>	<i>QX Cyg</i>
V2875 Cyg	000-BLC-617	19 52 13.26 +37 57 55.0	EB	2457079.164	0.5821835	14.85–15.6 V	OO Cyg
V2876 Cyg	000-BLC-688	19 52 34.35 +37 53 12.8	EB	2456501.4307	0.6952	15.33 V (0.20)	OO Cyg
V2877 Cyg	000-BLC-764	19 53 26.99 +37 54 00.2	DSCTC	2456506.5187	0.1895	14.55 V (0.05)	OO Cyg
2MASS J19524346+3756501	000-BLC-861	19 52 43.46 +37 56 50.2	EA	2456502.4914	2.6716	12.37 V (0.23)	OO Cyg
V2887 Cyg	000-BKQ-391	19 59 03.74 +38 20 34.3	DSCT:	2456168.4229	0.1027	15.55 V (0.18)	QX Cyg
V2888 Cyg	000-BKQ-300	19 59 13.86 +38 14 08.8	EB	2457592.9538	0.5276081	15.13 V (0.45)	QX Cyg
V2890 Cyg	000-BKQ-403	19 59 31.85 +38 14 13.6	DSCTC	2456163.331	0.1471	12.90–12.96 V	QX Cyg
2MASS J19584213+3814080	000-BLC-434	19 58 42.13 +38 14 08.1	EA	2456154.498	1.9208	13.12 V (0.14)	QX Cyg
2MASS J19585960+3813158	000-BLC-540	19 58 59.61 +38 13 15.8	DSCT	2456148.444	0.2486	13.74 V (0.06)	QX Cyg
2MASS J19572341+3850246	000-BKP-191	19 57 23.42 +38 50 24.5	DSCT	2456126.51593	0.0803	15.16 V (0.15)	QT Cyg
2MASS J19575567+3849241	000-BKP-234	19 57 55.67 +38 49 24.1	EW	2456122.4589	0.6178	15.68 V (0.47)	QT Cyg
2MASS J19580410+3844355	000-BKP-190	19 58 04.12 +38 44 35.5	EB	2456120.5566	0.3726	14.86 V (0.49)	QT Cyg

Name	AUID	Coordinates (J2000)	Type	Epoch (HJD)	Period (d)	Mag. range	Field
2MASS J20512504+3537427	000-BLD-000	20 51 25.04 +35 37 42.9	EW	2456512.4032	0.5190	15.33 V (0.35)	V1870 Cyg
2MASS J20520784+3543540	000-BLD-004	20 52 07.84 +35 43 54.0	EW	2456517.61432	0.6014	13.67 V (0.40)	V1870 Cyg
2MASS J21595106+4436345	000-BMX- 690	21 59 51.07 +44 36 34.4	EW	2457253.338	0.24226	15.94 V (0.07)	CM Lac
UCAC4 674-108700	000-BLR-979	21 58 50.01 +44 41 10.9	EA	2457255.6224	1.89411	14.57 V (1.04)	CM Lac
UCAC4 674-108865	000-BLR-770	21 59 27.54 +44 40 20.4	EW	2456915.5665	0.45147	14.74 V (0.21)	CM Lac
CMC15 J194210.5+313801	000-BLY-564	19 42 10.51 +31 38 01.1	EW	2457582.457	0.38126	17.45 V (0.9)	V947 Cyg
GSC 02656-03021	000-BLY-682	19 39 46.37 +31 37 18.8	EW	2457595.4131	0.38380	13.33 V (0.23)	V947 Cyg
UCAC4 609-084468	000-BLY-672	19 40 44.70 +31 43 13.3	HADS	2457590.4805	0.16766	13.63 V (0.18)	V947 Cyg
UCAC4 609-084904	000-BLY-565	19 41 17.63 +31 41 49.2	EB	2457582.5249	0.52520	15.32 V (0.60)	V947 Cyg
GSC 02673-01309	000-BMJ-750	19 55 16.18 +33 29 07.3	DSCT	2457599.38513	0.169600	15.26 V (0.11)	V1457 Cyg
UCAC4 618-093005	000-BMJ-724	19 54 22.74 +33 26 04.4	EW	2457599.5696	0.453600	16.39 V (0.28)	V1457 Cyg
GSC 02673-01609	000-BMJ-751	19 56 44.17 +33 28 52.9	EW	2457939.5474	0.673527	14.18 V (0.48)	V1457 Cyg
UCAC4 618-094244	000-BMJ-723	19 56 23.77 +33 24 36.9	RRC	2457939.33169	0.254453	15.43 V (0.25)	V1457 Cyg
UCAC4 601-078128	000-BLY-490	19 22 52.87 +30 05 33.9	HADS	2457573.4204	0.10015	15.42 V (0.3)	V789 Cyg
UCAC4 601-078164	000-BLY-489	19 22 55.80 +30 07 55.2	RRAB	2457573.4383	0.56818	16.84 V (0.9)	V789 Cyg
UCAC4 601-078444	000-BLY-486	19 23 29.52 +30 10 48.3	EW	2457572.3789	0.24319	17.1 V (0.75)	V789 Cyg
UCAC4 607-075897	000-BLR-792	19 27 45.35 +31 21 00.5	EW	2457241.5462	0.36095	17.09 V (0.55)	V1437 Cyg
UCAC4 608-077894	000-BLR-563	19 27 47.92 +31 30 38.9	EW	2457225.4441	0.38916	14.94 V (0.40)	V1437 Cyg
UCAC4 608-078344	000-BLR-309	19 28 36.89 +31 30 55.3	EW	2457224.4928	0.2852	16.60 V (0.74)	V1437 Cyg
UCAC4 711-092693	000-BMK- 452	22 02 07.77 +52 09 14.0	EW	2457979.6111	0.3896	14.6 V (0.30)	V1416 Cyg

Table 2: Programme stars in Gemini. The revised object GR Gem (row 1, in italics) is listed first, followed by the 7 new EW-type discoveries.

Name	AUID	Coordinates (J2000)	Type	Epoch (HJD)	Period (d)	Mag. range	Field
<i>GR Gem</i>	<i>000-BDQ-846</i>	<i>06 23 20.25 +20 49 58.3</i>	<i>EA</i>	<i>2457774.4935</i>	<i>0.5274471</i>	<i>14.85–15.80 V</i>	<i>GR Gem</i>
CMC15 J062325.4+205619	000-BMD-923	06 23 25.49 +20 56 20.0	EW	2457774.4812	0.3357	17.34 (0.60) C	GR Gem
2MASS J06103575+2252411	000-BMZ-240	06 10 35.75 +22 52 41.1	EW	2458498.446	0.367500	16.65 (0.60) C	BS Gem
2MASS J06440196+1459265	000-BMY-413	06 44 01.96 +14 59 26.5	EW	2458495.331	0.226040	16.70 (0.40) C	V351 Gem
UCAC4 525-032209	000-BMY-592	06 42 58.39 +14 56 37.2	EW	2458495.266	0.372671	17.35 (0.30) C	V351 Gem
UCAC4 525-032522	000-BMY-378	06 44 03.54 +14 50 07.0	EW	2458495.554	0.445244	14.40 (0.50) C	V351 Gem
UCAC4 526-032227	000-BMY-540	06 43 53.95 +15 02 48.2	EW	2458495.470	0.374000	17.10 (0.80) C	V351 Gem

Name	AUID	Coordinates (J2000)	Type	Epoch (HJD)	Period (d)	Mag. range	Field
UCAC4 554-026264	000-BMF-255	06 27 27.52 +20 39 41.9	EW	2457786.2611	0.3406	15.55 (0.63) C	SX Gem

4 Light Curves

Phase-folded light curves and finding charts for each programme star are presented below, grouped by constellation and monitored field. Different colours in the phase plots correspond to data obtained on different observing nights. Finding charts are from the Digitized Sky Survey (DSS2 red / F/POSSII), oriented with North up and East to the left.

4.1 Cygnus

Field 1 – OO Cyg

OO Cyg (000-BDN-390) – EW – Revision

Folded on HJD 2456499.571, $P = 0.26890536$ d. W UMa-type morphology, amplitude ~ 0.47 mag (V). Observed over 8 nights in 2013.

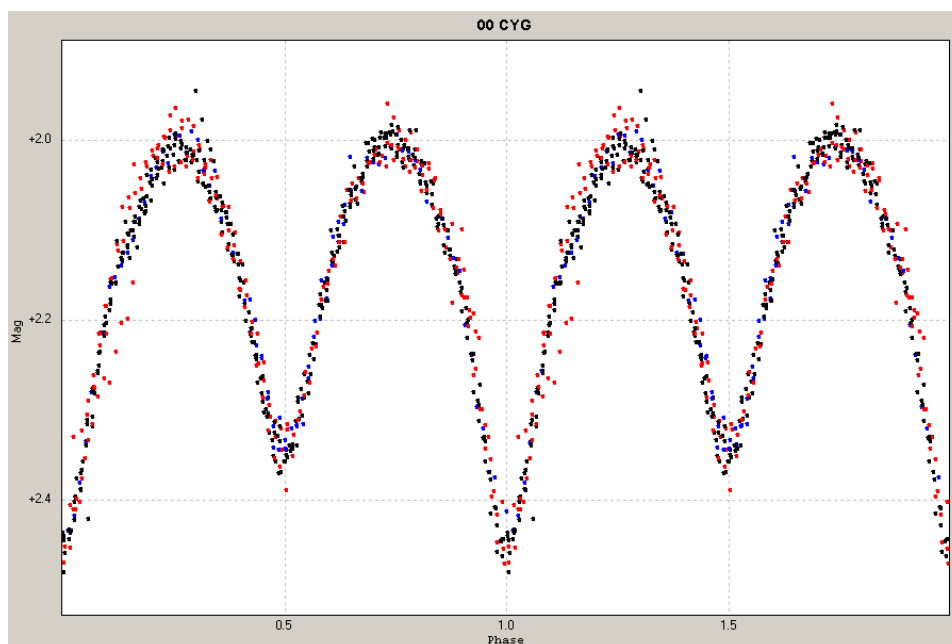


Figure 1: Phase plot of OO Cyg.

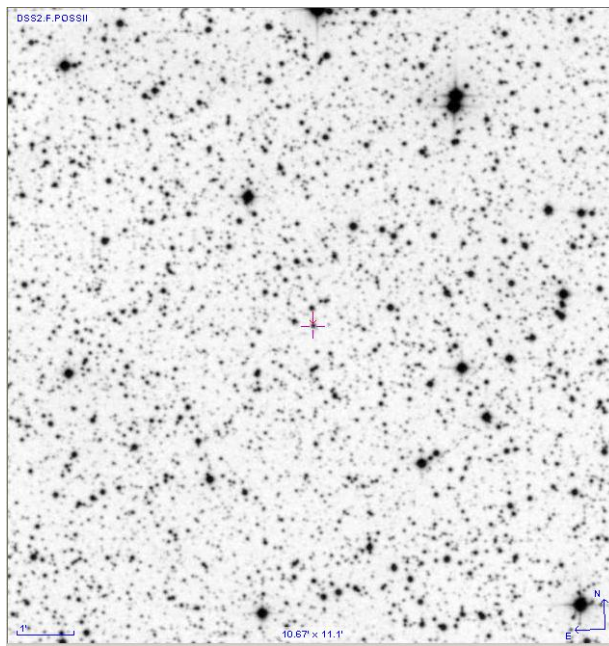


Figure 2: Finder chart for OO Cyg (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

V2875 Cyg (000-BLC-617) – EB – New discovery

Folded on HJD 2457079.164, $P = 0.5821835$ d. Beta Lyrae-type morphology, amplitude ~ 0.75 mag, range 14.85–15.6 V. GCVS 2019.

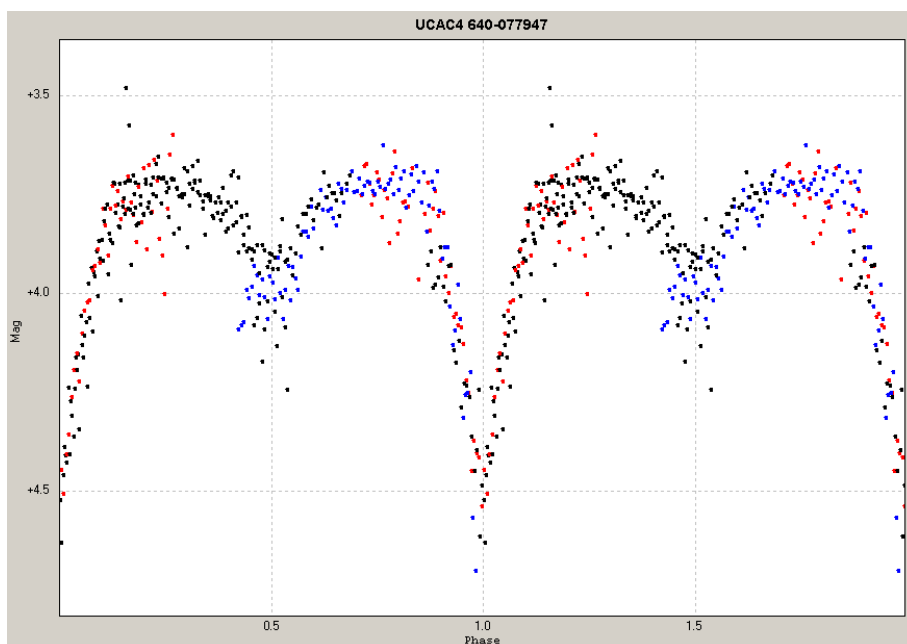


Figure 3: Phase plot of V2875 Cyg.

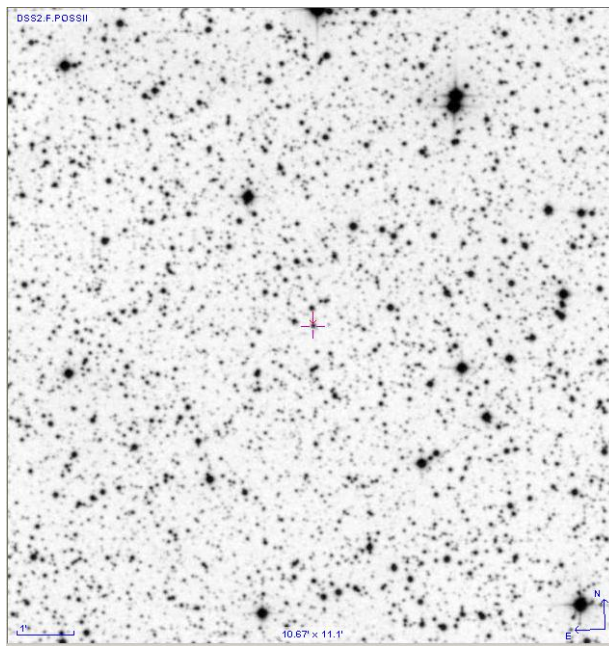


Figure 4: Finder chart for V2875 Cyg (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

V2876 Cyg (000-BLC-688) – EB – New discovery

Folded on HJD 2456501.4307, $P = 0.6952$ d. Amplitude 0.20 mag, mean 15.33 V. GCVS 2019.

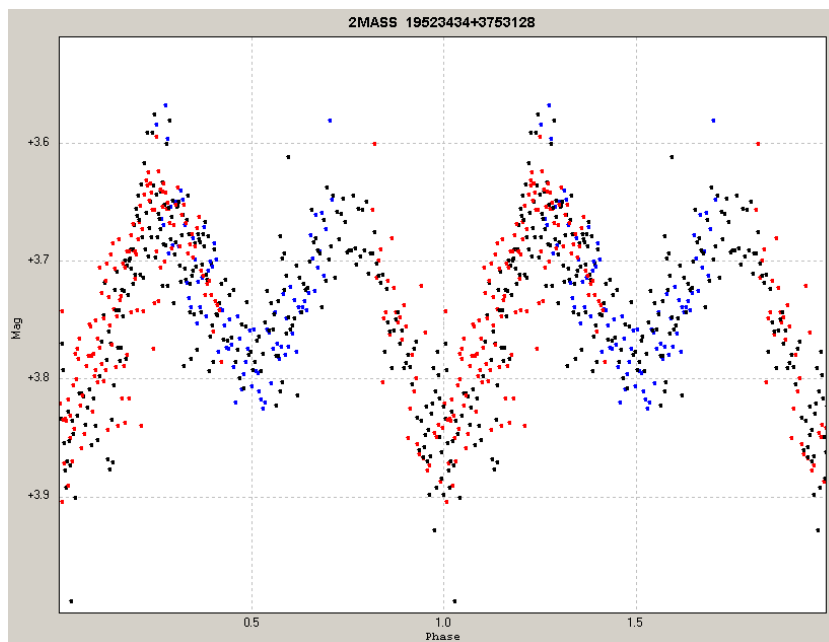


Figure 5: Phase plot of V2876 Cyg.

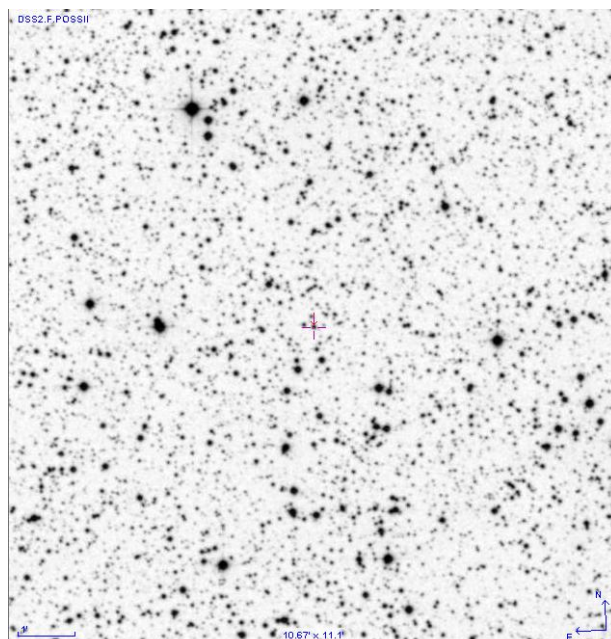


Figure 6: Finder chart for V2876 Cyg (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

V2877 Cyg (000-BLC-764) – DSCTC – New discovery

Folded on HJD 2456506.5187, $P = 0.1895$ d (4.55 h). Delta Scuti candidate, amplitude 0.05 mag (V). GCVS 2019.

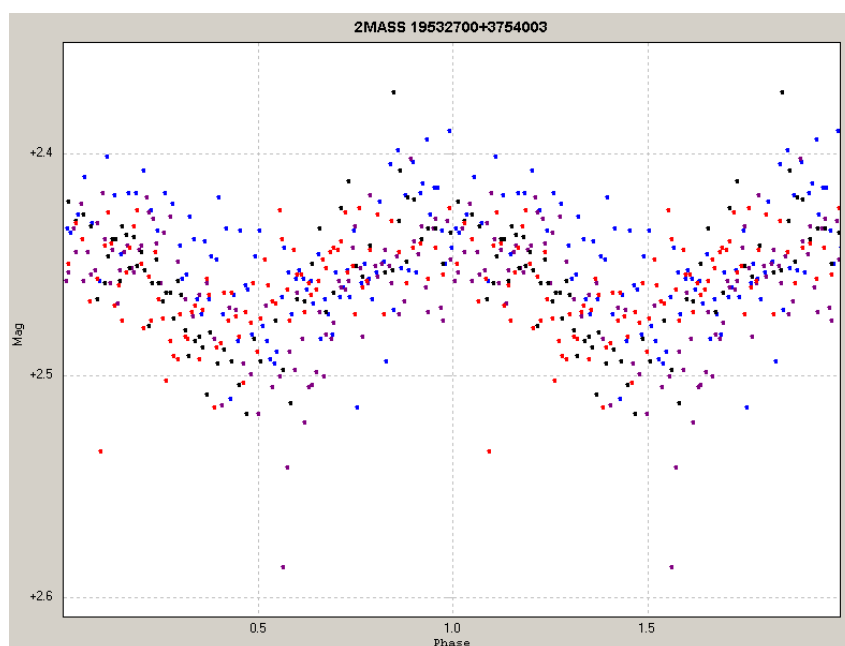


Figure 7: Phase plot of V2877 Cyg.

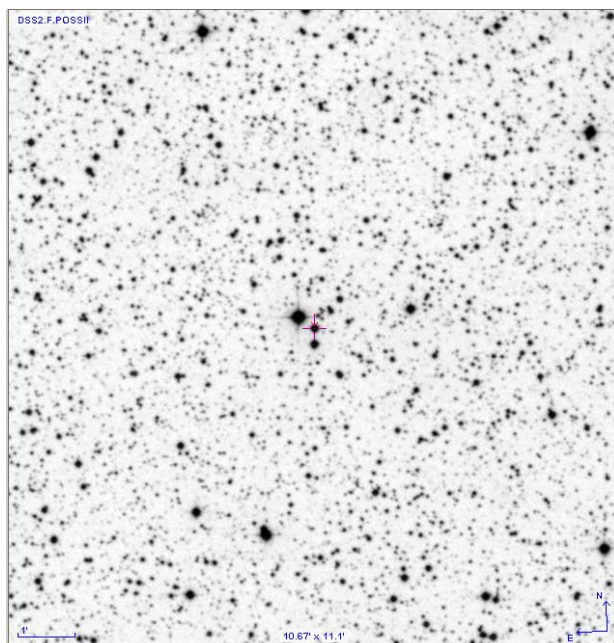


Figure 8: Finder chart for V2877 Cyg (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

2MASS J19524346+3756501 (000-BLC-861) – EA – New discovery

Folded on HJD 2456502.4914, $P = 2.6716$ d. Algol-type, primary eclipse amplitude 0.23 mag, duration $\sim 8\%$ (~ 5 h).

