New Magnetic Field Topologies and Amplification by Local Depletion of Electron Thermal Energy

A. Fletcher[1,2] and B. Coppi[1]
[1]MIT and [2]Boston University

The conventional theory of magnetic reconnection by the tearing mode in weakly collisional and collisionless plasmas involve characteristic length scales that are unrealistically small for space plasmas. This fact motivates the search for modes that produce magnetic reconnection over microscopic scale distances that remain significant when large macroscopic scale distances are considered. Modes producing magnetic reconnection that are driven by an electron temperature gradient can have this desired property [1].

We refer in particular to a neutral sheet configuration such as was considered in Ref. [2] where the first theory around substorms induced by magnetic reconnection processes occurring in the Earth's magnetotail. A new kind of mode that is localized within the region where reconnection takes place is found with an exact analytical solution of the equation describing the reconnected field. The topology of this is different from that of the well known drift-tearing type of modes and consists of two parallel strings of magnetic islands.

The mode is of the oscillatory kind with a characteristic phase velocity. This is another feature that makes it different from the purely growing tearing modes. The new mode is found for weakly collisional regimes where the evolution of the perpendicular temperature differs from that of the parallel (to the unperturbed magnetic field) temperature. This kind of mode lends itself to generate relatively small populations of high energy particles, through an appropriate sequence of mode-particle resonance processes, rather than converting magnetic energy into particle kinetic energy on a large scale. Sponsored in part by the U.S. DOE.

[1] B.Coppi, *Plasma Physics Reports*, **42**, No. 5, 383 (2016).
[2] B. Coppi, G. Laval and R. Pellat, Phys. Rev. Letters, **16**, 1207 (1966).