OP *VERSUS* OPAL OPACITIES: CONSEQUENCES FOR B STAR OSCILLATIONS

A.A. PAMYATNYKH[1,2], W.A. DZIEMBOWSKI[1],
P. MOSKALIK[1] and M.J. SEATON[3]

[1] *N. Copernicus Astronomical Center, Bartycka 18, 00-716 Warsaw, Poland*
[2] *Institute of Astronomy, 48 Pyatnitskaya St., 109017 Moscow, Russia*
[3] *Department of Physics and Astronomy, University College London, Gower St., London WC1E 6BT, UK*

Radiative Rosseland-mean opacities for stellar envelopes from The Opacity Project, hereafter OP, became available (Seaton *et al.* 1993). Here we present a preliminary survey of pulsation properties of B-star models, obtained with this new opacity data and compare these properties with those of models built with the OPAL opacities (Iglesias, Rogers and Wilson 1992). The two opacity projects employ very different approximations in treatment of the plasma and atomic physics. In addition the OP tables are calculated including absorbtion due to three iron group elements ignored in OPAL tables, namely Cr, Mn and Ni.

Using standard codes for modelling stellar evolution and linear nonadiabatic oscillations we have surveyed properties of stars in the Main Sequence and early Post-Main Sequence phases, covering mass range from 3 to 16 $M_{\odot}$. This range corresponds to β Cephei stars (Dziembowski and Pamyatnykh 1993) and Slowly Pulsating B-type (SPB) stars (Waelkens 1991; Dziembowski, Moskalik and Pamyatnykh 1993). We have studied pulsation properties of p- and g-modes of low spherical harmonic degrees l.

Occurence of unstable modes in a model sequence of $12M_{\odot}$, which is typical for the β Cephei stars, is shown in Fig. 1. The difference between OPAL and OP results for the same mixture (G91, see Iglesias, Rogers and Wilson 1992) is noticable, but generally small. In particular OPAL opacities favour first overtone pulsations, while OP prefer the fundamental. The inclusion of the additional iron group elements (S92 mixture) shifts the Blue Edge of the instability strip to significantly higher effective temperature and consequently leads to broadening of the strip. The effect is caused by a slight displacement of the critical opacity bump towards higher temperatures, *i.e.* to deeper layers.

The β Cephei instability domains in the H-R diagram are shown in Fig. 2. With the OP opacities and $Z = 0.02$ we obtain a pleasing agreement with observational data. Thus, there is no longer a need to invoke high-Z values to explain pulsations in the hotter objects. The general displacement of the instability strip is not only to higher $T_{\rm eff}$ but also towards higher L.

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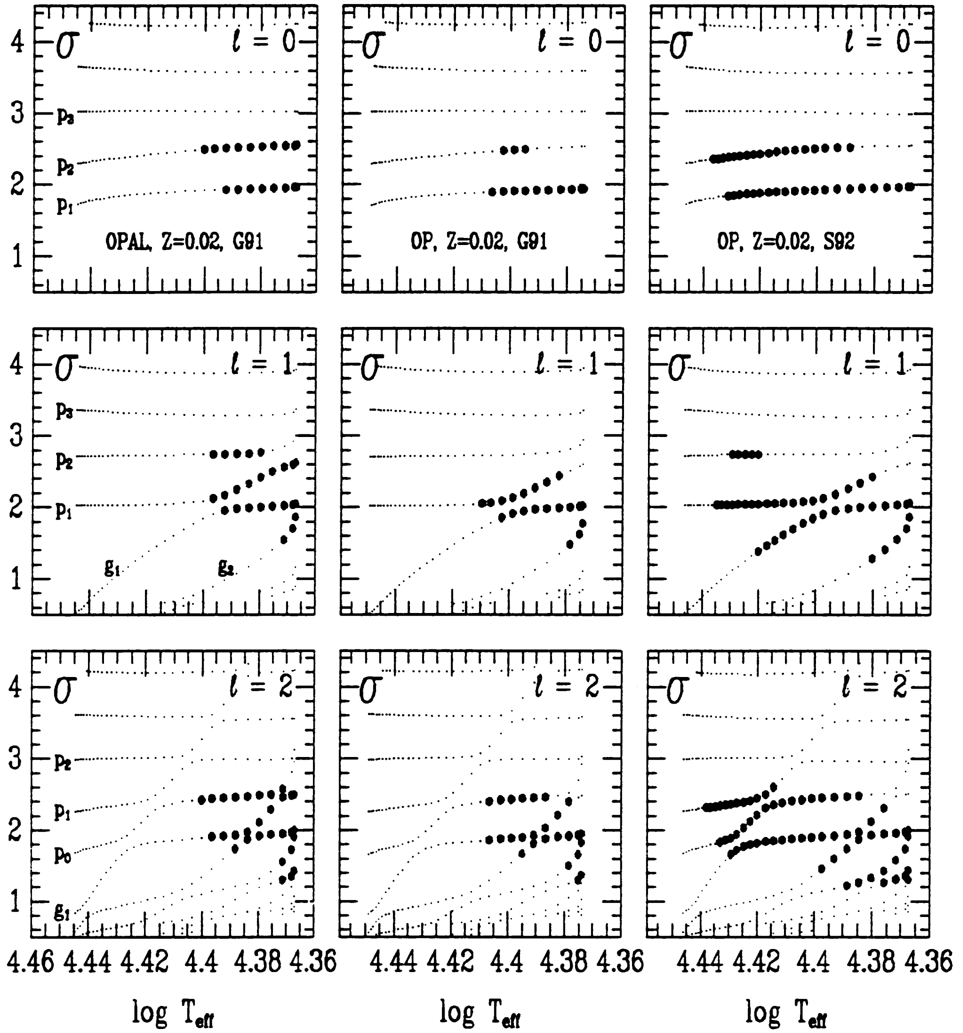

