DPP06-2006-000877

Abstract for an Invited Paper
for the DPP06 Meeting of
the American Physical Society

Magnetic Reconnection : Collisionless Dynamics and Three-Dimensional Geometry[1]

AMITAVA BHATTACHARJEE, Center for Magnetic Self-Organization and Space Science Center, University of New Hampshire

Magnetic reconnection is a ubiquitous mechanism for self-organization, and is the engine that drives near-explosive topological relaxation of plasmas. In the last fifteen years, major advances have been made on two fronts: fast reconnection in collisionless systems and three-dimensional reconnection. These major advances are the result of discoveries from fusion and other laboratory experiments (discussed in a companion tutorial by M. Yamada), satellite observations of magnetospheric and interplanetary plasmas, X-ray images of the Sun, and computer simulations based on two-fluid and kinetic models. Despite the enormous range of plasma parameters and boundary conditions in these systems, unifying themes have emerged. Fast collisionless reconnection is governed by a generalized Ohms law, which includes the effects of finite particle inertia, Hall current, and electron pressure tensor. The rate of reconnection can be fast. Furthermore, it often exhibits an impulsive phase when the reconnection rate changes suddenly, seen during sawtooth crashes in tokamaks and reversed-field pinches, magnetotail substorms, and eruptive flares. Theoretical models of reconnection can now account for some important features of these impulsive dynamics, but open questions remain. Unlike toroidal devices where reconnection occurs near closed field-lines, reconnection in space plasmas (and some laboratory experiments) occurs often in a web of magnetic nulls, and even in line-tied systems where there are neither closed field lines nor nulls. This review talk will discuss the present status in experiment and theory, drawing on results from laboratory and astrophysical plasmas, identify outstanding issues for future research, and prospects for future experiments.

[1]This research is supported by the DOE, NSF, and NASA.