# MONITORING OF LUMINOUS BLUE VARIABLES CANDIDATES IN M31

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We present the results of spectroscopic and photometric study of Luminous Blue Variable (LBV) candidates in the Andromeda galaxy. Two targets in M31 galaxy J004526.62+415006.3 and J004425.18+413452.2 from Massey's list [1] have been observed with the 6-m Russian telescope BTA from 2012 to 2017 in the optical range. Photometric data in BVR filters for all objects obtained at Schmidt telescope at NAO Rozhen Bulgaria from 2015 to 2018. Using these data in combination with other archive photometric data we show photometrical curve and produce multi-epoch spectral energy distributions (SED) of these stars. Taking into account an inherent property of LBVs that their bolometric luminosity of LBV stars are constant we determine the stellar temperatures and radii in different LBV states, as well as the extinction. We have obtained estimates bolometric magnitudes $M_{bol} \approx -10.4^m$ and $M_{bol} \approx -8.4^m$ for J004526.62+415006.3 and J004425.18+413452.2 respectively. Both objects showed photometric and spectral variability that confirm their classification as LBV.

**Keywords:** stars: emission-line, LBV – galaxies: individual: M31

## 1. INTRODUCTION

The optical spectra and photometry obtained at the Russian 6-m telescope BTA with SCORPIO spectrograph from 2012 to 2017. Photometric data in BVR filters for all objects obtained at Schmidt telescope at NAO Rozhen from Nov. 2015 to Dec. 2018. We use archive data of Panoramic Survey Telescope and Rapid Response System (Pan-STARRS) [2], Palomar Transient Factory (PTF) [3] and data from work [4]. For data Pan-STARRS archive we use equations

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for photometric transformations between the SDSS and other systems [5] and http://www.sdss.org/dr4/algorithms/sdssUBVRITransform.htm

**J004526.62+415006.3**

In Fig.1 (left) we present light curve obtained according to our and archive photometric data in R-filter in period from 2006 to 2019. We see irregular variability $\Delta R \approx 1.0^m$. The arrows indicate the dates of the obtained spectra. Spectral studies of this object were carried out in 2006 by Massey [1], in 2010, 2015 by [6], in 2011, 2012, 2017 by us on the BTA telescope [7]. Our data suggest its clear LBV-like variability the star with the same reddening but the star becomes brigter.
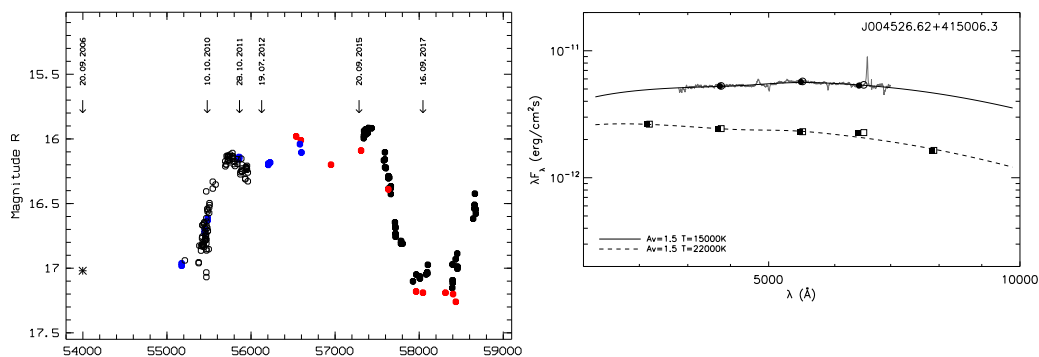


**Fig. 1.** Left: Light curve in R-filter for J004526.62+415006.3. Open circles - data PTF [3], filled circles - data from NAO Rozhen telescope, asterisks - data [1], blue circles - data from Pan-STARRS [2], red circles - data from [4]. The arrows indicate the dates of the obtained spectra. Right: SED modelling. Circle indicate the B, V, R photometry observed simultaneously with our spectra, filled circles indicate photometry with the contribution of bright emission lines. Square are the data by Massey et al. [1], filled square - with the contribution of bright emission lines. The curves designate the blackbody approximation with reddening applied according to Table 1. The solid curve shows our fit to the optical part of our spectra, the dashed curve shows the fit to the data of [1]. All parametres which we estimate from SED: photosphere temperature, absolute and bolometric magnitudes presented in Table 1.

**J004425.18+413452.2**

In Fig.2 (left) we present a compiled photometric curve of J004425.18+413452.2 constructed from our and archive data for the period from 2006 to 2019. The object shows the variability $\Delta R \approx 0.6^m$. In Fig.2 we show the SED for J004425.18+413452.2. We use our spectrum and photometry from BTA/SCORPIO obtained in 18 Dec. 2015. We confirmed the spectral and photometric change in that object.
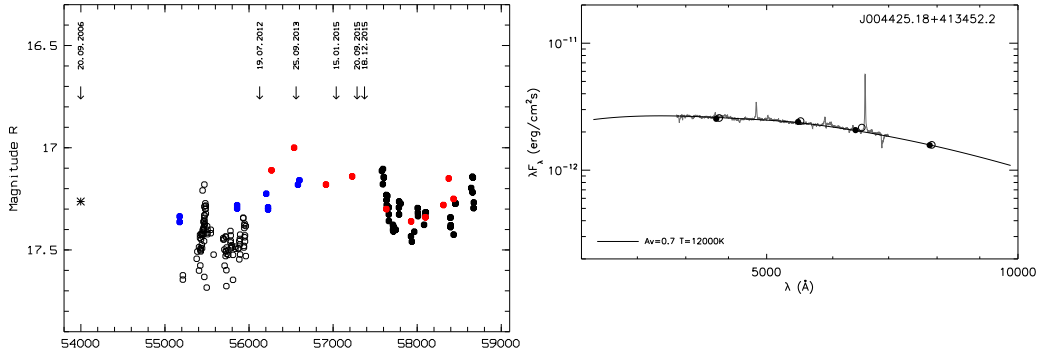
**Fig. 2.** Left: Light curve for J004425.18+413452.2. Symbols are the same as on Fig.1. Right: SED modelling. Circles indicate the B, V, R, I photometry observed simultaneously with our spectra, filled circles indicate photometry with the contribution of bright emission lines. The solid curve shows the fit to the optical part of our spectrum. All parametres which we estimates from SED presented in Table 1.

| Star | $A_V,^m$ | $M_V,^m$ | $T_{sp}$,kK | $T_{SED}$,kK | $M_{bol},^m$ |
|---|---|---|---|---|---|
| J004526.62+415006.3 | $1.5 \pm 0.1$ | -9.5 | $15-25$ | 15 | -10.4 |
| J004526.62+415006.3 | $1.5 \pm 0.1$ | -8.5 | $15-25$ | 22 | -10.4 |
| J004425.18+413452.2 | $0.7 \pm 0.2$ | -7.8 | $10-15$ | 12 | -8.4 |

**Table 1.** Parameters of the studied stars.

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