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NEW VARIABLE STARS FROM SSVS. I: 2017-2018 CAMPAIGN.

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Abstract: We present twelve new variable stars discovered during the search for new stars with variability in certain fields of Auriga, Andromeda, Lyra, Draco and Delphinus in the years 2017 and 2018. Most of the new discoveries are eclipsing binary stars, while there are also other types like DSCT or HADS. All of them are already reported in the AAVSO's The International Variable Stars Index (VSX).

1. Introduction.

Through this paper we announce the discovery of twelve new variable stars. These discoveries have been made from an intensive observation campaign in certain fields of different boreal constellations between the end of 2017 and 2018.

At the end of 2017 one of the authors detected the possible variability of a star while he was tracing the pulsating variable GSC 02623-01174 included in the observational program of High Amplitude Delta Scuti stars coordinated by Patrick Wils (Wils, 2014). Since it was not listed as a variable star in any catalog, photometric monitoring was carried out over several nights, a task that required help from a group of fellow observers. Once the follow-up campaign of this star was completed, we were able to confirm its variability as an EA type.

From this work, possible new variable stars were detected, so that, after a little more than a year of work, they reached the number of twelve. Given the productivity of this observation campaign, we decided to group together under the name of Spanish Survey on Variable Stars (SSVS), which does not refer to any constituted association but to an informal group of observers who share the same passion for stellar photometry.

After these first discoveries, our work is still ongoing and we hope to continue studying variable stars already known, as well as to contribute new discoveries.

2. Observers and Methology.

The Spanish Survey on Variable Stars group is composed of five observers who have their observatories in different parts of Spain, most of them in the southwest of the Iberian Peninsula. Almost all have observatories with Minor Planet Center code and adequate equipment for photometric observations. Usually they are dedicated to the monitoring and confirmation of supernovae and variable stars, astrometry of double stars, as well as comets and asteroids. A detailed description of the equipment used can be seen in Table 1.

Table 1: Location and main characteristics of the observers and their equipment.

Observer	Observatory	Localization	MPC Code	Telescope	CCD chip	FOV	Plate scale	Filter
Juan-Luis González Carballo	Cerro del Viento	Badajoz, Spain	I84	0.20-m	KAF-8300	46'x31'	1,36"/pixel	V Johnson
Fernando Limón Martínez	Mazariegos	Mazariegos, (Palencia), Spain	Z50	0.20-m	ICX-285AL	20'x 15'	0.85"/pixel	R y V Johnson
Rafael Benavides Palencia	Posadas	Posadas (Córdoba), Spain	J53	0.28-m	KAF-8300	49'x36'	1,75"/pixel	V Johnson
Rafael González Farfán	Uraniborg	Écija (Sevilla), Spain	Z55	0.28-m	ICX-825 Sony	18'x13'	078"/pixel 1,56"/pixel	V Johnson
José María Fernández Andújar	Inmaculada del Molino	Sevilla, Spain	—	0.15-m	ICX 694	33'x27'	0,71"/pix	V Johnson

As mentioned above, the first discovery was made by serendipity while tracking the variable star GSC 02623-01174. From there, a campaign to study this possible new variable star was organized in a coordinated way. New discoveries were added to this, so that during the end of 2017 and all 2018 it was possible to reach the number of twelve new discoveries.

The acquisition of images was done through *MaxImDL* software (Diffraction Limited, 2012), which allows the automation of the entire data collection process during the observation session. Most observers also used the well-known *PHD Guiding* (StarLabs, 2014) software as a complement to their telescope auto guiding in long exposures.

To detect possible new variable stars in our images we use the software developed by Julio Castellano *FotoDif 3.95* (Castellano, 2018), which implements a function that allows us to track all the stars that appear in the field of CCD images looking for changes in brightness.

In most cases we have complemented our observations with data from the All-Sky Automated Survey for Supernovae, ASAS-SN (Kochanek et al., 2017), what has helped us to more accurately characterize the stars suspected from variability.

The calibration of the images with dark and flat frames was done with *MaxImDL* and the reduction of them to obtain photometric data was done with *FotoDif 3.95*. The reference stars were taken from UCAC4/APASS catalogs (Zacharias et al., 2000; Henden et al., 2018). In most cases, the magnitudes in the V band were used. To obtain the zero point and to adjust our measurements to those of ASAS-SN, we use the function implemented in the *Peranso 2.60* software (Paunzen & Vanmunster, 2016) "Time / Mag Offset"; for this, we always resort to the maximum and minimum moments of its light curves.

For a preliminary analysis of light curves we use, once again, *FotoDif 3.95*, although to refine the data obtained and generate light curves based on differential photometry we use *Peranso 2.60* which also allows us to add observations from professional surveys very easily.

3. Identification and characterization of the new variables.

After a year of work obtaining images and processing them to obtain high quality data, we can conclude that the twelve new variables fit perfectly to certain types of variability included in the GCVS (Samus et al., 2017).

Table 2 shows the new variable stars that we present. It offers data such as its identification from several catalogs, coordinates and type. As can be seen, eight of them are eclipsing variable stars (6 of them EW UMa type, 3 algolids and 1 EB), while two are pulsating ones (1 HADS and 1 DSCT). We consider especially interesting the case of the HADS discovered since it has a period of only 104.911 minutes, as well as the DSCT whose amplitude is only 0.03 magnitudes.

