Variable Star and Exoplanet Section of the Czech Astronomical Society

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Abstract

We present a short introduction of the Variable Star and Exoplanet Section of the Czech Astronomical Society, which celebrate the 90th anniversary of its foundation this year. Its history is closely tied up with Zdeněk Kopal who was its president in years 1930-1933. Kopal considerably influenced the growth of its activity and scientific importance. Both amateur variable star observers and professional scientists are organized in this section. At our web page (http://var2.astro.cz/EN/), many on-line instruments have been provided for observers to make their work easier in the last decade. Probably the most known are the Exoplanet Transit Database and the O-C gateway (database of eclipsing binaries minima timings). Our group considerably contributes to a study of eclipsing binaries (project B.R.N.O.), various kinds of intrinsic variable stars (MEDÚZA, HERO) or stellar systems with transiting exoplanets (TRESCA). In addition, the activity of our members is evident from the CzeV catalogue, which comprises variable stars discovered by Czech astronomers. This list currently contains over six hundred stars. Scientific results are published, among others, in our on-line electronic journal OEJV.

Introduction

Variable Star and Exoplanet Section (hereafter VSES) is one of the most active parts of the *Czech Astronomical Society* (CAS) which unites mainly amateur observers of variable stars. The research programme is coordinated by professional scientists, who are in many cases VSES members too. The division was founded in 1924 as a small group with about a dozen visual observers (current number of members is 82), but during history it became important European organisation which contributes significantly to the variable star research.

Since the Czech Republic boasts one of the highest density of public observatories in the world, the cooperation of amateurs and professionals is very close. It allows us to lead young, interested people to a systematic work. Often such excited amateur becomes a professional researcher. One of the best examples is Zdeněk Kopal, who was a very active observer and a very successful leader of VSES in thirties of the 20th century. At that time he obtained more than 10 000 visual estimations of brightness of variable stars. He initiated many activities, such as preparing materials for other observers (maps, summaries of observations), communication with other international groups or scientists, and started with publishing a journal. The Kopal's legacy in VSES is, therefore, very strong.

During years, VSES was involved in a lot of different activities. Several of them reached international importance, e.g. the Exoplanet Transit Database (database of exoplanet transit measurements, Poddaný, Brát & Pejcha, 2010) or O-C gateway (database of eclipsing binaries minima timings, Paschke & Brát, 2006). Work of members is organized in a few observing projects according to the type of variability. Observing campaigns are announced when measurements of particular objects is needed. The VSES also offers many on-line tools, e.g. minima and transit predictions, observers can store their observation at the web after logging in, they can analyse light curves, and many other instruments. VSES also organizes annular meetings (see fig. 1) and observation practices for new observers.

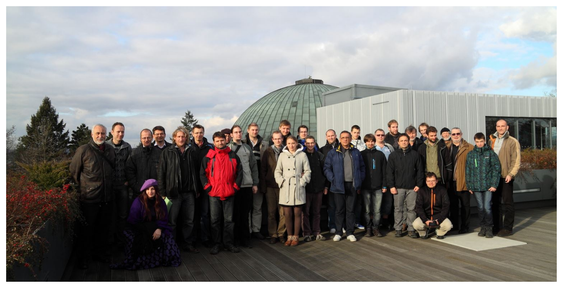

Figure 1: Participants of 45th Conference on Variable Star Research, 30th November 2013, Brno Observatory and Planetarium, photo Libor Šindelář.

Observation projects

Until nineties of the 20th century the main observing programme was dedicated to eclipsing binaries. Currently, observations are organized in four projects:

- **B.R.N.O.**, or Brno Regional Network of Observers is the name of the most extensive program started in 1960 involving observation and research of eclipsing binaries. The main aim of this project is obtaining of high accurate minima timings of eclipsing systems and study of their periods. Recently about 25 000 times of minima were gathered by the members! The list of new minima has been published more or less annually as a "B.R.N.O. Contributions". Actually the 38th Contributions with 3417 times of minima for 969 objects gathered from 80 observers was published last year (Hoňková et al., 2013).

