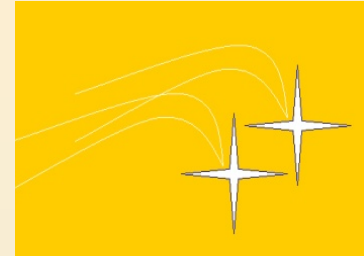


IX BULGARIAN-SERBIAN ASTRONOMICAL CONFERENCE: ASTROINFORMATICS



Sofia, 2 – 4 July, 2014



UV CETI TYPE VARIABLE STARS PRESENTED IN THE GENERAL CATALOGUE OF VARIABLE STARS

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IX BULGARIAN-SERBIAN ASTRONOMICAL CONFERENCE: ASTROINFORMATICS

Abstract

We present the place and the status of UV Ceti type variable stars in the General Catalogue of Variable Stars (GCVS4, edition April 2013) having in view the improved typological classification, which is accepted in the already prepared GCVS4.2 edition. The improved classification is based on understanding the major astrophysical reasons for variability. The distribution statistics is done on the basis of the data from the GCVS4 and addition of data from the 80th Name List of Variable Stars - altogether 47 967 variable stars with determined type of variability.

The class of the eruptive variable stars includes variables showing irregular or semi-regular brightness variations as a consequence of violent processes and flares occurring in their chromospheres and coronae and accompanied by shell events or mass outflow as stellar winds and/or by interaction with the surrounding interstellar matter. In this class the type of the UV Ceti stars is referred together with the types of Irregular variables (Herbig Ae/Be stars; T Tau type stars (classical and weak-line ones), connected with diffuse nebulae, or RW Aurigae type stars without such connection; FU Orionis type; YY Orionis type; Yellow massive evolved hypergiants with Rho Cas as a prototype); S Doradus type variables - giants and supergiants with high mass loss and occasional larger eruptions (with subtypes η Car and P Cyg, connected with diffuse nebulae and surrounding by expanding envelopes); R Coronae Borealis variables (prototype R CrB), which are simultaneously eruptive and pulsating variables, showing brightness fading suddenly for months to years; Wolf-Rayet variables with binary interactions and rotating gas clumps around the star; Gamma Cassiopeiae fast-rotating Be spectral type variables with formation of equatorial rings or disks; proto-planetary objects; as well as L dwarfs with causes of variability not quite clear yet.

The statistics shows that the eruptive stars are the most common class of variable stars after pulsating and eclipsing classes on the base of their total number. About 60% of all eruptive stars are considered as irregular variables with not completely clear origin of light variations and spectral types and that is why being rather inhomogeneous group of objects. The type of UV Ceti flare stars designated as UV (for flare stars from the solar vicinity) and UVN types variables (flare stars in stellar clusters and associations) are the next ones (30%), and only 10% are the other eruptive variable stars – with designations GCAS+Be, SDor, WR, and RCB.

How many UV Ceti type variable stars there are among the known variable stars in the General Catalogue of Variable Stars (GCVS4, edition April 2013)

Semantics in Astroinformatics
Definition of flare star? UV and UVN?

Typological classification of variable stars (according to

<http://cdsarc.u-strasbg.fr/afoev/var/etypo.htm>)

Class of the eruptive variable stars in GCVS

Includes: variables showing irregular or semi-regular brightness variations as a consequence of violent processes and flares occurring in their chromospheres and coronae and accompanied by shell events or mass outflow as stellar winds and/or by interaction with the surrounding interstellar matter.

Separated types: **UV Ceti** stars; Irregular variables (**Herbig Ae/Be** stars; **T Tau** type stars (classical and weak-line ones), connected with diffuse nebulae, or **RW Aurigae** type stars without such connection; **FU Orionis** type; **YY Orionis** type; Yellow massive evolved hypergiants with **Rho Cas** as a prototype); **S Doradus** type variables - giants and supergiants with high mass loss and occasional larger eruptions (with subtypes η Car and P Cyg, connected with diffuse nebulae and surrounding by expanding envelopes); **R Coronae Borealis** variables (prototype R CrB), which are simultaneously eruptive and pulsating variables, showing brightness fading suddenly for months to years; **Wolf-Rayet** variables with binary interactions and rotating gas clumps around the star; **Gamma Cassiopeiae** fast-rotating Be spectral type variables with formation of equatorial rings or disks; proto-planetary objects; as well as **L dwarfs** with causes of variability not quite clear yet.