Table 2: Summary (I) of the new variable stars discussed in this paper.

SSVS	Main Design.	Other Design.	AAVSO UID	RA	Dec	Var. Type
1	UCAC4 603-063839	2MASS J18255073+3032573 USNO-B1.0 1205-0289211	000-BMT-296	18 25 50.74	+30 32 57.3	EA
2	UCAC4 694-123652	2MASS J23203575+4847227 GSC 03644-02189	000-BMV-679	23 20 35.75	+48 47 22.7	EB
3	GSC 03348-01493	2MASS J04523750+4819206 UCAC4 692-030941 USNO-B1.0 1383-0148013	000-BMS-299	04 52 37.50	+48 19 20.7	EA
4	UCAC4 693-032226	2MASS J04515621+4833340 USNO-B1.0 1385-0127733	000-BMR-630	04 51 56.22	+48 33 34.1	HADS
5	UCAC4 694-031510	2MASS J04513486+4840387 USNO-B1.0 1386-0128086	000-BMS-231	04 51 34.87	+48 40 38.7	DSCT
6	UCAC4 738-059916	2MASS J18395078+5725572 GSC2.3 N15O000253 USNO-B1.0 1474-0341221	000-BMV-069	18 39 50.79	+57 25 57.2	EA
7	UCAC4 738-059942	2MASS J18403552+5726298 GSC2.3 N15O000773 USNO-B1.0 1474-0341352	000-BMT-967	18 40 35.50	+57 26 29.8	EW
8	USNO-B1.0 1475-0340480	—	000-BMT-711	18 41 17.25	+57 33 48.7	EW
9	USNO-B1.0 1473-0343583	GSC2.3 N15O005116 USNO-A2.0 1425-09244691	000-BMV-426	18 40 03.01	+57 19 10.1	EW

10	UCAC4 522-133668	2MASS J20521681+1422510 GSC 01102-00912 USNO-A2.0 0975-19730142 USNO-B1.0 1043-0613528	000-BMW-375	20 52 16.81	+14 22 51.0	EW
11	2MASS J23200752+4841143	GSC2.3 N2S8018037 USNO-A2.0 1350-18141858 USNO-B1.0 1386-0492458	000-BMV-481	23 20 07.52	+48 41 14.4	EW
12	UCAC4 524-137549	2MASS J20530178+1437582 GSC2.3 N2QD019789 USNO-A2.0 0975-19747694 USNO-B1.0 1046-0593641	000-BMV-954	20 53 01.79	+14 37 58.2	EW

In table 3 we present the necessary data for its correct characterization according to its type of variability (period, range, amplitude and epoch) obtained from the behavior of its light curves. We also offer some remarks on peculiar aspects of each of them, as if an O'Connell effect is visible in its light curve.

All of the stars are already registered in the AAVSO's The International Variable Stars Index, VSX (Watson et al., 2006).

Table 3: Summary (II) of the new variable stars discussed in this paper. Remarks listed below.

SSVS	Designation	Var. Type	Period	Mag. Range	Rise/Eclipse duration	Epoch (HJD)	Remarks
1	UCAC4 603-063839	EA	0.588675 d ±0.000004	15.07 - 15.69 V	10%	2457209.8688	(1)
2	UCAC4 694-123652	EB	0.740481 d ±0.000040	13.79 - 14.39 V	—	2457580.9672	(2)
3	GSC 03348-01493	EA	2.465085 d ±0.003585	13.49 - 13.84 V	8%	2457675.932	(3)
4	UCAC4 693-032226	HADS	0.072855 d ±0.000002	15.52 - 15.78 V	44%	2458107.3715	(4)
5	UCAC4 694-031510	DSCT	0.089852 d ±0.000137	13.61 - 13.64 V	—	2458107.4344	—
6	UCAC4 738-059916	EA	0.606759 d ±0.000054	14.83 - 15.16 V	13%	2458333.953	(5)
7	UCAC4 738-059942	EW	0.305357 d ±0.000009	13.891 - 14.134 V	—	2458367.5186	(6)
8	USNO-B1.0 1475-0340480	EW	0.280052 d ±0.001757	17.034 - 18.144 CV	—	2458369.4063	—
9	USNO-B1.0 1473-0343583	EW	0.332093 d ±0.000677	16.93 - 17.37 CV	—	2458377.3871	(7)
10	UCAC4 522-133668	EW	0.763465 d ±0.000050	13.29 - 13.50 V	—	2458392.8463	(8)
11	2MASS J23200752 +4841143	EW	0.293206 d ±0.007241	16.88 - 17.65 CV	—	2458397.4089	(9)
12	UCAC4 524-137549	EW	0.418086 d ±0.000008	14.51 - 14.77 V	—	2458416.3478	—

Remarks

(1) Min II = 15.22 V.
(2) Min II = 14.01 V. ASAS-SN magnitudes contaminated by UCAC4 694-123657 (V= 14.65; sep. 7.6"). Range has been corrected.
(3) Primary eclipse might be the secondary.
(4) ASAS-SN magnitudes contaminated by UGPS J045157.41+483333.1 (V= 15.7; sep. 12") and UGPS J045157.61+483332.0 (V= 14.1; sep. 14"). Range has been corrected.
(5) Min II = 15.03 V. O'Connell effect.
(6) O'Connell effect.
(7) O'Connell effect.
(8) Min II = 13.45 V. ASAS-SN magnitudes partially contaminated by UCAC4 522-133669 (V= 13.4; sep. 15"). Range has been corrected.
(9) O'Connell effect.

