

THIRTY-FOUR NEW VARIABLE STARS DISCOVERED IN LACERTA

N. Ruocco

Osservatorio Astronomico Nastro Verde, Sorrento (Italia) - MPC Code C82

Email: nello_ruocco@hotmail.com | osservatorionastroverde@gmail.com

Abstract

We present the discovery of 34 new variable stars in the constellation Lacerta, found during a long-term photometric survey carried out between 2011 and 2019. The sample includes eclipsing binaries of the W Ursae Majoris (EW), Algol (EA) and beta Lyrae (EB) types, as well as two High Amplitude Delta Scuti (DSCT) candidates. For each star we provide coordinates, variability type, period and magnitude range derived from differential CCD photometry; all objects have been submitted to and approved in the AAVSO International Variable Star Index (VSX).

1. Introduction

As part of an ongoing amateur survey of unstudied fields, CCD time-series photometry was obtained for several regions in the constellation Lacerta between 2011 and 2019. The data were searched for periodic photometric variability not previously catalogued. This work led to the identification of 34 new variable stars, predominantly short-period eclipsing binaries of the W UMa (EW) type, together with a smaller number of Algol-type (EA), beta Lyrae-type (EB) eclipsing systems and two candidate High Amplitude Delta Scuti (HADS) pulsators. All objects were submitted to the AAVSO Variable Star Index (VSX) and have been approved with the designations listed in Table 1.

2. Instrumentation and Data Reduction

Observations were carried out with a Meade LX200 25 cm (10-inch) Schmidt-Cassegrain telescope, native focal ratio $f/10$, used with a focal reducer giving an effective focal ratio of $f/6.3$, and equipped with SBIG ST-8 and SBIG ST-7 CCD cameras, operating unfiltered (clear) for most targets. Image calibration (dark and flat-field correction) and differential aperture photometry were performed using MaxIm DL (Diffraction Limited) and MuniWin (Hroch 1998). For each target, a suitable comparison star was selected in the field, and the resulting differential light curves were period-searched and folded using Peranso (Paunzen & Vanmunster 2016), which implements multiple algorithms including Lomb-Scargle, phase dispersion minimisation (PDM) and analysis of variance (AoV).

3. Results

Table 1 summarises the main properties of the 34 new variables: 2MASS/UCAC4/URAT1 designation, AAVSO Unique Identifier (AUID), J2000 coordinates, variability type, period and magnitude range (the value in parentheses indicates the peak-to-peak amplitude). The large majority (24 objects) are W UMa-type (EW) contact binaries with periods between 0.25 and 0.78 days, consistent with the expected period distribution for this class. Three stars (000-BLS-498, 000-BMW-034 and 000-BMY-147) show longer periods and deeper, narrower minima, more typical of Algol-type (EA) detached or semi-detached systems. A further EA system, 000-BLS-087 (GSC 03632-02808), shows a much longer period ($P = 1.07022$ d) and a deep (0.64

mag), narrow primary eclipse with a long flat-bottomed maximum, typical of a well-detached system. A sixth EA system, 000-BKH-045, shows an even longer period ($P = 2.751$ d) with a deep, narrow primary eclipse and a very shallow secondary; this star has since received the GCVS designation V0688 Lac (Kazarovets et al., 2020). A seventh EA system, 000-BKS-748, with $P = 0.690701$ d and a 10% primary eclipse, was likewise updated and assigned the GCVS designation V0910 Lac (Kazarovets et al., 2023); this target is a close visual binary with a 1.2 arcsec companion. A third star with a GCVS designation, 000-BKS-597 (V0912 Lac), shows a small-amplitude EB-type light curve ($P = 1.15003$ d, range 13.39-13.50 g) and is the brightest object in the sample ($V \sim 13.2$); an ellipsoidal (ELL) nature has also been suggested for this star (Kazarovets et al., 2023). Two further stars (000-BKF-424 and 000-BMK-299) show short periods (0.099-0.161 d) and light-curve shapes consistent with high-amplitude delta Scuti pulsators, and are tentatively classified as DSCT.

Table 1. *New variable stars discovered in Lacerta.*

V	Name	AUID	Coordinates (J2000)	Var. type	Period (d)	Mag. range
V1	<i>2MASS J22000388+4351113</i>	000-BKF-424	22 00 03.88 +43 51 11.3	DSCT:	0.16106	14.92 V (0.06)
V2	<i>2MASS J22162837+4952131</i>	000-BMB-228	22 16 28.37 +49 52 13.3	EW	0.31914	17.13 V (0.26)
V3	<i>2MASS J22163381+4952290</i>	000-BMB-313	22 16 33.85 +49 52 29.3	EW	0.61075	16.49 V (0.81)
V4	<i>2MASS J22192946+4416566</i>	000-BLD-336	22 19 29.45 +44 16 56.7	EW	0.4338	16.22 V (0.3)
V5	<i>2MASS J22235378+5122249</i>	000-BMK-621	22 23 53.79 +51 22 25.0	EW	0.29116	17.6 V (0.85)
V6	<i>2MASS J22243032+5126076</i>	000-BMK-607	22 24 30.32 +51 26 07.6	EW	0.2995	16.8 V (0.57)
V7	<i>2MASS J22253540+5118014</i>	000-BLZ-606	22 25 35.40 +51 18 01.4	EA	0.86561	16.9 V (0.55)
V8	<i>2MASS J22282227+5228058</i>	000-BLZ-023	22 28 22.30 +52 28 05.9	EW	0.36280	17.3 V (0.65)
V9	<i>2MASS J22293014+5231171</i>	000-BMK-300	22 29 30.14 +52 31 17.1	EW	0.3887	16.8 V (0.48)
V10	<i>2MASS J22331661+5038561</i>	000-BKG-542	22 33 16.60 +50 38 55.8	EW	0.3128	16.12 V (0.3)
V11	<i>2MASS J22333278+5040263</i>	000-BML-573	22 33 32.79 +50 40 26.3	EW	0.2509	17.7 V (1.0)
V12	<i>2MASS J22335381+5043227</i>	000-BKG-521	22 33 53.82 +50 43 22.7	EW	0.4409	15.5 V (0.7)
V13	<i>2MASS J22422253+5057575</i>	000-BKG-492	22 42 22.55 +50 57 57.5	EW	0.4428	16.22 V (0.4)
V14	<i>2MASS J22425519+5059043</i>	000-BKG-519	22 42 55.20 +50 59 04.4	EB	0.5228	14.96 V (0.3)
V15	<i>2MASS J22432320+5056006</i>	000-BKG-540	22 43 23.21 +50 56 00.7	EW	0.3252	16.56 V (0.6)
V16	<i>UCAC4 689-111349</i>	000-BMK-299	22 10 07.52 +47 41 58.7	DSCT:	0.099548	14.9 V (0.10)

V	Name	AUID	Coordinates (J2000)	Var. type	Period (d)	Mag. range
V17	<i>UCAC4 700-108110</i>	000-BMB-311	22 16 34.95 +49 56 01.0	EW	0.47037	15.5 V (0.19)
V18	<i>UCAC4 700-108268</i>	000-BLZ-643	22 17 11.82 +49 59 48.8	EW	0.30660	15.54 V (0.28)
V19	<i>UCAC4 705-104781</i>	000-BLS-229	22 30 15.79 +50 58 22.3	EW	0.67587	15.68 V (0.41)
V20	<i>UCAC4 705-104975</i>	000-BLS-498	22 30 48.62 +50 49 20.3	EA	0.91107	16.2 V (0.49)
V21	<i>UCAC4 705-105013</i>	000-BLS-098	22 30 54.21 +50 55 56.8	EB	0.5350	15.94 V (0.59)
V22	<i>UCAC4 706-105719</i>	000-BMK-187	22 40 50.38 +51 03 56.0	EW	0.28407	16.6 V (0.42)
V23	<i>UCAC4 706-105733</i>	000-BMK-298	22 40 53.48 +51 01 55.8	EW	0.2800	15.9 V (0.65)
V24	<i>UCAC4 707-100174</i>	000-BMW-034	22 24 34.09 +51 18 34.1	EA	1.824987	14.81-15.24 V
V25	<i>UCAC4 707-100327</i>	000-BLZ-605	22 25 15.24 +51 14 32.6	EA	0.66609	15.67 V (0.85)
V26	<i>UCAC4 707-100455</i>	000-BLZ-600	22 25 46.61 +51 16 18.9	EB	0.47295	16.4 V (0.30)
V27	<i>UCAC4 707-100598</i>	000-BMY-147	22 26 13.16 +51 23 24.0	EA	1.958047	15.54-16.04 V
V28	<i>UCAC4 708-103075</i>	000-BML-632	22 25 26.33 +51 27 46.0	EW	0.7772	13.32 V (0.15)
V29	<i>UCAC4 712-099399</i>	000-BLY-971	22 27 09.04 +52 17 58.8	EW	0.31123	15.64 V (0.9)
V30	<i>URAT1 705-478678</i>	000-BMZ-699	22 30 17.51 +50 58 27.9	EW	0.383142	17.7-18.4 CV
V31	<i>GSC 03632-02808</i>	000-BLS-087	22 32 18.05 +50 45 53.7	EA	1.07022	14.06 V (0.64)
V32	<i>2MASS J22421663+5057275 (V0688 Lac)</i>	000-BKH-045	22 42 16.63 +50 57 27.6	EA	2.751	16.95 V (0.19)
V33	<i>2MASS J22243039+5133019 (V0910 Lac)</i>	000-BKS-748	22 24 30.37 +51 33 01.4	EA	0.690701	14.64-14.90 r
V34	<i>2MASS J22245686+5131380 (V0912 Lac)</i>	000-BKS-597	22 24 56.85 +51 31 37.9	EB	1.15003	13.39-13.50 g

4. Light Curves

Phase-folded differential light curves for each star are presented below. Different colours correspond to data obtained on different observing nights.

V1 = 2MASS J22000388+4351113 (000-BKF-424)

This star shows clear double-humped variability when folded on a period of $P = 0.16106$ d, with a peak-to-peak amplitude of about 0.13 mag in the clear (unfiltered) band. The light-curve morphology, with the two maxima of slightly different height and a smooth, continuous variation lacking flat eclipse-like minima, together with the very short period, supports a tentative classification as a High-Amplitude Delta Scuti (HADS) pulsator (DSCT:) (Fig. 1).

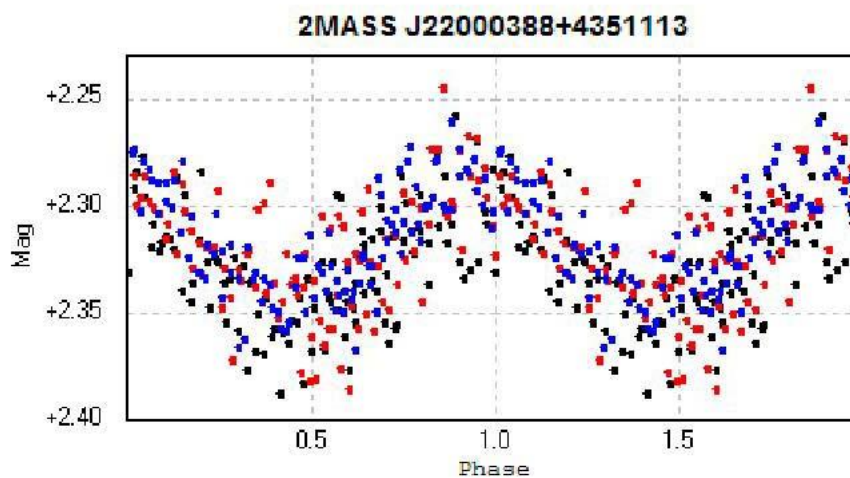


Fig. 1. Phase plot of 2MASS J22000388+4351113 folded on $P = 0.16106$ d.

V2 = 2MASS J22162837+4952131 (000-BMB-228)

Folded on $P = 0.31914$ d, the light curve shows two minima of different depth and continuous out-of-eclipse variation, characteristic of a W UMa-type (EW) contact eclipsing binary. The total peak-to-peak amplitude is about 0.45 mag (clear band). Data were obtained over three consecutive nights (27-29 September 2016), shown with different colours (Figs. 2-3).

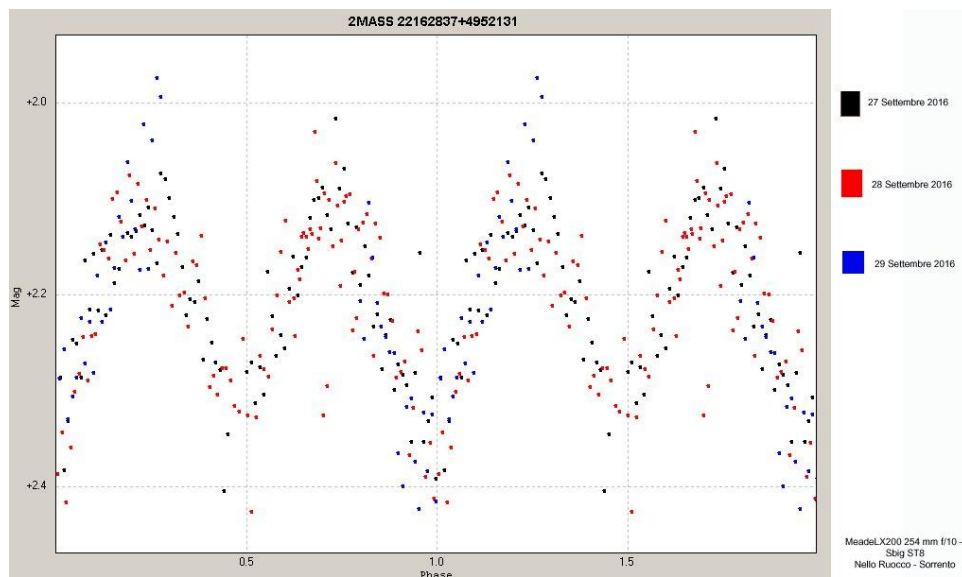


Fig. 2. Phase plot of 2MASS J22162837+4952131 folded on $P = 0.31914$ d.

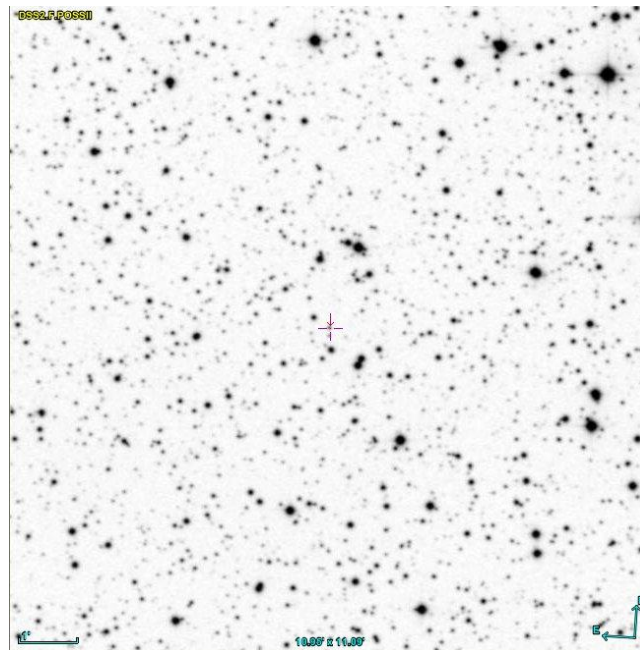


Fig. 3. Finder chart for 2MASS J22162837+4952131 (Aladin, DSS2 red, 10'x11', N up, E left).

V3 = 2MASS J22163381+4952290 (000-BMB-313)

Folded on $P = 0.61075$ d, this star shows a deep, narrow primary minimum and a broad, flat-topped maximum, with a total amplitude of about 0.81 mag (clear band) - one of the deepest in the present sample. The shape of the light curve, with unequal minima and a relatively short orbital period for the observed depth, is consistent with a W UMa-type (EW) contact or near-contact eclipsing binary, although a partially-eclipsing Algol-type (EA) system cannot be excluded without additional multi-colour data. Observations span four nights (27, 28, 29 September and 5 October 2016) (Figs. 4-5).

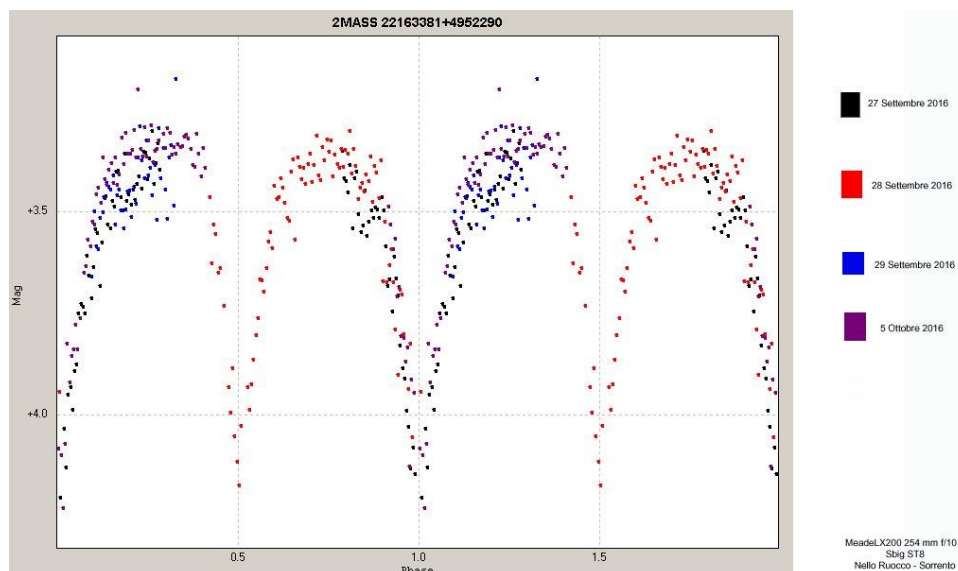


Fig. 4. Phase plot of 2MASS J22163381+4952290 folded on $P = 0.61075$ d.

