K2 Eclipsing White Dwarfs Survey

Avi Shporer - Sagan Postdoctoral Fellow, JPL

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 essential for the complete understanding of important observed astrophysical phenomenon, including for example, SuperNovae, cataclysmic variables, and substellar objects orbiting stellar remnants.

One way to push forward our understanding is to look for eclipsing binary systems with a white dwarf (WD) primary, since 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 (Maxted et al. 2006, Nature, 442, 543; Littlefair et al. 2006, Science, 314, 1578; Casewell et al. 2012, ApJ, 759, 34). Although no planetary-mass companions have been identified yet their existence is supported 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 habitable zones (Agol 2011, ApJL, 731, 25).

We propose to use K2 to monitor WDs from the spectroscopic SDSS WD catalog (Kleinman et al. 2013, ApJS, 204, 5). A brightness limit of r = 19 mag gives 19 targets (ordered by r mag in attached file) within 12 deg of the Campaign 0 boresight coordinates, and 916 targets for the 10 K2 campaigns. Number of objects that will eventually be on-CCD is smaller, but at least 50% of the above. Therefore, K2 can survey a few hundred WDs, allowing to determine the census of eclipsing WDs using a single survey. Our targets are prioritized solely according to magnitude. Taking a brightness limit of r = 18 mag gives 7 targets for Campaign 0 and 280 for all 10 campaigns. Fig. 1 shows the eclipse (complete occultation) detection signal to noise (S/N) vs. P_{orb} for a typical WD (0.01 $R_\odot$, 0.6 $M_\odot$), using the noise level from *Kepler* (keplerscience.arc.nasa.gov/CalibrationSN.shtml) degraded by a factor of 4, eclipse duration derived using Kepler's law, dilution of the short eclipse by the 30 min long cadence exposure, 80 day campaign. Eclipses by 0.1 $R_\odot$ objects (Jupiter-size planets, brown dwarfs, and small faint stars) is detected with a high S/N, indicating it can be done even in case of dilution from nearby stars blended within the K2 PSF. For 0.01 $R_\odot$ objects (small planets and another WD) the S/N is over 5 up to P_{orb} > 100 hours, and over ~10 up to P_{orb} ~10 hours, for an r = 19 mag target.

Obviously these targets are faint. The quality of the data obtained for the proposed Campaign 0 targets will help guide the K2 mission in future campaigns.

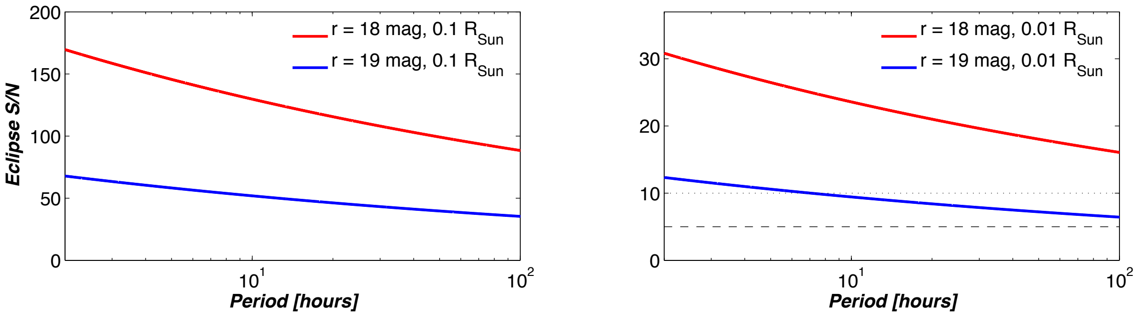

Figure 1. Eclipse S/N vs. orbital period (log scale, 2 – 100 hours), for an r=19 mag (blue lines) and r=18 mag (red lines) target, assuming an eclipsing companion with 0.1 $R_\odot$ (left) and a 0.01 $R_\odot$ (right). In the right panel the dashed black line marks S/N=5 and dotted line S/N=10.