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Editor-in-chief **Radek Kocián**

Participants of the conference in front of the observatory

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INTRODUCTION

Each year in November, when the full moon makes variable star observing difficult, the Variable Star and Exoplanet Section of Czech Astronomical Society holds a national conference on variable stars, stellar astrophysics in general and since recently also on extrasolar planets. The conference took place in Prague, capital city of Czech Republic in Stefanic observatory. The 2010 conference was held on a weekend from November 19th to November 21st.

Our conferences on variable star research provide unique opportunities for meetings between professional and amateur astronomers and have become a crucial platform for exchanging information and sharing knowledge. These events help to keep the local astronomical community alive and active.

I would like to express gratitude to all authors for their talks and posters and to all participants for their contribution to the discussions!

Luboš Brát
- president of Variable Star and Exoplanet
Section of Czech Astronomical Society
Pec pod Sněžkou, November 21st 2010

NOTES

The scientific content of the proceedings contributions was not reviewed by the OEJV editorial board.

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Blazhko effect – a century old challenge

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Abstract: A brief overview of the Blazhko effect is given in this paper. Although in the last few years there were made many precise observations that had a major impact on our view of this effect, this phenomenon still keeps its mystery.

Abstrakt: Tento příspěvek přináší krátký přehled o Blažkově jevu. Ačkoli bylo v posledních několika letech získáno mnoho kvalitních pozorování, která měla zásadní vliv na náš pohled na tento fenomén, stále si uchovává svá tajemství.

What is the Blazhko effect?

Several RR Lyrae type stars, similarly to other types of pulsation variables, show special behaviour. The shape of such stars light curves periodically changes. Also the amplitude and/or phase modulation is present. The modulation periods are typically from few days to hundreds of days. This phenomenon was named after one of its discoverers, Russian astronomer S.N. Blazhko (Blazhko, 1907), who noticed such behaviour in RW Dra.

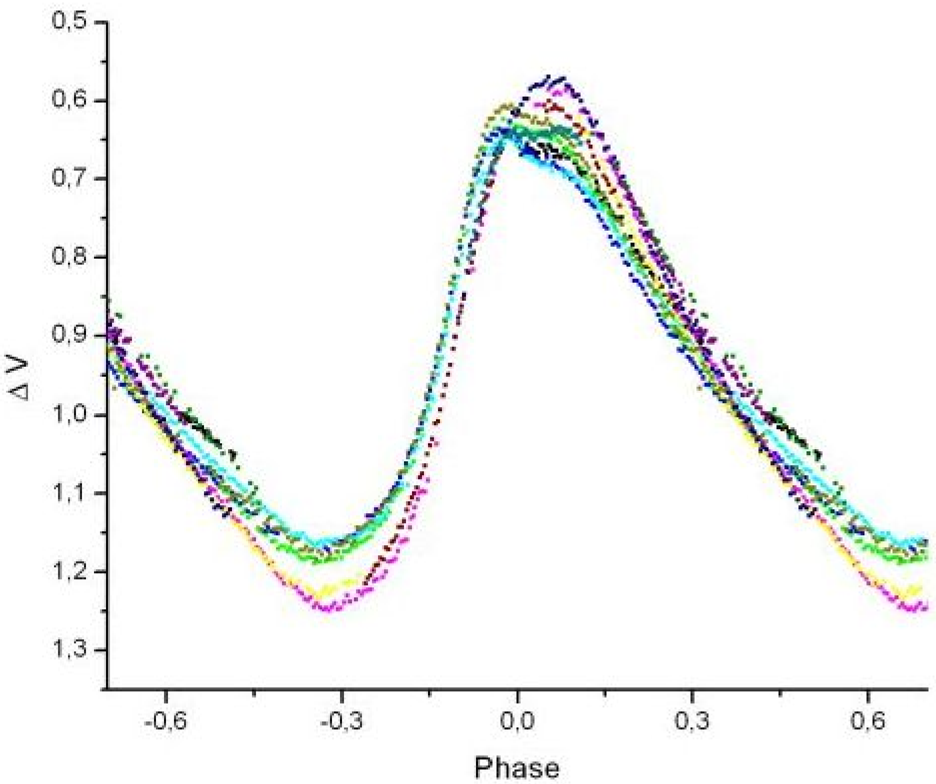

Figure 1: Blazhko effect in TV Boo. Every colour means one night. Data were gained at MU Observatory in Brno.

Moskalik & Poretti (2002) give the incidence rate of the Galactic field Blazhko variables about 20-30 % (RRab stars – RR Lyrae stars that pulsate in a fundamental mode) and about 5 % in the case of RRc stars (first overtone pulsators). Current observations from *Kepler* space telescope show the incidence rate of Blazhko stars up to 48 % (Benkö et al, 2010), so it seems, that Blazhko effect is relatively common. On the other hand, in the Large Magellanic Cloud the incidence rate for RRab stars is only half as large as the incidence rate given by Moskalik & Poretti (2002), which could be probably a metallicity effect (Alcock et al., 2003). From *Kepler* observations it is clear, that the precision of photometry plays a crucial role in a discovery of presence of the Blazhko effect. Is it possible, that at some low level every RR Lyrae variable could show the Blazhko phenomenon?

There are also indices, that Blazhko period can change. RR Lyrae itself shows such changes. Its Blazhko period decreased during 20 years from 40.8 days to 39.8 days (Kolenberg & Tsantillas, 2008). To estimate this problem, we need long time based photometry, which is not easy whereas we have photometrical data only one century to the past.

Models and frequency spectra

In the 20th century, there were suggested several models to solve the Blazhko behaviour. As the most probable there were considered two models:

- *Magnetic model* supposes the magnetic field with an axis inclined to the stellar rotation axis (Shibahashi & Takata, 1995). This magnetic field should cause splitting of the main radial mode to nonradial modes with l=2 (quadrupole component whose symmetry coincidences with the magnetic axis).
- *Resonance model* is based on a nonlinear resonance between the radial fundamental mode and the nonradial mode with l=1 and m=±1 (Nowakowski & Dziembowski, 2001).

Both models consider that the modulation of the light curve is a result of a stellar rotation in a combination with pulsations.

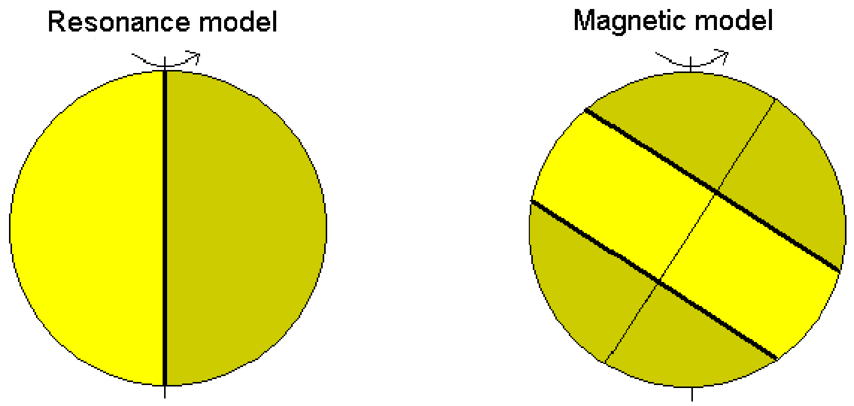

Figure 2: Models for the Blazhko effect.

In frequency spectra of the Blazhko stars, there appear repeating structures. There is a main pulsation frequency and its harmonics with side peaks in doublet, triplet or higher multiplet structure. This side peaks have small frequency separation corresponding to the Blazhko frequency. Usually the modulation peak to the right from the main pulsation frequency and its harmonics in frequency spectra has higher amplitude than the left one. In most cases the multiplet structure is symmetrical, but in some cases it is not. With higher precision photometry there appeared higher multiplet structures, like kvintuplets, heptaplets etc.

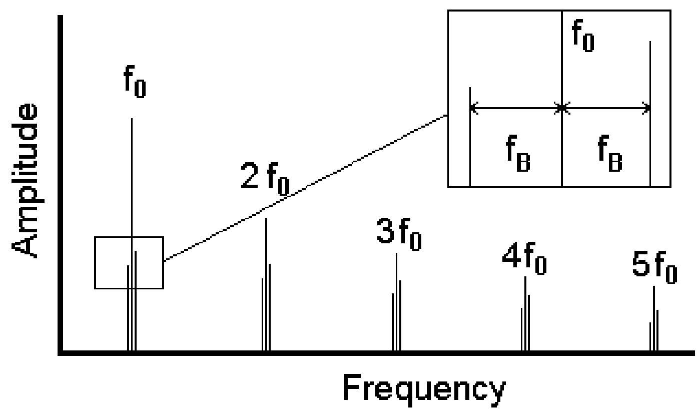

Figure 3: Illustration of the frequency triplet structure.

How much do we understand the Blazhko phenomenon?

At the end of the first decade of new millennium we are still at the beginning of understanding Blazhko effect. There are many problems, which have appeared with new high precision observations.
First of all, the current models cannot explain higher multiplets than kvintuplets in frequency spectra. Resonance model can explain triplet, magnetic model triplet and kvintuplet – it depends on geometry of observation. But this is the maximum. Concerning the frequency spectra feature, there are much more problems. How do we explain different amplitudes of the right-side and left-side peaks close to the main frequency and its harmonics appearing in frequency spectra of some stars? And what about not equally spaced side peaks? The harmonics of the main frequency show the exponential decrease, whereas the side peaks corresponding with Blazhko frequency decrease linearly. How do we explain this behaviour? In frequency spectra of some stars observed by the Kepler sky telescope were discovered odd multiples of the half value of the main frequency (Szabó et al., 2010). This new discovery could be very important in solving Blazhko problem, but all the mentioned problems are open questions. The change of Blazhko period is waiting for explanation too.

The RR Lyrae stars represent very important and useful class of stars, so the solving Blazhko problem is a necessary and interesting challenge.

Acknowledgements

I would like to thank for useful comments on the topic given during the conference. This work has been supported by grants MUNI/A/0968/2009 and GA ČR GD205/08/H005.

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V2240 Cyg - interesting case of eclipsing binary with changes within O-C diagrams

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Abstract: In 2010 I continued observing interesting binaries, which were chosen during the examination of the O-C gate (http://var.astro.cz/ocgate) on the server of Variable Star and Exoplanet section of Czech Astronomical Society. The changes in the appearance of the O-C diagrams imply that the mentioned changes could be caused by the following mechanisms: 1) the occurrence of the third star, 2) the system of eclipsing binaries with an eccentric orbit, 3) apsidal motion, 4) there is a combination of all those effects mentioned above.

Abstrakt: V roce 2010 jsem pokračoval v pozorování zajímavých zákrytových dvojhvězd, které byly vybrány při prohlídce O-C brány (http://var.astro.cz/ocgate) na serveru Sekce proměnných hvězd a exoplanet České astronomické společnosti. Změny ve vzhledu O-C diagramů naznačují, že tyto změny mohou být způsobeny následujícími mechanismy: 1) přítomnost třetí hvězdy, 2) jedná se o systémy zákrytových dvojhvězd s excentrickou drahou, 3) stáčení přímky apsid, 4) jedná se o kombinaci těchto efektů.

V 2240 Cyg (*GSC 2684 1255, R.A.=* $20^h15^m55^s.995$ *DEC.= +37°27'15".62 Equinox: 2000.0*)

(type EW, period 0.404177 day, amplitude 12.03 – 12.29 mag.)

This eclipsing binary was discovered by Jan Šafář in 1999 (Šafář, 1999) in the proximity to the eclipsing binary called 454 Cyg (see the Figure 1). Accurate minima have been measured during last 11 years and we find some indication of O-C diagram change with of about 64 minutes. The observation from 10^{th} October 2010 confirms the trend in the appearance of the O-C diagram (see the Figure 2), when the secondary minimum was set in JD_{hel}=2455480.47647 (see the Figure 3). The following observations will help to decide, if these changes are caused by the mass transmission (the O-C diagram parabolic shape) or they will be periodical (O-C diagram sinusoidal shape).