4. Phase Diagrams.

Using *FotoDif 3.95* and *Peranso 2.60* we have been able to make phase diagrams of the discovered variables. They have combined our own observations with others from All-Sky Automated Survey for Supernovae (ASAS-SN). As we mentioned earlier, the reference stars were taken from UCAC4/APASS catalogue. In most cases, the magnitudes in the V band are used. These phase plots are shown in Figures 1 to 12 below.

Although we tried different algorithms for the search of periods and phases, we obtained best results with the Phase Dispersion Minimization, PDM (Stellingwerf, 1978).

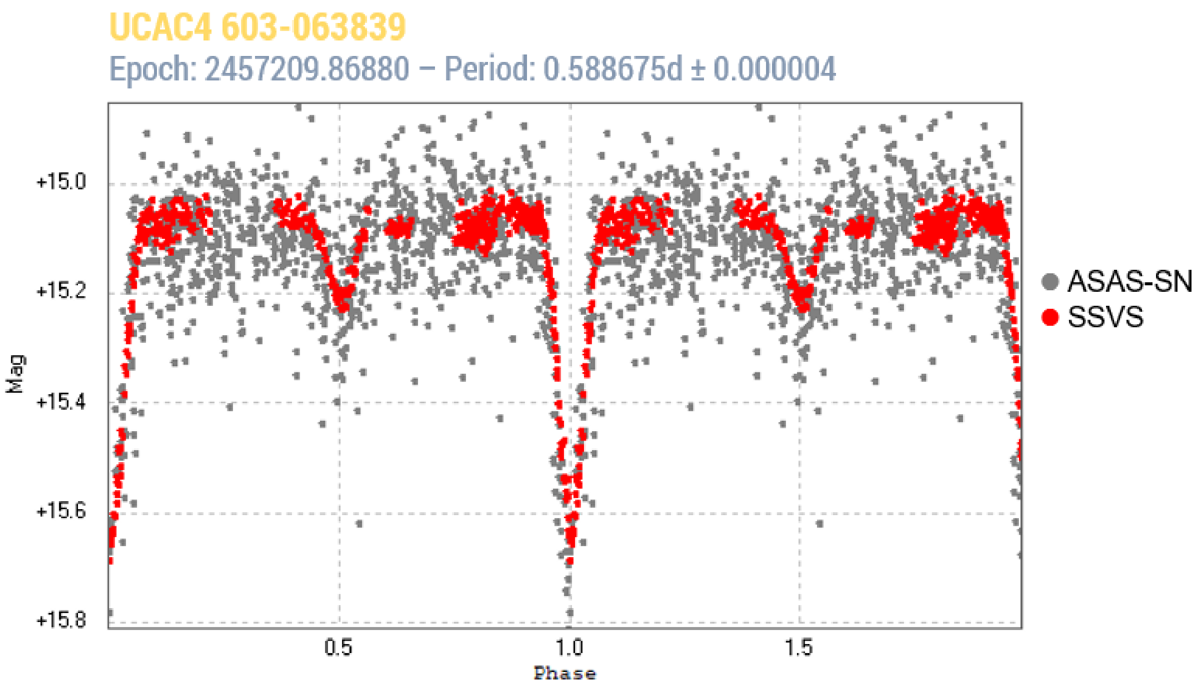

Figure 1: Phase plot of SSVS1 = UCAC4 603-063839.

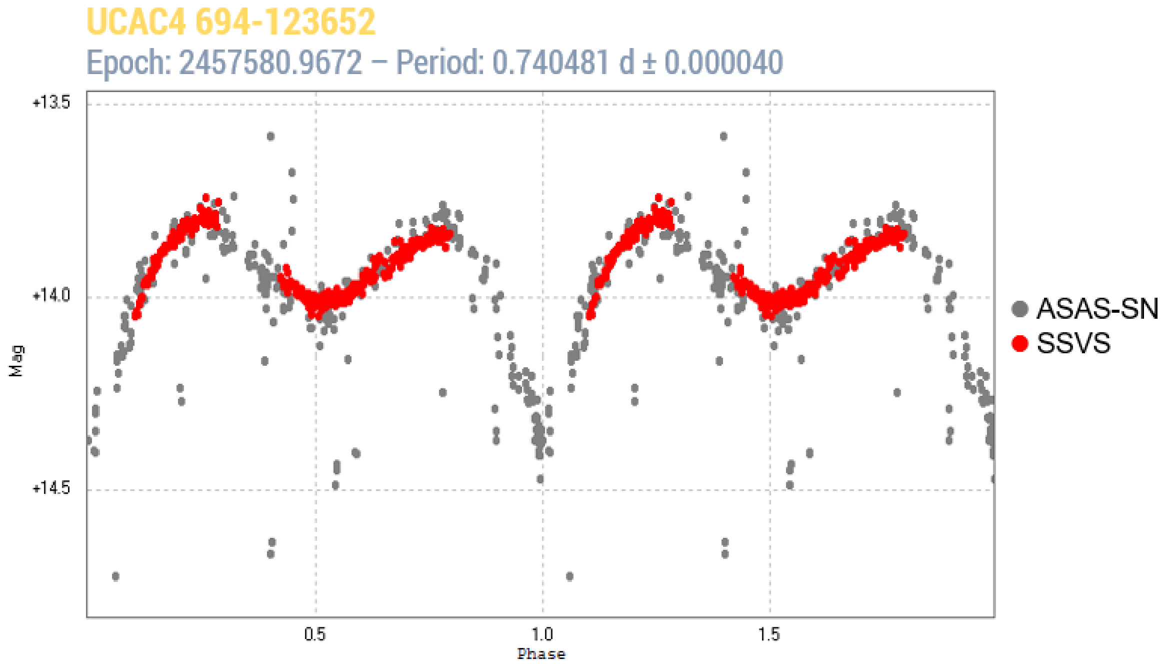

Figure 2: Phase plot of SSVS2 = UCAC4 694-123652.

