

Four new BY Draconis variables found in the NSVS data

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Abstract: As a part of VS-COMPAS data-mining program, in the paper four new rotating BY Draconis variables are presented. The research result on these objects is submitted to the VSX catalog for the first time by the VS-COMPAS team members. Photometric data from publicly available surveys (primarily, from the NSVS and CRTS) was used as a source for light curves.

I. Introduction

The BY Draconis variables are rotating K and M dwarfs which exhibit low-amplitude photometric variability with typical periods of a few days. These variable stars have been of exceptional importance in the development of stellar surface activity understanding and provided the important source of data to connect theory of spotted star's surface with rotation.

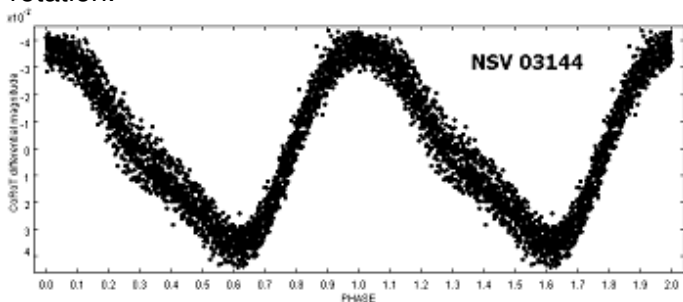


Figure 1. – Typical phase diagram of BY Draconis variable. The sample above is NSV 03144 (J.Greaves, 2010; PZP, 10, 8)

Resultant brightness fluctuations are generally less than 0.5 magnitudes. The first discovered BY Draconis variable is Ross 248 (HH Andromedae). Its variability was discovered by Gerald E. Kron in 1950. The variability of BY Draconis itself was discovered in 1966 and studied in detail by Chugainov in 1966 (Hall, 1994). The spectra of BY Dra variables are similar to RS CVn stars - another class of variable stars with active chromospheres. BY Draconis is a close binary consisting of a K6V dwarf and a M0V dwarf with an orbital period of 5.975 days and a mean separation of 0.05 AU.

Some of BY Draconis variables show flares, and are therefore UV Ceti stars (flare stars).

A model characterized by cooler, darker regions (starspots) on the surface of a rotating star appears to explain BY Draconis photometric variations (Kron, 1952; Torres and Ferraz Mello, 1973; Bopp and Evans, 1973; Vogt, 1975).

II. Candidates pre-selection and analysis

Candidates for analysis were selected by a custom piece of software created by I.Adamin. The

software used the publicly available photometric databases, such as the Northern Sky Variability Survey (Woźniak et al., 2004), The Catalina Real-time Transient Survey (Drake et al., 2012), as a source of photometric measurements.

Then, the whole set of candidates was distributed among the VS-COMPAS Project team members for further analysis. During this phase of research there was a custom period search and data analysis software used, created by combined efforts of A.Prokopovich and I.Adamin.

For high-precision periodogram calculation the Lafler-Kinman (Lafler, Kinman, 1965) statistical algorithm implementation was used. The VizieR web services were broadly used for obtaining data on the objects.

III. The list of discovered objects

We report the discovery of 4 new variables of BY Draconis type. These are: VSX J095115.5+220811, NSVS 352541, NSVS 6762026, NSVS 18711283.

Below the results of this research are presented: a light curve for each object along with the name of its discoverer and light curve elements (cf. Table 1).

For NSVS 352541 (J-K = 0.79) magnitudes are contaminated by two neighbors:

2MASS J01353005+6910236

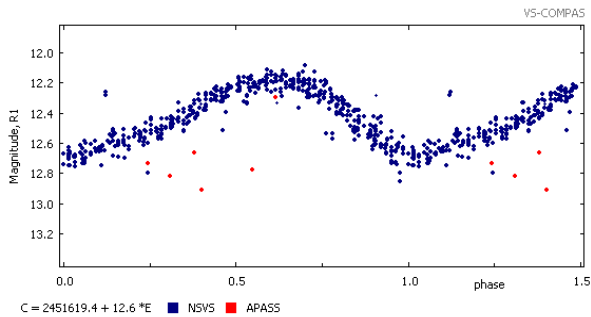
(J-K = 0.93, V = 14.35)

2MASS J01352603+6909398

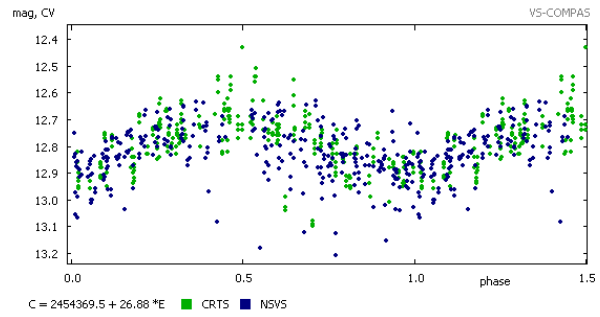
(J-K = 0.36, V = 14.0).

