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 ($\tau\sim 10^{-3}$) 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 $uvby$Hβ colors to ($T_{\rm eff}$, 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 $T_{\rm eff}$'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.

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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 250mÅ EWs than dwarfs. Yet as *Fig. 1* shows, while there is agreement between predictions from the two codes, their predictions fall short by ~100mÅ 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.

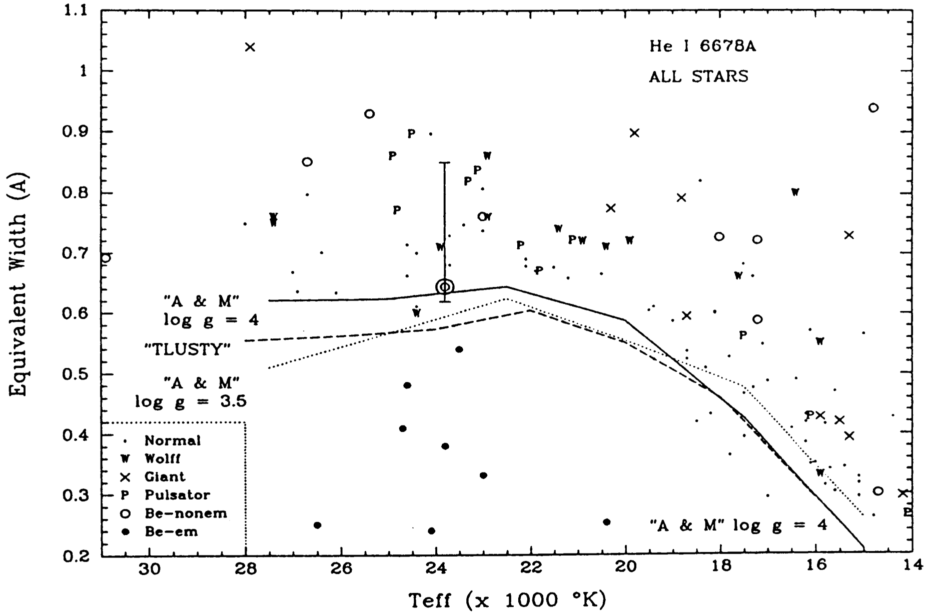

Figure 1 – Plot of predicted/observed EWs for λ6678. (EW range of λ Eri noted.)

References

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