Outer Atmospheric Structures of High-Luminosity G/K Stars

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1. Introduction

Utilizing the IUE satellite, we conducted a minimally-biased survey of the chromospheric and transition region (TR) emission properties of a sample of G supergiants and early-K bright giants. Our magnitude-limited sample included the 15 single, nonvariable G supergiants with $V < 4.8$ and the 15 single early-K bright giants with $V < 4.5$. The sample is complete out to $\sim 4000, 800,$ and $200$ pc for the G Ia, G Ib, and early-K II stars, respectively. The goal of this survey work is to gain a better understanding of the diversity of outer atmospheric structures observed in high-luminosity G/K stars.

2. Observations

From the IUE archive, we compiled a data set of 160 long-wavelength, high-dispersion (LW-HI) and 170 short-wavelength, low-dispersion (SW-LO) spectra of the 30 sample stars. For each star, we constructed mean profiles for the Mg II $h + k$ resonance lines by coadding the LW-HI spectra, weighted by exposure time. The profiles were used to measure the mean Mg II flux of each star, and to search for blueshifted wind absorption superimposed on the chromospheric Mg II emission. In the SW-LO spectra, we measured the fluxes of several chromospheric (O I) and TR (C IV, N V, Si IV) diagnostics. We converted the observed emission fluxes to surface fluxes using stellar angular diameters obtained via the Barnes-Evans relation (Barnes et al. 1978). Figure 1 shows the relationship of the extinction-corrected surface fluxes of C IV and Mg II to $(B - V)_0$. $E(B - V)$ for each star was calculated using the hydrogen column density estimated from nearby sources included in Fruscione et al. (1994). The UV extinction was determined using the relations given by Cardelli et al. (1989).

3. Discussion

The following trends are observed in our sample of high-luminosity G/K stars:

- C IV emission is detected in 22 of the 28 sample stars (79%) for which SW-LO spectra, uncontaminated by hot companions, are available.

- Among the lowest-gravity stars (Ia-Ib), the latest spectral class in which C IV emission is detected is G5. In the higher-gravity stars (Ib-II), C IV emission is observed throughout the range of spectral classes represented in our sample, including spectral classes as late as K3.
Figure 1. Extinction-corrected surface fluxes of C IV and Mg II plotted vs. \((B - V)\). G supergiants are plotted as circles, K bright giants as diamonds. Filled circles indicate stars with Mg II wind absorption. Symbols with arrows represent upper limits to the surface fluxes.

- Mg II wind absorption is observed in 40% of the G supergiants and 60% of the K bright giants in the sample.

- G supergiants which exhibit Mg II wind absorption do not differ in their C IV and Mg II surface fluxes from those which do not. K bright giants which possess cool winds may, on average, have higher C IV and Mg II surface fluxes than those which do not. Also, while wind absorption is observed in only one-third of the K bright giants with \((B - V)\) < 1.5, it is seen in all six stars with \((B - V)\) \(\geq 1.5\).

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References