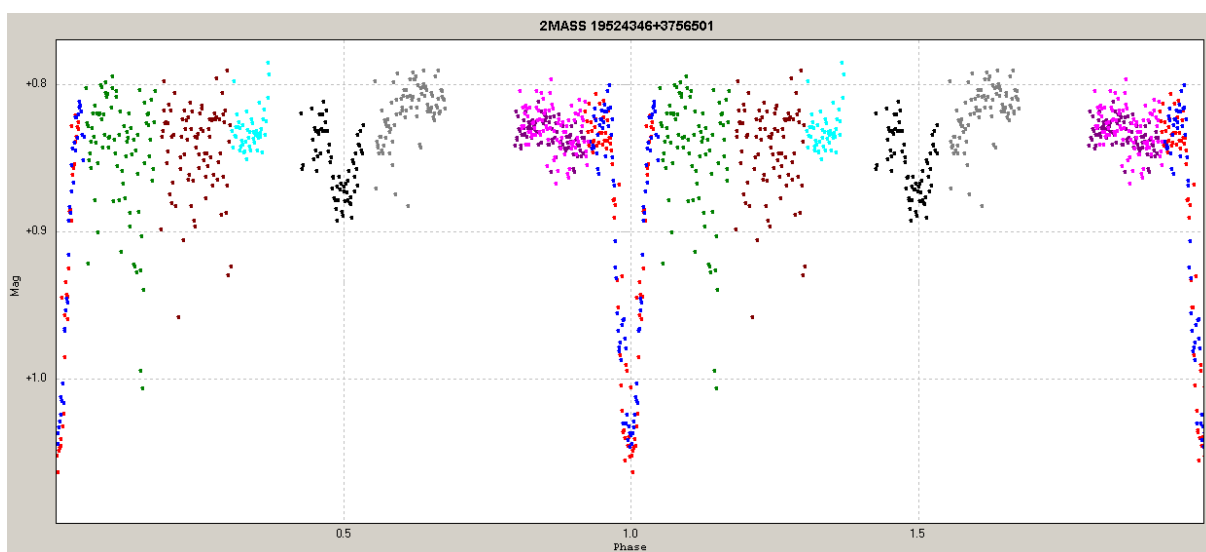


Figure 9: Phase plot of 2MASS J19524346+3756501.

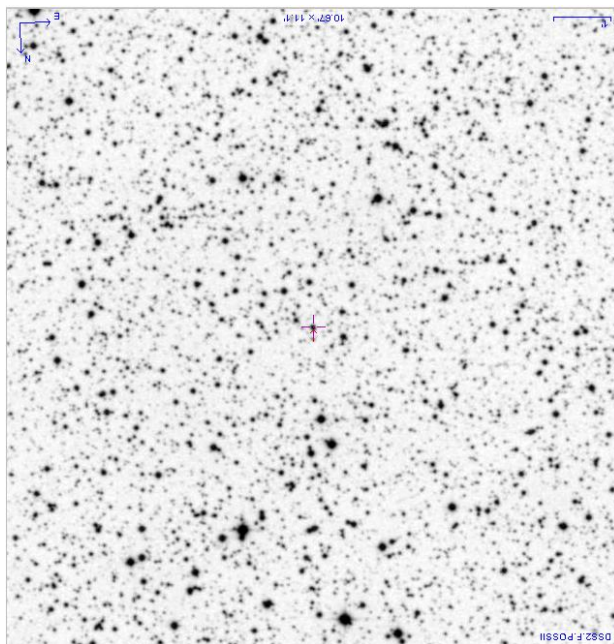


Figure 10: Finder chart for 2MASS J19524346+3756501 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

Field 2 – QX Cyg

V2884 Cyg (000-BKQ-254) – EB – Revision

Folded on HJD 2458010.898, $P = 0.7053073$ d. Beta Lyrae-type, amplitude ~ 0.30 mag (Ic). 12 nights 2012. GCVS 2019.

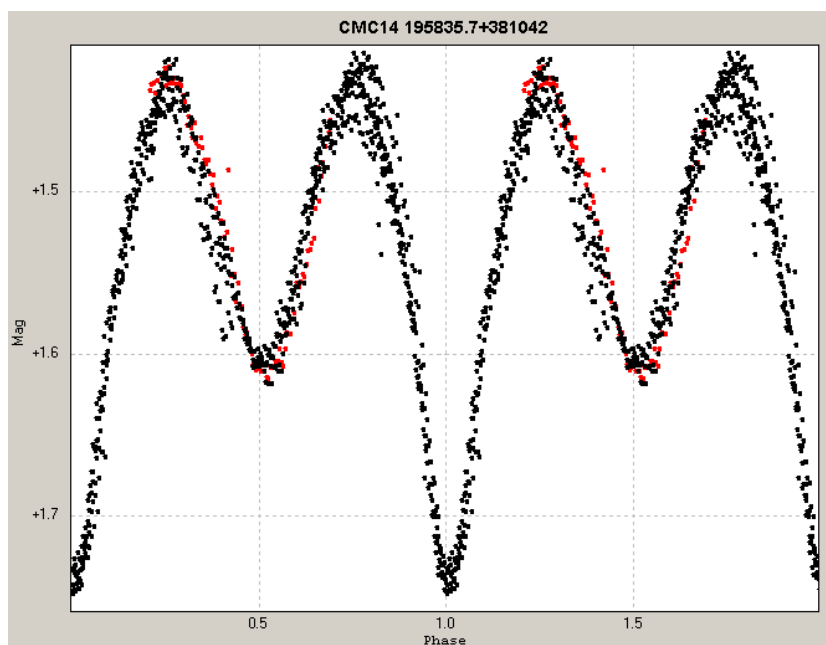


Figure 11: Phase plot of V2884 Cyg.

V2887 Cyg (000-BKQ-391) – DSCT: – New discovery

Folded on HJD 2456168.4229, $P = 0.1027$ d. Delta Scuti candidate, amplitude 0.18 mag. Visual binary, companion 4 arcsec PA 50° . GCVS 2019.

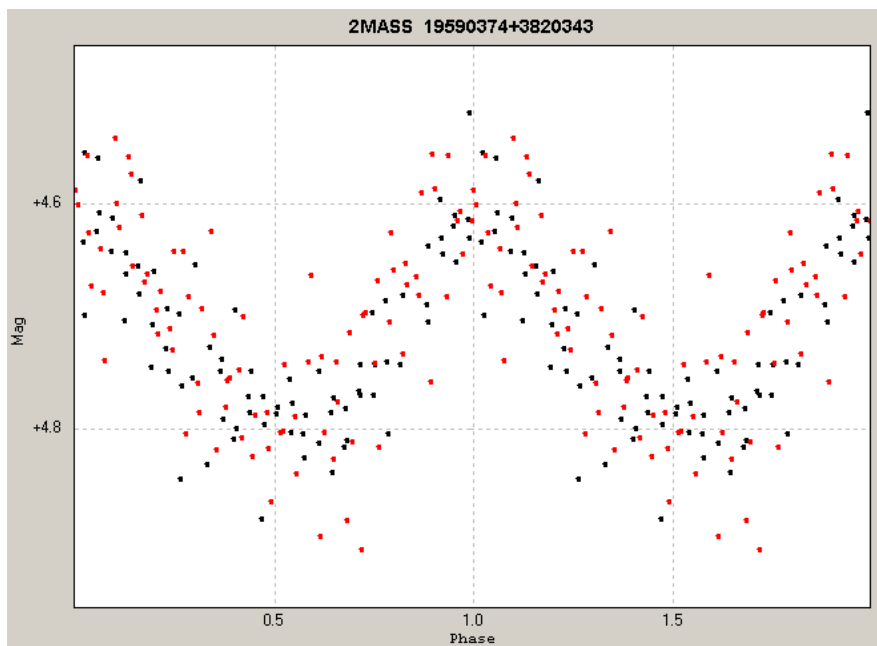


Figure 12: Phase plot of V2887 Cyg.

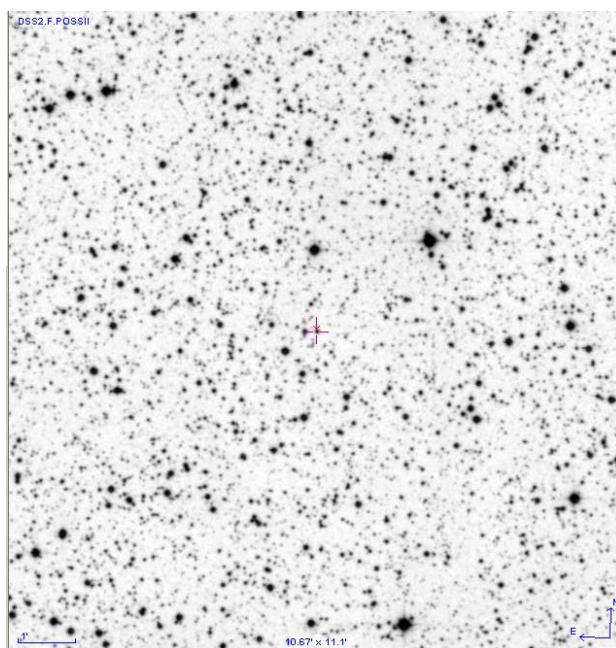


Figure 13: Finder chart for V2887 Cyg (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

V2888 Cyg (000-BKQ-300) – EB – New discovery

Folded on HJD 2457592.9538, $P = 0.5276081$ d. Amplitude 0.45 mag. GCVS 2019.

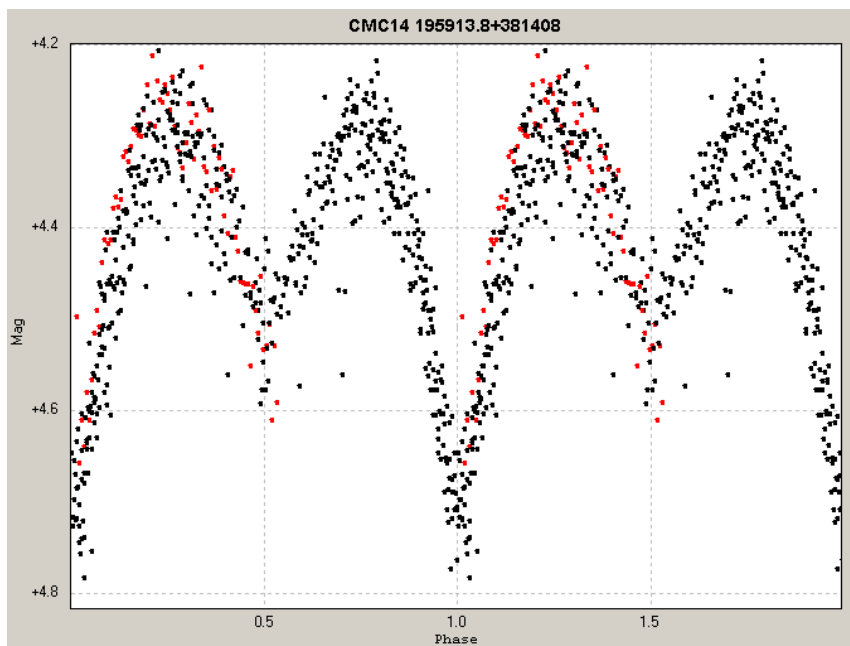


Figure 14: Phase plot of V2888 Cyg.

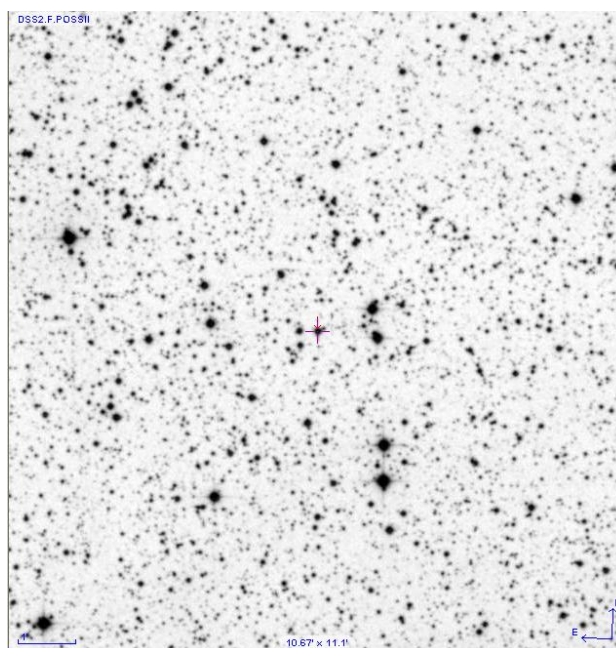


Figure 15: Finder chart for V2888 Cyg (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

V2890 Cyg (000-BKQ-403) – DSCTC – New discovery

Folded on HJD 2456163.331, $P = 0.1471$ d. Amplitude 0.06 mag (V), mean 12.99 V. GCVS 2019.

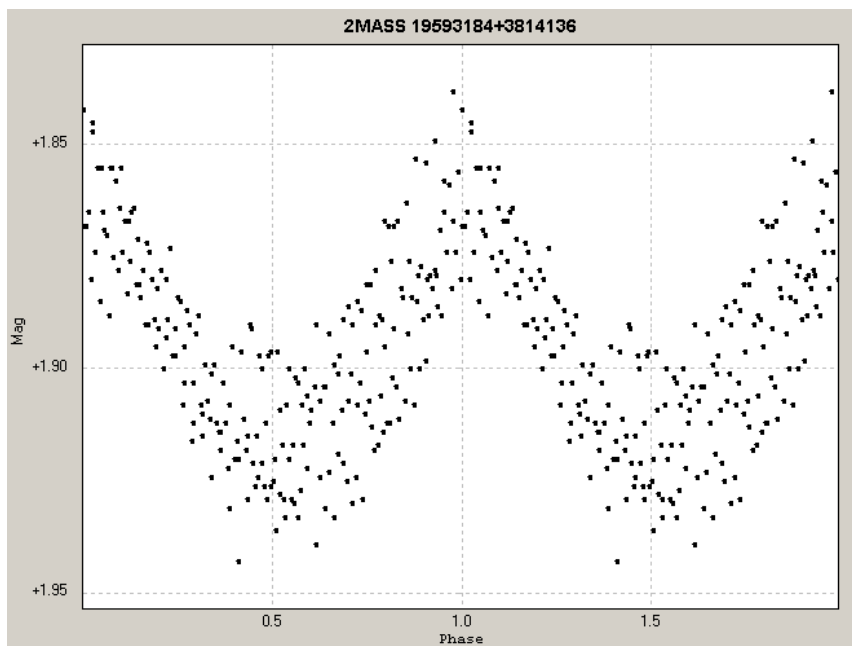


Figure 16: Phase plot of V2890 Cyg.

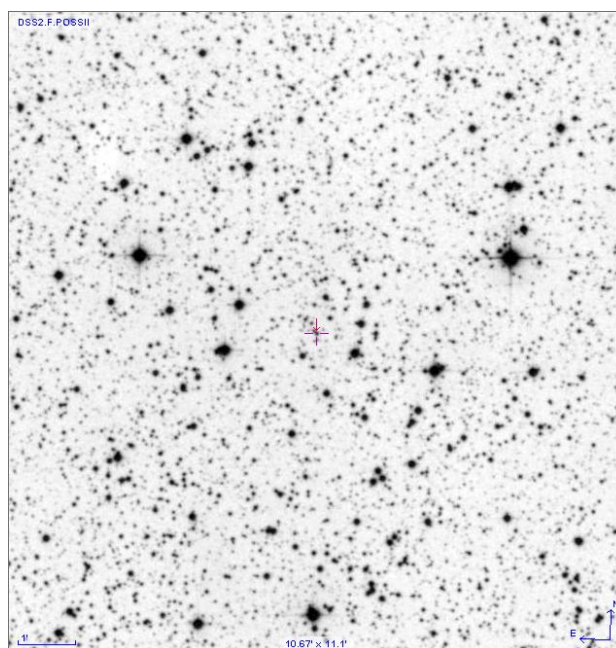


Figure 17: Finder chart for V2890 Cyg (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

2MASS J19584213+3814080 (000-BLC-434) – EA – New discovery

Folded on HJD 2456154.498, $P = 1.9208$ d. Primary eclipse duration $\sim 9\%$ (~ 4 h), amplitude 0.14 mag.

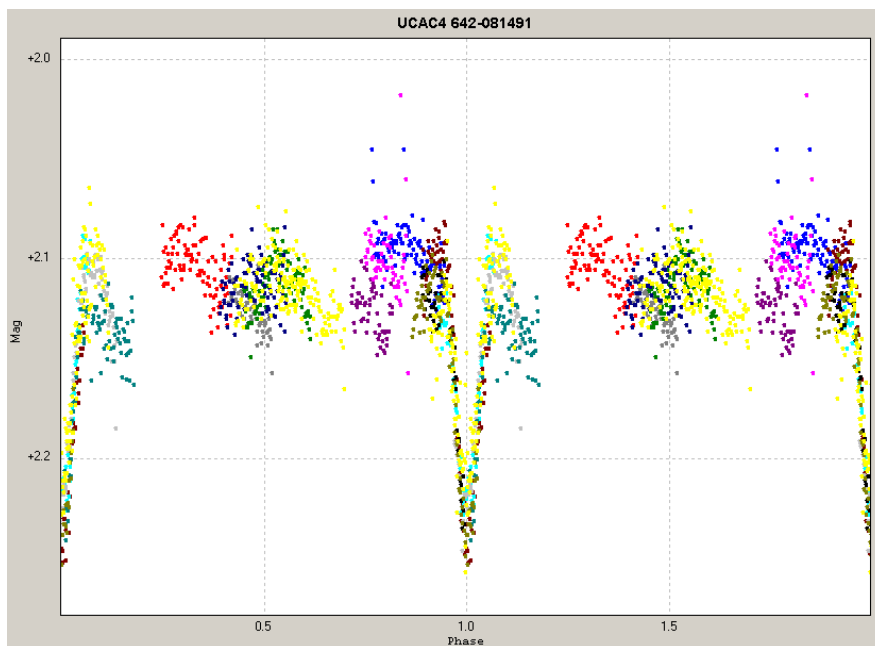


Figure 18: Phase plot of 2MASS J19584213+3814080.

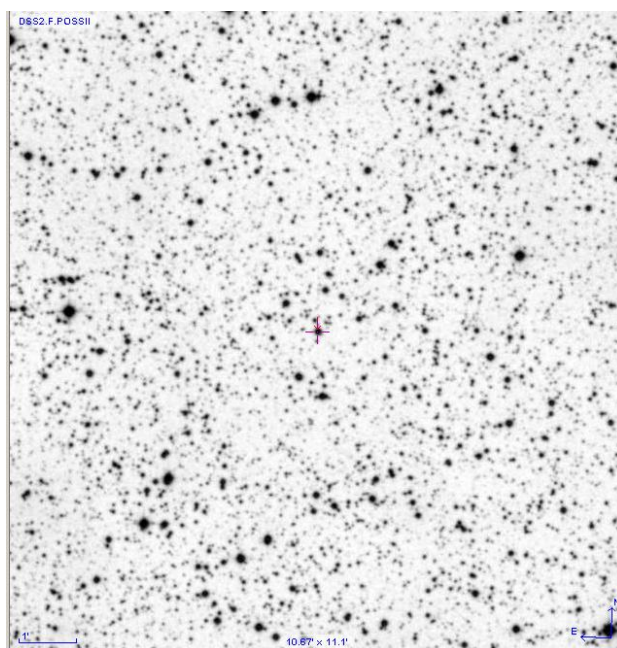


Figure 19: Finder chart for 2MASS J19584213+3814080 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

2MASS J19585960+3813158 (000-BLC-540) – DSCT – New discovery

Folded on HJD 2456148.444, $P = 0.2486$ d. Amplitude 0.06 mag, mean 13.74 V.

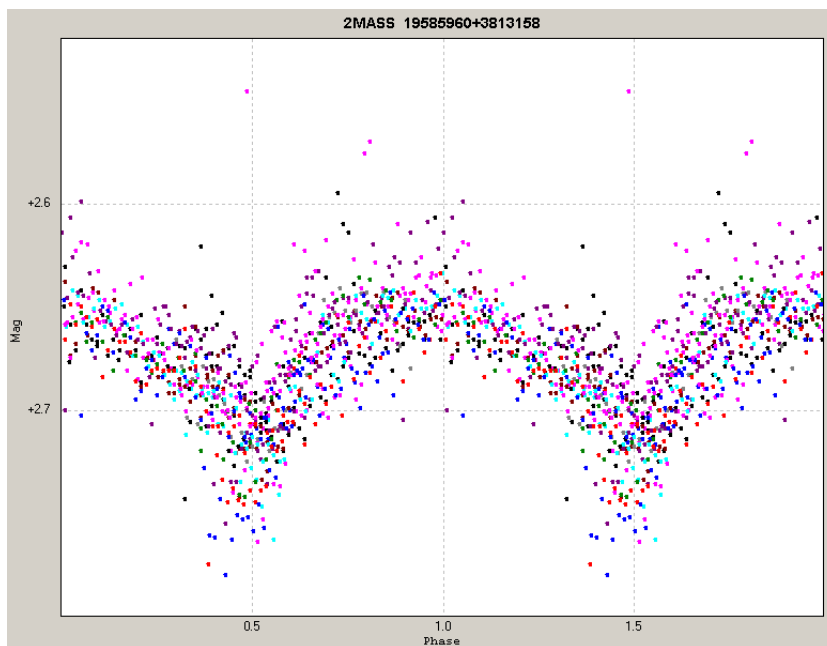


Figure 20: Phase plot of 2MASS J19585960+3813158.

