Contrib. Astron. Obs. Skalnaté Pleso **43**, 462 – 464, (2014)

V1010 Oph investigated by a cm-class telescope

M. Zejda[1], Z. Mikulášek[1,2], L.-Y. Zhu[3,4], S.-B. Qian[3,4], J. Liška[1] and J. Janík[1]

[1] *Department of Theoretical Physics and Astrophysics, Masaryk University, Brno, Kotlářská 2, CZ-611 37 Brno, Czech Republic, (E-mail: zejda@physics.muni.cz)*

[2] *Observatory and Planetarium of Johann Palisa, VŠB–Technical University, Ostrava, Czech Republic*

[3] *National Astronomical Observatories/Yunnan Observatory, Chinese Academy of Sciences, Kunming, China*

[4] *Key Laboratory for the Structure and Evolution of Celestial Objects, Chinese Academy of Sciences, Kunming, China*

Received: November 10, 2013; Accepted: December 20, 2013

Abstract. *V* 1010 Oph is a relatively bright near contact binary. We present a new study including four-colour photometry and a model of the system. The uniqueness of our study is in the using of only a centimetre-class telescope with a CCD camera. We show that such small, cheap equipment seems to be very helpful in the investigation of bright variable stars.

1. Introduction

Near Contact Binaries (NCBs) have been defined as a new subtype of close binaries with both components filling or nearly filling their critical Roche lobes by Shaw (1990, 1994). The typical light curve of NCB shows EB-type light changes. Generally, NCBs are divided into two subclasses. V1010 Oph-type systems are defined as those with a more massive primary component at or near the Roche lobe and a secondary one well inside the Roche lobe. FO Vir-type systems are defined as those that have a normal size primary component inside its Roche lobe and a secondary at or near the Roche lobe (Shaw 1994). We selected one of the subclass prototypes, V1010 Oph (V=6.1-7 mag), as a target for our study.

Our goal is to show the possibility of obtaining photometric data of interesting bright variable stars. Nowadays, stars brighter than 6 mag are usually hardly measurable. Most photometric surveys also do not offer data of bright stars. The modern solution for this lack of photometric data of bright stars is the project BRITE[1] of nano-satellites with on-board telescopes of only 3 cm in diameter. However, we decided to test a telescope of such size for ground based photometric observation.

[1]http://www.univie.ac.at/brite-constellation/index.html

2. Observational data and light curve modelling

For our photometric observations, we used a G2-402 CCD camera made by Moravian Instruments, Czech Republic (Kodak chip KAF0402ME, 768 × 512 pixels, pixel size 9 × 9 μm) with a set of $BVRI$ Johnson-Cousins photometric filters. We attached to this camera a Helios 2/58 objective (inner diaphragm of 34 mm used). The equipment was installed on the small table mount EQ1.

In the time interval JD 2 455 703 – 2 456 141 we obtained new photometric CCD measurements of V1010 Oph using our "microtelescope". In the figure we show a comparison with photometric data obtained by (1) a more than 10 times larger telescope equipped with a photoelectric photometer (Leung & Wilson, 1977), (2) data from the Hipparcos satellite and (3) data from the Pi of the Sky survey (Burd et al., 2004).

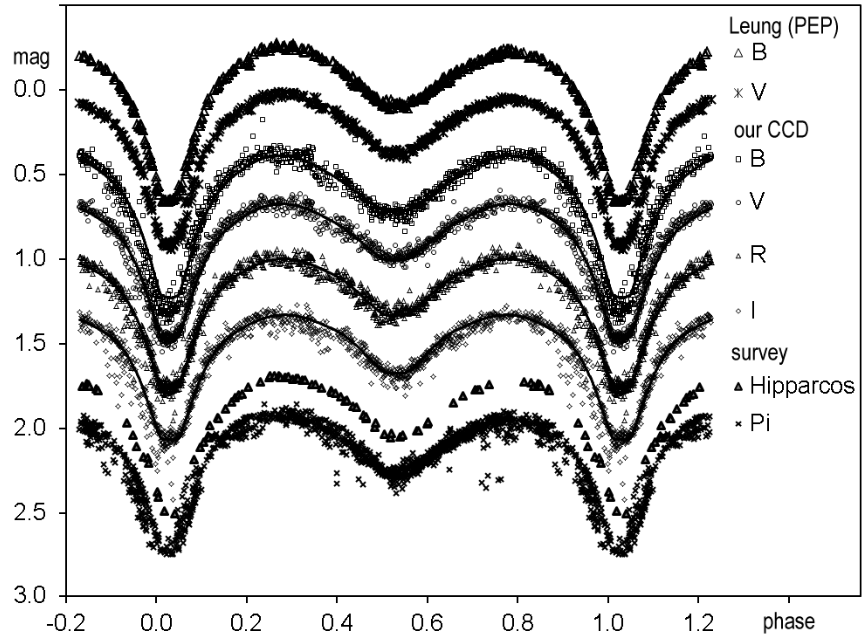

Figure 1. Our new CCD light curves of V1010 Oph obtained using a "microtelescope" in $BV(RI)_C$ compared with light curves obtained by photoelectric measurements (Leung & Wilson 1977), and based on data from Pi of the Sky survey and HIPPARCOS satellite. Fits of very prelimary model are shown in our CCD light curves.

The new complete $BV(IR)_c$ CCD light curves were analyzed using the 2003 version of the Wilson-Van Hamme code (Wilson & Van Hamme 2003). Our preliminary solutions are consistent with those obtained by Leung & Wilson

(1977) and show that V1010 Oph is a marginal contact binary with both components filling their critical Roche lobes. More detailed investigations and the corresponding parameters will be published soon elsewhere.

3. Conclusions

We determined the parameters of the system. We know that also spectroscopic observations are available. However, we would like to show that it is possible to obtain a LC solution comparable with that obtained using a photoelectric photometer and a 40cm telescope by Leung (1974) simply using photometric data obtained with a small photo lens equipment equipped with a CCD camera.

Acknowledgements. This study was partly supported by the grants of Czech Science Foundation GAP209/12/0217, Masaryk University MUNI/A/0968/2009 and the Ministry of Education, Youth and Sports LH12175 and by the Chinese Natural Science Foundation (Nos. 11133007 and 11325315).

References

Burd, A., Cwiok, M., et al.: 2004, *AN* **325**, 674

Leung,K.-C.: 1974, *AJ* **79**, 852

Leung, K.-C., & Wilson,R. E.: 1977, *ApJ* **211**, 853

Shaw, J. S.: 1994, *Memorie SAI* **65**, 95

Shaw, J. S.: 1990, *NATO ASIC Proc. 319: Active Close Binaries Proceedings, NATO Advanced Study Institute* **241**,

Wilson R. E., Van Hamme W.: 2003, *Computing Binary Stars Observables, the 4th ed. of the W-D program, ftp: astro.ufl.edu, directory pub/wilson/lcdc2003* ,