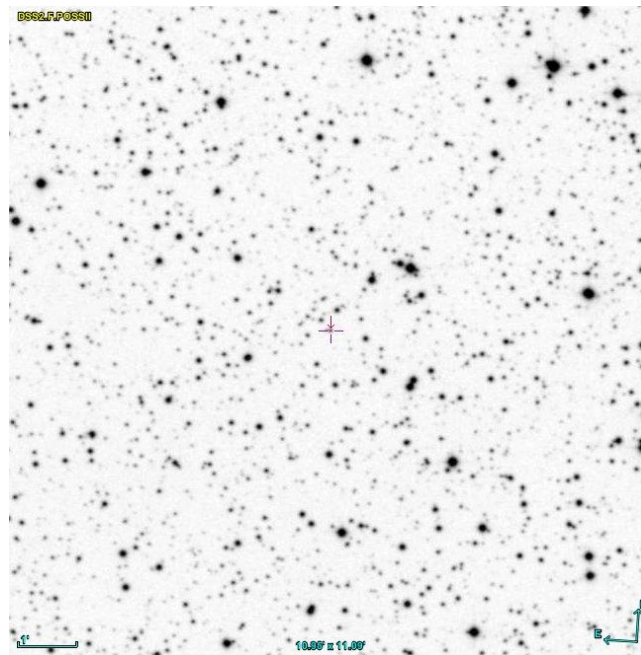


Fig. 5. Finder chart for 2MASS J22163381+4952290 (Aladin, DSS2 red, 10'x11', N up, E left).

V4 = 2MASS J22192946+4416566 (000-BLD-336)

Folded on $P = 0.4338$ d, the light curve shows two broad maxima of similar height separated by a narrower, deeper minimum, with a total amplitude of about 0.4 mag (clear band), typical of a W UMa-type (EW) contact binary. Observations cover three nights (data shown in black, red and blue/violet) (Figs. 6-7).

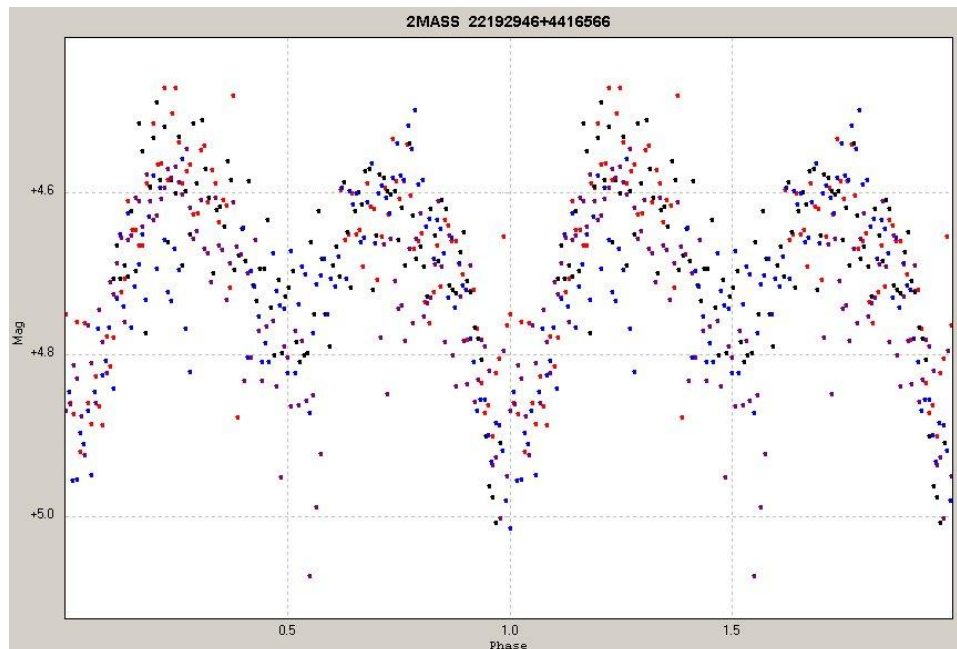


Fig. 6. Phase plot of 2MASS J22192946+4416566 folded on $P = 0.4338$ d.

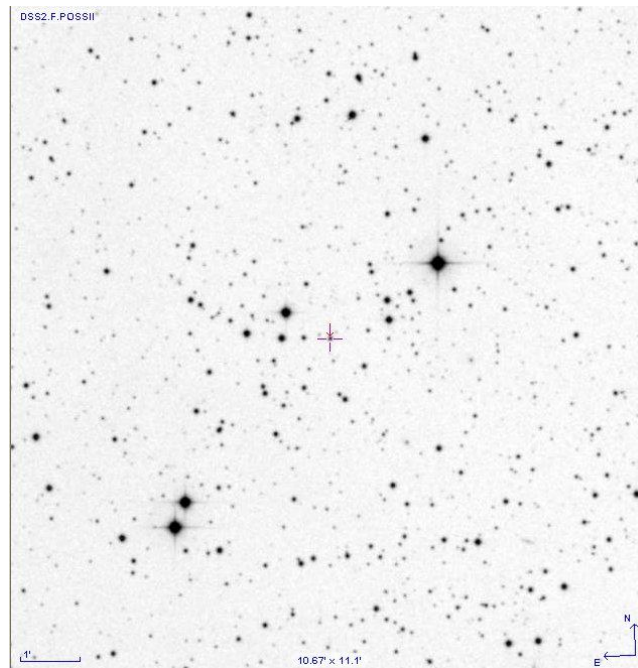


Fig. 7. Finder chart for 2MASS J22192946+4416566 (Aladin, DSS2 red, 10.67'x11.1', N up, E left).
 V5 = 2MASS J22235378+5122249 (000-BMK-621)

Folded on $P = 0.29116$ d, the light curve shows two maxima of comparable height and two minima of different depth, with a total amplitude of about 0.85 mag (clear band), consistent with a W UMa-type (EW) contact eclipsing binary. Observations span four nights (26, 28, 30 and 31 August 2017) (Figs. 8-9).

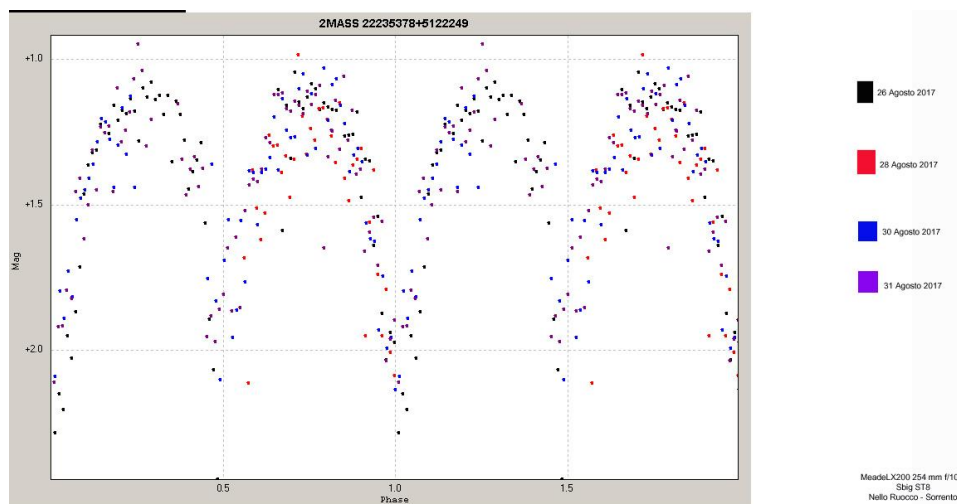


Fig. 8. Phase plot of 2MASS J22235378+5122249 folded on $P = 0.29116$ d.

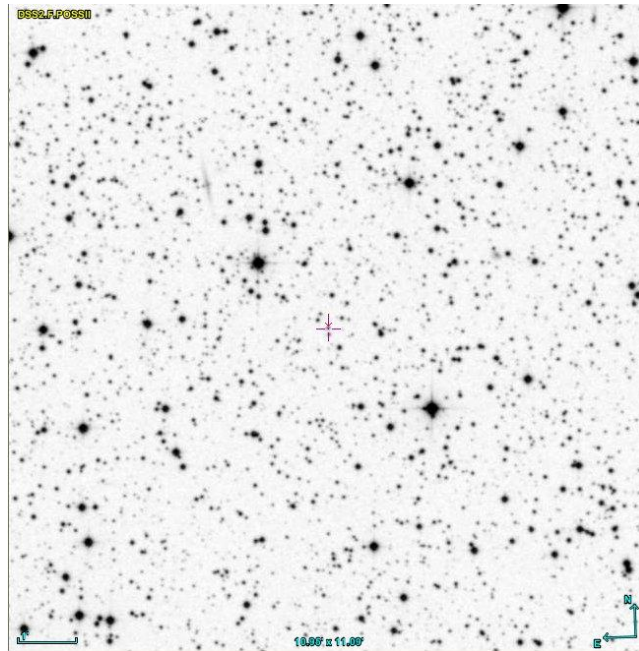


Fig. 9. Finder chart for 2MASS J22235378+5122249 (Aladin, DSS2 red, 10'x11', N up, E left).

V6 = 2MASS J22243032+5126076 (000-BMK-607)

Folded on $P = 0.2995$ d, the light curve shows two maxima of similar height and two minima of slightly different depth, with a total amplitude of about 0.57 mag (clear band), typical of a W UMa-type (EW) contact eclipsing binary. Observations were obtained on two consecutive nights (24-25 August 2016) (Figs. 10-11).

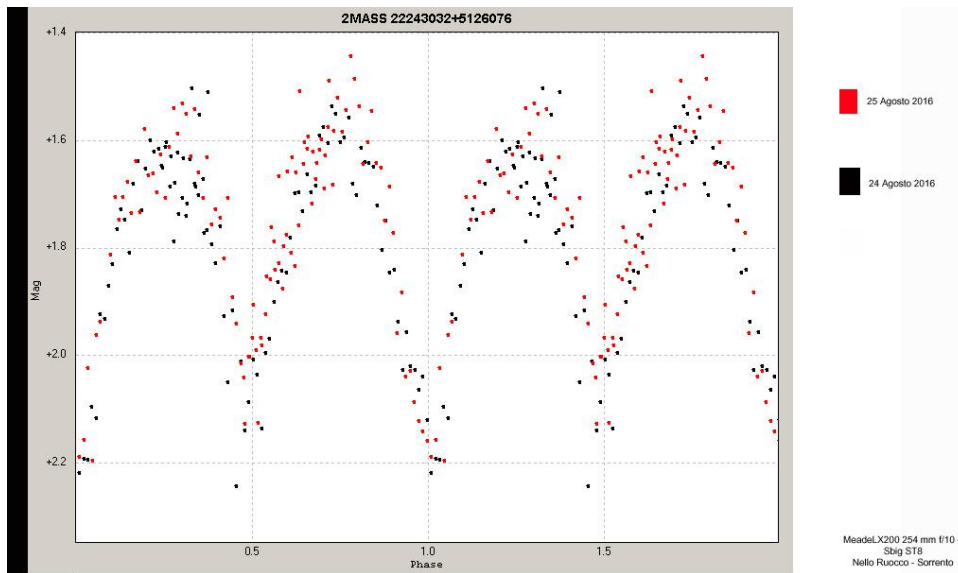


Fig. 10. Phase plot of 2MASS J22243032+5126076 folded on $P = 0.2995$ d.

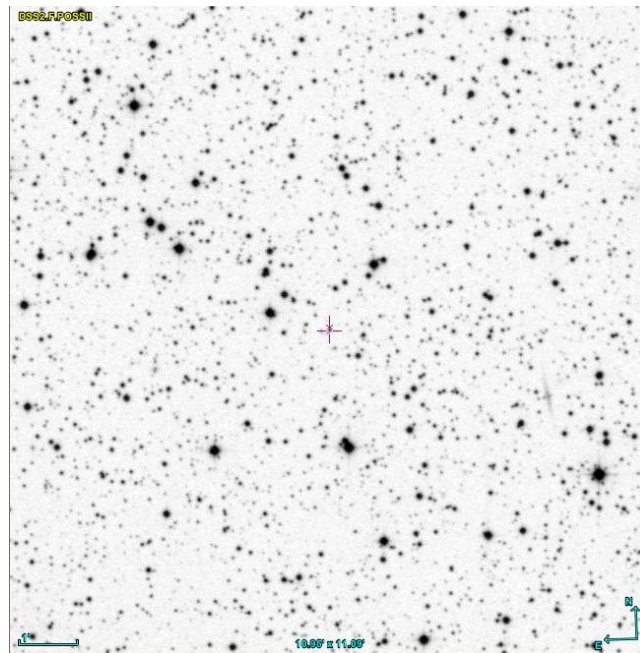


Fig. 11. Finder chart for 2MASS J22243032+5126076 (Aladin, DSS2 red, 10'x11', N up, E left).

V7 = 2MASS J22253540+5118014 (000-BLZ-606)

Folded on $P = 0.86561$ d, the light curve shows a single, relatively narrow and deep minimum (eclipse duration about 18%, or 3.7 h) and a flat, broad maximum, with a total amplitude of about 0.55 mag (clear band). This morphology is consistent with an Algol-type (EA) detached or semi-detached eclipsing binary. Observations span seven nights (25, 27, 28, 30 August, 1, 2, 3 and 6 September 2016) (Figs. 12-13).

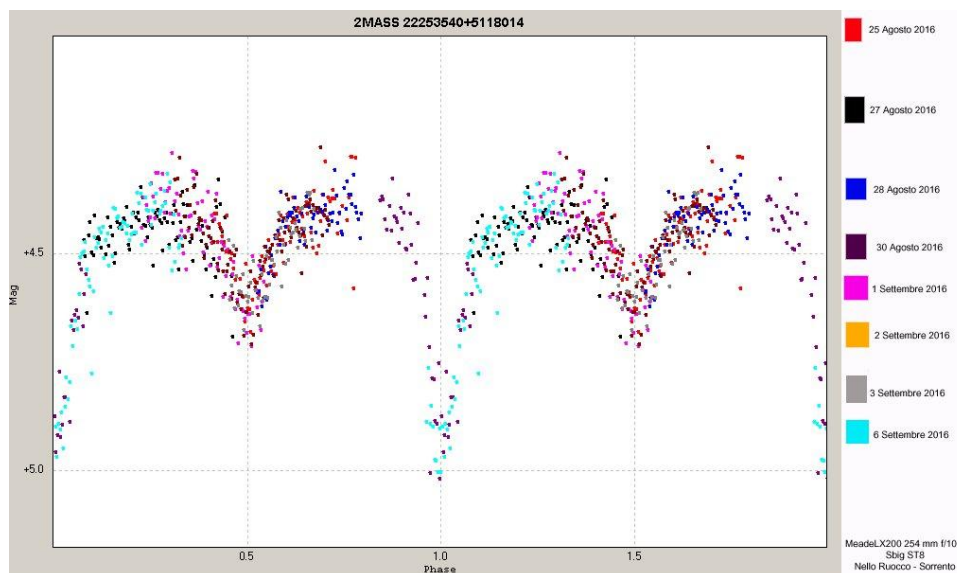


Fig. 12. Phase plot of 2MASS J22253540+5118014 folded on $P = 0.86561$ d.

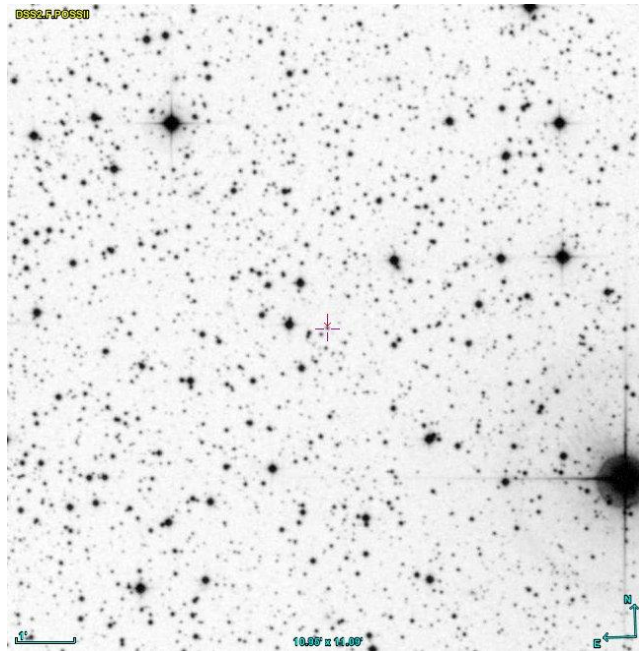


Fig. 13. Finder chart for 2MASS J22253540+5118014 (Aladin, DSS2 red, 10'x14', N up, E left).

V8 = 2MASS J22282227+5228058 (000-BLZ-023)

Folded on $P = 0.36280$ d, the light curve shows two maxima and two minima of different depth, with a total amplitude of about 0.65 mag (clear band), consistent with a W UMa-type (EW) contact eclipsing binary. Observations span seven nights (4, 7, 8, 9, 13, 14 and 15 August 2016) (Figs. 14-15).

