FIELD LINE RANDOM WALK FOR NON-AXISYMMETRIC MAGNETIC FLUCTUATIONS

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The random walk of magnetic field lines in non-axisymmetric 2D+slab turbulence is relevant to the solar modulation of galactic cosmic rays and particle acceleration at a nearly perpendicular shock. Assuming homogeneous turbulence, a diffusive (Gaussian) random walk, and Corrsin's hypothesis, we derive non-perturbative, analytic formulae for any distance along the mean field direction, allowing us to determine where the Gaussian approximation breaks down. The two coupled, quadratic equations for x- and y-diffusion coefficients are evaluated in various limits. For a fixed ratio of 2D to slab turbulent energy, equal x-y anisotropies of the two components, and equal correlation lengths for Bx and By in slab turbulence, we find that the 2D turbulence dominates the field line random walk for extreme anisotropy. A surprising result is that for very anisotropic slab turbulence, the diffusion coefficient in the direction of weak slab turbulence falls below the value for 2D turbulence alone.
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