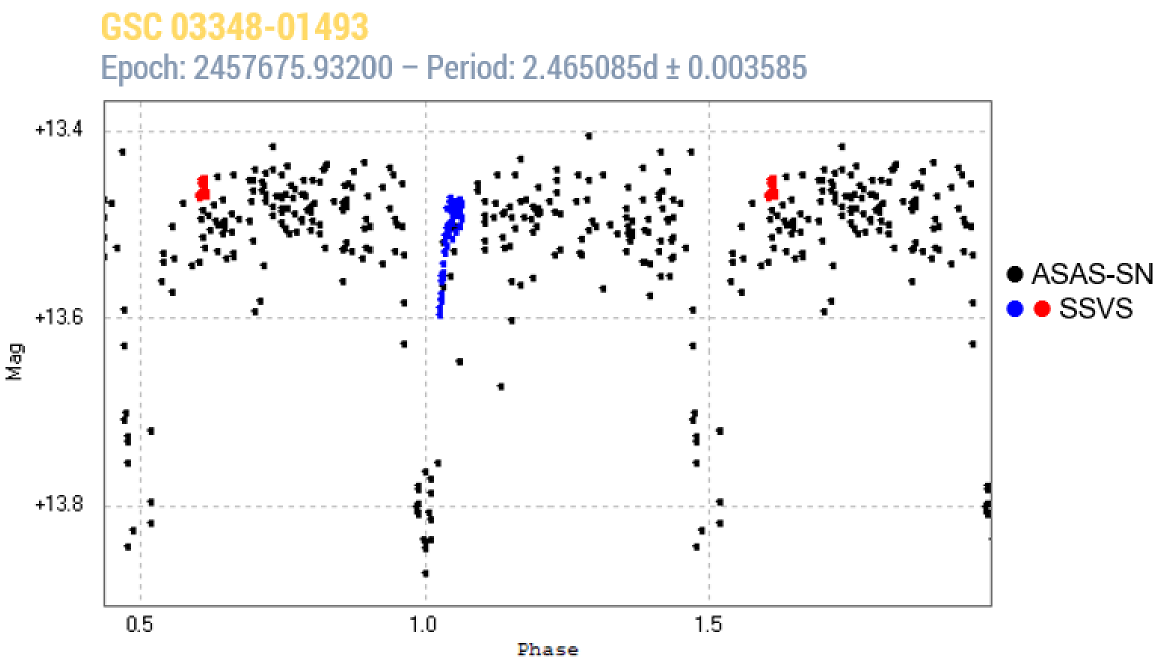

Figure 3: Phase plot of SSVS3 = GSC 03348-01493.

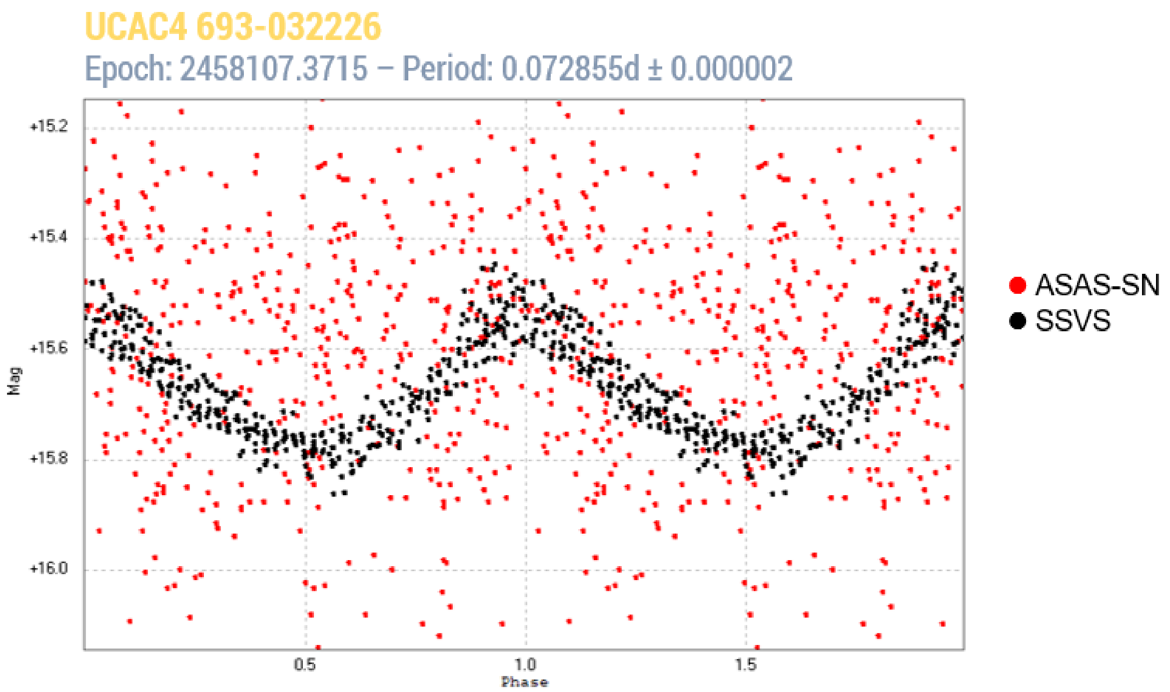

Figure 4: Phase plot of SSVS4 = UCAC4 693-032226.

