



Contribution ID: 64

Type: Poster

A Field-line Braiding Model for Variable Ion Compositions of solar energetic particle (SEP) events in the inner heliosphere

Tuesday, 25 May 2021 13:00 (40 minutes)

Recent Parker Solar Probe (PSP) observations of several small SEP events show highly variable helium to hydrogen ratios over a factor of ~50 and evidence of variable ion compositions in other species. We use numerical simulations for calculating SEP propagation in a turbulent interplanetary magnetic field with a Kolmogorov power spectrum from large scale down to the gyration scale of energetic particles. We show that when the source regions for different species are offset by a distance comparable to the size of the source region, the observed energetic particle composition He/H can be strongly variable over more than one order of magnitude, even if the source region ratio is at the nominal value. Assuming a nominal $3\text{He}/4\text{He}$ ratio of 10% in small impulsive 3He -rich events and same source offsets, the $3\text{He}/4\text{He}$ ratio can also be quite variable. The variability of the ion composition ratios depends on the source offset, source size, and additional background source. We will discuss the implication of these results to the variability of ion composition of impulsive events and on further PSP and solar orbiter observations close to the Sun.

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Session Classification: Poster session: SQ4 and SQ5

Track Classification: Ion acceleration during impulsive flares