Continuing *K2* Advances with White Dwarfs in Field 10

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We propose short-cadence observations in K2 *Field 10 of four candidate pulsating white dwarfs and two known remnant planetary systems. These DDT observations supplement our GO proposal; two of these targets have new spectroscopy putting the stars within 250 K of the empirical instability strip, and we now propose two faint targets having seen the success of* K2 *with $K_p \sim 19.0$ stars.*

As they cool, white dwarf (WD) stars with hydrogen-dominated (DA) atmospheres pulsate as DAVs (a.k.a. ZZ Ceti stars) when they reach the appropriate effective temperature to foster a hydrogen partial-ionization zone, which drives global oscillations. This range of temperatures empirically spans roughly $12{,}600-11{,}100$ K for canonical-mass (0.6 $\mathrm{M}_{\odot}$), $\log g = 8.0$ WDs (Gianninas et al. 2011, ApJ, 743, 138). Pulsating WDs provide an important window into the interior of the future of the vast majority ($> 97\%$) of all stars in our Galaxy, including our Sun. Since the DAV instability strip is defined by temperature, color selection is an excellent predictor of variability. Our team discovered all DAVs in the original *Kepler* mission, and we have lead the way in discovering and characterizing pulsating WDs in *K2* — we have rapidly published results showing that WDs that have undergone a common-envelope phase rotate faster than isolated WDs (Hermes et al. 2015a, MNRAS, 451, 1701) and have shown that the coolest pulsating WDs outburst (Hermes et al. 2015b, ApJ, 810, L5). These space-based results are revitalizing the field of WD asteroseismology.

As part of an accepted Cycle 3 Guest Observer proposal, we proposed short-cadence (SC) data for two known and eight candidate pulsating WDs in Field 10 (K2-C10-0018-Hermes). These candidates were compiled using ugr colors of objects consistent with the empirical DAV instability strip.

Since the submission of our GO proposal, we have revisited our selection criteria and found four additional excellent DAV candidates on silicon in Field 10. We have recently obtained spectroscopy for our top two candidates (Priority 1, Table 1), which we have fit for atmospheric parameters, which are a far better predictor of variability than photometry alone (Mukadam et al. 2004, ApJ, 607, 982). We show these Priority 1 targets as blue squares in Figure 1. We note that our highest-priority DAV candidate, EPIC 229165995, sits firmly inside the red edge of the empirical DAV instability, and is in fact near the four known outbursting DAVs that have recently been discovered only thanks to the long duration of *Kepler* observations (Bell. et al. 2015, ApJ, 809, 14; Hermes et al. 2015b, ApJ, 810, L5). This exciting new outburst phenomenon, which may be responsible for the cessation of pulsations in cool WDs, only appears to occur in the coolest DAVs with the deepest convection zones, which have the most nonlinear mode coupling (Wu & Goldreich 1999, ApJ, 546, 469).

Additionally, we propose two faint candidates (Priority 2, Table 1) that we initially believed were too faint for our Cycle 3 proposal. Our experience with similarly faint pulsating WDs (specifically EPIC 211916160 in Field 5, $K_p = 19.0$) shows we can discover significant pulsation modes down to amplitudes of roughly 1.5 ppt (0.15%). Although we lack spectroscopy, both Priority 2 candidates have high enough reduced proper motions that there is a $> 99\%$ probability these are WDs (Gentile Fusillo et al. 2015, MRNAS, 448, 2260). Their ugr colors place them firmly inside the empirical DAV instability strip (see Figure 1), and there is very high probability that they pulsate.

Every new DAV we can observe with *K2* adds significant legacy value, since it brings us that much closer to statistically significant studies of WDs with ensemble asteroseismology (e.g. Chaplin et al. 2011, Science, 332, 213). There were only six pulsating WDs in the original *Kepler* mission, but that number has grown to at least 20 with *K2*, and will continue to grow as the extended mission progresses. With typical pulsations ranging from $100 - 1400$ s, we require **SC** observations of these WDs.

