COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS

Number 5768

Konkoly Observatory
Budapest
4 May 2007

HU ISSN 0374 – 0676

13 NEW ECLIPSING BINARIES WITH ADDITIONAL VARIABILITY IN THE ASAS CATALOGUE

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The All Sky Automated Survey has already collected over 6 years of observations for the majority of the sky (declinations $< +28°$), down to 14th magnitude. Semi-automatic classification of variable stars resulted in the ASAS Catalogue of Variable Stars — ACVS (Pojmański et al., 2006). For details on the classification procedure see Pojmański (2002). A big part of ACVS consists of eclipsing binaries, among them are 5384 contact (EC), 2957 semidetached (ESD), and 2758 detached (ED) binaries. Recently a sub-sample of these has been searched for period changes (Pilecki et al. 2007). During this investigation a side analysis was performed which resulted in 16 (13 new) binaries which are suspect to additional periodic behaviour of various origin; secondary variability may be due to spots, pulsations, or second eclipsing binary in the system. Two of them, namely 115143-6253.2 and 164802-6715.2, were found by D. Fabrycky, who pointed out (private comm.) that these stars showed eclipses with another period.

The search for second periodicity was performed on residual lightcurves of all EC and ESD binaries in ACVS (8,341 objects). After detecting an additional frequency for each object, all the lightcurves were sorted by amplitude of the frequency and the ones with a significant signal strength were inspected visually. This left us with 14 objects for which (together with additional two stars mentioned above) a more detailed analysis was performed.

In order to separate the lightcurves for both kinds of variability we applied an iterative method. In the first step the best fitting model of an eclipsing binary M_1 with orbital period P_1 was removed from the original lightcurve. Then we analysed the residual lightcurve in the search for secondary period P_2, which was used to construct the model M_2 of additional variability. This model was then subtracted from the original lightcurve and the residual lightcurve was again investigated to find a refined M_1. After subtracting the new M_1 from the raw lightcurve, the new M_2 was once again determined. In some cases one more step was performed to get a better model M_1.

Using residual lightcurves of models M_1 and M_2, variability was then classified with periods P_1 and P_2 using the same procedure as in Pojmański (2002). However, all pulsating types were combined into one PULS category and, when it was plausible, we changed automatic classification to ‘Spot’ type.

In Table 1 we listed both periods (P_1 and P_2), separate variability types and the possible degree of blending (0 for none, 1 for small and 2 for large) listed in two columns,

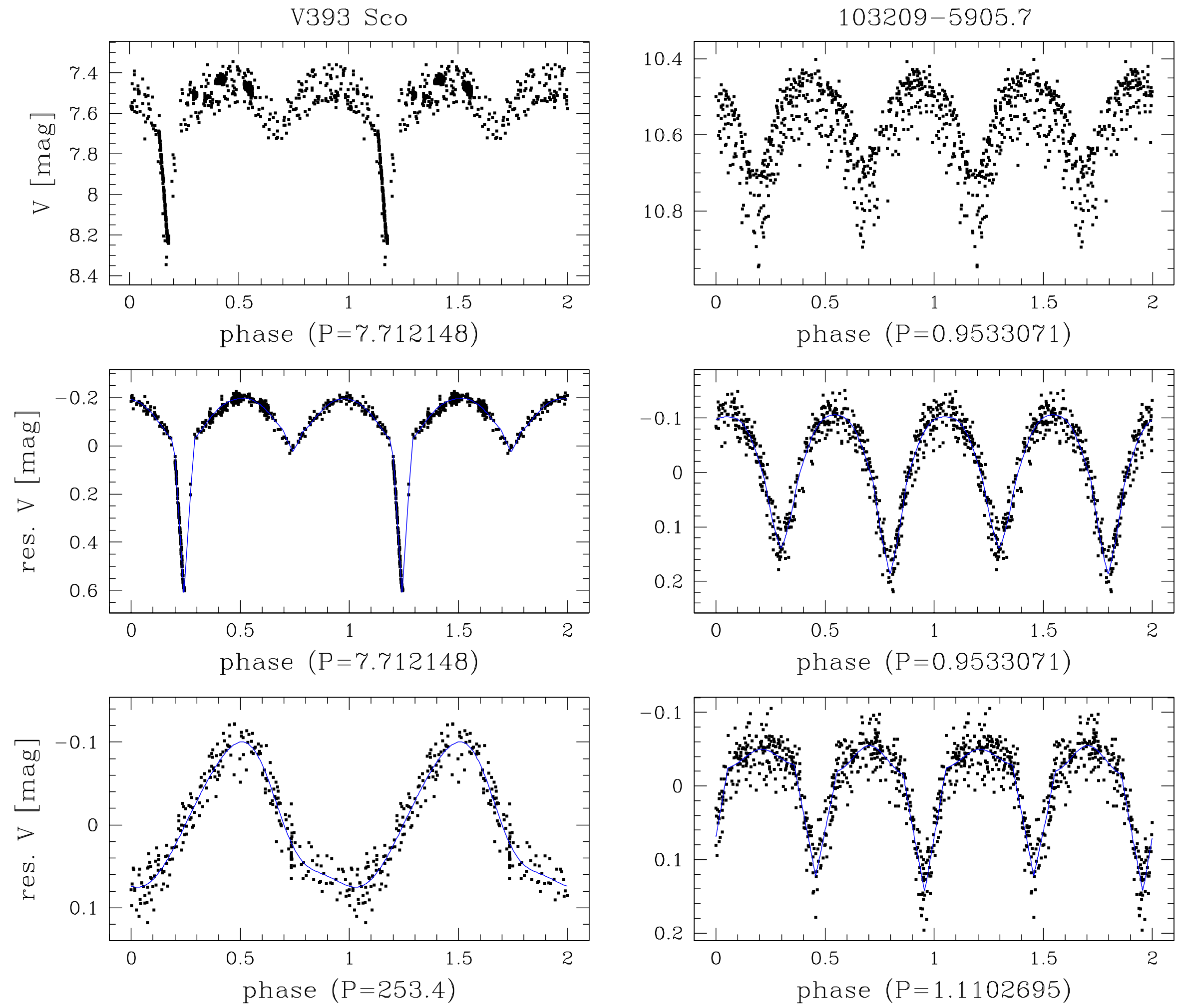

Figure 1. Two examples of double periodic behaviour. Original and residual lightcurves are showed. Plots of the rest of the light curves are given electronically

Table 1. ASAS eclipsing binaries exhibiting additional periodic variability

ASAS ID (RA-DEC)	$V_{\rm max}$ [mag]	P_1 [days]	Type	P_2 [days]	Type	Blend I A	Other data	Other ID
174848-3503.5	7.45	7.71215	ESD	253.4	PULS	0 0	B3III	V393 Sco
103209-5905.7	10.50	0.953307	ESD	1.110270	ESD = ED	2 1	F	HD 302992
153713-1820.1	8.38	6.86170	ESD	6.87811	Spot	0 0	K1III, X	IV Lib
172738-3808.6	11.56	0.378603	ESD	0.423350	EC/PULS	2 2	—	—
115143-6253.2	9.93	0.876114	ESD	19.11(×2)	ED	2 1	B5	BV 729
164802-6715.2	10.43	0.422509	EC = ESD	1.593378	ED/ESD	2 2	—	TYC 9050-298-1
144001-1959.5	10.00	0.354445	EC = ESD	0.334349	ESD/EC	0 1	G0, X	BD-19 3931
031509-5144.2	9.61	21.4105	EC/ESD	21.1067	Spot	1 0	K1, X	CD-52 646
125523-7322.2	9.74	206.1	EC	250.2	?	1 0	—	TYC 9253-1392-1
103513-1206.5	11.43	0.384647	EC	0.353901	ESD/EC	0 0	—	—
131055-4844.0	10.80	7.06562	EC?	3.537421	Spots?	2 0	—, X	—
103308-7133.8	10.58	0.816190	EC	0.388607	ESD=ED	0 0	—	TYC 9219-3329-1
190004-2741.4	12.24	0.439555	EC	0.537903	ESD/EC	2 2	—	V395 Sgr

Table 2. Objects examined independently by Pigulski & Michalska

ASAS ID (RA-DEC)	2nd type	Blend I A	Other ID
182323-1240.9	PULS	2 0	FR Sct
234520-3100.5	EC/PULS	0 0	—
084350-4607.2	ESD/EC	2 2	ALS 1135

designated by I and A. The first one (I) is the degree of blending evaluated subjectively by an examination of higher resolution images from Digitized Sky Survey, whereas A is the result of brightness comparison in different apertures of ASAS photometry. The radius of the smallest aperture is 1 pixel and for the largest 3 pixels, so two faint stars close to each other are separated when using small aperture and counted as one object when using a large aperture, significantly increasing the brightness. Some additional information from the SIMBAD database is given (if available) such as an other identifier, spectral type, and whether the star might be an X-ray source (X).

Two stars were found in the WDS catalogue of astrometric doubles and multiples (Mason et al., 2001). 234520-3100.5 was identified as a double star (11.58 mag + 11.94 mag) with a separation of 1″ and 125523-7322.2 (10.6 mag + 11.5 mag) with a separation of 2.4″.

In the course of this analysis 7 out of 13 objects turned out to be double eclipsing binaries (ie. quadruples that consist of two doubles), whereas one exhibits additional pulsations. For one object we have not been able to determine which of the above two scenarios is more probable. There are also 2 stars whose secondary periods have values close to that of primary periods. This kind of behaviour is believed to be due to spots on one of the binary's components. For the remaining two we have no plausible explanation.

Three stars listed in Table 2 were independently found and recently analysed by Pigulski & Michalska (2007a, 2007b). They found FR Sct to be a triple VV Cephei-type system, 234520-3100.5 to show additional δ Scuti behaviour, and 084350-4607.2 to exhibit β Cephei-type variations. For them we quote only our second variability type and an estimation of a degree of blending.

One star, namely 131055-4844.0, has a secondary period value close to (but not the same as) half the value of the primary variation period. Moreover, a residual lightcurve of the second variability has an eclipsing-like shape with two minima of different depth. This cautions, that the primary period may be two times smaller and the primary variability may be due to pulsations rather than eclipses.

Acknowledgements. We would like to thank D. Fabrycky for pointing out two stars with additional periodic behaviour. Our analysis made use of the Digitized Sky Survey images made available by the STScI. This work was supported by the MNiSW grant N203 007 31/1328.

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