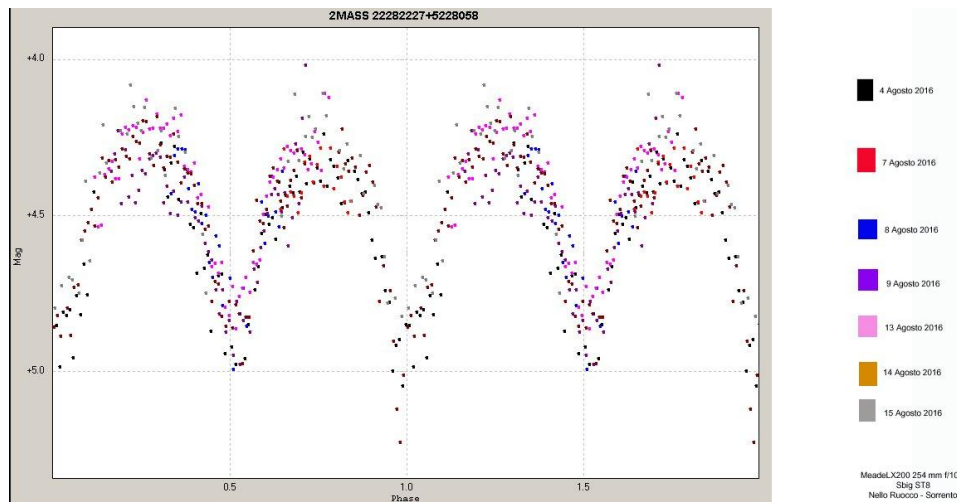


Fig. 14. Phase plot of 2MASS J22282227+5228058 folded on $P = 0.36280$ d.

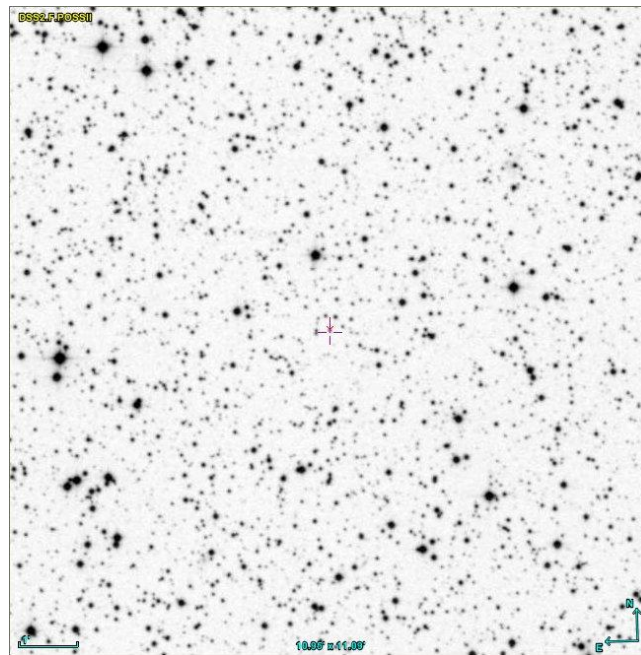


Fig. 15. Finder chart for 2MASS J22282227+5228058 (Aladin, DSS2 red, 10'x11', N up, E left).

V9 = 2MASS J22293014+5231171 (000-BMK-300)

Folded on $P = 0.3887$ d, the light curve shows two maxima of similar height and two minima of different depth, with a total amplitude of about 0.48 mag (clear band), consistent with a W UMa-type (EW) contact eclipsing binary. Observations were obtained on two consecutive nights (13-14 August 2016) (Figs. 16-17).

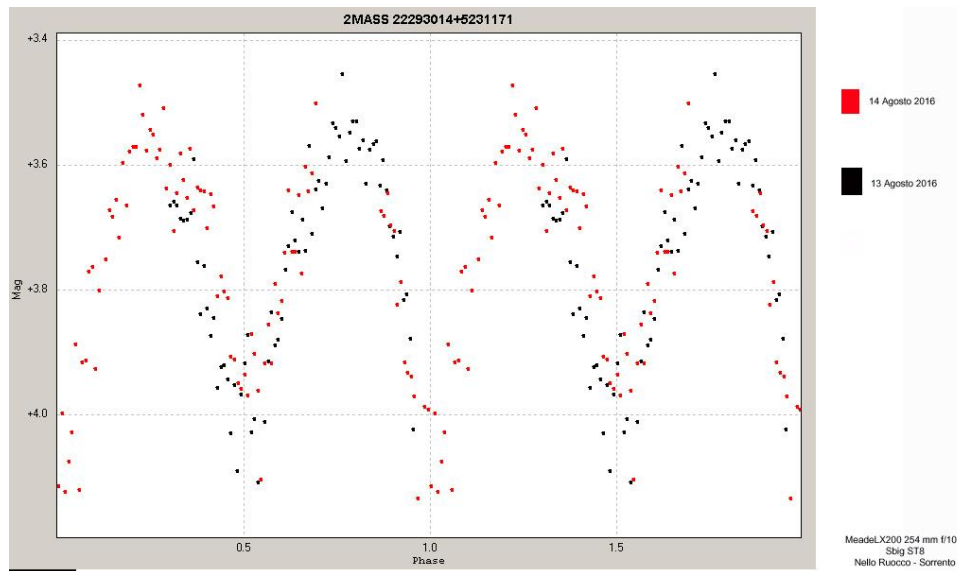


Fig. 16. Phase plot of 2MASS J22293014+5231171 folded on $P = 0.3887$ d.

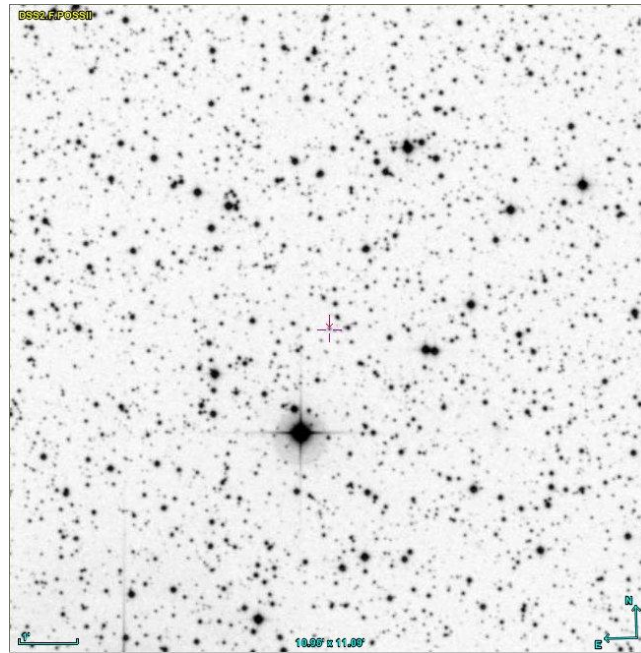


Fig. 17. Finder chart for 2MASS J22293014+5231171 (Aladin, DSS2 red, 10'x11', N up, E left).

V10 = 2MASS J22331661+5038561 (000-BKG-542)

Folded on $P = 0.3128$ d, the light curve shows two maxima of similar height and two minima of slightly different depth, with a total amplitude of about 0.3 mag (clear band), consistent with a W UMa-type (EW) contact eclipsing binary. Observations were obtained over two nights (Fig. 18).

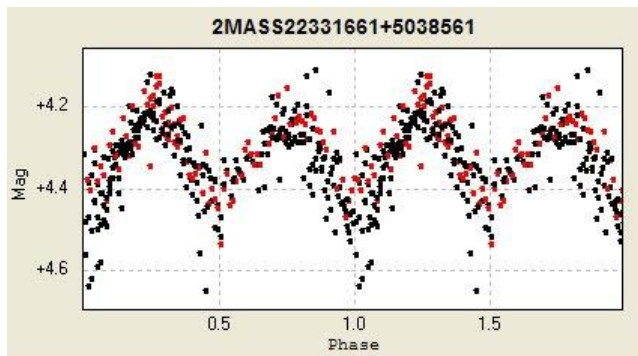


Fig. 18. Phase plot of 2MASS J22331661+5038561 folded on $P = 0.3128$ d.

V11 = 2MASS J22333278+5040263 (000-BML-573)

Folded on $P = 0.2509$ d, the light curve shows two maxima of similar height and deep, narrow minima, with a total amplitude of about 1.0 mag (clear band) - the largest of the present sample. The shape and amplitude are consistent with a W UMa-type (EW) contact eclipsing binary. Observations span three nights (7, 8 and 11 October 2017) (Figs. 19-20).

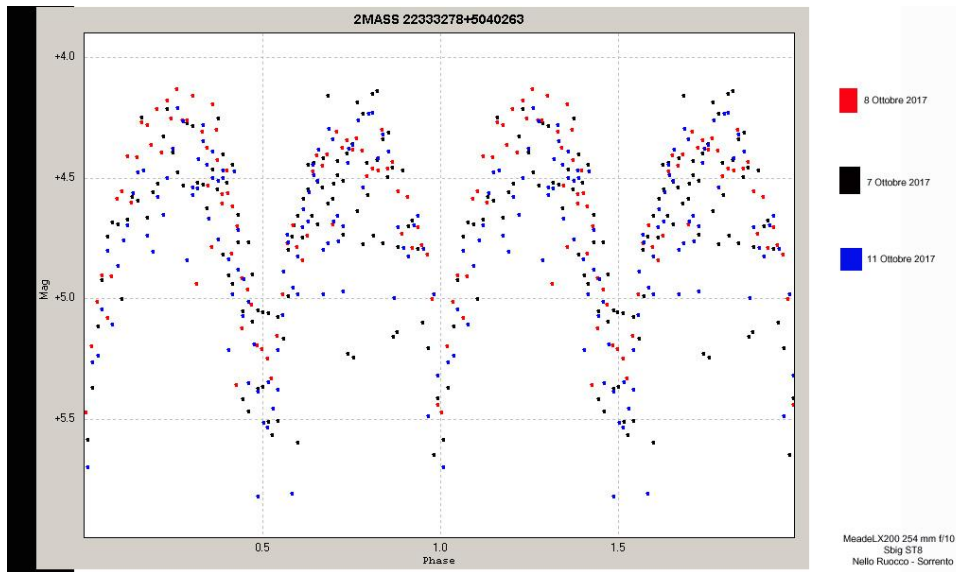


Fig. 19. Phase plot of 2MASS J22333278+5040263 folded on $P = 0.2509$ d.

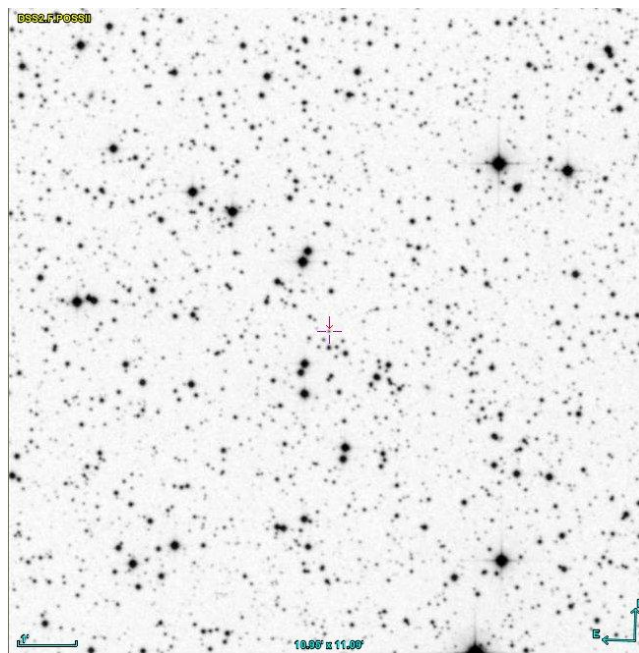


Fig. 20. Finder chart for 2MASS J22333278+5040263 (Aladin, DSS2 red, $10 \times 11'$, N up, E left).

V12 = 2MASS J22335381+5043227 (000-BKG-521)

Folded on $P = 0.4409$ d, the light curve shows two broad, rounded maxima of similar height and two minima of comparable depth, with a total amplitude of about 0.7 mag (clear band), consistent with a W UMa-type (EW) contact eclipsing binary. Observations were obtained over two nights (Fig. 21).

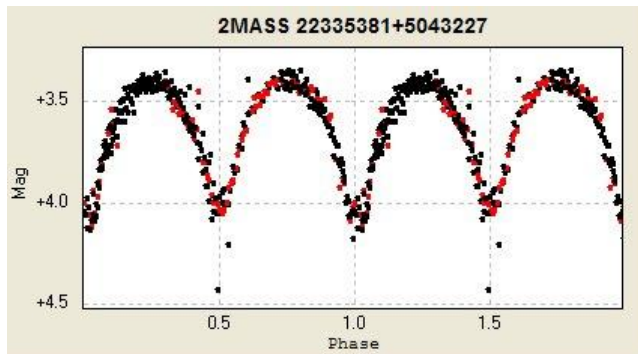


Fig. 21. Phase plot of 2MASS J22335381+5043227 folded on $P = 0.4409$ d.

V13 = 2MASS J22422253+5057575 (000-BKG-492)

Folded on $P = 0.4428$ d, the light curve shows a broad, double-humped maximum and two minima of similar depth, with a total amplitude of about 0.4 mag (clear band), consistent with a W UMa-type (EW) contact eclipsing binary. Observations were obtained over multiple nights (Fig. 22).

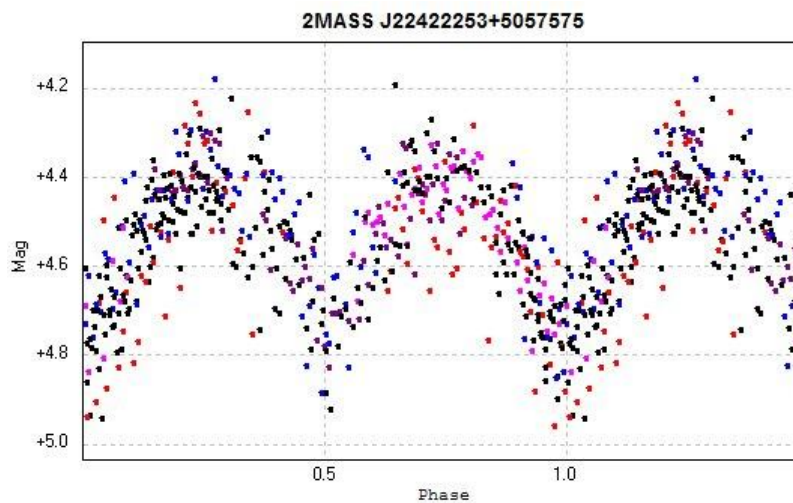


Fig. 22. Phase plot of 2MASS J22422253+5057575 folded on $P = 0.4428$ d.

V14 = 2MASS J22425519+5059043 (000-BKG-519)

Folded on $P = 0.5228$ d, the light curve shows two maxima of different height and two minima of different depth, with a total amplitude of about 0.3 mag (clear band). The asymmetric maxima and the relatively flat-bottomed minima support a classification as a beta Lyrae-type (EB) eclipsing binary. Observations were obtained over multiple nights (Fig. 23).

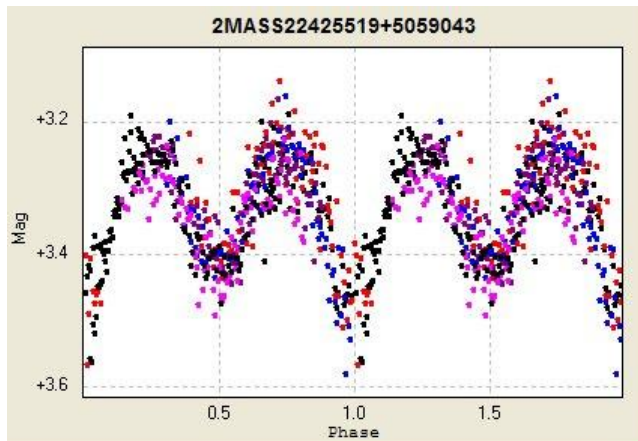


Fig. 23. Phase plot of 2MASS J22425519+5059043 folded on $P = 0.5228$ d.

V15 = 2MASS J22432320+5056006 (000-BKG-540)

Folded on $P = 0.3252$ d, the light curve shows two maxima of similar height and two minima of different depth, with a total amplitude of about 0.6 mag (clear band), consistent with a W UMa-type (EW) contact eclipsing binary. Observations were obtained over multiple nights (Fig. 24).

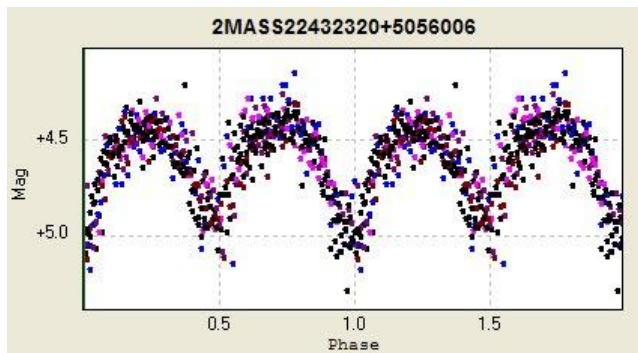


Fig. 24. Phase plot of 2MASS J22432320+5056006 folded on $P = 0.3252$ d.

