Massive Stars Near and Far
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Structure in stellar winds of early B type supergiants

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Abstract. One significant difficulty in reliable quantification of the rates of mass-loss from hot, massive stars lies in uncertainties associated with quantifying temporal and spatial variability within stellar winds. The consequences of low-metallicity conditions for wind structure also merit continued investigation. We present initial results from ULLYSES data with the aim of identifying structure within the stellar winds of early B type supergiants with sub-solar metallicities in the Large and Small Magellanic Clouds. We demonstrate how single-epoch ULLYSES data can be used to investigate significant wind structure for these stars.

Keywords. stars: winds, outflows, supergiants, ultraviolet: stars, techniques: spectroscopic

1. Background and Technique

Mass-loss rates are critical for understanding the evolution of hot, massive stars and their feedback into the interstellar medium. These stars exhibit structured and variable stellar winds and diagnostics of these features are reflected in the UV wind line profiles. Through use of the HST ULLYSES UV data sets, we have the opportunity to probe wind structure of these stars at sub-solar metallicity.

Earlier studies, such as Prinja & Massa (2010) have sought to identify observational signatures of structures within the stellar winds of OB type stars, based on individual UV spectra, including the effect of wind clumping on doublet line ratios. We focus here on evidence for structure in winds of B type supergiant stars within the Large and Small Magellanic Clouds (LMC, SMC).

In smooth winds, the ratios of the optical depths of the doublet components will be the same as the ratios of the doublet oscillator strengths (f). In structured winds however, the doublet component optical depths are determined by the coverage fraction, which itself describes the fraction of the wind structure that is optically thick. In such a case therefore, the optical depth ratio of the doublet components will depart from the f-value ratio and approach unity.

We consider evidence for such departure by examining each element of the Si IV 1394, 1403 Å feature (f-value ratio $= 2$) in the UV spectra of target stars. These doublet components are well-separated for moderate terminal wind velocities, so can be treated as radiatively decoupled, permitting them to be separately fitted using a Sobolev with exact integration method (SEI) model (Lamers et al. (1987), Massa et al. (2003)).

Table 1. Tabulation of spectral types of initial target stars and mean radial optical depth ratios, across a normalised velocity (v/v_∞) range of 0.7-0.35, for blue/red components of the Si IV 1394, 1403 Å doublet feature (f-value ratio = 2). The final two columns show the standard deviation and standard error for each mean optical depth ratio calculation.

Star	Spectral type	$< \tau_{blue}/\tau_{red} >$	Std dev.	Std error
AzV 210	B1.5 Ia	1.55	0.27	0.10
AzV 242	B0.7 Iaw	1.59	0.25	0.09
AzV 266	B1 I	1.68	0.57	0.20
Sk-68 140	B0.7 Ib-Iab Nwk	1.59	0.46	0.16
NGC2004 ELS 3	B5 Ia	1.92	0.20	0.07

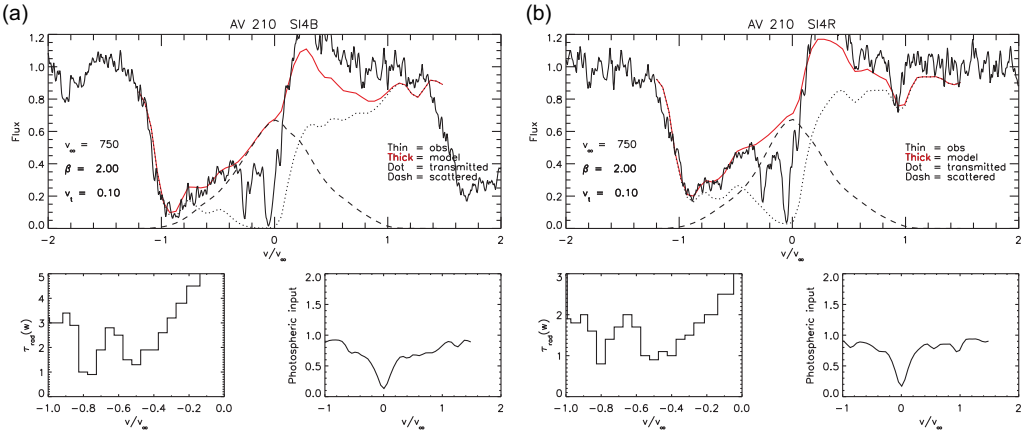

Figure 1. SEI-derived model fits for (a) blue and (b) red components of the Si IV doublet feature in the UV spectrum of SMC star AzV 210 (spectral type B1.5 Ia).

2. Observations, Results and Future Work

The target stars initially examined are all supergiant stars, principally early B types (see Table 1). Fig. 1 shows an example, for the SMC blue supergiant AzV 210, of the separate SEI model fit for the blue and red components of the Si IV doublet (thick red line), together with radial optical depths across normalised wind velocities and the photospheric contribution to the spectrum, from a normalised TLUSTY model fit (Hubeny (1988) and later guides).

We present initial results, showing evidence for wind structure around the SMC stars, AzV 210 and AzV 242 and a lack of significant wind structure around the later-type LMC star, NGC2004 ELS 3. Other results are inconclusive. Further early B type supergiant stars from the ULLYSES database are being similarly examined.

Supplementary material

To view supplementary material for this article, please visit http://dx.doi.org/10.1017/S1743921323001771.

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