K2 Observations of 3 Candidate Pulsating WDs in Field 9

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We propose short-cadence observations in Field 9 of the K2 *mission of three candidate pulsating white dwarfs, as identified from the VST Photometric Hα Survey of the Southern Galactic Plane and Bulge (VPHAS+).*

As they cool, white dwarf 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 efficiently 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 white dwarfs provide an important glimpse below the surface and 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, which has led to exquisite insight into WD interiors (e.g., Greiss et al. 2014, MNRAS, 438, 3086). We have lead the way in discovering and characterizing pulsating white dwarfs in *K2* — we have rapidly published results showing that white dwarfs that have undergone a common-envelope phase rotate faster than isolated white dwarfs (Hermes et al. 2015a, MNRAS, 451, 1701) and have shown that the coolest pulsating white dwarfs outburst (Hermes et al. 2015b, ApJ, 810, L5). These space-based results are revitalizing the field of white dwarf asteroseismology.

Using the same photometric selection methods as in the past, we have identified three white dwarfs on silicon in *K2* Field 9 with colors consistent with the empirical DAV instability strip using photometry from The VST Photometric $H\alpha$ Survey of the Southern Galactic Plane and Bulge (VPHAS+; Drew et al. 2014, MNRAS, 440, 2036); see Figure 1. While these targets are only photometrically identified, we plan to obtain optical spectra of all three when the field is back from around the Sun in early 2016 using our ample ground-based resources.

Every new DAV we can observe with *K2* adds significant legacy value, since it brings us that much closer to statistically significant studies of white dwarfs with ensemble asteroseismology (e.g. Chaplin et al. 2011, Science, 332, 213). There were only six pulsating white dwarfs 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 **short-cadence** observations of these WDs. Minute-cadence *K2* observations have the added benefit of catching transits/eclipses of the WD, revealing any unresolved double-degenerate binaries or even minor planetary companions, which were discovered for the first time around a white dwarf in *K2* Campaign 1 (Vanderburg et al. 2015, Nature, 526, 546).

In the event that only one target can be selected, we have ranked our targets in order of priority. Notably, EPIC 224048262 is our highest priority, as it has an $r - H\alpha$ color most consistent with white dwarfs, which typically have $r - H\alpha < 0$. The other two may still be white dwarfs but suffer from an incomplete color calibration in this data release. These targets were selected using a new internal data release of VPHAS+, which was not fully calibrated and sorted for our selection purposes before the original deadline for Cycle 3 targets in Campaign 9, hence our submission of a DDT proposal here.

Table 1: Candidate pulsating white dwarfs in Field 9 (all require SC)

ID	K_p	$(u-g, g-r)$	$(r-H\alpha, r-i)$
EPIC 224048262	15.0	(−0.96, 0.04)	(−0.17, 0.09)
J181343.0−213843.9	15.1	(−1.18, 0.08)	(0.09, 0.23)
J175504.3−244849.2	15.7	(−1.04, 0.11)	(0.15, 0.21)

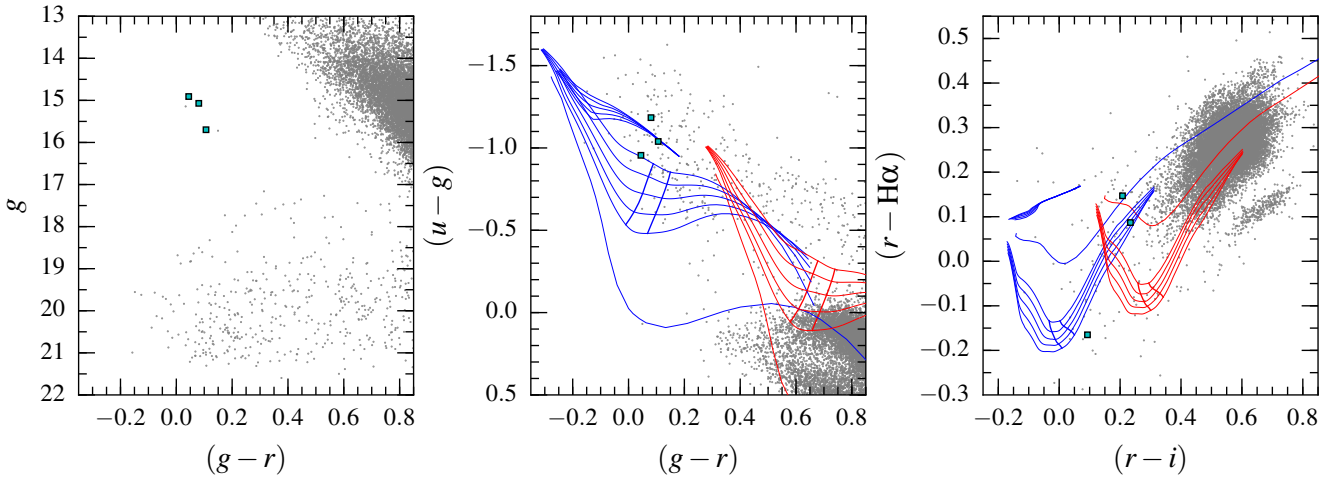

Figure 1: Our three targets in three different color regions from VPHAS+ photometry: the g, g-r plane, the u-g, g-r plane, and the the r-$H\alpha$, r-i plane, all expressed in Vega magnitudes. These were identical color selection regions we used to identify the four additional pulsating white dwarfs discovered in the original *Kepler* mission using the KIS Survey (Greiss et al. 2014, MNRAS, 438, 3086; Greiss et al. 2016, MNRAS, submitted), especially the r-$H\alpha$ colors, which are especially sensitive to the broad Balmer absorption lines present in white dwarfs. The solid blue lines show theoretical cooling tracks of white dwarfs of different mass, and the connecting lines show the empirical DAV instability strip, where pulsations are observed. While these are all relatively bright (and thus close) white dwarf candidates, we do not know the extinction towards them in the Galactic plane. The solid red lines are the same as the blue lines but show the effect of increased extinction, in this case $E(B-V) = 0.5$. EPIC 224048262 has the lowest $r - H\alpha$ color and is our highest priority candidate.