



## **Physical Modelling of Proton Energy Spectra in Large SEP Events**

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Large gradual SEP events are the main cause of radiation damage to spacecraft in interplanetary orbits. The consensus model for their origin is shock acceleration in fast CME-driven coronal and interplanetary shocks. However, the observed fluence spectra in the largest events are often showing features that are difficult to understand in terms regular diffusive shock acceleration (DSA). In particular, fluences of Ground Level Enhancements (GLEs) of cosmic rays show steep power-law spectra (Tylka & Dietrich 2009) in rigidity from below 1 GV up to above 10 GV in the largest events, which indicates that these spectra are incompatible with exponential or super-exponential roll-overs predicted by standard DSA. We have studied a model, where the shock-accelerated spectrum of protons is modified by self-consistent stochastic acceleration downstream of the shock. The results are compatible with steep power-law spectra at the highest energies. We will discuss the implications of these findings to the requirements of physical modelling of large gradual SEP events.