Interstellar particles detected by high-power large-aperture radar

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We report the first characterization of interstellar dust and meteoroids as a function of its orbital parameters using plasma data collected by two high-power large-aperture radars, including ALTAIR and the Jicamarco Observatory, during a year-long experiment. We achieve this by measuring the weak plasma called head echoes that form when particles ablate and ionize in our atmosphere. Head echoes move with the parent particle and provide information on the plasma signal strength, 3D position, velocity and deceleration that is achievable through the radar's monopulse and interferometric systems. We use a new Finite Difference Time Domain (FDTD) model, in addition to an analytical scattering model, to correlate measured signal strength with plasma density and particle mass. Through analysis of the ballistic coefficient, we are further able to characterize the bulk density of the dust or meteoroid as a function of its orbital parameters by identifying those particles with eccentricities > 1. Our results indicate that interstellar particles are rare in Earth's atmosphere, comprising less than 5 % of the total detected population, and are also detected at the limit of sensitivity. Interstellar particles also have lower bulk densities than interplanetary particles detected in Earth's atmosphere with masses below 1 microgram.

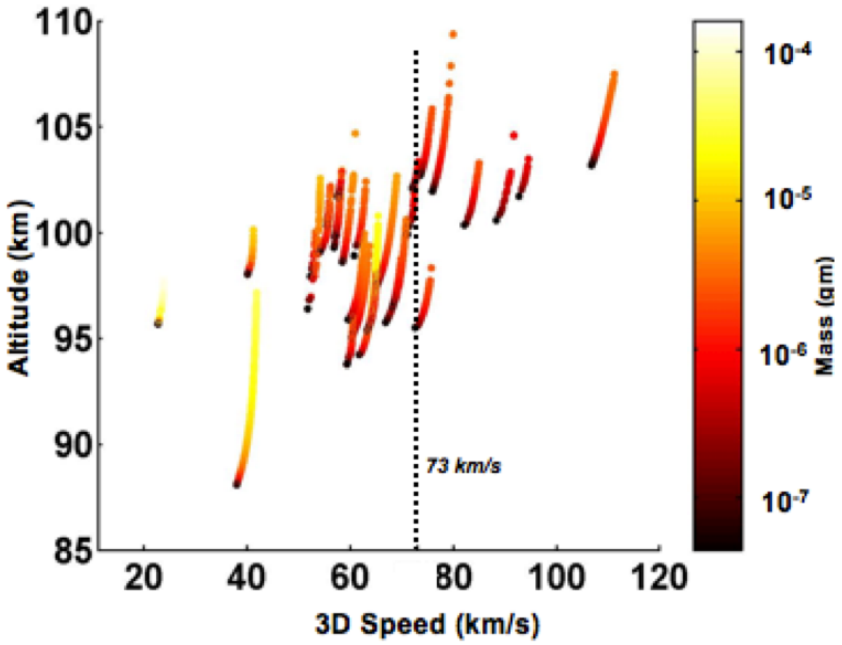

Figure: High-power large-aperture radar data showing individual head echo streaks as a function of altitude and speed, color-coded for particle mass. Interstellar particles were identified by applying orbital analysis to the interferometric data.