Observations mentioned above were taken at Valašské Meziříčí Observatory on the telescope Schmidt - Cassegrein 0.28m f/6.3 reflector and SBIG ST-7 CCD camera + V, R and I band filter. CCD frames were mostly reduced by C-MuniPack code (Motl, 2009), the well-known adaptation of MuniPack code (Hroch, 1998), based on DaoPhot routines (Stetson, 1987). All frames were dark-frame and flat-field corrected before application of further reduction steps. Minima timings were mostly determined by Kwee-van Woerden method using program AVE (Barberá, 1999).

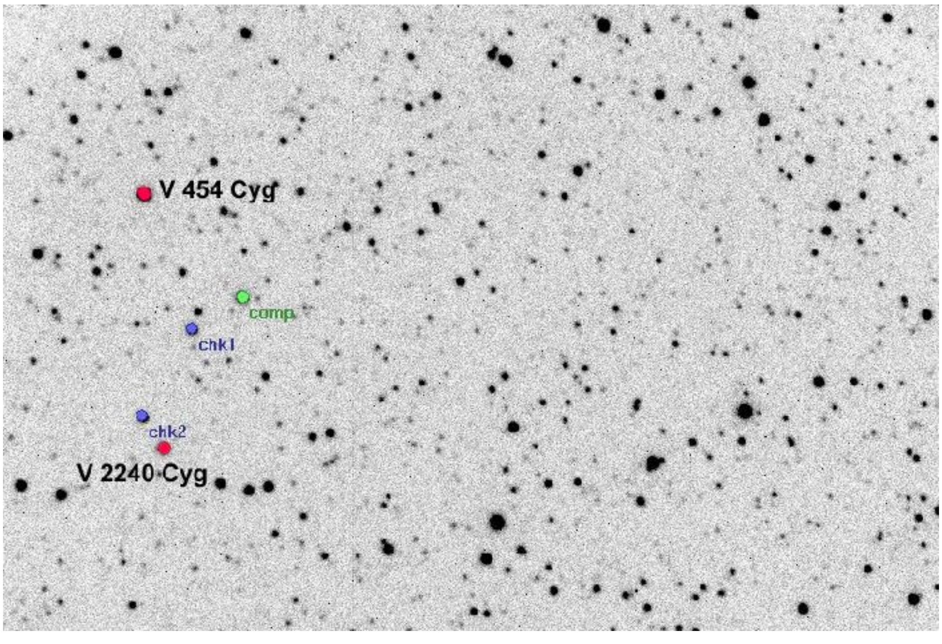

Figure 1: CCD picture of the variable stars V454 Cyg a V 2240 Cyg.

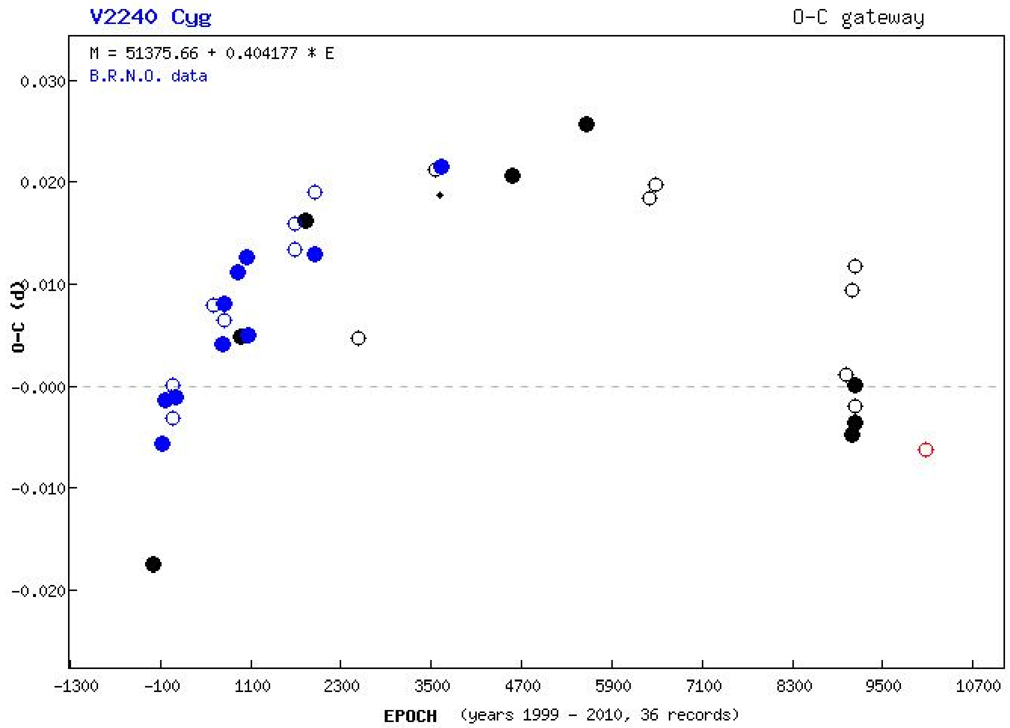

Figure 2: O-C diagram V 2240 Cyg. The red circle represents the last secondary minimum observed in 10th October 2010.

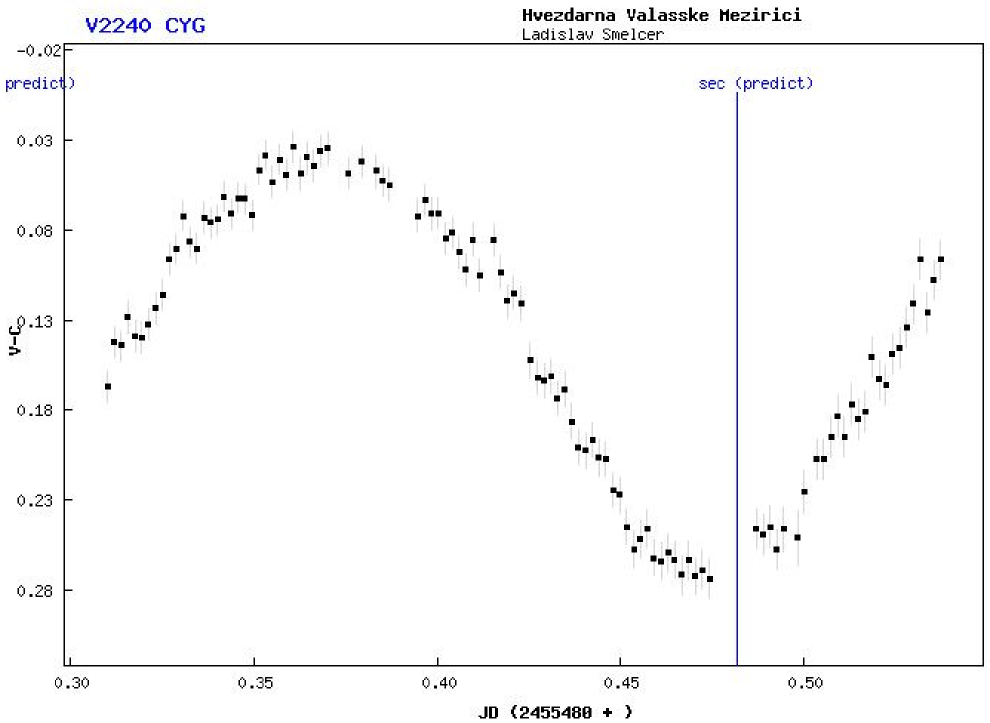

Figure 3: Light curve of secondary minimum observed in 10th October 2010 (19:28 – 00:57 UT).

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Extrasolar planetary system WASP–10

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Abstract: We present photometric observation of transiting exoplanetary system WASP-10 made in Stará Lesná observatory, Slovakia. One of the most interesting results of our analysis was the determination of the radius of WASP–10 b: $R_p = 1.22 \pm 0.05\ R_J$, which is in good agreement with the discovery paper (Christian et al. 2009). This result did not confirm the smaller radius of WASP–10 b by Johnson et al. (2009).

Abstrakt: V tomto článku prezentujeme pozorování extrasolárního planetárního systému WASP-10 z observatoře ve Staré Lesné na Slovensku. Jeden z nejzajímavějších výsledků analýzy těchto dat je určení poloměru extrasolární planety WASP–10 b: $R_p = 1.22 \pm 0.05\ R_J$. Tento výsledek je v dobré shodě s poloměrem určeným v objevitelské práci (Christian et al. 2009). Pozdější určení menšího poloměru v práci Johnsona a kol. (2009) není potvrzeno.

Introduction

Transiting extrasolar planet WASP–10 b was discovered in 2008 by WASP Consortium (Christian et al. 2009). The exoplanet with the mass of 2.96 M_J (Jupiter mass) orbits the K5 dwarf star in the distance of 0.0369 AU. They determined the radius of the exoplanet as R_p=1.28 R_J (radius of Jupiter).

Soon after the discovery (Johnson et al. 2009) performed high quality follow up observation of this system. One of the most interesting results was the new value of the radius of the planet: $R_p = 1.08\pm0.02\ R_J$, which was 16% smaller than that given in the discovery paper.

Observation and data analysis

We performed our observation of WASP–10 with the Newton 508/2500 mm telescope (located at Stará Lesná, Slovakia) equipped with the CCD camera SBIG ST10 XME in R band of Johnson photometric system (Krejčová et al. 2010). We performed aperture photometry and obtain a 1σ accuracy of about 3-5 mmag per 1 CCD exposure depending on observing conditions. We also removed the linear trend in the out-of-transit data. Four light curves we obtained are in Figure 1.

We search for the best values of following system parameters: inclination i, the center of the transit TC, planet to star radius ratio $R_p/R*$ and the star radius to the semimajor axis ratio R*/a. For this purpose we minimize the χ^2 function via the downhill simplex method implemented in routine AMOEBA (Press et al. 1992). For estimation of uncertainties of the best-fitting parameters we employed the Monte Carlo simulation method. To obtain analytical transit light curve we use the formulae from Mandel & Agol (2002) assuming the quadratic limb darkening law.

The resulting parameters determined from our data are in Table 1. Figure 2 shows the resulting best fit light curve together with measured data from all four nights. Our estimate of the planet radius $R_p = 1.22 \pm 0.05\ R_J$ is significantly higher (by about 12%) than the most recent value of Johnson et al. (2009).

parameter	results
R_P/R_*	0.168 ± 0.001
R_*/a	0.094 ± 0.001
i [deg]	87.3 ± 0.1
P_{orb} [days]	3.092 731 ± 1×10^{-6}
R_P [R_J]	1.22 ± 0.05
R_* [R_{SUN}]	0.75 ± 0.03
T_D [days]	0.0974 ± 8×10^{-4}

Table 1: Parameters of extrasolar system WASP–10. R_P/R^* is the planet to star radius ratio, R^*/a is the star radius to semi major axis ratio, i is the inclination of the orbit, P_{orb} is the orbital period, R_P is the planet radius, R* is the host star radius, and T_D is the transit duration assuming the semimajor axis a = 0.036 9 ± 0.0012 0.0014 (Christian et al. 2009).

Soon after the presentation of our work on WASP–10, the work of Dittmann et al. (2010) appeared. They determined the planet to star radius ratio: $R_P/R_* = 0.16756 \pm 0.0006$, which is in a very good agreement with the results published by Christian et al. (2009).

