K2 Cycles 2-3: Transiting planets as a part of whole planetary systems

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Summary: I propose that K2 observe stars with extant IR observations of the small-body components of their planetary systems. Planets or transiting dust concentrations discovered by K2 in these systems will benefit from this information, which could play a key role in interpreting their origins. This proposal will eventually span all K2 fields, with of O(500) targets, including particularly interesting young stars in the dusty giant impact phase of terrestrial planet formation.

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Kepler was defined by the ability to discover the lowest-mass planets around main-sequence stars. However, the populations of asteroids and comets (i.e. debris disks) in these systems are too faint at the distance of Kepler stars to allow their discovery with all-sky WISE observations (Kennedy & Wyatt 2012). Therefore, testing for a correlation between the presence of Earth-mass planets and disk brightness (e.g. Raymond et al 2011), or whether known dust populations transit and show signatures of dynamical planet influence (e.g. Stark et al 2013), has not been possible.

K2 provides a key opportunity to detect planets orbiting nearer and younger stars that have already been searched for debris disks (a search that will not be repeated in the far-IR for about a decade). Four examples of valuable science are: **i)** Comparison of star and planet inclination with disk geometry, allowing tests of system-wide alignment and close-in planet origins. **ii)** Dynamical study of disk stability in the face of perturbations from planets, where the possibility of secular (resonant) perturbations means that the planet(s) and dust need not be in close proximity. **iii)** New insight into migration mechanisms; high-eccentricity migration is a popular theory for the origin of some close-in planets, but this process should also scatter/eject small body populations, and thus an anti-correlation between close-in planets and disk brightness might be expected. So far however, the opposite is seen for super-Earth planets and debris disk brightness (Wyatt et al 2012), so further study with K2 will be beneficial. **iv)** The possibility of transiting dust concentrations. Stark et al (2013) searched for these using Kepler data but were unsuccessful. Such a study with K2 using our target stars would benefit from prior dust detections that allow a focus on specifically dusty systems. Further, any transiting dust detection could be interpreted with the advantage of detection of (or limits on) the dust population. This aspect will be particularly important for young stars, which will be observed during the late stages of terrestrial planet formation in K2 fields 2 & 4, when many dusty giant impacts occur (e.g. Earth-Moon system forming events).

Our Cycle 2+3 samples comprise ~400 stars (almost all are young stars for Cycle 2) observed by Spitzer IRAC/MIPS (3-160um) and Herschel PACS (70-160um). While the all-sky WISE mission observed at 3-22um, Spitzer observations at the same wavelengths have higher resolution and typically greater depth, and debris is better detected at longer wavelengths (i.e. 50-160um). We select targets regardless of whether a disk was detected or not, because upper limits on the disk brightness could be as important as detections.

References: Kennedy & Wyatt 2013, MNRAS, 433, 2334 | Raymond et al 2011, A&A, 530, 62 | Stark et al 2013, ApJ, 764, 195 | Wyatt et al 2012, MNRAS, 424, 1206