A Massive Star Odyssey, from Main Sequence to Supernova
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FUSE[1] observations of stellar wind variability in the LMC supergiant Sk −67°166 (O4 If$^+$)

Alexander W. Fullerton[1,2], Derck L. Massa[3], Raman K. Prinja[4], Ian D. Howarth[4], Allan J. Willis[4], and Stanley P. Owocki[5]

[1]*Department of Physics and Astronomy, University of Victoria, PO Box 3055, Victoria, BC V8W 3P6, Canada,*
[2]*Department of Physics and Astronomy, The Johns Hopkins University, 3400 North Charles Street, Baltimore, MD 21218, USA*
[3]*SGT Inc., NASA's Goddard Space Flight Center, Code 681.0, Greenbelt, MD 20771, USA*
[4]*Department of Physics and Astronomy, University College London, Gower Street, London, WC1E 6BT, UK*
[5]*Bartol Research Institute, University of Delaware, Newark, DE 19716, USA*

Abstract. We describe *FUSE* time-series observations of stellar wind variability in Sk −67°166 (HDE 269698), a nitrogen-rich O4 supergiant in the LMC.

1. Probing the structure of DACs with *FUSE*

Discrete absorption components (DACs) are recurrent optical depth enhancements that slowly accelerate blueward through stellar-wind profiles of early-type stars. Their kinematic behavior has been extensively characterized by monitoring programs with the *IUE* satellite. However, little is known about the thermodynamic properties of DACs because the resonance lines accessible to *IUE* are poor diagnostics of changes in the ionization balance. Resonance lines from a larger range of ions are accessible to the *Far Ultraviolet Spectroscopic Explorer* (*FUSE*, Shanow *et al.* 2000), many of which exhibit well-developed but unsaturated P-Cygni profiles in the spectra of O-type stars. Consequently, observations with *FUSE* provide qualitatively new diagnostics of the ionization and density changes associated with the wind structures that produce DACs.

2. *FUSE* time series observations of Sk −67°166 (O4 If$^+$)

We used *FUSE* to monitor stellar wind variability in Sk −67°166 for 18.9 d in the autumn of 2000. DACs appear near $-900\,\mathrm{km\,s^{-1}}$ (about half the terminal

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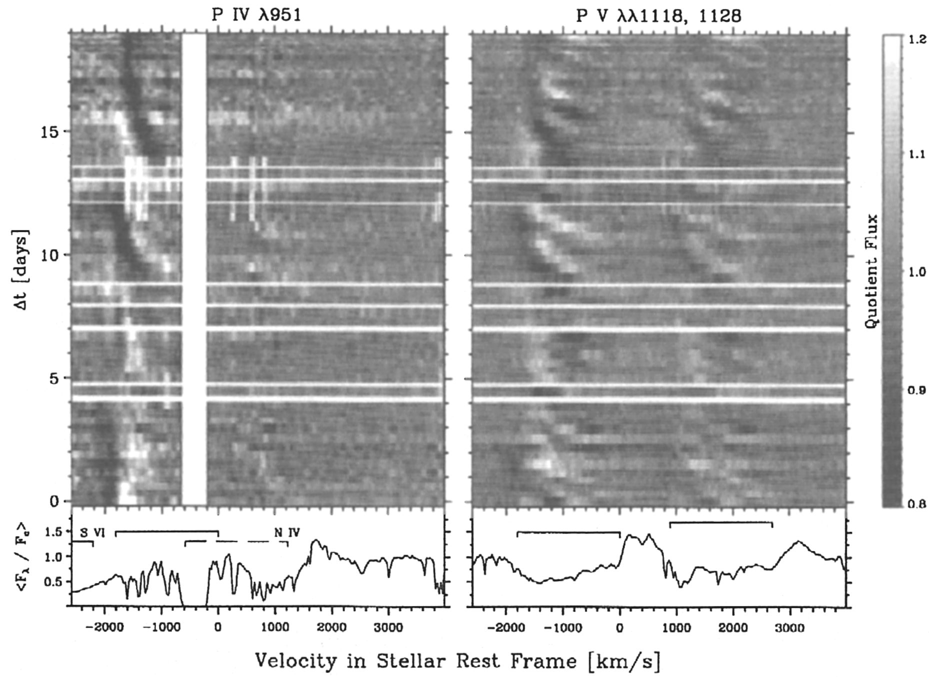

Figure 1. Dynamic spectra for the P IV and P V lines of Sk −67°166. The dynamic spectra were formed by dividing individual spectra in the time series by the mean profile. The detection of DACs in the P IV line is remarkable because blending with S VI λ944 obliterates the underlying P-Cygni profile.

velocity) at semi-regular intervals of ~5 d, and propagate to their maximum velocity (which is not always the same) in a little more than a day.

To first order, lines from all ions vary in the same sense at similar velocities and times, irrespective of whether they are due to ions above or below the dominant stage of ionization. However, the DACs are strongest in wind profiles for low ions (*e.g.*, S IV, P IV), which preferentially trace regions of greater density because they are formed by recombination from the dominant ion. For example, Figure 1 shows that the DACs are stronger and more distinct in the resonance line of P IV compared with those in the resonance doublet of the dominant P V ion, and that P IV strengthens at the expense of P V as the DAC accelerates. Since all lines respond similarly, the DACs must be caused by a flattening of the velocity law or a localized increase in the wind density. However, because density and velocity are dynamically coupled, we suspect that the interplay between them is ultimately responsible for the formation of DACs. The wealth of diagnostic information contained in the *FUSE* time series will help to disentangle their relative contributions.

References

Shanow, D.J., Moos. H.W., Ake, T.B., *et al.* 2000, ApJ (Letters) 538, 7