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λ BOOTIS STARS

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RESUMEN. Presentamos las estrellas tipo λ Bootis pertenecientes al grupo de las estrellas peculiares de la secuencia principal superior. Su deficiencia en abundancia de elementos metálicos está comprobada por observaciones fotométricas en el sistema Δa midiendo la región espectral alrededor de λ5200 con una densidad de líneas elevada.

ABSTRACT. We describe the λ Bootis stars which belong to the group of upper main sequence peculiar stars. Their underabundance in metals is confirmed by photometric observations in the Δa system which measures the spectral region around λ5200 with enhanced line density.

Key words: **PHOTOMETRY – STARS-λ BOOTIS – STARS-PECULIAR**

λ Bootis stars have been known since the study of Morgan et al. (1943) who described them as of spectral type A0 with very weak metallic lines. In the late sixties a number of authors have tried to explain the nature of these stars. Baschek and Searle (1969) (further references therein) carried out a curve of growth analysis for a very small sample of λ Bootis stars and found that only 3 stars (out of 5!) form a distinct chemical composition group. Metal deficiencies are at the level of a factor of about 3, while oxygen is normal. Low turbulent velocities are a further property they share. Since the space velocities of the λ Bootis stars are typical for Population I stars, Baschek and Searle arrive at the conclusion that these stars must be related to the Ap-stars (which are also main sequence objects) in the sense that their deviation from normal chemical composition is restricted to the stellar surface.

More than a decade later λ Bootis stars again attracted the interest of researchers including the question of their behaviour in the *uvby* and Geneva photometric systems (Hauck and Slettebak, 1983) and in the satellite UV (Baschek et al., 1984). The former introduced a spectroscopic definition of λ Bootis stars as A-F stars with metallic lines which are too weak for their spectral types when the latter are determined from the ratio of their K-line to Balmer-line strengths. In addition they should have normal space velocities and moderately large rotational velocities.

Gray (1988) proposed a more precise working definition requiring broad, but often shallow hydrogen line wings and weak Mg II λ 4481 lines. Moreover he claims the existence of two groups, those with normal and those with peculiar hydrogen-line profiles. Baschek and Slettebak (1988), however, emphasize that this division is based on subtle profile differences and should be confirmed by additional observations. The subject of their work was an abundance analysis of 10 λ Bootis stars based on IUE-spectra. Their result basically agrees with the earlier study of Baschek and Searle, i.e. underabundances of about 0.5 dex in the heavier elements (Mg,Al,Si, S,Mn,Fe and Ni), while C, N and O appear to be slightly overabundant to normal.

The most likely explanation is the effect of a diffusion process for which, on the other hand, the relatively large rotation presents difficulties.

A general problem in dealing with λ Bootis stars is the treatment of small samples for which, in addition, a

very perfect definition has not yet been established. Some authors express doubts whether they constitute a definite class (see e.g. Wolff, 1983). Faraggiana (1987) calls for a significant increase of observational efforts, especially in the southern hemisphere, in order to enlarge the sample of known λ Bootis stars beyond those 16 objects in her list which have been spectroscopically identified by different authors.

Following a suggestion by Arne Slettebak we started a program for Δa-photometry of λ Bootis stars at Hvar observatory in 1987 (Maitzen, Pavlovski, 1989a). This technique had been introduced by Maitzen (1976) for the photometric identification of magnetically peculiar stars (CP2-stars) which show a broad band (several hundred Angstroms) flux depression around λ 5200. Since these stars show overabundances of the heavier elements and are clearly separated in a diagram of the index a (which measures the depth of λ 5200) versus $b-y$ (or another suitable color index) from the well-defined line of normal composition stars, it was natural to ask whether the underabundances of λ Bootis stars would reflect in a deviation to the other side of the normal stars' line. This expectation was fulfilled to a surprisingly high degree taking into account the moderate underabundances in λ Bootis stars compared to the generally much larger overabundances in CP2-stars. All stars with $b-y > 0.100$ were below the line of unreddened normal stars. As in Gray's (1988) diagram $m1$ vs. $b-y$ the bluest stars merge with the normal ones. But it is important to note that stars which were on the normal stars' line have discordant λ Bootis identifications. Considering the uncertainty in spectroscopic classification Maitzen and Pavlovski (1989a) conclude that at least 70 percent of the λ Bootis stars are individually detectable by Δa-photometry.

We have followed our own suggestion to corroborate these first results and obtained Δa-observations of further objects taken from the list kindly provided by C.Böhm (1988). This was done during runs at Hvar observatory in November 1988 and at the 61cm Bochum telescope at ESO in January 1989 (Maitzen, Pavlovski, 1989b).

Fig. 1 shows the combined data from both papers. The general trend of the first paper (Maitzen, Pavlovski, 1989a) is clearly confirmed. A new feature is the substantial increase of objects below the normality line also with $b-y$-colours bluer than 0.1. Two possible gaps and the difference in nature between stars on and below the line should be the subject of further investigations.

In view of the uncertainties concerning the definition of λ Bootis stars it is both interesting and comforting to state one excellent agreement between spectroscopic and our photometric results: *for all 9 objects which we have in common with the list of Hauck and Slettebak (1983) there is coincidence in the assignment or non-assignment of λ Bootis characteristics.*

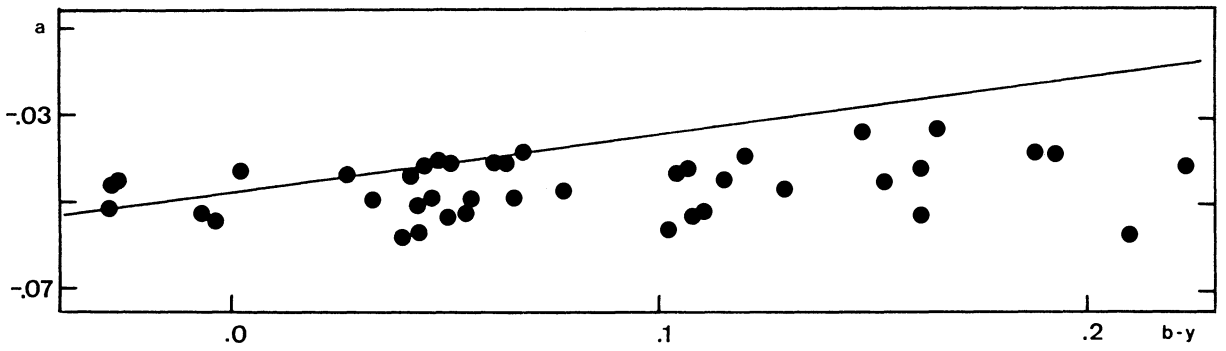

Fig. 1: a vs. $b-y$ for the λ Boo stars of Maitzen and Pavlovski (1989a,b). Data were reduced to the zero-point of 1989a. Straight line represents normal unreddened stars. Units are magnitudes.

The possibility of photometric discrimination of λ Bootis stars has an important consequence for further application:

Michaud et al. (1983) proposed the combined working of diffusion (producing a chemically stratified atmo-

sphere) and mass loss in order to explain both the Am- and λ Bootis stars. As a result, during the main sequence life time both over- and underabundances of different elements may appear at the top of the atmosphere. Observations in open clusters using the Δa-technique could yield valuable hints about the time dependence of chemical composition in λ Bootis stars.

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