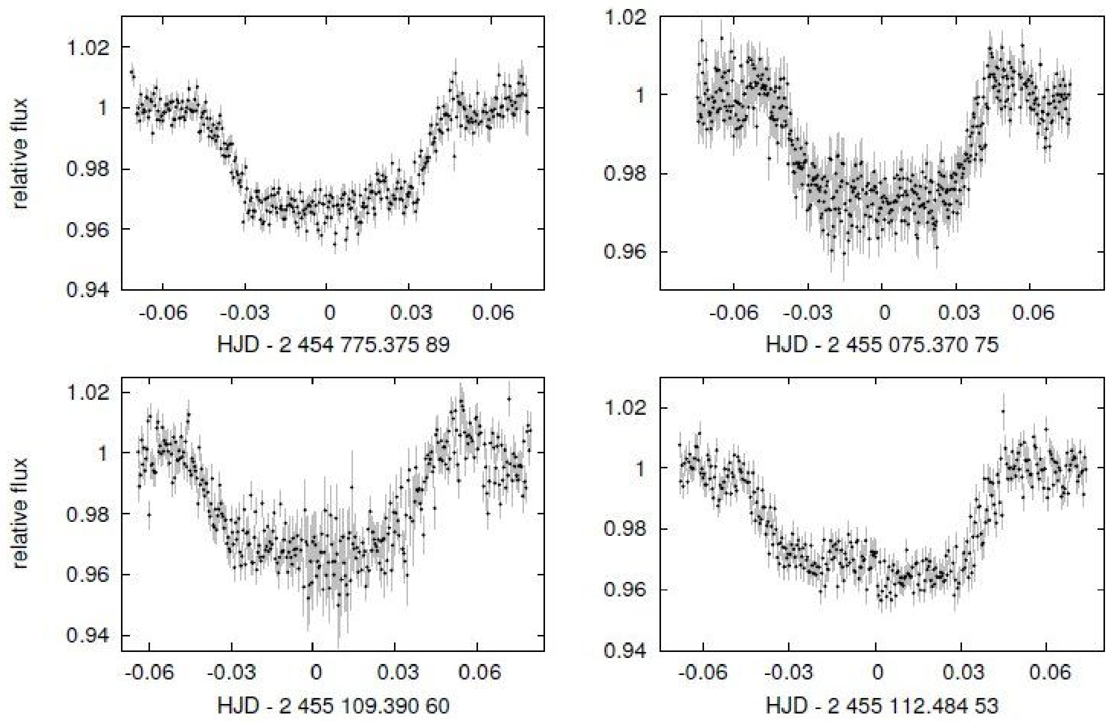

Figure 1: Light-curves of transiting extrasolar planet WASP–10 from the following nights from top left: 4/11/08, 31/8/09, 4/10/09 and 7/10/09 (dd/mm/yy).

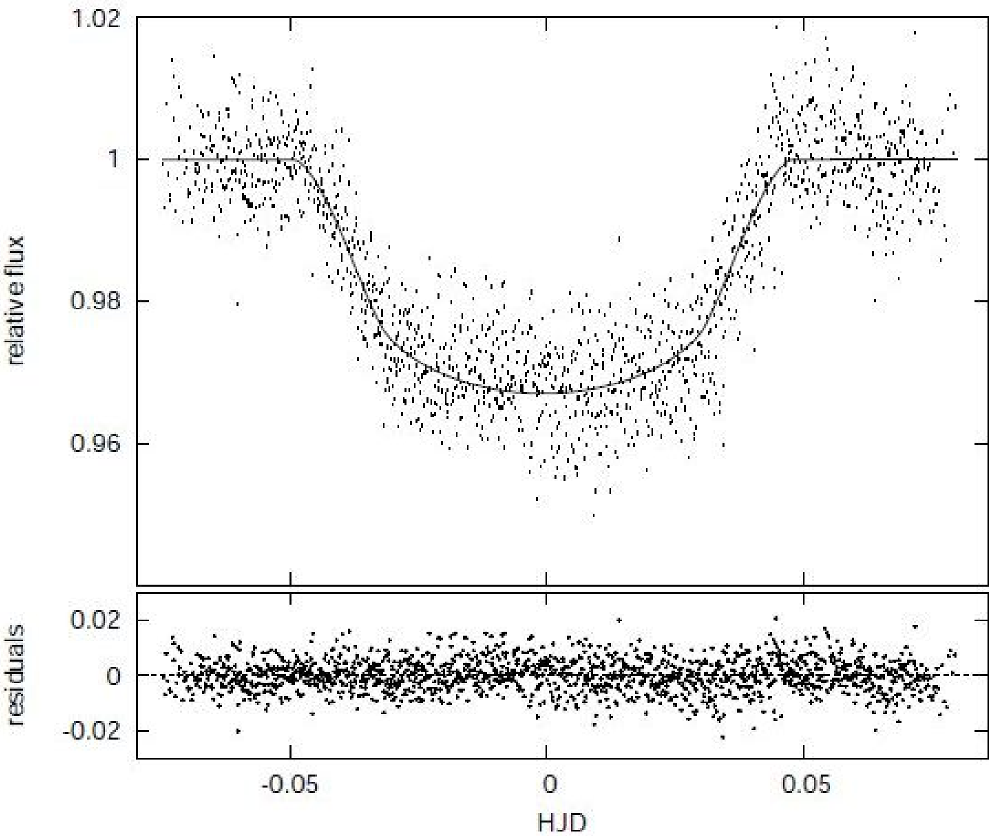

Figure 2: Top: Composition of 1 533 data point from the four nights: 4/11/08, 31/8/09, 4/10/09 and 7/10/09 (dd/mm/yy) of the exoplanetary system WASP10 –b. The observations were made in filter *R* (UBVRI system). The solid line is the best fit transit curve. Bottom: Residuals from the best fit model.

Second exoplanet in the WASP–10 system

Maciejewski et al. (2011) propose the existence of potential second planet WASP–10c. They found that the transit timing could not be explained by a constant period. The mass of the second planet was proposed to be M◎0.1 M_J with the orbital period P ◎5.23 day. The second planet must be confirmed by both spectroscopic and photomeric observations.

Acknowledgement

This work has been supported by the Marie Curie International Reintegration Grant FP7-200297, grant GA CR GD205/08/H005, the National scholarship programme of Slovak Republic, and partly by VEGA 2/0078/10, VEGA 2/0074/09.

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Having CCD camera? Some tips what to observe and what not to observe

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Abstract: Many new CCD observations of eclipsing binaries and their minima are published every year in astronomical journals. In some of these systems the need of new observations is rather questionable. Several interesting systems needing new observations are introduced in the present paper.

Abstrakt: Každý rok je v astronomických časopisech publikováno velké množství CCD pozorování zákrytových dvojhvězd a jejich minim. U některých z nich je otázkou, nakolik jsou nová pozorování potřeba. V tomto článku předkládáme několik zajímavých systémů, u nichž jsou nová měření velice vítána.

Foreword

Collaborating with many amateur astronomers, who have their own CCD cameras and also time and will to observe time to time some photometry, I have found out that these people often do not know what they want to observe specifically, but for sure they want to observe something. Dealing with the variable stars and specifically the eclipsing binaries, the criteria used for the target selection seem to be rather important. Therefore, I would like to encourage the observers to do useful observations instead of doing just only observations. I will focus only on the minima observations, because this seems to be the main observational effort of amateur observers.

What not to observe

One important fact for the target selection process is how neglected the systems are and how new observations for the particular system would be useful for the scientific community. Certainly, there are some systems where new observations are not so needed just because of the fact that these systems are under intensive long-term monitoring programme.

This is e.g. the case of the new high-precision photometric satellites like KEPLER, COROT, etc. In that sense it is absolutely useless to observe nowadays the systems from the KEPLER field, which are for example BR Cyg, V461 Lyr, V995 Cyg, V810 Cyg, V404 Lyr, V379 Cyg, V2290 Cyg, V1580 Cyg, UZ Lyr, etc., because we have the whole light curves of these systems measured with unprecedented accuracy of about 1 mmag. The same apply for the COROT field with the systems like AU Mon, etc. However, the important fact is that the observations for these systems would be of particular interest if you are dealing with the standard UBVRI photometry, because the data from the satellites are not in these filters and the colour information is missing.

What to observe

I would like to divide this section into the several subsections according to the type of the object, why it is so useful to be observed with the CCD photometry.

1. <u>The systems with the third body</u>

There are many systems, where the additional component orbiting around the barycentre with the eclipsing pair was detected and new precise CCD minima times for these systems could reveal, confirm, or only make better the solution of the light-time effect it produces (periodically changing the delays between minima as orbiting around the barycentre). These systems are for instance:

KR Com - system of W UMa type, shallow minima, orbit of 11 years, also some long-term luminosity changes

V 505 Sgr - system of Algol type, primary minimum about 1 mag deep, third body on 38 years orbit

BD –22 5866 - Algol type system, minima about 0.2 mag deep, quadruple system with long period about 10 yr

EE Peg – Algol type system, primary minimum about 0.6 mag deep, period about 4 yr from the spectroscopy

V1031 Ori – Algol type system, minima about 0.4 mag deep, period a few decades from the visual orbit

V2388 Oph – the W UMa type system, minima about 0.3 mag deep, suspected period about 10 years

MR Del – Algol type system, primary minimum about 0.3 mag deep, period of the third body uncertain

QS Aql – Algol type binary, shallow minima about 0.1 mag deep, long period about 75 years

V635 Mon – Algol type system, primary minimum about 0.2 mag deep, visual orbit of period 225 years

V819 Her – Algol type system with primary about 0.13 mag deep, period of the third body is 5.5 years

- another possible ones: SZ Cam, VX Lac, AI Dra, DM Del, TY Del, WZ And, V803 Aql, FZ Ori, DK Cep, RR Dra, TZ Eri, UZ Sge, UW Cyg, T LMi, IV Cas, EW Lyr, AD And, WY Per, …

2. The systems with apsidal motion

Systems with eccentric orbit are still "on the stage", therefore new minima times for some of them are very welcome and could specify more precisely the period of such phenomena. Some of the eccentric Algol types are:

V456 Oph – system with the shortest orbital period known among the eccentric systems, apsidal period 22 yr

V490 Cyg – system with the shortest apsidal motion period known nowadays, about only 18.7 years

AR CMa – system where the suspected apsidal motion has period about 34 years

V498 Mon – new apsidal motion system with period about 62 years

V730 Mon – new apsidal motion system with period about 47 years

V643 Ori – binary with rather long orbital period about 52 days, but suspected for eccentricity

V994 Her – system with both third body and apsidal motion, double eclipsing binary (two eclipsing pairs)

GK Boo – system with very short period, but still suspected for eccentricity

- another possible ones: V401 Lac, V402 Lac, FT Ori, V442 Cyg, V478 Cyg, HS Her, AV CMi, CV CMa, TV Cet, RW Lac, …

3. The other systems

There are many systems, which seems to be interesting according to their O-C behaviour during the last years, but their nature is still questionable – there could be the third body as well as some abrupt changes of the period or some other period modulation, which is still not very clear. Some of them are for example:

BF CMi, R CMa, RT Per, ST Per, RW Per, TW Lac, SW Lac, AC Tau ,…

Conclusion

There are many eclipsing binaries, which could be observed, but the selection criterion is always on the observer and no one else. It is therefore advisable to check for first the particular system – if this system shows some interesting O-C behaviour (periodic modulation, difference between primary and secondary), as well as how often this system is observed by the other astronomers. For example if we are dealing with the short periodic system, where every year there are several new observations and nothing is obviously happening there (like AP And or ER Vul), it is probably not very useful to observe it again.

New ephemeris of the eclipsing binary V1060 Her

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Abstract: The new ephemeris of EA eclipsing binary V1060 Her = ROTSE1 J172741.29+274503.5 = GSC 02083-00557 = USNO-B1.0 1177-0363083 (R.A. = $17^h27^m41.313^s$, DEC. = +27°45'03.44", J2000.0, R1 = 12.23 - 13.03 mag; Min. I = HJD 2455062.42587 + 4.7251102 d x E) has been determined from dataset obtained during 22 nights by 0.40-m f/5 reflector at Hradec Králové observatory.

Abstrakt: Nová efemerida zákrytové proměnné hvězdy typu EA V1060 Her = ROTSE1 J172741.29+274503.5 = GSC 02083-00557 = USNO-B1.0 1177-0363083 (R.A. = $17^h27^m41.313^s$, DEC. = +27°45'03.44", J2000.0, R1 = 12.23 - 13.03 mag; Min. I = HJD 2455062.42587 + 4.7251102 d x E) byla určena na základě analýzy souboru dat pořízeného během 22 nocí 0.40-m f/5 reflektorem na hvězdárně v Hradec Králové.

