OPEN EUROPEAN JOURNAL ON VARIABLE STARS
September 2010 http://var.astro.cz/oejv ISSN 1801-5964

TWO NEW EW-TYPE ECLIPSING VARIABLES NEAR AK CNC

NATALIA A. VIRNINA

Department "High and Applied Mathematics"
Odessa National Maritime University, Odessa, Ukraine, virnina@gmail.com

Abstract: Two new eclipsing variable stars, USNO-B1.0 1015-0165372 = 2MASS 08543896+1133002 and USNO-B1.0 1017-0168554 = 2MASS 08534894+1143534, were discovered in the field of the cataclysmic variable star AK Cnc. The remotely controlled astrophysical refractor AP-180 of the Tzec Maun Observatory (USA) has been used.

Both binary systems were classified as EW-type. All parameters needed for the General Catalog of Variable Stars with corresponding errors were determined for both stars. We have registered these stars in VSX (Variable Stars Index, AAVSO) and these stars have got names VSX J085438.9+113300 and VSX J085348.9+114353, respectively.

We've observed the field, centered on the cataclysmic dwarf nova variable star AK Cnc during its superoutburst in January, 2010. Two new eclipsing variable stars were discovered in this field. All observations were obtained using the remotely controlled astrophysical refractor AP-180 (D=180mm, F=1317mm) of the Tzec Maun Observatory (Mayhill, New Mexico, USA). The field of view was 87.5' x 58.3', the scale was 2.63"/pix. All observations were unfiltered. This telescope was equipped with the CCD camera SBIG STL-11K. The maximum quantum efficiency of the camera sensor lies between 600nm and 625nm, which is close to the standard R-band. Although the "unfiltered" photometric system has a wider spectral band then the R one, the color transformation coefficients between the instrumental system and that of Henden (2007) are close to zero (Virnina, 2010). Thus we have used the calibration in R. The time used is UTC, taking into account the "leap second".

We have discovered the variability of USNO-B1.0 1015-0165372 and USNO-B1.0 1017-0168554 using the software package C-Munipack (Motl, 2007) by analyzing the dependence of the standard deviation of the brightness estimates for a given star on its mean brightness.

For calibration our photometry we used three reference stars: USNO-B1.0 1012-0165673, USNO-B1.0 1012-0165793 and USNO-B1.0 1012-0165741. Their magnitudes in R-band according to the AAVSO chart 3722kh (the 30'-vicinity of AK Cnc), are given in the Table 1, and their positions with the position of AK Cnc are marked on the Figure 1. The 20'-vicinity of the new variable stars are shown on the Figure 2 and 3. The overall field used is available as Appendix 3. The r.m.s. values of the deviations of the magnitude differences for the comparison stars from corresponding mean values are 0.021, 0.023 and 0.024 mag for (Ref2-Ref1), (Ref3-Ref1) and (Ref3-Ref2), respectively.

To determine the approximate values of the periods of new variable stars and to make the preliminary light curves, the software "WinEffect" (Goransky, 2005) was used. The periods have been determined from the periodogram analysis using the method by Lafler and Kinman (1965). Statistical properties of the non-parametric methods of the periodogram analysis were reviewed by Andronov and Chinarova (1997). Both stars were classified as EW-type.

Then the FDCN software (Andronov, 1994, 2003) was used, which allows to determine the coefficients of the statistically optimal trigonometric polynomials using the least squares method routine with differential corrections for the period. Other parameters of the light curve and their error estimates are determined using this approximation.

