# High-Resolution Spectroscopy of Stellar Winds in Recently Recognized LBV Candidates

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**Abstract.** We present the results of high-resolution spectroscopic observations of two high-luminosity stars, MWC 314 and AS 314, obtained at the 6-meter telescope of the Russian Academy of Sciences. Both stars are suspected to be candidate LBVs in quiescence.

## 1 Introduction

MWC 314 = BD +14°3887 was discovered by Merrill (1927), who found hydrogen and Fe II emissions in its spectrum. Photometric observations by Bergner et al. (1995) showed that it is variable with an amplitude of $0\overset{m}{.}3$. Recently it was assigned the name V1492 Aql (Kazarovets and Samus 1997). Miroshnichenko (1996) concluded that MWC 314 is a heavily reddened supergiant ($A_V = 5\overset{m}{.}7$, $\log L/L\odot = 6.2$, $T_{\rm eff} = 30\,000$ K) with a strong wind ($v_\infty = 500$ km s$^{-1}$ and $\dot{M} = 3\,10^{-5}$ M$_\odot$ yr$^{-1}$) and suggested it to be a candidate LBV. He also noted that a higher-resolution spectroscopy was needed to obtain more detailed emission line profiles and to detect photospheric lines. The star's temperature estimate was based mainly on a noisy UV spectrum. Moreover, He II lines have not been detected in its spectrum indicating that $T_{eff} < (26\text{–}27)\ 10^3 K$ (Schmutz et al. 1991).

AS 314 = LS 5017 = V452 Sct is a poorly-studied heavily reddened ($E_{B-V} \sim 0\overset{m}{.}9$) star. Its spectral type was reported as A3: Ia (Hiltner and Iriarte 1955) or B9 Ia (Stephenson and Sanduleak 1971). Dong and Hu (1991) identified the star with an IRAS source 18365−1353, that made AS 314 potentially interesting object.

## 2 Observations

The spectroscopic observations were obtained at the 6-meter telescope of the Special Astrophysical Observatory (SAO) of the Russian Academy of Sciences on 1997 July 23 (MWC 314 and AS 314) and on 1997 November 22 (MWC 314). The July spectrum was taken in the range 5370–6670 Å (resolution 0.4 Å) with the echelle-spectrometer LYNX (Klochkova 1995) mounted at the Nasmyth focus and equipped with a 1140×1170 pixels CCD. The November spectrum was obtained in the prime focus with the echelle-spectrometer PFES (Panchuk et al. 1998) in the range 4700–8590 Å (resolution ∼ 0.8 Å).

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## 3 Results

In our spectrum of MWC 314 we found 408 emission lines, 63 photospheric lines (not observed previously), and 60 diffuse interstellar bands. Nearly 100 mostly double–peaked emission lines of Fe II, 37 weak single-peaked [Fe II] lines, 8 Fe III lines, and 6 [Fe III] lines were identified. The Balmer lines do not show any noticeable changes in comparison with the data obtained by Miroshnichenko (1996) in 1991. Even at the high resolution they display no P Cyg-type absorption components, that implies that the stellar wind is non-spherical and is viewed not edge-on. The detection of He II lines is doubtful. We found no O II photospheric lines in the spectrum of MWC

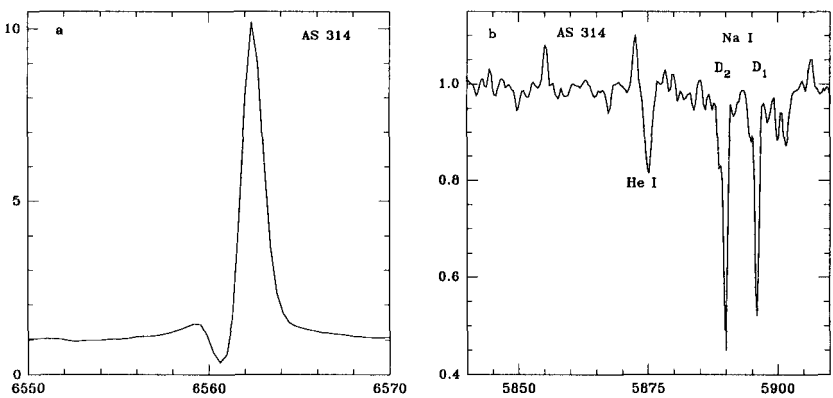


**Fig. 1.** Parts of the spectrum of AS 314. a. The H$\alpha$ line. b. The region of the He I 5876 Å and Na I $D_{1,2}$ lines. The wavelengths are given in Angströms, the intensity is normalized to the continuum level.

