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Dependence of the initial plasma beta on the structure of the reconnection exhaust

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One of the most important problems on magnetic reconnection has been in the point that how fast reconnection occurs even in the situation with high magnetic Reynolds number. In order to explain this problem, for example, two pairs of slow-mode shocks attached to the localized diffusion region [e.g., Petschek, 1964], the Hall effect [e.g., Birn, et al., 2001], and the existence of turbulence [e.g., Matthaeus and Lamkin, 1986] have been discussed. Recently, some authors advocated fast reconnection theories from the viewpoint of MHD turbulence [e.g., Lazarian and Vishniac, 1999; Yokoi and Hoshino, 2011], and the turbulence magnetic reconnection is the hotly-debated issue not only in terms of the reconnection problem itself but also in many astrophysical phenomena (e.g., Magneto rotational instability in the accretion disk, whose saturation level is supposed to be controlled by magnetic reconnection in turbulent structures [e.g., Sano, et al., 2004]).

We focus on turbulence in magnetic reconnection, and, especially in this study, self-generation of turbulence in “collisionless” magnetic reconnection is investigated by using a two-dimensional electromagnetic hybrid code. We suggest that whether or not reconnection exhausts become turbulent or laminar strongly depends on the ion plasma beta in the initial inflow region. In order to clarify this, we present some simulation results, where the plasma beta in the initial inflow region is controlled by varying the ion temperature with Alfven velocity constant. Results show that the turbulent reconnection exhaust is observed with $b_{i0}<0.1$, where b_{i0} is the initial ion plasma beta in the inflow region, while the reconnection exhaust becomes laminar in the range of $b_{i0}>0.1$. In addition, reconnected magnetic flux increases as the initial ion plasma beta becomes smaller. It is also suggested that such turbulence in low beta plasmas is associated with electromagnetic waves generated in the plasma sheet boundary layer (PSBL) rather than the central plasma sheet. In this presentation, we mainly discuss why such turbulent structures appear only in the low beta plasma with attention to the property of waves generated in the PSBL.

Keywords: reconnection, turbulence, laminar flow, hybrid simulation, kinematics, ion temperature