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

A NEW BINARY SYSTEM WITH AN UNUSUAL ASYMMETRIC LIGHT CURVE

NATALIA A. VIRNINA, IVAN L. ANDRONOV

Department "High and Applied Mathematics",
Odessa National Maritime University, Odessa, Ukraine, virnina@gmail.com, il-a@mail.ru

Abstract: We report the discovery of a new eclipsing binary system USNO-B1.0 1629-0064825 ($05^h28^m07.975^s$, $+72^d56^m06.05^s$) with an unusual asymmetric light curve. The first maximum is much higher than the second one. Another feature of this curve is that the secondary minimum is shifted from the phase 0.5, the phase of the secondary minimum is ϕ=0.543±0.007. From the pure monochrome photometry, this star is very similar to the well known binary system V361 Lyr. We assumed that there is an accretion stream which impacts into the atmosphere of the star-accretor and forms a hot spot.

All parameters needed for the General Catalog of Variable Stars were determined with corresponding error estimates. We have preliminary registered this variable star in the VSX, the star has got the name VSX J052807.9+725606.

We discovered a new eclipsing binary system USNO-B1.0 1629-0064825 ($05^h28^m07.975^s$, $+72^d56^m06.05^s$) using the remotely controlled astrophysical refractor AP180 (D=180 mm, f/7.32) of Tzec Maun Observatory (USA). This telescope was equipped with the unfiltered monochrome CCD camera SBIG STL-11K. The field of view was 87.5' x 58.3'. The maximum quantum efficiency of the camera sensor is close to the standard R-band.

To discover this variable star, we used the software package C-Munipack (Motl, 2007). The position of the new variable star and the reference stars are marked on the Fig. 1.

Our observations cover the interval from JD 2455249 to JD 2455274 in which we obtained 10 fit series of observations.

We chose 3 stars to calibrate the photometry: USNO-B1.0 1629-0065214, USNO-B1.0 1628-0064903, USNO-B1.0 1629-0065309 to decrease the mean error. Unfortunately, there is no data in photometry catalogs on the stars in the vicinity of our new binary system. Therefore we were forced to use the USNO-B1.0 photometry. The star USNO-B1.0 1629-0065214 has a slightest difference between R1 and R2 measurements: R1=14.37 mag, R2=14.38 mag, so we used the mean value R=14.375 mag. Then, using 20 qualitative images, we calculated comparative magnitudes for another two comparison stars. We got R=13.849 mag for USNO-B1.0 1628-0064903 and R=14.438 mag for USNO-B1.0 1629-0065309. The information about these reference stars is given in the Tab. 1. All HJD photometry data are attached to the paper and are available from the OEJV web-site. The time used is UTC, taking into account the "leap second".

We used the sotware "WinEffect" (Goransky, 2005) to find the approximate value of the period and to made the preliminary phase curve. For the periodogram analysis, the method by Lafler and Kinman (1965) was chosen. Then the software FDCN (Andronov, 1994, 2003) was used to compute the coefficients of the statistically optimal trigonometric polynomial, using the least squares method routine and differential correction for the period. Also we have used the program MCV (Andronov and Baklanov 2005). All the parameters needed for the General Catalog of Variable Stars (GCVS, Samus' et al. 2010) have been determined with corresponding error estimates. The degree of the statistically optimal trigonometric polynomial is s=6. The period of P=0.41179±0.00005 d, the initial epoch T_0=HJD 2455261.8484±0.0016. The values of maxima and minima: min_I=16.590±0.020, min_{II}=16.387±0.018, Max_I=15.924±0.016, Max_{II}=16.213±0.020. The final phase curve is shown on Fig. 2. The smoothing curve with the corresponding ±1σ and ±2σ corridors is

shown on Fig. 3. We registered the new variable star in the VSX catalog as an eclipsing binary system (E-type) and the star has got the name VSX J052807.9+725606.

It is very unusual that the difference between maxima is so large; its value is 0.289±0.026 mag. Besides, the secondary minimum is shifted from the phase ϕ=0.5. In fact, the phase of the secondary minimum is ϕ=0.543±0.007. The possible explanation of such asymmetric light curve is that there is a spot in the atmosphere of one of the stars.