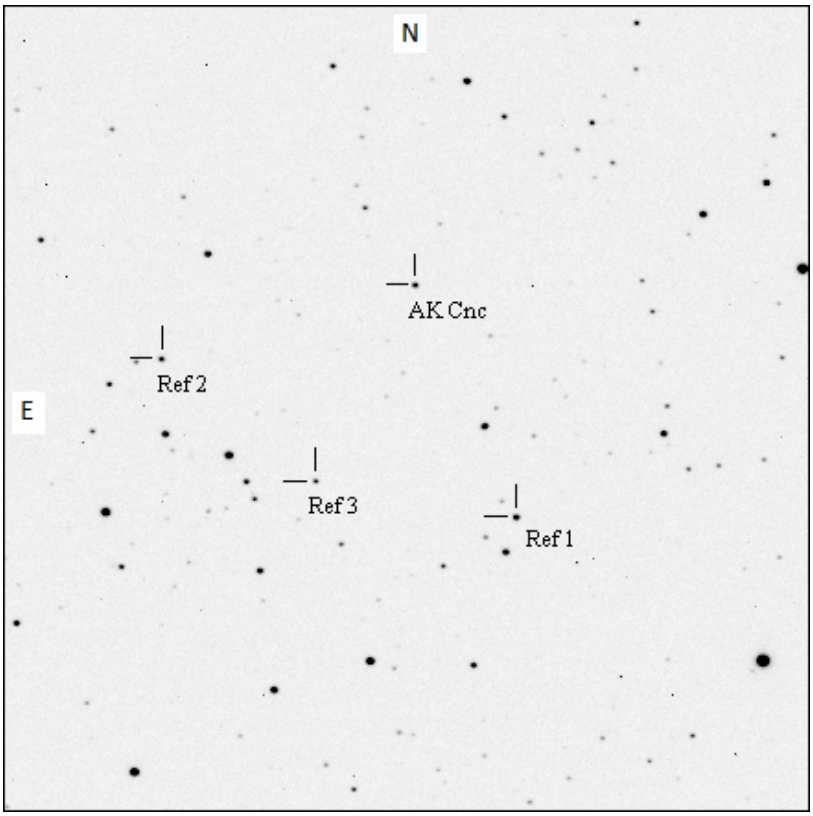

Figure 1. Reference stars and AK Cnc. The field of view is 20'x20'.
North is up, East is left.

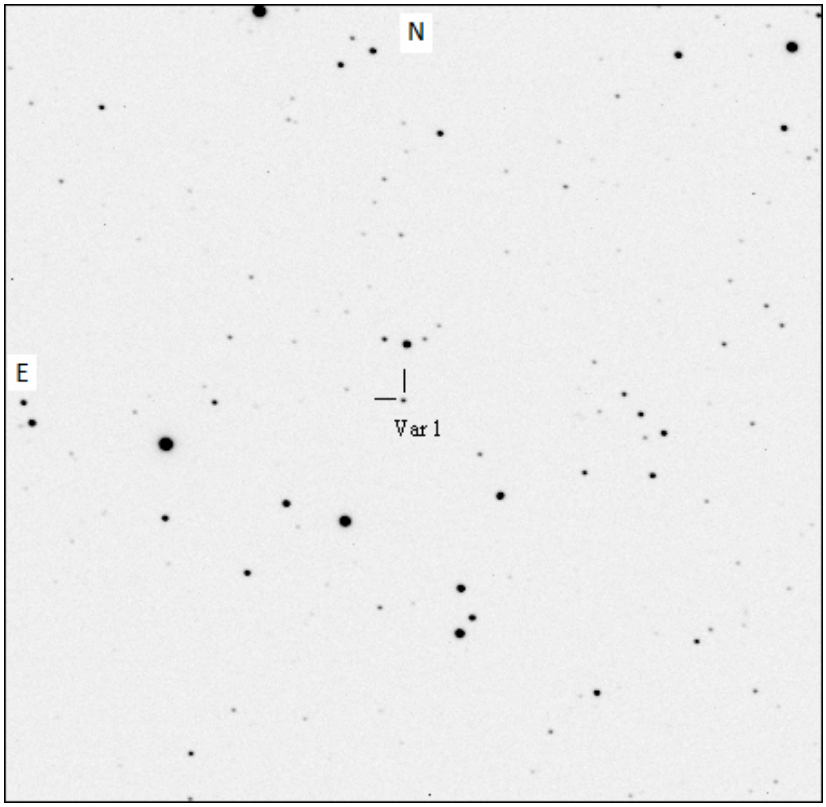

Figure 2. The 20' vicinity of USNO-B1.0 1015-0165372.
North is up, East is left.

