Enormous Accumulation of Hot Dust Grains in the Immediate Vicinity of Main-sequence Stars

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Near-infrared interferometric observations of main-sequence stars have revealed an enormous accumulation of hot dust particles in the vicinity of the stars, irrespective of their spectral types. The vast dust accumulation is, however, not expected, since the size of hot dust particles lies in the submicrometer range where stellar radiation pressure immediately sweeps away the particles from near-stellar environments, A-type stars in particular. One and only mechanism proposed for prolonging the residence time of hot grains in the near-stellar environments is trapping of charged nanoparticles by stellar magnetic fields. The model of magnetic grain trapping predicts that hot dust grains are present in the vicinity of main-sequence stars with high rotation velocities. On the contrary, we find no correlation between the detection of hot dust grains and the rotation velocities of central stars nor their magnetic field strengths. Our numerical evaluation of electric grain charging indicates that the surface potential of submicrometer-sized grains in the vicinity of main-sequence stars is typically 4–5 V, more than one order of magnitude smaller than the value assumed by the model of magnetic grain trapping. On the basis of our numerical simulation on sublimation of dust grains in the vicinity of a star, it turns out that their lives end due to sublimation in a timescale much shorter than the period of one revolution at the gyroradius. It is, therefore, infeasible to dynamically extend the dwell time of hot grains inside the sublimation zone by magnetic trapping and thus some other unrecognized mechanism must be at work. We will present consequences of a dynamical effect that counterbalances the Poynting-Robertson effect in the vicinity of stars and results in an enormous accumulation of hot dust particles at the outer edge of sublimation zone.