Contrib. Astron. Obs. Skalnaté Pleso **38**, 417 – 418, (2008)

# Vertical stratification of iron abundance in atmospheres of blue horizontal-branch stars

**V. Khalack[1], F. LeBlanc[1], B.B. Behr[2], G.A. Wade[3] and D. Bohlender[4]**

[1] *Département de Physique et d'Astronomie, Université de Moncton,*
[2] *Department of Astronomy, University of Texas at Austin*
[3] *Department of Physics, Royal Military College of Canada*
[4] *National Research Council of Canada, Herzberg Institute of Astrophysics*

Received: November 20, 2007; Accepted: December 3, 2007

**Abstract.** The observed slow rotation and abundance peculiarities of certain blue horizontal branch (BHB) stars suggests that atomic diffusion can be important in their stellar atmospheres and can lead to vertical abundance stratification of chemical species in the atmosphere. To verify this hypothesis, we have undertaken an abundance stratification analysis in the atmospheres of six BHB stars, based on recently acquired McDonald-CE spectra. Our numerical simulations show that the iron abundance is vertically stratified in the atmospheres of two stars in M15: B267 and B279. One star WF2-2541 in M13 also appears to have vertically stratified iron abundance, while for WF4-3085 the signatures of iron stratification are less convincing. In all cases the iron abundances increase towards the lower atmosphere. The other two stars in our sample, WF4-3485 and B84, do not show any significant variation of iron with atmospheric depth. Our results support the idea that atomic diffusion dominates other hydrodynamic processes in the atmospheres of BHB stars.

**Key words:** stars: atmospheres – stars: horizontal branch – stars: – chemically peculiar

## 1. Introduction

Atomic diffusion is often proposed to explain the various observed anomalies (abundance peculiarities, photometric jumps and gaps, and low gravities) of BHB stars. Comprehensive surveys of BHB star abundances show that stars hotter than $T_{\rm eff} \simeq 11\,500$ K have abundance anomalies as compared to the other stars in the same globular cluster. Behr *et al.* (2000) demonstrated that the BHB stars with $T_{\rm eff} > 11\,500$ K show modest rotation ($v \sin i < 10$ km s$^{-1}$), while the cooler stars are rotating more rapidly.

The metal abundance anomalies and slow rotation suggest that microscopic atomic diffusion is effective in stellar atmospheres of BHB stars with $T_{\rm eff} > 11\,500$ K. In this scenario, the competition between radiative levitation (acting primarily through bound-bound atomic transitions) and gravitational settling yields a net acceleration on atoms, which results in their diffusion in the atmosphere. This process naturally produces vertical abundance stratification of different chemical species. Direct estimation of this stratification from line profile analysis would be a convincing argument in favour of efficient atomic diffusion in the atmospheres of hot BHB stars.

## 2. Results of spectral analysis

The line profile simulations are performed in a Phoenix LTE stellar atmosphere model with solar metallicity, but with enhanced iron and depleted helium abundances (Behr, 2003), employing the ZEEMAN spectrum synthesis code. For each line profile the iron abundance, radial velocity and $v \sin i$ were fitted using an automatic minimization routine (Khalack *et al.*, 2007 a).

All the analysed stars are slowly rotating objects and have strong He depletion. The results of our numerical simulations show that iron appears to be vertically stratified in the atmospheres of three stars: B267 and B279 in M15 and WF2-2541 in M13. The Fe abundance increases towards the lower atmosphere, while for the upper atmospheric layers it is near its solar value. For WF4-3085 in M13 we can not reach a final conclusion, because models with higher (by 1000 K) $T_{\rm eff}$ and with solar abundances do not provide confident results for iron stratification, taking into account the uncertainties. The other two stars, WF4-3485 in M13 and B84 in M15, show no evidence of stratification of iron. More details concerning these results are discussed by Khalack *et al.* (2007 b).

## 3. Discussion

We have found, for the first time, evidence of vertical stratification of iron in the atmospheres of three BHB stars. These results support the common belief that atomic diffusion is important in the atmospheres of these objects. As abundance stratification will modify the atmospheric structure, such observational results can serve as constraints in the development of atmospheric models such as those of Hui-Bon-Hoa *et al.* (2000).

## References

Behr, B.B.: 2003, *Astrophys. J., Suppl. Ser.* **149**, 67

Behr, B.B., Djorgovski, S.G., Cohen, J.G., McCarthy, J.K., Côté, P., Piotto, G., Zoccali, M.: 2000, *Astrophys. J.* **528**, 849

Hui-Bon-Hoa, A., LeBlanc, F., Hauschildt, P.H.: 2000, *Astrophys. J.* **535**, L43

Khalack, V., LeBlanc, F., Bohlender, D., Wade, G.A., Behr, B.B.: 2007 a, *Astron. Astrophys.* **466**, 667

Khalack, V., LeBlanc, F., Behr, B.B., Wade, G.A., Bohlender, D.: 2007 b, *Astron. Astrophys.* **477**, 641