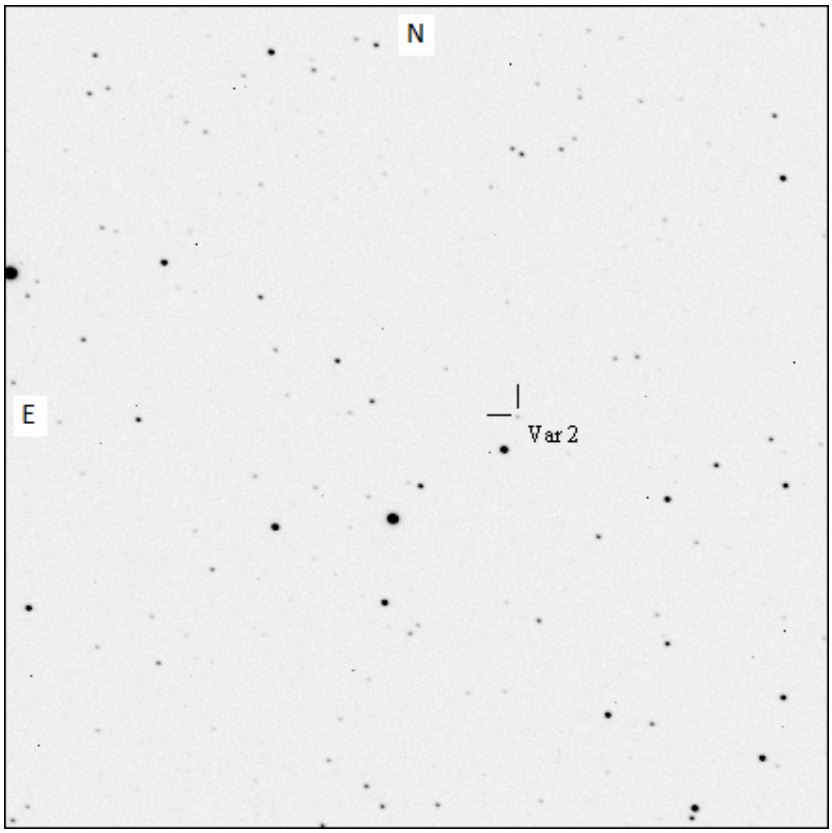

Figure 3. The finding chart for the USNO-B1.0 1017-0168554. North is up, East is left.

For the first variable star, USNO-B1.0 1015-0165372, the degree of the statistically optimal smoothing trigonometric polynomial is s=6. We determined the value of the period P=0.434515±0.000016 d, the initial epoch is T_0=HJD2455233.6296±0.0006. The minima and maxima: min_I=14.558±0.004, min_{II}=14.408±0.004, Max_I=14.170±0.003. The phase curve is shown on the Figure 4. There is not enough data to determine the value of the second maximum. But it is clear that the second maximum on the phase curve is higher than the first one, which means that there might be a spot in the atmosphere of at least one of the stars.

The degree of the smoothing polynomial for the second star, USNO-B1.0 1017-0168554, is s=4. The period is P=0.268769±0.000026, the initial epoch T_0=HJD2455233.4364±0.0011. The values of minima and maxima: min_I=16.376±0.014, min_{II}=16.296±0.014, Max_I=16.006±0.011, Max_{II}=16.035±0.013. The phase curve of this star is shown on the Figure 5.

We've preliminary registered our new variable stars in the VSX catalog, operated by AAVSO. The first star, USNO-B1.0 1015-0165372 has got name VSX J085438.9+113300, the second star, USNO-B1.0 1017-0168554 has got name VSX J085348.9+114353.

The whole information about these new binary systems was summarized in the Tables 2 and 3. The Table 2 contains the coordinates and the cross-identification. In the Table 3 there are values of the periods, initial epochs, minima and maxima.

The tables of HJD photometry are attached to the paper as Appendix 1 and 2.

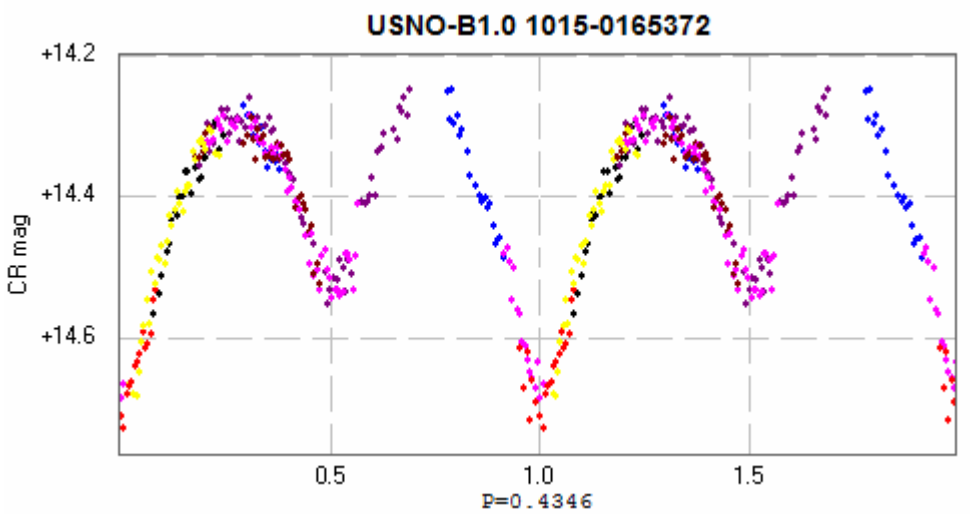

Figure 4. The phase curve of the USNO-B1.0 1015-0165372 = VSX J085438.9+113300
Each color means another night.