V16 = GSC 03632-02808 (000-BLS-087)

Folded on $P = 1.07022$ d, the light curve shows a deep (0.64 mag), narrow primary minimum (eclipse duration about 14%, or 3.6 h) and a shallower secondary minimum, separated by a long, flat-bottomed maximum. This morphology, together with the relatively long period, is consistent with a well-detached Algol-type (EA) eclipsing binary. Observations span eight nights (27, 29, 30 August, 1, 2, 3, 8 and 11 September 2015) (Figs. 25-26).

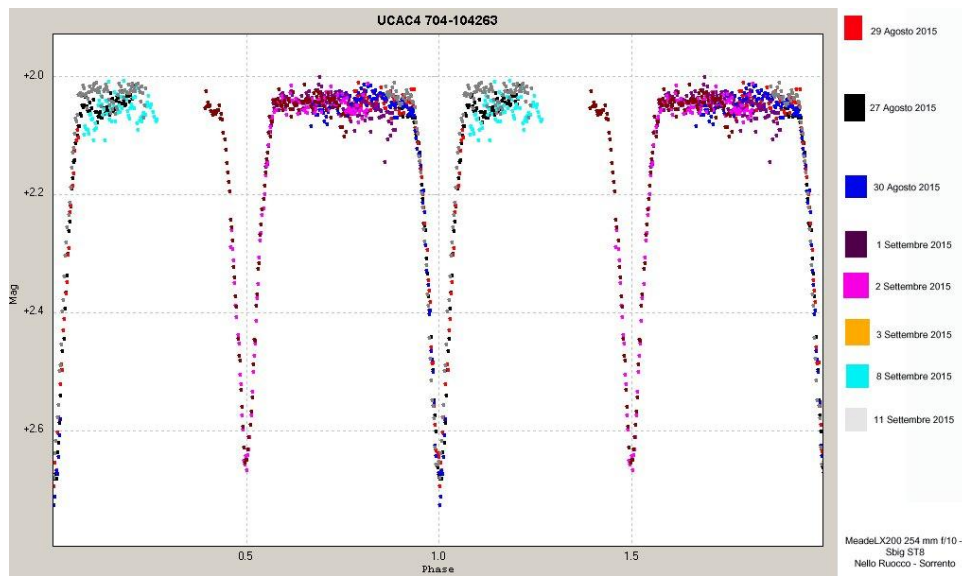


Fig. 25. Phase plot of GSC 03632-02808 (UCAC4 704-104263) folded on $P = 1.07022$ d.

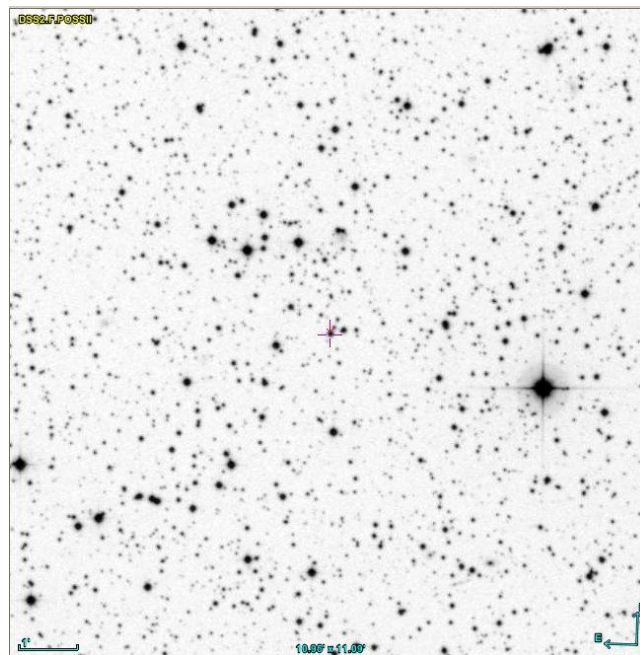


Fig. 26. Finder chart for GSC 03632-02808 (Aladin, DSS2 red, 10'x11', N up, E left).

V17 = UCAC4 689-111349 (000-BMK-299)

Folded on $P = 0.099548$ d (2.39 h), the light curve shows a smooth, single-humped sinusoidal variation with a total amplitude of about 0.10 mag (clear band). The very short period and the symmetric, continuous shape (with no flat minima) are consistent with a High-Amplitude Delta Scuti (HADS) pulsator, and the star is tentatively classified as DSCT:. Observations span three nights (1, 2 and 3 August 2017) (Figs. 27-28).

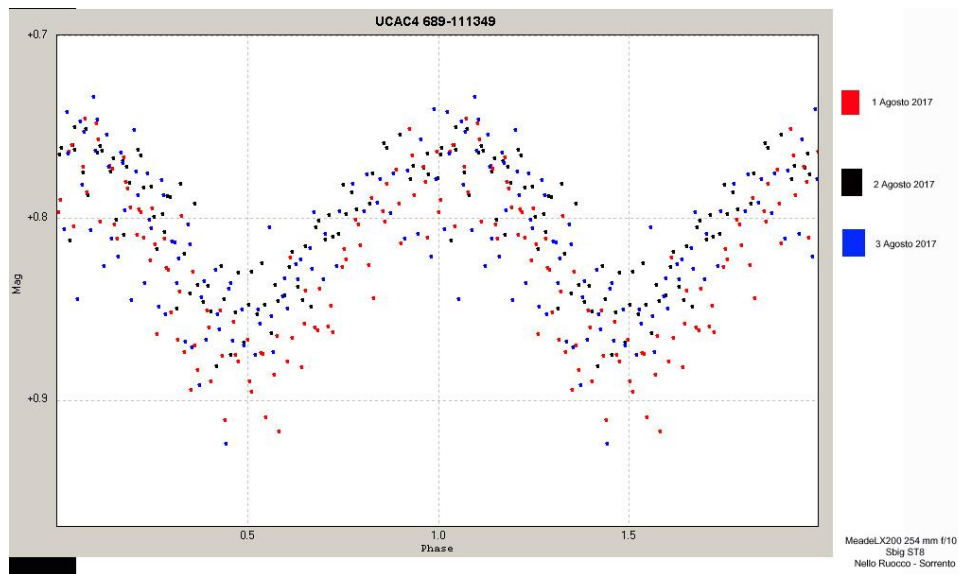


Fig. 27. Phase plot of UCAC4 689-111349 folded on $P = 0.099548$ d.

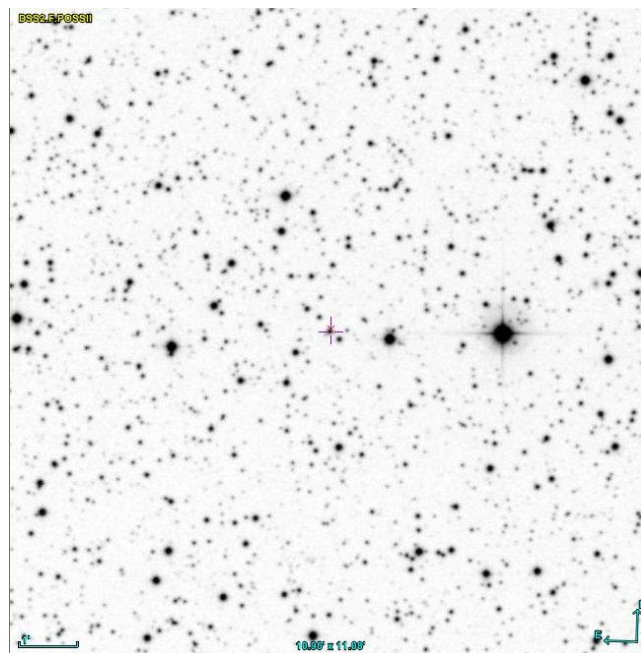


Fig. 28. Finder chart for UCAC4 689-111349 (Aladin, DSS2 red, $10' \times 11'$, N up, E left).

V18 = UCAC4 700-108110 (000-BMB-311)

Folded on $P = 0.47037$ d, the light curve shows two maxima of similar height and two minima of similar depth, with a total amplitude of about 0.19 mag (clear band), consistent with a W UMa-type (EW) contact eclipsing binary. Observations span five nights (14, 27, 28, 29 September and 5 October 2016) (Figs. 29-30).

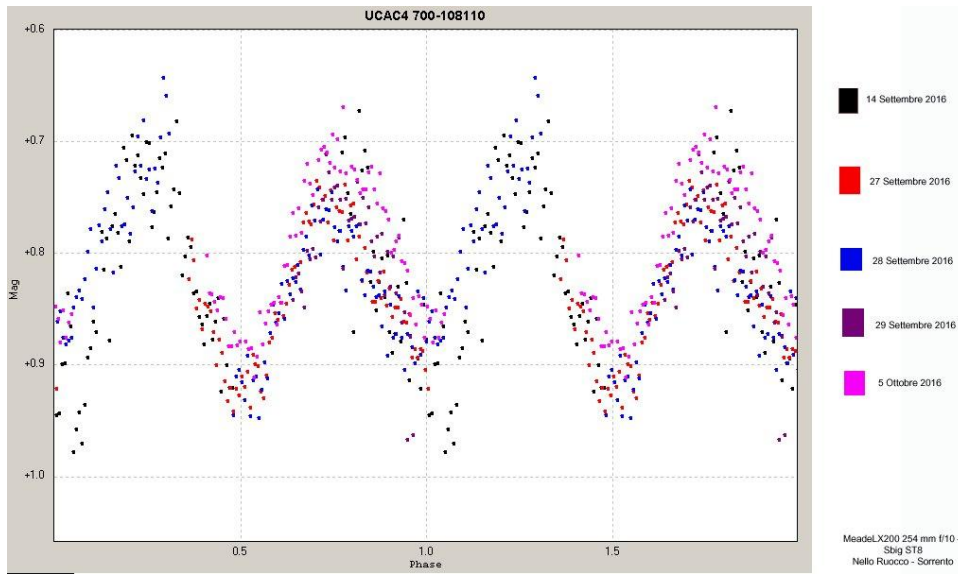


Fig. 29. Phase plot of UCAC4 700-108110 folded on $P = 0.47037$ d.

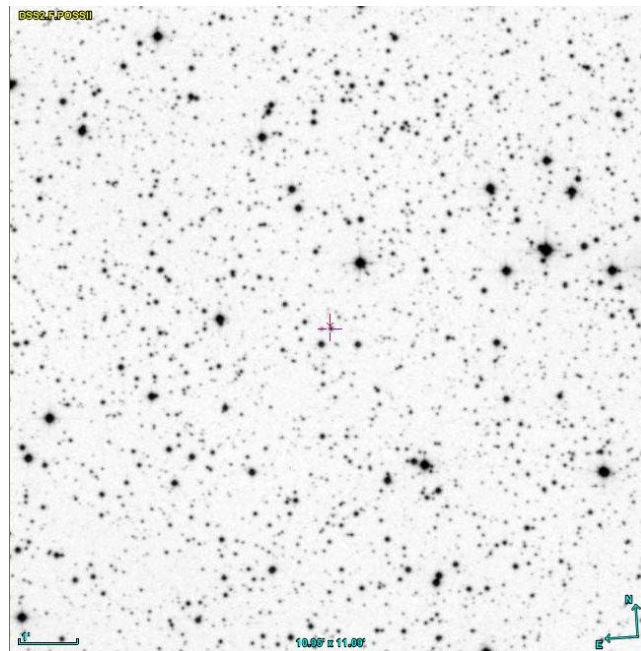


Fig. 30. Finder chart for UCAC4 700-108110 (Aladin, DSS2 red, 10'x11', N up, E left).

V19 = UCAC4 700-108268 (000-BLZ-643)

Folded on $P = 0.30660$ d, the light curve shows two maxima of similar height and two minima of similar depth, with a total amplitude of about 0.28 mag (clear band), consistent with a W UMa-type (EW) contact eclipsing binary. Observations were obtained on two consecutive nights (13-14 September 2016) (Figs. 31-32).

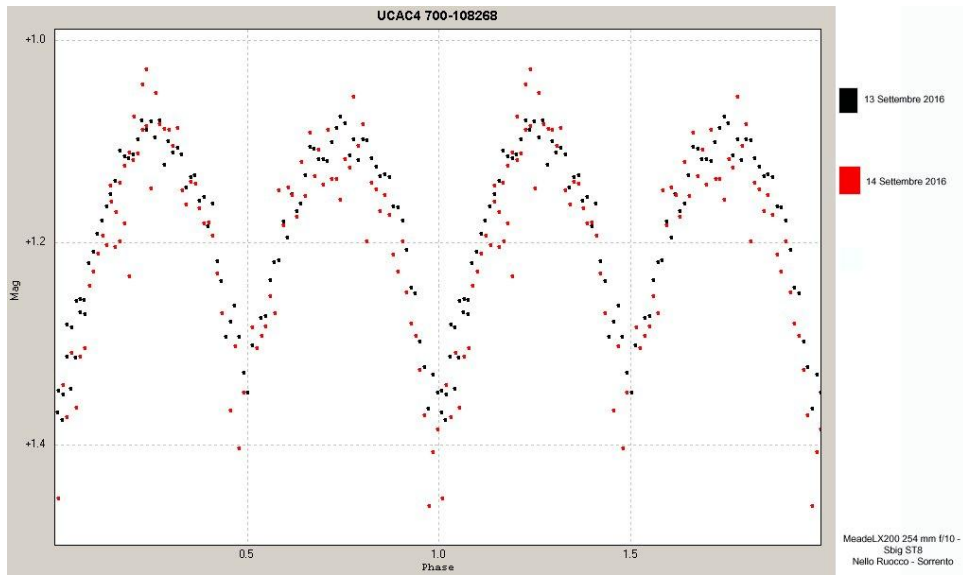


Fig. 31. Phase plot of UCAC4 700-108268 folded on $P = 0.30660$ d.

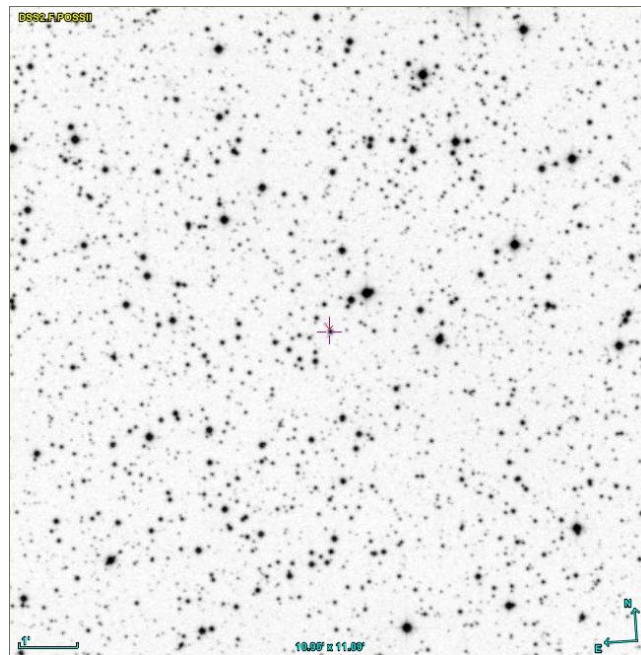


Fig. 32. Finder chart for UCAC4 700-108268 (Aladin, DSS2 red, 10'x11', N up, E left).

V20 = UCAC4 705-104781 (000-BLS-229)

Folded on $P = 0.67587$ d, the light curve shows two maxima of similar height and two minima of slightly different depth, with a total amplitude of about 0.41 mag (clear band), consistent with a W UMa-type (EW) contact eclipsing binary. Observations span six nights (12, 13, 15, 17, 18 and 19 August 2015) (Figs. 33-34).

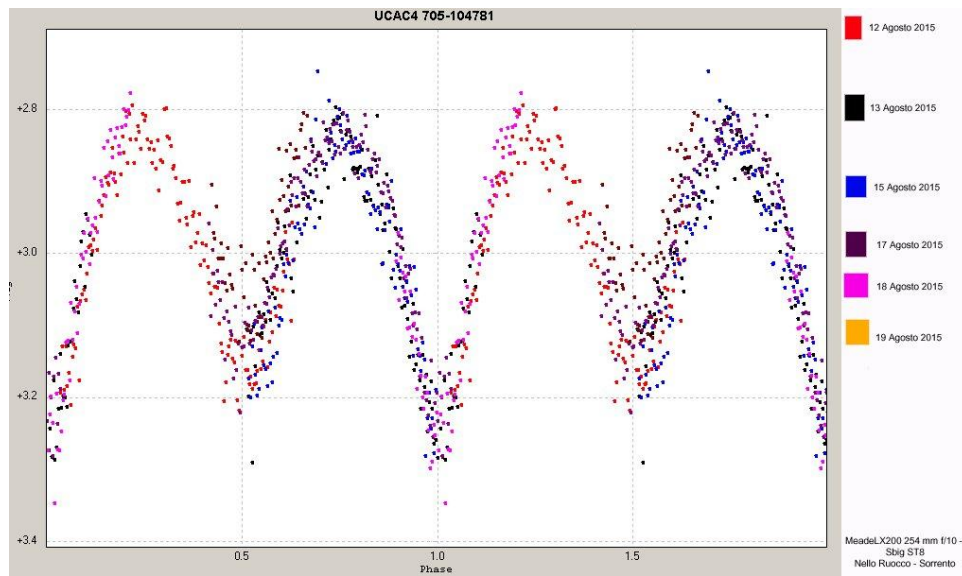


Fig. 33. Phase plot of UCAC4 705-104781 folded on $P = 0.67587$ d.