Is there a hot spot or a cold one? The cold spot, which decreases the brightness of the system by almost 0.3 magnitude (it means that the spot covers a rather big area) can't be too steady. In this case the further observations must show the changes in the form of the phase curve. On the other hand, the present form of the curve is very close to that one of the well known exotic binary system V361 Lyr. The first, who proposed the explanation of such unusual form of its phase curve were Andronov and Richter (1987). They assumed that one of the components fills its Roche lobe. The accretion stream doesn't form the accretion disk, but, deviated by the Coriolis force from the line of centers, impacts into the photosphere of the accretor with a shift towards the orbital motion. The shock appears, which heats the surrounding plasma, and a hot spot is formed in the atmosphere. Such systems may be called "impactors".

Both stars, the V361 Lyr and VSX J052807.9+725606, are short periodic binary systems with an extremely big difference between the maxima, and, for both stars, the secondary minimum is shifted a little from the phase 0.5 in the same positive direction. So, we assume that VSX J052807.9+725606 is similar to V361 Lyr. Further observations may clarify this question.

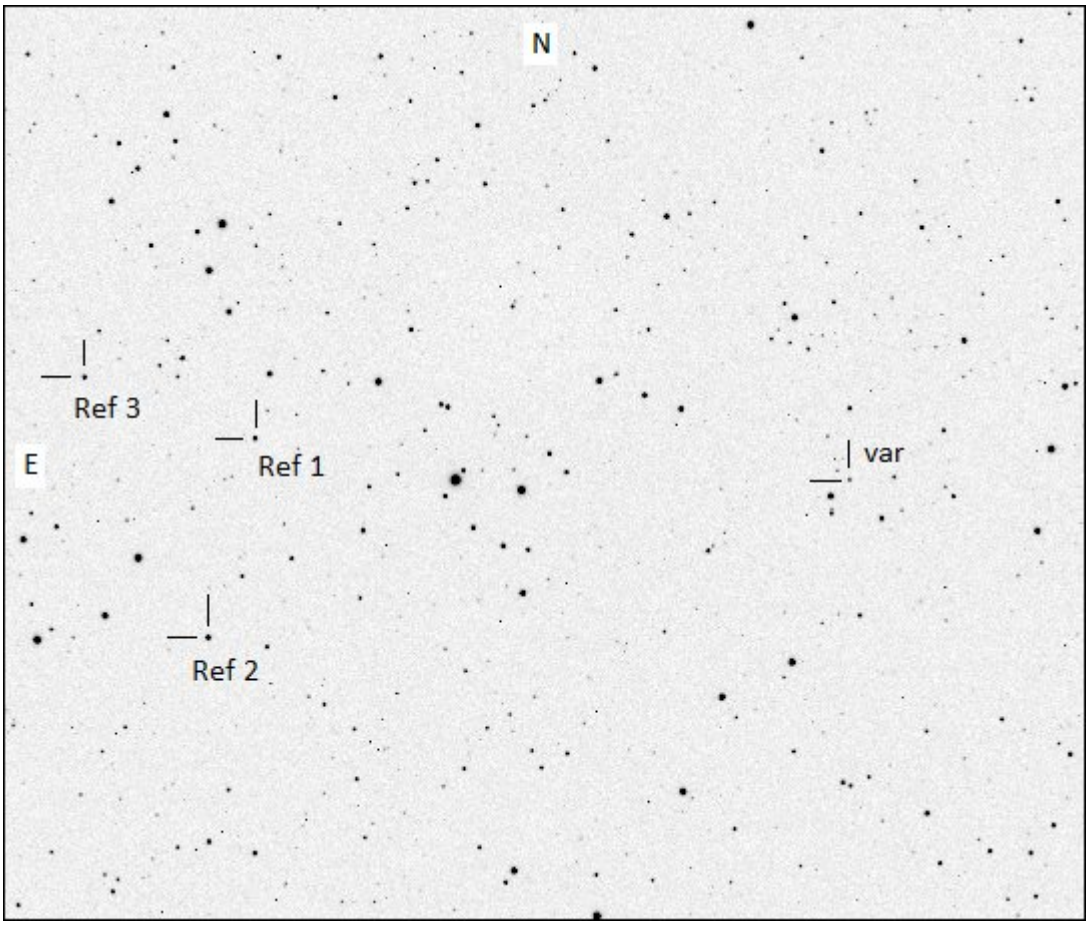

Fig. 1. Finding chart. The new variable star VSX J052807.9+725606 and the reference stars are marked. The field of view is 25' x 20'.

