FIELD LINE SEPARATION IN TWO-COMPONENT MAGNETIC TURBULENCE

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We consider the diffusive separation of magnetic field lines for 2D· turbulence, which is known to serve as a reasonable model of the solar wind. In our model, we assume the turbulence is homogeneous, the separation is diffusive (Gaussian), and Corrsin's hypothesis holds. We derive a non-perturbative formula for any distance along the mean field direction, allowing us to determine where the Gaussian approximation breaks down. If the random walk of magnetic field lines is diffusive and dominated by the 2D contribution, then field line separation occurs with twice the 2D contribution to the single field line random walk coefficient (fast diffusive separation). If, on the other hand, the slab contribution is dominant, we instead predict two regimes of field line separation: fast diffusive separation at long distances, and at shorter distances, a regime of slow diffusive separation with a rate determined by the autocorrelation of the flux function for 2D turbulence at the initial field line separation. We predict supradiffusive separation in between the two regimes. In the solar wind, it is believed that the 2D contribution dominates, leading to fast diffusive separation. This suggests that recent ACE observations of sharp boundaries between regions of high and low density of solar energetic particles will require an alternative explanation, such as non-homogeneous turbulence.

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