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4. High energy cosmic rays (HE-CR I)

Compound model of CR-diffusion: a fractional approach

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Cosmic ray transport process is considered in framework of the compound diffusion model, assuming decomposition of the process into the longitudinal (random motion along a magnetic force line) and transversal (motion with the force line, performing random walk in space). Originally, both these motions were considered as normal Gaussian processes. Nowadays, there exist some reasons to refuse the simple models and pass to more realistic models including finite velocity of free motion and multiscale (fractal) character of interstellar magnetic fields. The new (fractional) approach interprets the longitudinal component as a one-dimensional asymmetric walk of a particle with a finite constant speed and alpha-type asymptotic of the free path distribution. The corresponding integral equation becomes in long-time asymptotics a differential equation including material derivative of fractional operator.

The perpendicular component is conctructed by involving exponential truncation of free path distribution and coupling collision points with perpendicular displacement events. Analytic investigation shows that this model reveals different behavior in various time domains: we observe the superdiffusion in the parallel direction and subdiffusion in the perpendicular one in the intermediate time region, meanwhile the long-time asymptotics of the process is characterized by the normal regimes of both components. The numerical results are compared with those of other authors and the reasons of discrepancy are discussed.