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Non-Extensive Statistical Analysis of Energetic Particle Flux Enhancements Caused by the Interplanetary Coronal Mass Ejection - Heliospheric Current Sheet Interaction

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We present results concerning properties of acceleration of energetic particles associated with the dynamics of regions filled with small-scale magnetic islands (SMIs) with a typical size of ∼0.01-0.001 AU at 1 AU. We study the energetic particle non-extensive fractional acceleration mechanism producing kappa distributions and the intermittent turbulence mechanism producing multifractal structures related with the Tsallis q-entropy principle. We analyze ∼0.5 MeV ion time-intensity profiles observed by the STEREO A spacecraft during a rare, widely discussed event. In order to understand the properties of energetic particles and the particle acceleration mechanism, the statistical characteristics are obtained and the results refer to the estimation of the Tsallis q-triplet, $(q_{sen}\,,\ q_{stat}\,,\ q_{rel})$. The study reveals significant differences in statistical and dynamical features between the periods identified, indicating an important differentiation in the energetic ion intensities in terms of changes of the entropy production, relaxation dynamics and meta-equilibrium stationary states. A significant difference was found in the q-triplet parameters of the dynamical system between the quite region and the energetic particle flux enhancement regions. This finding reveals the relation of energetic particle enhancement and fractional acceleration processes with the topological phase transition process to the self-organized plasma instabilities states corresponding to meta-equilibrium stationary states.