K2 Observations of Short-Period, p-mode Pulsating Subdwarf B Stars during F2 and F3

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During K1, nineteen pulsating subdwarf B (sdBV) stars were detected, none of which were known to pulsate previously. Of these, **only 2** were predominantly short-period p-mode (atmosphere-probing) pulsators, with the rest being longer period, g-mode (core-probing) pulsators. Both of these pulsators produced interesting and surprising results. KIC 2991276 observations produced the first unambiguous case of *stochastic* oscillations in an sdBV star (Ostensen, Reed, Baran, Telting, A&A, 564, L14). However, only KIC 10139564 had a p-mode spectrum sufficiently rich to produce constraints for p-modes, and it contained surprises: p-mode overtones were spaced roughly 1/3 those of models; g-mode overtone spacings were also different from the K1 g-mode dominated pulsators (Baran et al. 2012, MNRAS, 424). Ground-based observations of Balloon 090100001 (hereafter Ba09) revealed the only other known p-mode dominated hybrid for which rotational multiplets allowed mode identifications. Ba09 does not show g-mode period spacings indicative of overtones, leaving quite a mystery: Are p-mode sdBV stars structurally different from g-mode sdBVstars? And if so, how? Other than slightly thicker envelopes which produce cooler temperatures, structural models do not suggest differences between p- and g-mode sdB stars. Overtone period spacings like those of the K1 g-mode stars have been found in one blue horizontal (HB) star (Ostensen et al 2012, ApJL, 753) and on the red HB edge (Beck et al. 2012, AN, 333). So why not in the p-mode sdBV stars? Likewise, the constraints on structural models provided by the g-mode sdBV stars have already been (and will continue to be, as it will take years to fully interpret and exploit K1 data) transformative for understanding HB cores (e.g. are chemical transition zones mixed or sharp?; e.g. Reed et al. 2011, MNRAS, 414, 2885). Only a handful of K1 g-mode sdBV data sets have been fully analyzed, to date, yet these reveal detailed seismic structure, to which models now need to catch up (and modifications are already under way!). There has also been a longstanding observation that hotter horizontal-branch stars rotate faster than cool ones (e.g. Peterson, Rood, & Crocker 1995, ApJ, 453). We do *not* find this result for sdB stars, which are extremely hot HB stars. One of the most exciting discoveries from K1 is that sdB stars, even in 0.5 day binaries are *slowly* rotating (e.g. Pablo et al. 2012, MNRAS 422).

In order to exploit seismology of p-mode sdBV stars, we need to more fully resolve pulsations and identify the modes: that is, we need to associate n and l values with periodicities, measure asymptotic overtones, and constrain Ledoux constants. To do this, we need to observe several p-mode sdBV stars with K2. While observing all sdB stars in the correct temperature range for g-mode pulsations provided an 80% success rate, p-mode sdBVs are much less frequent (c. 10% of candidates). Therefore it is important for K2 to observe as many p-mode pulsators as possible.

There are few areas in the HR diagram where K2 seismology has such potential. Since their discovery just 15 years ago, several methods have been attempted to observationally constrain models, with only limited success. Only for K1's KIC 10139564 are the observations sufficient to overconstrain models. We need more of these if our understanding of He-fusing stars is to advance. These stars need to have SC observations as pulsations (of a few minutes) occur well beyond the Nyquist of LC data. As ground-based data was sufficient to detect their pulsations, K2 data will detect them all with greatly improved limits.

Our target list includes three prospective pulsators: one He-sdOB star in F3 and one each prospective sdB and He-sdOB pulsators in F2. Since KIC selected *against* sdB+MS binaries and EPIC did not, K2 offers us the chance to explore this interesting binary parameter space.