Formation of Plasmoid Chains due to Resonant Magnetic Perturbations

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Recent studies have shown that the current sheets that typically characterize magnetic reconnection processes can be unstable to the formation of a large wavenumber chain of secondary islands, generally called plasmoids [1]. This phenomenon has fundamental importance since it leads to a novel nonlinear regime that allows for a large increase of the magnetic reconnection rate [2,3]. Here we present new results on the formation of plasmoid chains due to resonant magnetic perturbations, which can drive magnetic reconnection in laboratory fusion plasmas even if the equilibrium is tearing-stable. By considering a fundamental problem of forced magnetic reconnection, the so called Taylor problem [4], in which magnetic reconnection is driven by a small amplitude boundary perturbation in a tearing-stable slab equilibrium, we have derived an expression for the threshold perturbation amplitude required to trigger the development of plasmoids [5]. We have also derived an analytical expression for the reconnection rate in the plasmoid-dominated regime [5]. These analytical calculations are complemented by visco-resistive magnetohydrodynamic simulations, which confirm the analytical predictions [5,6]. The plasmoid formation may play a crucial role in allowing fast reconnection in laboratory fusion plasmas, and these results suggest that it may occur and have profound consequences even if the plasma is tearing-stable.

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