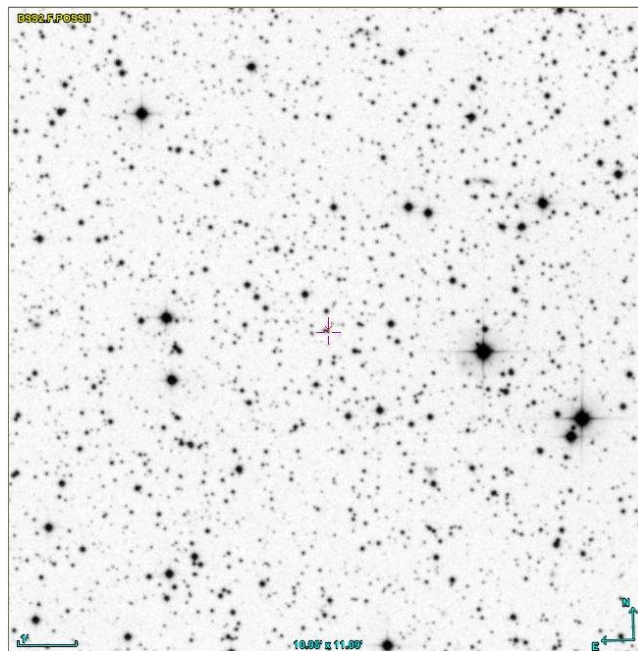


Fig. 34. Finder chart for UCAC4 705-104781 (Aladin, DSS2 red, $10' \times 11'$, N up, E left).

V21 = UCAC4 705-104975 (000-BLS-498)

Folded on $P = 0.91107$ d, the light curve shows a flat, nearly constant maximum and a single, deep and relatively narrow minimum (eclipse duration about 19%, or 4.2 h), with a total amplitude of about 0.49 mag (clear band), consistent with an Algol-type (EA) detached eclipsing binary. A 17th-magnitude companion located 3 arcsec to the SW is blended with the target in the present photometry; the reported magnitude and amplitude refer to the blended light. Observations span seven nights (3, 8, 11, 13, 15, 17 September and 12 October 2015) (Figs. 35-36).

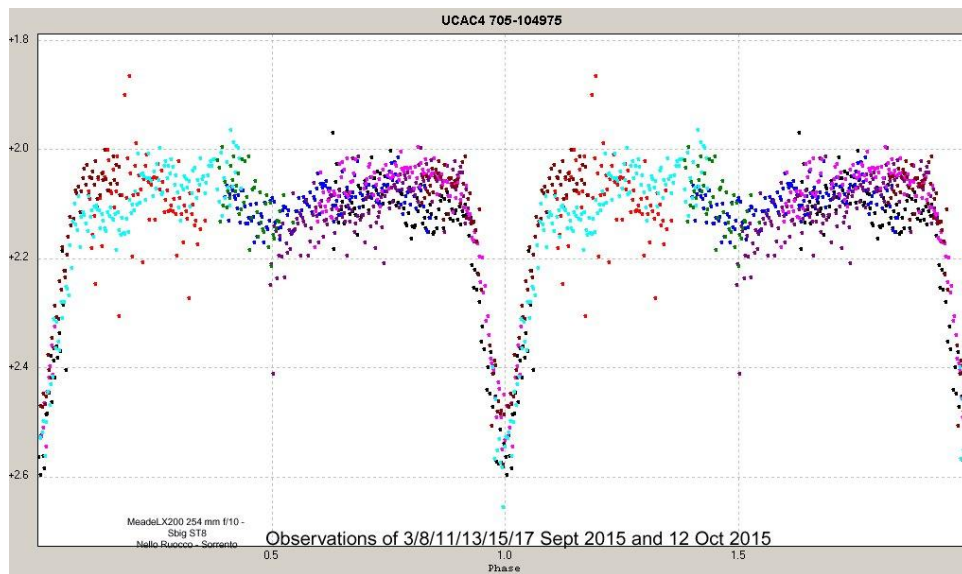


Fig. 35. Phase plot of UCAC4 705-104975 folded on $P = 0.91107$ d.

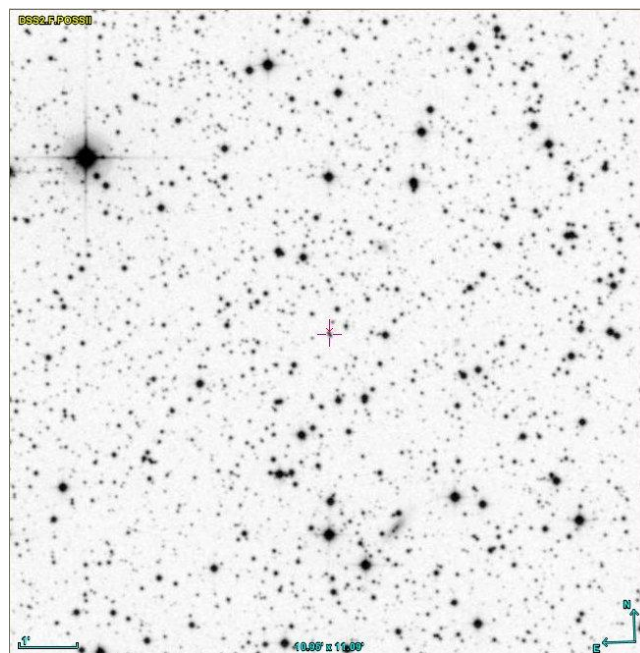


Fig. 36. Finder chart for UCAC4 705-104975 (Aladin, DSS2 red, 10'x11', N up, E left).

V22 = UCAC4 705-105013 (000-BLS-098)

Folded on $P = 0.5350$ d, the light curve shows two maxima of different height and a single deep, narrow minimum, with a total amplitude of about 0.59 mag (clear band). The pronounced asymmetry between the two maxima and the narrow, deep minimum support a classification as a beta Lyrae-type (EB) eclipsing binary. Observations span three nights (12, 13 and 15 September 2015) (Figs. 37-38).

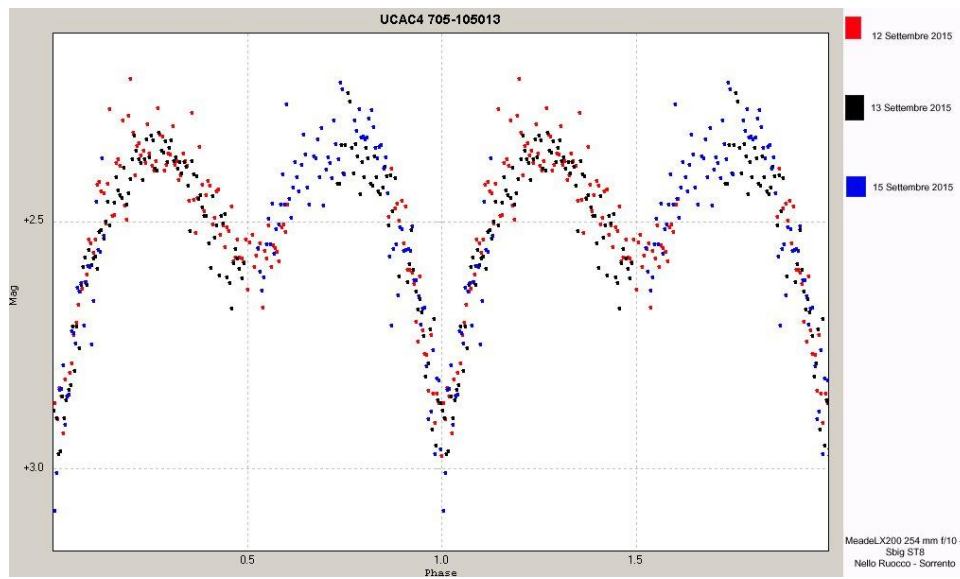


Fig. 37. Phase plot of UCAC4 705-105013 folded on $P = 0.5350$ d.

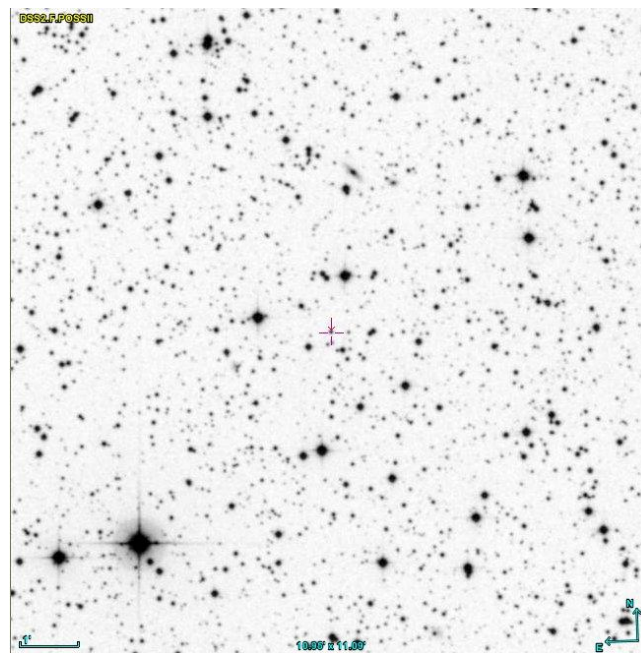


Fig. 38. Finder chart for UCAC4 705-105013 (Aladin, DSS2 red, $10' \times 11'$, N up, E left).

V23 = UCAC4 706-105719 (000-BMK-187)

Folded on $P = 0.28407$ d, the light curve shows two maxima of similar height and two minima of slightly different depth, with a total amplitude of about 0.42 mag (clear band), consistent with a W UMa-type (EW) contact eclipsing binary. Observations were obtained on two consecutive nights (30-31 July 2017) (Figs. 39-40).

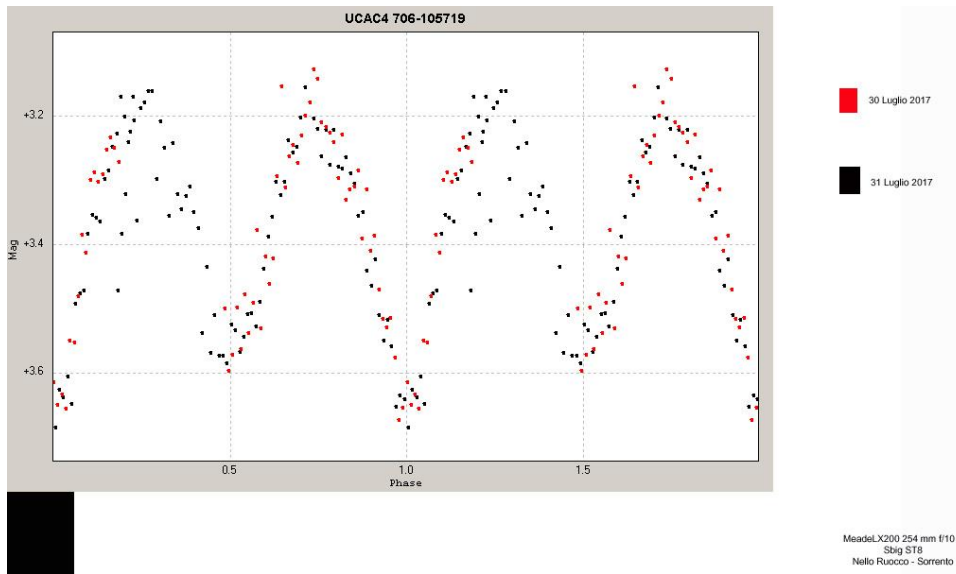


Fig. 39. Phase plot of UCAC4 706-105719 folded on $P = 0.28407$ d.

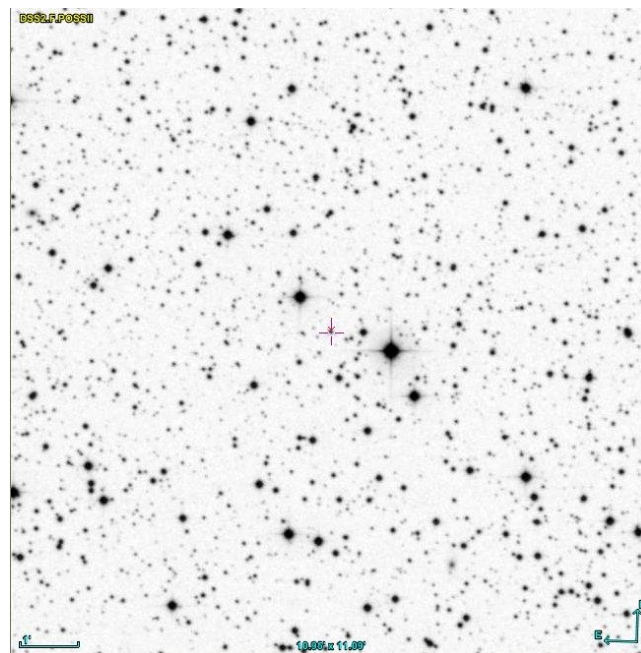


Fig. 40. Finder chart for UCAC4 706-105719 (Aladin, DSS2 red, 10'x11', N up, E left).

V24 = UCAC4 706-105733 (000-BMK-298)

Folded on $P = 0.2800$ d, the light curve shows a single broad maximum and a single deep, narrow minimum per cycle, with a total amplitude of about 0.65 mag (clear band). This morphology is classified as W UMa-type (EW) in VSX; the relatively narrow and deep minimum compared to the broad maximum may also be consistent with a near-contact or semi-detached configuration. Observations were obtained on two consecutive nights (30-31 July 2017) (Figs. 41-42).

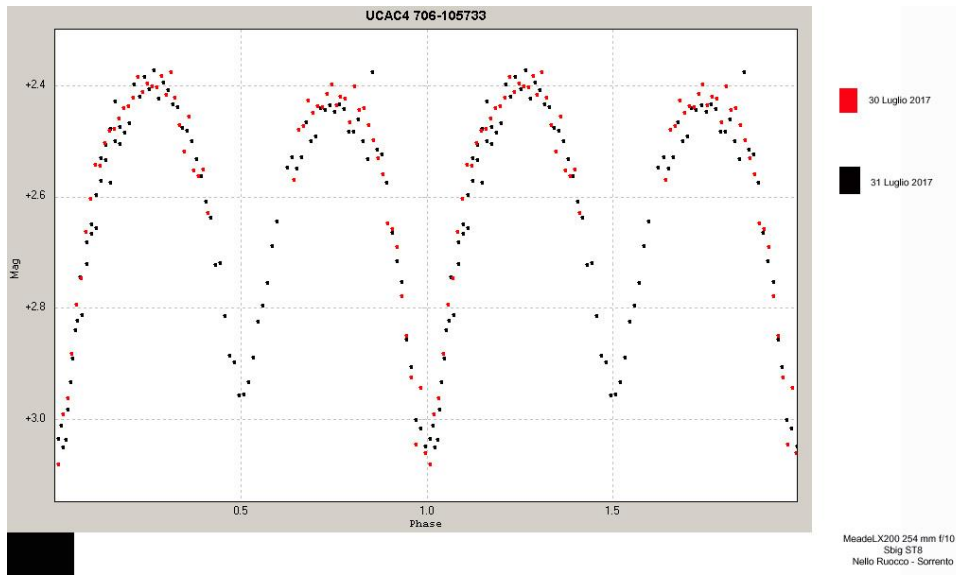


Fig. 41. Phase plot of UCAC4 706-105733 folded on $P = 0.2800$ d.

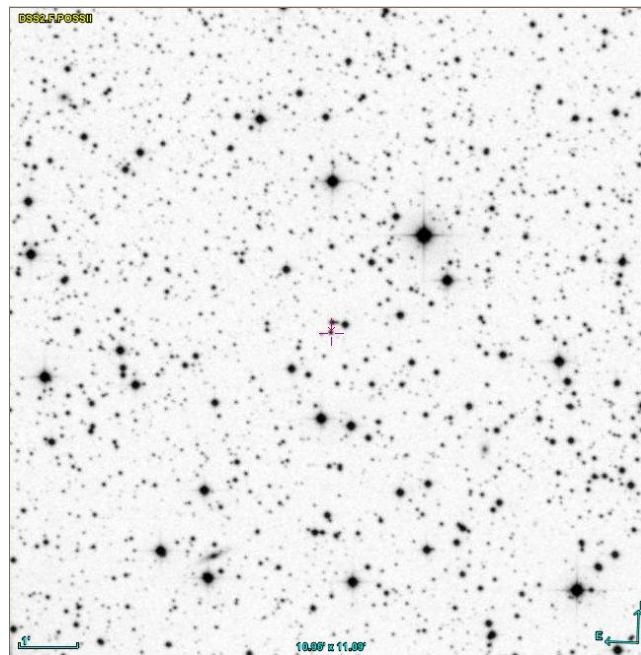


Fig. 42. Finder chart for UCAC4 706-105733 (Aladin, DSS2 red, 10'x11', N up, E left).

V25 = UCAC4 707-100174 (000-BMW-034)

Folded on $P = 1.824987$ d, the light curve shows two narrow, well-separated eclipses of similar depth (eclipse duration about 13%, or 5.69 h) superimposed on a flat out-of-eclipse level, with a total range of 14.81-15.24 V. This morphology is consistent with a well-detached Algol-type (EA) eclipsing binary. The phase plot combines data from the present survey (red) with public ASAS-SN photometry (black; Kochanek et al. 2017), which together well constrain the period (Figs. 43-44).