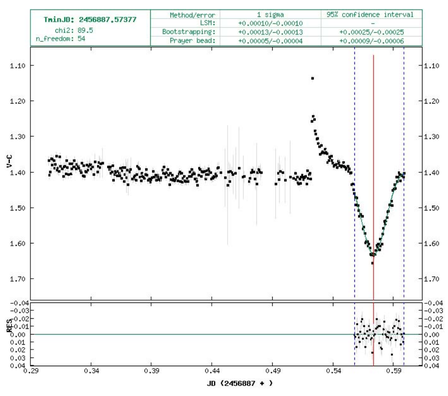

Figure 2: An example of the light curve of an eclipsing binary star GJ 3236 Cas showing a new on-line fitting tool for determining time of minimum. In this light curve a flare just before the main eclipse was detected (observer Ladislav Šmelcer).

Since October 2012, times of minima are precisely determined using a new tool (fig. 2), which fits the shape of light curve using phenomenological models (Brát, Mikulášek & Pejcha 2012). The output contains uncertainties determined by LSM, Bootstrapping or Prayer bead (fig. 2).

- **MEDÚZA**, or "jellyfish" in English, is a project focused on observing of intrinsic variable stars (mostly long period red variables SR, M, RCB, symbiotic stars, cataclysmic variables, novae, supernovae). The project was described e.g. in Hájek, Brát & Sobotka (1996). Light curves obtained from visual, or currently (mainly) with CCDs observations in *BVRI* bands (example in fig. 3) are stored at our web (more than 168 000 visual and 182 000 CCD observations).

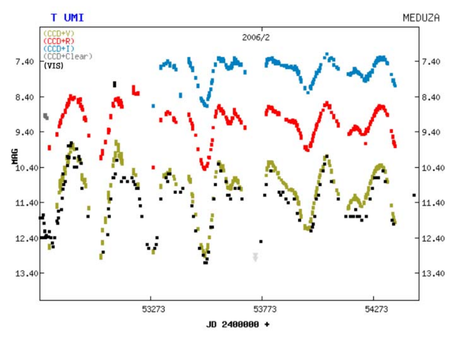

Figure 3: Long term visual and CCD observations of Mira-type pulsating star T UMi which undergoes variations in its pulsations, and period shortening (CCD observations from Ladislav Šmelcer).

Currently, MEDÚZA was extended with short period pulsating stars of RR Lyrae type (the Czech RR Lyrae Observation Project, Skarka, Hoňková & Juryšek, 2013).

- **HERO** is an acronym of High EneRgy Objects. This project (since 2008) deals with photometric observations and research of high energy sources (x-ray, gamma-rays).

- **TRESCA** is an acronym of *TRansiting ExoplanetS and CAndidates*. The project involves observing exoplanetary transits and their evaluation by an on-line fitting tool (fig. 4). This project is very popular among observers from all over the world (see the map in fig. 5). The data from TRESCA (almost 3700 transits!) are archived in ETD (see section "Databases").

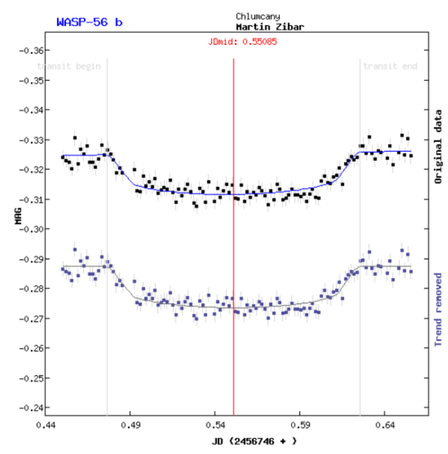

Figure 4: Observation of transit of WASP-56b with mid-transit determination (observations from Martin Zíbar).

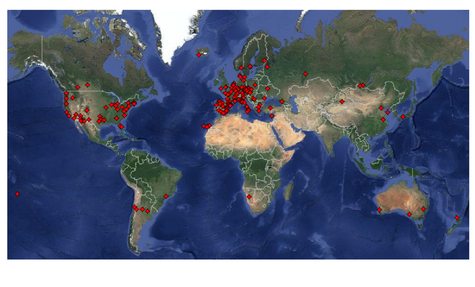

Figure 5: The world map of exoplanet transit observers.

Other activities

Except for providing many useful on-line tools, the VSES organizes annual meeting (conference) where results from previous year are discussed, and an one-week course for beginners where the basics of CCD photometry are introduced.

The VSES offers observers and other astronomers to publish their results in an on-line electronic journal *Open European Journal of Variable stars, OEJV*. All OEJV publications are included in Smithsonian/NASA ADS (Astrophysics Data System) and Simbad database.

Figure 9: The logo of OEJV.

