Applying Non-Extensive Entropy Definition to Turbulent Collisionless Plasmas—a Feasibility Study

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Entropy is commonly considered to be one of the quantities for measuring disorder in a system. According to the second law of thermodynamics, on a global scale entropy can only increase as the system evolves, and a number of processes such as turbulence can contribute to its growth. There are several definitions for entropy of which Gibbs-Boltzmann (GB) is the most commonly used. However, a generalised entropy definition—Tsallis q-entropy—seems better suited for describing space plasmas. Its theoretical formulation involves a free parameter (entropic index q) characterising the the degree of non-extensivity, or non-locality, of the system. In other words, the system can have long range interactions and memory effects. Moreover, while GB entropy produces a Maxwellian distribution in velocity space when applied to particles, the equilibrium distribution for Tsallis entropy is a long-tailed kappa distribution similar to the ones observed, e.g., in the solar wind. We present a feasibility study on using statistical tools to estimate q from proton and electron distribution data measured by the Wind satellite. We also address the question of applying q-entropy to the magnetic field in order to describe the coupled system of field and fluid.