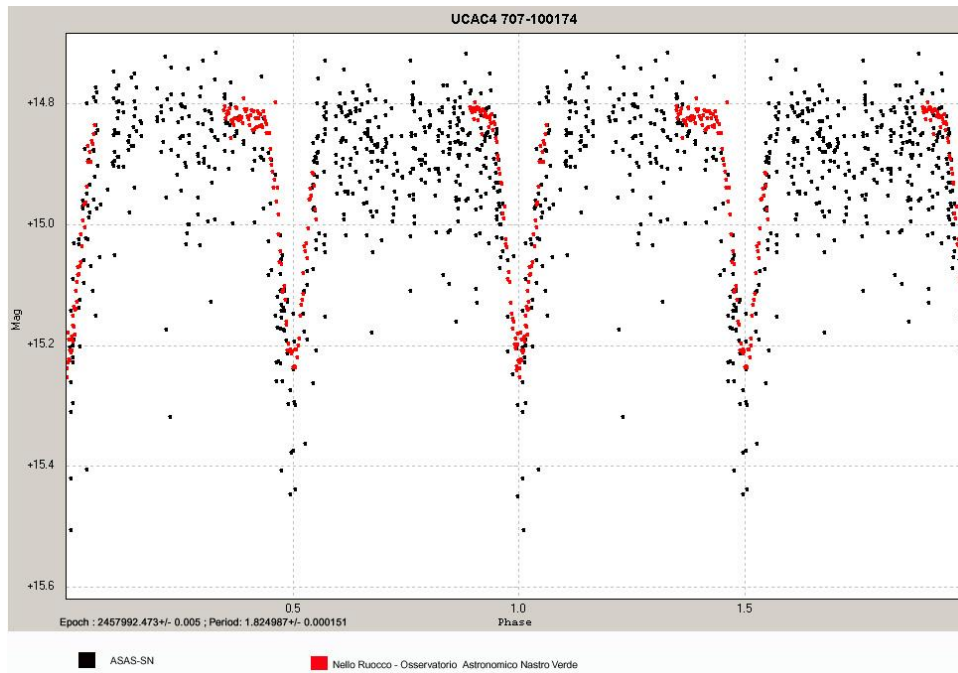


Fig. 43. Phase plot of UCAC4 707-100174 folded on $P = 1.824987$ d (red: this work; black: ASAS-SN).

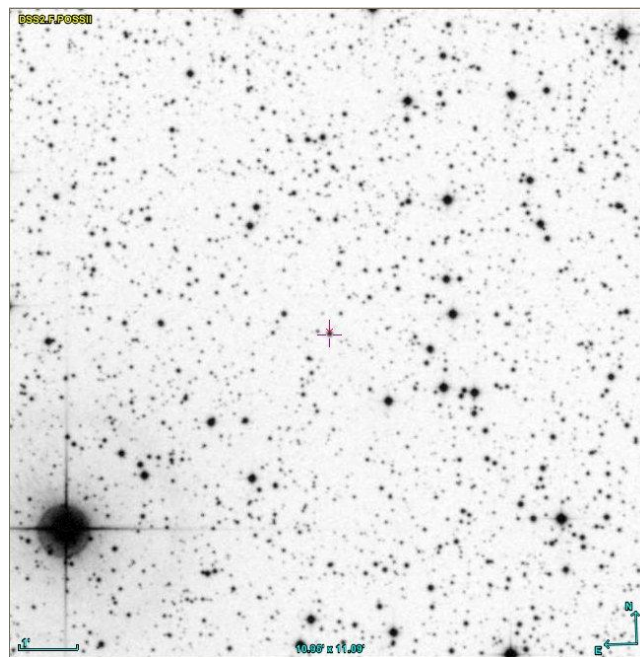


Fig. 44. Finder chart for UCAC4 707-100174 (Aladin, DSS2 red, 10'x11', N up, E left).

V26 = UCAC4 707-100327 (000-BLZ-605)

Folded on $P = 0.66609$ d, the light curve shows a flat out-of-eclipse level and two deep, narrow minima of similar depth (eclipse duration about 19%, or 3.0 h), with a total amplitude of about 0.85 mag (clear band), consistent with a well-detached Algol-type (EA) eclipsing binary. Observations span seven nights (25, 27, 28, 30 August, 1, 2 and 6 September 2016) (Figs. 45-46).

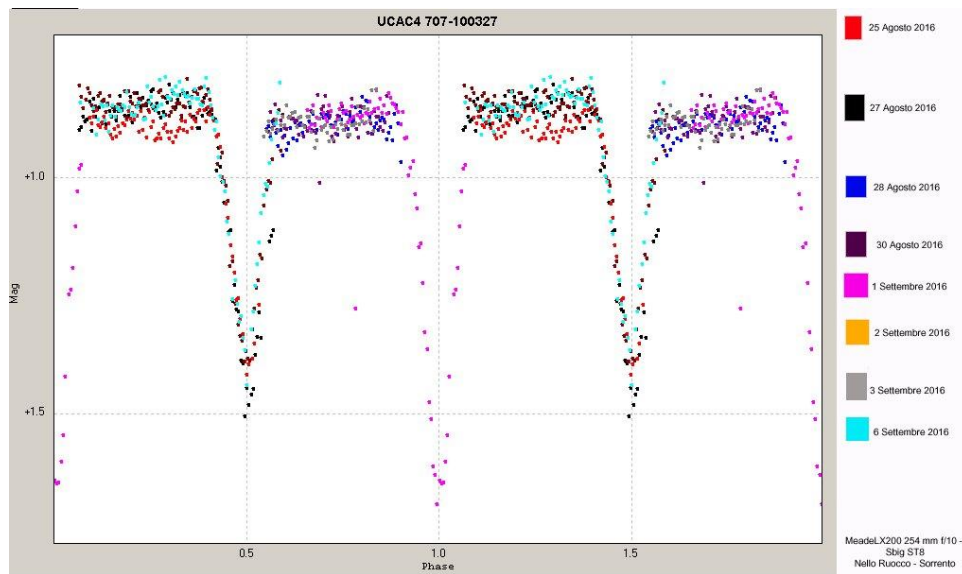


Fig. 45. Phase plot of UCAC4 707-100327 folded on $P = 0.66609$ d.

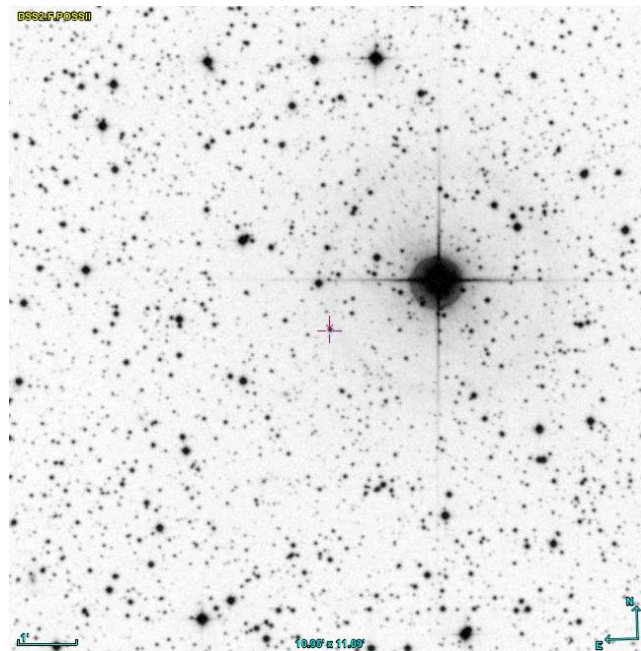


Fig. 46. Finder chart for UCAC4 707-100327 (Aladin, DSS2 red, 10'x11', N up, E left).

V27 = UCAC4 707-100455 (000-BLZ-600)

Folded on $P = 0.47295$ d, the light curve shows two broad, rounded maxima of similar height and a single, deeper minimum per cycle, with a total amplitude of about 0.30 mag (clear band). The continuous variation and the relative depths support a classification as a beta Lyrae-type (EB) eclipsing binary. Observations span seven nights (25, 27, 28, 30 August, 1, 2 and 6 September 2016) (Figs. 47-48).

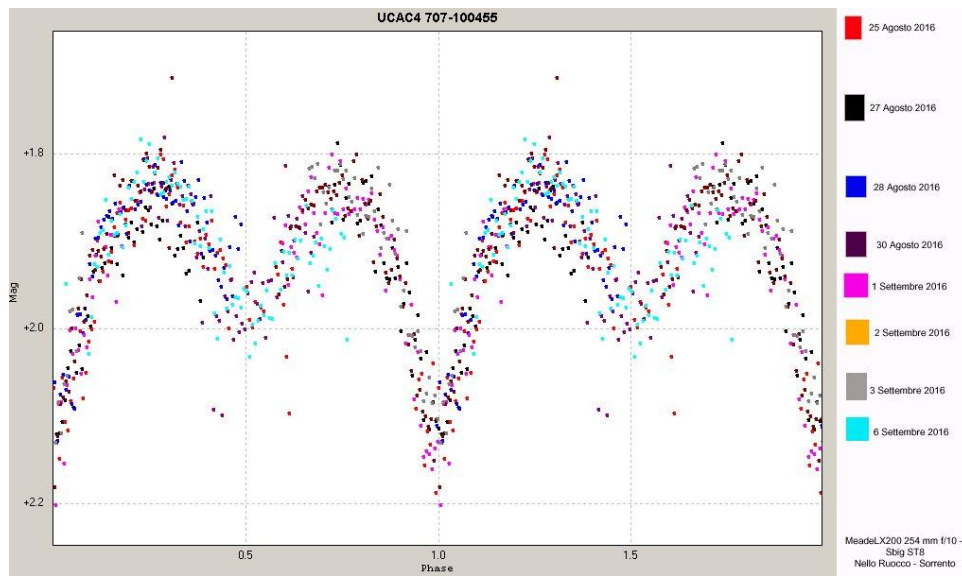


Fig. 47. Phase plot of UCAC4 707-100455 folded on $P = 0.47295$ d.

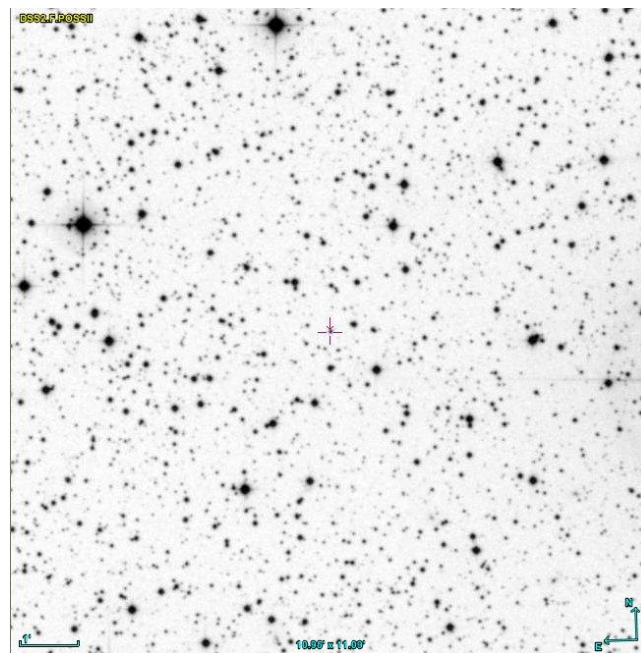


Fig. 48. Finder chart for UCAC4 707-100455 (Aladin, DSS2 red, 10'x11', N up, E left).

V28 = UCAC4 707-100598 (000-BMY-147)

Folded on $P = 1.958047$ d, the light curve shows a flat out-of-eclipse level and narrow, deep eclipses (eclipse duration about 10%, or 4.70 h), with a total range of 15.54-16.04 V, consistent with a well-detached Algol-type (EA) eclipsing binary. As for V25, the phase plot combines the present survey data (red) with public ASAS-SN photometry (black; Kochanek et al. 2017); the ASAS-SN magnitudes were found to be contaminated by several nearby stars, and the reported magnitude range has been corrected accordingly (Figs. 49-50).

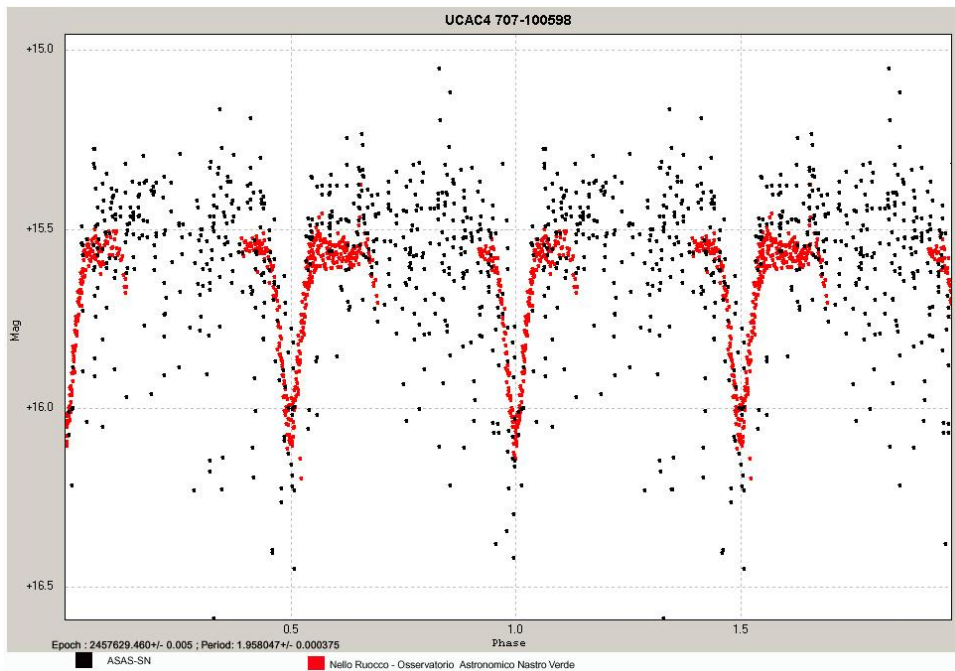


Fig. 49. Phase plot of UCAC4 707-100598 folded on $P = 1.958047$ d (red: this work; black: ASAS-SN).

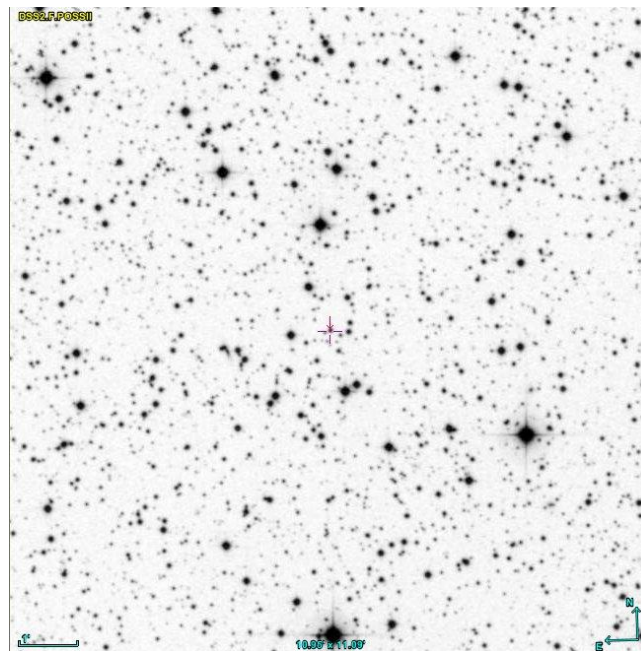


Fig. 50. Finder chart for UCAC4 707-100598 (Aladin, DSS2 red, 10'x11', N up, E left).

V29 = UCAC4 708-103075 (000-BML-632)

Folded on $P = 0.7772$ d, the light curve shows two maxima of similar height and two minima of slightly different depth, with a total amplitude of about 0.15 mag (clear band), consistent with a W UMa-type (EW) contact eclipsing binary. At $V = 13.32$, this is the brightest target in the present sample. Observations span five nights (15, 17, 18, 19 and 20 October 2017) (Figs. 51-52).

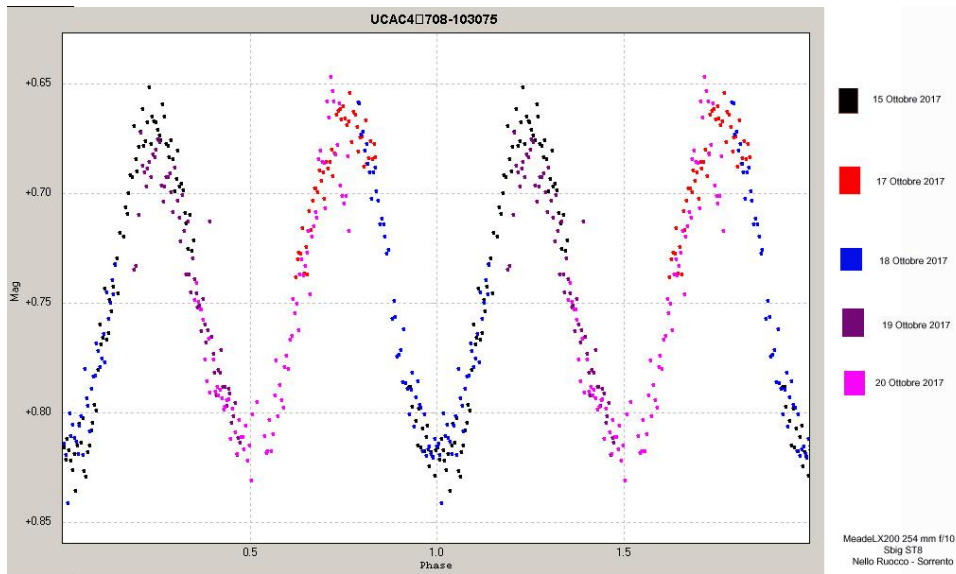


Fig. 51. Phase plot of UCAC4 708-103075 folded on $P = 0.7772$ d.

