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On the λ Bootis spectroscopic binary hypothesis

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Abstract. It is still a matter for some debate whether the group of λ Bootis stars has been homogeneously defined. A widely discussed working hypothesis postulates that two solar-abundant stars of an undetected spectroscopic binary system would mimic a single, metal-weak spectrum, thus preventing any reliable analysis of the group characteristics. Using the newest available stellar-atmosphere models and synthesis codes, we investigate whether the proposed spectroscopic-binary model can explain both the observed abundance patterns and the photometric metallicity indices, and what would be the percentage of undetected spectroscopic binary systems.

Key words: stars: chemically peculiar – binaries: spectroscopic

1. Introduction

More than 60 years after the peculiar nature of λ Bootis (HR 5351) was made clear, the origin and even the existence of a homogeneous group of λ Bootis stars still appears to be a matter for debate. Several theories have been developed to explain the main characteristics of this group, which is comprised of main-sequence late-B to early-F stars. We examine the hypothesis formulated by Faraggiana and Bonifacio (1999) and Gerbaldi *et al.* (2003) that some, if not all, λ Bootis stars are in fact undetected spectroscopic-binary systems with two spectroscopically unresolved solar-abundance components simulating a single-lined metal-weak spectrum.

2. Stellar atmosphere models and observations

We have synthesized 105 hypothetical binary systems in the relevant range of astrophysical parameters. These model fluxes were used to derive photometric indices. Similar indices were also derived for the single stellar atmospheres: Vega, and two well known typical λ Bootis stars, HD 107233 and HD 204041. The models were created with LLmodels (Shulyak *et al.*, 2004), and synthetic photometry was generated with the *Fluxconv* code developed by Ch. Stütz. Our observations include 57 λ Bootis stars and the same number of standard stars of similar spectral type.

3. Discussion and conclusions

Figure 1 shows two graphs comparing observations and computations in two relevant filter indices. The open squares denote our standard models, which compare well with the observed standard stars (full black squares). The same is true for the observed binary stars (full blue circles), and for the synthesized intrinsic λ Bootis stars (open blue circles), whereas the synthetic photometric indices of the simulated spectroscopic binaries (filled red triangles) generally follow the standard (solar abundant) stars.

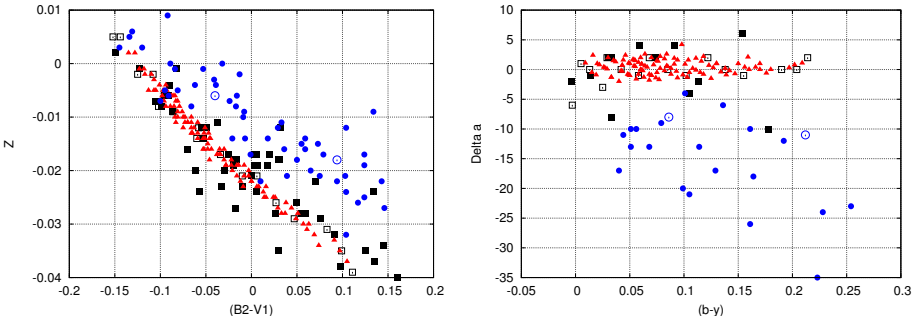

Figure 1. Two relevant color indices (Δa and Geneva Z) versus the appropriate photometric temperature index. For explanation of the symbols see the text above.

Only in the hot regime does the λ Bootis group overlap the standard stars and spectroscopic binaries. We see that the Δa index isolates the λ Bootis stars quite clearly from the rest of the sample. Unfortunately not all of our program objects have been measured yet in this photometric system.

The position of a star in these two color diagrams sets strong constraints on the total flux distribution, and moreover the percentage of undetected spectroscopic binary systems mimicking a single, metal-weak object seems very low. From 47 well investigated stars, only four objects seem good candidates for further investigation, or less than 10% of the complete sample. We conclude that, on the basis of a careful preselection, the group of λ Bootis stars can be established homogeneously.

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