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Analysis of main-sequence A-type stars showing radial velocity variability

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Abstract. We obtained high–resolution spectroscopic data for 33 bright (V < 8) A-type HIPPARCOS programme stars at the "Observatoire de Haute-Provence" (OHP) in December 2004. All our targets show some indication of radial velocity variability (Grenier et al, 1999), are located in or near the lower part of the Cepheid instability strip, and are poorly studied objects. In this contribution, we present the new data of the most interesting programme stars and we derive a physical interpretation for their variable nature.

Key words. Stars: abundances – Stars: fundamental parameters – Stars: variables: general

1. Introduction

A very interesting region of the Hertzsprung-Russel diagram lies at the intersection of the main sequence and the classical Cepheid instability strip, where a variety of phenomena are at play in the stellar atmospheres. These phenomena consist in the different pulsation mechanisms (acting in the δ Scuti, SX Phe, γ Dor and roAp variable stars) and in the various processes involving magnetism, diffusion, rotation and convection. The latter processes may boost or inhibit the presence of chemical peculiarities (occurring in Ap, Am, ρ Puppis and λ Boo stars). The competition between these processes and mechanisms leads to a large mix of stellar groups of different atmospheric composition which also behave in different ways with respect to pulsation and binarity. In preparation of a research project aiming at investigating the chemical composition of both pulsating and non pulsating A- and F-type stars, we initiated a systematic analysis of the spectra of a sample of 33 poorly known main-sequence stars in this region of the HR diagram. The selection criteria as well as the observational procedure adopted at the "Observatoire de Haute-Provence" are summarized in Frémat et al. (2005). We report on the approach and the techniques used to derive their fundamental stellar parameters (effective temperature, surface gravity and projected rotation velocity) and to identify their chemical peculiarities.

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2. Fundamental parameters

We derived $T_{\rm eff}$ and V sin i of the apparently single stars by fitting theoretical spectra, computed assuming LTE and adopting Kurucz's (Kurucz 1993) model atmospheres, to the observed data. In a first step, the surface gravity was kept fixed to log g = 4. Three dif-

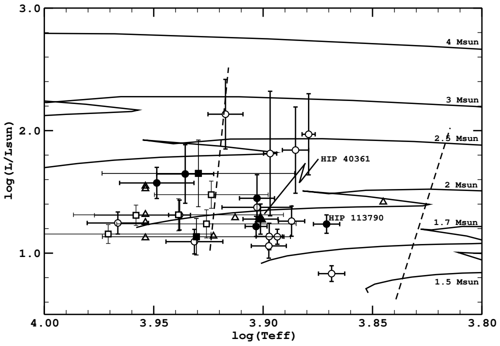

Fig. 1. Location of the stellar sample relatively to theoretical evolution tracks (full lines) in the HR diagram. Open and filled circles represent stars whose spectra are apparently single and can be consistently described with one set of fundamental parameters. Open and filled squares stand for targets with inconsistent ($T_{\rm eff}$, log g, V sin i) sets, while open triangles locate stars for which the CCF shows evidence of multiplicity. Candidate pulsating stars are plotted using filled symbols. Broken lines represent the borders of the δ Scuti instability strip (Dupret et al. 2005).

ferent spectral domains, centered on the Hγ, Mg II 4481 and Hα line-profiles, were separately considered. This procedure led to the determination of 3 sets of ($T_{\rm eff}$, V sin i) corresponding to each of the 3 wavelength ranges and allowing to detect any inconsistency related, for instance, to chemical peculiarities or to hidden multiplicity. This approach also allowed us to derive uncertainties on the parameters. The surface gravity was estimated next by using the $T_{\rm eff}$, the HIPPARCOS parallax (ESA 1997) and the V magnitude of the stars and by interpolating their mass and radius in the theoretical evolution tracks of Schaller et al. (1992). Two further iterations were needed to test the parameters' dependence on log g and to locate the stars in the HR diagram (see Fig. 1). For binary stars, a more detailed analysis is needed to isolate the components' individual spectroscopic contribution. Therefore, we estimated their location from the listed spectral types (Grenier et al. 1999) in this early stage.

3. Conclusions

Out of a sample of 33 bright A-type stars showing some indication of radial velocity variation, we discovered 6 spectroscopic binaries (SB1, SB2, triple SB2), 4 suspected multiple systems, 3 suspected Am stars while 9 objects are clearly short-period (on a time-scale of several hours) spectroscopically variable. Six stars of the latter group have also been photometrically monitored at high cadence during 2–3 nights. Inspection of their light curves showed that at least 2 are δ Scuti stars, 2 are ellipsoidal variable stars and one is (possibly) a constant star. In one case, the data were not sufficient to unambiguously interpret the physical cause of the observed variations. In order to perform systematic observations of a few of our most interesting targets (e.g. the new intrinsic variable stars HIP 40361 and HIP 113790 which are both lying in the δ Scuti instability strip), an intensive photometric campaign is planned for next autumn.

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