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Application of time-dependent convection models to the photometric mode identification in γ Doradus stars

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Abstract. We apply the Time-Dependent Convection (TDC) treatment of Gabriel (1996) and Grigahcène et al. (2005) to the photometric mode identification in γ Dor stars. Comparison of our theoretical results with the observed amplitudes and phases of the star γ Dor is presented. This comparison makes the identification of the degree ℓ of its pulsation modes possible and shows that our TDC models better agree with observations than Frozen Convection (FC) models.

Key words. Stars: oscillations – Convection – Stars: interiors – Stars: variables: general

1. Introduction

As shown in Dupret et al. (2005, and these proceedings), the amplitude ratios and phase differences predicted by our TDC non-adiabatic models are completely different from the ones predicted by FC models. TDC results better agree with observations and allow the identication of the degree ℓ of the modes with a higher degree of confidency. We present here the application of our TDC treatment to the star γ Dor.

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2. Application to γ Dor

In this study, we use the Strömgren photometric observations by Balona et al. (1994) and the spectro-photometric observations by Balona et al. (1996). From these observations, three modes with frequencies $f_1 = 1.32098$ c/d, $f_2 = 1.36354$ c/d and $f_3 = 1.47447$ c/d are detected.

In Fig. 1, we give the theoretical and observed Strömgren photometric amplitude ratios we obtained for different models of γ Dor. The lines are the theoretical predictions for different ℓ and the error bars represent the observations for the frequencies f_1 and f_2 (the error bars are too large for f_3). TDC treatment is adopted for the left and middle panels and FC treatment for the right one. FST atmosphere

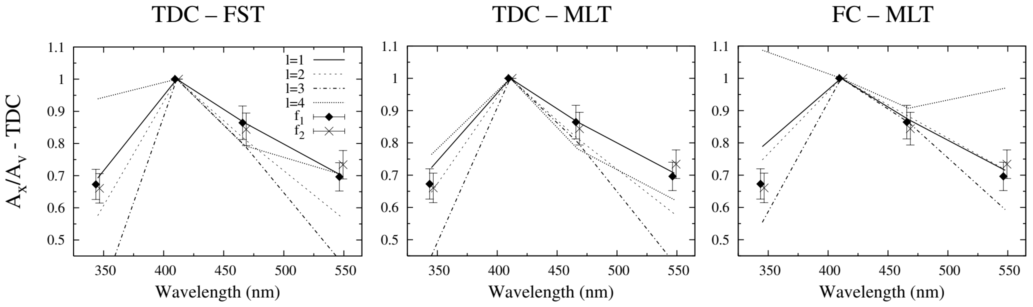

Fig. 1. Theoretical (lines) and observed (error bars) Strömgren photometric amplitude ratios for different models of γ Dor.

models (Heiter et al. 2002) are used in left and right panels and Kurucz MLT models are used for the middle panel.

The comparison between theory and observations shows that the frequencies f_1 and f_2 are identified as $\ell = 1$ modes. The best agreement is found for a model with $\alpha = 2$, FST atmosphere and TDC treatment (left panel). For all the models, a good agreement between the theoretical and observed b/v and y/v amplitude ratios is obtained. The theoretical u/v amplitude ratio is very sensitive to the value of f_T (amplitude of effective temperature variation for a normalized radial displacement) and to the adopted atmosphere model. Small values of f_T (around 0.5) and FST atmospheres are required to obtain the best agreement with the observed u/v amplitude ratio.

From the spectro-photometric observations by Balona et al. (1996), the phase difference between the magnitude variation in Johnson V and the displacement can be determined. The observed values are: $\Delta\phi_{\rm obs,2} = -65 \pm 5°$ for the component 2 and $\Delta\phi_{\rm obs,3} = -29 \pm 8°$ for the component 3 (no velocity variations are detected for the component 1). The theoretical phase differences obtained with TDC treatment, $\ell = 1$ mode and a model with $\alpha = 2$ are $\Delta\phi_{\rm TDC,2} = -28°$ and $\Delta\phi_{\rm TDC,3} = -27°$. While the phase differences obtained with FC treatment, same modes and model are $\Delta\phi_{\rm FC,2} = -167°$ and $\Delta\phi_{\rm FC,3} = -165°$. The phase-lags predicted by FC models completely disagree with observations, while the TDC ones are in reasonably good agreement with them. We remark that no significant phase differences between the photometric magnitude variations in different passbands are observed for γ Dor. Taking this into account, the value $\Delta\phi_{\rm obs,2} = -65°$ seems a bit large and must be considered with care, the real phase-lag could be closer to 0°.

3. Conclusions

Using our TDC treatment, we have identified the components $f_1 = 1.321$ c/d and $f_2 = 1.364$ c/d of γ Dor as $\ell = 1$ modes. We obtain a good agreement between the theoretical TDC phase-lags between light and velocity curves and the observations, contrary to FC results.

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