TWO NEW ECLIPSING VARIABLE STARS IN THE FIELD OF RX J2133

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Abstract: Two new eclipsing variable stars USNO-B1.0 1411-0397871 and USNO-B1.0 1411-0397855 were discovered in the 9.4'x9.4' field of 1RXS J213344.1+510725 = RX J2133 which had been observed using the 1-meter Vihorlat National Telescope in the Astronomical Observatory on Kolonica Saddle. We preliminary registered these stars in the VSX (http://vsx.aavso.org/) and they got names VSX J213321.5+510857 and VSX J213320.0+510819, respectively.

Types of variability were determined as EW for both stars. For the statistical modeling, the program FDCN (Andronov, 1994) was used, which allowed to determine degrees of the statistically optimal trigonometric polynomials and all photometric parameters, which are needed for the General Catalogue of Variable Stars, with their corresponding errors.

During monitoring of the intermediate polar 1RXS J213344.1+510725 = RX J2133 using the 1-meter reflector "Vihorlat National Telescope" (Slovakia, Astronomical Observatory on Kolonica Saddle), equipped with CCD camera FLI PL1001Enand, Rc filter, two new variable stars were discovered. The first star is USNO-B1.0 1411-0397871 with the preliminary number VSX J213321.5+510857 (R.A.(2000)=$21^h33^m21.573^s$, Dec(2000)=+$51^d08^m57.04^s$) and the second is USNO-B1.0 1411-0397855 = VSX J213320.0+510819 (R.A.(2000)=$21^h33^m20.073^s$, Dec(2000)=+$51^d08^m18.83^s$). Also these stars got names Kol7 and Kol8 according to the catalog of new variable stars, discovered using the telescopes of Astronomical Observatory on Kolonica Saddle. All observations were obtained at R-band during 5 nights, which covers period from HJD= 2455059.31 to HJD=2455101.49. Both stars were classified as EW-type because of periods shorter than 1 day and amplitudes smaller than 0.8m.

These new variable stars were discovered on the one night observations (JD=2455059) while analyzing the dependence of the standard deviation on the mean brightness using the program package C-Munipack (Motl, 2007).

Locations of the star RX J2133, new variable stars and reference stars, are shown on the Fig.1. There were five reference stars, which were used for the ensemble photometry. Their names, positions, R-magnitudes and color indexes according to Henden (2009) are shown in the Tab.1.

№	Reference stars	Coordinates	R	V–R
1	USNO-B1.0 1411-0397967	$21^h33^m28.06^s$, +$51^d08^m57.2^s$	**15.727**	0.571
2	USNO-B1.0 1411-0398049	$21^h33^m34.19^s$, +$51^d08^m06.4^s$	**15.913**	0.671
3	USNO-B1.0 1411-0397971	$21^h33^m28.49^s$, +$51^d08^m31.7^s$	**15.733**	0.562
4	USNO-B1.0 1410-0399021	$21^h33^m21.38^s$, +$51^d04^m33.8^s$	**15.592**	0.504
5	USNO-B1.0 1410-0399093	$21^h33^m28.39^s$, +$51^d04^m30.3^s$	**15.459**	0.553

