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Effects of a New Equation of State on Cepheid Pulsation Models

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Abstract. We present the results of several numerical experiments aimed at testing the dependence of theoretical observables predicted by Cepheid hydrodynamical models on the equation of state (EOS). We focus our attention on nonlinear and time-dependent Cepheid convective models at solar chemical composition. We find that current predictions for both the blue and red edge of the instability strip present a mild dependence on the EOS. The same outcome applies to the morphology of the lightcurves.

1. Introduction

Previous pulsation models developed by our group include the most recent opacity evaluations (Iglesias & Rogers, 1996; Alexander & Ferguson, 1994), but still rely on the Stellingwerf (1982) EOS (see, e.g, Bono et al., 2000). To test whether theoretical predictions are affected by this key physical ingredient, we present in Sect. 2 the results of several numerical experiments performed by adopting the EOS recently provided by Irwin (2001). A few comments concerning the future work are briefly outlined in Sect. 3.

2. Results

The left panel of Fig. 1 shows the blue and the red edges of fundamental mode Cepheids constructed by adopting the labeled stellar masses. Dashed and solid lines refer to models based on the old and the new EOS respectively. The temperature difference between new and old edges is within the adopted temperature step (100 K) with which models are constructed and it is comparable with the

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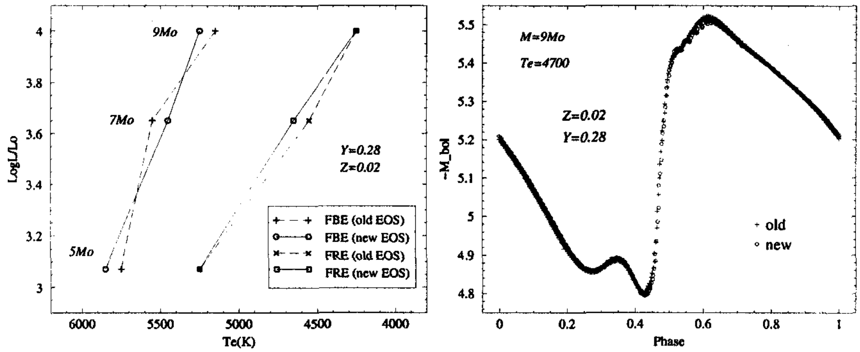

Figure 1. Left: Blue and red edges for fundamental Cepheids (FBE and FRE respectively) for the labeled mass values and at solar chemical composition. Right: Cepheid light-curves of a model constructed by adopting the labeled input parameters.

uncertainties due to the choice of the spatial resolution throughout the envelope models. We note that the use of the new EOS does not shift systematically the edges towards lower temperatures as obtained for linear radiative models (Petroni et al., 2001). The right panel of Fig. 1 shows the light-curve of a $9M_{\odot}$ Cepheid located close to the middle of the instability strip.

3. Final remarks

The results presented in this paper show that theoretical predictions based on nonlinear, convective models present a negligible dependence on the EOS. Both the shape of the light curves and the modal stability do not show significant difference when moving from the old to the new EOS. However, the difference between old and new input physics depends on the chemical composition and increases at the lower effective temperatures (see Petroni et al., 2001). As a consequence, to assess on a quantitative basis the effects of the EOS on theoretical observables, it is necessary to complement current analysis with long-period Cepheids at different chemical compositions.

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