

SEP events with >40 MeV proton intensities above the “streaming limit” intensity

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Large solar energetic particle (SEP) events constitute a serious radiation hazard to astronauts on deep space missions such as those to the Moon or Mars. It is essential to determine the highest intensities reached during large SEP events, especially at energies that pose serious risks to human health and spacecraft performance (e.g., protons above ~40 MeV). It has been argued that the highest particle intensities measured during large SEP events occur in association with the passage of shocks driven by coronal mass ejections (CMEs); whereas the intensities measured early in the SEP events (i.e., the prompt components) are bounded by a maximum-intensity plateau that results from wave-particle interactions that restrict the free streaming of particles (also called the “streaming limit”). We analyze the highest intensities measured by the GOES spacecraft during the last 20 years to examine whether the highest intensities are measured during the prompt component of the SEP events or during the energetic storm particle (ESP) events. We find three [two] events in which the highest 39-82 MeV [110-500 MeV] proton intensities measured during the prompt component of the SEP events exceed the previously determined “streaming limit” intensity. Arguments to explain the exceeding of this limit during these SEP events invoke either interplanetary conditions that inhibit the amplification of waves resonating with the streaming particles, or the presence of interplanetary structures able to confine and/or mirror energetic particles.

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