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Influence of overshooting and metallicity on the δ Scuti and γ Doradus instability strips

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Abstract. Computations of theoretical instability strips (IS) for δ Scuti (Sct) and γ Dor (Dor) stars are presented. The Time-Dependent Convection (TDC) theory of Gabriel (1996) and Grigahcne et al. (2005) is adopted in our models. We are able to obtain the δ Sct and γ Dor IS. We present a prospective study on the influence of the overshooting and metallicity on the location of these IS in the HR diagram.

Key words. Stars: oscillations – Overshooting – Metallicity – Stars: interior – Stars: variables: general

1. Introduction

There are, until now, standing problems in stellar structure and evolution. Modeling of overshooting is taken into account by the use of an ad hoc parameter representing efficiency of overshooting from stellar convective cores. Occurring in cores, overshooting is out of reach of observations. Asteroseismology is a promising way to constrain it (Dziembowski & Pamyatnykh 1991). On the other hand, uncertainty in chemical composition leads to great uncertainty in the stellar mass value for given point in the HR diagram. Mode identification may help constraining it also (Pamyatnykh 2000).

The use of TDC (Gabriel 1996; Grigahcène et al. 2005) with different values of metallicity Z and overshooting parameter α_{ov} permits to study their influence on the IS of δ Sct and γ Dor variables.

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2. Influence of Metallicity

In the internal structure the metallicity has some notable effects. We note great sensibility of ZAMS points to Z. Tracks shift to high effective temperature with larger Z. And the width of the main sequence reduces a little with larger Z. In the δ Sct stars the excitation mechanism is principally the κ mechanism in the He ionization zone. We expect no great influence of the metallicity. We obtain the stabilization with our TDC. The IS does not move nearly. The ZAMS and TAMS points move. Depending on the metallicity, the TAMS point is located inside or outside of the IS. Fig. 1 gives the evolution of damping rate (negative for excited modes) for mode $\ell = 1$ p_6

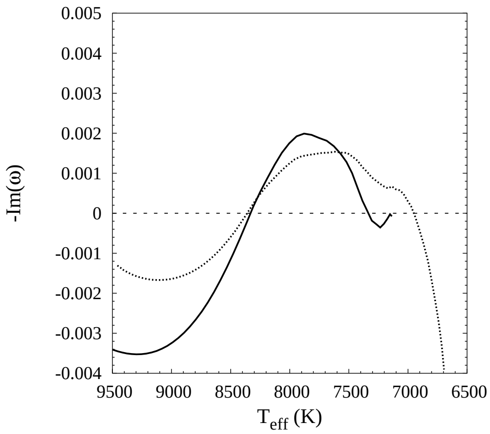

Fig. 1. Evolution of damping rate for mode $\ell = 1$ p_6 for two different models with $M = 2.1 M_{\odot}$, $\alpha = 1.8$ and $Z = 0.015$ (solid line) $Z = 0.02$ (dashed line).

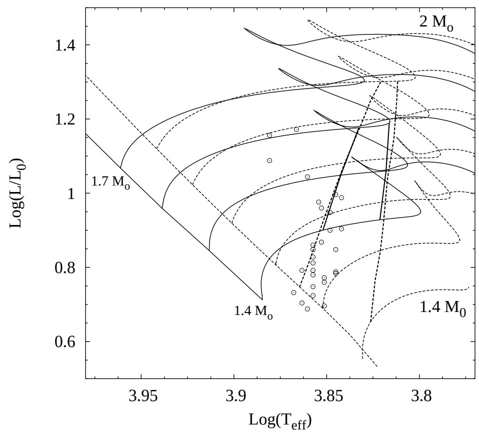

Fig. 2. Theoretical IS for γ Dor stars for $\ell = 1$ modes, for models with $Z = 0.01$ (solid lines) and $Z = 0.02$ (dashed lines).Small empty circles are observations of *bona fide* γ Dor stars (Handler 2002).

for two different models with $M = 2.1 M_{\odot}$, $\alpha = 1.8$ and $Z = 0.015$ (solid line) $Z = 0.02$ (dashed line). Stabilization of the modes occurs for lower effective temperatures for metal-poor stars. Fig. 2 shows theoretical IS for γ Dor stars for $\ell = 1$ modes, for models with $\alpha = 1.8$, $Z = 0.01$ (solid lines) and $Z = 0.02$ (dashed lines) compared to observations. The γ Dor IS is not influenced by metallicity. We have nearly the same IS for models with different matallicities.

3. Influence of Overshooting

In the internal structure the overshooting has several effects. For instence, there is no sensibility of ZAMS points. Displacement of all the track to high effective temperature with larger α_{ov}. The main sequence is larger with larger α_{ov} (Pamyatnykh 2000).

We obtain the stabilization with our TDC. The IS does not move nearly. The ZAMS and TAMS points move. Depending on the overshooting, the TAMS point is located inside or outside of the instability strip.

4. Conclusions

Changing metallicity and overshooting mainly affects the stellar evolution tracks. On the other hand, it does not have great influence on the position of the IS of δ Sct and γ Dor stars. Depending on the overshooting or/and the metallicity, the TAMS point is located inside or outside of the instability strip.

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