Dependence of Heavy Element Abundances on First Ionization Potential in Small Solar Energetic Particle Events


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Using the Solar Isotope Spectrometer on the Advanced Composition Explorer, we have measured the \(\sim 10-20\) MeV/nucleon heavy (\(Z \geq 6\)) element abundances of \(\sim 30\) small solar energetic particle (SEP) events which occurred between 3 April 1998 and the present. Average O fluxes during the small events were between \(6 \times 10^{-7}\) and \(7 \times 10^{-6}\) (s sr cm\(^2\) MeV/nuc\(^{-1}\)). We have classified the events according to their \(\sim 4.5-5.5\) MeV/nucleon \(^3\)He/\(^4\)He ratios and have compared their average heavy element composition with that of past studies, obtaining good agreement. We have also examined each SEP event for a dependence of abundances relative to those of the solar photosphere on first ionization potential (FIP). We find a statistically significant FIP effect in virtually all of the small SEP events, including those which are \(^3\)He-rich and have heavy element abundances typical of impulsive SEP events. This research was supported by NASA at Caltech (under grant NAG5-6912), JPL, and GSFC.