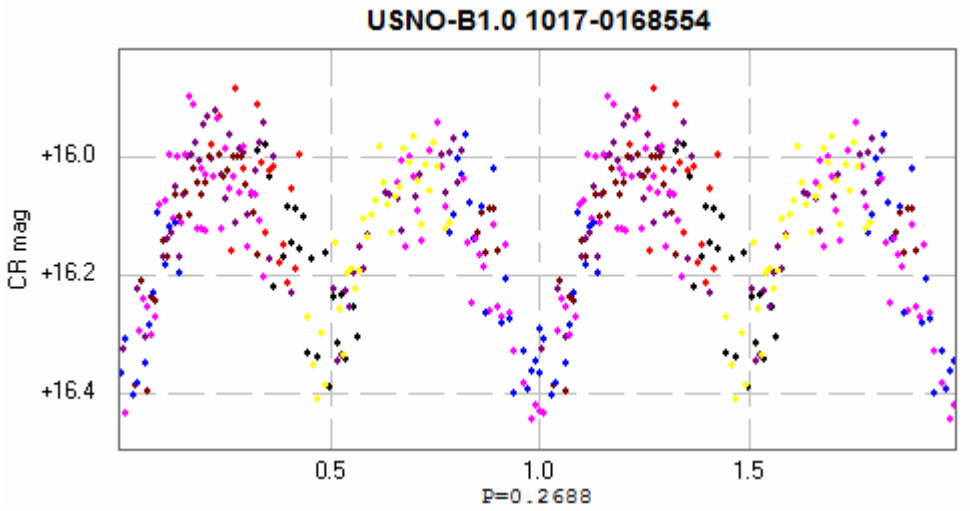

Figure 5. The phase curve of the USNO-B1.0 1017-0168554 = VSX J085348.9+114353.
Each color means another night.

Table 1. Comparison stars.

	USNO-B1.0	RA (2000.0)	Dec (2000.0)	R mag
Comp 1	1012-0165673	$08^h55^m11.347^s$	$+11^d12^m44.46^s$	13.201
Comp 2	1012-0165793	$08^h55^m45.753^s$	$+11^d16^m28.69^s$	13.801
Comp 3	1012-0165741	$08^h55^m30.773^s$	$+11^d13^m35.74^s$	14.516

Table 2. Coordinates and cross-identifications of the discovered stars

#	USNO-B1.0	RA	Dec	VSX
1	USNO-B1.0 1015-0165372	$08^h54^m38.967^s$	$+11^d33^m00.23^s$	VSX J085438.9+113300
2	USNO-B1.0 1017-0168554	$08^h53^m48.933^s$	$+11^d43^m53.64^s$	VSX J085348.9+114353

Table. 3. Characteristics of the discovered stars

#	Type	Period, d	Max	min_I	min_{II}	Initial epoch, HJD
1	EW	0.434515±0.000016	14.170±0.003	14.558±0.004	14.408±0.004	2455233.6296±0.0006
2	EW	0.268769±0.000026	16.006±0.011	16.376±0.014	16.296±0.014	2455233.4364±0.0011

Acknowledgements:

This work is based on data collected with the Tzec Maun Observatory, operated by the Tzec Maun Foundation. The author is grateful to Ron Wodaski (director of the observatory) and Donna Brown-Wodaski (director of the Tzec Maun Foundation).

Also the author is thankful to Prof. Ivan L. Andronov for helpfull discussions.

References:

- AAVSO, http://www.aavso.org
- Andronov I.L., 1994, OAP 7, 49, http://cdsads.u-strasbg.fr/abs/1994OAP.....7...49A , http://uavso.pochta.ru/OAP7_049.pdf
- Andronov I.L., 2001, OAP 14, 255, http://cdsads.u-strasbg.fr/abs/2001OAP....14..255A , http://oap14.pochta.ru/OA14_255.pdf
- Andronov I.L., 2003, ASPC 292, 391, http://cdsads.u-strasbg.fr/abs/2003ASPC..292..391A
- Andronov I.L., Baklanov A.V., 2004, Astronomy School Reports, 5, 264, http://uavso.pochta.ru/mcv
- Andronov I.L., Chinarova L.L., 1997, KFNT 13, 67, http://cdsads.u-strasbg.fr/abs/1997KFNT...13f..67A
- Goransky V.P., 2005, http://vgoray.front.ru/software/
- Henden A., 2007, ftp://ftp.aavso.org/public/calib/
- Lafler J., Kinman T.D., 1965, ApJ.Suppl., 11, 216, http://adsabs.harvard.edu/abs/1965ApJS...11..216L
- Motl D., 2007, C-Munipack Project v1.1, http://integral.physics.muni.cz/cmunipack/index.html
- Samus N.N. et al., General Catalogue of Variable Stars, http://cdsads.u-strasbg.fr/abs/2009yCat....102025S , http://www.sai.msu.su/groups/cluster/gcvs/
- Tsesevich V. P. (ed.), 1971, Instationary stars and methods of their investigation. Eclipsing variables., Moskva: Nauka, 352 p. 1971isme.conf.....T
- Virnina N. A., 2010, OEJV, 124, 1, http://cdsads.u-strasbg.fr/abs/2010OEJV..119....1V, http://var.astro.cz/oejv/issues/oejv0124.pdf
- VizieR, 2010, http://vizier.u-strasbg.fr/viz-bin/VizieR