The variability of V1060 Her = ROTSE1 J172741.29+274503.5 = GSC 02083-00557 = USNO-B1.0 1177-0363083 (R.A. = $17^h27^m41.313^s$, DEC. = +27°45'03.44", J2000.0, R1 = 12.23 - 13.03 mag) was discovered by ROTSE-1 (Robotic Optical Transient Search Experiment 1). The first ephemeris Min. I = HJD 2451291.827 + 1.5768 x E were published in the IBVS 5060 with a note, that period may be doubled (Diethelm, 2001).

New CCD observations had been made by Martin Lehký at Hradec Králové observatory (HPHK) using a 0.40-m f/5 JST (Jan Šindel Telescope) reflector and SBIG ST-7 CCD camera + R band filter. During 22 nights (2009 April – 2010 July; time span 438 days) were obtained a total of 4001 CCD frames of V1060 Her. Images were processed using C-Munipack (Motl, 2010) and three minima timings were determined using the Kwee and Van Woerden method implemented in AVE (Barbera, 2000).

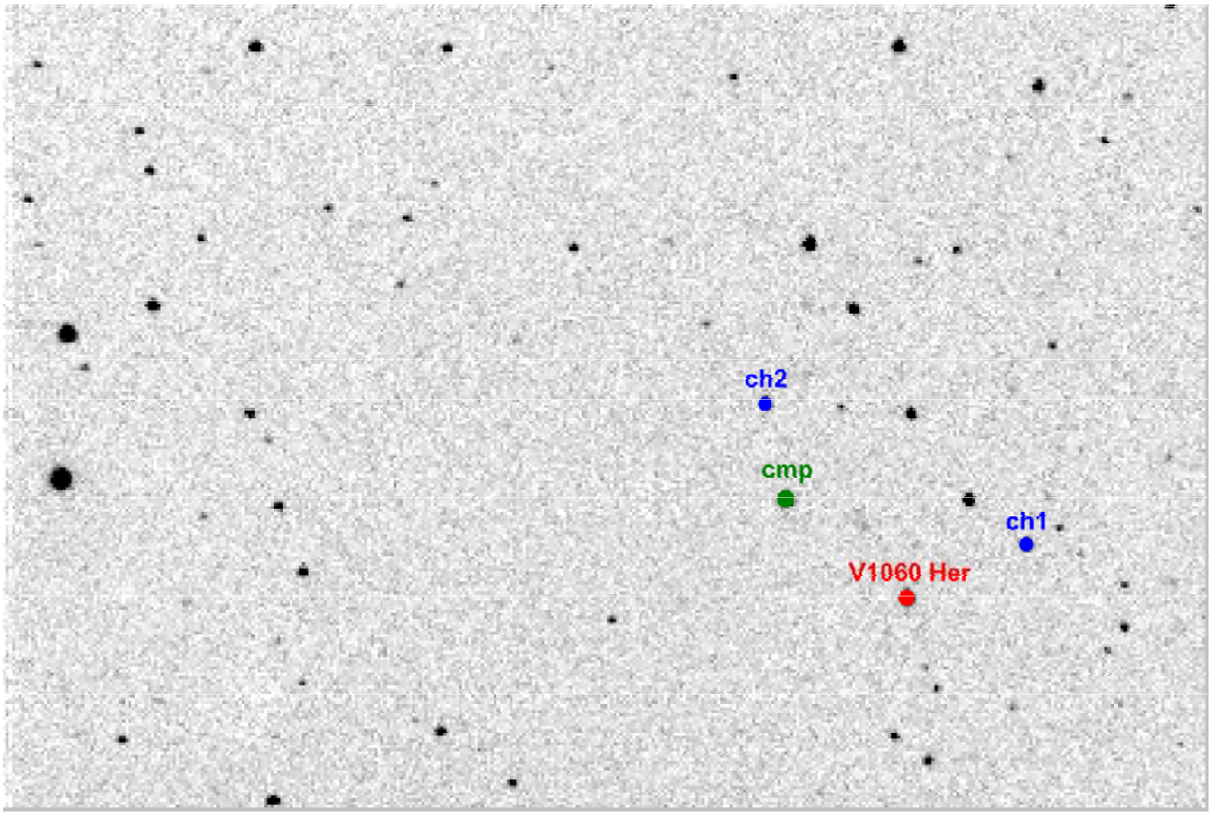

Figure 1: Close vicinity of V1060 Her (field of view is 13' x 9', N is to the top, E to the left).

Comparison stars are cmp USNO-B1.0 1177-0363137 (R.A. = $17^h27^m47.017^s$, DEC. = +27°45'58.18", J2000.0, R1mag = 13.08), ch1 USNO-B1.0 1177-0363036 (R.A. = $17^h27^m36.056^s$, DEC. = +27°45'38.67", J2000.0, R1mag = 13.73) and ch2 USNO-B1.0 1177-0363151 (R.A. = $17^h27^m48.204^s$, DEC. = +27°46'54.49", J2000.0, R1mag = 13.73). R1 magnitudes were taken from the USNO-B1.0 catalogue.

Approximate period valid for the whole time span of my data was obtained using PerSea 2.01 (Maciejewski, 2004) and further refined using linear least-squares analysis of three minima timings. The basic minimum was improved upon as well in the process. Dataset were also checked for one-day and one-year aliases of the determined period. The differential light curve of the comparison and check stars was constant with a standard deviation of 0.023 mag in the case of cmp-ch1 and 0.026 mag in the case of cmp-ch2, respectively.

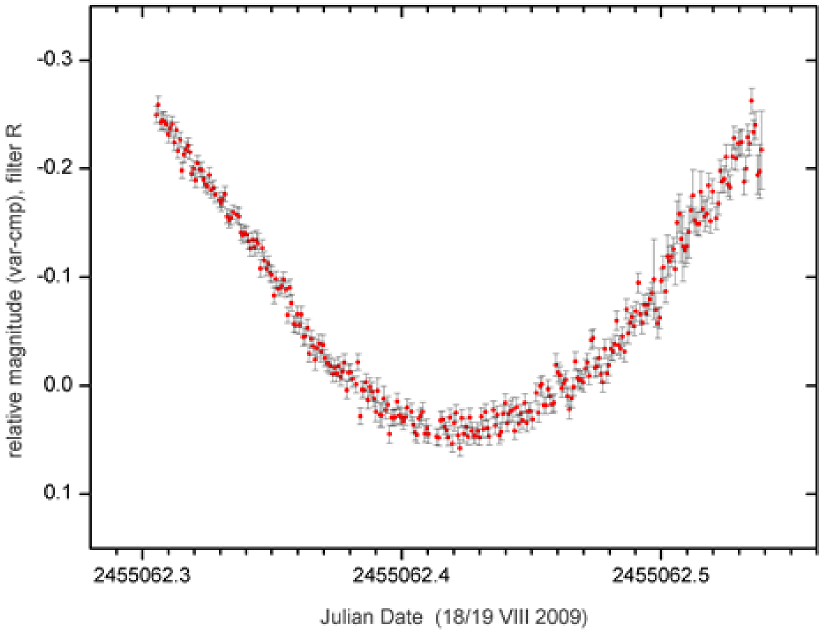

Figure 2: CCD R-band light curve of V1060 Her showing primary minimum (basic minimum).

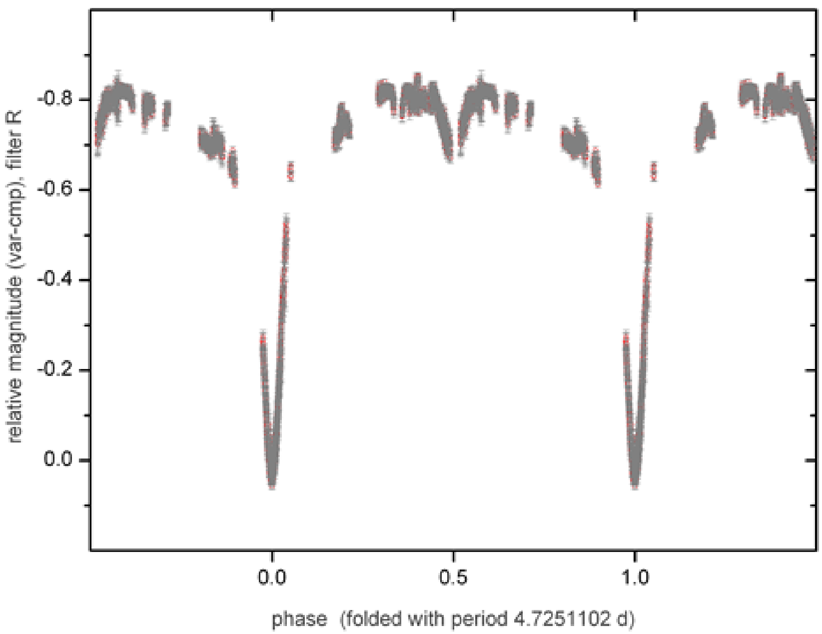

Figure 3: Phased CCD R-band light curve of V1060 Her.

Phased R band light curve (folded with period 4.7251102 d) is shown in Figure 3; minima timings are given in Table 1. All times given are heliocentric UTC. Final ephemeris is:

$$\text{Min. I} = \text{HJD } 2455062.42587 + 4.7251102 \text{ d} \times E$$
$$\pm 0.00159 \pm 0.0000296$$

Figures 2, 3 and the period given above suggest that V1060 Her is an EA type eclipsing binary with depth of primary minimum 0.80 mag (R1 = 12.23 - 13.03 mag) and depth of secondary minimum 0.15 mag.

Based on the new ephemeris could be determined new minimum time from ROTSE-1 data (Akerlof et al., 2000).

Hel. J.D.	Error	Type	O – C	Epoch	Observer	Remarks
2451291.8233	0.0013	Min I	0.03534	– 798	ROTSE-1	Lehký, Paschke
2455062.42599	0.00030	Min I	0.00012	0	ML	
2455355.38412	0.00080	Min I	0.00142	62	ML	
2455388.45765	0.00030	Min I	– 0.00082	69	ML	

Table 1: Minima timings of V1060 Her.

Acknowledgement

I acknowledge overall support and used telescope with CCD camera of the Hradec Králové observatory (HPHK) and Astronomical Society at Hradec Králové (ASHK). I would like to thank Anton Paschke for his help and assistance with ROTSE-1 dataset.

This research has made use of the SIMBAD and VizieR databases operated at the CDS at Strasbourg, France, of the International Variable Star Index (AAVSO), of the Smithsonian/NASA Astrophysics Data System and of the O-C Gateway at Variable Star and Exoplanet Section of Czech Astronomical Society.

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Motl, 2010, Project C-Munipack

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Restoration of the project PROSPER

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Abstract: Short report about restoration of the project PROSPER is given. Project is focused on observations of neglected binaries with unknown or wrong established orbital ephemerides. The archived observational data will be used for calculating of orbital elements and models of systems. The list of stars included in the project will be then check and supplement by new stars from Czech and Slovak catalogues of suspected variables.

Abstrakt: Zde je předložena krátká zpráva o obnovení projektu PROSPER. Projekt je zaměřen na pozorování zanedbaných dvojhvězd s neznámými nebo špatně určenými orbitálními efemeridami. Archivní naměřená data budou použita pro výpočty orbitálních elementů a modelů systémů. Seznam hvězd zahrnutých v projektu bude následně zkontrolován a doplněn o nové hvězdy z českého a slovenského katalogu hvězd podezřelých z proměnnosti.

Information about PROSPER

Project PROSPER was founded by D. Motl, M. Zejda et al. in 2001 and it was presented for the first time in Czech local astronomical bulletin Perseus (PER 3/2002). Primary aim of the project was visual observation of neglected eclipsing binaries with unknown or wrong established orbital periods and combination with other data for example CCD measurements and data from automatic sky surveys (ASS) determined ephemerides. Subsequent deeper purpose was also used this CCD data for calculation models and determined physical parameters of binary systems.

