Dynamical Petscheck Reconnection

Kusano, Kanya (1), kusano@nagoya-u.jp; Takashi Nakabo (1); Takuya Shibayama (1); Takahiro Miyoshi (2); and Grigory Vekstein (3).
(1) Solar-Terrestrial Environment Laboratory, Nagoya University, Nagoya, Japan
(2) Graduate School of Science, Hiroshima University, Japan
(3) The University of Manchester, Manchester, UK

Magnetic reconnection is the major mechanism for explosive energy liberation in the various plasmas. However, the mechanism of fast reconnection in high magnetic Reynolds number (S) plasmas is still unclear. While Petscheck (1964) proposed the fast reconnection model driven by slow mode shock, the previous studies suggested that the Petscheck-type reconnection is not stable in uniform resistivity and some anomalous resistivity or non-MHD effects are needed for fast reconnection.

In this paper, we developed the high-resolution magnetohydrodynamics (MHD) simulation of magnetic reconnection for the high-S (S~10^4-10^6) regime aiming at revealing the acceleration mechanism of magnetic reconnection in the MHD regime of uniform resistivity. As a result, we found that a new type of fast reconnection appears after the secondary tearing mode instability grows. When the width of magnetic island formed by the secondary tearing mode instability becomes large enough, the electric current sheets between some particular magnetic islands bifurcate to V-shape current layers. The reconnection at the apex of bifurcated current layers is preferentially accelerated, because the bifurcated current layers create slow mode shocks. The slow mode shocks are repeatedly created and dissolved corresponding to the formation and transportation of plasmoids. These results indicate that, even though resistivity is uniform, when the magnetic Reynolds number is high enough, the multiple X-line reconnection of Sweet-Parker current sheets (plasmoid reconnection) is switched to a new regime called “dynamical Petschek reconnection”.