

K2 Exoplanet Ecliptic Survey – KEES

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For billions of years the Earth’s shadow against the Sun has swept a path through space revealing our existence to our stellar neighbors within 0.26° of the ecliptic. Photometric observations of the quality obtained by *Kepler* performed at our ecliptically aligned stellar neighbors can discover the Earth transiting the Sun (Figure 1). We propose to survey all GKM dwarf stars within 0.26° of the ecliptic using the *K2* spacecraft in order to **identify transiting planetary systems that can mutually discover Earth via transit observations performed by another civilization**. This survey will significantly expand the number of ecliptic aligned planets known from the two Jupiter-class planets (WASP-47b – Hellier et al. 2012 ; and the direct imaging discovered 5 Myr old 1RXS-J160929b – Lafrenière et al. 2008) into the regime of Super-Earth size planets. The primary goal is to generate a catalog of planet candidates for prioritizing SETI searches. Secondary goals are to follow up the most favorable candidates for asteroseismic stellar characterization and radial velocity follow up. With *K2* data it will also be possible to search these targets for artificial transiting structures (Arnold 2013) and non-astrophysical time variable signals (Walkowicz et al. 2014).

External observers along the ecliptic can make direct geometrical measurements of the Earth’s radius through transits and asteroseismic determinations of the Sun’s radius (Huber et al. 2013). An accurate and precise radius, coupled with radial velocity and/or astrometry observations, yields an accurate and precise measurement of Earth’s density. Non-ecliptic observers of Earth would have to rely upon challenging (to us currently) interferometric or indirect radius estimate via bolometric flux and albedo estimates (Schneider et al. 2010) making it difficult to confirm the rocky nature of Earth (Rogers & Seager 2010). Thus, we conjecture that external observers along the ecliptic may prioritize communicating with Earth after having confirmed its rocky nature. In addition, SETI followup during secondary eclipse may detect non-thermal or narrow band transmissions emanating from the planet.

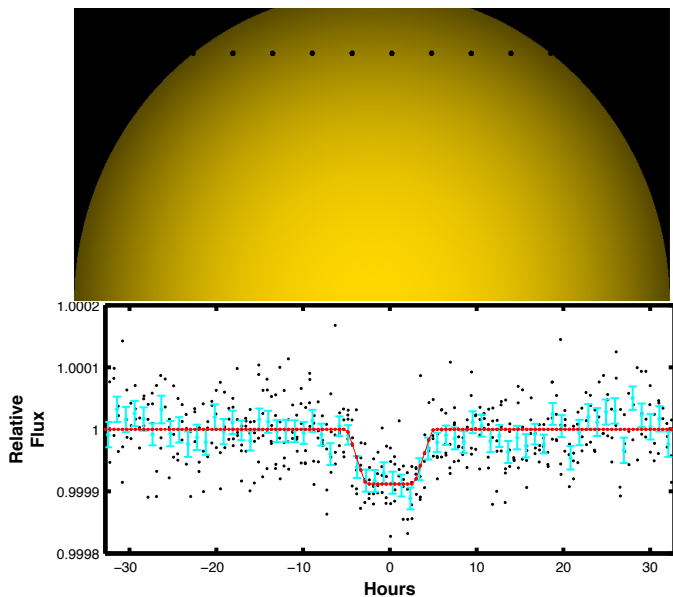


Fig. 1.— A *Kepler*-like spacecraft located at WASP-47 discovering Earth via transit observations. To illustrate the detection, we employ Q1-Q16 *Kepler* observations of KIC 11869975 ($R_\star=1.02 R_\odot$, $T_{\text{eff}}=5802$ K, $\log g=4.40$, $K_p=11.1$ mag; Huber et al. 2014) appropriate for the Sun as seen from WASP-47. Top: Earth transiting the Sun from WASP-47 for impact parameter, $b=0.8$. Bottom: Detrended observations (black points) and model fit (red line) to the $R_p = 1 R_\oplus$ planet signal with $P_{\text{orb}} = 365.25$ day injected into the Q1-Q16 *Kepler* observations of KIC 11866975 resulting in four transits. The transit was injected into the Pre-search Data Conditioning (PDC) data and successfully recovered using the Transiting Planet Search (TPS) algorithm of the *Kepler* pipeline (Tenenbaum et al. 2014).

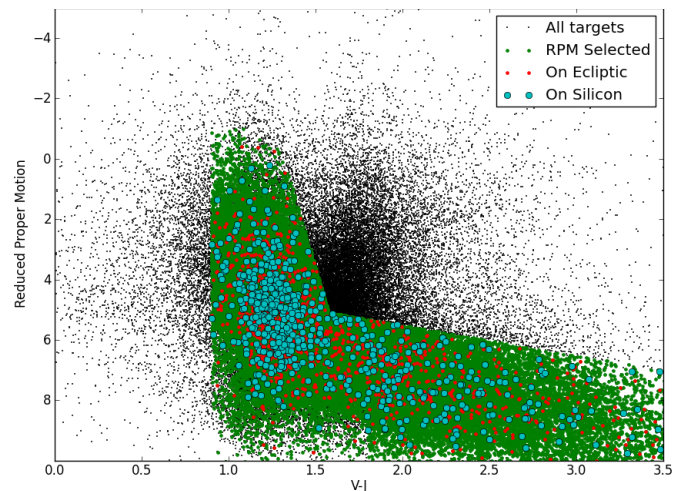


Fig. 2.— Using the EPIC catalog available at MAST we construct a reduced proper motion diagram, using $V - J$ color as a proxy for temperature, and $V + 5 \log \mu$ as a proxy for absolute magnitude (where μ is the total proper motion). After eliminating stars with proper motions measured with less than 2σ significance, we discriminate between giants and main-sequence stars (black and green points, respectively) following Gould & Morgan (2003). Combining Campaign 2 & 3 fields, the total sample is 1519 targets within $\pm 0.26^\circ$ of the ecliptic, brighter than $K_p = 16$, and lie on silicon according to the GO’s K2FOV tool. The target list priority order is based upon the expected transit signal significance using a combination of magnitude and reduced proper motion. If we assume a transit probability of 1% we will detect of order 15 planets in this field, assuming every star hosts exactly one planet.

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