Tab.1. Numbers in USNO-B1.0, coordinates, R-magnitudes and color indexes for five reference stars which were used for calibration photometry.
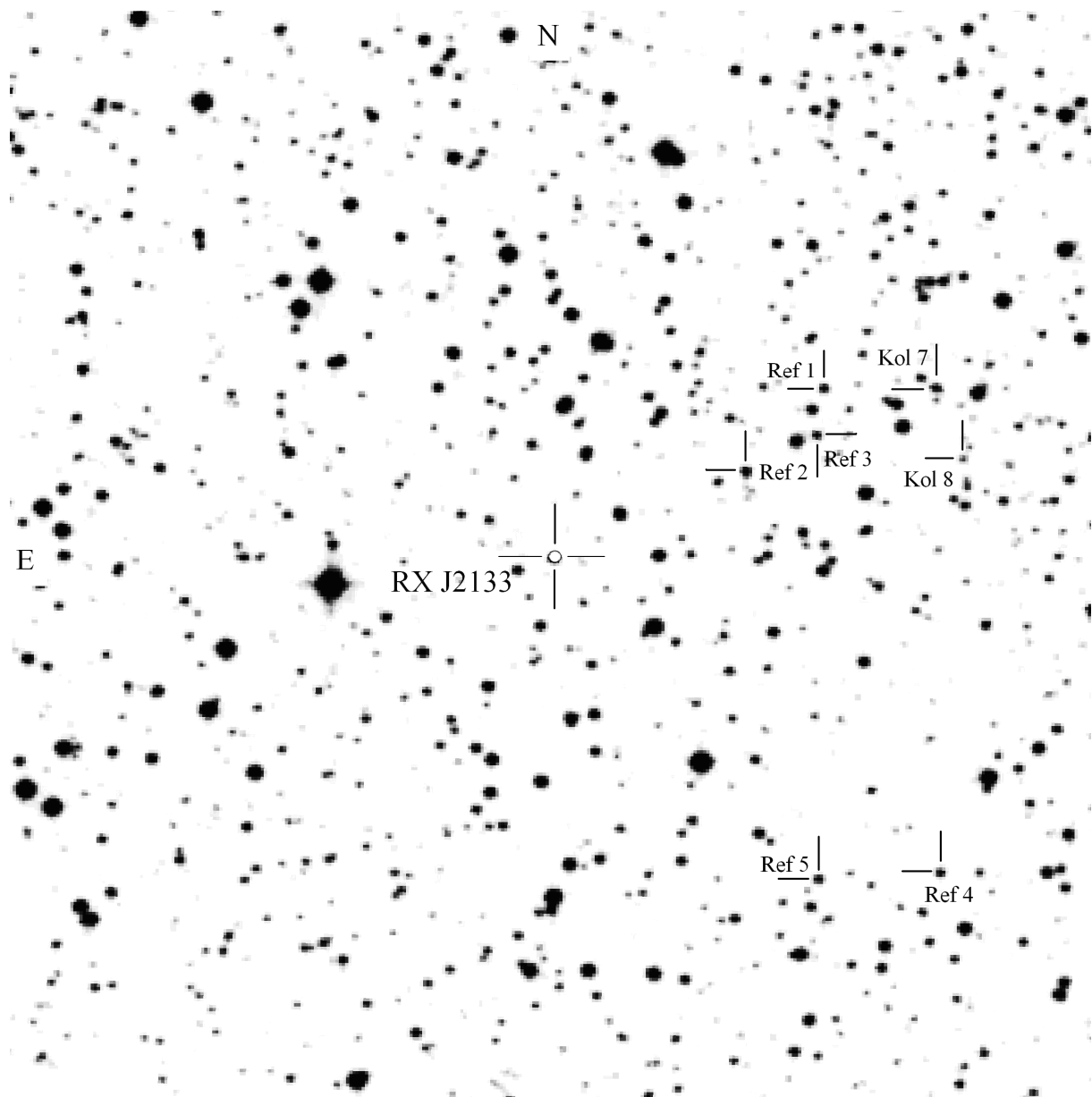
Fig.1. Finding chart for the new variable stars Kol7 and Kol8, and 5 reference stars. Field of view is 9.4'x9.4', which equals to the field of view of the "VNT". RX J2133 is also shown in the center.

The tables of original observations are available electronically as the attachments to this paper from the web-site of OEJV as Tab.3 and 4 respectively.

The approximate periods and initial epochs were determined using the period analysis software Peranso v2.20 (Vanmunster, 2007). The Lafler-Kinman (1965) method was used. Statistical properties of the non-parametric methods for the periodogram analysis were reviewed by Andronov and Chinarova (1997). The results are shown in the Fig.2 and 3.