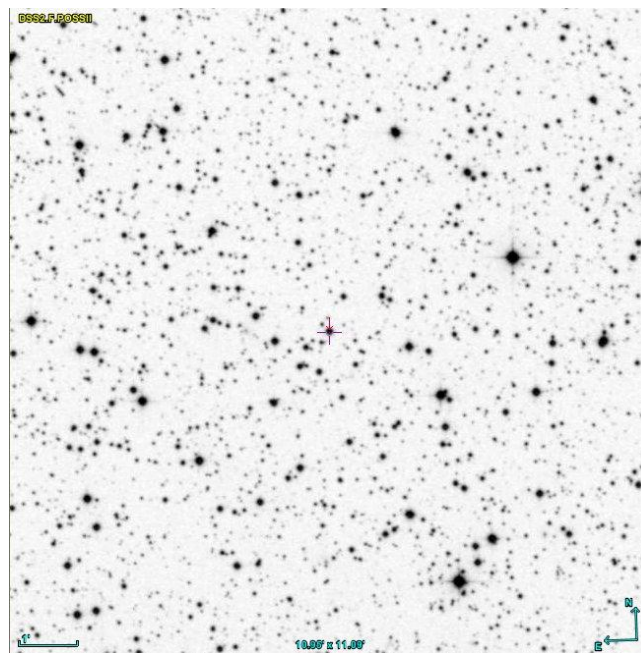


Fig. 52. Finder chart for UCAC4 708-103075 (Aladin, DSS2 red, 10'x11', N up, E left).

V30 = UCAC4 712-099399 (000-BLY-971)

Folded on $P = 0.31123$ d, the light curve shows two broad maxima of similar height and two deep, narrow minima, with a total amplitude of about 0.9 mag (clear band), consistent with a W UMa-type (EW) contact eclipsing binary. Observations span five nights (4, 7, 8, 9 and 10 August 2016) (Figs. 53-54).

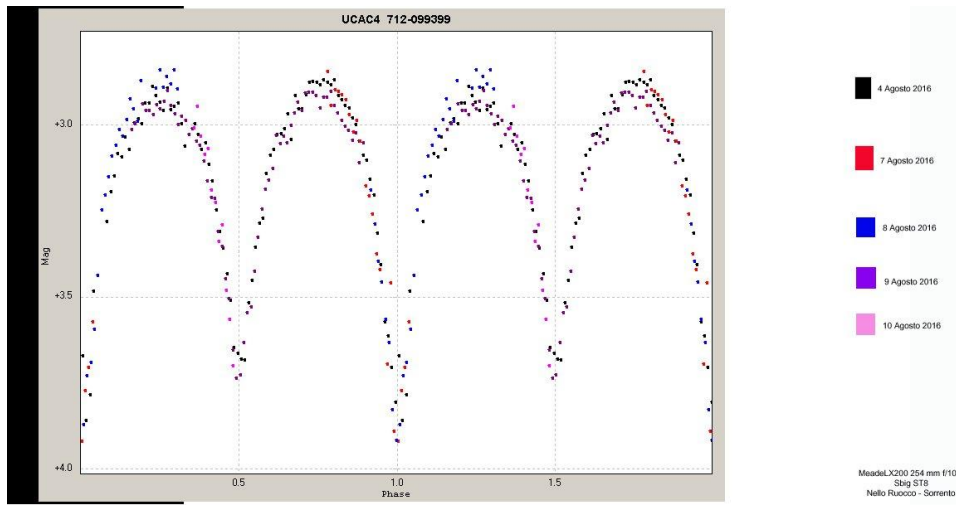


Fig. 53. Phase plot of UCAC4 712-099399 folded on $P = 0.31123$ d.

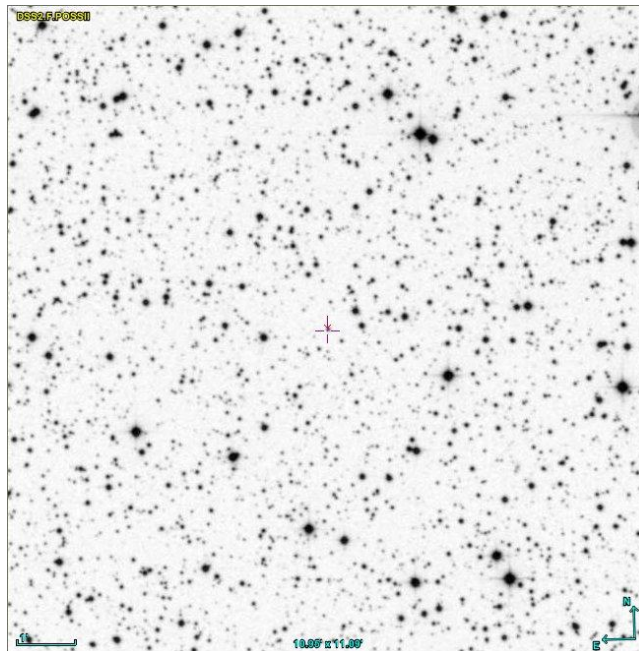


Fig. 54. Finder chart for UCAC4 712-099399 (Aladin, DSS2 red, 10'x11', N up, E left).

V31 = URAT1 705-478678 (000-BMZ-699)

Folded on $P = 0.383142$ d, the light curve shows two broad maxima of similar height and two minima of similar depth, with a total range of 17.7-18.4 CV. This morphology is consistent with a W UMa-type (EW) contact eclipsing binary. At $V \sim 18$, this is the faintest and most challenging target of the present sample, and the light curve shows correspondingly larger photometric scatter (Figs. 55-56).

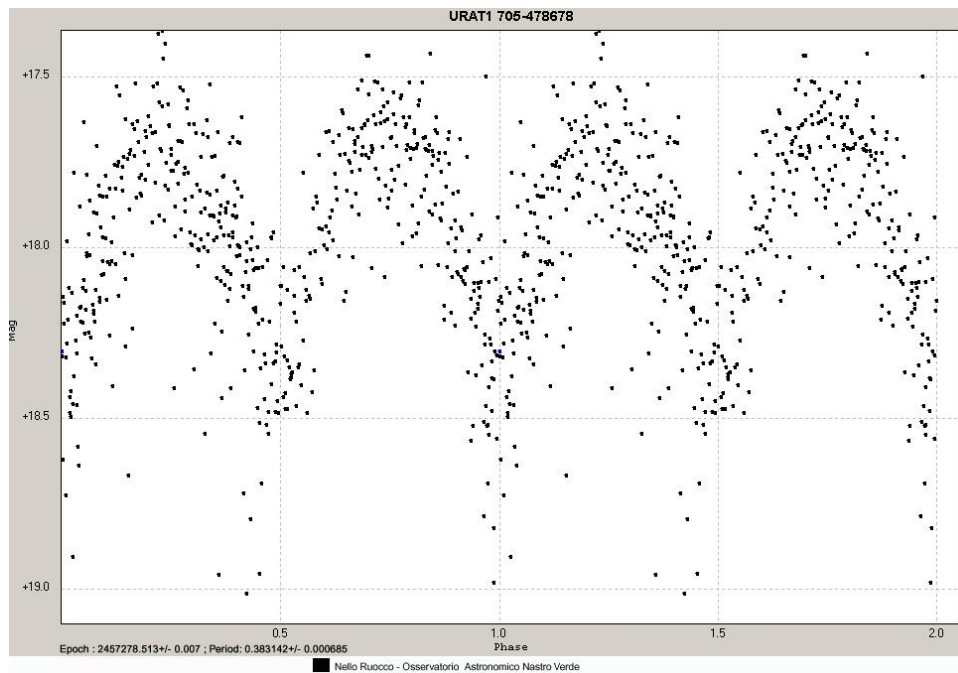


Fig. 55. Phase plot of URAT1 705-478678 folded on $P = 0.383142$ d.

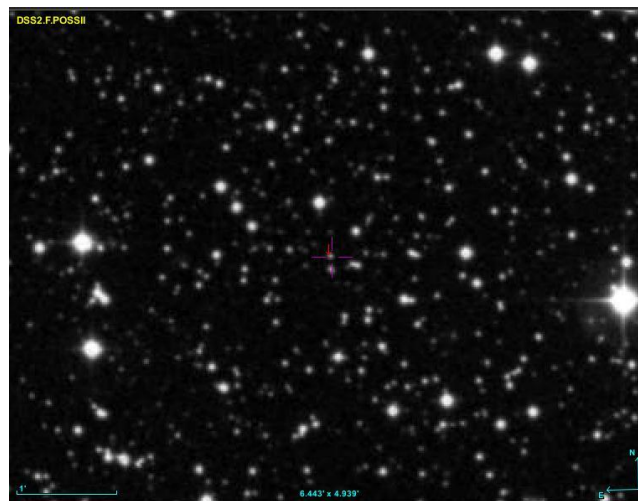


Fig. 56. Finder chart for URAT1 705-478678 (Aladin, DSS2 red, $6.4' \times 4.9'$, N up, E left).

V32 = 2MASS J22421663+5057275 = V0688 Lac (000-BKH-045)

Folded on $P = 2.751$ d, the light curve shows a deep (about 0.2 mag), narrow primary eclipse and a very shallow secondary minimum near phase 0.5, with an otherwise flat out-of-eclipse level, consistent with a well-detached Algol-type (EA) eclipsing binary. This star was originally submitted in 2011-2012 and was subsequently assigned the official GCVS designation V0688 Lac (Kazarovets et al., 2020) (Fig. 57).

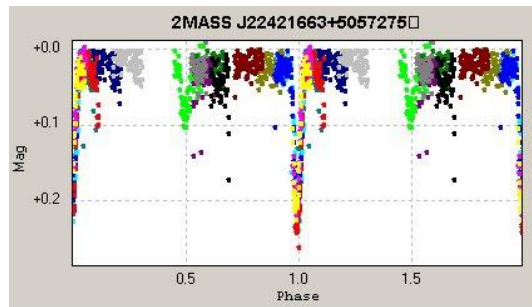


Fig. 57. Phase plot of 2MASS J22421663+5057275 (V0688 Lac) folded on $P = 2.751$ d.

V33 = 2MASS J22243039+5133019 = V0910 Lac (000-BKS-748)

Folded on $P = 0.690701$ d, the light curve shows a flat out-of-eclipse level and a deep, narrow primary eclipse (eclipse duration about 10%, or 1.66 h) with total range 14.64-14.90 r, consistent with a well-detached Algol-type (EA) eclipsing binary. The Kazarovets et al. (2023) name-list notes that the target is a visual binary (components A = 15.2 mag and B = 15.6 mag, separation 1.2 arcsec), with the quoted range referring to the combined light of both components; the secondary minimum reaches $r = 14.87$. This star was originally submitted in 2012 and subsequently assigned the official GCVS designation V0910 Lac (Fig. 58).

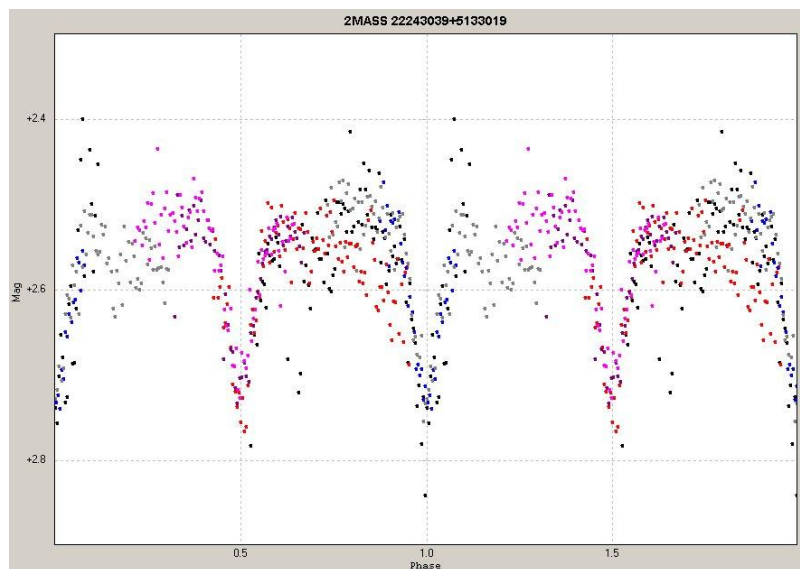


Fig. 58. Phase plot of 2MASS 22243039+5133019 (V0910 Lac) folded on $P = 0.690701$ d.

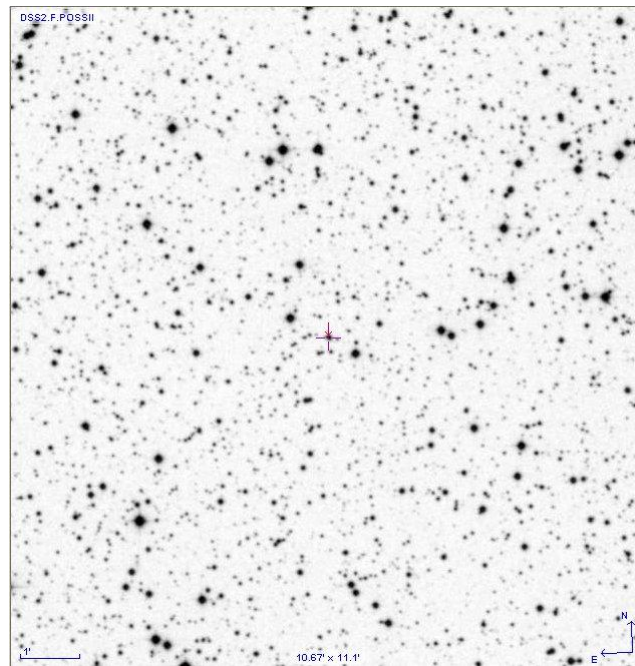


Fig. 59. Finder chart for V0910 Lac (Aladin, DSS2 red, 10.67'x11.1', N up, E left).

V34 = 2MASS J22245686+5131380 = V0912 Lac (000-BKS-597)

Folded on $P = 1.15003$ d, the light curve shows two maxima and two minima of similar depth, with a small total range of 13.39-13.50 g (Min II = 13.47 g), consistent with a beta Lyrae-type (EB) eclipsing binary; given the small amplitude and the smooth, continuous variation, an ellipsoidal (ELL) variable cannot be excluded. At $V \sim 13.2$, this is the brightest target in the present sample. This star was originally submitted in 2012 and subsequently assigned the official GCVS designation V0912 Lac (Kazarovets et al., 2023) (Fig. 60).

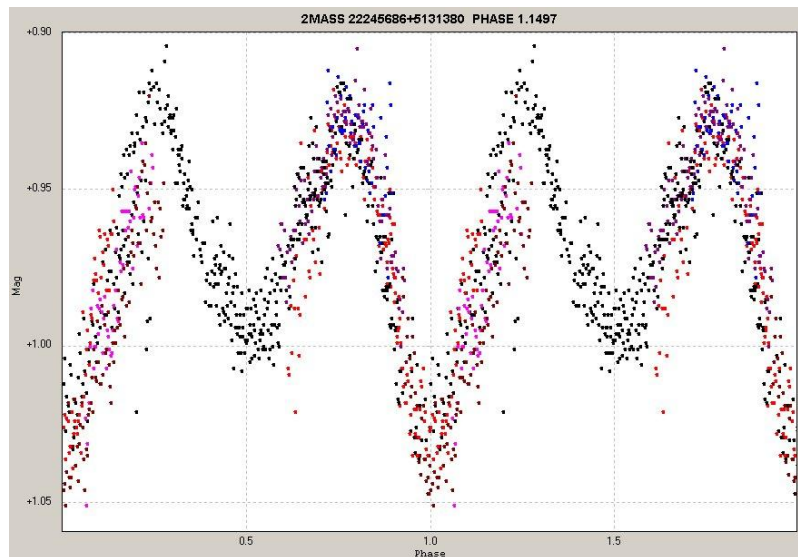


Fig. 60. Phase plot of 2MASS J22245686+5131380 (V0912 Lac) folded on $P = 1.15003$ d.

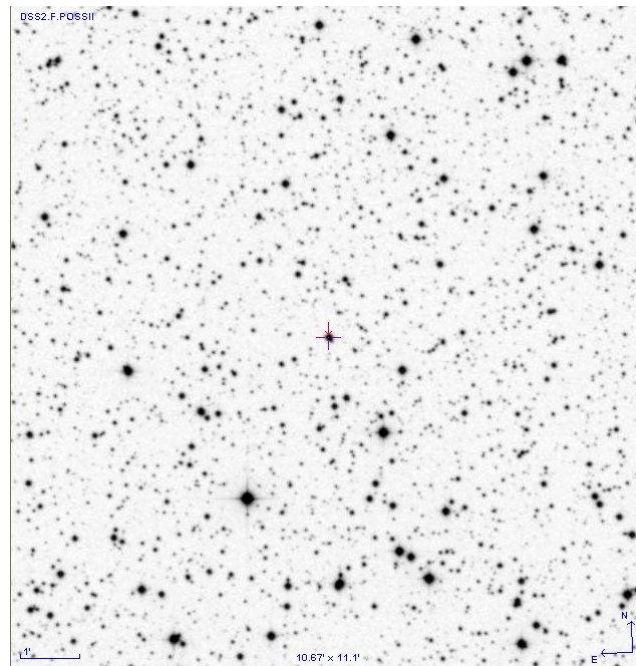


Fig. 61. Finder chart for V0912 Lac (Aladin, DSS2 red, 10.67'x11.1', N up, E left).