Fig. 1. Oscillation frequencies in units of $\sqrt{4\pi G\langle\rho\rangle}$ for low order p- and g-modes of spherical harmonic degrees $l = 0-2$, plotted against $T_{\rm eff}$. The models correspond to $12 M_\odot$ star in the Main Sequence expansion phase. Big dots represent pulsationlly unstable modes. The three consecutive columns display results for OPAL (G91 mixture), OP (G91 mixture) and OP (S92 mixture: Cr, Mn, Ni added) opacities, respectively.

In the case of the SPB stars the effect of switching to the OP opacities is also significant. The high-order g-mode instability domain in the H-R diagram is now extended towards higher luminosities. Furthermore, the longest periods for the unstable modes are even longer than before. Excitation of modes with $P > 4$ days is now possible. This improves the agreement with observations accommodating longer period SPB stars like HD 27563.

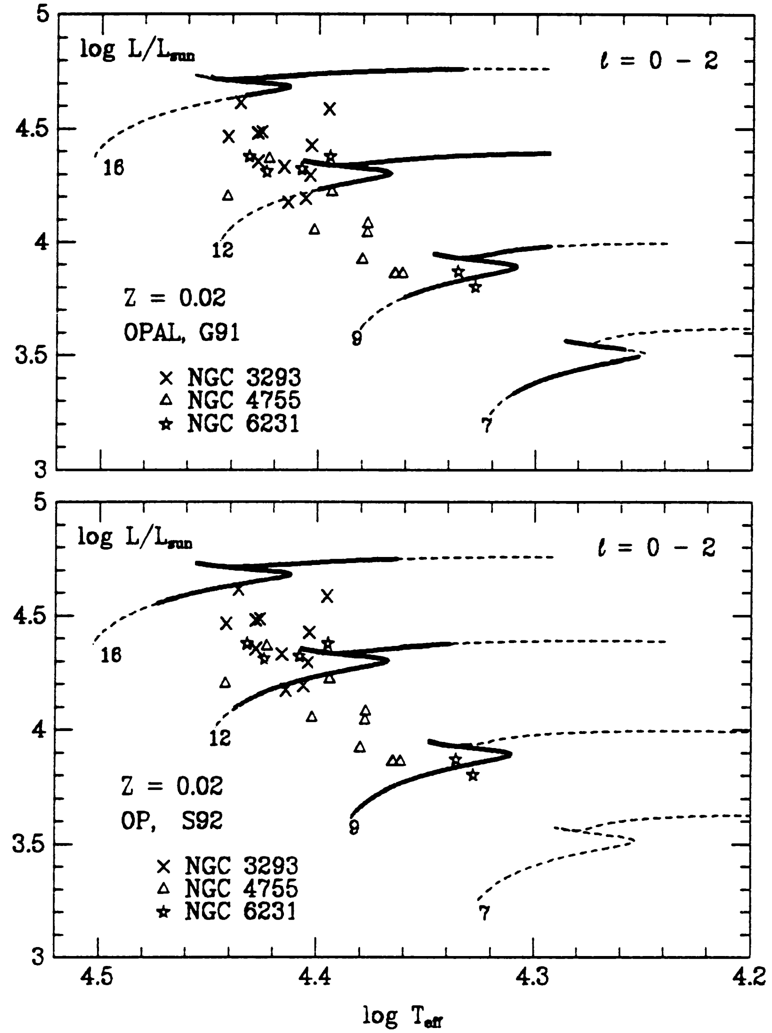

Fig. 2. Evolutionary tracks for stellar masses of $7M_\odot$, $9M_\odot$, $12M_\odot$ and $16M_\odot$, calculated with the OPAL (top) and OP/S92 (bottom) opacities. Thick lines correspond to models, which are vibrationally unstable to low degree modes ($l = 0-2$). The practical Red Edge of the instability strip can be identified with the lowest $T_{\rm eff}$ points of the Main Sequence track, because the Post-Main Sequence evolution is very fast. Cluster β Cephei stars are shown for comparison (Balona 1993, Balona and Koen 1993, Heynderickx 1991).

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