A Massive Star Odyssey, from Main Sequence to Supernova
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FUSE observations of Luminous Blue Variables

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Abstract. P Cyg, AG Car, HD 5980 and η Car were observed with the *Far Ultraviolet Spectroscopic Explorer* (*FUSE*) satellite. *FUSE* covers the spectral range from 980 Å to 1187 Å at a resolution of 0.05 Å. In this paper we discuss the far-UV properties of these LBVs and explore their similarities and differences. The *FUSE* observations of P Cyg and AG Car, both spectral type B2pe, are very similar. The atmospheres of both η Car and HD 5980 appear to be somewhat hotter and have much higher ionization stages (Si IV, S IV, and P V) in the *FUSE* spectrum than P Cyg and AG Car. There is a very good agreement between the *FUSE* spectrum of P Cygni and the model atmosphere computed by John Hillier with his code CMFGEN. The *FUSE* spectrum of η Car, however, does not agree very well with existing model spectra.

1. Introduction

LBVs are evolved massive stars in an unstable evolutionary phase, that display photometric and spectroscopic variability on different timescales and amplitudes. Massive O-stars evolve into Wolf-Rayet stars following the end of core-hydrogen burning. Circumstellar and interstellar absorption components along the line of sight toward P Cygni, AG Carinae, HD 5980 and η Carinae, observed with the *FUSE* satellite, are investigated.

2. How are P Cygni, AG Carinae, HD 5980 and η Carinae similar?

The *FUSE* spectra of P Cyg and AG Car are very similar; they are both spectral type B2pe and seem to be in the same evolutionary stage. The η Car spectrum shows many velocity components and is more complicated than HD 5980, a Wolf-Rayet star in the SMC.

2.1. η Carinae

η Car was observed with the *FUSE* satellite four times during the last two years, February and March 2000, March and July 2001. In addition to many strong interstellar atomic species, the spectrum contains several prominent P Cygni features, including C III 977,1175, S IV 1062-1073, Si IV 1122,1128, and P V 1117,

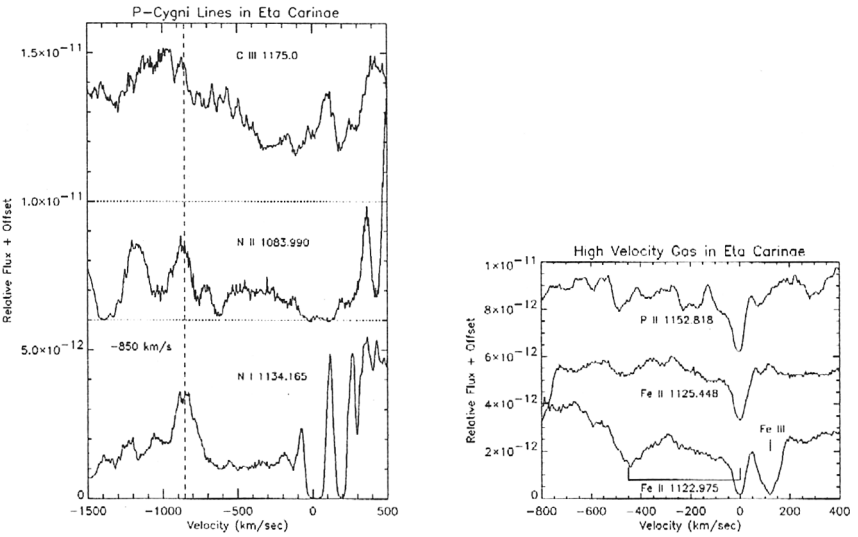

Figure 1. P-Cygni lines and high-velocity gas in η Carinae.

1128 Å. The largest spectral differences between the four observations occur in the wind lines, especially in the N I, N II and C III P-Cygni lines (see Figure 1). The P-Cygni features are broad with unsaturated absorption troughs, implying that the wind is clumpy and/or only partly covers the emitting surface. The wind absorption extends to $-850\,\mathrm{km\,s^{-1}}$. The shape of the spectrum shortward of 1110 Å is dominated by strong absorption bands of interstellar molecular hydrogen at velocities +15 and $-30\,\mathrm{km\,s^{-1}}$. The flux level declines toward the Lyman limit, where converging molecular and atomic hydrogen features completely blanket the spectrum. The ISM in the vincity of η Car is caracterized by both hot gas at velocities +15 and $-150\,\mathrm{km\,s^{-1}}$ as indicated by the O VI 1032 Å and warm gas with velocities between 0 and $-500\,\mathrm{km\,s^{-1}}$. Figure 1b shows line profiles of Fe II 1123, Fe II 1125 and P II 1153, illustrating the strong component at about $-490\,\mathrm{km\,s^{-1}}$.

2.2. P Cygni and AG Carinae

A model atmosphere, using John Hillier's code CMFGEN, has been computed for P Cyg with very good agreement with the *FUSE* spectrum. The *FUSE* spectrum of η Car does not agree with existing model spectra, due in part to the complexity of the circumstellar environment.

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