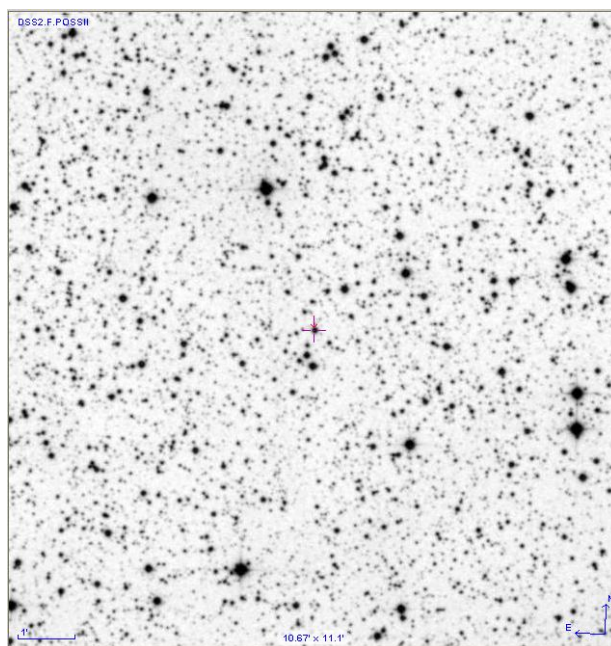


Figure 21: Finder chart for 2MASS J19585960+3813158 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

Field 3 – QT Cyg

2MASS J19572341+3850246 (000-BKP-191) – DSCT – New discovery

Folded on HJD 2456126.51593, $P = 0.0803$ d (115.6 min). Delta Scuti candidate, amplitude 0.15 mag.

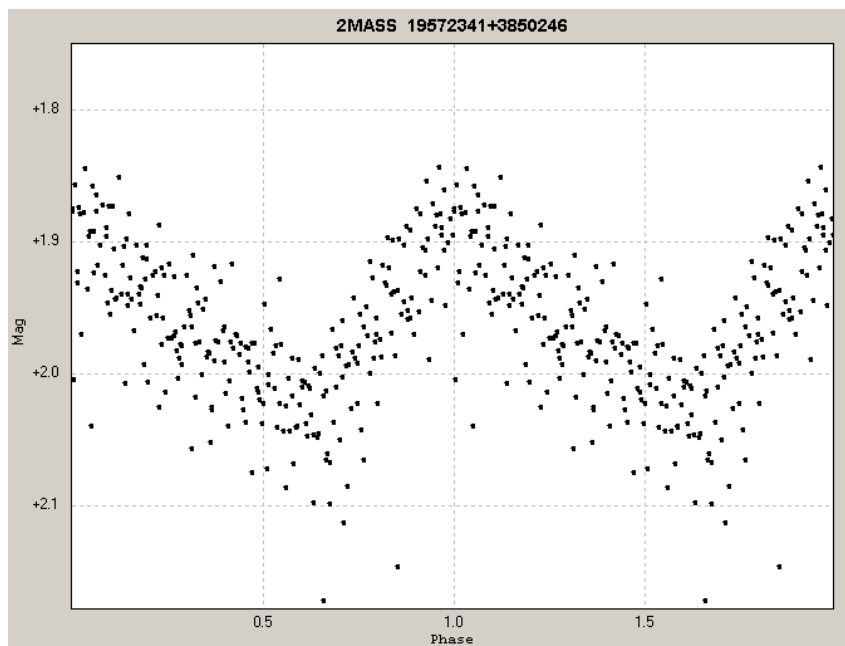


Figure 22: Phase plot of 2MASS J19572341+3850246.

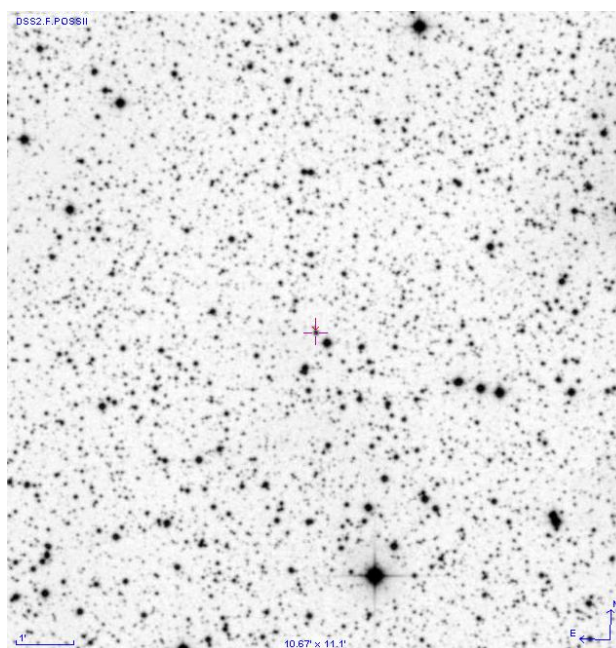


Figure 23: Finder chart for 2MASS J19572341+3850246 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

2MASS J19575567+3849241 (000-BKP-234) – EW – New discovery

Folded on HJD 2456122.4589, $P = 0.6178$ d. W UMa-type morphology, amplitude 0.47 mag.

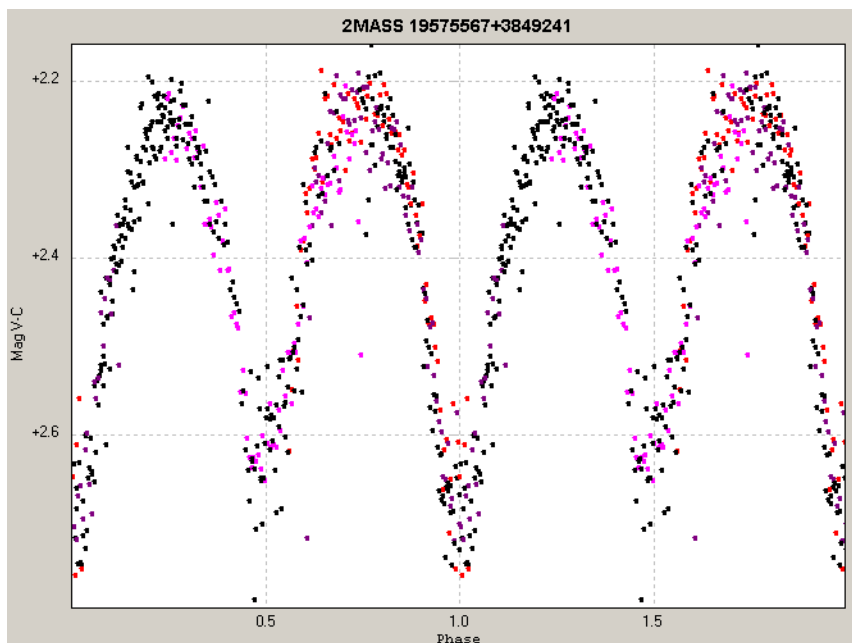


Figure 24: Phase plot of 2MASS J19575567+3849241.

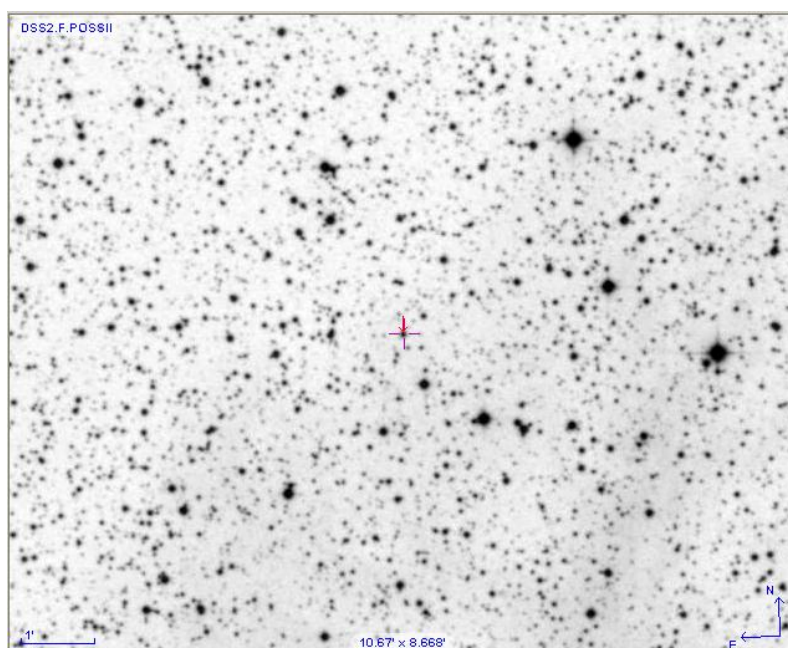


Figure 25: Finder chart for 2MASS J19575567+3849241 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

2MASS J19580410+3844355 (000-BKP-190) – EB – New discovery

Folded on HJD 2456120.5566, $P = 0.3726$ d. Beta Lyrae-type morphology, amplitude 0.49 mag.

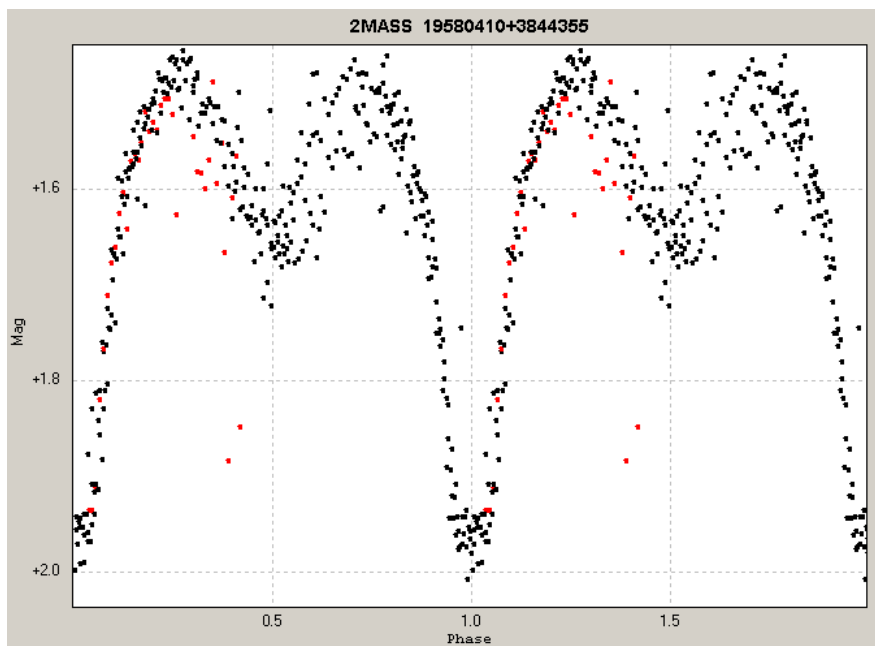


Figure 26: Phase plot of 2MASS J19580410+3844355.

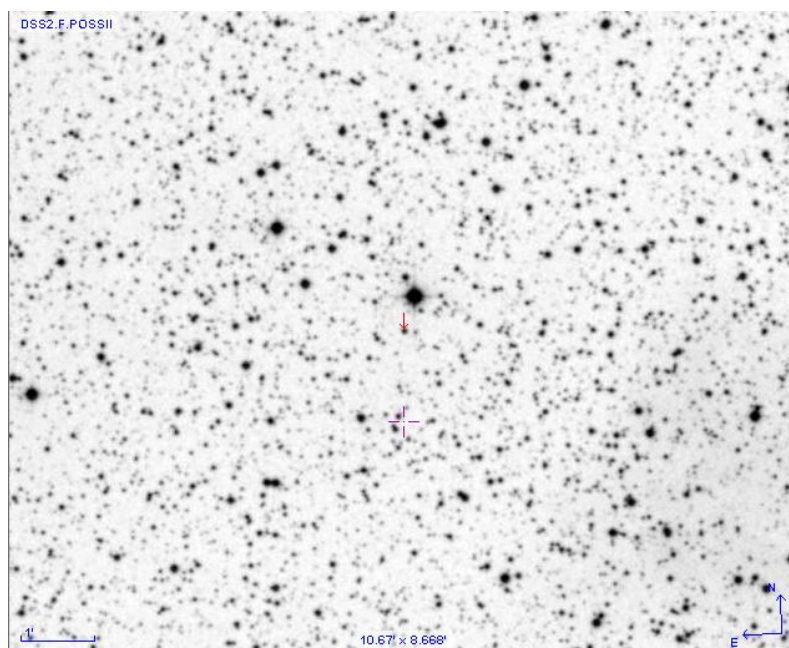


Figure 27: Finder chart for 2MASS J19580410+3844355 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

Field 4 – V1870 Cyg

2MASS J20512504+3537427 (000-BLD-000) – EW – New discovery

Folded on HJD 2456512.4032, $P = 0.5190$ d. W UMa-type morphology, amplitude 0.35 mag.

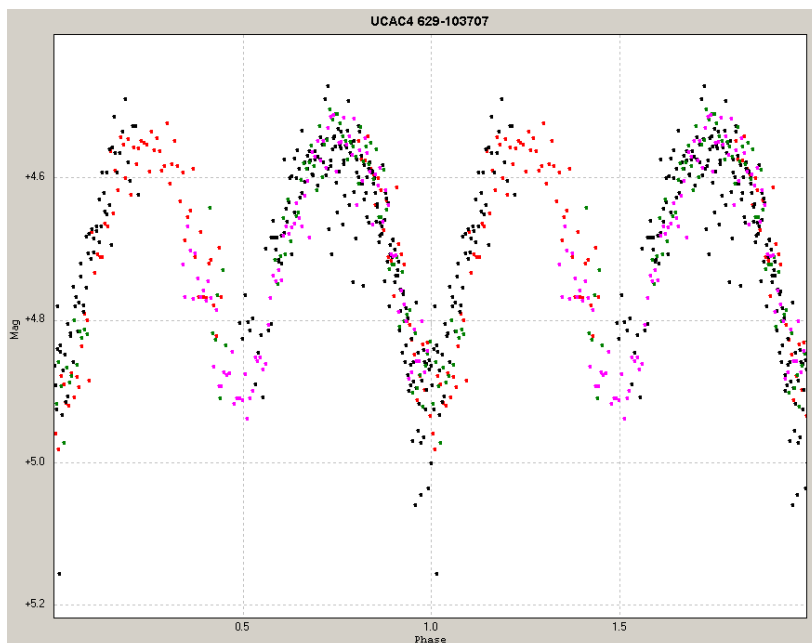


Figure 28: Phase plot of 2MASS J20512504+3537427.

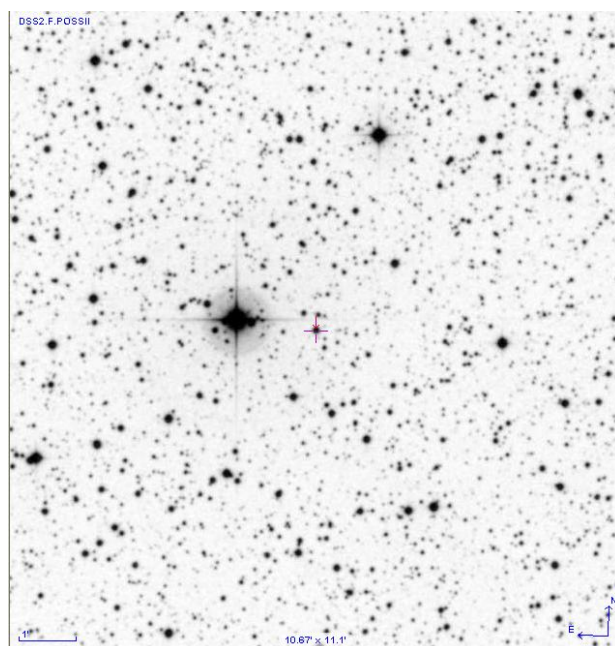


Figure 29: Finder chart for 2MASS J20512504+3537427 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

2MASS J20520784+3543540 (000-BLD-004) – EW – New discovery

Folded on HJD 2456517.61432, $P = 0.6014$ d. W UMa-type morphology, amplitude 0.40 mag, mean 13.67 V. $B-V = 0.62$ (G-type).

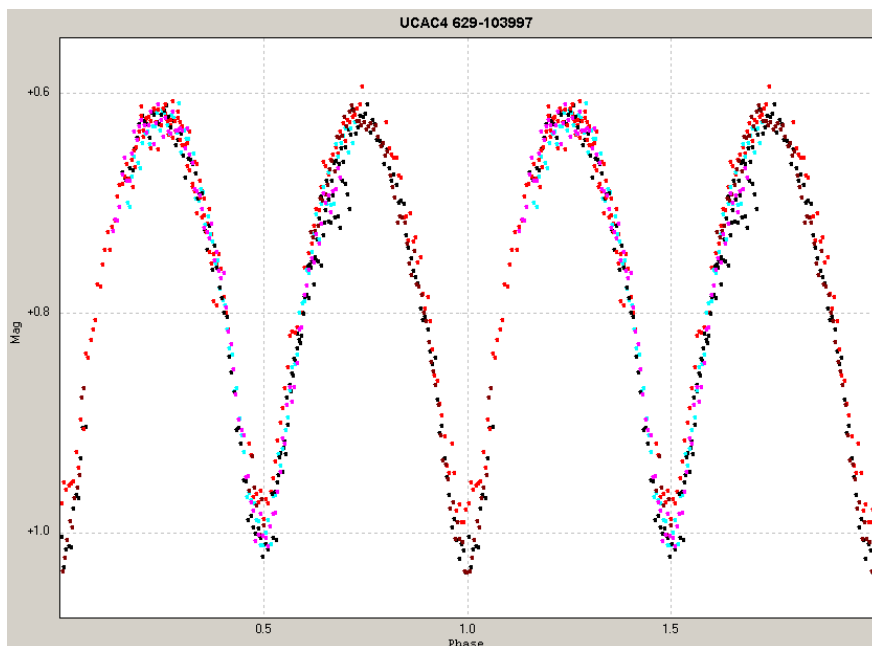


Figure 30: Phase plot of 2MASS J20520784+3543540.

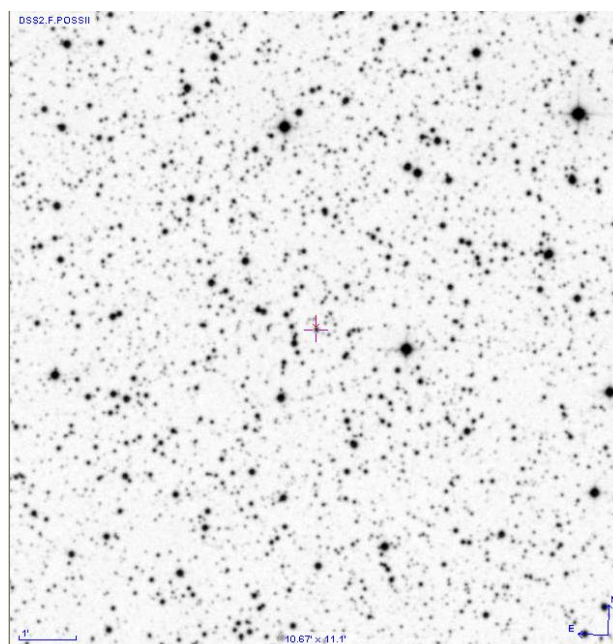


Figure 31: Finder chart for 2MASS J20520784+3543540 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

Field 5 – CM Lac

2MASS J21595106+4436345 (000-BMX-690) – EW – New discovery

Folded on HJD 2457253.338, $P = 0.24226$ d. W UMa-type morphology, amplitude 0.07 mag (V). Submitted December 2018.

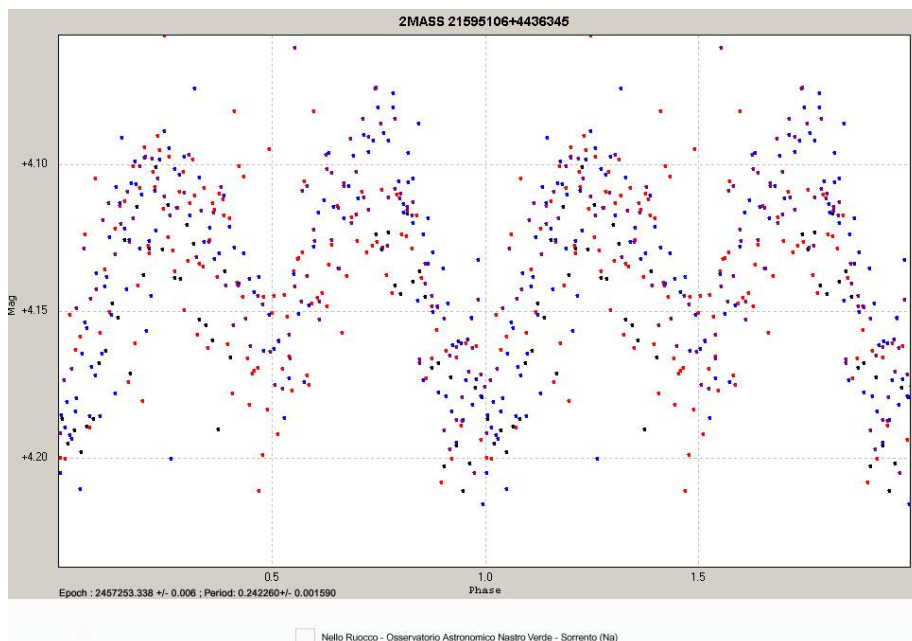


Figure 32: Phase plot of 2MASS J21595106+4436345.

UCAC4 674-108700 (000-BLR-979) – EA – New discovery

Folded on HJD 2457255.6224, $P = 1.89411$ d. Algol-type, primary eclipse amplitude ~ 1.04 mag, duration $\sim 11\%$. Min II = 0.18 clear. Close companion 8 arcsec to the WNW. 5 nights (August 2015).