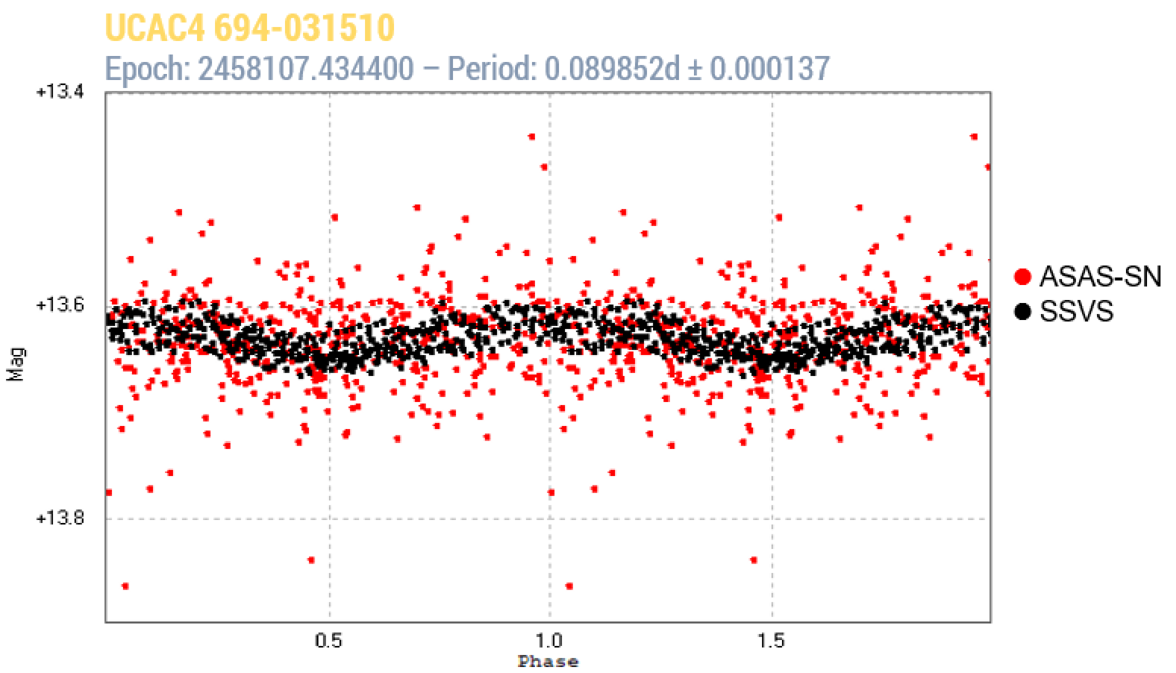

Figure 5: Phase plot of SSVS5 = UCAC4 694-031510.

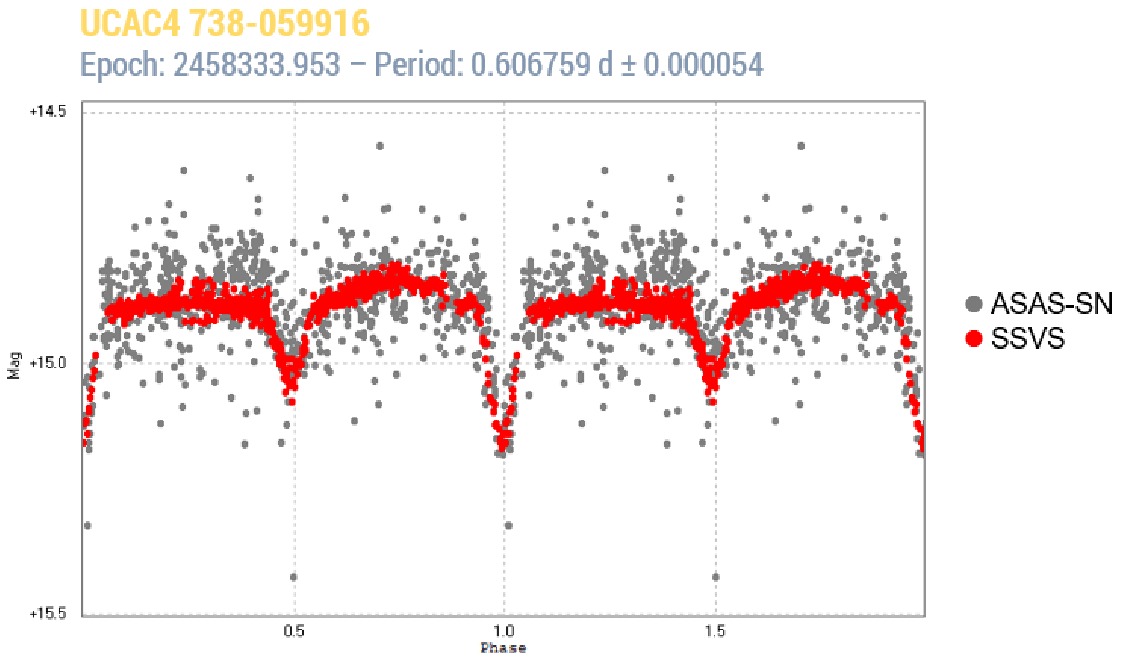

Figure 6: Phase plot of SSVS6 = UCAC4 738-059916.

