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New data for the LBV in NGC 4736

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We present new spectral and photometric data of a confirmed LBV star from the NGC 4736 galaxy. The star NGC 4736_1 ($M_{bol} \approx -11.5^m$) showed a noticeable spectral variability from 2015 to 2018, which was accompanied by a significant change in brightness. We have also estimated the possible initial mass of the object NGC 4736_1 as $\sim$130 $M\odot$.

Keywords: Stars: emission lines, Be – stars: massive – galaxies: individual: NGC 4736 – stars: variables: S Doradus

1 Introduction

Luminous blue variable stars (LBVs) are a rare type of massive stars with masses $M > 25M_\odot$ (Humphreys et al., 2016) at one of their final evolutionary stages. These stars are characterized by a high luminosity of about $\sim 10^5 - 10^6 L_\odot$ (Humphreys & Davidson, 1994) and significant spectral and photometric variability at different time scales.

We present new spectral and photometric data on the LBV star NGC 4736_1 (Solovyeva et al., 2019) (12:50:57.264, +41:07:23.13) from the NGC 4736 galaxy (distance modulus of $m - M = 28.31$, Tully et al. (2013)).

2 Data

The first spectra of the NGC 4736_1 were obtained with SCORPIO focal reducer (Afanasiev & Moiseev, 2005) on the BTA telescope of the SAO RAS on 2015/01/18 (VPHG1200G grism). NGC 4736_1 was also observed on 2018/02/18 (VPHG1200G grism) and 2020/01/18 (VPHG1200B grism). New photometric data were obtained with the BTA (2020) of SAO RAS simultaneously with spectroscopy and Zeiss-1000

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(2019/04/09) of SAO RAS and also with 2.5-m telescope of the Caucasian Mountain Observatory of SAI MSU (2020/03/07). We added these data to light curve from previous work (Solovyeva et al., 2019) (see Fig. 2, left).

3 The spectral variability

The object NGC 4736_1 showed significant photometric variability: $\Delta V = 1.18^m \pm 0.12^m$ and $\Delta B = 0.90^m \pm 0.12^m$ in V and B bands (Solovyeva et al., 2019). The measurements with minimal errors were used for calculations. Based on photometric variability, spectra and luminosity NGC 4736_1 was concluded to be an LBV star.

The spectra of NGC 4736_1, obtained in 2015, show the typical features of well-known LBV stars: broad and bright hydrogen lines, He I lines, many iron Fe II lines (Figure 1) and a large number of forbidden iron lines [Fe II], [Fe III]. The spectrum obtained in 2018 has significant changes compared with the spectrum obtained in 2015: the Fe II and He I lines became indistinguishable, and the broad component of the Hβ line significantly weakened. The changes in the spectrum are accompanied by a decrease in brightness by ≈ 1 mag in V band from 2015 to 2018. Such behavior means an increase in the photosphere temperature (see Figure 2 in Solovyeva et al. 2019), which is typical for LBV stars.

The spectrum obtained in 2020 does not show changes compared to the spectrum obtained in 2018. Moreover, the photometric variability was also not detected from 2018 to 2020 (see Figure 2, left panel).

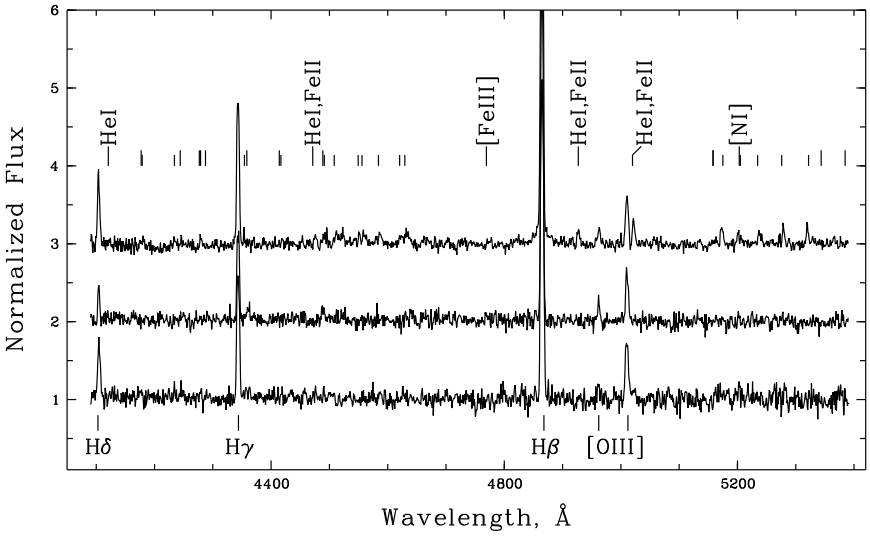


Figure 1 Spectra of NGC 4736_1 obtained in 2015 (top), 2018 (middle) and 2020 (bottom). The main spectral lines are indicated. The unlabelled short and long ticks designate the Fe II and [Fe II] lines, respectively.

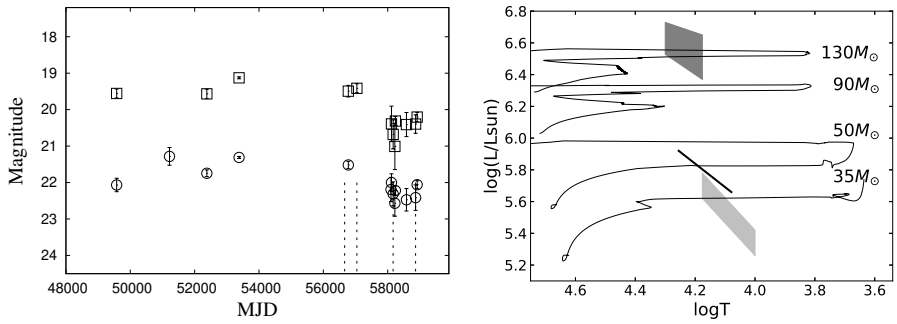


Figure 2 (left panel) Light curve of NGC 4736 1 in the B (circles) and V (squares) bands. The B band is shifted down by two magnitudes. (right panel) Temperature–luminosity diagram for NGC 4736_1, NGC 4736_2, NGC 4736_3 (from top to bottom). Possible ranges of temperature and bolometric luminosity are indicated by gray figures (NGC 4736_1, NGC 4736_3) and a black solid line (NGC 4736_2). Stellar evolutionary tracks for massive stars from Tang et al. (2014) were used.

Figure 2 (right panel) shows the position of NGC 4736_1 on the temperature - luminosity diagram. The positions of NGC 4736_2, NGC 4736_3 from (Solovyeva et al., 2019) are also shown. We used stellar evolutionary tracks from Tang et al. (2014) with $Z = 0.01$ for NGC 4736 (Pilyugin et al., 2014). Gray areas show the range of possible temperature and luminosity values of objects. The photosphere temperatures and bolometric luminosities estimates, given in Solovyeva et al. (2019), were used.

NGC 4736_1 has an initial mass of about 130 $M_\odot$, while NGC 4736_2 and NGC 4736_3 may have an initial mass of about 50 and 35 $M_\odot$. A mass of 40 $M_\odot$ is enough to pass the LBV stage (Maeder, 1996), so the star NGC 4736_3 is a less luminous LBV candidate.

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