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The Evolutionary Status of λ Boo Stars

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Abstract. We summarise the history of the λ Boo criterion and our strategy to determine the evolutionary status of this group of stars.

1. Introduction

λ Boo stars present a considerable challenge to our understanding of stellar atmospheres, structure and evolution. They are rather fast rotators ($v \sin i >$ 50 km s^{-1}), have no measurable magnetic field, 7000 K $< T_{\rm eff} <$ 9000 K, and $3.5 < log\,g < 4.2$. CNO slightly is over-abundant, but most of the heavy elements are under-abundant up to 1/100 relative to the Sun. From dynamic arguments these metal poor stars belong to Pop. II.

Two mechanisms are discussed for generating the λ Boo phenomenon:

•*Accretion* of metal depleted gas from a remnant protostellar cloud which would generate *unevolved* λ Boo stars at the ZAMS (Charbonneau 1991). A flux-excess (marginally detected by IRAS) corroborate this model.

•*Diffusion and mass loss* proposed by Michaud & Charland (1986) produce λ Boo stars only at the end of the main-sequence lifetime. A mass-loss rate of about $10^{-13} M_\odot y^{-1}$ can lead to the observed under-abundances after 10^9 years, thus implying *evolved* λ Boo stars.

2. Classification criteria

Unfortunately, the group of λ Boo stars, which was introduced by Morgan et al. (1943), still is not well defined in contrast to, e.g., the Am or CP2 stars. Morgan described the spectrum of the prototype, λ Boo, as weak in Ca II K lines, hydrogen lines being similar to A0 V, and an otherwise featureless classification spectrum. Later research helped to improve the classification criteria by including, among others, spectral features in the UV (Baschek, Gray, Faraggiana, Hauck, Holweger, Slettebak).

Morgan et al. (1943) refers to only one λ Boo star, Faraggiana et al. (1990) list 20 members and Renson et al. (1990) already 101 candidates. A critical assessment of these lists, however, resulted in only 40 probably true λ Boo stars (Paunzen et al. 1995). Evidently, a larger sample of well defined λ Boo stars is needed for a statistically sound treatment.

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3. Survey for λ Boo stars

Based on $uvby\beta$ and Geneva photometry we selected stars in the galactic field and in various galactic clusters of different age which populate the parameter space typical for λ Boo stars (Weiss et al. 1994). This procedure resulted in about 1800 candidates which by and large will be checked with classification spectroscopy. Presently, 120 candidates have been observed at OHP, UTSO (Chile) and Monterey (California) and 2 new λ Boo stars have been found so far.

The problem of border-line cases for membership is frequently encountered and only high resolution spectroscopy can decide about inclusion to the group of λ Boo stars. In addition, similar investigations are needed for undisputed λ Boo stars in order to improve the significance of the abundance pattern assumed to be typical for these stars. Presently, we are studying 5 λ Boo stars (for 29 Cyg see paper on *Fine analysis of pulsating CP stars* in this volume).

All together, a catalogue of stars which belong with high probability to the group of λ Boo stars has been compiled (Paunzen et al. 1995) and presently contains 40 entries, thus doubling the catalogue of Gray (1988).

4. Asteroseismology of λ Boo stars

A very powerful tool to determine the evolutionary status of λ Boo stars and hence to decide between the two competing theories can be provided by asteroseismology (Weiss et al. 1994). We initiated therefore a photometric survey for pulsating λ Boo stars at ESO, CTIO, SAAO and Lowell observatory which up to now resulted in the discovery of 10 new pulsating stars.

For an asteroseismic inversion it is necessary to determine a set of at least 4 frequencies (Breger, this volume). Such a frequency spectrum can only be obtained from the ground with a multi-site campaign. The first two campaigns are presently organised for April to June '95 at SAAO, New Zealand and CTIO.

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