Hydrodynamical Models of Radially Pulsating Hot Extreme Helium Stars

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Abstract

The blue edge of the instability region of radially pulsating helium stars is located on the H-R diagram nearly vertically at luminosities less than $10^4 L_\odot$ and corresponds to $T_{eff} = 7400K$ and $1.1 \cdot 10^4 K$ for stars with mass of $1 M_\odot$ and $0.7 M_\odot$, respectively. The pulsation instability of the stars located along the vertical part of the instability edge is characterised by the increasing order of the pulsation mode with decreasing luminosity. For example, for stars with $M = 0.7 M_\odot$ and $T_{eff} = 10^4 K$ the principal pulsation mode is nearly second overtone for $M_{bol} = -5$ mag and is nearly fourth overtone for $M_{bol} = -4$ mag. For stars brighter than $M_{bol} = -5$ mag the blue edge turns blueward so that the models with T_{eff} as high as $3 \cdot 10^4 K$ are pulsationally unstable. The sequences of the hydrodynamic models characterized by constant luminosity ($M_{bol} < -5$ mag) reveal the decrease of the light amplitude with increasing T_{eff}, whereas the amplitude of the radial velocities of the outer layers is almost independent of T_{eff}. For example, for stars with $T_{eff} > 2 \cdot 10^4 K$ the light amplitude is less than 0.01 mag, whereas the radial velocity amplitude is in the range from 20 to 50 km/s. The pulsation instability of these stars is driven mainly due to the γ-mechanism. Fourier analysis of the hydrodynamic solution shows that the pulsation motions of the hot helium stars can be represented as a superposition of the running waves (in contrast to Classical cepheids where the pulsation motions are described in the terms of superposition of standing waves). The pulsation constant gradually decreases with increasing T_{eff}, down to $Q \approx 0.012$ day at $T_{eff} \approx 3 \cdot 10^4 K$.

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