Than all basic elements with corresponding errors, needed for General Catalogue of Variable Stars, were improved using the program FDCN (Andronov, 1994). In this program, the finding of the statistically optimal trigonometric polynomial was realized, based on the least squares method. This program allows to determine positions and values of maxima and

minima, corrected values of period and initial epoch. For better accuracy estimate, the initial epoch was chosen to be closest to the mean time of observations. The resulting trigonometrical polynomial fit m(ϕ) and its 1-σ and 2-σ coridors are shown in Fig.4 and 5.
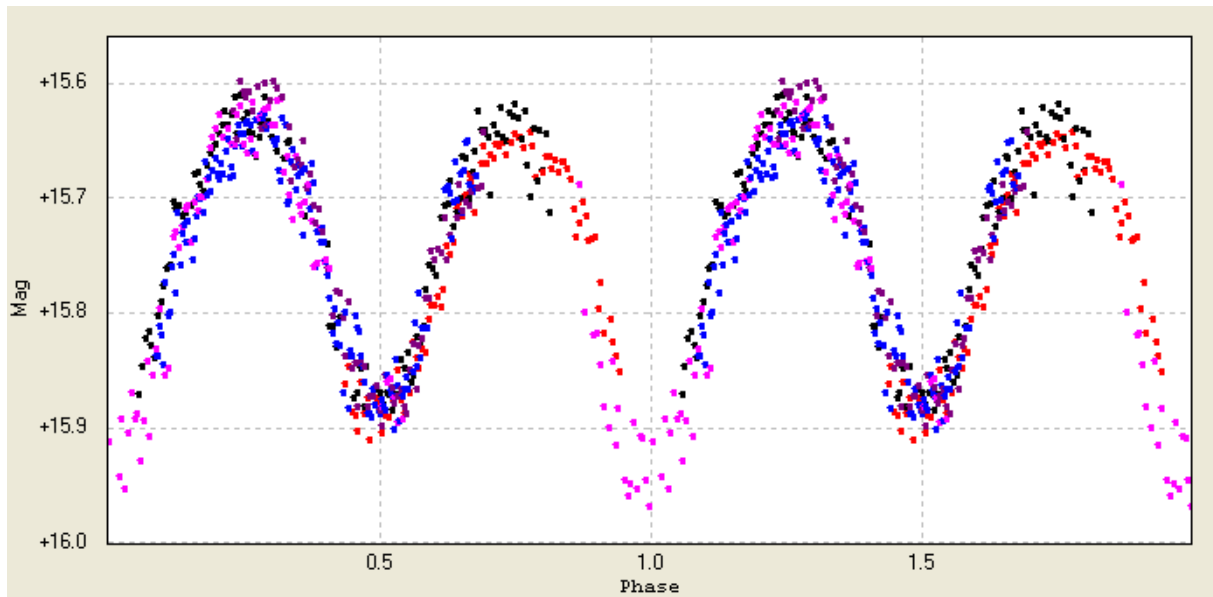

