Twelve new High-Amplitude Delta Scuti variables from the NSVS and CRTS surveys

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Abstract: As a part of VS-COMPAS data-mining program, here are twelve new pulsating High-Amplitude Delta Scuti variables 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 δ Scuti variables are pulsating variable stars with periods less than 0.3 days and spectral types A0 to F5. They were known as early as 1900. The large-amplitude ones were classified as RR Lyrae stars, sub-type RRs. Visual amplitudes for Delta Scuti variables are in the range from a few thousandths of a magnitude to about 0.8 mag. As of October, 2013 there are about 360 HADS variables in the VSX database.

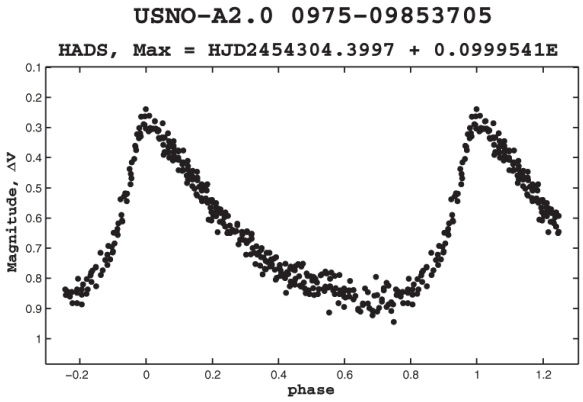


Figure 1. – Typical light curve of High-Amplitude Delta Scuti variable USNO-A2.00975-0985370, found on the Scanned Moscow Archive Plates (Antipin et al., 2007)

The variability of δ Scuti was discovered by W.W. Campbell and W.H. Wright (Lick Observatory). By June 1956, four delta Scuti stars were known (Eggen 1956): delta Scuti, rho Puppis, CC Andromedae, and DQ Cephei. Soon Eggen also discovered a fifth, delta Delphini. And the number of known Delta Scuti stars began to raise rapidly since then.

The Delta Scuti variables form a group which lies in the downward extension of the Cepheid instability strip in the H-R diagram which also includes the classical Cepheids at its bright end and the pulsating white dwarfs. δ Scuti stars can show very complex light variations, since the pulsations may simultaneously include both radial and non-radial modes, i.e. multiperiodic.

In 1955, Harlan J. Smith introduced the term *Dwarf Cepheid*, which was later used to denote the large-amplitude RRs variables. In the 1970s, Michel Breger showed that the majority of Dwarf Cepheids were not fundamentally different from Delta Scuti stars.

High-amplitude Delta Scuti variables were first classified as AI Velorum stars. Typically, they show non-sinusoidal asymmetrical light curves, similar to those of RRab. Population II HADS stars are called SX Phoenicis and are discovered mainly in the globular clusters. SX Phoenicis variables are generally considered to be a subclass of Delta Scuti variables that contain old stars. SX Phe variables also follow a period-luminosity relation

II. Candidates pre-selection and analysis

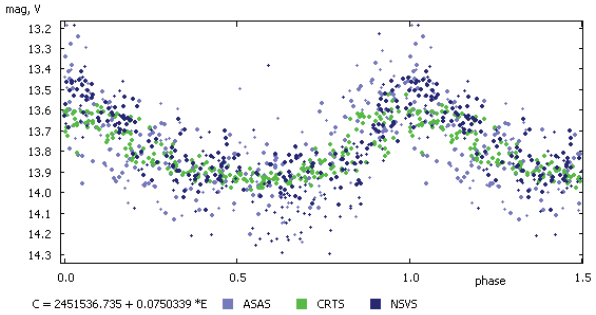
Candidates for analysis were selected by a custom piece of software created by Ivan Adamin. The software used the publicly available photometric databases, such as the Northern Sky Variability Survey (Woźniak et al., 2004), The Catalina Real-time Transient Survey (Drake et al., 2012), as a source of photometric measurements.

Then, the whole set of candidates was distributed among the VS-COMPAS Proejct 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 Andrey Prokopovich and Ivan Adamin.

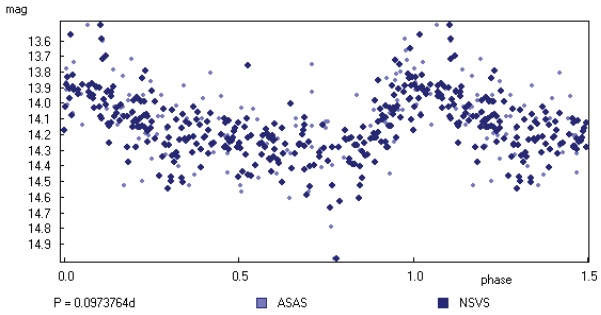
For high-precision periodogram calculation the Lafler-Kinman (Lafler, Kinman, 1965) statistical algorithm implementation was used. The VizieR web services were broadly used for obtaining data on the objects.