Thus, the range has been corrected for this object, taking into account photometric properties of its neighbors..

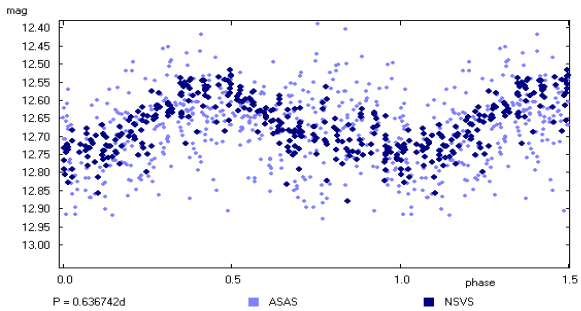
VSX J095115.5+220811 is particularly interesting for its short period, which is 0.636742 of a day. There are only 149 BY Draconis variables with period less than a day (out of 2633) in the VSX catalog at the moment of publication.



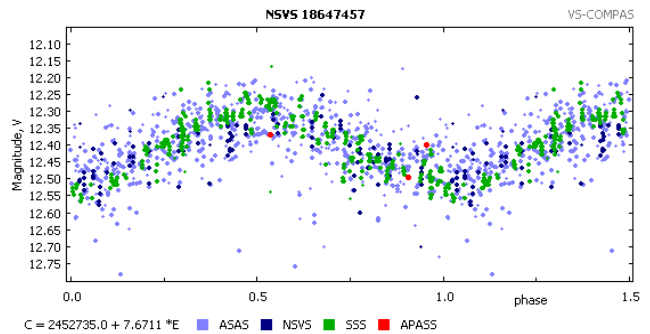
NSVS 352541 in Cassiopeia
by Alexandr Ditkovsky (VS-COMPAS)



NSVS 6762026 in Taurus
by Valery Tsehmeystrenko (VS-COMPAS)



VSX J095115.5+220811 in Leo
by Andrey Prokopovich, Ivan Adamin (VS-COMPAS),
Sebastian Otero



NSVS 18711283 in Centaurus
by Alexandr Ditkovsky (VS-COMPAS)

Table 1. – The list of discovered BY Draconis variables, presented in the paper for the first time.

Object Designation	RA (J2000)	DEC (J2000)	Var. Type	Epoch, HJD	Period	Mag. Range
NSVS 352541	01 35 31.60	+69 09 55.3	BY	2451619.4	12.6	12.16 - 12.69 R1
NSVS 6762026	04 19 24.33	+29 45 58.6	BY	2454369.50	26.88	12.6 - 13.0 CV
VSX J095115.5+220811	09 51 15.52	+22 08 11.6	BY	2451631.436	0.636742	12.55 - 12.77 V
NSVS 18711283	12 24 43.31	- 35 52 27.0	BY	2452735.00	7.6711	12.25 - 12.55 V

References

- Drake, A. J. et al., 2009, *Astrophysical Journal*, 696, 870
- Pojmanski, G., 1997, *Acta Astronomica*, 47, 467
- Pojmanski, G., 2002, *Acta Astronomica*, 52, 397
- Bopp, Bernard W., 1981; *ApJ*, 249, 210
- Vogt, S. S.; Penrod, G. D.; Soderblom, D. R., 1983; *ApJ*, 269, 250
- Caillault, J.-P.; Drake, S.; Florkowski, D., 1988; *Astronomical Journal*, 95, 887
- Bopp, B. W. & Fekel, F., Jr., 1977; *Astronomical Journal*, 82, 490
- Watson, C.; Henden, A. A.; Price, A., 2006-2010, *AAVSO International Variable Star Index VSX, VizieR On-line Data Catalog: B/vsx*
- Percy, J. R., 2007, "Understanding variable stars", Cambridge University Press
- Samus, N. N.; Durlevich, O. V.; Kazarovets, E. V.; Kireeva, N. N.; Pastukhova, E. N.; Zharova, A. V. et al., 2007-2013, *General Catalogue of Variable Stars, VizieR On-line Data Catalog, B/gcvs*
- Sterken, C.; Jaschek, C., 1996, "Light Curves of Variable Stars, A Pictorial Atlas", Cambridge University Press
- Lafler, J.; Kinman, T. D., 1965, *Astrophysical Journal Supplement*, 11, 216
- Woźniak, P. R. et al., 2004, *The Astronomical Journal*, 127, 2436