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Nano Dust as a Possible Cause of Hot Emission in Planetary Debris Disks

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Planetary debris disks are tenuous disks consisting of dust replenished by collisions of leftover planetesimals and cometary activity, events that are driven through gravitational shepherding and stirring by planets. The majority of the disks show warm and cold dust emission in a structure analogous to that of minor body belts in the solar system with asteroid- and/or Kuiper-belt components. Roughly 20–30% of main sequence stars observed interferometrically in the near-infrared (NIR) show extended excess emission that has been attributed to very small ($\lesssim$200 nm) hot dust in the vicinity of the stars. These NIR hot excesses have no obvious correlation with the presence of cold dust measured by far-infrared (Ertel *et al.* 2014). Detailed models on two dozens of such NIR excesses (e.g., Kirchschlager *et al.* 2017) suggest that the NIR excesses are (1) dominated by thermal dust emission from refractory material (amorphous carbon, graphite, or Mg/Fe oxides), (2) with grain sizes less than 200 nm, (3) located within ∼0.01–1 au from the star, depending on its luminosity, and (4) a total dust mass in the range of $(0.2–3.5)\times10^{-9}$ $M_{\oplus}$. Various mechanisms have been proposed to explain the origins of these nanograins, particularly with regard to how they are retained in the presence of strong radiative force around early-type stars. It is unlikely that these NIR excesses arise from in-situ dust emission produced by collosional cascades of parent bodies or transient events as discussed by Kral *et al.* (2017). These nanograins most likely come from the outer part of the planetary system either transported under the influence of Poynting-Robertson drag (Kobayashi *et al.* 2008) and/or scattered by multiple low-mass planets (Bonsor *et al.* 2014) or exterior eccentric planet(s) (Faramaz *et al.* 2017). Due to the radiation pressure, the lifetime of the nanograins is very short (less than days to weeks), requiring a high replenished rate that is difficult to sustain by the transport and delivery hypotheses. Possible mechanisms to prolong the lifetime of nanograins include either interaction with gas (Lebreton *et al.* 2013) or magnetic trapping with a weak stellar magnetic field (Su *et al.* 2013; Rieke *et al.* 2016) similar to the nanograins detected and modeled in the solar system (Czechowski & Mann 2010). Howevre, further refinements on theories and future observations are needed to advance our understanding of this phenomenon.

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