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Spectral analysis of LBV stars in M31: AF And and Var 15

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Abstract. We study spectra of two bona fide LBV stars in M31: AF And and Var 15. The spectra were obtained with the 6-m telescope (Russia) from 2005 to 2012. The model spectra were calculated with the CMFGEN code. We have not found strong changes in the spectra of the LBV stars in that time interval, however a certain variability has been detected. We estimate the star and wind parameters, such as luminosity, temperature, raduis, mass loss rate, escape velocity, hydrogen content, and reddening. We study the stars on the Hertzsprung-Russell diagram and find their initial masses using evolutionary tracks by Meynet *et al.* (1994).

Keywords. stars: individual (AF And, Var 15)

The observations were obtained with the 6-m BTA telescope with SCORPIO and MPFS (Integral Field Unit, IFU) spectrographs (Afanasiev & Moiseev 2005). A summary of all observations is presented in Table 1.

We have performed the spectral analysis of two LBV stars in the Andromeda galaxy. AF And has shown no significant changes in its spectrum in 2005–2012. In the M31 Var15 star we have found small changes in the HeII λ4686 indicating a temperature difference between 2005 and 2012. Using the P Cyg profiles in HeI lines of Var15, we have estimated the wind terminal velocity. The model spectra were calculated with the CMFGEN code (Hillier & Miller 1998). In Fig. 2 we present the comparison of the model and observed spectra.

We estimate the star and wind parameters, such as luminosity, temperature, raduis, mass loss rate, escape velocity, hydrogen content, and reddening (Table 2).

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Table 1. Summary of observations.

Object	Date	Exposure (sec)	Spectral range (Å)	Spectral resolution (Å)
AF And	2005.10.10	4500 (IFU)	4100–6900	7
	2012.10.14	2 × 900	3850–7200	11.3
	2012.10.15	2 × 900	3850–7200	5.4
Var 15	2005.01.15	3600 (IFU)	4100–6900	7
	2012.10.14	2 × 900	3850–7200	11.8
	2012.10.20	2 × 900	4100–5880	2.3

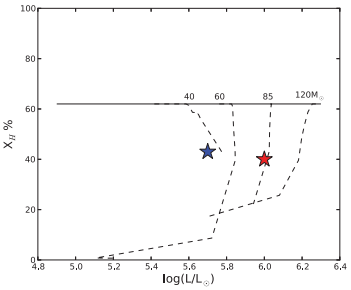

Figure 1. Mass estimates of AF And and Var15 (blue and red asterisks, respectively). The evolution tracks by Meynet *et al.* (1994) for M31 metallicity ($Z = 0.04$) are shown by dashed lines.

Table 2. Stellar parameters.

	AF And	**Var 15**
T_* [kK]	22.7±0.5	23.1±0.5
v_∞ [km s^{-1}]	$\lesssim$300	300±50
$X_{\rm H}$	0.4±0.1	0.43±0.1
$\log(L/L_\odot)$	6.0±0.30	5.7±0.30
$\log(\dot{M}/\sqrt{f})$ [$M_\odot$ yr^{-1}]	-5.0±0.25	-4.7±0.25

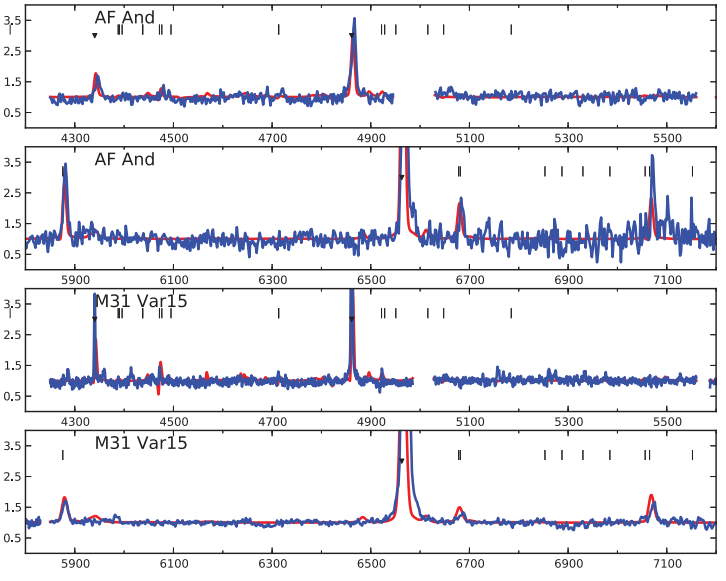

Figure 2. The observed spectra (blue) of AF And and Var15 are presented in comparison with CMFGEN models (red). The red part of Var15 spectrum was obtained with lower resolution. The H lines are marked with triangles and HeI lines with vertical bars.

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