Well start-up project which had included 24 variable stars in the early 2006 was slowly aborted and a major part of measurements remains unpublished. Meaningful output is only report about two eclipsing systems KZ Dra and IM Vul in Proceedings of the Zdeněk Kopal's Binary Star Legacy (Pejcha et al. 2005).

Other interesting information about activity in PROSPER can be find in Proceedings of the 37th Conference on Variable Star Research (Motl, 2006) or also in Perseus[1] (Motl, Zejda, 2002), (Motl, 2003), (Motl, 2004).

This report was written as information that the project PROSPER will again continue. At first we plan to use observed data for publication. Majority of the eclipsing binaries in a PROSPER observing program has preliminary determined light ephemeris and very good defined light curve and are prepared for calculations of models. However some stars included in the project have probably different type of variability because after the longtime CCD photometric monitoring they do not show expected light variations.

The other future plan is to check PROSPER's list, to discard solved eclipsing binaries and supplement the list by suspected variable stars from Czech (CzeV[2]) and Slovak (SvkV[3]) catalogues, because there is a lot of stars with no published information about variability in both databases. The main goal is determination of type of variability, amplitude of brightness variations and ephemeris in case of periodic variable stars. There are 210 stars (CzeV catalogue) and 18 stars (SvkV catalogue) suspected of variability in both databases.

Discussion

Project PROSPER is focused on neglected variable stars preferentially eclipsing binaries. Nowadays, it seems unnecessary to find periods in unstudied binaries which are presumably observed by some of ASS, because a lot ASS search period of variability as well.

However, project PROSPER can be better in following cases - when selected stars are not observed by any ASS, when selected stars are fainter than stars observed by ASS, when the frequency of observation in ASS is too low and when the monitored stars have longer period than is working time of ASS. Further good reason for our interest in these stars suspected of variability is that no or not enough information about their variability exists in databases such as SIMBAD or in published articles although some of ASS identified this star as variable. Our work may help other astronomers as a notice on interesting objects.

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[1] http://var2.astro.cz/perseus/
[2] http://var.astro.cz/newvar.php
[3] http://var.astro.cz/newsvkv.php

Acknowledgement

This work has been supported by MUNI/A/0968/2009 (Student project grant at MU - specific research programme) and by grant GD205/08/H005 (Doctor grants).

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CzeV, Suspected variable stars catalogue CzeV

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Motl, D., 2006, Project PROSPER, OEJV, 23, 73

Pejcha et al., 2005, Ap&SS, 296, 285

SvkV, Suspected variable stars catalogue SvkV

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Two Binary Systems with Unusually Asymmetric Light Curves

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Abstract: We review an exotic class of interacting binary stars, which exhibit an effect of a direct impact of the accretion stream from the donor star, which fills its Roche lobe, onto the accreting star. We've discovered a new binary system USNO-B1.0 1629-0064825 = VSX J052807.9+725606 = 2MASS 05280799+7256056 with an unusually asymmetric light curve, which is very similar to the well-known binary system V361 Lyr with a hot spot in the "accretor's" atmosphere.

Abstrakt: Zaměřili jsme se na exotickou třídu interagujících dvojhvězd, které vykazují efekt přímého dopadu akrečního proudu hmoty z primární složky, jež vyplňuje svůj Rocheův lalok, na sekundární složku. Objevili jsme nový binární system USNO-B1.0 1629-0064825 = VSX J052807.9+725606 = 2MASS 05280799+7256056 s neobvyklým asymetrickým tvarem světelné křivky, jež se velmi podobná dobře známému system V361 Lyr s horkou skvrnou v atmosféře sekundární složky.

During our search for new variable stars, we have discovered, studied and classified more than 50 variable stars of different types. Among them, we have discovered an exotic eclipsing variable, USNO-B1.0 1629-0064825 = VSX J052807.9+725606, which is similar to V361 Lyr – a binary system with a direct impact of the accretion stream into the photosphere of the accretor. The investigation and model of V361 Lyr was published by Andronov and Richter (1987). This model was confirmed by van Rensbergen et al. (2008), who also noted few other variables. We have examined available data on these stars and found that V361 Lyr is distinctly different from this group by the value of the effect.

The star which we discovered (USNO-B1.0 1629-0064825 = VSX J052807.9+725606) had been published by Andronov and Virnina (2010) in OEJV 0127. We have additionally studied both these stars in BVR filters using the telescopes 12" Maksutov-Newton and 16" Ritchey-Chretien of the Tzec Maun observatory and detected a very strong increase of the effect towards shorter wavelengths.

The phase curves of V361 Lyr, based on our observations, are shown on the Fig. 1. We've used Henden's data (Henden, 2010) to calibrate our photometry of V361 Lyr. The comparison star was USNO-B1.0 1370-0359302 with coordinates R.A.(2000) = $19^h02^m27.948^s$, DEC.(2000) = +47°01'05.92" and magnitudes B=14.855 mag, V=14.131 mag, R=13.724 mag.

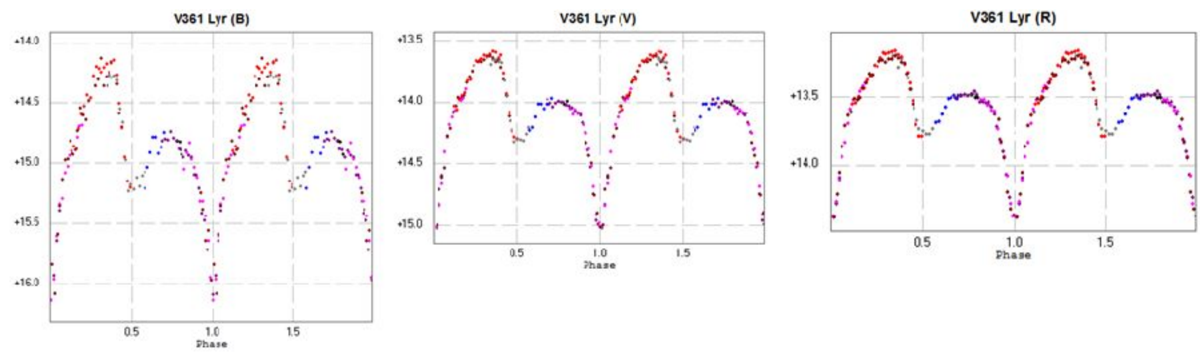

Figure 1: BVR phase curves of V361 Lyr are shown in the same scale either in phase, or magnitude.

All observations of VSX J052807.9+725606, which had been collected till November, 2010, using Tzec Maun Observatory's telescopes, were used to make BVR phase curves (Figure 2). As we have not reliable data about the stars in the vicinity of VSX J052807.9+725606, we present the instrumental photometry. The comparison stars were USNO-B1.0 1629-0064660 (R.A.(2000) = $05^h26^m55.944^s$, DEC.(2000) = +72°54'18.61"), USNO-B1.0 1629-0064838 (R.A.(2000) = $05^h28^m14.411^s$, DEC.(2000) = +72°57'03.35") and USNO-B1.0 1629-0064880 (R.A.(2000) = $05^h28^m31.013^s$, DEC.(2000) = +72°59'11.55"). VSX J052807.9+725606 is rather faint, especially in B-band, thus our photometry is rather inaccurate.

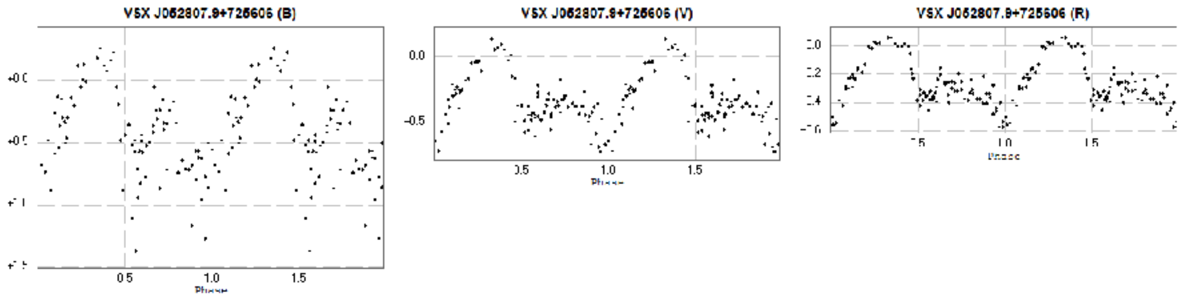

Figure 2: BVR phase curves of VSX J052807.9+725606 are shown in the same scale either in phase, or magnitude.

Both stars could be separated in an exotic class of interacting binary stars, which exhibit an effect of a direct impact of the accretion stream from the donor star, which fills its Roche lobe, onto the accreting star. The accretion stream declines from the line of center due to the Coriolis force. The shock wave produced by a direct impact of the accretion stream into the atmosphere of non-degenerate accretor produces a “hot spot”, which, in some cases, may have a luminosity compared with that of the stellar components. The shift of position of the “hot spot” from the line of centers produces a very interesting photometric effect – asymmetry not only of the primary and secondary minima, but also a difference in brightness of maxima.

Thus we suggest separate these stars, V361 Lyr and VSX J052807.9+725606, and all another stars with the same effects, which could be found in future, in the new subclass of eclipsing binary systems.

Plans for further study

As the new binary star VSX J052807.9+725606 is rather faint, we need to collect further observations using other, bigger, telescopes. After that we hope to compute the models with the hot spots of both stars, VSX J052807.9+725606 and V361 Lyr.

Acknowledgements

Author is very thankful to Luboš Brát for hospitality during her stay in Prague on the “42nd conference on variable star research”.

Also, author is thankful to Prof.I.L.Andronov for helpful discussions.

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Two new eclipsing binary stars near the CN And

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(2) Variable star and exoplanet section of Czech Astronomical Society

Abstract: Two new eclipsing binary stars GSC 2786 1409 = SvkV 18 (R.A. $00^h18^m50.31^s$, DEC. +40°04’04.9”, J2000, 13.7 – 14.2 mag, Min. I = HJD 2455411.0687 + 0.2908864*E) and GSC 2786 1360 = SvkV 19 (R.A. $00^h19^m58.9^s$ DEC. +40°32’30.7”, J2000, 13.9 – 14.2 mag, Min. I = HJD 2455460.4324 + 0.521930*E) were identified near the known variable star CN And.

Abstrakt: Dve nové zákrytové premenné hviezdy GSC 2786 1409 = SvkV 18 (R.A. $00^h18^m50.31^s$, DEC. +40°04’04.9”, J2000, 13.7 – 14.2 mag, Min. I = HJD 2455411.0687 + 0.2908864*E) a GSC 2786 1360 = SvkV 19 (R.A. $00^h19^m58.9^s$ DEC. +40°32’30.7”, J2000, 13.9 – 14.2 mag, Min. I = HJD 2455460.4324 + 0.521930*E) boli identifikované v poli známej premennej hviezdy CN And.

Two new eclipsing binary stars GSC 2786 1409 = SvkV 18 (R.A. $00^h18^m50.31^s$, DEC. +40°04’04.9”, J2000, 13.7 – 14.2 mag, Min. I = HJD 2455411.0687 + 0.2908864*E) and GSC 2786 1360 = SvkV 19 (R.A. $00^h19^m58.9^s$ DEC. +40°32’30.7”, J2000, 13.9 – 14.2 mag, Min. I = HJD 2455460.4324 + 0.521930*E) were identified during routine observation of the known variable star CN And on 1st August 2010. During the discovery observation was used 0.15 m, f/5 Newtonian reflector and the G2-1600 CCD camera. Discovery of GSC 2786 1409 and GSC 2786 1360 has been preliminary published in the Slovak variable star catalogue (SvkV 18 And and SvkV 19 And).

