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About the Luminous Blue Variable He3-519

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Abstract. Luminous Blue Variables (LBVs) are massive stars, in a transition phase, from being O-type stars and rapidly becoming Wolf-Rayet objects. LBVs possess powerful stellar winds, high luminosities and show photometric and spectroscopic variability. We present the stellar and wind parameters of He3-519 obtained by the modeling of UVES observations with the model atmosphere code CMFGEN. We compare our results to previous studies in order to find mid-time scale variability of the stellar parameters and finally, we use stellar evolution models to determine the evolutionary status of this star.

Keywords. stars: early-type, stars: winds, outflows, stars: variables: other

1. Introduction

In 1994, He3-519 was reclassified as a LBV by Smith *et al.* (1994) with a WN11 spectral type. This LBV, surrounded by a nebulae of size 1', is located at 8 kpc from the sun and at 20' from AG Car. In 2008, we obtained and reduced seven new spectra obtained over two nights with the UVES spectrograph. Then we derived new stellar and wind parameters from the fit of the observational spectrum with the atmosphere model code CMFGEN (Hillier & Miller 1998). We compared them to the work of Smith *et al.* (1994), and we report a mid-time scale variability. Finally, we study its stellar evolution status with Geneva models in order to determine its initial mass of and its position in the HR diagram.

2. Tools and results

For our study, we use the code CMFGEN which computes line-blanketed, NLTE models, through a super-level approach, thus allowing the inclusion of many energy levels from ions of several species. The code solves the radiative transfer and statistical equilibrium equations in the comoving frame of the fluid, for a spherically symmetric outflow. After convergence of the model, a formal solution of the radiative transfer equation is computed in the observer's frame, thus providing the synthetic spectrum for comparison to observations. The code does not solve the full hydrodynamics, but rather assumes the density structure computed with TLUSTY (Lanz & Hubeny, 2003) in the deep layers, and the wind is described with a standard-velocity law. The velocity law is connected to the hydrostatic density structure from TLUSTY above (approximately) the sonic point. A simple, parametric treatment of wind clumping is implemented in CMFGEN. It assumes a void interclump medium and the clumps to be small compared to the photon mean free path. Others physical processes observed in stellar winds are included in the code, e.g. X-rays.

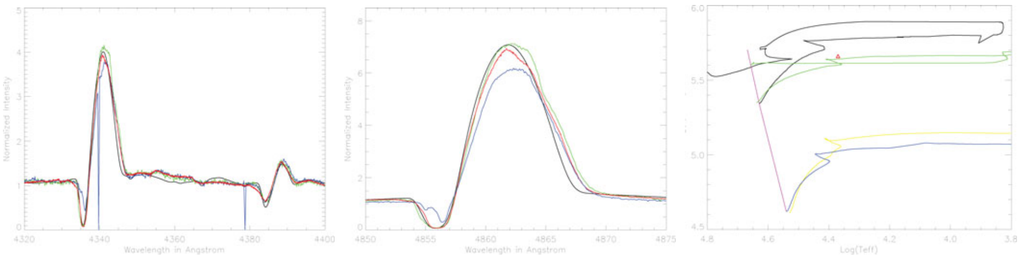

Figure 1. Left: Our best fit (in black) of H_γ λ 4340 and HeI λ 4387 of the UVES data (in red) and the spectra of Smith obtained in march 1991 and december 1993 (in green and blue, respectively). Center: The same as on the left, but for H_β λ 4861. Right: The upper part of the HR diagram. He3-519 (in red) is close to the evolution of a massive star of $40M_\odot$ (in green) without initial rotation. But, the comparison of chemical abundance lead us to choose the model with rotation (in black). The evolution tracks of a $25M_\odot$ with and without rotation (in blue and yellow, respectively) are added for comparison.

Table 1. Stellar and wind parameters of He3-519 compared to the most famous LBV, AG Car

	T_{eff} (K)	V_∞ (km.s^{-1})	$\dot{M}$ (10^{-5} $M_\odot$ yr^{-1})	f	$\frac{He}{H}$ (in number)	$\frac{N}{H}$ (in number)	
He3-519 (2008)	23,500	350	5.5	0.3	0.33	$6.32.10^{-4}$	our work
He3-519 (1993)	27,200	365	12.0	no	0.55	*	Smith *et al.* (1994)
AG Car (1987-1990)	26,200	300	1.5	0.1	*	*	Groth *et al.* (2009)
AG Car (2003)	14,300	150	6.0	0.25	0.43	$1.40.10^{-4}$	Groth *et al.* (2009)

We have determined new stellar parameters for He3-519 (Fig.1, Tab.1). This LBV possesses a powerful stellar wind with a mass loss rate estimated about 5.5 10^{-5} M.yr^{-1} and a low terminal velocity of 350 kms^{-1}. Futhermore P Cygni wings of Hβ and Hγ show evidence of clumping. The analysis of the abundances of the principal elements confirmed the evolved status of this star. (2.0 and 3.44 for N). Nevertheless, the lack of O and C lines in our data, doesn't allow us to measure the abundances for these elements. As for others LBVs like AG Car, we suspect a mid-time scale variability lower than 15 years (Fig. 1). The difference between our results and those from previous studies (Smith *et al.* 1994) can't be blamed only on an evolution of the stellar atmosphere code but instead are real. With the evolution code of Geneva and our stellar parameters, we determined a possible evolution pattern. Our results are most compatible with the evolution of a $40M_\odot$ initial mass (nevertheless, for LBVs, it is difficult to determine the mass of the star by spectroscopy). In the near future, it will be important to re-observe He3-519 in order to constrain the knowledge of its variability cycle. Observations in the UV band can also help us to determine the abundance of oxygen and carbon and compare them to the evolution model.

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