

CHARACTERIZING AMPLITUDE AND FREQUENCY SPECTRUM VARIABILITY IN HYBRID GAMMA DOR/DELTA SCT STARS

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The delta Scuti and gamma Doradus pulsating variables are main-sequence (core hydrogen-burning) stars with masses somewhat larger than the sun (1.2 to 2.5 solar masses). The lower-mass gamma Dor stars are pulsating in nonradial gravity modes with periods of near one day, whereas the delta Sct stars are radial and nonradial p-mode (acoustic mode) pulsators with periods of order two hours. Because of the near one-day periods of gamma Dor stars, it is very difficult to discover and monitor these variables from ground-based photometry or spectroscopy due to the 1 cycle/day alias. Hybrid gamma Dor/delta Sct stars are among the most interesting targets for asteroseismology because the two types of modes (pressure and gravity) probe different regions of the star and are sensitive to the details of the two different driving mechanisms. Because these driving mechanisms are somewhat mutually exclusive, hybrid stars exhibiting both types of pulsations are expected to exist only in a small overlapping region of temperature-luminosity space in the Hertzsprung-Russell diagram. However, Kepler Asteroseismic Science Consortium (KASC) Working Groups 4/10 (delta Sct/gamma Dor) have discovered that hybrid stars are surprisingly ubiquitous. In a study of 750 KASC A-F stars observed for up to four quarters, 47% show hybrid pulsations. Despite extensive study of this large sample during the past summer by the KASC WGs, no obvious frequency or amplitude correlations have emerged, and there seems to be no clear separation of gamma Dor and delta Sct pulsators in the HR diagram. The known driving mechanisms cannot explain the pulsation behavior. In our Cycle 1 Guest Observer program, targeting only 14 stars, five show clear hybrid behavior, and five more show gamma Dor pulsations. In addition, at least six stars showed some amplitude variability between Q2 and Q4 in the long-cadence data. We are awaiting data on an additional 187 targets from the Cycle 2 GO program, searching for more hybrids. Here we propose to take advantage of the Kepler unprecedented micromagnitude photometric precision and ideal cadence length for these pulsation periods to supplement the KASC sample for fainter stars, and perform longer-term monitoring to quantify and characterize amplitude or frequency spectrum variation. After Kepler, we will likely not have the opportunity in this generation of researchers to obtain such data (unless a European mission, Plato, competes successfully). We propose continued monitoring of the gamma Dor/delta Sct candidates discovered in Cycle 1, as well as continued monitoring of the Cycle 2 stars. In addition, we propose to observe 517 new targets to fill in the statistics for the magnitude 14-15 stars with T_{eff} and $\log g$ appropriate for gamma Dor or delta Sct stars. Our aim with this set is to determine whether there is actually a magnitude cutoff for detecting variability as hinted at in the KASC analysis. Long-term monitoring of a large sample of these stars with the high-precision Kepler photometry is essential to help resolve the mysteries surrounding the theoretical model predictions and to realize the potential for asteroseismology of these stars.