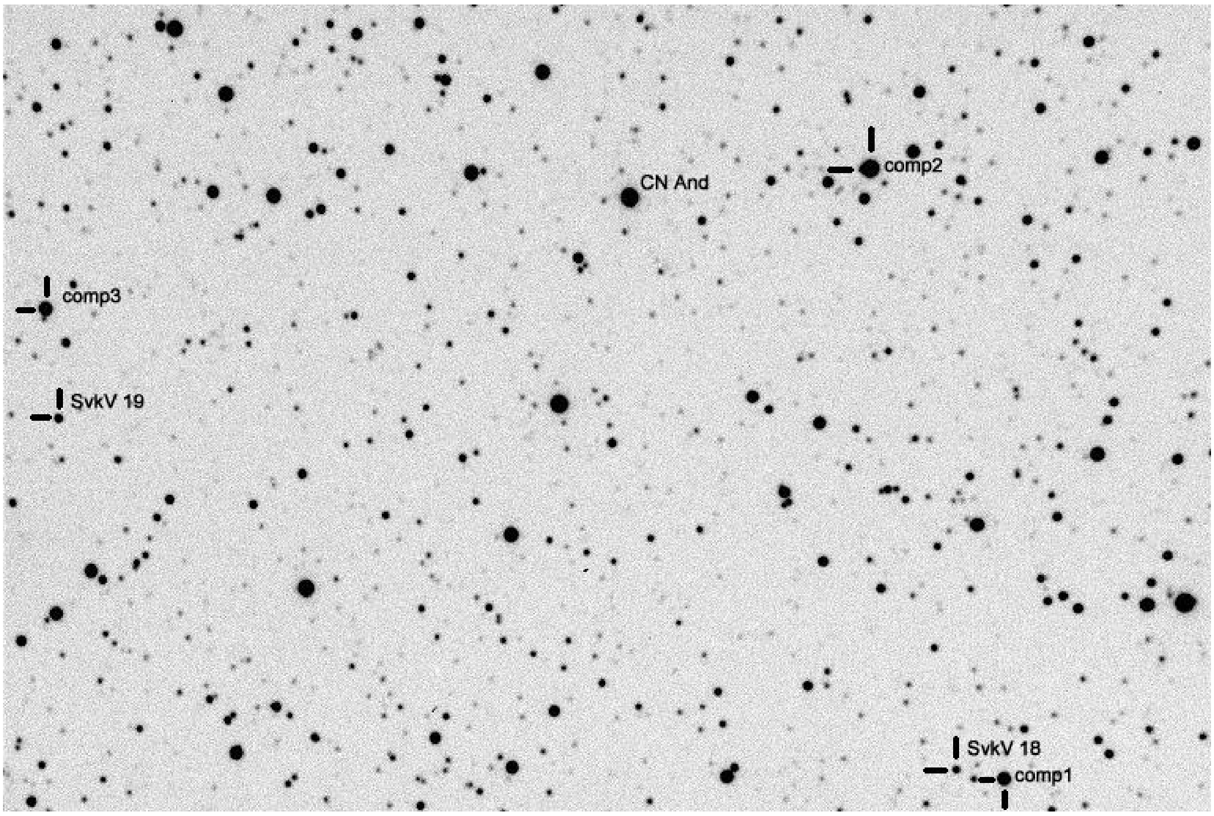

Figure 1: Finding chart for the new variable SvkV 18, SvkV 19 and comparison stars (comp1=TYC 2786 993, comp2=TYC 2787 1927, comp3=GSC 2787 1895). Field of view is 39’ x 26’ (N is to the left E to the top).

Data of phase curve for SvkV 18 were observed during 4 nights from 20th September to 23rd September 2010, completely 682 points. From the 1st August to 23rd September were obtained 7 times of minima, using 0.15 m f/5, 0.24 m f/5 Newtonian reflector, respectively, as shown in Table 1. Data of phase curve for SvkV 19 were observed during 5 nights from 20th September to 2nd November 2010, completely 763 points. During this time were obtained 3 times of minima using 0.24 m f/5 newtonian reflector, as shown in Table 2. The CCD images were reduced with program package MuniWin (Motl, 2006), times of primary and secondary minima have been determined using AVE (Barberá, 2000, method Kwee-van Woerden). Phase curve and preliminary light elements were obtained using PerSea (Maciejewski, 2004, method A.Schwarzenberg–Czerny) and further refined using linear least-squares analysis of all minima timings. The star SvkV 18 was classified as EB type with depth of primary minima 0.5 mag and depth of secondary minima 0.35 mag. The star SvkV 19 was classified as EW type with depth of minima 0.3 mag.

HJD	error	type	O - C	observer	published	remarks
2455410.4866	0.0013	Min I	-0.00033	MV	B.R.N.O.	0.15m, f/5
2455423.4310	0.0006	Min II	-0.00037	MV	-	0.15m, f/5
2455446.4133	0.0002	Min II	+0.00190	MV	B.R.N.O.	0.15m, f/5
2455452.3743	0.0003	Min I	-0.00027	MV	B.R.N.O.	0.15m, f/5
2455460.3733	0.0002	Min II	-0.00064	MV	B.R.N.O.	0.24m, f/5
2455461.3917	0.0004	Min I	-0.00035	MV	B.R.N.O.	0.24m, f/5
2455463.2825	0.0002	Min II	-0.00027	MV	-	0.24m, f/5

Table 1: Minima timings of GSC 2786 1409 = SvkV 18 And.

Final light ephemeris of SvkV 18:

Min I = HJD 2455411.0687 (±0.0002) + 0.2908864 d (±0.0000012) * E

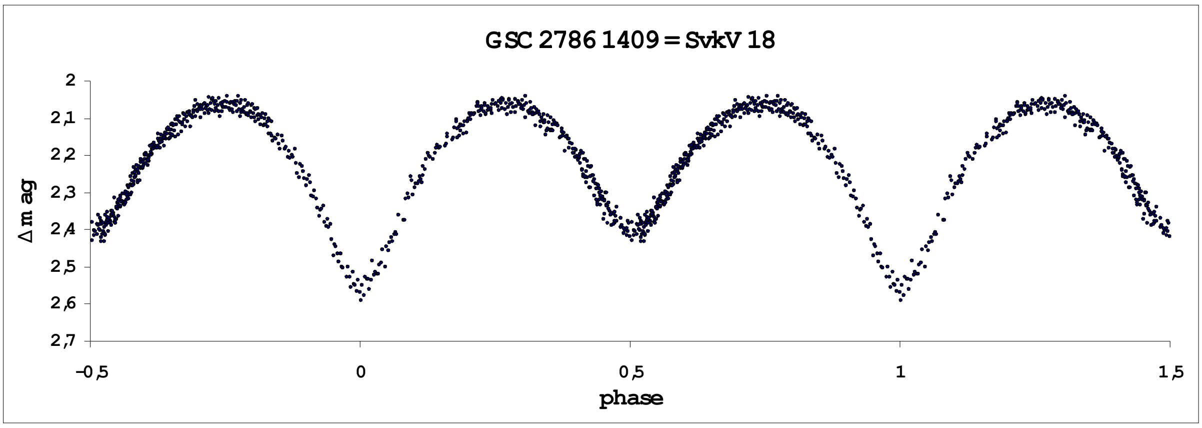

Figure 2: Phased light curve of SvkV 18 obtained during 4 nights, clear filter.

HJD	error	type	O - C	observer	remarks
2455460.4338	0.0003	Min I	+0.0014	MV	0.24m, f/5
2455463.3019	0.0006	Min II	-0.0011	MV	0.24m, f/5
2455481.3092	0.0015	Min I	-0.0003	MV	0.24m, f/5

Table 2: Minima timings of GSC 2786 1360 = SvkV 19 And.

Final light ephemeris of SvkV 19:

Min I = HJD 2455460.4324 (±0.0005) + 0.521930 d (±0.000084) * E

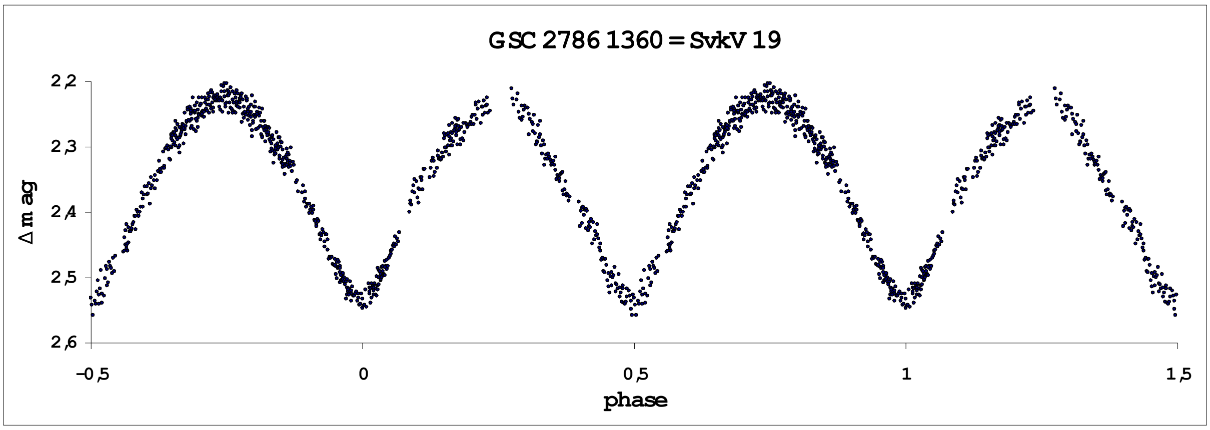

Figure 3: Phased light curve of SvkV 19 obtained during 5 nights, clear filter.

Acknowledgement

I would like to thank RNDr. Miloslav Zejda, Ph.D. for his helpful comments and support.

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Motl, D., 2006, Project MuniWin version 1.1.24

Two new eclipsing binary stars in field of HAT-P-16b

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(2) Variable star and exoplanet section of Czech Astronomical Society

Abstract: Two new eclipsing binary stars GSC 2792 1770 = SvkV 20 (R.A. $00^h36^m35.7^s$, DEC. +42°18'19.0", J2000, 11.5 – 11.8 mag, Min. I = HJD 2455473.839 + 1.18552*E) and TYC 2792 1914 = SvkV 21 (R.A. 00^h36^m 54.1^s, DEC. +42°20'22.7", J2000, 10.2 – 10.4 mag, Min. I = HJD 2455473.288 + 0.503365*E) were identified near the known exoplanet system HAT-P-16b.

Abstrakt: Dve nové zákrytové premenné hviezdy GSC 2792 1770 = SvkV 20 ((R.A. $00^h36^m35.7^s$, DEC. +42°18'19.0", J2000, 11.5 – 11.8 mag, Min. I = HJD 2455473.839 + 1.18552*E) a TYC 2792 1914 = SvkV 21 (R.A. 00^h36^m 54.1^s, DEC. +42°20'22.7", J2000, 10.2 – 10.4 mag, Min. I = HJD 2455473.288 + 0.503365*E) boli identifikované blízko známeho exoplanetárneho systému HAT-P-16b.

Two new eclipsing binary stars GSC 2792 1770 = SvkV 20 (R.A. $00^h36^m35.7^s$, DEC. +42°18'19.0", J2000, 11.5 – 11.8 mag, Min. I = HJD 2455473.839 + 1.18552*E) and TYC 2792 1914 = SvkV 21 (R.A. 00^h36^m 54.1^s, DEC. +42°20'22.7", J2000, 10.2 – 10.4 mag, Min. I = HJD 2455473.288 + 0.503365*E) were identified during observation of the known exoplanet system HAT-P-16b. During the discovery observation was used 0.24 m f/5 Newtonian reflector and the G2-1600 CCD camera. Discovery of GSC 2792 1770 and TYC 2792 1914 has been preliminary published in the Slovak variable star catalogue (SvkV 20 And and SvkV 21 And).

