

Using K2 to understand the rocky-gaseous transition

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Summary: We propose to use the Kepler telescope to detect small transiting planets, particularly those orbiting stars amenable to radial velocity (RV) follow-up. To this end we provide a catalog of 37,200 stars in fields 2 and 3, selected by virtue of planet detectability. Our catalog of late F, G and K dwarf stars with bright Kepler magnitudes provides the best targets for both transit searching and follow-up observations.

Target selection: We created a list of the brightest main-sequence stars in fields 2-3. Our starting point was the provisional TESS Dwarf Star Catalog, an all-sky catalog of 3m F5-M5 candidate stars selected from the 2MASS and Tycho-2 after rejecting giants via reduced proper-motion. The catalog provides VIJHK magnitudes and an estimated T_{eff} based on those magnitudes. For K2, we chose stars according to apparent-magnitude limit that varies with effective temperature (a proxy for stellar radius), optimized for planet detectability and follow-up observations (**see Figure 1**). For field 2, we selected 23,500 stars (black dots on the Figure) that lie within the CCDs, and 29,500 more stars that are close to the focal plane (empty dots). For field 3, we selected 13,700 within the CCDs, and 14,000 close to the focal plane.

Target prioritization: The stars are separated into nine priority groups, according to their potential for RV follow-up. We estimate the amount of telescope time required to detect a 10 Earth mass planet with an orbital period of 2 days, based on the estimated stellar mass, and on the estimated RV noise (which increases with the apparent magnitude and the expected width of spectral lines, which in turn depends on effective temperature). The dashed green lines in Figure 1 separate different priority groups. Each successively lower line represents a factor-of-2 increase in telescope time with respect to the next higher line. Within each group, stars are prioritized according to the smallest detectable planet. For each star, we evaluated the potential for transiting-planet detection based on its estimated stellar radius and achievable photometric precision (assumed to be 4 times worse than a star of the same apparent magnitude observed by Kepler). We calculated the radius of the smallest transiting planet that could be detected in a 2-day orbit with $\text{SNR} > 7$. The colored lines in **Figure 1** show the minimum planet radius.

Expected yield: We estimated the yield of K2 if all 37,200 stars are selected, based on the transit-detection rates of the normal Kepler mission. We predict that approximately 100 planet candidates will be detected, of which 70 have radii from 1.75 to 3 Earth radii. We estimate that 5-7 nights of Keck time would be enough to measure the masses of the ten most favorable objects in this size range.

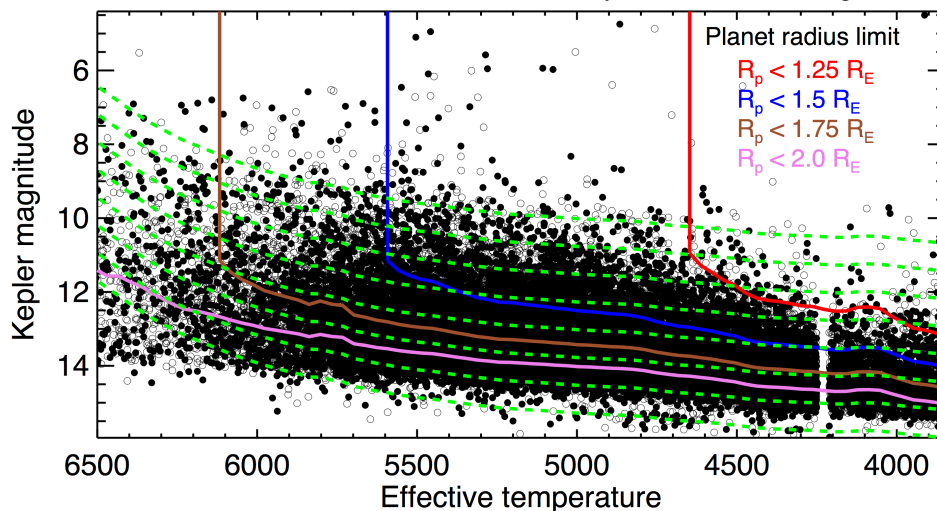


Figure 1. Estimated effective temperatures, and apparent Kepler magnitudes, of the 53,000 stars in our field 2 catalog. Colored lines are approximate thresholds for the detection of transiting planets of various sizes. Dashed lines represent contours for the expected amount of telescope time required for an RV mass determination.