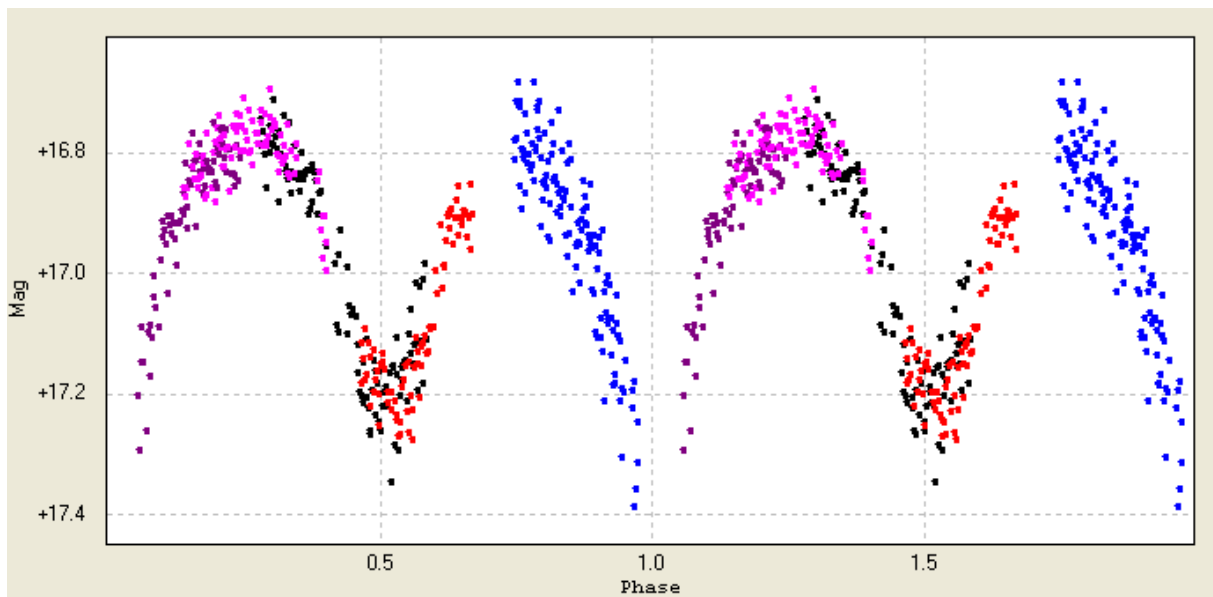Fig.2. Phase curve for Kol 7. Each color means another night.

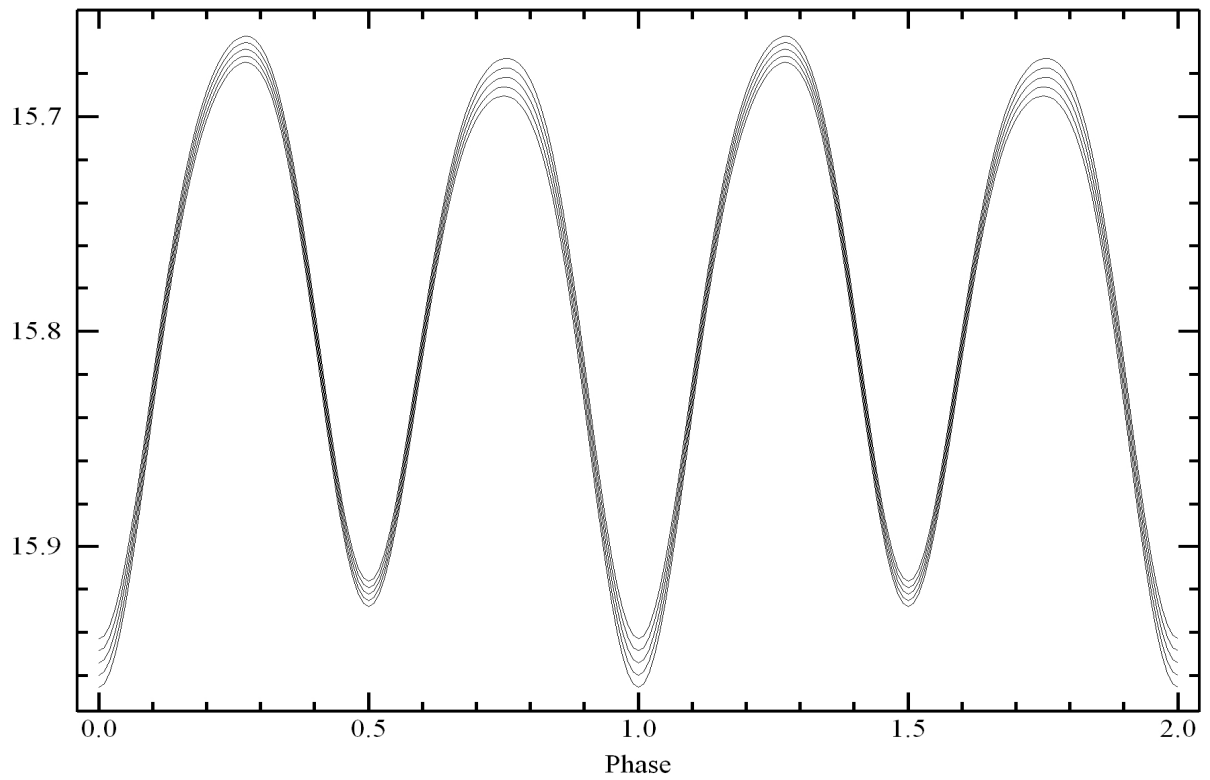Fig.3. Phase curve for Kol8. Each color means another night.

