Nonlinear Radiative RR Lyrae Models: A Search for Double-Mode Behavior

Joyce A. Guzik and Arthur N. Cox

Los Alamos National Laboratory, Los Alamos, New Mexico, USA

Cox (1991), Kovacs, Buchler, and Marom (1991), and Kovacs et al. (1992) showed that opacity changes indicated by the Livermore OPAL opacities increase the pulsation masses of double-mode RR Lyrae variables. We calculated limiting amplitude solutions for radiative RR Lyrae models of 0.75 $M_{\odot}$, 51 $L_{\odot}$, and Z=0.0001 (Oosterhoff II) to investigate the effects of the mass increase and opacity changes suggested by the OPAL opacities. In particular, we modified the Stellingwerf analytical fit (1975) to the Cox-Tabor (1976) tables to decrease the opacity by 20% between 20,000 and 30,000 K. The Stellingwerf periodic relaxation method was used to converge the models to a limit cycle, and the Floquet matrix analysed to search for a tendency of the fundamental mode to grow from the full-amplitude overtone solution, and the overtone to grow from the full-amplitude fundamental mode solution, thereby predicting double-mode behavior.

Models with $T_{eff} < 7000$ K have positive fundamental-mode growth rates in the overtone solution, in contrast to the models with older Los Alamos opacities of Hodson and Cox (1982). Models with $T_{eff} > 7000$ K have positive 1st overtone growth rates in the fundamental-mode solution. However, no double-mode candidate models were found. An opacity decrease over a wider temperature range (15,000-70,000 K), as suggested by the most recent OPAL opacities with intermediate coupling, increases the switching rates, but still does not produce double-mode behavior near 7000 K.

References:

Cox, A. N. and Tabor, J. E., 1976, Astrophys. J. Suppl. **31**, 271.

Cox, A. N., 1991, Astrophys. J. **381**, L71.

Hodson, S. W. and Cox, A. N., 1982, in: *Pulsations in Classical and Cataclysmic Variable Stars*, eds. J. P. Cox & C. J. Hansen, U. of Colorado, Boulder, p. 201.

Kovacs, G. D., Buchler, J. R., and Marom, A., 1991, Astron. Astrophys. **252**, L27.

Kovacs, G. D., Buchler, J. R., Marom, A., Iglesias, C. A., and Rogers, F. J., 1992, Astron. Astrophys. (in press).

Stellingwerf, R. F., 1975a, Astrophys. J. **195**, 441.

Stellingwerf, R. F., 1975b, Astrophys. J. **199**, 705.

https://doi.org/10.1017/S0252921100117567 Published online by Cambridge University Press