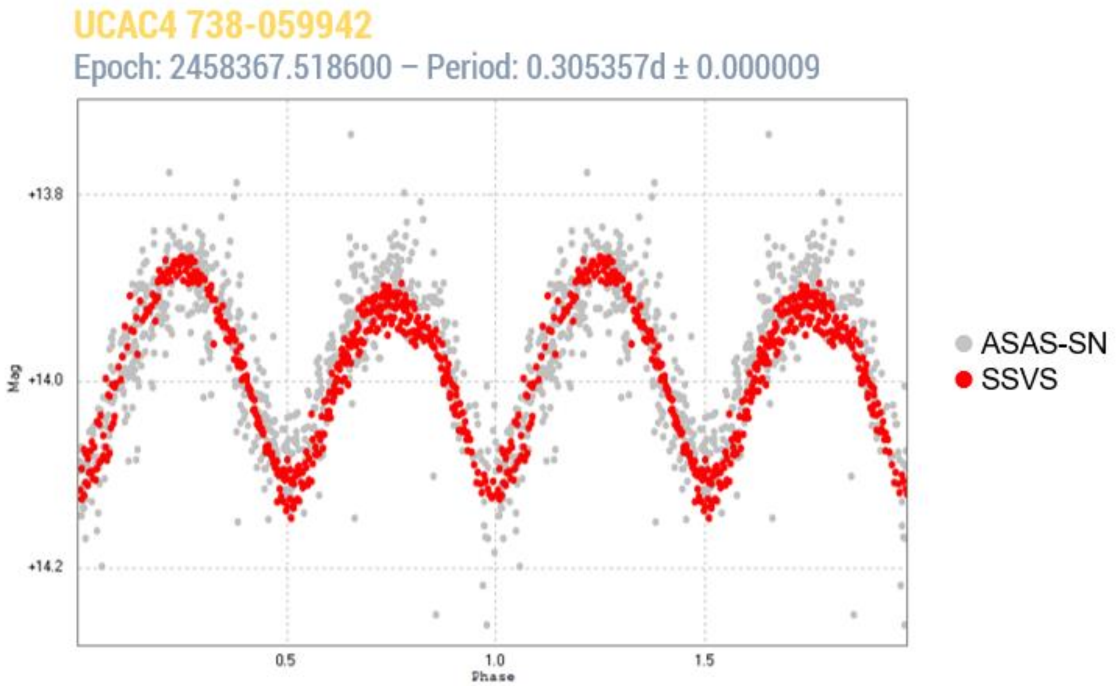

Figure 7: Phase plot of SSVS7 = UCAC4 738-059942.

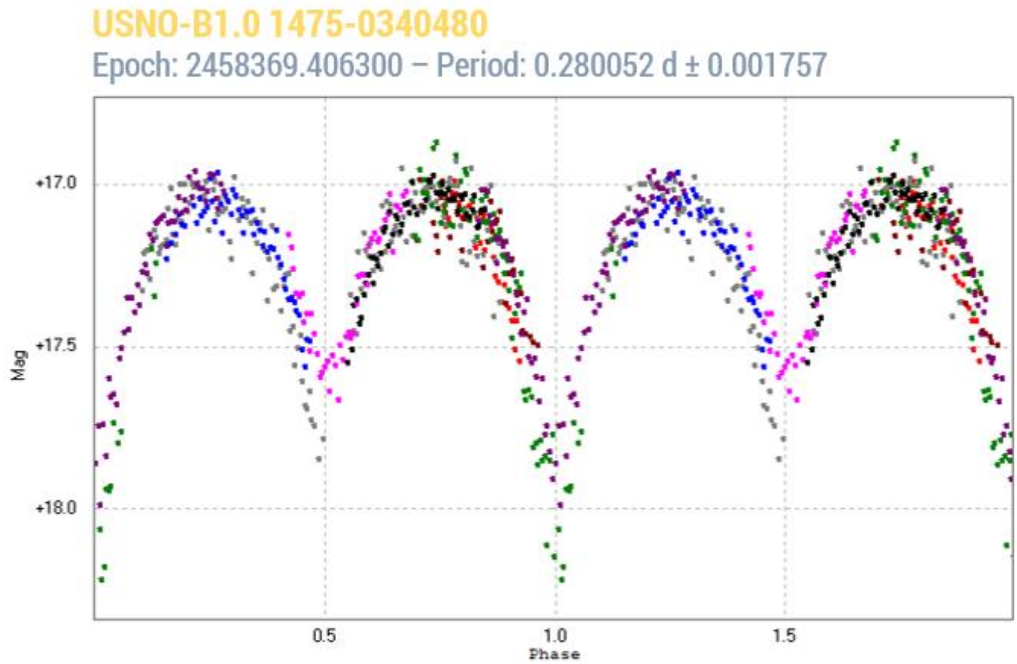

Figure 8: Phase plot of SSVS8 = USNO-B1.0 1475-0340480.

