Comm. in Asteroseismology
Vol. 157, 2008, Wrocław HELAS Workshop 2008
M. Breger, W. Dziembowski, & M. Thompson, eds.

The driving mechanism of roAp stars : effects of global metallicity

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Abstract

We have investigated the influence of global metallicity on the excitation mechanism of roAp star pulsations. Our computations show that the opacity in the driving region of the roAp modes is strongly sensitive to the metal content but surprisingly the roAp theoretical instability strip is only weakly affected by metallicity changes.

Context

Up to now several studies have been dedicated to the excitation of pulsations in roAp stars (e.g. Dolez & Gough 1982, Dziembowski & Goode 1996, Gautchy et al. 1998, Balmforth et al. 2001, Cunha 2002). Standard as well as non-standard models have been proposed to account for the roAp properties but they did not suceed in reproducing the right position and extent of their instability strip. These previous studies did not however investigate the effects of metallicity variations.

Recent observations show that the surface metallicity of magnetic A stars increases with their effective temperature (e.g. Ryabchikova et al. 2004). As no roAp star hotter than 8700K is detected, this could suggest a relation between the excitation mechanism of roAp modes (supposedly the κ-mechanism acting in the H ionization region) and their heavy element distribution. With this in mind we have investigated the effects of global metallicity variations on the driving of roAp modes to test if nonsolar metallicities could explain the extent of the roAp instability strip.

Computations and results

We have computed grids of stellar evolutionary models adequate for roAp stars using the code Clés (Scuflaire et al. 2007). The metal mixture used is the solar one (Asplund, Grevesse and Sauval 2005) with X=0.71. Each grid is computed with a different [Fe/H] value (between -0.89 to +0.83). The opacity tables (computed with the AGS05 mixture) are those of OPAL96 (Iglesias & Rogers 1996) completed at low temperature with tables based upon calculations from Ferguson et al. (2005). As outer boundary conditions, Kurucz atmospheres (Kurucz 1998) are joined to the interior at an optical depth equal to 1. We computed standard models with fully radiative envelope, assuming that the convection is suppressed by the magnetic field (following Balmforth et al.2001). The stability of these models has been computed using the non-adiabatic pulsation code MAD (Dupret 2002).

Our results show that the so-called "H-opacity bump" (where the pulsations are driven) of our models is strongly sensitive to the global metal content of the star: the larger the

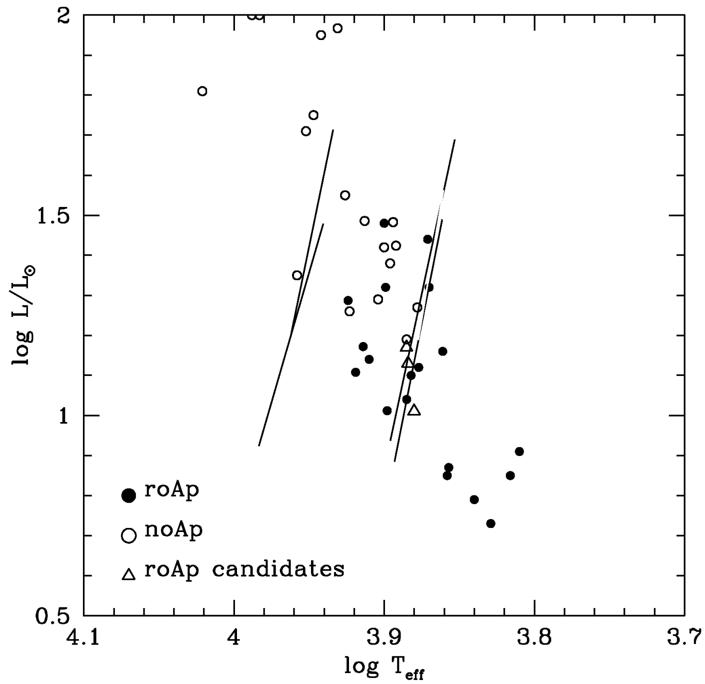

Figure 1: Theoretical instability strips for models with different metallicities (black lines : [Fe/H]= 0.00, grey lines : [Fe/H]= +0.89, -0.83). Observational points are from Kochukhov & Bagnulo (2006) and North et al. (1997).

metallicity, the larger the opacity bump. Surprisingly, the theoretical instability strip is only weakly affected by these changes (see fig.1). These results, which will be discussed in details in a forthcoming paper (Théado, Dupret and Noels 2008), show that global metallicity effects could not help solving the question of the roAp modes excitation in cool roAp stars.

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Théado, S., Dupret, M.-A., & Noels, A. 2008, A&A, submitted