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Particle Acceleration at Interplanetary Discontinuities

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Interplanetary discontinuities, long-duration Alfvenic fluctuations and transient structures such as shocks, stream interfaces (SIs), and coronal mass ejections (CME's) are considered to be prime candidates for accelerating particles in space and are therefore also responsible for producing the suprathermal particle population. The spectral slope of the phase space density of of the suprathermal particle population has been reported to cluster around v^{-5} but may vary significantly over longer time periods [1]. It is unclear, however, how such as slope is generated and how these interplanetary structures contribute. In a statistical study for the years 2007-2009 we investigate shocks, SIs (alone or combined) as well as CME's with respect to ion acceleration efficiency and the formation of suprathermal tails in the particle distribution. This depends on solar wind plasma conditions (for example, the presence of Alfvenic fluctuations) and on the acceleration process, the shock geometry, and on the intensity of the source population. Pickup helium (He^{+}) is an excellent tracer for interplanetary discontinuities. It is abundant at these plasma discontinuities because it is preferentially accelerated compared to solar wind ions (including He^{+2}). This study shows that all of these discontinuities produce a suprathermal population with varying number density and spectral slope. Depending on the discontinuity/structure type, the solar wind plasma conditions, the data accumulation time, and the location within the discontinuity, the slopes of the suprathermal tails are shown to vary between v^{-3} and v^{-7}. This large range is most likely due to the fact that the plasma at these discontinuities has not yet reached stationary state conditions. This conjecture can be confirmed by measurements and simulated particle distributions.

[1] Gloeckler et al., : AIP Conf. Proc. 1436, 136 (2012); doi: 10.1063/1.4723601