K2 Eclipsing White Dwarfs Survey – Campaign #1

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In a binary system, when the primary component evolves beyond the main sequence the orbit changes in ways that are currently poorly understood. Bridging this gap in astrophysical knowledge is critical for the complete understanding of important astrophysical phenomenon, such as SuperNovae, CVs, and substellar objects orbiting stellar remnants.

One way to improve our understanding is to look for eclipsing binary systems with a white dwarf (WD) primary, as such systems are believed to be the progenitors of the objects mentioned above. Due to the properties of a typical WD the orbital period (P_{orb}) can be on the scale of hours, and the eclipsing companion can be a cold and faint object as small as the Earth, showing eclipses that are complete occultations. Such objects include M-type stars, another (second) WD, brown dwarfs, and planets as small as the Earth. The sample of known WD-M-type binaries and double WD binaries is continuously growing, and a few short-period WD-brown dwarf systems have already been detected (e.g., Casewell et al. 2012, ApJ, 759, 34; Beuermann et al. 2013, A&A, 558, 96). Although no planetary-mass companions have been identified yet their existence is supported both observationally (Zuckerman et al. 2010, ApJ, 722, 725) and theoretically (Nordhaus et al. 2010, MNRAS, 408, 631). WDs may even be relevant for the search for planets in potential habitable zones (Agol 2011, ApJL, 731, 25).

We propose to continue our K2 monitoring of WDs, initiated in Campaign 0. Our proposed Campaign 1 long cadence targets are 103 spectroscopically-confirmed SDSS WDs (Kleinman et al. 2013, ApJS, 204, 5) that are on-silicon in Campaign 1, down to a brightness limit of Kepler magnitude K_p=20 mag. This large number of WDs is sufficient for studying the occurrence rate of eclipsing companions.

Our targets are prioritized solely according to brightness, with 16 WDs brighter than K_p=18, and 57 WDs brighter than K_p=19. The remaining 46 WDs are in the K_p=19-20 range and are hence of lower priority. Fig. 1 shows a *realistic* eclipse (complete occultation) detection signal to noise (S/N) vs. P_{orb} for a typical WD (0.01 $R_\odot$, 0.6 $M_\odot$). We used the *Kepler* noise level reported at keplerscience.arc.nasa.gov/CalibrationSN.shtml, degraded by a factor of 4 (according to the estimated K2 noise level), an eclipse duration from Kepler's law, dilution of the short eclipse by the 30 min long cadence exposure, and assuming an 80 day campaign. Fig. 1 left panel shows that eclipses by 0.1 $R_\odot$ objects (size of gas-giant planets, brown dwarfs, and small stars) are detected with a high S/N, so they can be detected even at our brightness limit of K_p=20 mag, and in case of dilution from nearby stars blended within the K2 PSF. For 0.01 $R_\odot$ objects (small, Earth-size planets and another WD, where occultations are shorter) the S/N is >5 up to P_{orb} >100 hours, and over ~10 up to P_{orb}~10 hours, for a K_p<19 mag WD. Therefore, small planets are not expected to be detected around WDs with K_p=19-20 mag. At P_{orb} of a few hours small planets are not expected to exist anyway, due to the strong tidal forces from the WD host.

Follow-up observations, for confirmation and detailed characterization, will be done from facilities the PI has direct access to, including LCOGT Network (Brown et al. 2013, PASP, 125, 1031), and the CHIMERA multi-band fast-photometry camera on the Palomar 5m telescope.

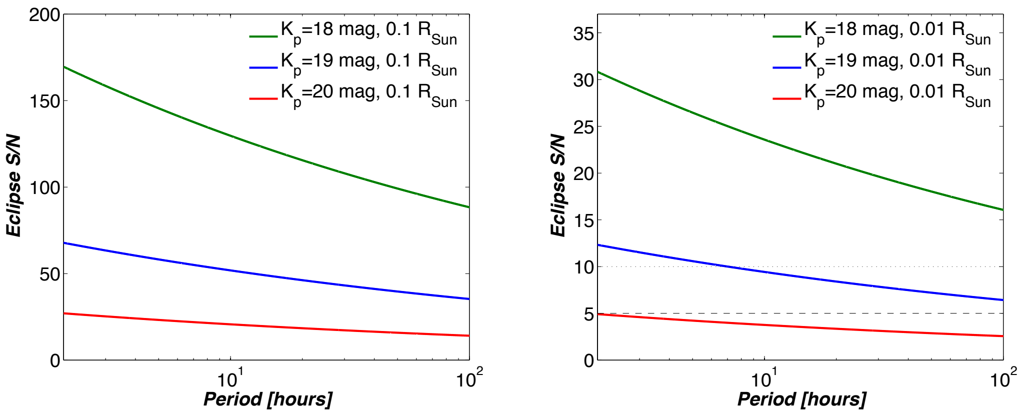

Fig. 1. Eclipse S/N vs. orbital period (log scale, 2 – 100 hours), for WDs with K_p=18 mag (green), K_p=19 mag (blue), and K_p=20 mag (red), assuming an eclipsing companion of 0.1 $R_\odot$ (left) and 0.01 $R_\odot$ (right). In the right panel the dashed black line marks S/N=5 and dotted line S/N=10.