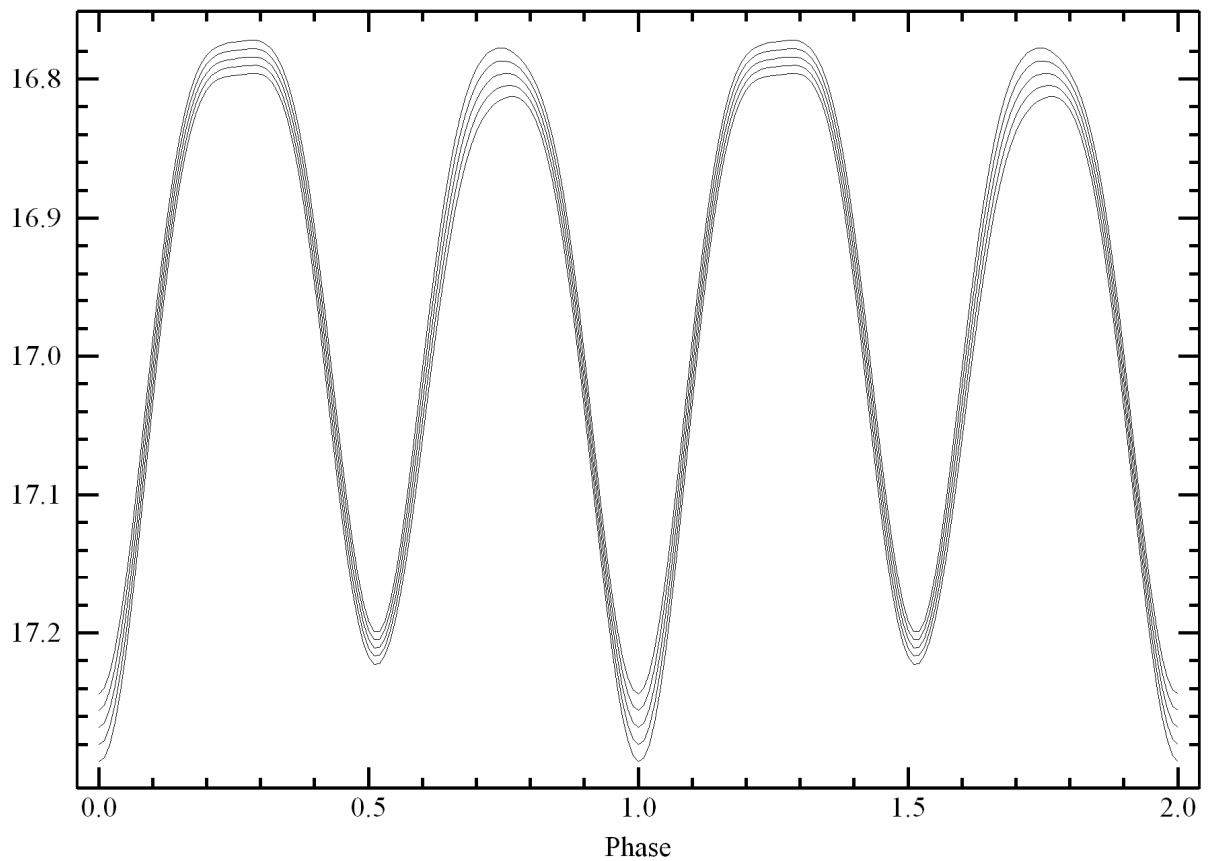Fig.4 Smoothing trigonometrical polynomial of statistically optimal degree s=4 for the star Kol7.