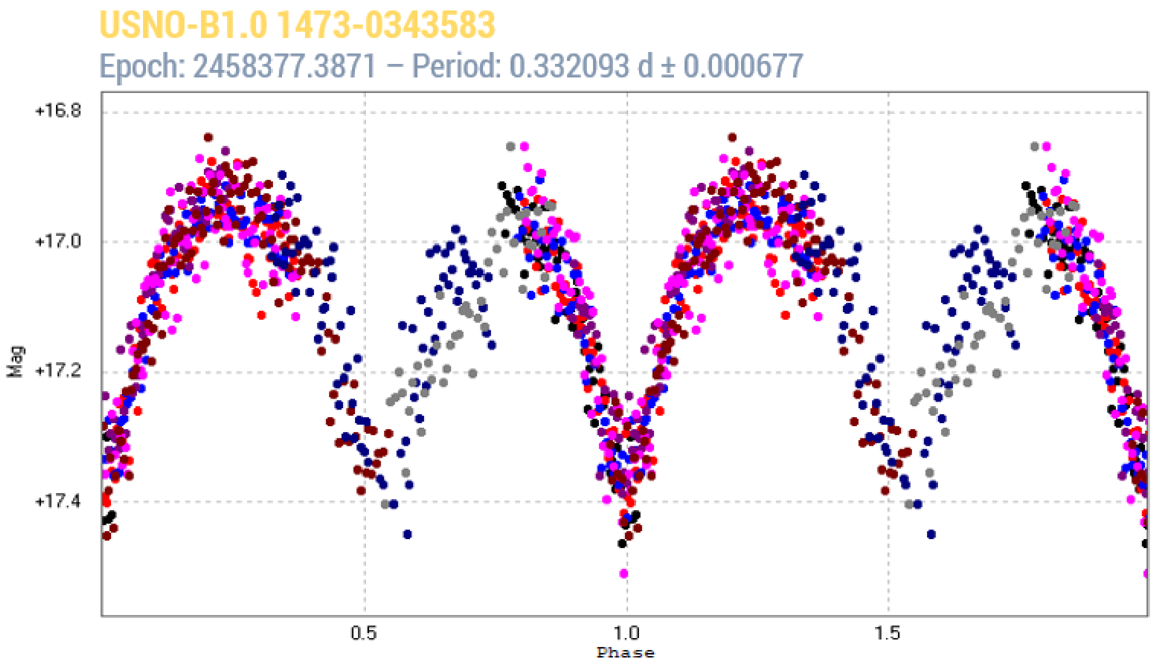

Figure 9: Phase plot of SSVS9 = USNO-B1.0 1473-0343583.

