Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM26-05 Room:302 Time:May 24 10:00-10:15

Dynamical Petschek Reconnection: New Mechanism of Fast Magnetic Reconnection

SHIBAYAMA, Takuya[1*] ; KUSANO, Kanya[1] ; MIYOSHI, Takahiro[2] ; NAKABOU, Takashi[1] ; VEKSTEIN, Grigory[3]

[1]Solar-Terrestrial Environment Laboratory, Nagoya University, [2]Hiroshima University, [3]University of Mancheter

Magnetic reconnection is a process to change the connectivity of magnetic field lines and thought to play a core role for explosive energy conversion from magnetic energy to kinetic and thermal energies during solar flare, magnetospheric substorm, and tokamak disruption. However, electric conductivity in the solar corona, where solar flares occur, is quite large. According to the Sweet-Parker theory, it is difficult to conduct magnetic reconnection efficiently in such highly conductive field. Petschek proposed another reconnection theory, in which small magnetic diffusion region realizes effective reconnection even in the solar corona. Magnetic energy is converted to thermal and kinetic energy in slow mode MHD shocks. Recent numerical simulations, however, suggest that Petschek reconnection is not stable in a system of spatially uniform resistivity. Some mechanism such as anomalous resistivity is needed to sustain the local diffusion region. It is, therefor, not elucidated yet that Petschek reconnection occurs spontaneously.

We perform resistive MHD simulation in a large system with a high spatial resolution and find slow mode MHD shocks, which are predicted by Petschek, spontaneously form even with the uniform resistivity. In this process, fast motion of large plasmoids in the current sheet play an important role and slow mode shocks form in front of moving plasmodia (fig1). This process exceeds magnetic reconnection intermittently and repeatedly because plasmoids are ejected and form repeatedly. This process enhances reconnection and achieve normalized reconnection rate of 0.01, which is necessary to explain the time scale of solar flares (fig2).

We name this fast reconnection regime 'Dynamical Petschek Reconnection'. In this regime, microscopic physics or anomalous resistivity is not necessary and only uniform resistivity is enough to realize fast reconnection. Motion of plasmoid affect the surrounding plasma flow and this flow play a role to localize electric current. As a consequence, slow mode MHD shocks, which are predicted by Petschek, form spontaneously and energy conversion occurs efficiently.

Keywords: Magnetic reconnection, Solar flare

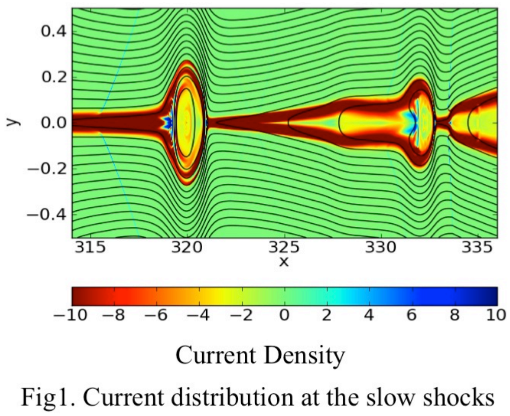

Fig1. Current distribution at the slow shocks

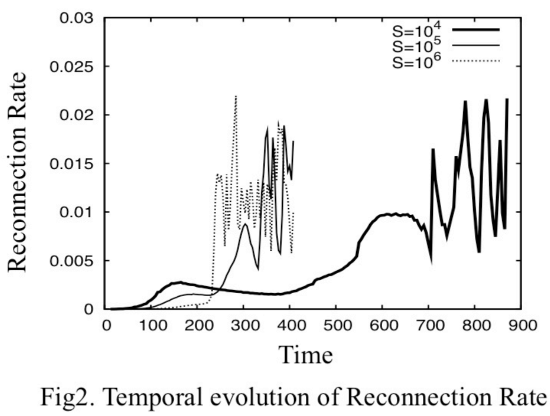

Fig2. Temporal evolution of Reconnection Rate