Role of Inertial and Inductive Modes in Magnetic Reconnection Events

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Recently, an accurate analysis of the database of magnetic island rotation with the JET machine [1] has revealed that, in the frame of zero radial electric field, the island rotation frequency is about $0.9\omega_{di}$, where ω_{di} is the ion diamagnetic frequency. The drift-tearing mode theory of reconnection in low collisionality regimes predicts a phase velocity in the opposite direction [2] and, under strictly collisionless conditions, stablity in the presence of electron temperature gradients [3]. To explain the observations, a "mode inductivity" $\mathcal{L}_{\|} \equiv (4\pi/c^2)S_L$ has been introduced [4] whose effects replace those of finite resistivity. This has lead to a linear instability [5] with ω close to ω_{di}. The reconnection layer thickness is proportional to the inductivity [4] and the mode has a dissipative growth rate. When considering plasmas with ultrarelativistic energies, the inertial skin depth c/ω_{pe} becomes significant. However, if c^2/ω_{pe}^2 is the only contribution to S_L, the class of reconnecting modes that must be considered are those close to ideal MHD marginal stability [6]. In this case the width of the reconnection layer is of the order of the inertial skin depth and can be considered as relevant to realistic theories.

References

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