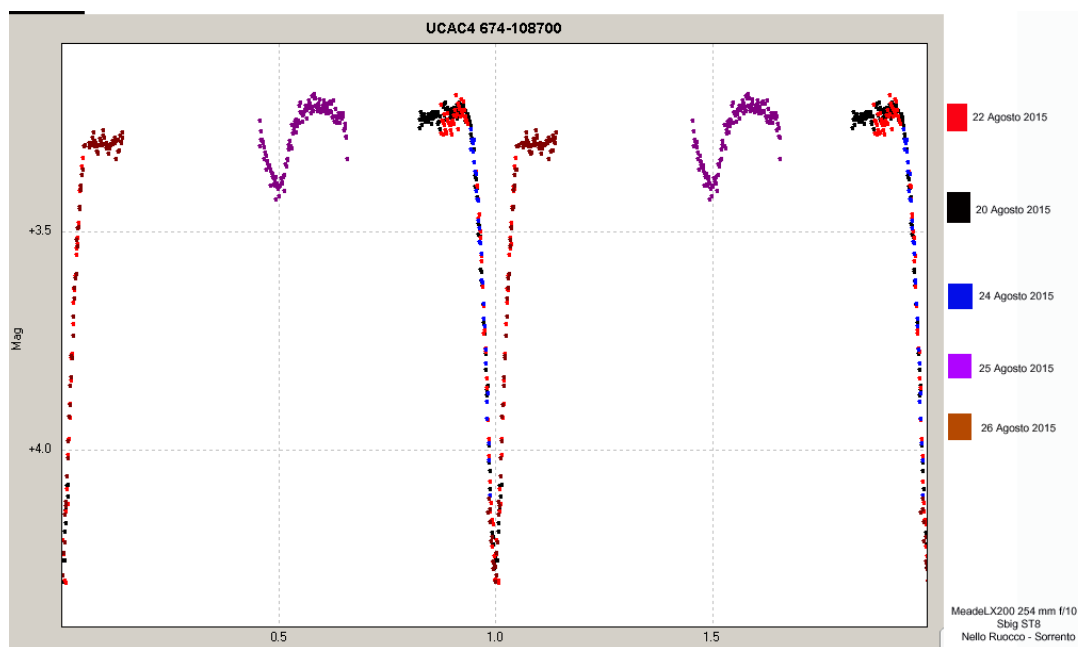


Figure 33: Phase plot of UCAC4 674-108700.

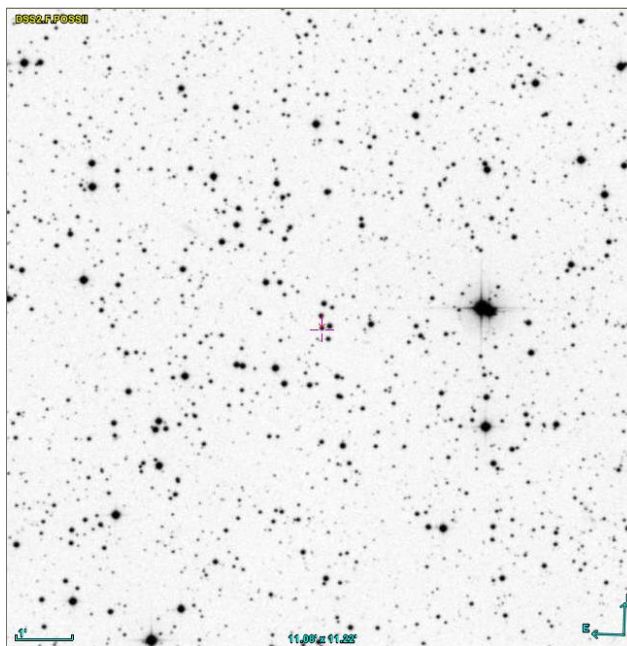


Figure 34: Finder chart for UCAC4 674-108700 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

UCAC4 674-108865 (000-BLR-770) – EW – New discovery

Folded on HJD 2456915.5665, $P = 0.45147$ d (10.8 h). W UMa-type, amplitude 0.21 mag, mean 14.74 V. $B-V = 0.61$ (G-type). 5 nights (2014–2015).

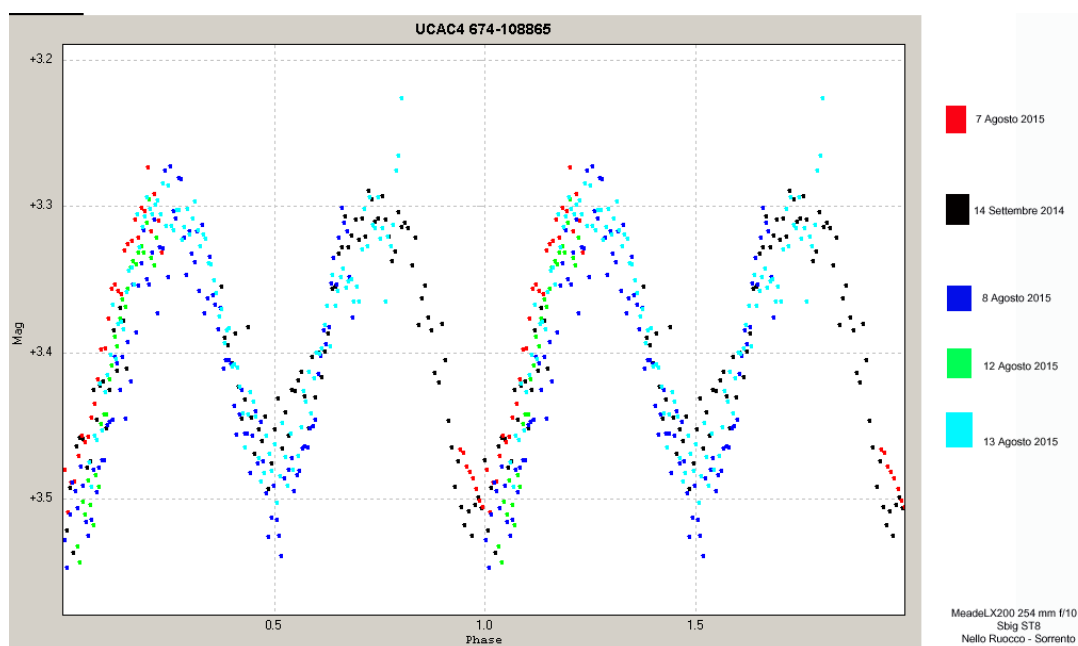


Figure 35: Phase plot of UCAC4 674-108865.

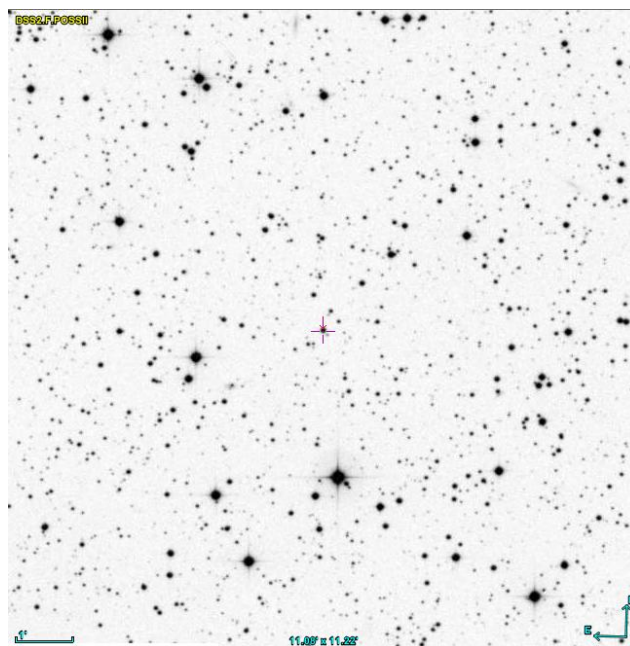


Figure 36: Finder chart for UCAC4 674-108865 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

Field 6 – V947 Cyg

CMC15 J194210.5+313801 (000-BLY-564) – EW – New discovery

Folded on HJD 2457582.457, $P = 0.38126$ d. Amplitude 0.9 mag, mean 17.45 V. 5 nights, July 2016.

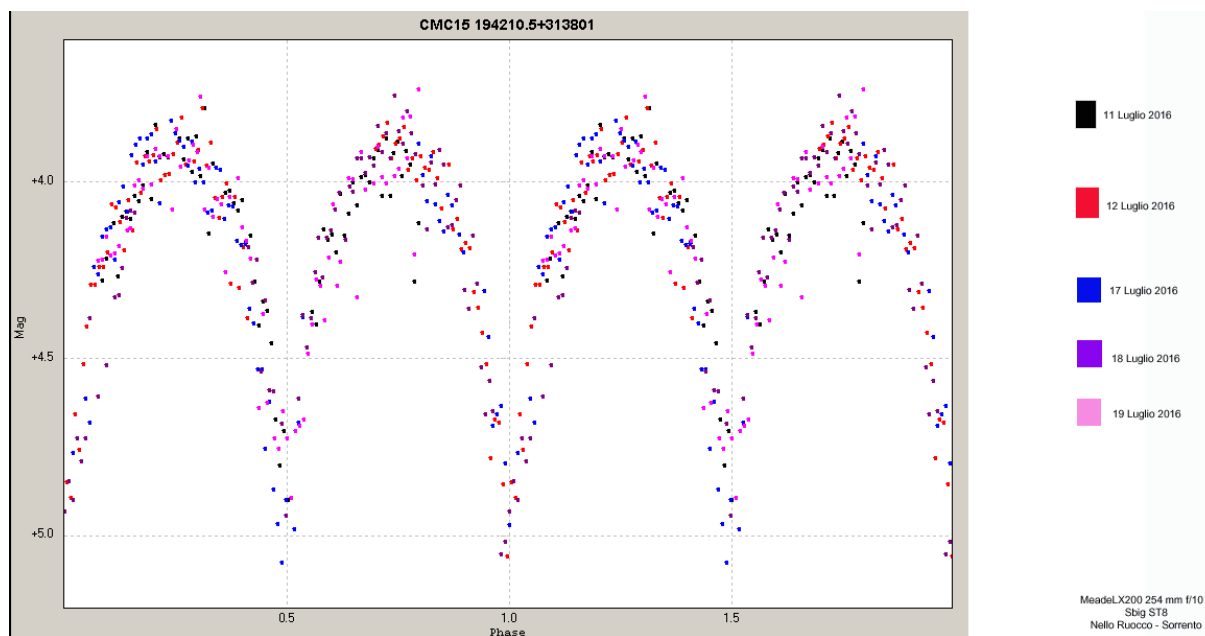


Figure 37: Phase plot of CMC15 J194210.5+313801.

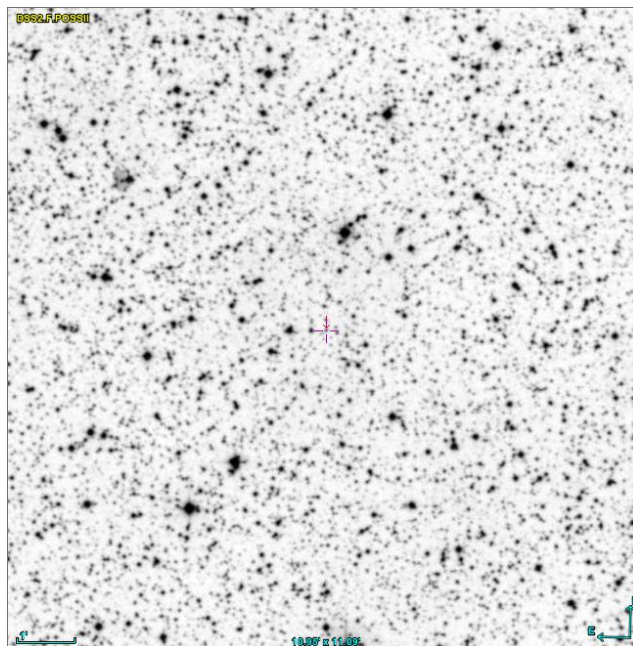


Figure 38: Finder chart for CMC15 J194210.5+313801 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

GSC 02656-03021 (000-BLY-682) – EW – New discovery

Folded on HJD 2457595.4131, $P = 0.38380$ d. Amplitude 0.23 mag, mean 13.33 V. 3 nights (July 2016).

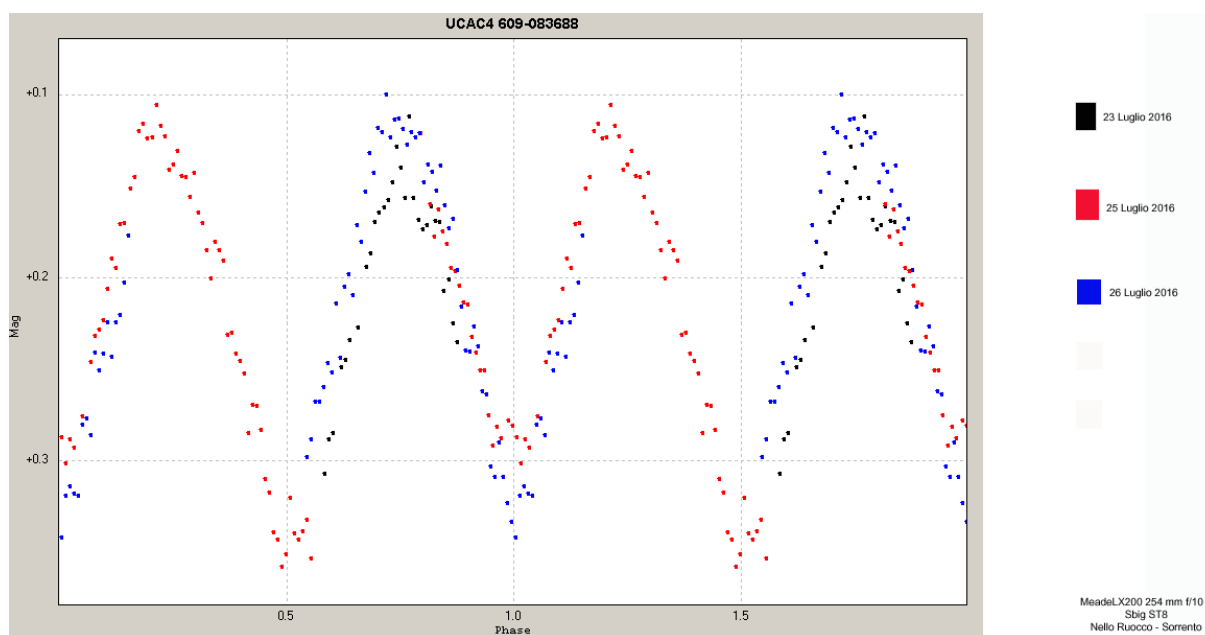


Figure 39: Phase plot of GSC 02656-03021.

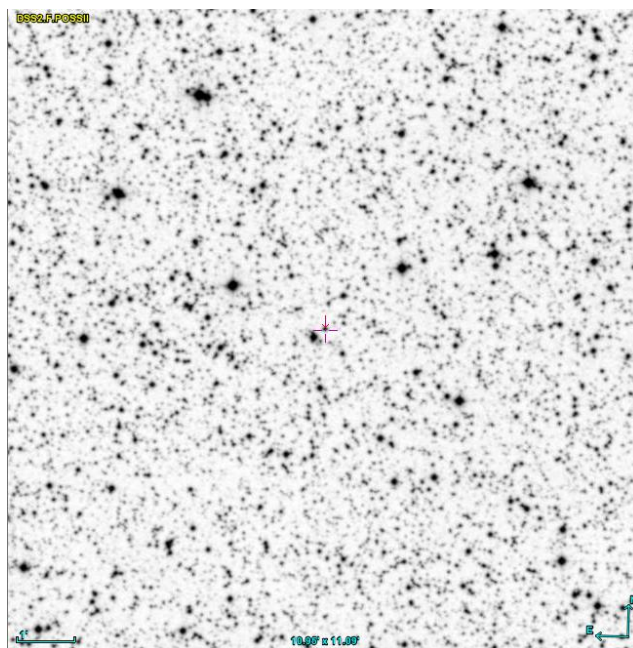


Figure 40: Finder chart for GSC 02656-03021 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

UCAC4 609-084468 (000-BLY-672) – HADS – New discovery

Folded on HJD 2457590.4805, $P = 0.16766$ d. High Amplitude Delta Scuti, amplitude 0.18 mag, rise time $\sim 40\%$. 5 nights.

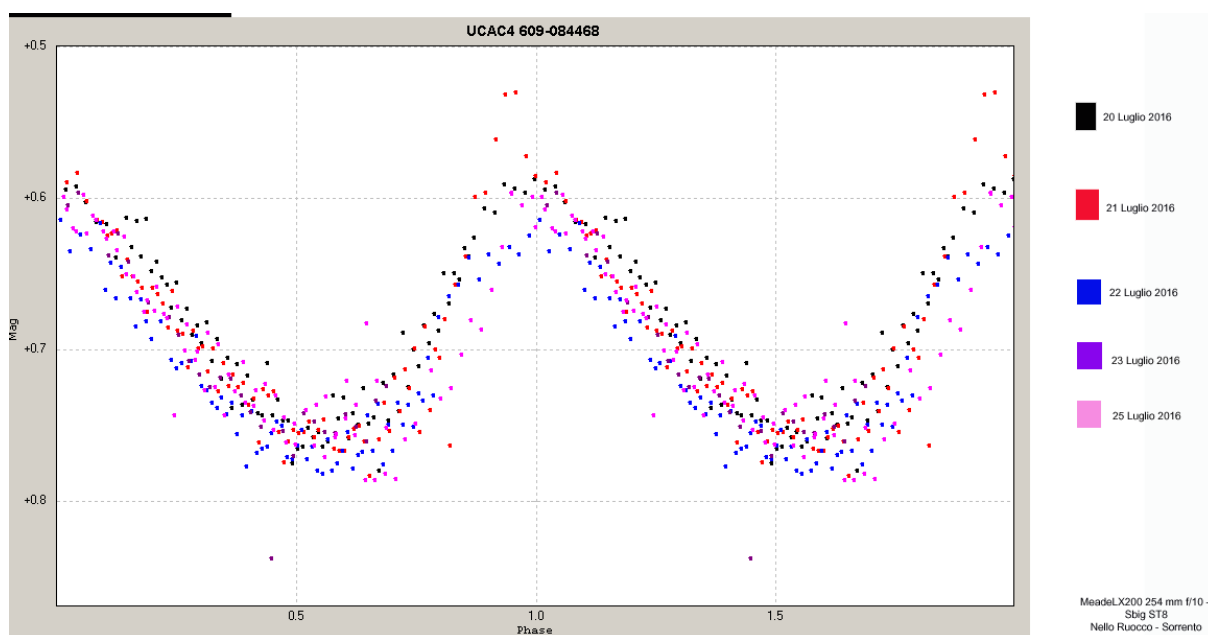


Figure 41: Phase plot of UCAC4 609-084468.

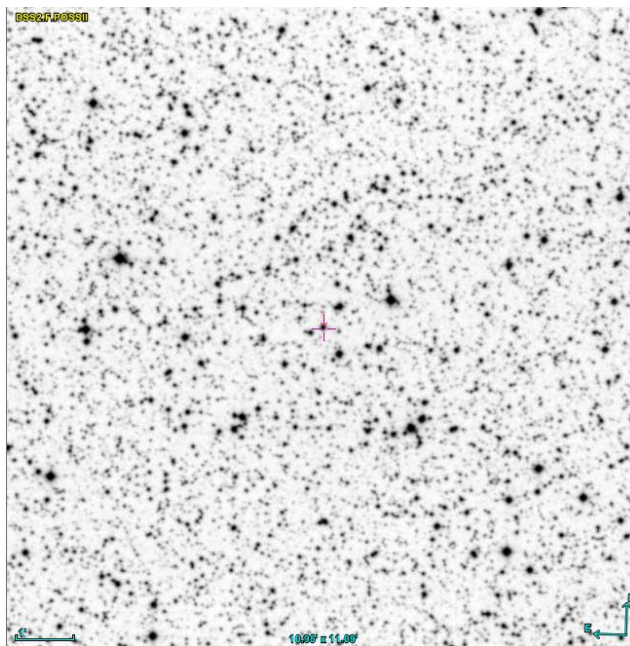


Figure 42: Finder chart for UCAC4 609-084468 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

UCAC4 609-084904 (000-BLY-565) – EB – New discovery

Folded on HJD 2457582.5249, $P = 0.52520$ d. Beta Lyrae-type, amplitude 0.60 mag. 5 nights.

