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# LET US BEGIN BY MODELLING TWO OBSERVED DELTA SCUTI STARS SIMULTANEOUSLY

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ABSTRACT We consider here two Delta Scuti stars GX Pegasi and V650 Tauri, which show very close masses and evolution stages as infered from photometrical calibration. The se two stars have been observed by the STEPHI team (Michel et al. 1990, Belmonte et al. this procedings) and they appear to be multiperiodic pulsators. For both these stars, an identification of the observed frequencies is proposed, from comparison with adiabatic eigenfrequencies computed for well suited stellar mode ls. This interpretation reveals very different pulsational behaviors despite the sta rs are expected to present very similar internal structures. We report here a first step toward constraining models by improving the fit between the observed and the calculated eigenfrequencies. The effect of overshooting and of the recent enhancement of the opacities are i nvestigated.

## INTRODUCTION

With the advent of multisite campaigns of observations, an increasing number of Delta Scuti stars are found to be multiperiodic pulsators and thus good candidates for a seismological approach. In addition to more precise stellar masses and ages, seismology of these stars is expected to provide some insights into the mixing process in the vicinity of the convective core or into the mechanisms of modal selection for instance.

We start here such a seismological approach of Delta Scuti stars. Stellar models are computed which describe two observed Delta Scuti stars GX Pegasi (HD213534) and V650 Tauri (HD23643). Oscillation eigenmodes are calculated for these models and calculated eigenfrequencies are compared with observed frequencies in order to obtain a modal identification. Such identifications are presented here for both stars and the results are compared. Then, according to this identification, it is possible to use the observations to constrain the input physics of the models.

## OBSERVATIONS AND MODELS

The observations which are used here are from the STEPHI network ( Michel et al. 1992a for GX Pegasi; preliminary results from STEPHI team for V650 Tauri, to be published elsewhere).

Models are calculated with an updated version of the Geneva stellar evolution program (Lebreton et al. 1988). Two sets of models have been computed:

- **LA models:** In this first set of models, Los Alamos opacities were used (Weiss et al. 1990). The initial helium abundance is $Y = 0.287$ and the metallicity $Z = 0.02$. The mixing length parameter is $\alpha = 2.18$ (from solar calibration).

A sequence of models with overshooting ($d_{ov} = 0.25Hp$, with $Hp$ the pressure scaleheight) has also been computed.

- **OPAL models:** In this second set of models, OPAL opacities were used (Rogers and Iglesias 1992). The initial helium abundance is $Y = 0.3$ and the metallicity $Z = 0.0194$. The mixing length parameter is $\alpha = 1.64$ (from solar calibration).

For both the sets of models, oscillation frequencies have been calculated using the adiabatic oscillation program kindly supplied by J. Christensen-Dalsgaard (1982).

## DISCUSSION

In the case of GX Peg, the observed frequencies can be identified as two radial ($n = 2, 3$) and one nonradial ($l = 1, n = 3$) triplet ($m = 1, 0, -1$) split by rotation (see Goupil et al. 1992). In the case of V650 Tau, the comparison of computed eigenfrequencies with observed ones raises a possible simple identification: 4 radial modes ($n = 2, 4, 5, 6$) ( A deeper discussion is postponed to a further paper: Michel et al 1992b, in progress).

It has already been noticed that very different pulsational behaviors can be found among Delta Scuti stars (Michel and Baglin 1991). The previous identifications given for both GX Pegasi and V650 Tauri illustrate this fact.The photometrical calibration (Kobi and North 1990) gives, for these two stars, very close global parameters (GX Peg.:$M_v = 1.48 \pm 0.1, T_{eff} = 7775 \pm 65K$, V650 Tauri.:$M_v = 1.64 \pm 0.1, T_{eff} = 8044 \pm 70K$. GX Pegasi and V650 Tau are thus expected to be very similar in mass and age (According to our models,$\Delta M \leq 0.15 M_{\odot}$, $\Delta A \leq 10^8 years$).

For both stars, differences occur between calculated frequencies and observed ones. Although they cannot be explained by numerical and observational uncertainties alone, they are not sufficient to reject the identification. They must rather be interpreted as differences between the models and the observed stars. In this point of view and in the case of V650 Tau, the comparison of the calculated and observed frequencies of 4 radial modes constitutes a very severe constraint on the modelizing of the stellar interior.

For V650 Tauri as for GX Pegasi, low order modes ($n = 2 - 4$) are found to fit the observations with a rather good accuracy while the higher order modes observed in V650 Tau show greater differences with observations.

When we change from LA to OPAL models, the fit between observed and calculated frequencies is improved in the case of GX Peg and for low order modes in the case of V650 Tauri, but it is poorer for higher order ($n = 5, 6$) modes in the case of V650 Tauri.

The effect of overshooting also has been investigated in LA models. Here again, when overshooting is taken into account, the fit is improved for low order modes but poorer for $n = 5, 6$ modes.

How can we interpret this? The $n = 5,6$ modes are more sensitive to the very outer shells than the lower order modes. Thus, if the proposed identifications are correct, the difference between the observations and the models may reflect the need to obtain a finer description of the very outer layers. Since the enhancement of the opacities is not sufficient to make the models to suit the observations, another parameter has to be taken into account. The combined effect of the chemical composition and of the opacities enhancement may help this way (work in progress).

## CONCLUSION

In this paper, we compare the results obtained through comparison of observed and calculated eigenfrequencies for two Delta Scuti stars of the STEPHI's set. The modal identifications reveal very different pulsational behaviors for these stars while they are expected to have very similar internal structures.

The recent enhancement of the opacities does not change the present identification, but it seems to emphasize that , for a better fit, the description of the very outer layers must be refined.

These preliminary results have to be tested on other stars for which similar observational data are available. No doubt that the extension of such an investigation to a larger set of Delta Scuti stars will bring some new enlightment on this subject.

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