

TRANSITION IN VARIABLE STARS: FROM SOLAR-TYPE TO GAMMA DORADUS-TYPE

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The Main Sequence solar-type pulsators are characterized by acoustic oscillation modes excited by turbulent granular convection in the upper convective boundary layer. As the stellar mass increases the convection zone shrinks, the scale and intensity of the turbulent motions increases, providing more energy for excitation of acoustic modes. When the stellar mass reaches about 1.6 solar masses (the gamma Doradus class) the upper convection zone consists of two very thin layers corresponding to H and He ionization, and in addition to the acoustic (p) modes the stars show strong internal gravity (g) modes. The thin convection zone is often considered insignificant for the stellar dynamics and variability. However, recent 3D radiative hydrodynamics simulations reveal supersonic granular-type convection of the scale significantly larger than the solar granulation, and strong overshooting plumes penetrating into the stable radiative zone. These plumes may contribute to the excitation of the g-modes or hybrid modes with p- and g-characteristics. Pulsations of these types despite substantial efforts have not been observed on Sun. The goal of this proposal is investigate the physics of the interaction between the turbulent convection and oscillations along the Main Sequence, from the solar-type stars to more massive gamma Doradus stars. This interaction will be investigated by comparing the convective and oscillation spectra with the numerical simulation models. The numerical simulations, specifically developed at NASA Ames and Stanford Center for Turbulence Research, will provide a critical theoretical support for interpretation of the observed variability of these stars. This type of turbulent convection cannot be correctly described by the traditional mixing-length models. The proposed investigation will include a series of interesting questions about the role of turbulent surface and subsurface motions in the stellar variability and magnetism, e.g. how the supergranulation pattern changes in this transition, what is the effect of this transition on the local dynamo, formation of magnetic structures and atmospheric heating. The gamma Doradus stars show an increase in UV radiation but the mechanism of this is unclear. The Kepler short-cadence data and the realistic numerical simulations carried out in conjunction with project offer a unique opportunity to investigate the physics of the transition in turbulent convection and oscillations, and also potential role of magnetic fields. This will provide an important insight for the understanding of these and other types of variable stars.