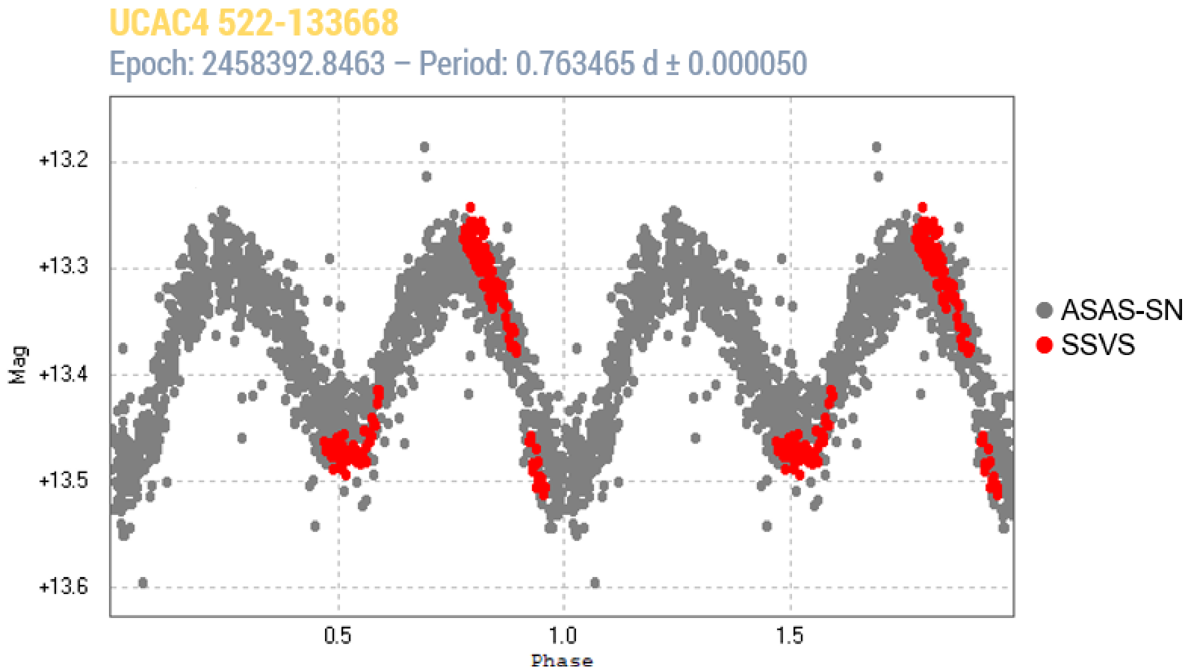

Figure 10: Phase plot SSVS10 = UCAC4 522-133668

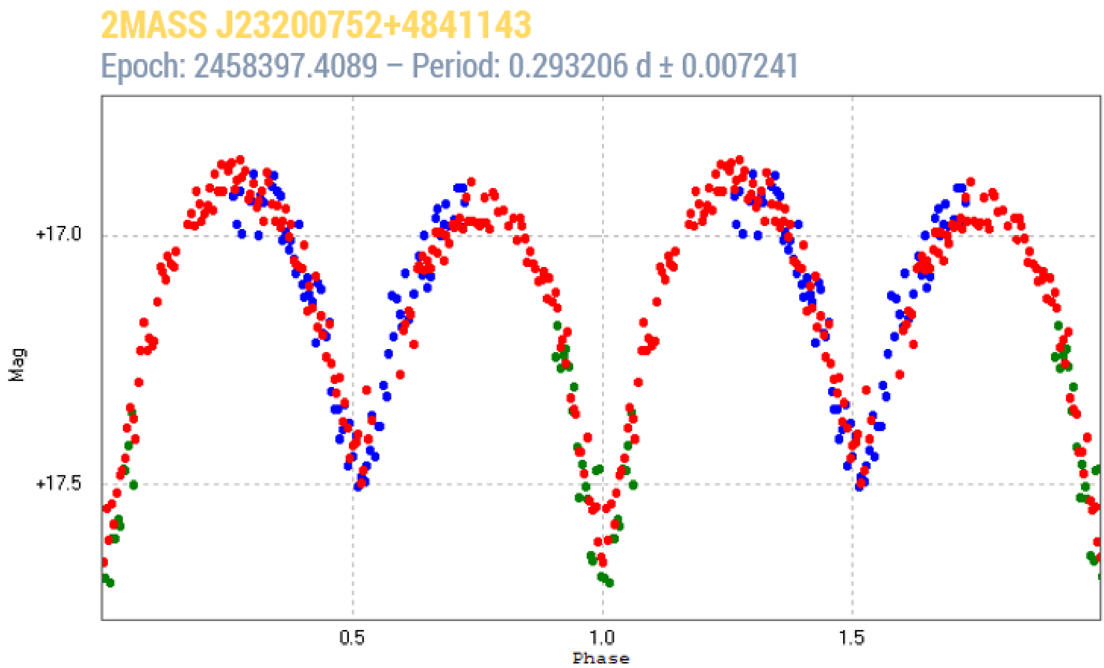

Figure 11: Phase plot of SSVS11 = 2MASS J23200752+4841143.

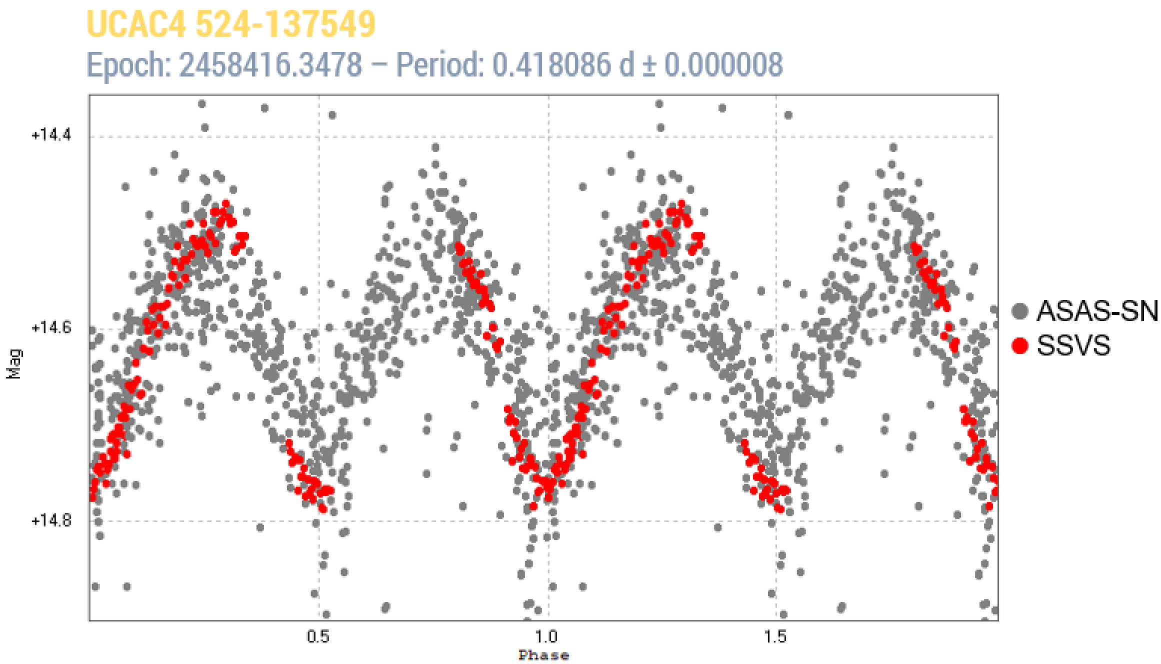

Figure 12: Phase plot of SSVS12 = UCAC4 524-137549.

5. Acknowledgments.

The authors thank Sebastián Otero, from AAVSO, for his help in the classification of these new variable stars.

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