Fig.5 Smoothing trigonometrical polynomial of statistically optimal degree s=4 for the star Kol8.

Another possible solution for Kol8 is T_0=2455083.5781±0.0013, P=0.92529±0.00004. In this case, the phase light curve is not covered completely, only one minimum is visible. The corresponding phase curve is shown on the Fig. 6.
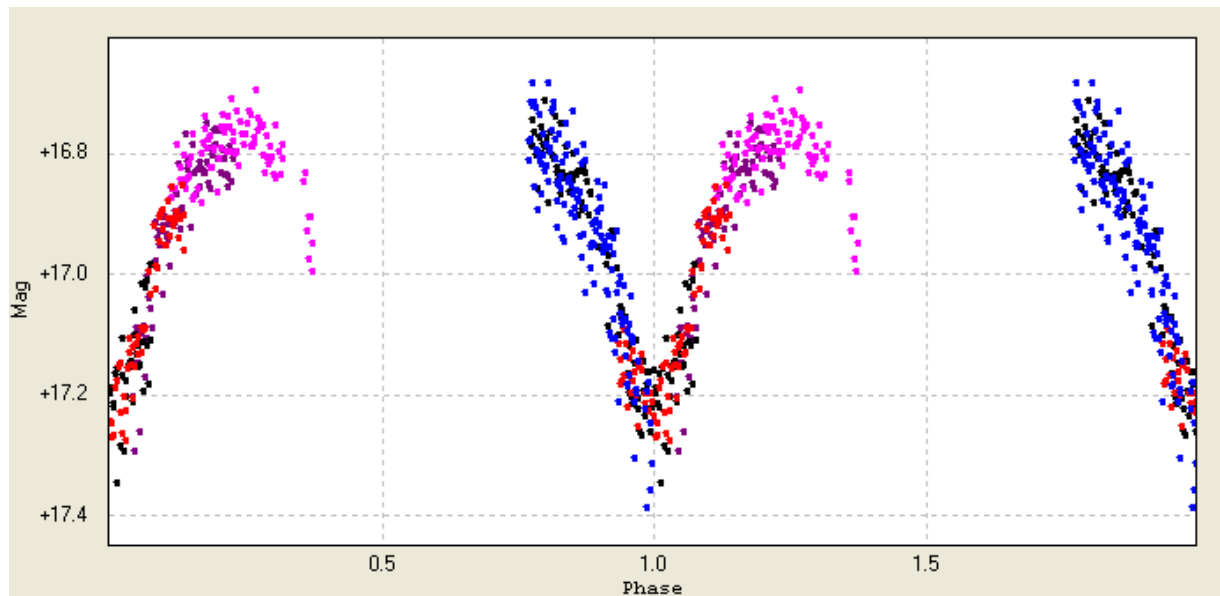

Fig. 6.

The Tab.2 presents all the parameters needed for the GCVS for these two newly discovered variables.

Parameters	Kol7	Kol8
Initial epoch (HJD)	2455084.1995±0.0005	2455083.7550±0.0023
Period (d)	0.371782±0.000006	0.91503±0.00015
$m_{min}I$ (R)	15.935±0.005	17.268±0.012
$m_{min}II$ (R)	15.887±0.003	17.210±0.006
m_{max} (R)	15.633±0.003	16.784±0.007
S	4	4

Tab. 2

Reference:
- AAVSO, http://www.aavso.org
- Andronov, 1994, OAP 9, 49 http://uavso.pochta.ru/OAP7_049.pdf
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