5. Colour-Magnitude Diagram

In order to place the new variables in the Hertzsprung-Russell diagram and verify the consistency of their variability classifications, we constructed a colour-magnitude diagram (CMD) using the dereddened near-infrared colour $(J-K)_0$ and the absolute magnitude M_{J0} .

Distances were derived from trigonometric parallaxes taken from the Gaia DR3 catalogue (Gaia Collaboration 2023; 2020yCat.1350....0G), retrieved via the SIMBAD astronomical database for each target individually by coordinate cross-match within 10 arcsec. Of the 26 stars with 2MASS J and K photometry, 22 had Gaia DR3 parallaxes with a relative uncertainty $plx_err/plx < 20\%$ and were retained for the CMD; four objects (V7, V20, V22 and V34) were excluded due to either no Gaia match or unreliable parallaxes (relative error $> 20\%$). Distances were computed as $d = 1000/plx$ pc, with no Lutz-Kelker correction applied given the quality cut applied.

Interstellar reddening was estimated from the dust maps of Schlegel et al. (1998) for the direction of Lacerta ($l \sim 100^\circ$, $b \sim -5^\circ$ to -10°), giving a mean $E(B-V) = 0.16$ mag. The corresponding extinctions in the 2MASS bands were computed as $A_J = 0.72 \times E(B-V) = 0.12$ mag and $A_K = 0.31 \times E(B-V) = 0.05$ mag (Cardelli et al. 1989), giving $E(J-K) = 0.07$ mag. Individual reddening values from the three-dimensional maps of Green et al. (2019) were not available through our query interface; the mean value adopted here is appropriate for the distance range (1.1-3.5 kpc) spanned by the sample.

The resulting CMD (Fig. 62) shows that the EW-type systems (W UMa contact binaries) are distributed along the main sequence between $M_{J0} \sim 1.6$ and 3.8, with $(J-K)_0$ colours in the range 0.1-0.8, consistent with F- to K-type dwarf primaries. The EA (Algol) and EB (β Lyrae) systems occupy similar positions, as expected for main-sequence or slightly evolved eclipsing binaries. The two DSCT: candidates (V1 and V17) fall at $M_{J0} \sim 1.6$ -2.8 and $(J-K)_0 \sim 0.2$ -0.5, consistent with the instability strip location of A-F type pulsating stars above the main sequence. The overall distribution of the sample is broadly consistent with their variability

classifications, confirming that the photometric periods and types assigned are physically reasonable. The distances of the programme stars range from about 1.1 to 3.5 kpc, placing them in the thin disc of the Milky Way.

A noteworthy exception is V1 (2MASS J22000388+4351113, 000-BKF-424), classified as DSCT: in VSX. Its position in the CMD at $(J-K)_0 = 0.50$ and $MJ_0 = 2.78$ places it well to the red of the classical instability strip for δ Scuti pulsators, which in the near-infrared corresponds to $(J-K)_0 \lesssim 0.30$ (spectral types A-F). This colour is more consistent with a G- or K-type star, for which δ Scuti pulsation would not be expected. Consistently, SIMBAD classifies this object as an RS CVn variable based on the ATLAS photometric catalogue (Chen et al. 2020, ApJS). It is therefore possible that V1 is not a HADS pulsator but rather an RS CVn-type spotted rotating star or a short-period eclipsing binary with unequal minima. The tentative DSCT: classification should be considered uncertain, and further multi-colour time-series photometry and spectroscopy are needed to resolve the nature of this object. In contrast, V17 (UCAC4 689-111349, 000-BMK-299) with $(J-K)_0 = 0.20$ and $MJ_0 = 1.58$ falls within the instability strip region and is consistent with a genuine DSCT: pulsator; SIMBAD independently classifies it as a pulsating variable (Gaia DR3 variability catalogue, 2022).

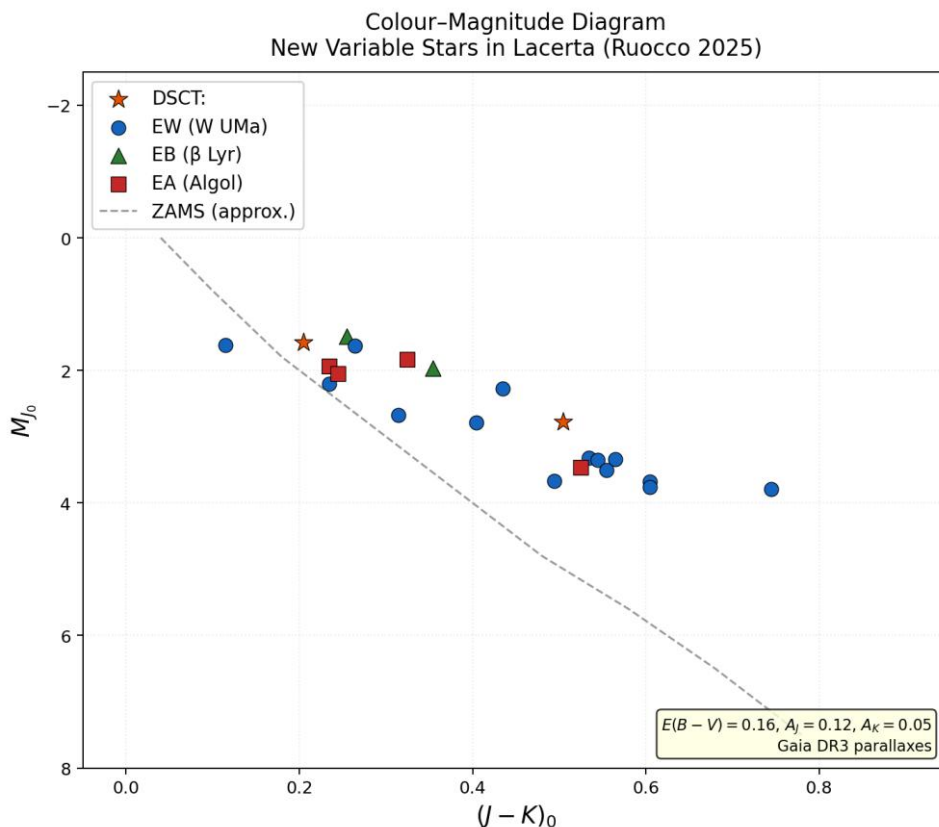


Fig. 62. Colour-magnitude diagram (MJ_0 vs. $(J-K)_0$) for 22 of the new variable stars with reliable Gaia DR3 parallaxes. Symbols indicate variability type: circles = EW, squares = EA, triangles = EB, stars = DSCT: . The dashed line shows an approximate solar-metallicity ZAMS. Reddening corrections: $E(B-V) = 0.16$, $A_J = 0.12$, $A_K = 0.05$.

6. Conclusions

We have presented 34 new variable stars discovered in Lacerta, all approved in the AAVSO VSX. The sample is dominated by short-period W UMa eclipsing binaries, with a smaller fraction of Algol/beta Lyrae systems and two candidate HADS pulsators. Three of the eclipsing

binaries (000-BKH-045, 000-BKS-748 and 000-BKS-597) have since been assigned official GCVS designations (V0688 Lac, V0910 Lac and V0912 Lac respectively; Kazarovets et al., 2020, 2023), confirming their status as recognised variable stars. Further multi-colour photometry and spectroscopy would be valuable to refine the classification of the two DSCT: candidates and to obtain absolute parameters for the eclipsing systems.

6. Cross-identifications and Catalogue Data

Cross-matches to the 2MASS, AllWISE, APASS and SDSS catalogues were obtained via the CDS X-Match Service, as listed on each star's VSX page. Selected results for the targets discussed individually above are given below; full astrometric and multi-band photometric data for all 34 objects, together with links to VizieR, Aladin and the SIMBAD database, are available through the corresponding VSX entries (Table 1).

2MASS J22000388+4351113 (000-BKF-424)

2MASS: J = 13.14, H = 12.67, K = 12.57 (J-K = 0.57)

AllWISE: W1 = 12.54, W2 = 12.58, W3 = 12.64 (W1-W2 = -0.04)

APASS-DR9: B = 15.92, V = 14.99, g' = 15.45, r' = 14.68, i' = 14.38 (B-V = 0.93)

SDSS-DR12: u = 17.19, g = 15.44, r = 14.67, i = 14.35, z = 14.16 (u-g = 1.75, r-i = 0.32)

2MASS J22162837+4952131 (000-BMB-228)

2MASS: J = 15.35, H = 14.80, K = 14.68 (J-K = 0.68)

AllWISE: W1 = 14.61, W2 = 14.72 (W1-W2 = -0.11)

2MASS J22163381+4952290 (000-BMB-313)

2MASS: J = 15.69

AllWISE: W1 = 14.74, W2 = 14.89 (W1-W2 = -0.16)

2MASS J22192946+4416566 (000-BLD-336)

2MASS: J = 14.72, H = 14.43, K = 14.42 (J-K = 0.30)

AllWISE: W1 = 14.37, W2 = 14.58 (W1-W2 = -0.21)

APASS-DR9: B = 16.96, V = 16.22, g' = 16.41, r' = 15.99 (B-V = 0.73)

2MASS J22235378+5122249 (000-BMK-621)

2MASS: J = 16.43, H = 15.65

AllWISE: W1 = 14.97, W2 = 15.05 (W1-W2 = -0.07)

2MASS J22243032+5126076 (000-BMK-607)

2MASS: J = 15.03, H = 14.60, K = 14.43 (J-K = 0.60)

AllWISE: W1 = 14.39, W2 = 14.56 (W1-W2 = -0.17)

2MASS J22253540+5118014 (000-BLZ-606)

2MASS: J = 15.30, H = 14.78, K = 14.73 (J-K = 0.57)

AllWISE: W1 = 14.95, W2 = 15.28 (W1-W2 = -0.33)

2MASS J22282227+5228058 (000-BLZ-023)

2MASS: J = 16.17, H = 15.69

AllWISE: W1 = 15.51, W2 = 15.79 (W1-W2 = -0.28)

2MASS J22293014+5231171 (000-BMK-300)

2MASS: J = 16.06, H = 15.85, K = 15.84 (J-K = 0.22)

2MASS J22331661+5038561 (000-BKG-542)
2MASS: J = 14.52, H = 14.07, K = 13.91 (J-K = 0.61)
AllWISE: W1 = 13.90, W2 = 13.98 (W1-W2 = -0.08)

2MASS J22333278+5040263 (000-BML-573)
2MASS: J = 15.71, H = 15.13, K = 14.90 (J-K = 0.81)
AllWISE: W1 = 15.57, W2 = 16.20 (W1-W2 = -0.63)

2MASS J22335381+5043227 (000-BKG-521)
2MASS: J = 14.38, H = 14.06, K = 14.00 (J-K = 0.37)
AllWISE: W1 = 13.47, W2 = 13.55 (W1-W2 = -0.08)

2MASS J22422253+5057575 (000-BKG-492)
2MASS: J = 15.13, H = 14.81, K = 14.63 (J-K = 0.50)

2MASS J22425519+5059043 (000-BKG-519)
2MASS: J = 13.88, H = 13.60, K = 13.56 (J-K = 0.31)
AllWISE: W1 = 13.49, W2 = 13.51 (W1-W2 = -0.02)

2MASS J22432320+5056006 (000-BKG-540)
2MASS: J = 15.11, H = 14.77, K = 14.44 (J-K = 0.67)
AllWISE: W1 = 14.28, W2 = 14.46 (W1-W2 = -0.17)

GSC 03632-02808 (000-BLS-087)
2MASS: J = 13.10, H = 12.82, K = 12.80 (J-K = 0.30)
AllWISE: W1 = 12.69, W2 = 12.72, W3 = 12.21 (W1-W2 = -0.03)

UCAC4 689-111349 (000-BMK-299)
2MASS: J = 13.95, H = 13.68, K = 13.68 (J-K = 0.27)
AllWISE: W1 = 13.60, W2 = 13.61 (W1-W2 = -0.01)

UCAC4 700-108110 (000-BMB-311)
2MASS: J = 14.35, H = 14.02, K = 14.02 (J-K = 0.33)
AllWISE: W1 = 14.02, W2 = 14.10 (W1-W2 = -0.08)

UCAC4 700-108268 (000-BLZ-643)
2MASS: J = 13.75, H = 13.35, K = 13.28 (J-K = 0.48)
AllWISE: W1 = 13.08, W2 = 13.19 (W1-W2 = -0.11)

UCAC4 705-104781 (000-BLS-229)
2MASS: J = 15.45, H = 15.29, K = 15.12 (J-K = 0.33)
AllWISE: W1 = 14.60, W2 = 14.69 (W1-W2 = -0.09)

UCAC4 705-104975 (000-BLS-498)
2MASS: J = 15.00
AllWISE: W1 = 14.02, W2 = 14.12 (W1-W2 = -0.10)

UCAC4 705-105013 (000-BLS-098)
2MASS: J = 15.29, H = 14.96, K = 14.94 (J-K = 0.36)
AllWISE: W1 = 15.22, W2 = 15.41 (W1-W2 = -0.19)

UCAC4 706-105719 (000-BMK-187)

2MASS: J = 14.94, H = 14.38, K = 14.31 (J-K = 0.62)

AllWISE: W1 = 14.31, W2 = 14.47 (W1-W2 = -0.16)

UCAC4 706-105733 (000-BMK-298)

2MASS: J = 14.14, H = 13.67, K = 13.58 (J-K = 0.56)

AllWISE: W1 = 13.53, W2 = 13.59 (W1-W2 = -0.07)

UCAC4 707-100174 (000-BMW-034)

No 2MASS/AllWISE cross-match data is listed on the VSX page for this star. Additional photometry is available from the ASAS-SN survey (Kochanek et al. 2017, PASP 129, 104502).

UCAC4 707-100327 (000-BLZ-605)

2MASS: J = 13.91, H = 13.37, K = 13.32 (J-K = 0.59)

AllWISE: W1 = 13.04, W2 = 13.18 (W1-W2 = -0.14)

APASS-DR9: B = 16.30, V = 15.67, g' = 16.04, r' = 15.33, i' = 15.12 (B-V = 0.63)

UCAC4 707-100455 (000-BLZ-600)

2MASS: J = 14.76, H = 14.52, K = 14.34 (J-K = 0.42)

AllWISE: W1 = 14.51, W2 = 14.60 (W1-W2 = -0.09)

UCAC4 707-100598 (000-BMY-147)

Cross-identification: 2MASS J22261315+5123240, URAT1 707-474537. No 2MASS/AllWISE photometric cross-match data are listed on the VSX page; basic parameters are as in Table 1. Additional photometry is available from the ASAS-SN survey (Kochanek et al. 2017, PASP 129, 104502).

UCAC4 708-103075 (000-BML-632)

2MASS: J = 12.42, H = 12.25, K = 12.24 (J-K = 0.18)

AllWISE: W1 = 12.10, W2 = 12.12, W3 = 12.30 (W1-W2 = -0.02)

APASS-DR9: B = 13.81, V = 13.33, g' = 13.48, r' = 13.19, i' = 13.15 (B-V = 0.48)

UCAC4 712-099399 (000-BLY-971)

2MASS: J = 14.27, H = 13.73, K = 13.65 (J-K = 0.62)

AllWISE: W1 = 13.73, W2 = 13.85 (W1-W2 = -0.12)

URAT1 705-478678 (000-BMZ-699)

No 2MASS/AllWISE cross-match data is listed on the VSX page for this faint ($V \sim 18$) star; the cross-identification is from the USNO-B1.0 and URAT1 catalogues.

2MASS J22421663+5057275 = V0688 Lac (000-BKH-045)

2MASS: J = 12.75, H = 12.52, K = 12.44 (J-K = 0.32)

AllWISE: W1 = 12.29, W2 = 12.32, W3 = 11.60 (W1-W2 = -0.04)

2MASS J22243039+5133019 = V0910 Lac (000-BKS-748)

2MASS: J = 13.45, H = 13.16, K = 13.06 (J-K = 0.39)

AllWISE: W1 = 12.99, W2 = 13.02 (W1-W2 = -0.03)

APASS-DR9: B = 15.60, V = 14.86, g' = 15.20 (B-V = 0.74)

2MASS J22245686+5131380 = V0912 Lac (000-BKS-597)

2MASS: J = 12.22, H = 12.06, K = 12.02 (J-K = 0.20)

AllWISE: W1 = 11.95, W2 = 11.97, W3 = 12.71 (W1-W2 = -0.03)

APASS-DR9: $B = 13.72$, $V = 13.21$, $g' = 13.39$, $r' = 13.07$, $i' = 13.01$ ($B-V = 0.51$)

7. Online Resources

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

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

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

SIMBAD Astronomical Database (CDS, Strasbourg): <https://simbad.u-strasbg.fr/simbad>

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

This research has made use of the AAVSO International Variable Star Index (VSX), the 2MASS, UCAC4 and URAT1 catalogues, and the AAVSO Variable Star Plotter. An AI assistant (Claude, Anthropic) was used to help prepare and format the manuscript text and tables based on the author's observational data and analysis.

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