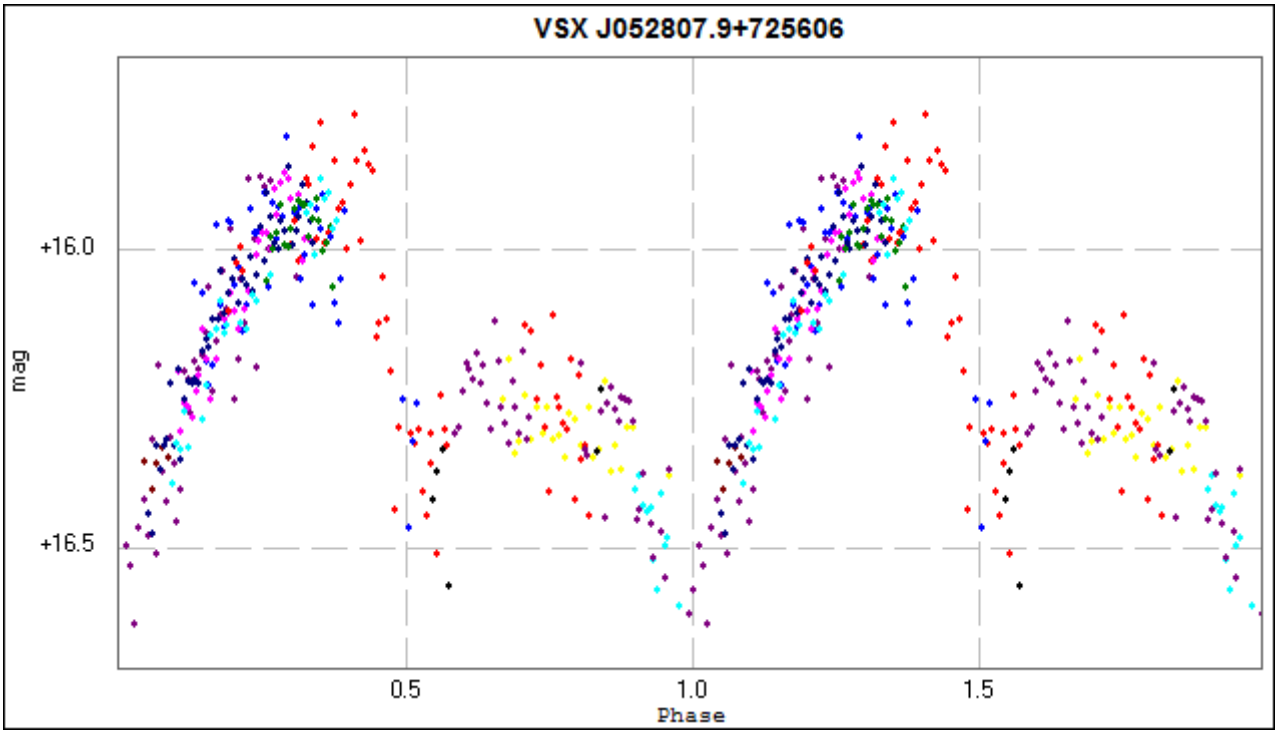

Fig. 2. The phase curve. Different colors mean different nights of observations.