III. The list of discovered objects

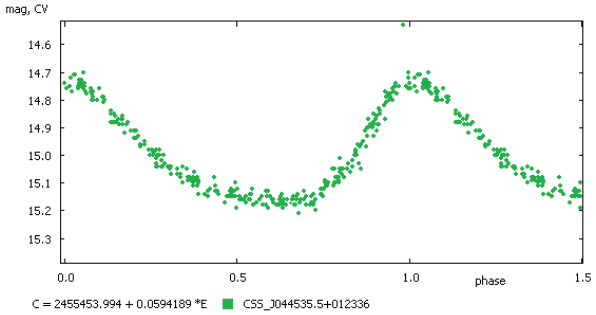
Below the results of this research is presented: light curve for each object along with the name of its discoverer and light curve elements (cf. Table 1).



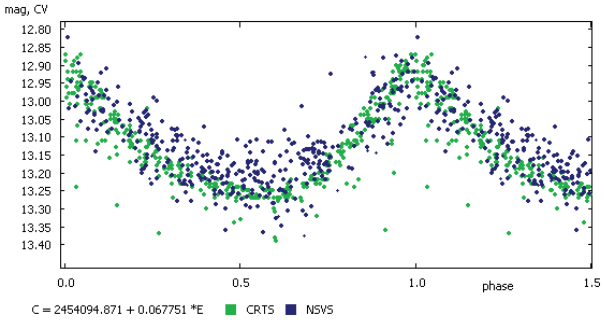
VSX J024048.2-070617 in Cetus
by Andrey Prokopovich (VS-COMPAS)



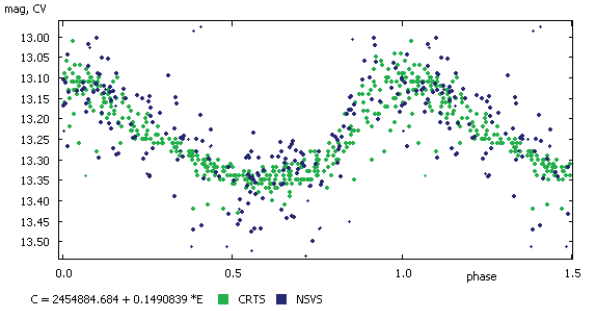
VSX J043039.1+124954 in Taurus
by Andrey Prokopovich, Ivan Adamin,
Alexey Tkachenko (VS-COMPAS)



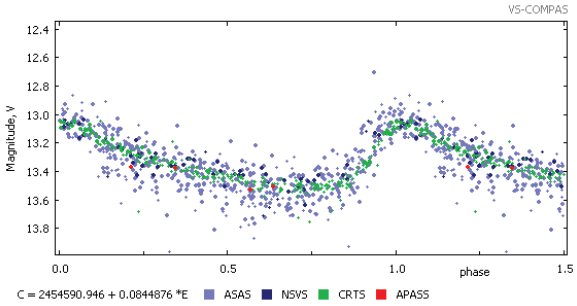
CSS_J044535.5+012336 in Taurus
by Andrey Prokopovich, Ivan Adamin (VS-COMPAS)



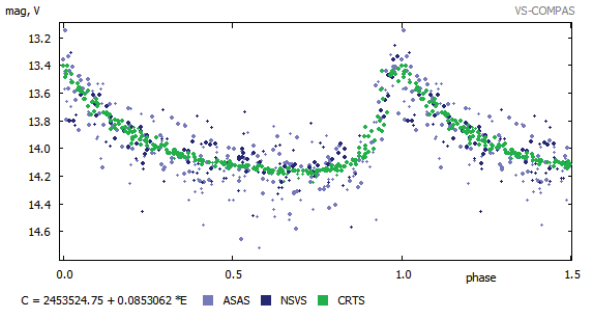
NSVS 7446012 in Lynx
by Alexandr Ditkovsky (VS-COMPAS)



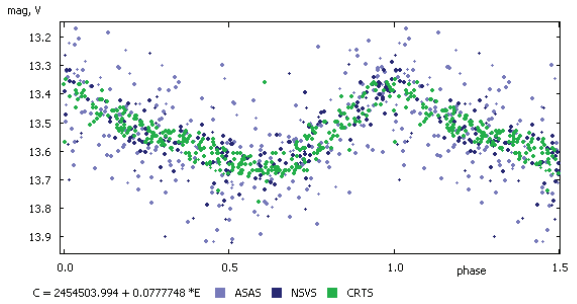
NSVS 7467387 in Leo
by Alexandr Ditkovsky (VS-COMPAS)