Terminology for eruptive variables of UV Ceti type according to GCVS

In 1958 at the X General Assembly of the International Astronomical Union (IAU), UV Ceti type stars were ranked as a special type of eruptive variables with UV Cet as a prototype of the flare stars from the solar neighbourhood and the best-known flare star.

The UV Ceti type stars are designated as “UV” in the GCVS in order to distinguish them from the flaring Orion variables designated as “UVN”. In addition to being related to nebulae and their location in stellar clusters and associations, UVN variables are normally characterized by being of earlier spectral types (Ke-Me), and having greater luminosity, with slower development of flares and greater amplitudes reaching up to 9.0 magnitudes in U photometric band - e.g. at V341 Tau, V515 Per, SV Ori, etc. according to the Flare Star Database (FSDB, K.Tsvetkova et al.) established in 1995.

Terminology for eruptive variables of UV Ceti type according to GCVS

According to the typological classification of the General Catalogue of Variable Stars (GCVS, Samus et al. 2013):

The stars (dwarfs of M spectral class) have unpredictable flare activity expressing itself with sudden increases in brightness across the spectrum with quit various amplitudes, reaching the maximum brightness for seconds or a few minutes and returning to their quiescent brightness in several more minutes to hours.

They are located in the solar neighbourhood and the common belief is that their flares are analogous to the solar flares but far more energetic and intensive.

The cause of the flares is the sudden release of magnetic energy in the photosphere of the star, expressing itself as a spike in brightness, i.e. a flare.

Terminology for eruptive variables of UV Ceti type according to GCVS

The observed differences between almost identical UV and UVN variable stars are due to the difference in ages. Except the increased luminosity during the flare, high energy particles are released such as x-rays and gamma rays. Still in the beginning of the discovery and the investigation of flare stars the idea that these flares may be similar to the solar flares is evinced.

The common physical nature of UV and UVN variables obviously is the cause that in the already prepared GCVS4.2 edition these two types of eruptive variables are merged in one according to N.N. Samus, Moscow, the GCVS team, (IAU XXVIth General Assembly, Prague, August 9, 2006, report titled *The draft classification for new GCVS versions*).

Some basic characteristics from statistical investigations of flare stars applying different methods for investigations of the flares and their random characters and enlarging the optical observations with spectral, polarimetric, ultraviolet, infrared and radio observations:

- The relative number of flare stars among all red dwarfs increases at lower luminosities.
- The flare stars are formed in a system from certain luminosity, and this limiting luminosity decreases with increasing age of the system.
- Allow determining their evolutionary status thus giving a plausible scenario how the most numerous stars in the Galaxy – the red dwarf stars - are evolved passing through the stage of flare activity.

Relation between the type of variability of the stars and their distance from the Sun

Several nearby red dwarf stars are flare stars:

- Proxima - the nearest stellar neighbour of the Sun (at distance of 1.3 pc),
- CN Leo (2.4 pc),
- UV Cet (at distance of 2.7 pc),
- V1216 Sgr (2.9 pc), etc.

The classical flare stars of the UV Ceti type around the Sun form likewise a physical system.

Name of installation: U.V. Ceti

(a fountain, a sitting area, and a bronze v-shaped centre piece with a big orb in the middle)

Artist: Andrew Posa, Canadian sculptor born 1938

Location: 31 Wellington St. E., Toronto

Date of display: 1982



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Improved typological classification, accepted in the already prepared GCVS4.2 edition (according to N.N. Samus, Moscow, the GCVS team, IAU XXVIth General Assembly, Prague, August 9, 2006).

