A STUDY OF PERIOD DOUBLING IN A ONE-ZONE PULSATING STELLAR MODEL

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Abstract. A simple one-zone model for nonlinear stellar pulsations is outlined and applied to the study of period doubling observed in some W Virginis and RV Tauri stars. The model reveals a number of period doubling bifurcations as the parameters are varied, similar to those found by Buchler & Kovacs in their series of hydrodynamic models. In the vicinity of a stable limit cycle, despite its large number of degrees of freedom, the model develops an essentially one-dimensional Poincaré's return map, determining the modulation of the amplitude. The analysis of these maps confirmed that period doubling has its origin in a strong nonlinear increase of total energy losses per period as radial amplitude, $\delta r/r$, increases. An additional study of nearly periodic hydrodynamic models with $P > 15$ days, calculated including radiative transfer effects, shows that the rate of energy dissipation per period by shocks in the atmospheres increases rapidly with $\delta r/r$, whereas the excitation rate, δ_0, remains rather stable. This permitted us to construct an analytic return map for maxima of the total kinetic energy which clearly demonstrates the mechanism of successive period doubling as δ_0, the sole bifurcation parameter, grows monotonically.

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