# Unconventional Roles of Novel Magnetic Reconnection Processes

B. Coppi and B. Basu
MIT

The most frequent adopted theories of reconnection have been based on a one-fluid description of plasmas with a finite electrical resistivity. This description is definitely inadequate for the collisionless or weakly collisional plasma regimes that characterize space plasmas or the well confined high temperature plasmas produced recently for fusion research.

In these cases, the onset of the magnetic reconnection is described by modes that are not purely growing as those found by purely resistive theories, are oscillatory and propagating in characteristic directions. Another significant finding is that new kinds of mode in this category can involve widths of the layers in which reconnection takes place that remain significant even when large macroscopic distances, such as those of interest to space and astrophysics, are involved.

In particular, a nearly collisionless mode is found when the evolutions of the electron transverse (to the magnetic field) temperature and that of the longitudinal electron temperature are different. The mode is radially localized within the region where magnetic reconnection takes place and produces a double string of magnetic islands. An exact analytic solution of the reconnected field equation is found as no "outer" asymptotic region [1] needs to be considered.

For the onset of this mode a reservoir of electron thermal energy and an inhomogeneous distribution of it is required. In fact, modes of this kind are suitable to create small high energy particle populations by an appropriate sequence of mode-particle resonance processes. In addition, they are shown to acquire momentum in their propagation direction and when considering toroidal configurations from which these modes can emerge they can be suitable for producing a local [2] spontaneous rotation of the plasma column. Sponsored in part by the U.S. DOE.

[1] B. Coppi, *Plasma Phys. Reports*, **42**, 5, 383, 2016.

[2] B. Coppi and T. Zhou, *Nucl. Fusion* **54**, 093001, 2014.