Based on understanding the major astrophysical reasons for variability.

Distribution statistics

The distribution statistics is done on the basis of the data from the GCVS4 (according to N.N. Samus [Moscow Inst. Astron.], O.V. Durlevich [Sternberg Astron. Inst., Moscow] 12-Feb-2009, total number of 41638 variable stars) and addition of data from the 80th Name List of Variable Stars (its three parts: IBVS 5969, 31 January 2011; 2036 stars; IBVS 6008, 21 December 2011, 2159 stars; IBVS 6052, 5 April 2013, 2133 stars).

GCVS4 (12-Feb-2009)	Total Number VS	41638
80th NL of VS	Total Number VS	6328
	Sum	47966

March 2014

There is some discrepancy in the total number of variable stars quoted at <http://www.sai.msu.su/gcvs/gcvs/>













General Catalog of Variable Stars (GCVS database) GCVS edition from March 2014 uploaded in April 9, 2014. Samus N.N., Goranskij V.P., Durlevich O.V., Kazarovets E V., Kireeva N.N., Pastukhova E.N., Zharova A.V., which can be downloaded at

<http://www.sai.msu.su/gcvs/gcvs/iii/iii.dat>

“This data set is the combined computer-readable version of the GCVS4 with improved coordinates [Vols. I-III](#) (Kholopov et al. 1985-1988) and Name-Lists of Variable Stars published in the system introduced during the preparation of the 4th GCVS edition. The total number of designated variable stars has now reached 47811”.

http://www.sai.msu.su/gcvs/gcvs/iii/

Index of /gcvs/gcvs/iii

<u>Name</u>	<u>Last modified</u>	<u>Size</u>	<u>Description</u>
 Parent Directory	20-Jun-2013 19:54	-	
 COLMN.TXT	06-Mar-2006 15:01	1k	
 abbrev.txt	30-Jan-2006 16:49	12k	
 constel.dat	25-Jul-2002 21:01	2k	
 html/	30-Jan-2006 19:20	-	
 iii.dat	09-Apr-2014 20:30	7.6M	
 ref.txt	18-Feb-2014 11:08	818k	
 ref_abbr.txt	30-Jan-2006 16:48	29k	
 remark.txt	28-May-2014 15:41	809k	
 variable.dat	13-Mar-2006 16:44	6k	
 vartype.txt	25-Sep-2012 14:40	53k	
 vol_pos.dat	08-Apr-2014 22:47	3.2M	

I. Difference of 155 variable stars! Or 0.3%

Checking the last version from March 2014:

The downloaded catalogue has the total number of variable stars 47968 (or with 2 stars more).









I can not explain why the total number given by Samus et al. is 47811.

II. You can find “GCVS5”, which causes some misunderstanding.

Practically this is a version revised taking into account the new data accumulated since the 4th GCVS edition for the constellations: *Aquila, Caelum and Camelopardalis*

The new version of the GCVS !

