Fractional Transport in Strongly Turbulent Plasmas

H. Isliker, and L. Vlahos

Department of Physics, Aristotle University of Thessaloniki, Thessaloniki 54124, Greece

We analyze statistically the energization of particles in a large-scale environment of strong turbulence that is fragmented into a large number of distributed current filaments. The turbulent environment is generated through strongly perturbed, 3D, resistive MHD simulations, and it emerges naturally from the nonlinear evolution, without a specific reconnection geometry being set up. Based on test-particle simulations, we estimate the transport coefficients in energy space for use in the classical Fokker-Planck (FP) equation, and we show that the latter fails to reproduce the simulation results. The reason is that transport in energy space is highly anomalous (strange), the particles perform Levy flights, and the energy distributions show extended power-law tails. Newly then, we motivate the use and derive the specific form of a fractional transport equation (FTE), we determine its parameters and the order of the fractional derivatives from the simulation data, and we show that the FTE is able to reproduce the high energy part of the simulation data very well. The procedure for determining the FTE parameters also makes clear that it is the analysis of the simulation data that allows to make the decision whether a classical FP or a FTE is appropriate.