Evolution of the Distributions and Composition of Inner-Source Pickup Ions

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Inner source pickup ions originate most likely from the interaction of the solar wind with dust particles in interplanetary space. They are thought to be generated either through saturation of dust with solar wind, subsequent desorption, and pickup, or through penetration of small dust grains by solar wind, neutralization, and subsequent re-ionization. In both cases a velocity distribution emerges, which is genuinely suprathermal, but peaks below the solar wind speed. Using Monte Carlo simulations we investigate the properties of inner-source pickup ions in more detail. We apply experimental results for charge exchange of solar wind ions with carbon foils as a proxy for the interaction of ions with small interplanetary dust grains. As the initial pickup ion distributions we adopt the velocity distribution functions (VDFs) of solar wind particles, with which they exit from the grains. Subsequent pitch angle scattering and cooling will spread the distributions through velocity space. Since the emerging VDFs are narrower than VDFs of pickup ions from interstellar gas or pickup ions desorbed from grains, we also expect a somewhat narrower distribution at the observer location at 1 AU or beyond. The expected abundances of inner-source ions depend strongly on the amount and on the composition of sputtered grains, as well as on the ionization properties of the pickup ions. We will also make another attempt to estimate the production rate of pickup ions and compare our estimate with the observed grain densities.