A SURVEY OF LINE PROFILE VARIATIONS IN NON-EMISSION LINE B0-B5 III-V STARS

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1. Introduction

Some investigators have attributed the photometric and spectral line profile variations (*lpv*) that are common among the B stars to nonradial pulsation while others have attempted to explain them by rotation of photospheric or circumstellar structures with respect to our line of sight. One of the problems in resolving this debate has been our lack of knowledge of how these variations depend on fundamental stellar characteristics. Surveys of *lpv* have covered the Be and a few Bn stars (D. Penrod, unpublished), the O stars (Fullerton 1990), and B8-B9.5 main sequence stars (Baade 1989), but noone has carried out a systematic search for *lpv* among the near main sequence, non-emission line early- and mid-B stars. This paper describes preliminary results from such a survey.

2. Observational Program

Our survey sample consists of forty-eight non-emission line B0-B5 III-V stars. We excluded Be stars from the sample to eliminate *lpv* caused by circumstellar material and avoid duplication of earlier work. We selected the stars to cover as wide a range of $v \sin i$ as possible at each spectral type and luminosity class. However, the sample is biased towards lower $v \sin i$ because of the exclusion of Be stars. We excluded known β Cephei stars, double-line spectroscopic binaries, and large-amplitude single-line spectroscopic binaries. We included some small-amplitude single-line spectroscopic binaries to see if they are line profile variables whose variations have been misinterpreted and a couple of 53 Per stars that have not been well studied.

The spectra of the sharp-lined stars were recorded with either reticon or CCD detectors on the coudé spectrographs on the 1.2-m telescope of the Dominion Astrophysical Observatory ($\lambda/\Delta\lambda \approx 40{,}000$)and the 2.7-m telescope at McDonald Observatory ($\lambda/\Delta\lambda \approx 26{,}000$) and the échelle spectrograph on the 1.88-m telescope at the David Dunlap Observatory

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($\lambda/\Delta\lambda \approx 60{,}000$), The spectra of the broad-lined stars were recorded with a CCD detector on the cassegrain spectrograph of the 1.88-m telescope at the David Dunlap Observatory ($\lambda/\Delta\lambda \approx 8500$).

The final data set consists of an average of 15 spectra for each of the forty-eight stars in the survey. The He I λ447.1 nm and Mg II λ448.1 nm lines were the primary lines observed in the survey, but many other lines were observed in the échellograms. The typical star in our survey has spectra with $\langle S/N \rangle = 600$ in the continuum near the Mg II line, but the $\langle S/N \rangle$ ranges from 350 to 1600 for the stars in our sample. The observing program was designed to obtain a modest number of high S/N spectra to detect *lpv*, measure its amplitude, and characterize the "mode" of the variability. In most cases the spectra are too widely and irregularly spaced to allow us to measure the time scale or period(s) of the variations.

3. Preliminary Results

The work on this project has been delayed by the tragic death of the first author. To date, we have analyzed temporal variance spectra for thirty-nine of the forty-eight program stars. This sample is more biased toward low $v \sin i$ than the complete sample because the hotter broad-lined stars in our sample have not yet been analyzed.

We have not detected any *lpv* in stars with $\log T_{\rm eff} > 4.3$ and $v \sin i < 100$ km s^{-1}. Nearly all of the cooler slowly rotating stars are line profile variables. We are tempted to claim that $\log T_{\rm eff} \approx 4.3$ is the blue edge of the 53 Per instability strip, but we note that 53 Per-like *lpv* have been observed in the O9 V star 10 Lac (Smith 1977, 1978; Fullerton 1990). We haven't found any other correlation between the occurrence or amplitude of the *lpv* in the Mg II line and $T_{\rm eff}$, $\log g$ (or its proxy, $M_{\rm bol}$), or $v \sin i$.

Three of the stars in our sample have particularly interesting *lpv*. η UMa appears to be constant in one set of observations with $\langle S/N \rangle = 1000$, but weak *lpv* is detectable in a second set of spectra with $\langle S/N \rangle = 1600$. The moderately slow rotator ($v \sin i = 75$ km s^{-1}) HD 49567 has large amplitude *lpv*. Variations characteristic of both low- and high-order NRP modes are visible in its lines. Finally, the lines of the rapid rotator ($v \sin i = 332$ km s^{-1}) HD219688 appear to vary in a low-order mode, but rather than swaying from side-to-side, they show a single bump that moves across the line profile from blue to red.

References

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