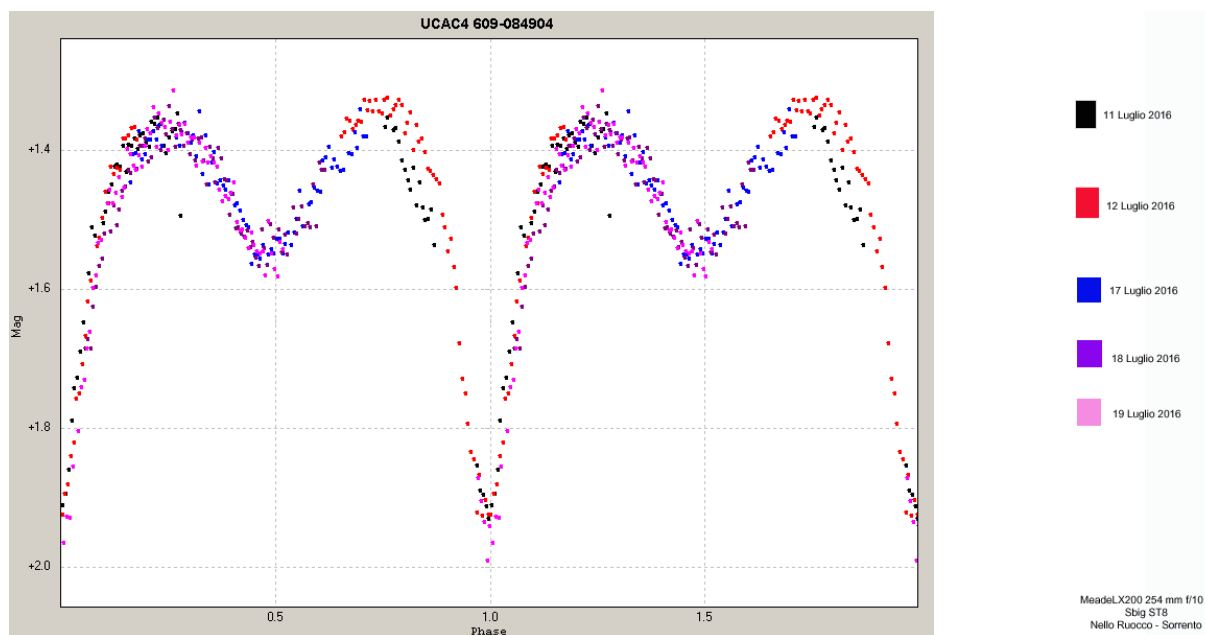


Figure 43: Phase plot of UCAC4 609-084904.

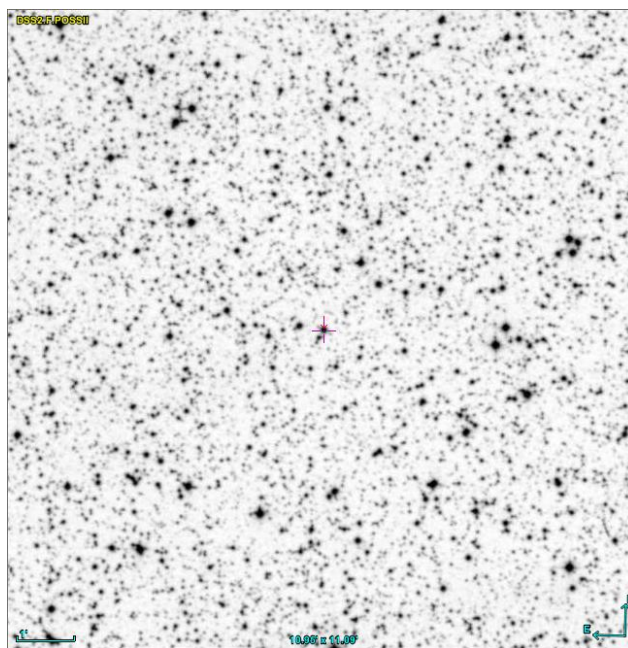


Figure 44: Finder chart for UCAC4 609-084904 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

Field 7 – V1457 Cyg

GSC 02673-01309 (000-BMJ-750) – DSCT – New discovery

Folded on HJD 2457599.38513, $P = 0.169600$ d. Delta Scuti candidate, amplitude 0.11 mag. 4 nights (2016–2017).

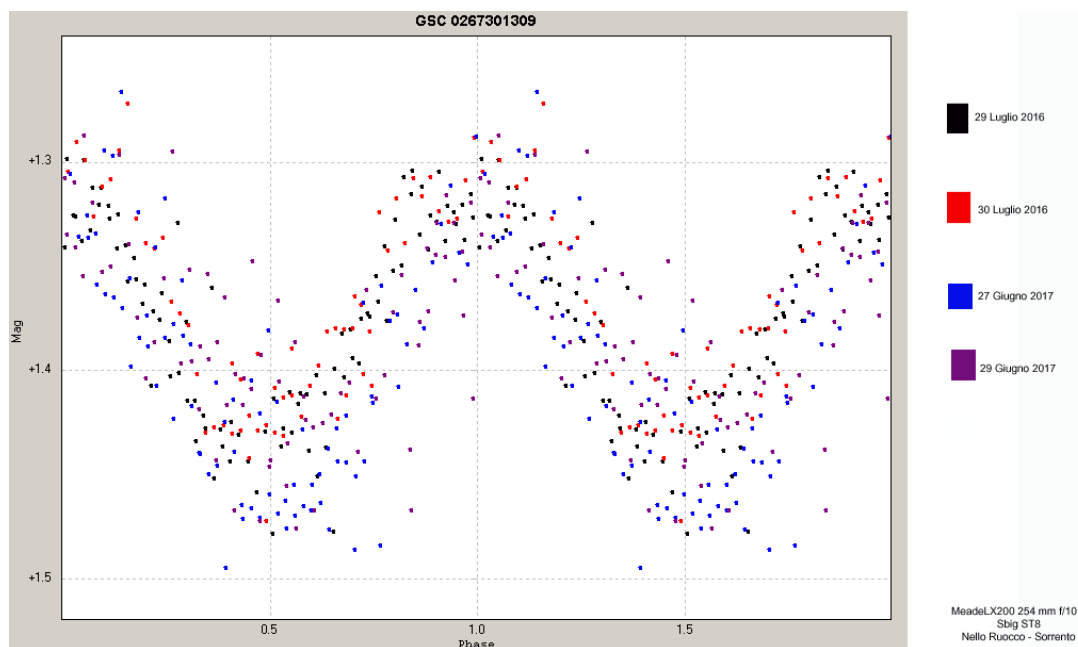


Figure 45: Phase plot of GSC 02673-01309.

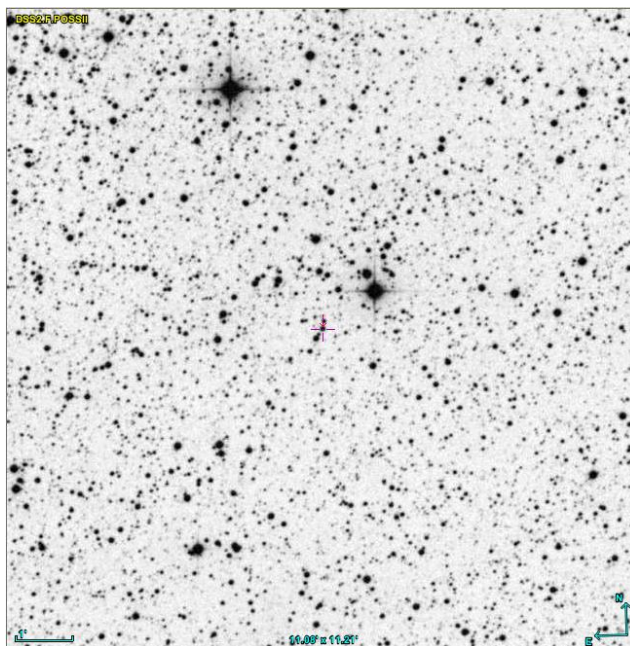


Figure 46: Finder chart for GSC 02673-01309 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

UCAC4 618-093005 (000-BMJ-724) – EW – New discovery

Folded on HJD 2457599.5696, $P = 0.453600$ d. W UMa-type, amplitude 0.28 mag. 5 nights (2016–2017).

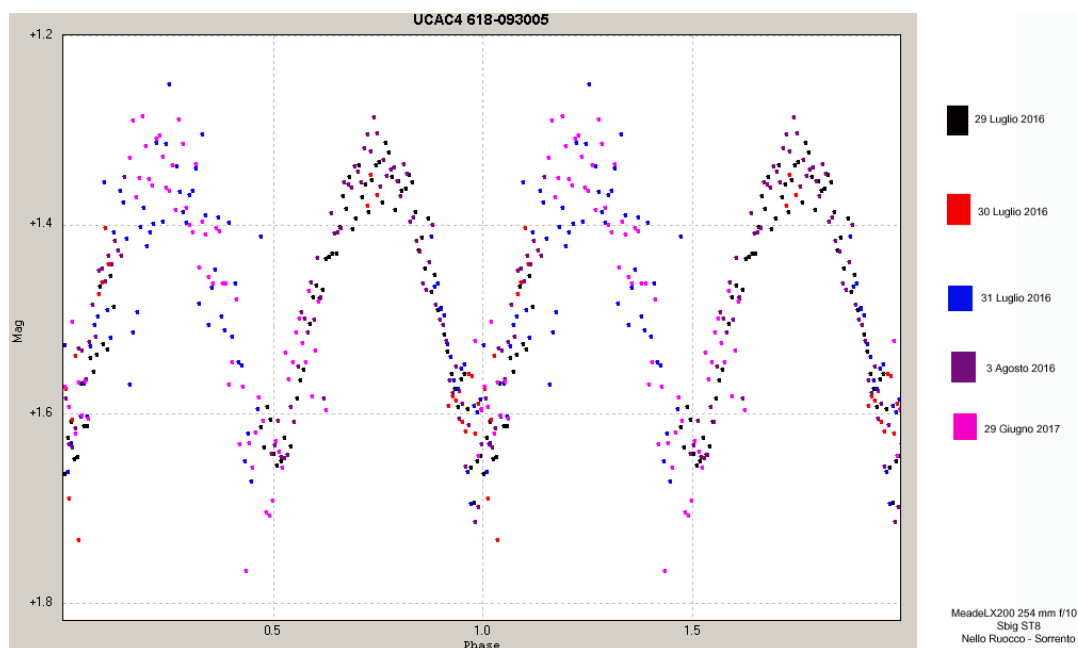


Figure 47: Phase plot of UCAC4 618-093005.

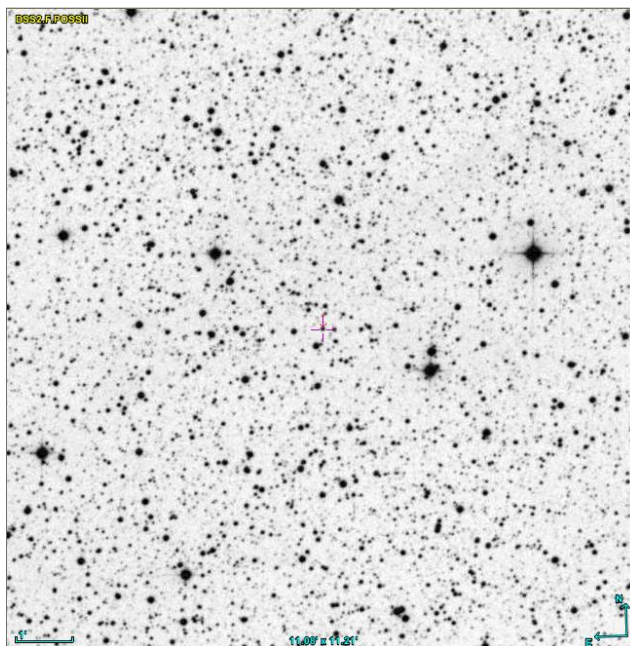


Figure 48: Finder chart for UCAC4 618-093005 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

GSC 02673-01609 (000-BMJ-751) – EW – New discovery

Folded on HJD 2457939.5474, $P = 0.673527$ d. W UMa-type, amplitude 0.48 mag. $B-V = 0.87$ (K-type). 4 nights (July 2017).

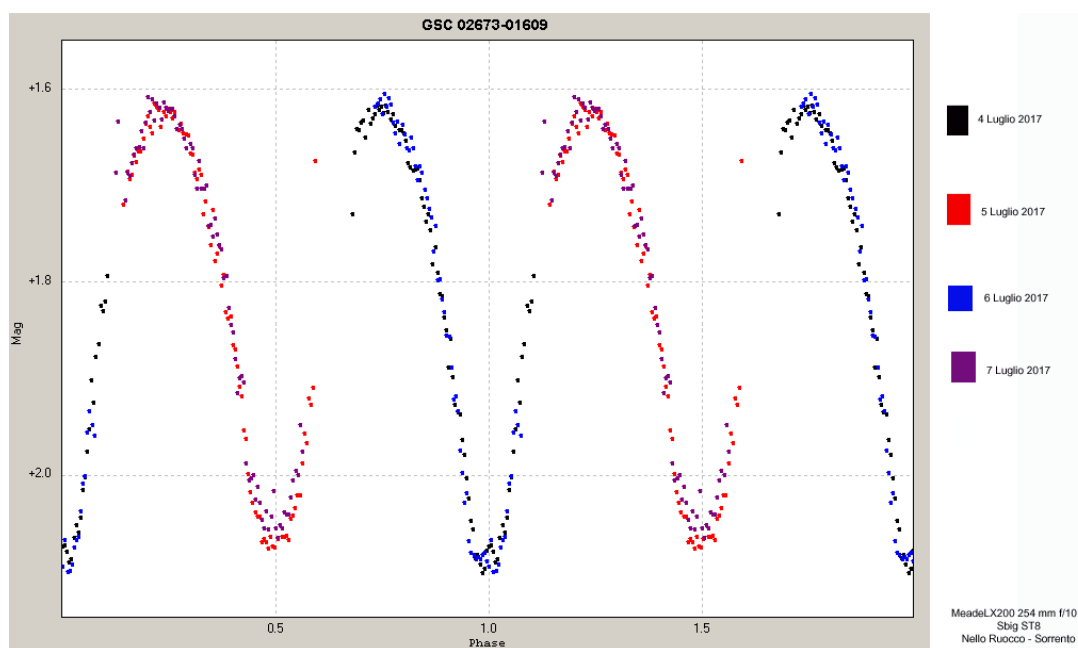


Figure 49: Phase plot of GSC 02673-01609.

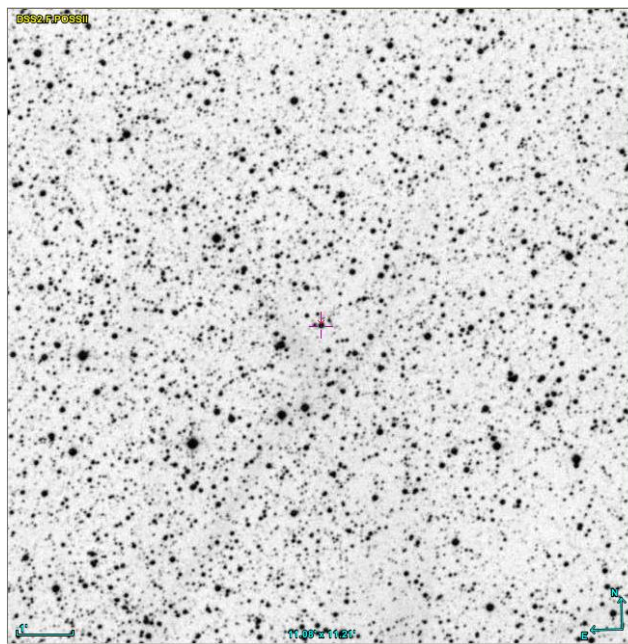


Figure 50: Finder chart for GSC 02673-01609 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

UCAC4 618-094244 (000-BMJ-723) – RRC – New discovery

Folded on HJD 2457939.33169, $P = 0.254453$ d. RR Lyrae c-type, amplitude 0.25 mag, rise time 43%. 4 nights.

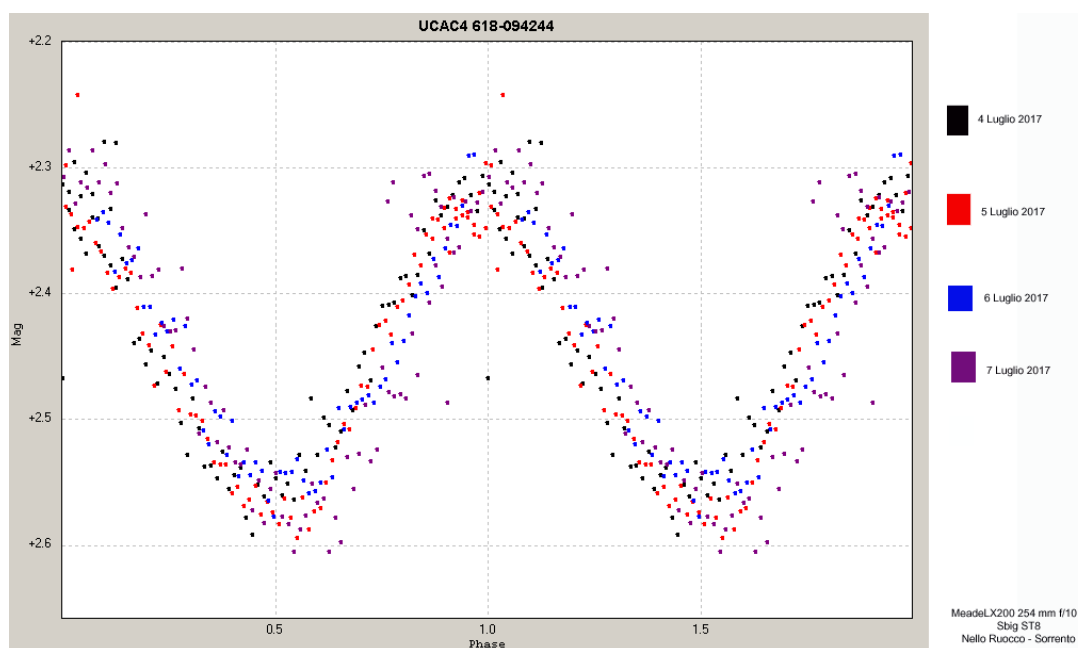


Figure 51: Phase plot of UCAC4 618-094244.

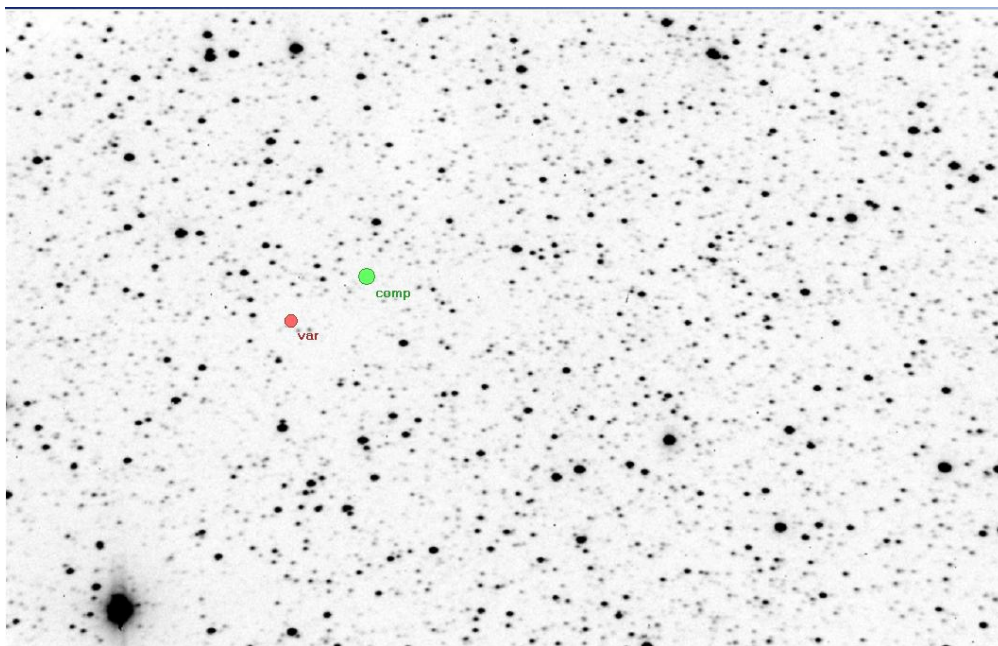


Figure 52: Finder chart for UCAC4 618-094244 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

Field 8 – V789 Cyg

V1111 Cyg (000-BDP-031) – RRAB/BL – Revision

Folded on HJD 2457573.5021, $P = 0.55820$ d. RR Lyrae ab-type with Blazhko effect, amplitude ~ 1.4 mag, mean 15.4 p. 9 nights.

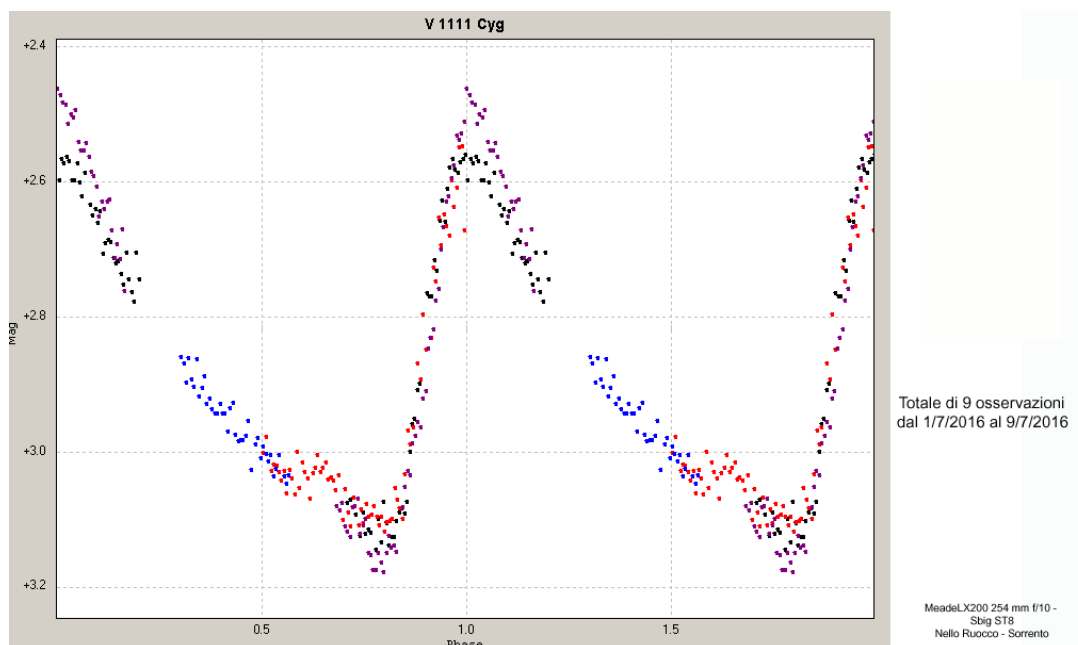


Figure 53: Phase plot of V1111 Cyg.