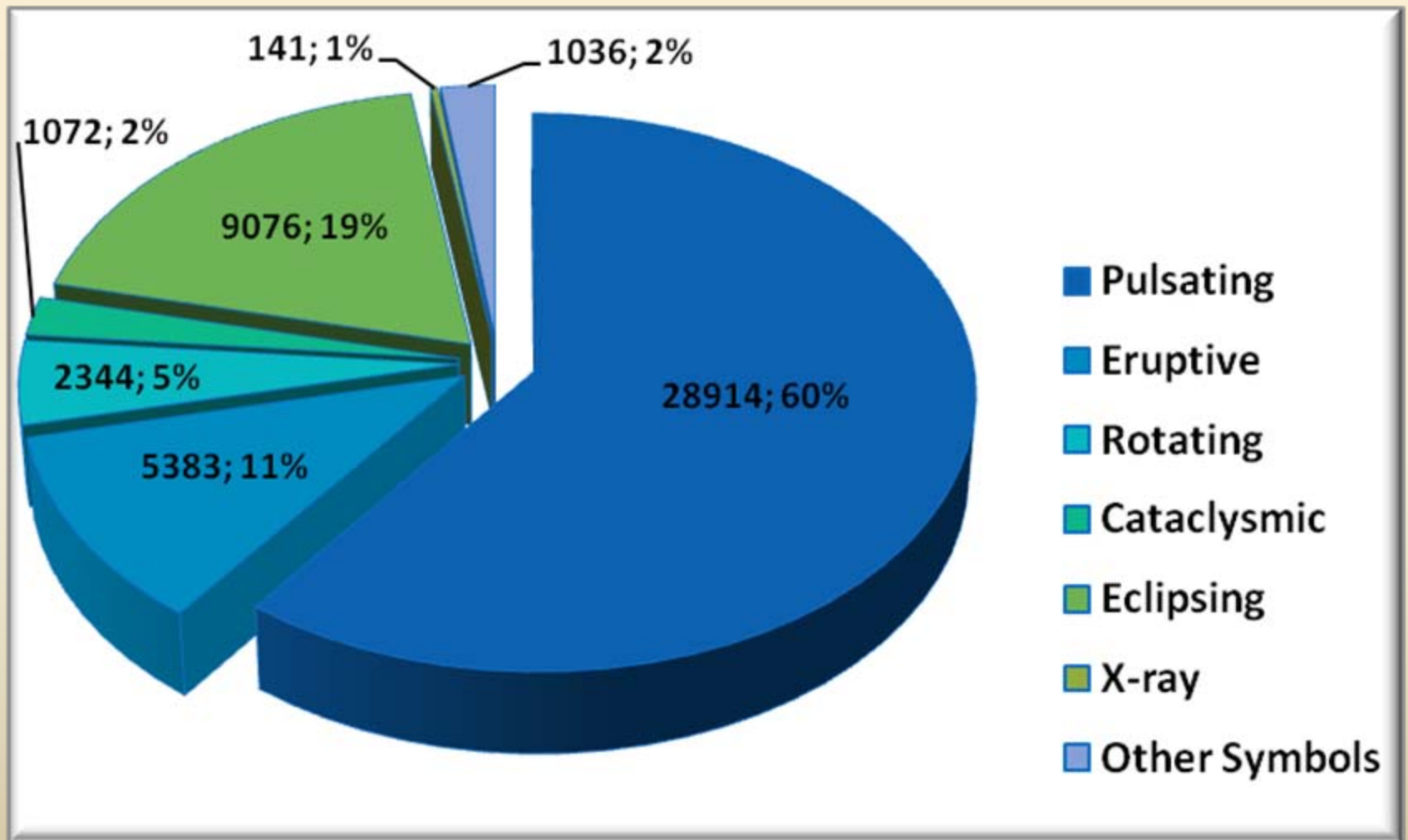
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Name	Last modified	Size	Description
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 GCVS5.txt	21-May-2009 19:57	241k	
 ReadMe.htm	08-Dec-2010 17:15	11k	
 ReadMe.txt	16-Feb-2007 19:38	8k	
 classif.htm	04-Sep-2006 18:06	26k	
 ref5.txt	16-Feb-2007 15:38	13k	
 rem5.txt	21-May-2009 19:57	10k	

