Revisiting the theoretical DBV (V777 Her) instability strip: the MLT theory of convection


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ABSTRACT: We re-examine the theoretical instability strip of pulsating DB (He-dominated atmospheres) white dwarfs, commonly known as DBV (V777 Her) variable stars. We performed an extensive g-mode non-adiabatic pulsation analysis on a new generation of full DB white dwarf evolutionary models spanning a wide range of stellar masses (0.530 to 0.870 Msun), for which the complete evolutionary stages of their progenitors from the ZAMS, through the thermally pulsing AGB and born-again phases, the domain of the PG1159 stars, and finally the DB white dwarf domain have been explicitly accounted for. We explicitly accounted for the evolution of the chemical abundance distribution due to time-dependent chemical diffusion processes. In this paper we present our first results about the effects of different prescriptions of the MLT theory of convection on the precise location of the blue edge of the DBV instability strip. We are planning to explore in brief the impact of the Canuto-Goldman-Mazzitelli (CGM) theory of convection on the theoretical DBV instability strip.

STEELR STRUCTURE AND EVOLUTION MODELING

We employ a new set of full evolutionary DB white dwarf models that descend from the post-born again PG1159 models computed by Miller Bertolami & Althaus (2006). Specifically, we employ the LPCODE evolutionary code (Althaus et al. 2006) to compute the evolution of the MLT theory of convection in terms of He, C, and O-dominated atmospheres. We consider the He-dominated atmospheres taking into account the input of the mass at the end of the thermal timescale at the time of the He/H mixed atmospheres taking into account the input of the mass at the end of the thermal timescale at the time of the He/H mixed atmospheres.

Our evolutionary tracks in the (log Teff - log g) plane for all of stellar masses considered. The theoretical blue (red) edges of the DBV instability strip is shown for four different prescriptions of the MLT theory of convection (see below). The location of the blue edge is strongly sensitive to the convective efficiency, being hotter for more massive DB models.

SUMMARY AND CONCLUSIONS

- The location of the blue edge of the DBV instability strip is strongly dependent on the assumed efficiency of convection. This is in agreement with previous works.
- Only the MLT(0.25) proposed by B99 is consistent with the location of all the known DBV stars in the (Teff-log g) plane.
- Our nonadiabatic computations assume the frozen-in convection approximation. So, in the absence of an explicit mechanism of damping, our models continue to pulsate well beyond the observational red (cool) edge, i.e., we are not able to found a theoretical red edge.
- The range of excited periods (in particular the longest excited periods) exhibits a strong dependence with the stellar mass, but not with the assumed convective efficiency. The less massive models are able to drive pulsations at longer periods than the massive models do.
- The presence of Hydrogen in the Helium-rich atmospheres of DBV white dwarfs is able to drive longer periods than the massive models do.
- The present work constitutes the first phase of a thorough pulsation study (adibatic and non-adibatic) of DBV stars on the basis of a new generation of full DB evolutionary models.

OUR NEXT STEP: to perform nonadiabatic analysis on DB models that include the full spectrum turbulence theory of convection of Canuto, Goldman & Mazzitelli (1996) (CGM) as to assess the possible impact of this treatment on the location and shape of the DBV instability strip.

REFERENCES: