# Interstellar Probe Measurements of Dust in Our Heliosphere

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Micron to sub-millimeter sized dust grains are present throughout the solar system as both interplanetary dust (IDP) and interstellar dust particles (ISD). Dust sources include grinding asteroids in the main belt, sputtered KBOs in the EKB, and sublimating comets in both regions, while sinks include solar radiation pressure and evaporation. Despite numerous previous observations over decades, the full shape and structure of the solar system's dust disks are poorly understood because we live inside of them. We especially do not understand the outer disks regions (e.g., how much dust is produced from the EKB nor how that dust migrates through the solar system) since near-Sun cometary contributions dominate near-Earth space and only one spacecraft, New Horizons, has ever flown a dedicated dust counter through the EKB. Compositional information on the makeup of interplanetary dust grains in the outer solar system is also extremely sparse, for the simple reason that when viewed from near 1 au, inner solar system grains obscure much of the signal from outer solar system dust. The ability to map the radial gradient of interplanetary dust grain composition(s) would provide strong constraints on the chemical and isotopic compositions of their parent bodies and in turn, on the formation and evolution of the solar system.

Interstellar dust grains (ISD) from the local galactic environment continuously flow through our solar system after passing through the ISM – heliosphere boundary at the heliosheath & heliopause. Their contribution to the energetics of the boundary layers are estimated to be as much as 1/3 of the total energy in the heliopause. ISDs also erode the surfaces of airless bodies at the outer reaches of our solar system, such as Oort Cloud Comets and Kuiper Belt Objects, thereby contributing to the production of the outer interplanetary dust disk. Each ISD grain also carries critical compositional information, delivering matter that may resemble the original solid building blocks of our solar system. Despite decades of observations and modeling efforts, understanding the ISD flux and its directional variability remains an unfinished and challenging task. *In-situ* measurements of ISD grains taken across a large range of heliocentric distances out past the Kuiper Belt are critical to understand and characterize the flux and composition of ISD, and how the solar system filters and interacts with this material. Despite this, a comprehensive experimental effort to explore the composition and dynamics of interstellar dust particles flowing through our solar system yet to be accomplished.

Using a dust analyzer instrument onboard an Interstellar Probe (ISP) to perform *in situ* dust collection as the spacecraft eits the solar system, we will measure the extent of the inner, near-earth zodiacal cloud; whether it connects smoothly into an outer cloud, or if there is a 2nd outer cloud sourced by the EKB and isolated by the outer planets. in situ sampling will inform about the cloud's local dust particle size and composition while performing the first ever chemical sampling of dust beyond 10 AU. It will help absolutely calibrate 3D cloud models produced by remote ISP VISIR imaging, determine if the dust in the outer system is icy or rocky or both, and help solve the current disconnect between remote imaging models of ISM dust near the Solar System and dust analyzer measurements of ISM dust made from the Ulysses and Cassini spacecraft. It will also carry a dust analyzer for the first time ever into the heliopause and heliosheath, allowing for our first understanding of the role that a dusty plasma could have in the boundary interation regions between our habitable astrosphere and the nearby local galaxy.