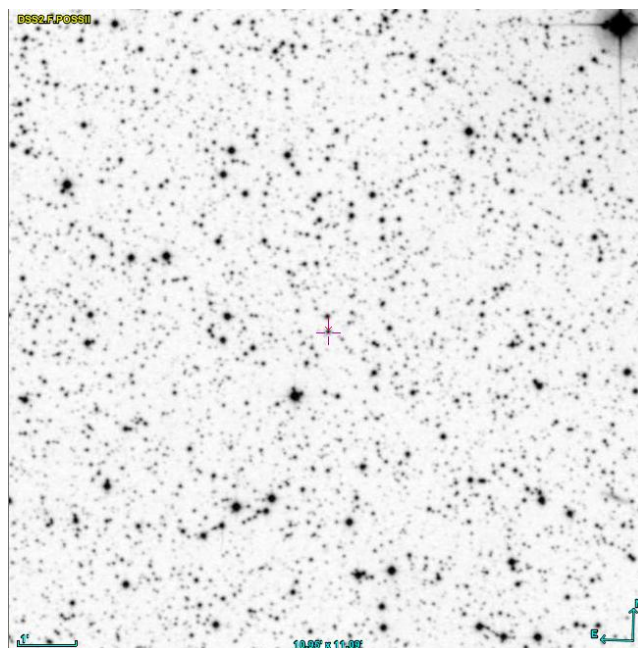


Figure 54: Finder chart for V1111 Cyg (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

UCAC4 601-078128 (000-BLY-490) – HADS – New discovery

Folded on HJD 2457573.4204, $P = 0.10015$ d. High Amplitude Delta Scuti, amplitude 0.3 mag, rise time $\sim 39\%$. 9 nights (July 2016).

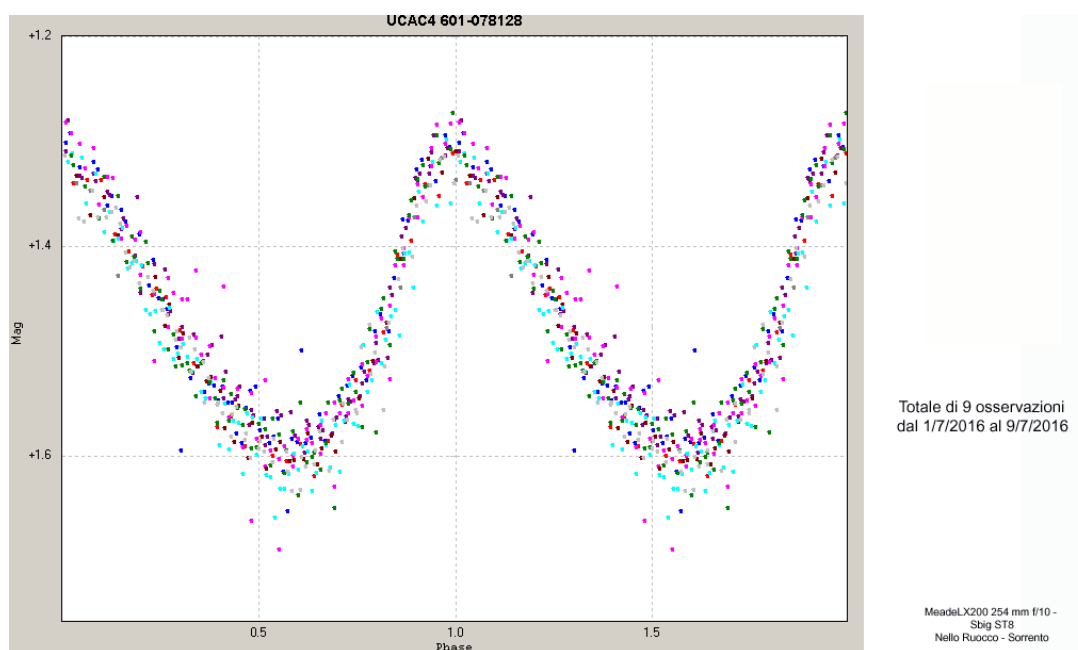


Figure 55: Phase plot of UCAC4 601-078128.

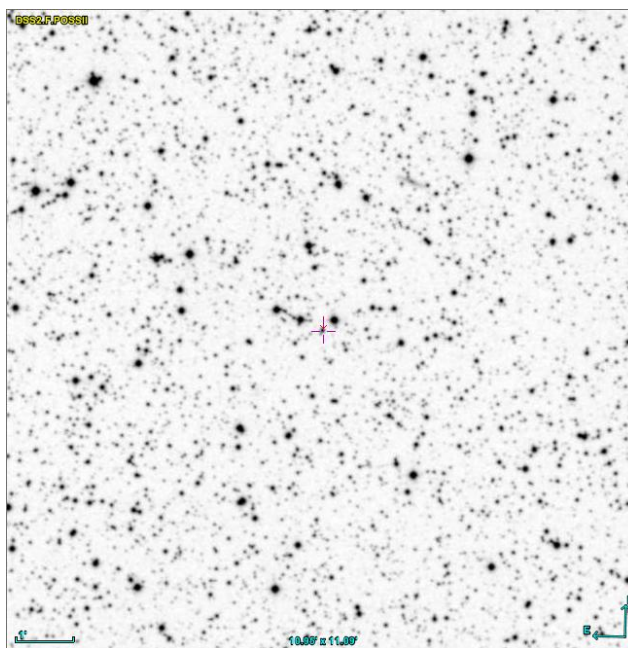


Figure 56: Finder chart for UCAC4 601-078128 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

UCAC4 601-078164 (000-BLY-489) – RRAB – New discovery

Folded on HJD 2457573.4383, $P = 0.56818$ d. RR Lyrae ab-type, amplitude 0.9 mag, rise time $\sim 12\%$. Mean 16.84 V. 9 nights.

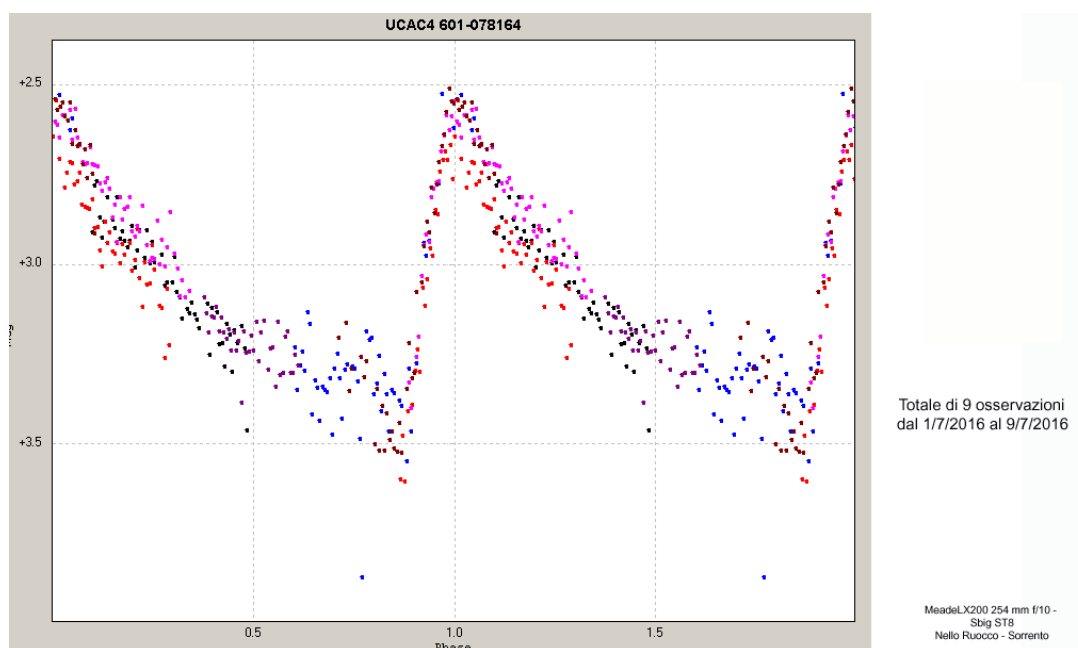


Figure 57: Phase plot of UCAC4 601-078164.

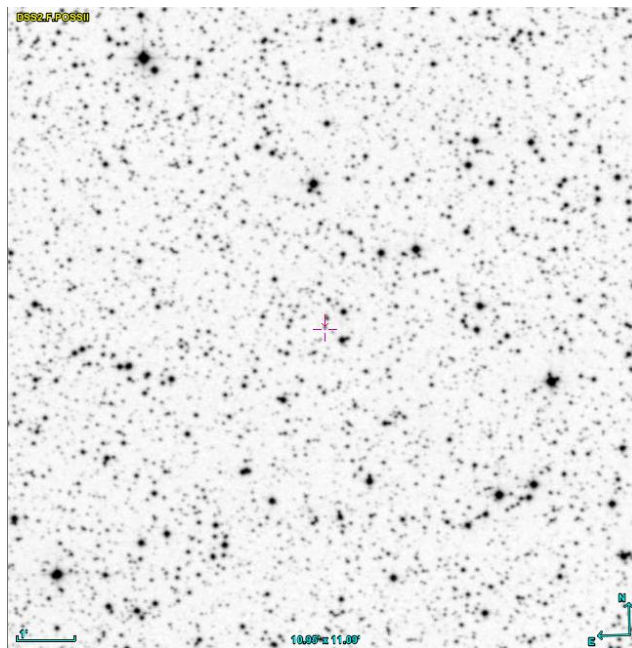


Figure 58: Finder chart for UCAC4 601-078164 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

UCAC4 601-078444 (000-BLY-486) – EW – New discovery

Folded on HJD 2457572.3789, $P = 0.24319$ d. W UMa-type, amplitude 0.75 mag, mean 17.1 V. $J-K = 0.71$ (K-type). 9 nights.

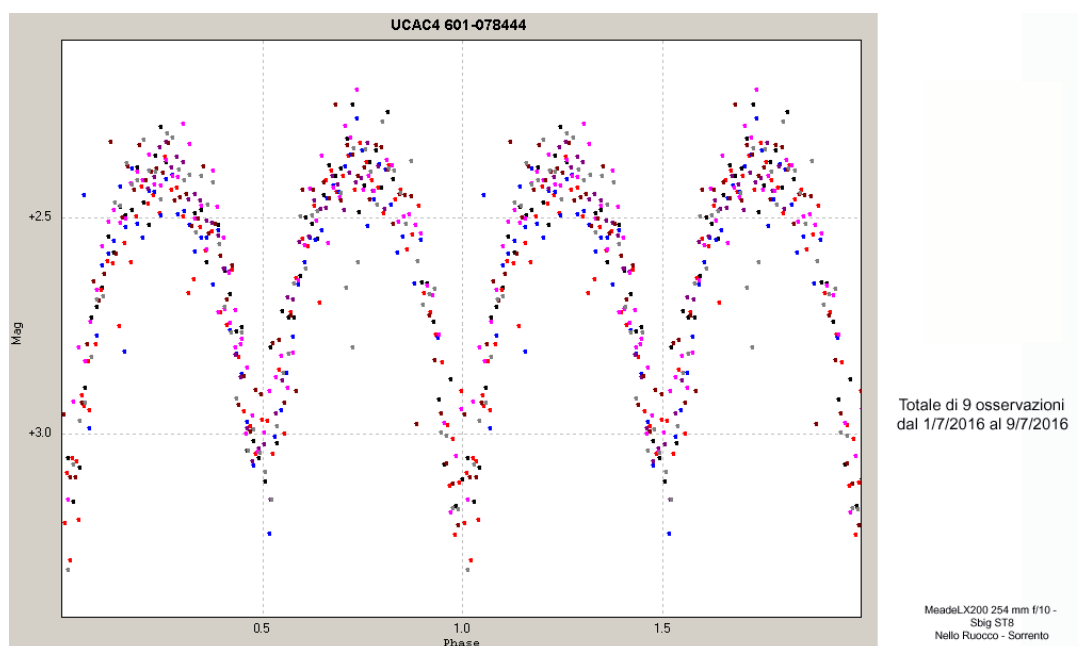


Figure 59: Phase plot of UCAC4 601-078444.

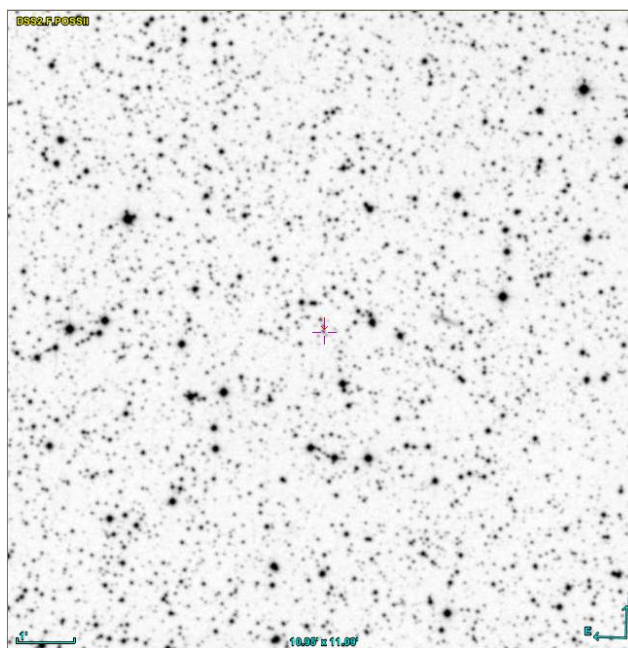


Figure 60: Finder chart for UCAC4 601-078444 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

Field 9 – V1437 Cyg

UCAC4 607-075897 (000-BLR-792) – EW – New discovery

Folded on HJD 2457241.5462, $P = 0.36095$ d. W UMa-type, amplitude 0.55 mag, mean 17.09 V. 2 nights.

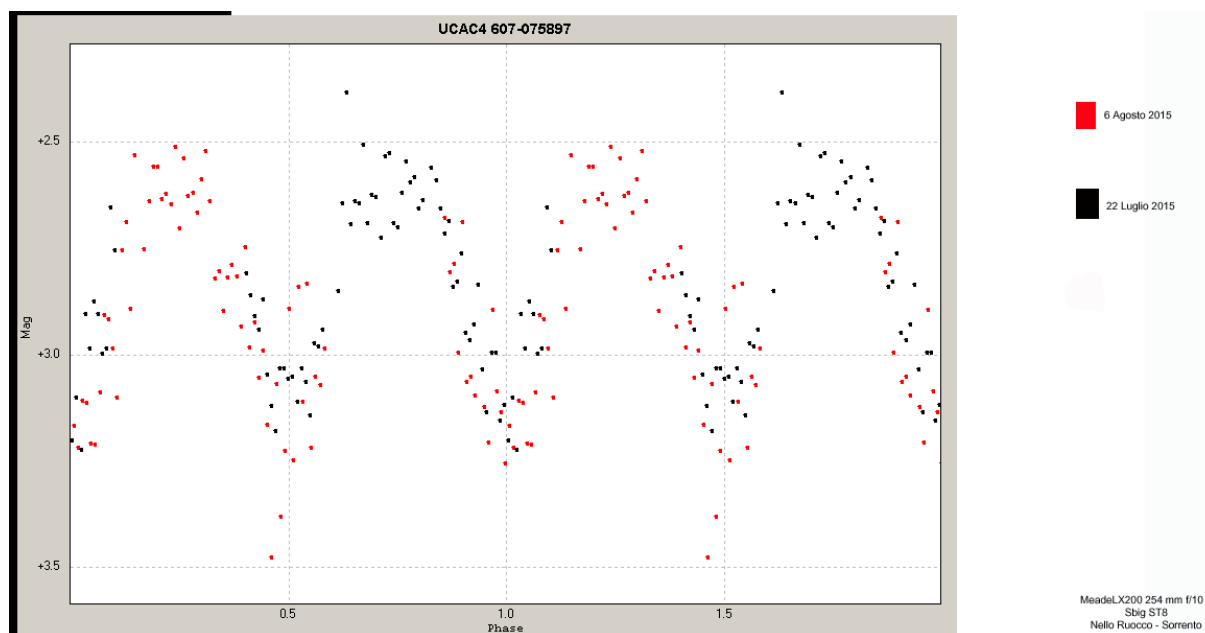


Figure 61: Phase plot of UCAC4 607-075897.

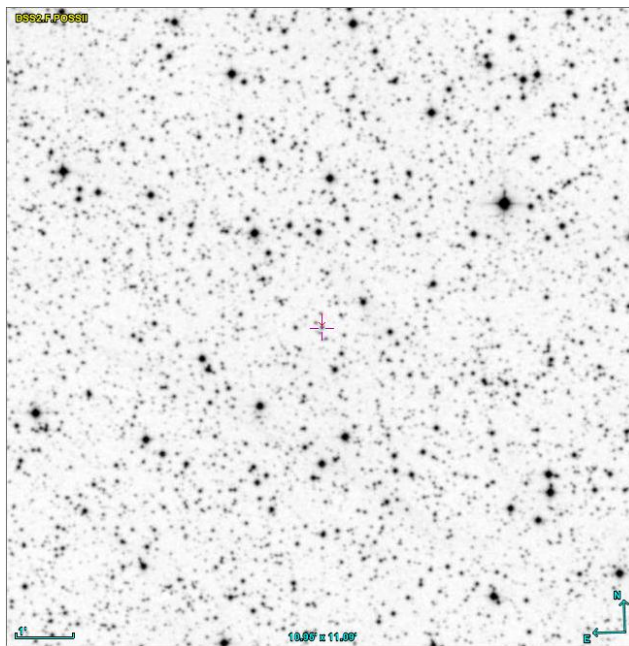


Figure 62: Finder chart for UCAC4 607-075897 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

UCAC4 608-077894 (000-BLR-563) – EW – New discovery

Folded on HJD 2457225.4441, $P = 0.38916$ d. W UMa-type, amplitude 0.40 mag, mean 14.94 V. 3 nights.

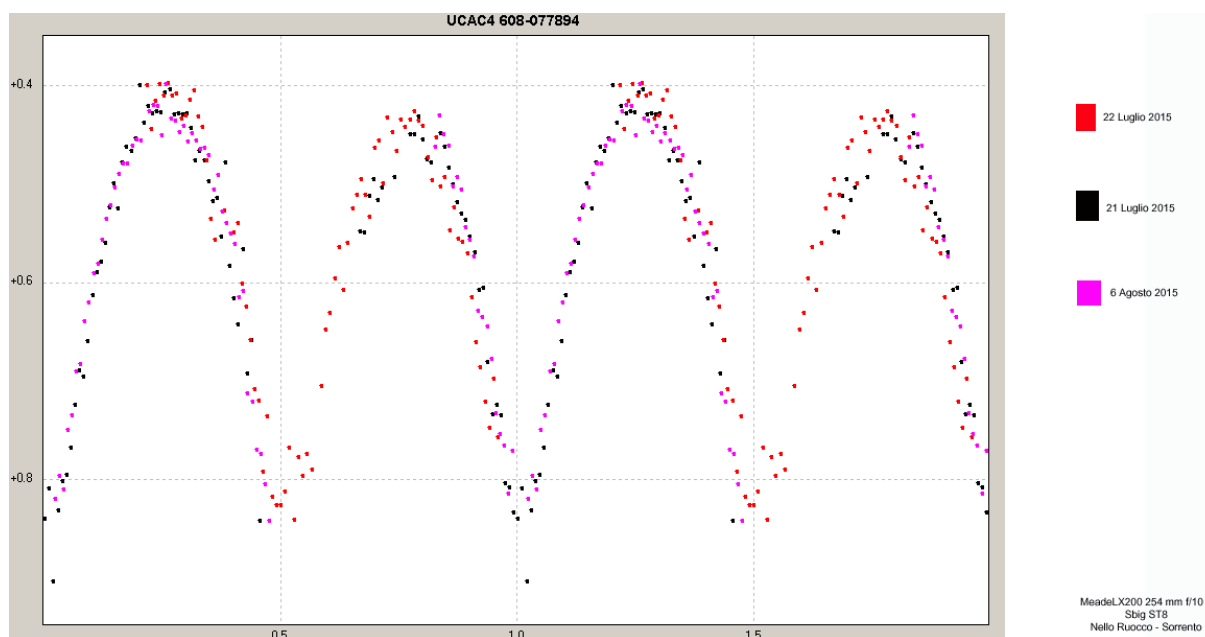


Figure 63: Phase plot of UCAC4 608-077894.

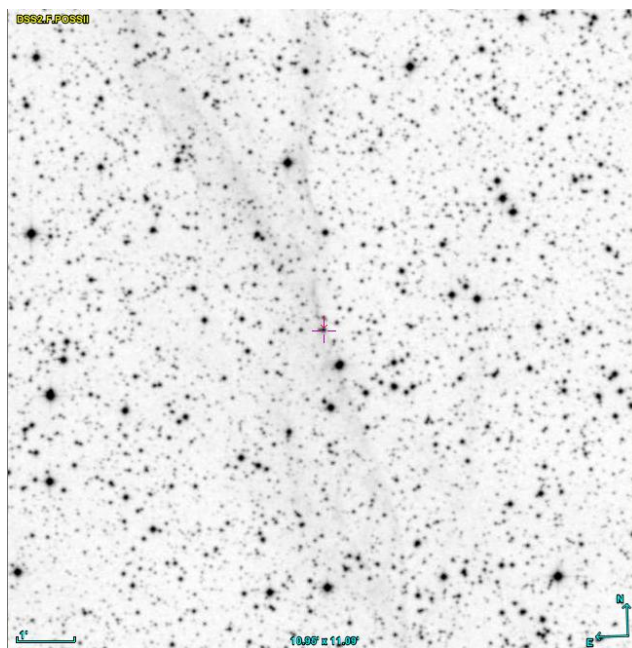


Figure 64: Finder chart for UCAC4 608-077894 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

UCAC4 608-078344 (000-BLR-309) – EW – New discovery

Folded on HJD 2457224.4928, $P = 0.2852$ d. W UMa-type, amplitude 0.74 mag, mean 16.60 V. 3 nights.

