Geophysical Research Abstracts, Vol. 7, 03738, 2005
SRef-ID: 1607-7962/gra/EGU05-A-03738

Particle transport in composite magnetic field turbulence: vortices and random disturbances.

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Energetic particle transport in a composite magnetic field turbulence is studied. The turbulence is modeled by regular and chaotic components: coherent nonlinear structures and a strongly fluctuating magnetic field superimposed on a background field. The structures are represented by two-dimensional vortices. The fluctuating field has a power-law spectrum and random phases for different wavenumbers. Particle dynamics is studied numerically in detail. Diffusion coefficients are computed by averaging over an ensemble of particles. We study properties of the particular diffusion regimes (subdiffusion, superdiffusion, classical diffusion) for different values of control parameters. These parameters are determined by the ratio between amplitudes of a random component and a regular field, and the ratio between an average particle gyroradius and a magnetic field correlation length. It is shown that anomalous diffusion occurs when the correlation length of the magnetic field disturbances is about the same or larger than the particle gyroradius. The result does not depend on the nature of the major component of the turbulence. The role of the Kubo parameter is studied. Application to cosmic ray transport in the heliosphere is discussed.