Finally, unrelated to our four DAV candidates, we have included SC requests for two WDs in Field 10 with known remnant planetary systems, which provide a more efficient search for transits (Priority 3, Table 1). These two WDs show metals (spectrally classified as DZ) and are thus actively accreting tidally disrupted rocky material in remnant planetary systems (e.g., Koester et al. 2014, A&A, 566, 34). SC is necessary to probe possible variability from the debris disk which sits within the WD tidal disruption radius; material there would have orbits of order minutes. SC will also provide more dynamic transit information, in case the system is edge-on, such as the disintegrating minor planets discovered for the first time around a WD with *K2* (Vanderburg et al. 2015, Nature, 526, 546).

We recognize that asking for all six short-cadence targets would utilize a large fraction of the available Field 10 DDT pixels. However, all our proposed targets are fainter than $K_p > 17.5$ mag, which may allow for using small postage stamps. We have also ranked our proposed targets in order of priority in Table 1. None of the objects are interrelated; that is, omission of one will not jeopardize the science for any other target. If all targets cannot be observed in SC, please cull from the end first.

Table 1: Candidate pulsating white dwarfs in Field 10 (all require SC)

Priority	**EPIC**	K_p	$(u-g, g-r)$	$T_{\rm eff}$, $\log g$
1	229165995	18.9	(0.494, −0.110)	10520 K, $\log g$= 7.90
1	229056690	17.5	(0.441, −0.221)	12900 K, $\log g$= 7.93
2	229029998	19.0	(0.339, −0.144)	
2	228936292	19.1	(0.371, −0.155)	
3	229041897	18.2		10100 K, DZ
3	228886332	18.0		10180 K, DZ

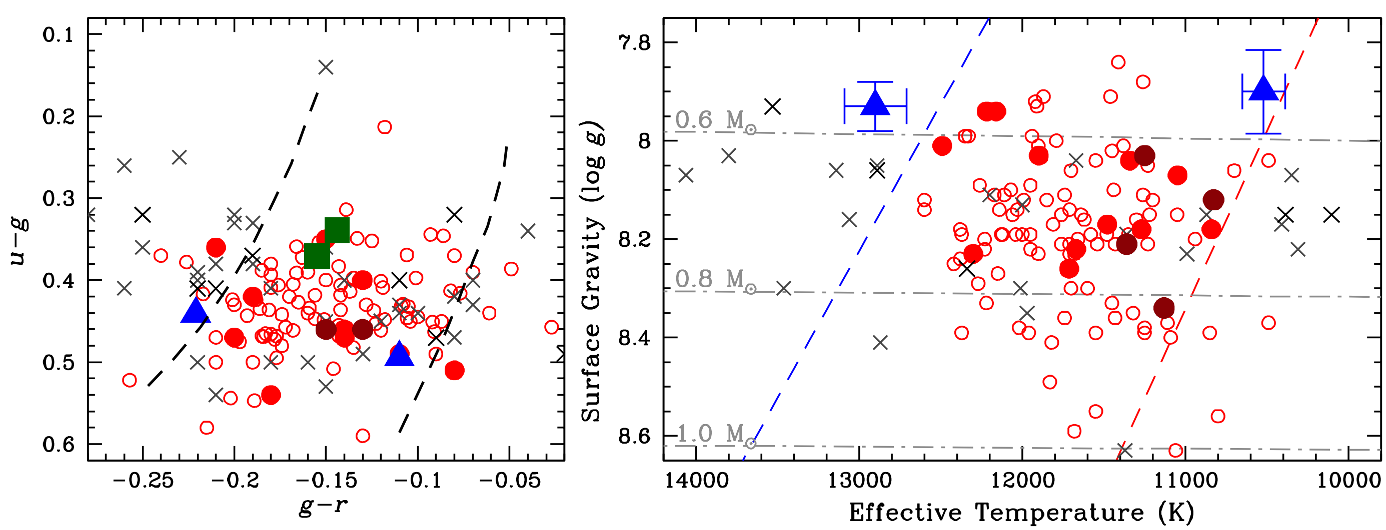

Figure 1: Left: Selection of our DAV candidates. Blue triangles show our two Priority 1 candidate DAVs, which also have SDSS spectroscopy, and green squares show our two Priority 2 candidates. Known DAVs are shown as red open circles, and WDs which do not vary to at least 0.4% relative amplitude are shown as gray crosses. The DAVs that have so far been observed by *Kepler* are shown as filled red circles, and the outbursting DAVs are marked as dark-red circles. Right: Using the same symbols, we shows targets with measured atmospheric parameters from spectroscopy, which include corrections for the three-dimensional dependence of convection.