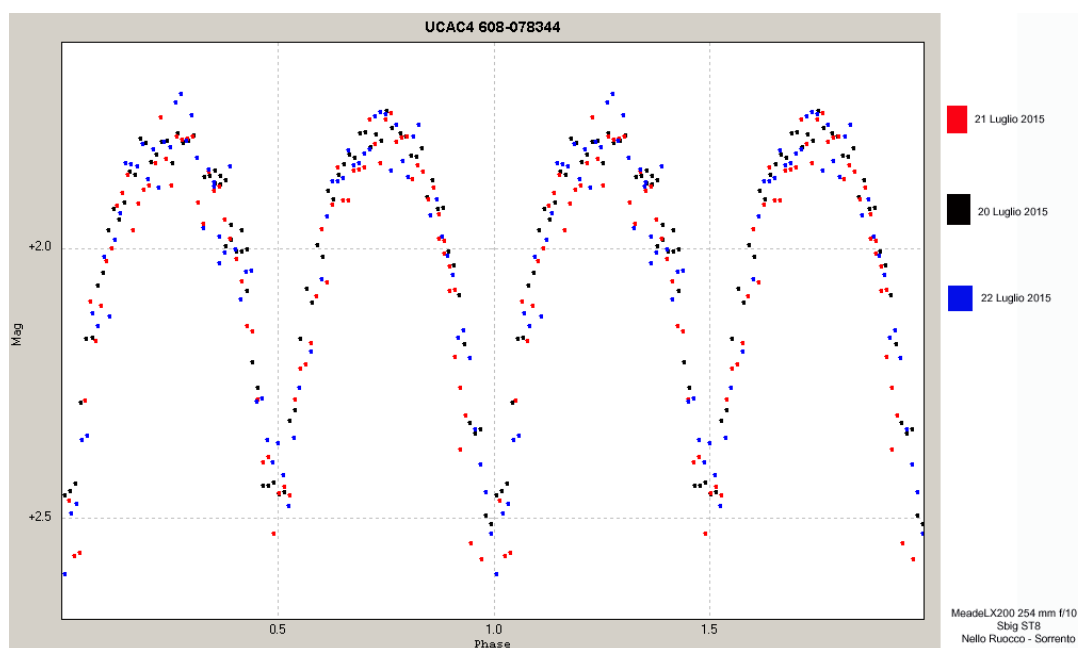


Figure 65: Phase plot of UCAC4 608-078344.

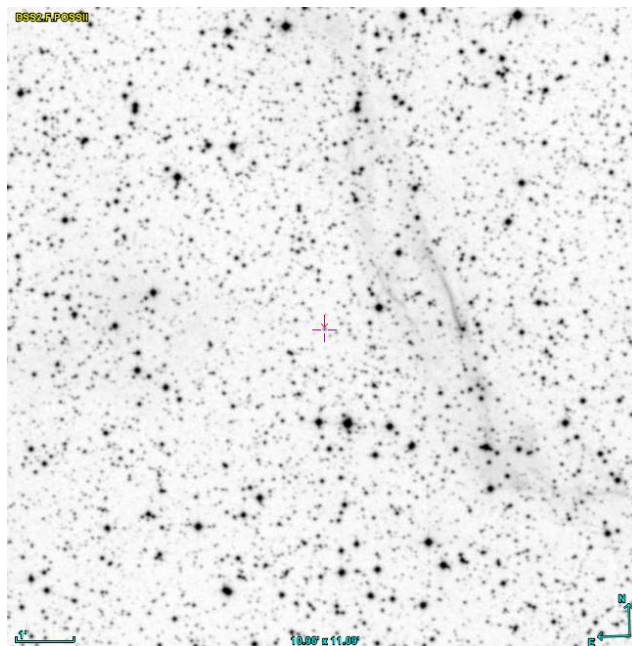


Figure 66: Finder chart for UCAC4 608-078344 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

Field 10 – V1416 Cyg

UCAC4 711-092693 (000-BMK-452) – EW – New discovery

Folded on HJD 2457979.6111, $P = 0.3896$ d (9.35 h). W UMa-type, amplitude 0.30 mag, mean 14.6 V. $B-V = 0.79$ (K-type), $J-K = 0.46$. 3 nights (August 2017).

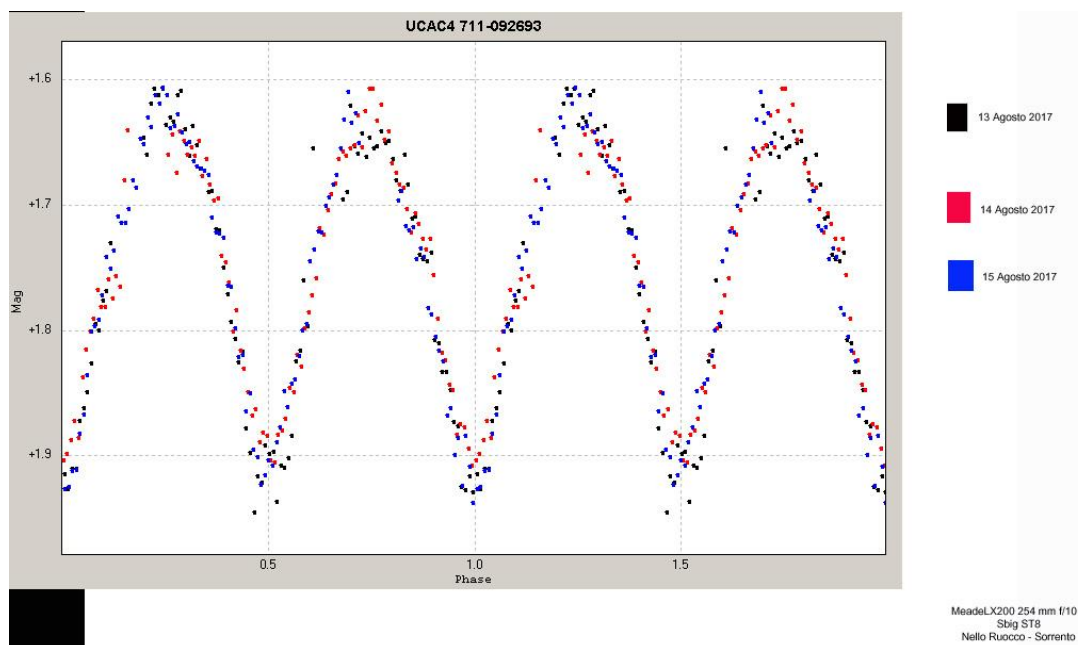


Figure 67: Phase plot of UCAC4 711-092693.

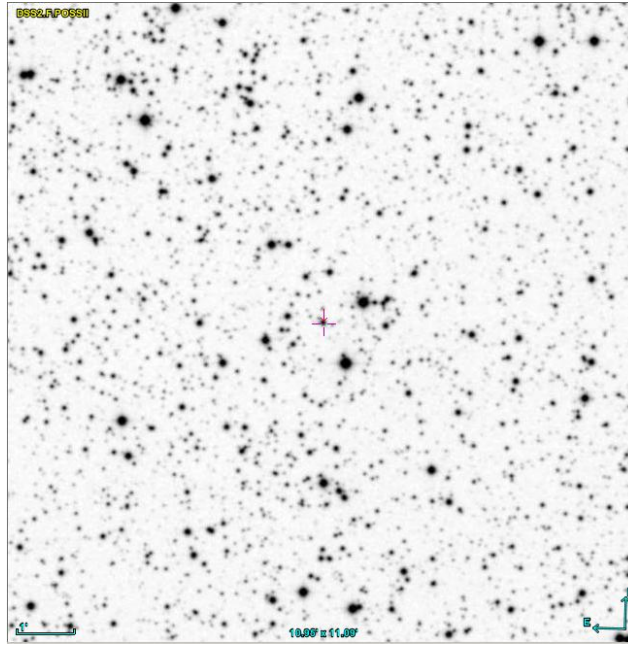


Figure 68: Finder chart for UCAC4 711-092693 (Aladin, DSS2 red, $\sim 11' \times 11'$, N up, E left).

4.2 Gemini

Monitoring sessions span two distinct epochs: January–February 2017 (GR Gem, CMC15 J062325.4+205619, and UCAC4 554-026264 fields) and January–February 2019 (BS Gem and V351 Gem fields). The field of view was approximately $11' \times 7'$ to $12' \times 9'$.

GR Gem – Re-observed Known Variable

GR Gem (2MASS J06232025+2049578; UCAC4 555-026739; J2000.0: 06h 23m 20.25s, $+20^\circ 49' 58.3''$) is a known EA-type eclipsing binary first discovered by Hoffmeister (1957). Its period of 0.5274471 d and magnitude range 14.85–15.80 V are well established in VSX. I observed this system on 20 and 21 January 2017, primarily to use it as a reference field for the discovery of new variables. From my data I derive a revised epoch of primary minimum: $\text{HJD}(\text{Min I}) = 2457774.4935 \pm 0.001$, yielding the light elements: $\text{HJD}(\text{Min I}) = 2457774.4935 + 0.5274471 \cdot E$.

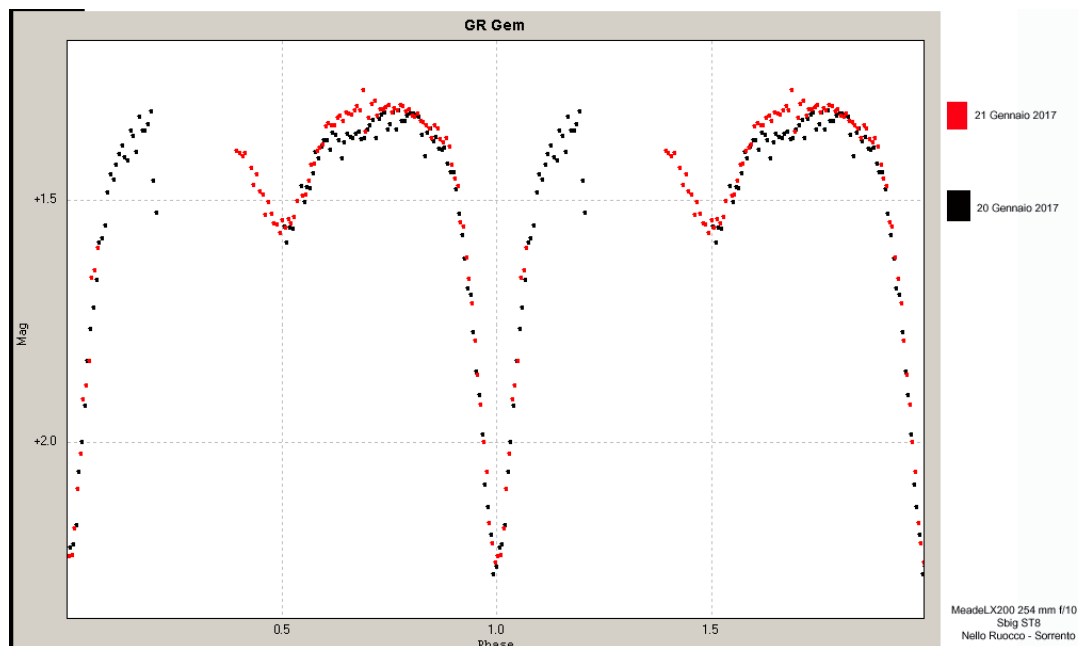


Figure 69: Phase-folded light curve of GR Gem (EA, $P = 0.5274471$ d). Red: 21 Jan 2017; Black: 20 Jan 2017.

CMC15 J062325.4+205619 (000-BMD-923) – EW – New discovery – field of GR Gem

I discovered this W UMa-type binary in the photometric field of GR Gem during sessions of 20–21 January 2017. Cross-identifications: 2MASS J06232549+2056200; ASASSN-V J062325.49+205620.0. Coordinates (J2000.0): 06h 23m 25.49s, $+20^{\circ} 56' 20.0''$. Period: $P = 0.3357$ d (8.06 h); epoch $T_0 = \text{HJD } 2457774.4812$. Mean magnitude ~ 17.34 (clear). Amplitude ~ 0.60 mag. VSX oid: 476551.

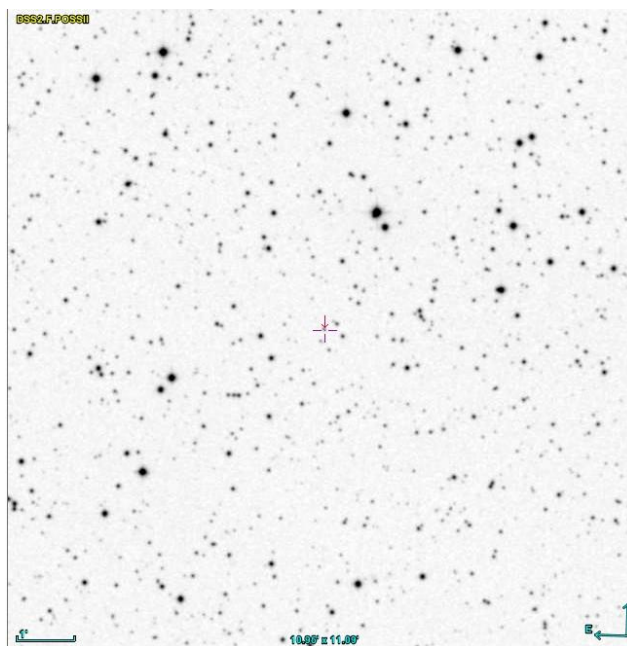


Figure 70: DSS2 F.POSSII finding chart for CMC15 J062325.4+205619. N up, E left.

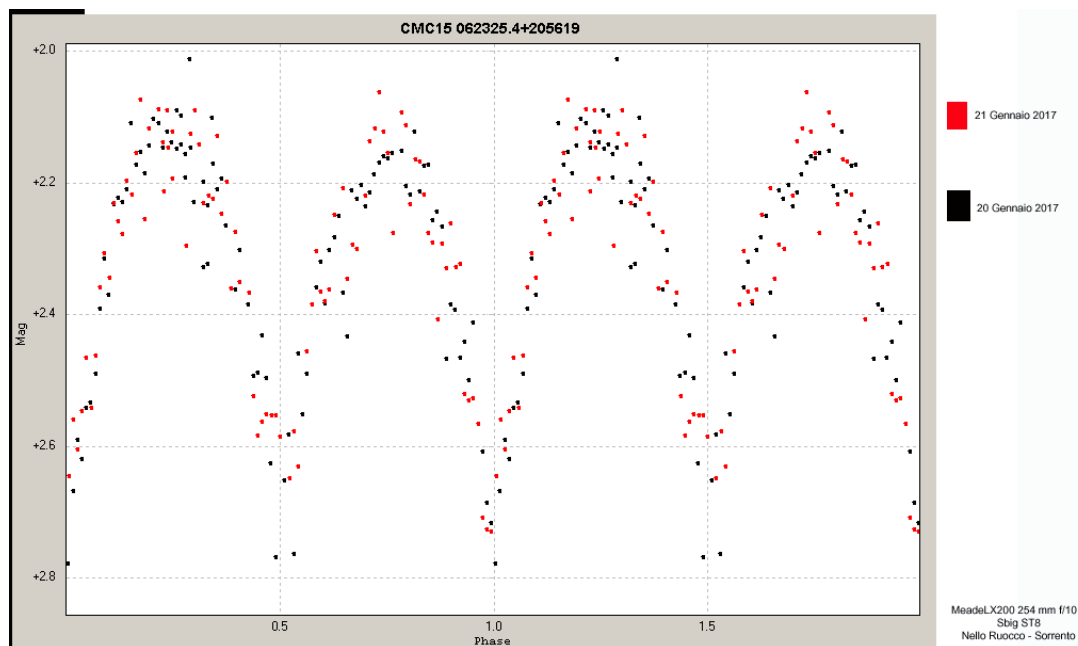


Figure 71: Phase-folded light curve of CMC15 J062325.4+205619.

2MASS J06103575+2252411 (000-BMZ-240) – EW – New discovery – field of BS Gem

This contact binary was found in the field of BS Gem during monitoring sessions in early 2019. Cross-identifications: ASASSN-V J061035.75+225241.1. Coordinates (J2000.0): 06h 10m 35.75s, +22° 52' 41.1". Period: $P = 0.367500 \pm 0.000601$ d (8.82 h); epoch $T_0 = \text{HJD } 2458498.446 \pm 0.002$. Mean magnitude ~ 16.65 (clear). Amplitude ~ 0.60 mag. VSX oid: 684234.

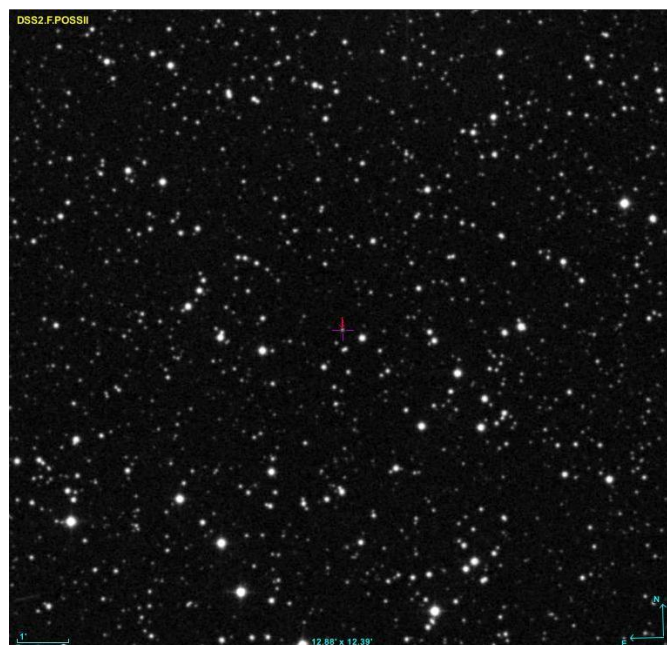


Figure 72: DSS2 F.POSSII finding chart for 2MASS J06103575+2252411. N up, E left.

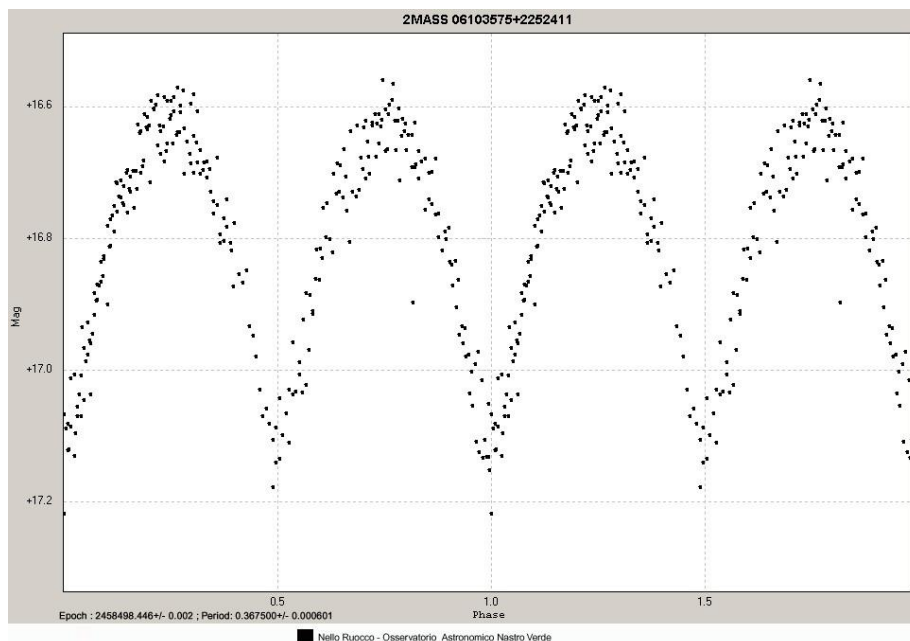


Figure 73: Phase-folded light curve of 2MASS J06103575+2252411.

2MASS J06440196+1459265 (000-BMY-413) – EW – New discovery – field of V351 Gem

Discovered in the field of V351 Gem. Coordinates (J2000.0): 06h 44m 01.96s, +14° 59' 26.5". Period: $P = 0.226040 \pm 0.009810$ d (~ 5.4 h) — the shortest-period binary in the sample, close to the empirical lower limit for W UMa systems. Epoch $T_0 = \text{HJD } 2458495.331 \pm 0.002$. Amplitude ~ 0.40 mag. Mean magnitude ~ 16.70 (clear). VSX oid: 683974.