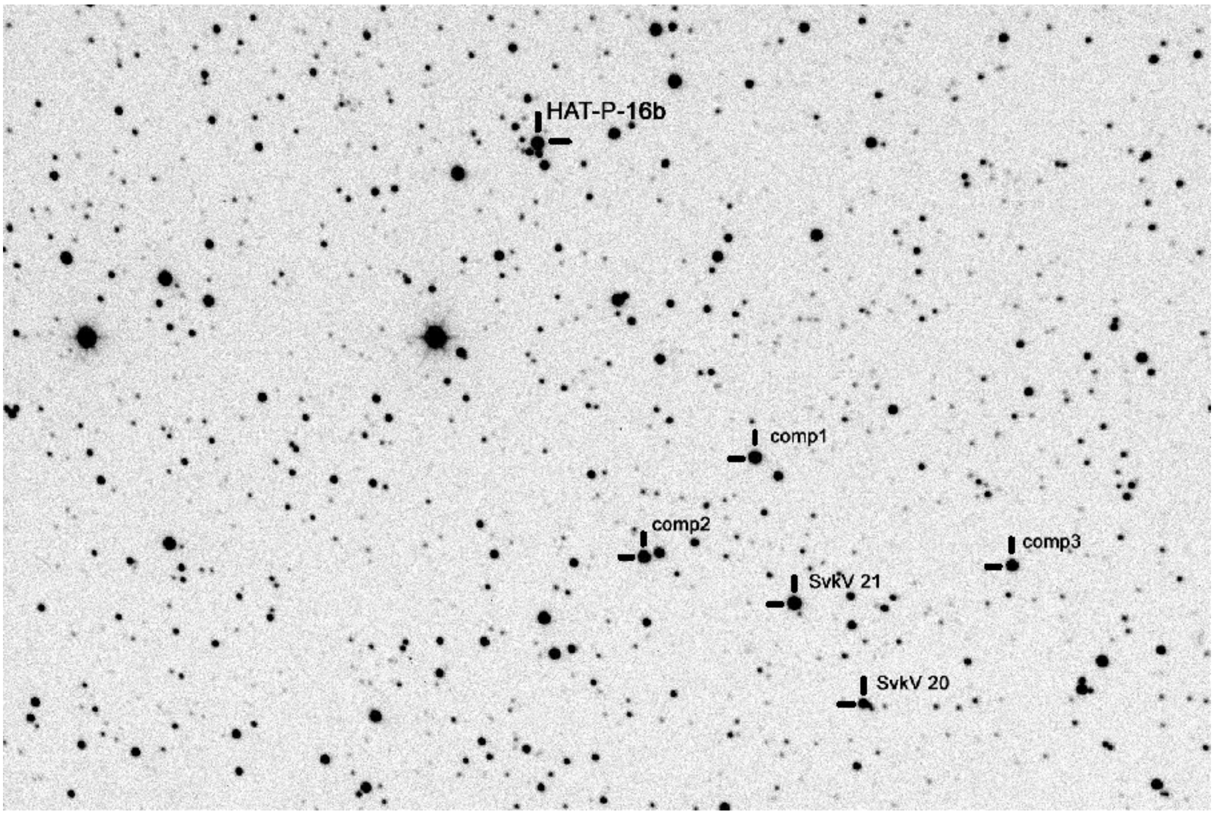

Figure 1: Finding chart for the new variable SvkV 20, SvkV 21 and comparison stars (comp1=TYC 2792 1703, comp2=TYC 2792 1762, comp3=GSC 2792 1806). Field of view is 39' x 26' (N is to the left E to the top).

Data of phase curve for SvkV 20 And a SvkV 21 And were observed during 9 nights from 23rd September to 2nd November 2010, completely 1285 points. In this period was obtained 3 times of minima SvkV 20 and 5 times of minima SvkV 21 using 0.24 m f/5 Newtonian reflector and G2-1600 CCD camera without photometric filters. The resulting minima times are listed in Table 1, respectively in Table 2. The CCD images were reduced with program package MuniWin (Motl, 2006), times of primary and secondary minima have been determined using AVE (Barberá, 2000, method Kwee-van Woerden). Phase curve and preliminary light elements were obtained using PerSea (Maciejewski, 2004, method A.Schwarzenberg–Czerny) and further refined using linear least-squares analysis of all minima timings.

HJD	error	type	O - C	observer	Remarks
2455473.4314	0.0008	Min II	-0.00036	MV	0.24m, f/5
2455476.3963	0.0002	Min I	+0.00074	MV	0.24m, f/5
2455482.3231	0.0001	Min I	-0.00006	MV	0.24m, f/5

Table 1: Minima timings GSC 2792 1770 = SvkV 20 And.

Final light ephemeris of SvkV 20 And:

Min I = HJD 2455473.8390 (±0.0005) + 1.18552 d (±0.00006) * E

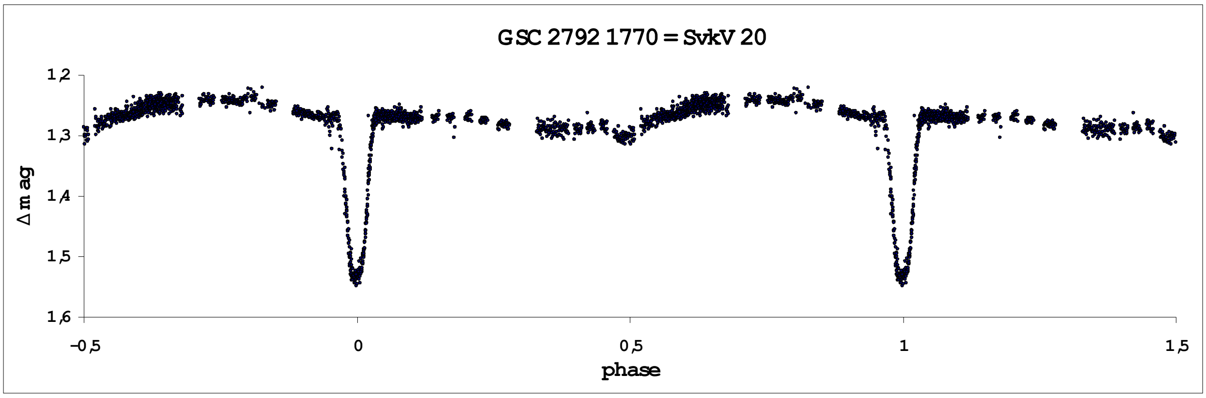

Figure 2: Phased light curve SvkV 20 And obtained during 9 nights, clear filter.

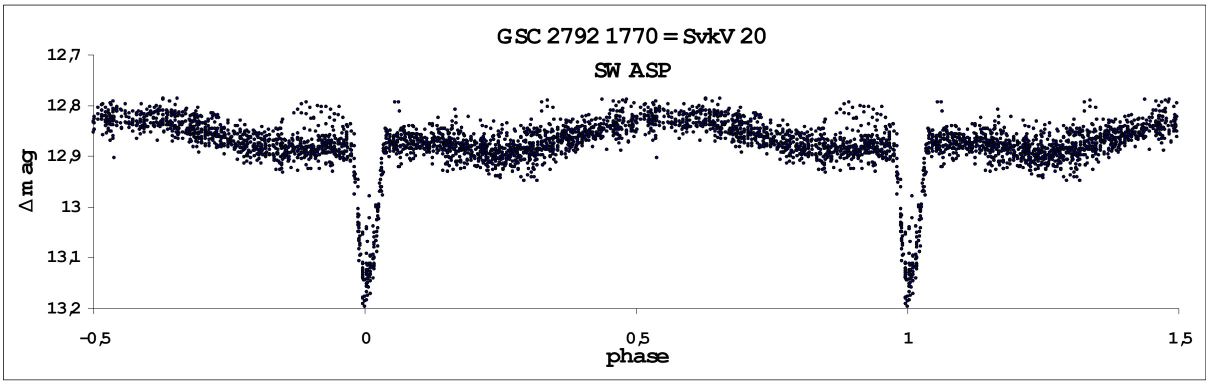

Figure 3: Phased light curve SvkV 20 And, SuperWASP data JD = 2454318 – 2454333, clear filter.

HJD	error	type	O - C	observer	Remarks
2455473.2862	0.0003	Min I	-0.00180	MV	0.24m, f/5
2455476.3176	0.0005	Min I	+0.00941	MV	0.24m, f/5
2455477.3177	0.0002	Min I	+0.00278	MV	0.24m, f/5
2455481.3379	0.0007	Min I	-0.00394	MV	0.24m, f/5
2455482.3477	0.0003	Min I	-0.00087	MV	0.24m, f/5

Table 2: Minima timings TYC 2792 1914 = SvkV 21 And.

Final light ephemeris of SvkV 21 And:

Min I = HJD 2455473.2880 (±0.0004) + 0.503365 d (±0.000024) * E

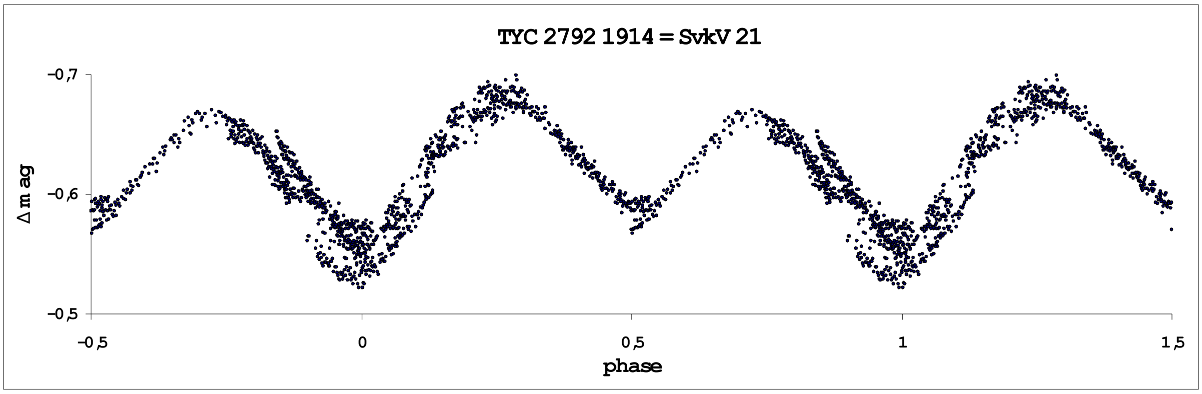

Figure 4: Phased light curve SvkV 21 And obtained during 9 nights, clear filter.

Discussion

The star SvkV 20 And was classified as EA type with depth of primary minima 0,3 mag and depth of secondary minima less than 0.1 mag.

As seen from the shapes of light curves SvkV 20 And (Figure 3) obtained from SuperWASP project's data (Butters et al., 2010) and from author's data (Figure 2), their shapes are slightly different. For the "SWASP" light curve a brightening appears around phase 0.5, probably due to reflection effect. The author's light curve shows a brightening at phase 0.75. If there is no reflection effect, this anomaly can be explained by the existence of hot spot on the one of components or the existence of the accretion disk around one of the components. Support for this assertion is the fact that SvkV 20 And is likely to coincide with the ROSAT X-ray source 1RXS J003636.5+421828. This makes this system very interesting for further observation.

The star SvkV 21 And was classified as EW type with depth of primary and secondary minima 0.2 mag. The SvkV 21 And system shows positive O'Connell effect, this means that the maximum after the primary minimum is higher than the maximum after the secondary minimum. Phased light curve obtained by the author (Figure 4) shows the different depth of the primary minimum. For confirmation of this effect were subsequently processed data available from SWASP survey. As seen in the Figure 5, the depth of primary minimum and peak of maximum is really variable.