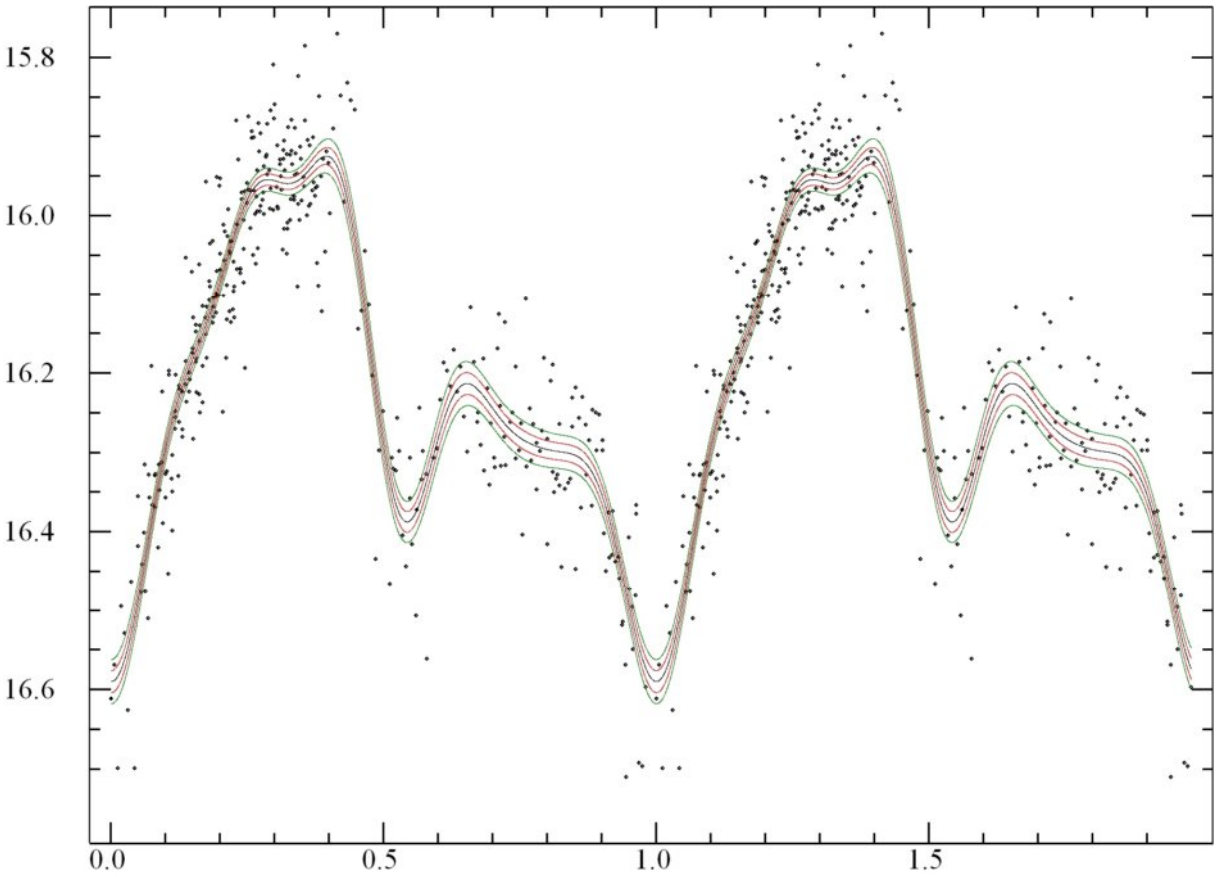

Fig. 3. The phase curve and its statistically optimal trigonometric polynomial fit of order s=6 with corresponding ±1σ and ±2σ corridors.

Tab. 1. The reference stars.

#	USNO-B1.0	RA	DEC	R mag
1	USNO-B1.0 1629-0065214	$05^h31^m05.161^s$	$+72^d57^m01.62^s$	14.375
2	USNO-B1.0 1628-0064903	$05^h31^m18.891^s$	$+72^d52^m40.76^s$	13.849
3	USNO-B1.0 1629-0065309	$05^h31^m56.249^s$	$+72^d58^m21.06^s$	14.438

Acknowledgments:

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).

References:

- Andronov I.L., 1994, OAP 7, 49, 1994OAP.....7...49A , http://uavso.pochta.ru/OAP7_049.pdf
- Andronov I.L., 2003, ASPC 292, 391, 2003ASPC..292..391A
- Andronov I.L., Baklanov A.V., 2004, Astronomy School Reports, 5, 264, http://uavso.pochta.ru/mcv
- Andronov I. L., Richter G. A., 1987, V 361 Lyrae - an exotic binary system with a 'hot spot' between the components, 1987AN....308..235A
- Goransky V.P., 2005, http://vgoray.front.ru/software/
- Lafler J., Kinman T.D., 1965, ApJ.Suppl., 11, 216, 1965ApJS...11..216L
- Motl D., 2007, C-Munipack Project v1.1, http://integral.physics.muni.cz/cmunipack/index.html
- Samus' N.N. et al., 2010, General Catalog of Variable Stars, 2009yCat....102025S , http://www.sai.msu.su/groups/cluster/gcvs/
- VizieR, 2010, http://vizier.u-strasbg.fr/viz-bin/VizieR
- VSX, http://vsx.aavso.org/