Magnetic reconnection in three-dimensional quasi-helical pinches

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Abstract:

This paper deals with the phenomenology of magnetic reconnection during reversed-field pinch helical self-organization. Numerical results obtained by solving a three-dimensional nonlinear visco-resistive fluid model to describe the hot current-carrying plasma are summarized. Magnetic reconnection manifests itself during the plasma dynamics, interrupting the persistence of quasi-helical states. The main signatures of magnetic reconnection in reversed-field pinches are discussed: partial conversion of magnetic into kinetic energy, current sheet formation, steepening of plasma current profiles, locking of the angular phases between different Fourier components of the magnetic field. The latter is recognized as the three-dimensional trigger of the reconnection events. Then the paper deals with the temporal scales of the process: low visco-resistive dissipation in the model, corresponding to high plasma current in the experiments, results in longer characteristic time between reconnection events. Furthermore, it is confirmed that the scaling of the reconnection rate is compatible with a modified Sweet-Parker model. A discussion of magnetic reconnection during the 2D simplified tokamak internal kink mode evolution, showing the development of secondary tearing instabilities, is presented and the similarities with RFP evolution are highlighted.