Anomalous convection diffusion model of cosmic rays

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Transport of cosmic rays (energetic particles) in a turbulence field remains to be an important issue, both from astrophysical and nonlinear science points of view. In particular, it is known that the transport in a plasma with large amplitude MHD turbulence can exhibit properties of non-gaussian statistics. A natural formalism to model such anomalous transport processes is the fractional diffusion equation, in which the time and/or spatial derivative contain fractional differentiation operators. After briefly introducing the idea of the fractional differentiation/integration operators and numerical methods, we discuss the diffusive shock acceleration process by solving numerically the fractional convection diffusion equation. The results will be compared with those obtained by test particle simulations using sub- and super- diffusive particles. Possible applications of the present model to other high-energy astrophysical phenomena will be discussed as well.

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