314, which was also reported for the LBVs AG Car and HR Car (Hutsémekers and van Drom 1991). The heliocentric velocities of the photospheric lines are $\sim +81$ km s$^{-1}$, while those of the lines of ionized metals and of the Balmer lines are $\sim +41$ km s$^{-1}$. The latters were used to estimate the distance ($D$) toward MWC 314 employing differential rotation of the Galaxy. It turned out to be $D = 3.0\pm 0.2$ kpc, which is in good agreement with the estimate of Miroshinchenko (1996). Thus, we confirmed that MWC 314 is one of the most luminous stars in the Galaxy. The above results are described in more detail by Miroshnichenko et al. (1998).

The spectrum of AS 314 (shown in part in Fig. 1) contains a rather strong H$\alpha$ (EW = 14 Å) in emission with a narrow P Cyg profile ($\Delta v \sim 100$ km s$^{-1}$). Many weak Fe II emission lines as well as a few Fe I and forbidden lines were also found. The He I lines at 5876 and 6678 Å are seen in absorption. The Na I $D_{1,2}$ lines are purely interstellar. The strengths of the photospheric lines (S II, N II, C II, Si II, Ne I, and Al III) are consistent with a spectral type of

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B9 ± 1. The mean radial velocity of the most spectral lines is $\sim -50$ km s$^{-1}$ which is significantly smaller than that of stars around AS 314. This might imply that the object has a large peculiar velocity and may be a runaway star and a binary system.

While in the optical and near-IR region AS 314 looks like a reddened B–type star, it shows an excess of longward radiation, which implies the presence of circumstellar dust and is similar to that of AG and HR Car. This may indicate that the star experienced a matter ejection event in the past rather than a steady-state mass loss. Its luminosity was estimated using the strengths of the Si II lines at 6347 and 6371 Å (Rosendhal 1974), which give $\log L_{bol}/L\odot \sim 4.9$ and $D \sim 8$ kpc. This brings the star close to the line of LBVs in the Hertzsprung-Russell diagram (Stothers and Chin 1994).

## References

Allen, D.A. (1973), MNRAS, **161**, 145
Bergner, Yu.K., Miroshnichenko, A.S., Yudin, R.V., et al. (1995), A&AS, **112**, 221
Dong, Y.S. and Hu, J.Y. (1991), Chin. A&A, **15**, 275
Hiltner, W.A., Iriarte, B. (1955), ApJ, **122**, 185
Hutsémekers, D., van Drom, E. (1991), A&A, **248**, 141
Kazarovets, E.V., Samus, N.N. (1997), IBVS No. 4471
Klochkova, V.G. (1995), Echelle-spectrometer LYNX. User Manual. Spec. Astrophys. Obs. Technical Report N 243
Merrill, P.W. (1927), ApJ, **65**, 286
Miroshnichenko, A.S. (1996), A&A, **312**, 941
Miroshnichenko, A.S., Frémat, I., Houziaux, L., et al. (1996), A&AS, **131**, 469
Panchuk, V.E., et al. (1998), Bull. Spec. Astrophys. Obs., **44**, *in press*
Rosendhal, J.D. (1974), ApJ, **187**, 261
Schmutz, W., Leitherer, C., Hubeny, I., et al. (1991), ApJ, **372**, 664
Stephenson, C.B., Sanduleak, N. (1971), Publ. Warner & Swassey Obs., **1**, 1
Stothers, R.B., Chin, C.W. (1994), ApJ, **426**, L43

### Discussions

### Discussion

**T. Szeifert**: Could the secondary maximum in AS 314 be caused by the electron scattering wings around H$\gamma$?
**A. Miroshnichenko**: This cannot be excluded. However, our first attempts to model the line profile under the assumption of a disk-like geometry show that the secondary peak can be fit quite well.

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