

KEPLER GAMMA DORADUS AND DELTA SCUTI STARS: FILLING THE GAPS

Joyce Guzik

Los Alamos National Security, LLC

GO40011

In preparation for the potential end of the Kepler mission during Cycle 4, we propose to "fill the gaps" in the Kepler discoveries related to delta Scuti and gamma Doradus stars and their hybrids so that this data will be useful in the future for asteroseismic interpretations. 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. We were surprised to learn from the first Kepler data that most of these variables actually show pulsations of both type simultaneously. Theoretical models predict only a small overlap region in the Hertzsprung-Russell diagram where hybrid behavior was expected, due to the different, almost mutually exclusive, driving mechanisms for the two types of pulsation. The Kepler Asteroseismic Science Consortium (KASC) and our Cycle 1, 2, and 3 Guest Observer investigations have been searching for new hybrids and characterizing their pulsation behavior to inform a new explanation for the variety of frequency and amplitude spectra, and compile statistics on the occurrence of pulsators and constant stars. We are proposing GO Cycle 4 observations with several objectives: 1) Obtaining one month of short-cadence (1-minute integrations, SC) data for bright delta Sct and gamma Dor stars that so far have only been observed in long cadence (30-minute integrations, LC) by KASC. The SC data is essential to sort out intrinsic pulsation frequencies from 'reflection' frequencies that may be in the Fourier transform due to undetected frequencies above the LC Nyquist frequency. For these bright stars where it will be possible to obtain ground-based spectroscopic data for further constraints and intensive study, we want to derive an unambiguous intrinsic pulsation frequency set for asteroseismology. 2) Obtaining extended SC time series for several bright KASC hybrid stars that have high frequencies requiring SC data, but will fall on Module 3 or were otherwise deprioritized in the more restricted KASC target list for remaining quarters and Extended Mission planning. It is important to observe these brighter targets that have excellent potential for ground-based followup to optimize signal-to-noise and monitor amplitude and frequency variations. 3) LC monitoring of a number of stars that have been identified as interesting gamma Dor or delta Sct stars in GO Cycle 1 and 2 observing programs to study frequency and amplitude variations and improve signal-to-noise. 4) LC observations for a new sample of stars never monitored before by Kepler, taking advantage of the work of Co-I Kinemuchi on identifying potential variables by difference imaging of eight Kepler full-frame images from Quarter 0, taken during the commissioning phase when the telescope was optimally focused and thermally stable. From Cycle 2 observations, we learned that gamma Dor or delta Sct variability was easily observed even for stars at 15th-16th magnitude and we would like to extend the statistics for fainter objects, as discussed in our Cycle 3 GO proposal. We will likely never have the opportunity after Kepler in this generation of astronomers to discover so many gamma Dor stars due to the 1 cycle/day alias of ground-based observations. We expect that filling in these gaps in the observing will provide a body of data that will be useful for years to come to develop statistics on the frequency of variability, and explaining the variety of frequency spectra, and as input for detailed asteroseismic studies.