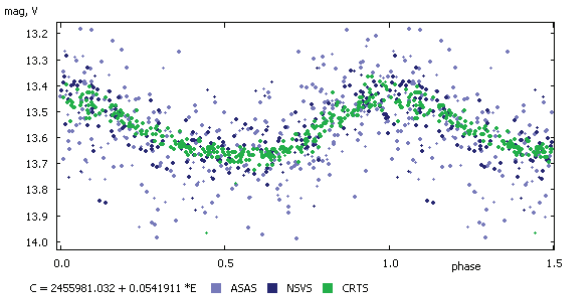
NSVS 18433413 in Hydra
by Alexandr Ditkovsky (VS-COMPAS)



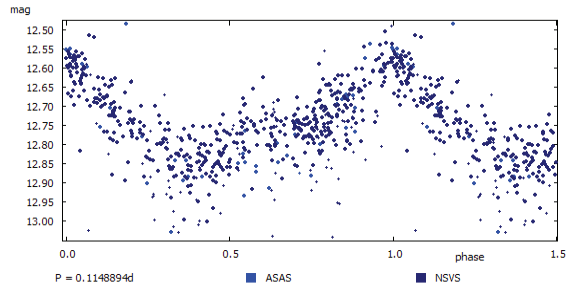
NSVS 13316502 in Virgo
by Siarhey Hadon (VS-COMPAS)



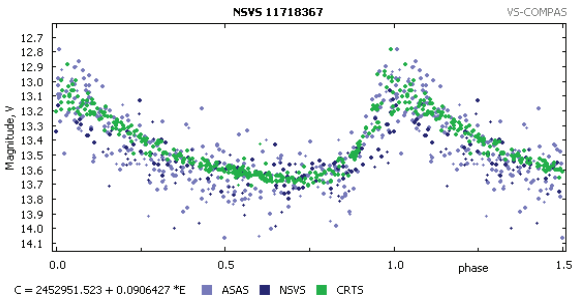
NSVS 10553101 in Boötes
by Alexandr Ditkovsky (VS-COMPAS)



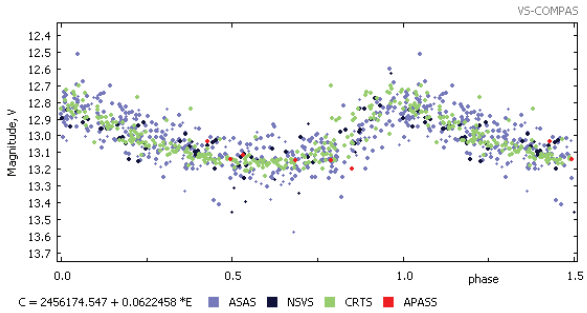
NSVS 10590484 in Serpens
by Alexandr Ditkovsky (VS-COMPAS)



NSVS 8748519 in Vulpecula
by Valery Tsehmeystrenko (VS-COMPAS)



NSVS 11718367 in Pegasus
by Alexandr Ditkovsky (VS-COMPAS)



NSVS 17436362 in Sculptor
by Alexandr Ditkovsky (VS-COMPAS)

Table 1. – The list of discovered HADS variables.

Object Designation	RA (J2000)	DEC (J2000)	Rise Dur.	Epoch, HJD	Period	Mag. Range
VSX J024048.2-070617	02 40 48.21	- 07 06 17.3	34%	2451536.735	0.0750339	13.5 - 13.95 V
VSX J043039.1+124954	04 30 39.12	+12 49 54.9	21%	2453701.658	0.0973764	13.85 - 14.4 V
CSS_J044535.5+012336	04 45 35.48	+01 23 36.6	27%	2455453.994	0.0594189	14.73 - 15.17 CV
NSVS 7446012	09 14 52.36	+34 18 34.6	40%	2454094.871	0.067751	12.90 - 13.28 CV
NSVS 7467387	09 47 05.64	+32 01 55.0	40%	2454884.684	0.1490839	13.10 - 13.35 CV
NSVS 18433413	10 01 35.50	- 24 57 15.7	24%	2454590.947	0.0844877	13.05 - 13.55 V
NSVS 13316502	14 18 09.96	- 04 05 22.4	26%	2453524.750	0.0853062	13.40 - 14.15 V
NSVS 10553101	14 47 29.92	+11 58 38.9	36%	2454503.994	0.0777748	13.35 - 13.68 V
NSVS 10590484	15 13 22.01	+18 15 58.3	43%	2455981.032	0.0541911	13.40 - 13.70 V
NSVS 8748519	21 19 05.29	+27 31 47.9	60%	2452836.971	0.1148894	12.55 - 12.9 V
NSVS 11718367	22 04 02.39	+14 21 51.2	25%	2452951.523	0.0906427	13.0 - 13.68 V
NSVS 17436362	23 47 23.28	-33 37 50.5	35%	2456174.547	0.0622458	12.76 - 13.2 V

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