

NEW LBV CANDIDATES IN NGC 247 GALAXY

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We present a study of two bright $H\alpha$ -sources in NGC 247 galaxy. The objects 004703-204708.4 (absolute magnitude $M_V \approx -9.2^m$) and 004702-204739.9 ($M_V \approx -9.5^m$) show spectral lines typical for well-studied LBV stars. We have obtained estimates of reddening, photosphere temperature of objects, and bolometric magnitudes $M_{bol} \approx -10.6^m$ and $M_{bol} \approx -10.7^m$, which corresponds to bolometric luminosities $\log(L_{bol}/L_\odot) \approx 6.2$ and $\log(L_{bol}/L_\odot) \approx 6.1$ for 004703-204708.4 and 004702-204739.9 respectively.

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1. INTRODUCTION

Luminous blue variables (LBVs) are bright massive stars at one of their final evolutionary stages [1]. LBVs are characterized by a high luminosity of the order of $\sim 10^6 L_\odot$. They also show significant spectral and photometric variability at different time scales. We have found two new LBV-candidates 004703-204708.4 and 004702-204739.9 in NGC 247 galaxy.

004703-204708.4 shows the strong broad emission lines of hydrogen and helium He I with P Cyg profiles 1. There are many lines of iron Fe II, silicon Si II, weak emission lines of nitrogen N II (4630) and carbon C II (7052). The presence of these lines indicates that the photosphere temperature may be about $T_{sp} = 20 \pm 5$ kK. Bright forbidden lines [O III], [Ar III], [N II], [S II] are probably emitted by the surrounding nebula. Spectrum of 004702-204739.9 contains broad emission hydrogen lines $H\alpha$, $H\beta$ and many iron lines Fe II. Based on the presence of these lines, we estimated the photosphere temperature of 004702-204739.9 as $T_{sp} = 15 \pm 5$ kK. The oxygen emission lines [O I] (6300, 6364) and the calcium dou-

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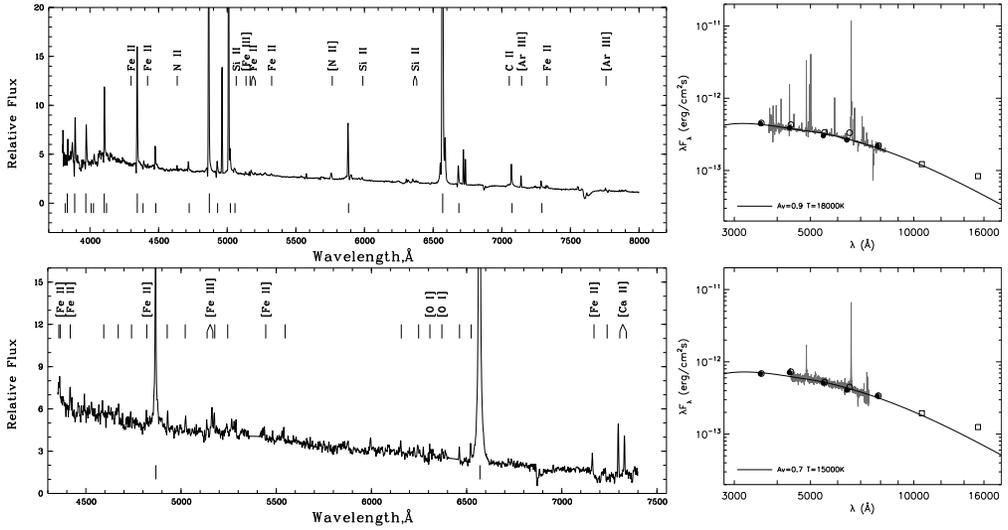


Fig. 1. Top: (left) The 004703-204708.4. spectrum; (right) 004703-204708.4 SED fitting. Bottom: (left) The 004702-204739.9. spectrum (right) 004702-204739.9 SED modelling. The unlabelled long and short ticks designate the hydrogen lines and He I lines, respectively. The filled circles indicate photometry from Subaru (2016) with the contribution of bright emission lines, unfilled - excluding emission lines. The unfilled squares indicate photometry from HST/WFC3/IR. Dereddened spectra are shown by gray colour.

blet [Ca II] (7291, 7324) indicate the presence of circumstellar gas. These lines are characteristic of the spectra of B[e] - supergiants and warm hypergiants. We estimated the reddening $A_V = 0.8 \pm 0.1^m$ (for 004703-204708.4) and $A_V = 0.9 \pm 0.2^m$ (for 004702-204739.9) using hydrogen lines of surrounding nebula, assuming the B case photoionization [2].

