

Spectroscopic H α and H γ survey of field Be stars: 2004-2008

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Abstract. Massive O- and B-type stars are “cosmic engines” in the Universe and can be the dominant source of luminosity in a galaxy. Be stars are rapidly rotating B-type stars that lose mass in an equatorial, circumstellar disk (Porter & Rivinius 2003) and cause Balmer and other line emission. Currently, we are unsure as to why these stars rotate so quickly but three scenarios are possible: they may have been born as rapid rotators, spun up by binary mass transfer, or spun up during the main-sequence evolution of B stars. In order to investigate these scenarios for this population of massive stars, we have been spectroscopically observing a set of 115 field Be stars with the Kitt Peak Coudé Feed telescope in both the H α and H γ wavelength regimes since 2004. This time baseline allows for examination of variability properties of the circumstellar disks as well as determine candidates for closer examination for binarity.

We find that 90% of the observed stars show some variability with only 4% showing significant variability over the 4-year baseline. Such values may be compared with the significant variability seen in some clusters such as NGC 3766 (McSwain 2008). Also, while 20% of the sample consists of known binaries, we find that another 15-30% of the sample shows indications of binarity.

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Since fall 2004, we have spectroscopically investigated 115 field Be stars taken from the Yudin (2001) catalog of bright Be stars - our sample covers magnitudes 2 to 8. We chose the H α region to investigate disk properties (i.e., size, morphology) and also the H γ region to investigate stellar properties (i.e., rotation speed, $\log g$) but in some cases we can also examine disk properties. Our spectral resolution $R = \lambda/\Delta\lambda$ for the H α region was ~ 5000 (2004, 2006) and $\sim 11,500$ (2008). For the H γ region, it was $\sim 11,000$.

For each of the 115 Be stars we studied, we generated a “quadruple plot” such as the example shown in Figure 1. Also, while examining the H γ region spectra, we noticed that one can see changes in spectral features (like “shell” presence) and the most notable case was Pleione (HD 23862) - a star that has long been known to change between B, Be, and Be-shell states (see Fig. 2). The term “shell” star describes a star that has many absorption or emission lines associated with Fe II transitions (which indicates one is looking through or at circumstellar material). We found that fully 50% of our sample shows non-temperature-related shell emission or absorption features with a number showing variable shell features.

Especially from the H γ region spectra, one can also see radial velocity and line profile variations which can be indicative of binarity and/or nonradial pulsation. Through this survey, we have identified ~ 40 new nonradial pulsation and/or binarity candidates

Results from this survey and results concerning particular interesting stars are forthcoming and the reduced spectra will be made public in hopes the astronomical community will utilize them. We will continue to monitor these Be stars whenever possible as well as investigate nonradial pulsation and binary candidates more fully and at higher resolution. Another goal is to compare these field Be stars to Be stars in clusters.

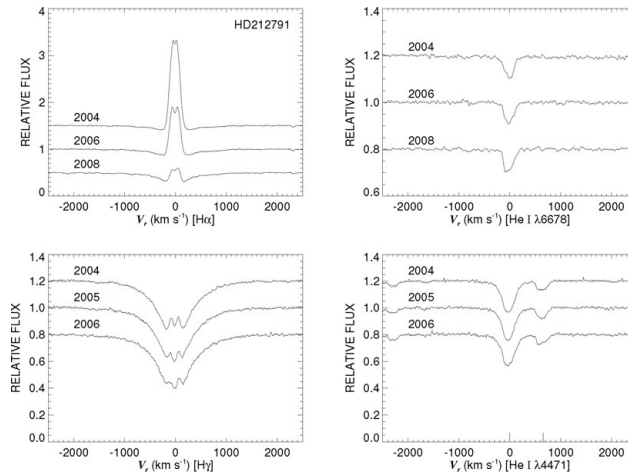


Figure 1. Example of a “quadruple plot” (this of HD 212791). In each quadrant are plots of the normalized fluxes of the seasonal averages of the spectra, offset for clarity, and in radial velocity space. Each is centered on the rest wavelength of a different spectral feature: *top left* - $H\alpha$, *top right* - He I $\lambda 6678$, *bottom left* - $H\gamma$, and *bottom right* - He I $\lambda 4471$ (with a mark at $\sim 670 \text{ km s}^{-1}$ delineating Mg II $\lambda 4481$).

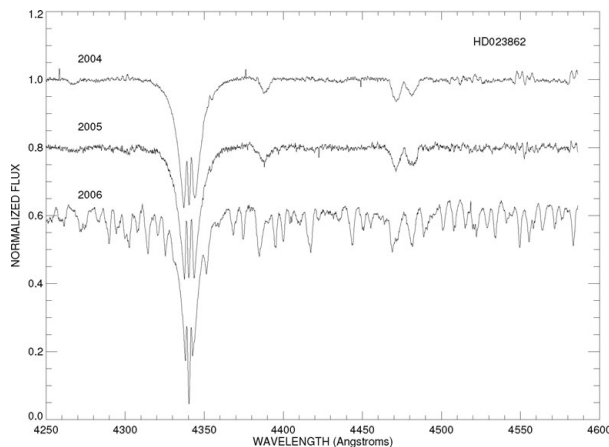


Figure 2. A plot of seasonal averages of the normalized flux versus wavelength for the blue spectrum of Pleione (HD 23862) - a known Be shell-Be variable. They are offset for clarity.

References

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