An electronic journal called *Perseus* is also offered to our members. Interesting discoveries and observations published all over the world, as well as original papers are reported in this journal.

Summary

The activities inside the Variable and Exoplanet section of CAS are presented. The VSES is closely connected with Zdeňek Kopal, who was its president for three years in thirties. The cornerstone of our division is the web page **http://var2.astro.cz/EN/** where all important links to various databases (O-C gateway, ETD, CzeV catalogue) and on-line tools for observers (storing observations, minima times and mid-transit determinations) can be found. All observations are available either publicly or on request.

Databases

Our division administrates three important databases:

- **Exoplanet Transit Database (ETD)** (e.g. Poddaný, Brát & Pejcha, 2010) is probably the most known and most used database. It is dedicated to provide a list of transiting exoplanets with transit-depth higher than 0.001 mag.

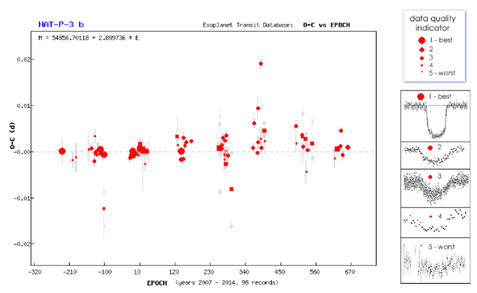

Figure 6: An example of transit timings vs. epoch in HAT-P-3b.

Database administrators regularly check for new transits to keep the list actual. For each exoplanet, there is available graphical output of transit TIMINGS vs. EPOCH, transit DURATION vs. EPOCH, transit DEPTH vs. EPOCH.

Data quality is rated for each loaded observation. Observers can plot their observations in diagrams, they can fit their transits (fig. 6), and find out parameters HJDmid, Depth, Duration through the ETD tools. In addition, the database provides global transit predictions. Currently, the ETD contains more than 4200 transits.

- **CzeV, SvkV and RafV catalogues** contain information about variable stars discovered by Czech observers (CzeV, Brát, 2006), Slovak observers (SvkV) or variables discovered in Hakos Guest Farm in Namibia (Paschke, 2005). Altogether they currently contain about 800 variable stars. The most of them are common eclipsing binaries of W UMa-type, Algol-type or δ Scuti pulsating stars. Nevertheless, there are also very interesting objects, e.g. RR Lyrae stars with the Blazhko effect CzeV283 and CzeV397 (Skarka & Cagaš 2013), long-period or irregular pulsating stars or eruptive dwarfs. However, one of the most interesting objects in these catalogues is CzeV343 (fig. 7), the double eclipsing binary with periods near 3:2 ratio (Cagaš & Pejcha 2012), or CzeV404, the cataclysmic variable star inside the CV "period gap" (Cagaš & Cagaš 2014).

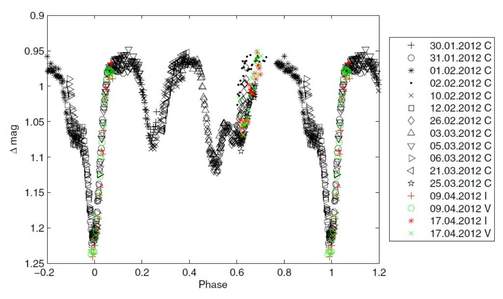

Figure 7: The light curve of CzeV343 - a double eclipsing binary with periods near 3:2 ratio. The light curve is phased with the 1.209-day orbital period of system A (Cagaš & Pejcha, 2012).

- **O-C gateway** (Paschke & Brát, 2006) provides O-C diagrams of more than 6200 eclipsing binaries (221 000 minima). Data from this database are often used for studies of apsidal motion, LiTE, mass transfer etc. (group around Marek Wolf and Petr Zasche, Miloslav Zejda and others).

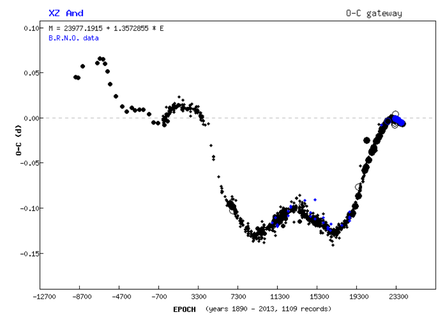

Figure 8: O-C diagram of an eclipsing binary XZ And which very likely shows multiple LiTE.

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