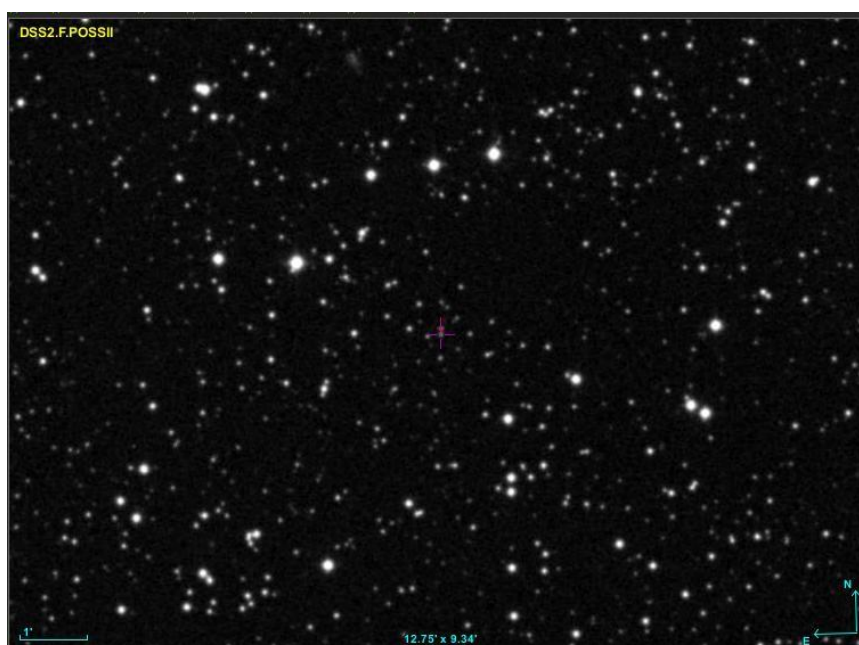


Figure 74: DSS2 F.POSSII finding chart for 2MASS J06440196+1459265. N up, E left.

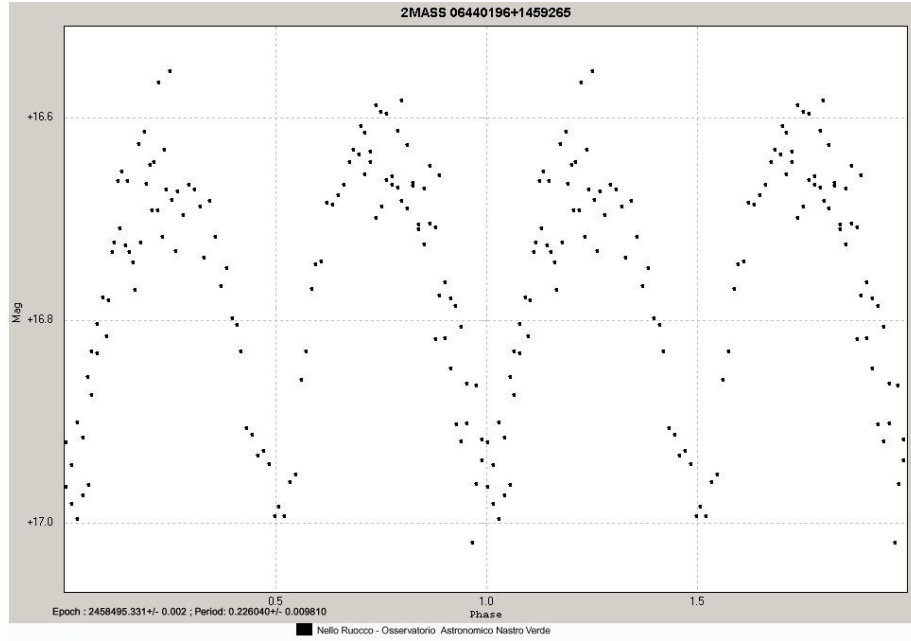


Figure 75: Phase-folded light curve of 2MASS J06440196+1459265.

UCAC4 525-032209 (000-BMY-592) – EW – New discovery – field of V351 Gem

A low-amplitude EW binary found in the same V351 Gem field. Period: $P = 0.372671 \pm 0.087960$ d (8.94 h); epoch $T_0 = \text{HJD } 2458495.266 \pm 0.002$. Amplitude ~ 0.30 mag — the smallest in the Gemini sample. Mean magnitude ~ 17.35 (clear). The large period uncertainty calls for additional observations. VSX oid: 684026.

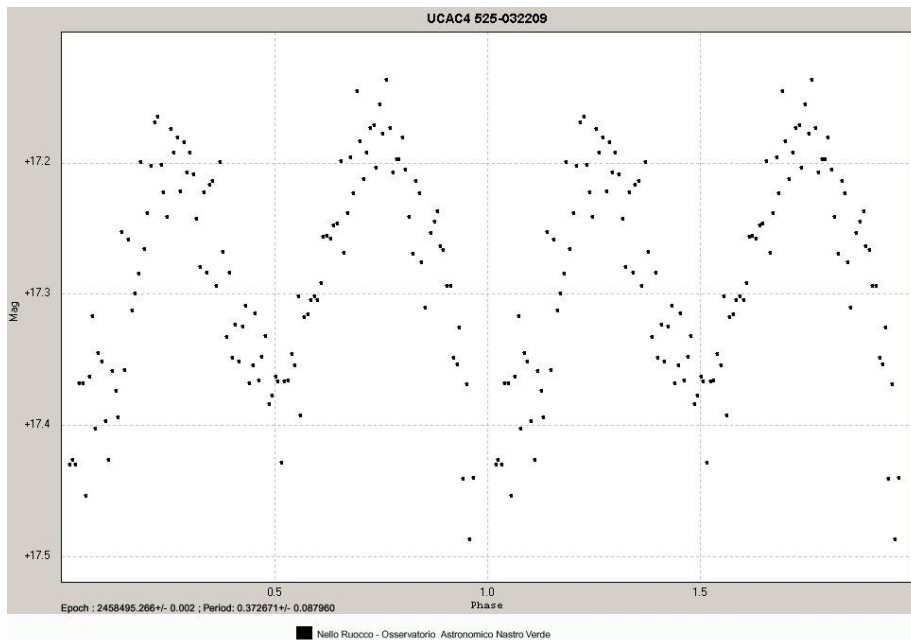


Figure 76: Phase-folded light curve of UCAC4 525-032209.

UCAC4 525-032522 (000-BMY-378) – EW – New discovery – field of V351 Gem

The brightest variable in the Gemini sample, mean magnitude ~ 14.40 (clear). I combined my own photometry with archival ASAS-SN data (Shappee et al. 2014; Kochanek et al. 2017) to

achieve a well-constrained period: $P = 0.445244 \pm 0.000054$ d (10.69 h). Epoch $T_0 = \text{HJD } 2458495.554 \pm 0.002$. Amplitude ~ 0.50 mag. VSX oid: 683956.

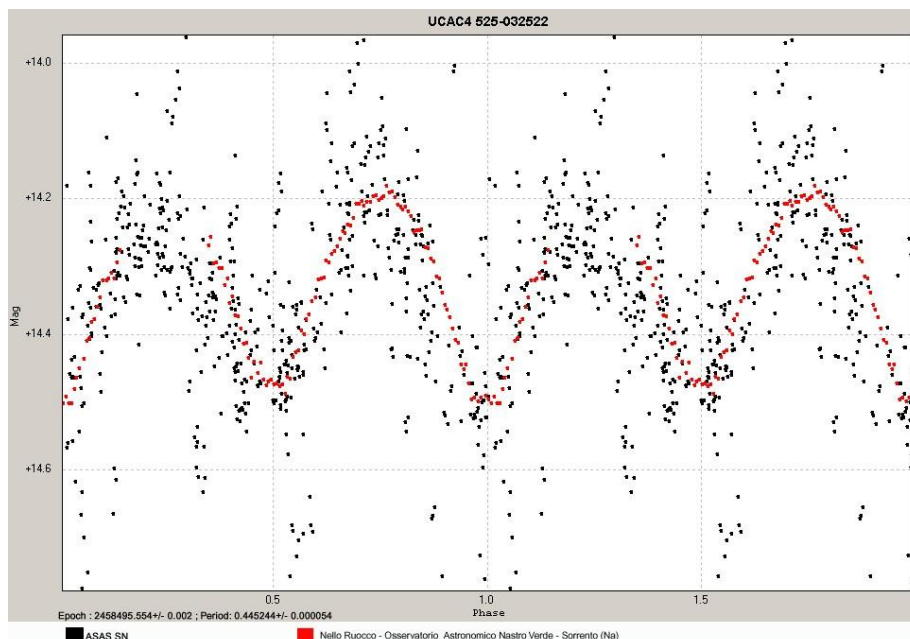


Figure 77: Phase-folded light curve of UCAC4 525-032522.

UCAC4 526-032227 (000-BMY-540) – EW – New discovery – field of V351 Gem

An EW binary with the largest amplitude in the Gemini sample (~ 0.80 mag). Period: $P = 0.374000 \pm 0.009811$ d (8.98 h); epoch $T_0 = \text{HJD } 2458495.470 \pm 0.006$. Mean magnitude ~ 17.10 (clear). VSX oid: 684012.



Figure 78: DSS2 F.POSSII finding chart for UCAC4 526-032227. N up, E left.

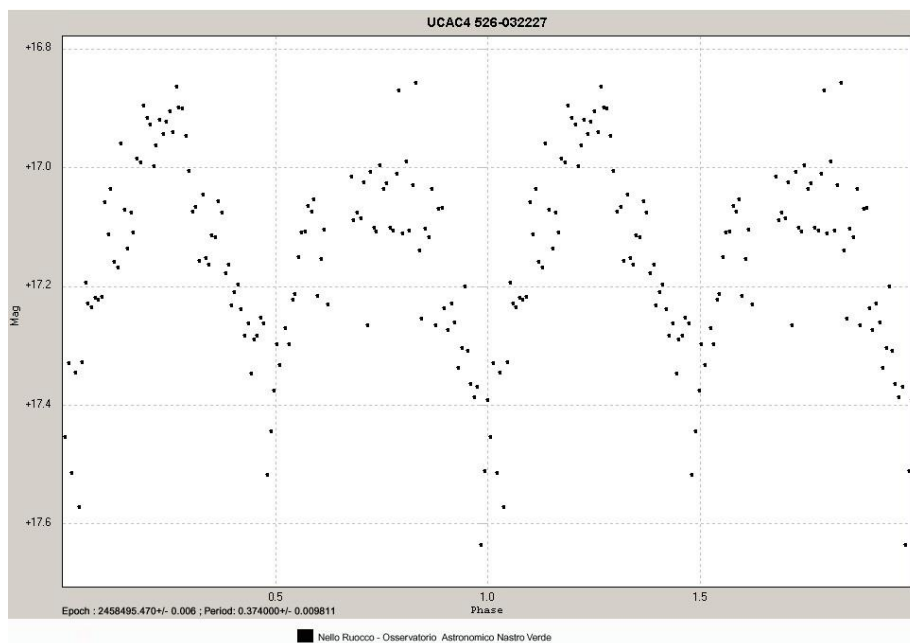


Figure 79: Phase-folded light curve of UCAC4 526-032227.

UCAC4 554-026264 (000-BMF-255) – EW – New discovery – field of SX Gem

This W UMa-type binary was found in the field of SX Gem on 30 January and 1 February 2017. Cross-identifications: 2MASS J06272751+2039419; ASASSN-V J062727.53+203941.7; CMC15 J062727.5+203941. Coordinates (J2000.0): 06h 27m 27.52s, +20° 39' 41.9". Period: $P = 0.3406$ d (8.17 h); epoch $T_0 = \text{HJD } 2457786.2611$. Magnitude: 15.55 V, amplitude 0.63 mag (clear). VSX oid: 476624.

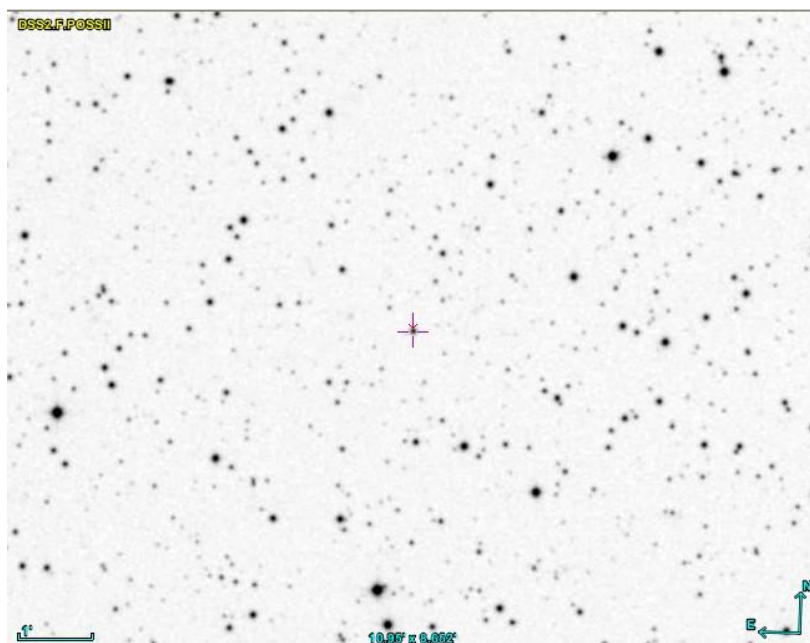


Figure 80: DSS2 F.POSSII finding chart for UCAC4 554-026264. N up, E left.

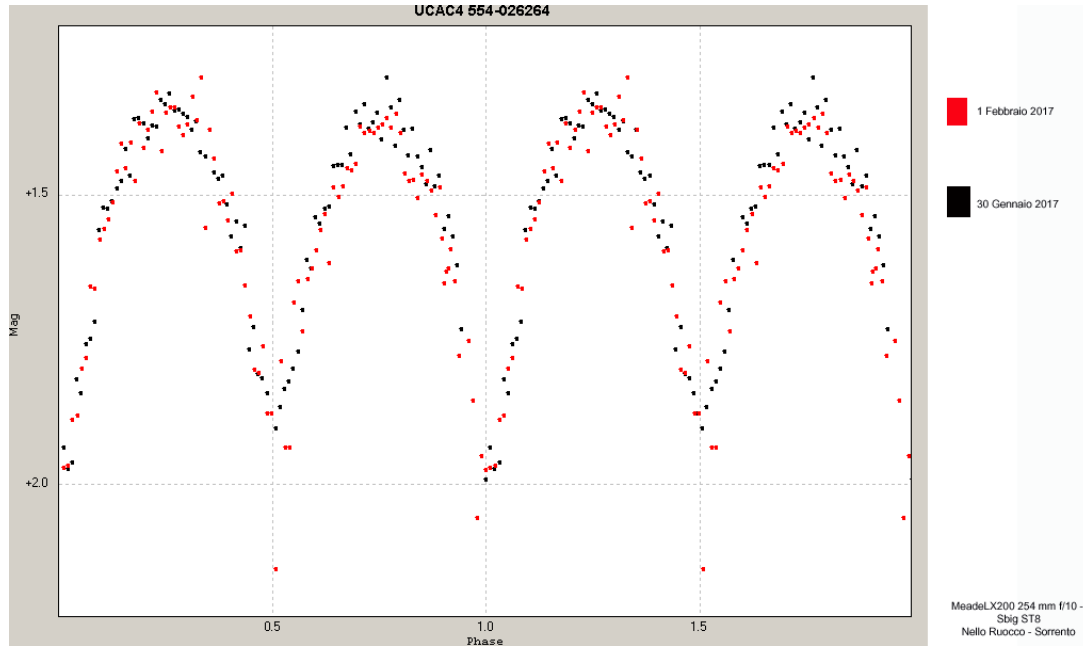


Figure 81: Phase-folded light curve of UCAC4 554-026264.

5 Colour-Magnitude Diagram

In order to place the new variables in the Hertzsprung–Russell diagram and verify the consistency of their variability classifications, I constructed a colour–magnitude diagram (CMD) using Gaia DR3 photometry, MG_0 vs. $(GBP-GRP)_0$, following the referee's suggestion to adopt a different photometric system and derive reddening individually for each star rather than as a single value per field. Distances were taken from the photogeometric distances of Bailer-Jones et al. (2021, based on Gaia DR3 astrometry), retrieved via VizieR (catalogue I/352/gedr3dis) by Gaia DR3 source_id; these correct for the well-known bias of a naive $1/\text{parallax}$ distance at low signal-to-noise, which in an earlier version of this analysis placed most stars spuriously below the zero-age main sequence. Interstellar extinction was likewise obtained individually, using the AG and $E(BP-RP)$ values from the Gaia DR3 GSP-Phot pipeline (Andrae et al. 2023), in place of the single reddening value per field used previously.

For the Cygnus sample, 28 of the 35 programme stars had a Gaia DR3 parallax with $\text{plx_err}/\text{plx} < 20\%$, valid G, BP, RP photometry and a valid GSP-Phot extinction estimate, and were retained for the CMD; for the Gemini sample, 7 of the 8 programme stars were retained. For five of these 35 stars, the GSP-Phot photometric distance (fitted jointly with AG and $E(BP-RP)$ from a single-star spectral model) disagrees with the Bailer-Jones geometric distance by more than a factor of two; this is expected, since GSP-Phot assumes single-star spectra while most programme objects are eclipsing or contact binaries with composite light. The geometric Bailer-Jones distance was used throughout to compute MG_0 , as it does not depend on a stellar-atmosphere assumption; four of these five stars fall within the normal CMD scatter, and only one (UCAC4 674-108700) is a clear outlier, flagged below.

The resulting CMD (Fig. 82) shows that, with individual distances and individual reddening, the programme stars lie on or above the zero-age main sequence (ZAMS; Pecaute & Mamajek

2013), rather than below it as in the previous, uniformly-dereddened version. This is the expected behaviour: the EW- and EB-type systems are eclipsing/contact binaries, whose combined light places them above the single-star ZAMS by up to ~ 0.75 mag for near-equal-mass components; the DSCT, DSCTC and HADS candidates fall within or just above the classical δ Scuti instability strip; and the single RRC star (UCAC4 618-094244) lies well above the ZAMS, as expected for an evolved horizontal-branch pulsator rather than a main-sequence object. Only one star (UCAC4 674-108700, EA) falls below the ZAMS, the same star flagged above for its inconsistent GSP-Phot distance, so its position should be treated with caution. The distribution is consistent with the assigned variability types and resolves the anomaly present in the previous version of this diagram.

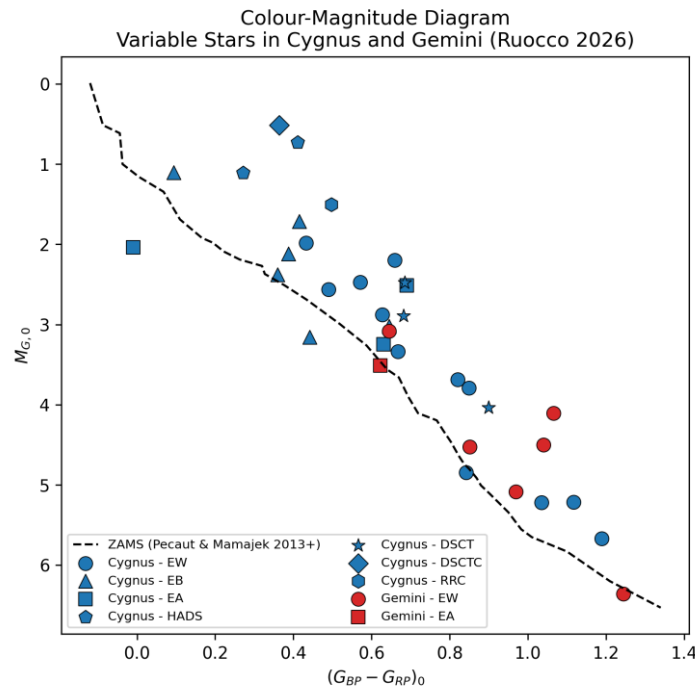


Figure 82: Combined colour–magnitude diagram ($M_{G,0}$ vs. $(G_{BP} - G_{RP})_0$) for 28 Cygnus and 7 Gemini programme stars with reliable Gaia DR3 astrometry and photometry, individual Bailer-Jones (2021) distances, and individual Gaia DR3 GSP-Phot reddening (A_G , $E(BP - RP)$). Blue = Cygnus, red = Gemini; marker shape indicates variability type (circles = EW, triangles = EB, squares = EA, pentagons = HADS, stars = DSCT, diamonds = DSCTC, hexagons = RRC). The dashed line is the empirical solar-metallicity ZAMS of Pecaut & Mamajek (2013, continuously updated).

6 Conclusions

I present the results of a long-term CCD photometric monitoring programme at the Osservatorio Astronomico "Nastro Verde" (MPC C82), Sorrento, covering fourteen fields in Cygnus/Lacerta and Gemini observed between 2012 and 2019. I provide revised light elements for four known variables: OO Cyg (EW), V1111 Cyg (RRAB/BL) and V2884 Cyg (EB) in Cygnus, and GR Gem (EA) in Gemini. I report the discovery of thirty-nine new variables, all submitted to and approved in the AAVSO VSX: 32 in Cygnus (14 EW, 6 EB, 3 EA, 2 RRAB, 1 RRC, 3 DSCT,

2 DSCTC, 2 HADS) and 7 in Gemini (all EW). Seven of the Cygnus discoveries subsequently received GCVS designations (V2875–V2877, V2884, V2887–V2888, V2890 Cyg; Kazarovets et al. 2019). The shortest period found in Gemini ($P = 0.226$ d for 2MASS J06440196+1459265) lies close to the empirical short-period cut-off for W UMa systems (~ 0.22 d; Rucinski 1992). These results confirm that systematic field-monitoring at small observatories remains an efficient and productive strategy for discovering new variable stars.

7 Online Resources

VSX (AAVSO International Variable Star Index): <https://vsx.aavso.org>

VizieR Catalogue Service (CDS, Strasbourg): <https://vizier.u-strasbg.fr>

Aladin Sky Atlas (CDS, Strasbourg): <https://aladin.u-strasbg.fr>

SIMBAD Astronomical Database: <https://simbad.u-strasbg.fr/simbad>

NASA Astrophysics Data System (ADS): <https://ui.adsabs.harvard.edu>

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