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The Nitrogen Abundance in Be Stars Determined from UV Spectra

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Abstract. A NLTE abundance analysis of the *IUE* spectra of 8 Be stars with $v \sin i < 150\ km\ s^{-1}$ reveals no evidence for nitrogen enrichment from mixing of core and photospheric material.

Keywords. stars: abundances, stars: emission-line, Be, stars: rotation, stars: evolution

1. Overview of Project

The abundance of nitrogen in Be stars is of interest because contemporary models for the structure and evolution of rapidly rotating OB stars predict a photospheric enrichment due to the mixing of the processed material from the stars core with the original surface material (Meynet & Maeder 2000, Maeder & Meynet 2000). But the analyses of Be star spectra using standard spectrum synthesis techniques are confronted with some challenges that are not encountered in abundance studies of sharp-lined, non-emission B stars, including the treatment of blended, rotationally broadened lines, assessment of the microturbulence, correction for disk emission and possible shell absorption, and latitudinal variation of $T_{\rm eff}$ and log g. Results are presented from a spectrum synthesis study of high dispersion FUV spectra of Be stars from the *IUE* spacecraft. The Hubeny/Lanz NLTE codes TLUSTY/SYNSPEC (Hubeny 1988, Hubeny & Lanz 1995) and the Lanz & Hubeny (2007) model atmospheres for B stars were employed. The FUV offers an advantage over the optical region as there is far less influence from disk emission and some FUV lines of N II-III are intrinsically stronger. However shell lines can sometimes significantly blend with the lines that are the focal point of the study and make it difficult to place the continuum. This study focused on Be stars with values of $v \sin i <$ 150 km s^{-1} in which the effect of latitudinal parameter variation is minimized (Frémat *et al.* 2005).

2. Results

The Be stars considered in this study are in the B1-B3 range and include 11 Cam (B3 Ve), FW CMa (B3 Ve), 16 Peg (B3 Ve), ω CMa (B2.5 Ve), 31 Peg (B2 IVe), μ Cen (B2 IV-Ve), MX Pup (B1.5 IVe), and χ Oph (B1.5 Ve). The starting values for $T_{\rm eff}$, log g, and $v \sin i$ were from Frémat *et al.* (2005). $T_{\rm eff}$ and log g were then adjusted based upon the observed strengths of the Si II and Si IV features. For the cooler Be stars log g was assessed from the outer red wing of Lyα. $V \sin i$ was determined from several moderately-strong, isolated lines. The most uncertain parameter is the microturbulence. Based upon several published abundance studies of B star spectra in the UV, I adopted a $V_{\rm turb}$ of 4 km s^{-1} for stars earlier than B2 and $1 - 2$ km s^{-1} for the cooler objects. Some useful spectral features for determining the carbon and nitrogen abundance include C III 1176 Å and N III 1183.0, 1184.5 Å for Be stars with spectral types of B2 or earlier and C II 1323.9 Å, C III 1247.4 Å, and N I 1243.2 Å in the B2–B3 stars.

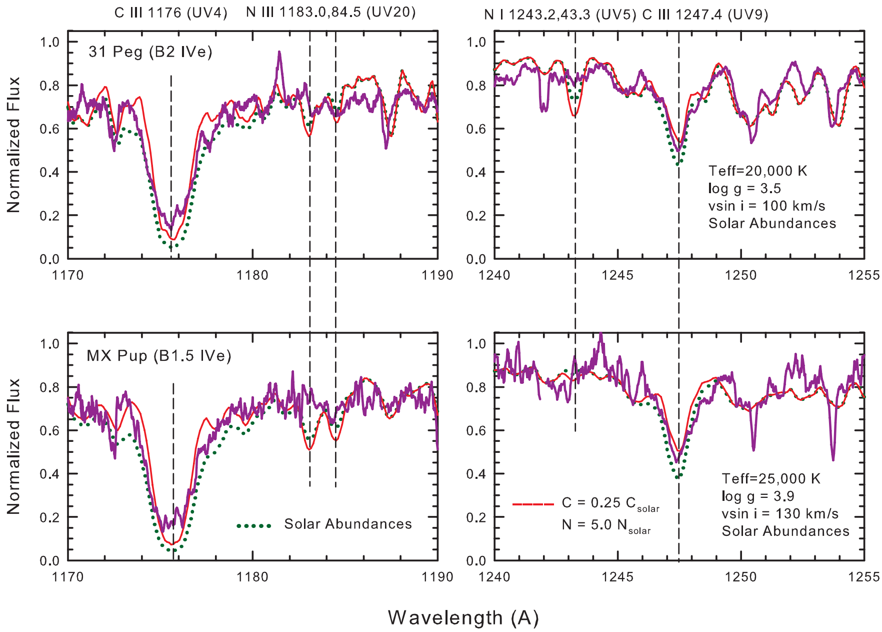

Figure 1. Comparison between the observed spectra of 31 Peg and MX Pup (*thick line*) and model spectra computed with the stellar parameters indicated on the plot. Model spectra are for solar abundances (*dotted line*) and elevated nitrogen but reduced carbon (*thin line*).

Representative comparisons between the model calculations and observations are shown in Fig. 1. The observed spectra were produced from coadding good SWP HIRES images that were taken with the large aperture. Nitrogen enrichment in the B2-B3 stars would be revealed by a stronger N I at 1243 Å, while in the hotter stars the N III doublet at 1183.0, 1184.5 Å would be prominent. From the spectra shown in Fig. 1 it is clear that the presence of an elevated nitrogen abundance is not indicated. In fact often the observed N lines are weaker than one would predict even with solar abundances. C III 1176 Å tends to be weak in most stars and its profile suggests emission filling. Overall the Si III lines are also weak and indicate the possible presence of a 20000 K circumstellar plasma that primarily radiates in the doubly-ionized species. Given the errors it appears that the N abundance in the Be stars is normal. None of the program Be stars show clear evidence for an elevated nitrogen abundance. Expected mixing is apparently suppressed, and this study lends no support for Be star models based upon critical rotation, a condition where an especially high N abundance is predicted.

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