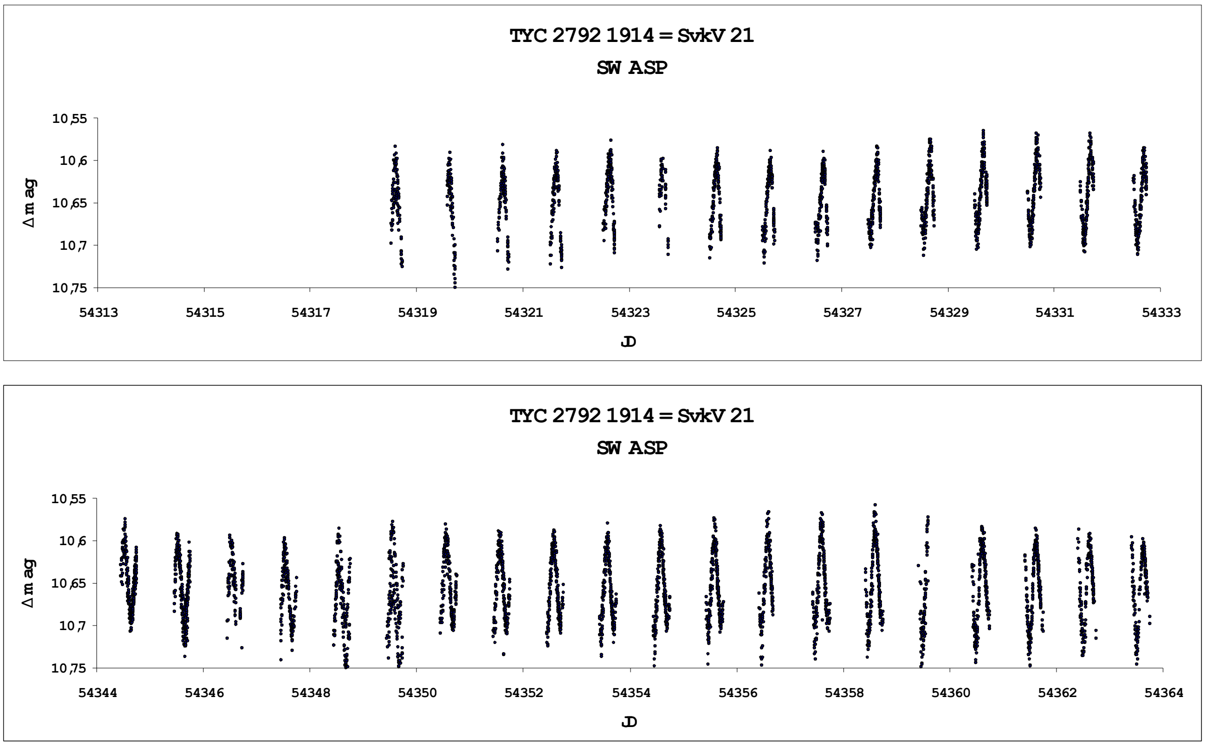

Figure 5: Light curve SvkV 21 And obtained from SuperWASP public archive. JD = 2454318 – 2454364.

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What the color indices can tell us about the optical counterparts of high energy sources

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Abstract: We show how optical counterparts of high energy sources can be analyzed by the method of the color indices. We discuss this method applied to the objects which are sufficiently bright to be observable by the amateur telescopes equipped with CCD detectors and a set of filters. We concentrate on the objects lying in our Galaxy (e.g. cataclysmic variables, supersoft X-ray sources, microquasars). We show that multifilter observations can reveal strong color changes during the transitions of the object between various states of activity (outbursts, high/low states).

Abstrakt: Ukazujeme, jak zkoumat optické protějšky vysokoenergetických zdrojů pomocí metody barevných indexů. Rovněž ukazujeme, že lze tuto metodu smysluplně použít i pro sledování objektů dostatečně jasných na to, aby byly v dosahu amatérských dalekohledů, které jsou vybaveny CCD detektory a sadou barevných filtrů. Soustředili jsme se zde na objekty, které se nacházejí v naší Galaxii (např. kataklyzmické proměnné).

Introduction

More and more variable star amateur observers use the telescopes equipped with CCD detectors. It enables them to observe fainter objects and to measure their brightness with a better precision. Another step forward is using a set of filters for this photometry. We show that multifilter observations by these instruments can reveal strong color changes during the transitions of the object between various states of activity (e.g. outbursts, high/low states).

Reasons for multifilter photometry

Why to use the color indices in analysis of optical counterparts of high energy sources? Simply because it is a powerful and sensitive approach which helps us to investigate spectral energy distribution and its changes even with small or moderate CCD telescopes using the commonly available photometric filters. Even quite faint objects can be observed in this way. This method also enables us to search for the common properties of the sources of a given kind (e.g. cataclysmic variables of various types, X-ray binaries...). This method can also be used for a search for the relations among colors and luminosities of a given object or of a kind of objects (if the distance and interstellar reddening are known). Color indices also enable us to constrain the properties of the local medium of the source (e.g. variable extinction inside the source). We can also distinguish among the individual radiation mechanisms (e.g. synchrotron radiation versus thermal emission). We will focus on the types of objects which are observable by the amateur CCD telescopes and for which the method of the color indices is only rarely used.

Color indices are determined from the magnitudes of an object measured in the individual filters (e.g. measured in the CCD images obtained by various filters). Usually, we thus obtain the indices B–V, V–R, R–I, sometimes even U–B. These color indices can provide us with important information on the spectral energy distribution of the observed object.

Importance of the color indices

In the first step, let us show the importance of the color indices on the stars in the globular cluster M4 (Alcaino & Liller 1984). The members of this cluster can be regarded as lying in approximately the same distance and affected by the same interstellar extinction (reddening). Most of these stars occupy the well-defined places in the diagram in which their absolute magnitude is plotted versus their color index. Especially main sequence is clearly visible.

Alcaino & Liller (1984) also show the role of reddening caused by interstellar extinction. This extinction modifies the color indices of the objects – they redden. Nevertheless, this reddening occurs in a well-defined direction in the color-color diagrams. The values of the color indices can be corrected, for example if this extinction, determined from spectra, is known. This extinction remains constant for a given object.

Color indices of variable stars of various types can be plotted and examined like the light curves. Important results can be obtained by comparing the variations of brightness with the simultaneous changes of the color indices.

What do we observe in optical counterparts of high energy sources?

What is the source of light of optical counterparts of high energy sources? Binary X-ray sources are emitters of radiation over a very broad range of wavelengths, typically from the X-ray to the infrared band.

In cataclysmic variables (Warner 1995) and low-mass X-ray binaries (LMXBs) (Lewin et al. 1995), accretion process (that is accretion of matter onto the compact object) is often the dominant source of luminosity. This accretion usually occurs via the accretion disk embedding the compact accretor (white dwarf, neutron star, black hole); only cataclysmic variables with highly magnetized white dwarf are an exception. The light of the donor (that is the mass donating stellar companion) is often significantly fainter. Most X-ray emission comes from the close vicinity of the compact object.

In high-mass X-ray binaries (HMXBs) (Lewin et al. 1995), the donor's light usually dominates in the optical band (except for some outbursts). Also in these systems, most X-ray emission comes from the close vicinity of the compact object.

The temperature and structure of the accretion disk largely vary with time. If the light of the disk is dominant in the optical band, this leads to the large-amplitude variations of brightness like outbursts or transitions between the high and low states. Of course, these brightness changes are often accompanied by significant variations of the color indices.

Color variations of selected objects

Color-color diagrams of the ensemble of cataclysmic variables of various subtypes presented by Bruch (1984) and Hack & la Dous (1993) show a very important role of the color indices in our understanding of the physics of accretion. These systems very strongly concentrate in a small region of this diagram during the peaks of their outbursts (or high states of brightness generally). The color indices of these systems very strongly vary when the high states are compared with those observed in the low states of activity (quiescence between outbursts, low states). Multifilter (UBV) observations of several cataclysmic variables called dwarf novae (VW Hyi, SS Cyg) which mapped the progress of their outbursts showed remarkable color variations during the rise to the outburst peak (Bailey 1980). Both the U–B and B–V indices reddened by about 0.5 mag during this phase.

Supersoft X-ray sources (SXSs) are another attractive group of objects. Most of them are a peculiar type of cataclysmic variables. The mass transfer onto the white dwarf occurs at a very high rate (about 10-7 Mo/yr). This allows steady-state hydrogen burning on this white dwarf (van den Heuvel et al. 1992). Strong activity of some these systems in the optical band makes them attractive targets for the observers. Known SXSs are mostly located in the Magellanic Clouds and in M31, but there are also several groups of their close relatives in our Galaxy (e.g. V Sge systems (Steiner & Diaz 1998) and some symbiotic systems).

The systems with short orbital periods (less than 4 days), even with different absolute V band magnitudes, concentrate in the well-defined regions of the (U–B)0 vs. (B–V)0 and (B–V)0 vs. (V–R)0 diagrams (i.e. with the colors corrected for the interstellar reddening). On the other hand, supersoft X-ray symbiotic systems display large shifts during transitions between the states of their activity (see (Šimon 2003) and Šimon et al. (2010) for details). Balmer jump of SXSs is frequently in emission, as inferred from the color indices of SXSs. Also the relation between the color indices and absolute magnitudes of SXSs helps us compare the properties and configuration of the reprocessing medium in the individual systems. Some similarity of the spectral profiles of SXSs to those of old novae emerges. Indeed, the color indices of old novae are similar to those of SXSs, but they display a larger scatter for the individual objects.

The relatively bright and hence easily observable V Sge displays a complicated long-term activity with the amplitude of about 2 mag, whose character changed considerably during about 40 years (e.g. Herbig et al. 1965, Šimon & Mattei 1999). The U–B and B–V indices remained almost the same for a given level of brightness in spite of the large changes of the character of the light curve (Šimon et al. 2001). This suggests that the process which gives rise to the large variations of brightness in V Sge underwent only small changes. As suggested by the shifts in the U–B vs. B–V diagram, Balmer jump is in emission and undergoes only minor changes during the high/low state transition. The continuum gets hotter toward the high state, as suggested by the decrease of B–V.

Microquasars are X-ray binaries (HMXBs and LMXBs) with relativistic jets (Mirabel & Rodríguez 1999). They contain mass-accreting neutron stars or black holes. This jet of rapidly outflowing matter is formed during some specific states of their activity (e.g. some phases of outburst). The relatively bright and hence easily observable object CI Cam (XTE J0421+560) belongs to this type. Its X-ray outburst occurred in 1998 (Frontera et al. 1998). This system rapidly brightened from about 11.7 mag(V) to about 9 mag(V) during this event and then gradually declined during the following several days. The peak of this outburst was accompanied by a significant reddening of the color indices V–R and B–V, that is of the spectral region longward of Balmer jump (i.e. except the U–B index) (Barsukova et al. 2002, Šimon et al. 2006).

Significant post-outburst activity of CI Cam with the amplitude of about 0.3 mag was observed in 1999–2004 (Šimon al. 2007ab, Clark et al. 2000, Šimon et al. 2010). The shifts in the color-color diagram are not explicable by the changes of the reddening intrinsic to CI Cam. They can be explained as being due to several superposed spectral components. The division of their dominant contributions occurs near the wavelength λ=550 nm, that is in the V band: free-free emission from wind and/or envelope, and another component in the blue region (Clark et al. 2000, Šimon al. 2007a). The observed hysteresis in the V–R vs. R–I diagram can be explained by the variations of the strength of the observed Hα changes which are not simple variations of the combined continuum and weaker emission lines at a stable Hα emission. The Hα emitting region evolves on the time scale of hundreds of days.

Also a comparison of the brightness and color activity in the optical band with the behavior of the X-ray intensity is important for our understanding of the physical processes in the object. Huge changes of extinction in X-rays and no extinction variations in the optical suggest that the X-ray emission of CI Cam comes from the close vicinity of the mass-accreting black hole, not from the giant donor (see Šimon et al. (2007a) for details).

General conclusions and guidelines

Not only the color indices of the object in a given time, but also the time evolution of these indices are important for its classification and study. Dense series of photometric observations in various photometric filters are necessary to distinguish and investigate the color variations which accompany the long-term activity of optical counterparts of high energy sources. Such series are particularly needed for resolving the state transitions like the rising and decaying branches of outbursts and high/low states. Such transitions are often very fast, especially the rising branches of some outbursts are very steep. If we can therefore repeat the observing series (e.g. BVRI) of a given object several times during a single night, it will definitely help. It is also desirable to place these events in the context of the long-term activity of a given system. A step forward is then to form a representative ensemble of events (e.g. outbursts) in (a) a given system, (b) in a type of systems. Even variations of strong emission lines with respect to the continuum can be distinguished by the color indices (e.g. Hα changes, Balmer jump changing from emission to absorption).

Full versions of most papers cited in this work can be found in the database NASA ADS (http://adswww.harvard.edu/).

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