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

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In this study we use theoretical concepts and computational-diagnostic tools of Tsallis non-extensive statistical theory (Tsallis q-triplet: qsen, qrel, qstat), complemented by other known tools of nonlinear dynamics such as Correlation Dimension and surrogate data, Hurst exponent, Flatness coefficient, and p-modeling of multifractality, in order to describe and understand Small-scale Magnetic Islands (SMIs) structures observed in Solar Wind (SW) with a typical size of \~0.01–0.001 AU at 1 AU. Specifically, we analyze \~0.5 MeV energetic ion time-intensity and magnetic field profiles observed by the STEREO A spacecraft during a rare, widely discussed event. Our analysis clearly reveals the non-extensive character of SW space plasmas during the periods of SMIs events, as well as significant physical complex phenomena in accordance with nonlinear dynamics and complexity theory. As our analysis also shows, a non-equilibrium phase transition parallel with self-organization processes, including the reduction of dimensionality and development of long-range correlations in connection with anomalous discussion and fractional acceleration processes can be observed during SMIs events.