Statistics

I. Among the classes of variable stars:

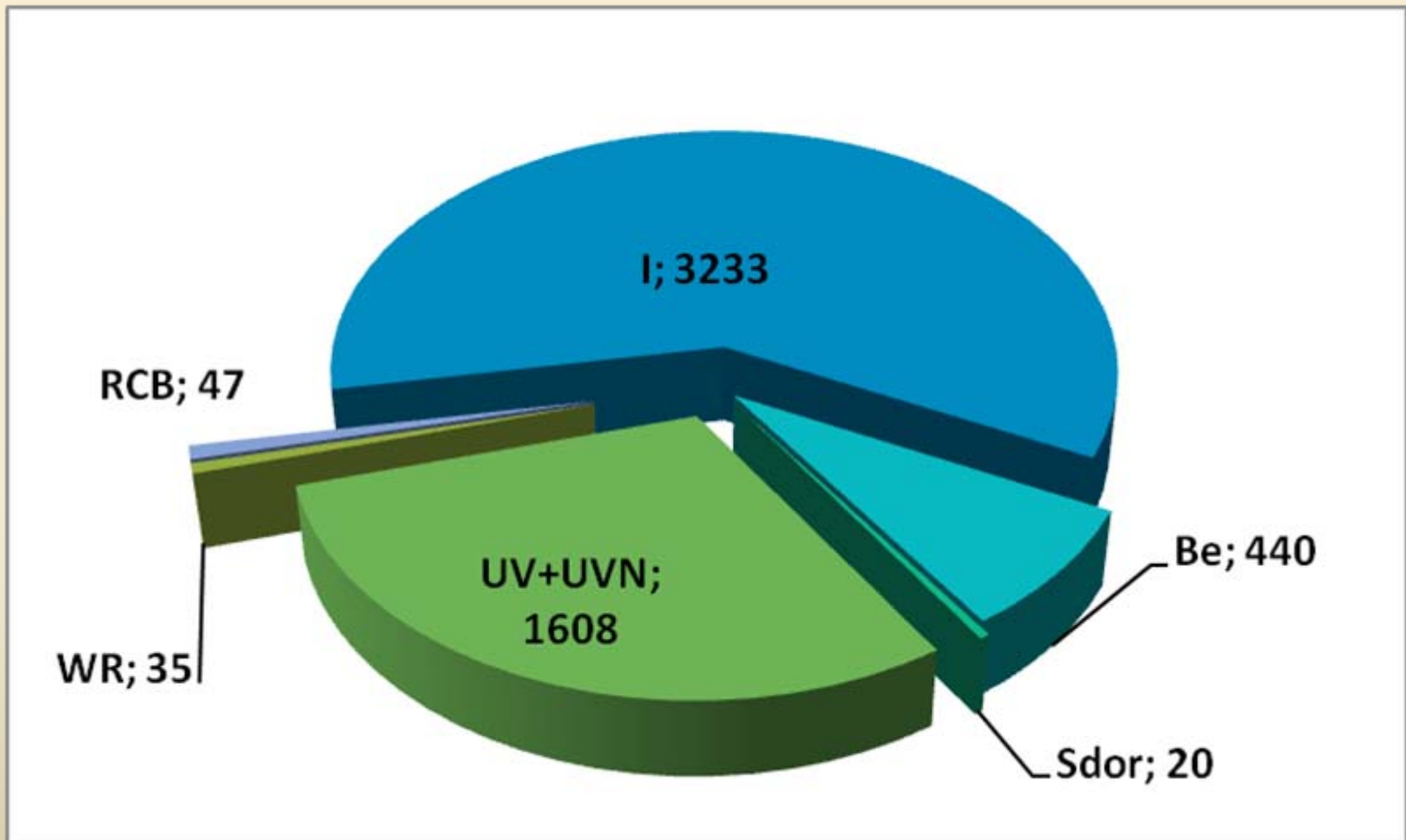
General Distribution of Variable Stars: Total Number 47966



Statistics

II. Inside the class of eruptive variables:

Total Number of Eruptive Stars: 5383



Results of the Statistics

I. Among the classes of variable stars:

The class of the eruptive variable stars follows the classes of the pulsating and eclipsing variables according to their number.

II. Inside the class of eruptive variables:

- About 60% of all eruptive stars (total number 5383) are considered as irregular variables with not completely clear origin of light variations and spectral types and that is why being rather inhomogeneous group of objects.
- The type of UV Ceti flare stars designated as UV (for flare stars from the solar vicinity) and UVN types variables (flare stars in stellar clusters and associations) with total number 1608, are the next ones (30%).
- About 10% are the other eruptive variable stars – with designations GCAS+Be, SDor, WR, and RCB.