PUZZLING PROBLEMS OF He I LINE FORMATION IN EARLY B STARS

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1. Introduction

Although NLTE model atmospheres have been shown to resolve most of the equivalent width (EW) discrepancies for blue He I lines (Auer and Mihalas 1972, 1973), Wolff and Heasley (1984, 1985) have demonstrated that discrepancies remain for the leading members of the singlet/triplet 2P – nD series, viz. λ6678 and λ5876. These two lines are the strongest nonresonance He I transitions and are important because they respond to thermal changes in the superficial atmosphere (τ ~ 10^{-3}) of early B stars. In order to understand the observed rapid variations of the λ6678 line in mild Be stars, we undertook a survey of EWs of λ6678 and λ4388, namely the first and third member of the same series. These two lines have a log gf ratio of 15 but have similar EWs in B star spectra. Our new observations confirm the red line discrepancy noted by WH85 and point to additional EW differences among various groups of B stars not noted hitherto.

2. Observations and Models

Observations were conducted at the McMath Solar telescope using a resolution of 50,000 and 30,000, respectively, for the red and blue line. We observed 100 chemically normal B0.5-B5 stars known not to have obvious secondary contamination. We converted their published uvbyHβ colors to (T_{eff}, log g) from WH85’s calibration, and when necessary the WH85 Hγ profile criterion to determine log g’s.

We used the TLUSTY code (Hubeny 1988) to compute pure H/He NLTE model atmospheres and line profiles. These models include 14 discrete singlet and triplet He I levels plus one for the He II ground state; additional He II states are unimportant for T_{eff}’s < 30,000K. Profiles computed with various ξ_t values showed negligible difference in EW. Figs. 1 and 2 show our observations against the models of AM73 and TLUSTY. Because Be stars with emission have contaminated photospheric EWs, these stars are omitted in the following discussion.
3. Results

λ4922 shows good agreement between EWs predicted by AM73, TLUSTY, and our data – nor do λ4922 EW differences exist among subgroups, except that giants are predicted/observed to show 250mA EWs than dwarfs. Yet as Fig. 1 shows, while there is agreement between predictions from the two codes, their predictions fall short by ~100mA of the observations. Also, contrary to theory, the EWs of giants are stronger than B dwarfs. Finally, EWs of known pulsating B stars, and Be stars without strong emission (at obsn.) are all larger than for B dwarfs.

The intergroup EW differences for λ6678, but not for λ4922, is a new result. We have tried to model these differences with a variety of toy model atmospheres with modified ρ, T distributions, including dense slabs. None of these can enhance the λ6678 EW without also influencing λ4922 and disturbing its agreement. To resolve this conflict, we are currently building a new generation of model atmospheres with blanketing by ~10^6 lines. This will include investigation of the influence of raised microturbulence in pulsating and Be star atmospheres.

![Graph](image)

*Figure 1 – Plot of predicted/observed EWs for λ6678. (EW range of λ Eri noted.)*

References