Photometric data from Subaru telescope (2016) were used to plot the spectral energy distribution (SED) of objects. The infrared data from the Hubble Space Telescope (2014) were plotted but were not used in SED-fitting. Photometric data were corrected for the contribution of the emission lines. SED was approximated by the Planck function taking into account interstellar extinction at $R_V = 3.07$ [3] with temperatures $T_{SED} = 18 \pm 2$ kK (for 004703-204708.4) and $T_{SED} = 15 \pm 2$ kK (for 004702-204739.9). In addition, the IR excess is not observed, which indicates the absence of circumstellar dust.

Based on the estimates of the photosphere temperature of objects and the reddening we estimated absolute and bolometric magnitudes and bolometric luminosity (Table 1). Objects do not show significant photometric variability: the brightness variations of 004703-204708.4 is $\Delta B \approx 0.3^m$ and $\Delta V \approx 0.3^m$ from 2011 (HST) to 2016 (Subaru), the variability of 004702-204739.9 is $\Delta U \approx 0.22^m$,

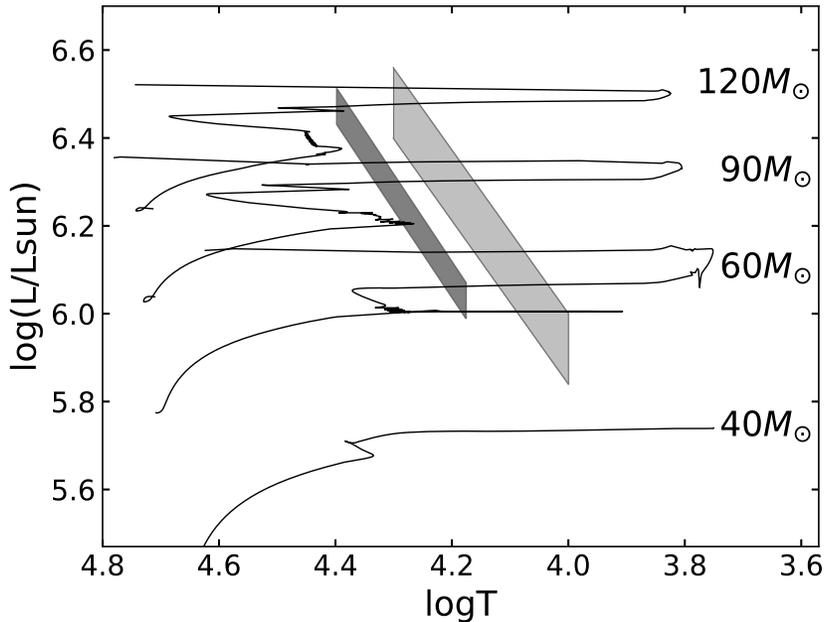


Fig. 2. Temperature - luminosity diagram for 004703-204708.4 (dark gray) and 004702-204739.9 (light gray). Stellar evolutionary tracks for $Z = 0.008$ stars are plotted. The gray figures indicate the ranges of temperature and luminosity.

$\Delta B \approx 0.15^m$, $\Delta V \approx 0.09^m$, $\Delta R \approx 0.09^m$ from 2009 (CTIO 0.9-m telescope) to 2016 (Subaru).

Star	$A_V,^m$	$M_V,^m$	T_{sp},kK	T_{SED},kK	$M_{bol},^m$	$\log(L_{bol}/L_{\odot})$
004703-204708.4	0.8 ± 0.1	-9.2	15 – 25	18	-10.6	6.2
004702-204739.9	0.9 ± 0.2	-9.5	10 – 20	15	-10.7	6.2

Table 1. Parameters of the studied stars.

The figure 2 shows the temperature - luminosity diagram for 004703-204708.4 and 004702 204739.9. We used stellar evolutionary tracks from [4] with $Z = 0.008$. Gray figures show the range of possible temperature and luminosity values of objects. The photosphere temperature estimates obtained from spectral data were used. Both objects have initial masses of about $40 M_{\odot}$. Such mass is sufficient for the star to pass the LBV stage [5]. For the final classification of objects, new photometric and spectroscopic data are required.

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