Investigation of kinetic dynamos driven by non-Gaussian, non-Markovian velocity fluctuations using meshless, Lagrangian numerical schemes

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Velocity fluctuations generate perturbations of the electric current and magnetic field that, under certain conditions, may generate an average, large-scale magnetic field. Such dynamo generation is important to understand the behavior of stars, planetary and laboratory plasmas. Kinematic dynamos are traditionally studied by assuming near-Gaussian, random velocity fluctuations that do not evolve self-consistently with the field evolution. This simplification allows to express the effective electromotive force appearing in Faraday's law in terms of a piece proportional to the large-scale magnetic field itself (the α-term) and another proportional to its curl (the β term), after having assumed that certain conditions are met. Physically, the α coefficient is a measure of the mean helicity of the turbulent flow, and is the one that drives the dynamo process. The β coefficient represents an enhanced magnetic diffusivity. In this contribution, we will discuss what new process might follow from assuming instead that Levy-distributed, Langrangian-correlated velocity fields drive the dynamo. These type of fluctuations have been previously identified as of relevance in regimes of near-marginal turbulence or in the presence of a strong, stable sheared flow. The (α, β) picture ceases to be valid in this situation, and new dynamo generation regimes become possible. The study has been carried out after implementing the kinematic dynamo equation using a Lagrangian, meshless numerical method inspired by the Smooth-Particle Hydrodynamics (SPH) schemes frequently used in hydrodynamics.