Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM026-11 Room:101 Time:May 24 17:00-17:15

Can slow-mode shocks be really formed in collision-less magnetic reconnection?

Katsuaki Higashimori[1*], Masahiro Hoshino[1]

[1]Tokyo Univ, Earth & Planetary Science

The issue that whether or not slow-mode shocks are formed in magnetic reconnection has been one of long-standing problems in space physics since Petschek [1964] proposed his idea that most energy conversion from the magnetic field to plasmas can be achieved by two pairs of slow shocks attached to the central diffusion region. Until now, both observations and MHD simulations have confirmed the existence of slow shocks in magnetic reconnection. However, none of kinetic simulations, like hybrid and particle-in-cell simulations, have shown the efficient dissipation of the magnetic field along reconnection layers, which is the strong evidence of slow shocks.

We suggest that the causality, which prevents slow shocks from being formed in collision-less plasmas, is the ion temperature anisotropy enhanced at the downstream region of the reconnection layer. Many preceding studies (both observations and simulations) have shown that such temperature anisotropy is due to the relative bulk velocity between cold ions convected from two lobes and PSBL (Plasma Sheet Boundary Layer) beam ions. Thus, the ion temperature parallel to the magnetic field ($T_{i,para}$) is usually higher than that perpendicular to the magnetic field ($T_{i,perp}$). On the other hand, according to the MHD Rankine-Hugoniot (RH) theory in anisotropic plasmas, it is known that as the temperature anisotropy, $T_{i,para}/T_{i,perp}$, becomes large, slow shocks cease to exist especially within low upstream Alfven Mach numbers.

Until now, by using an electromagnetic hybrid code, we showed that such temperature anisotropy relaxes with increasing the distance from the magnetic neutral point and made a prediction that slow shocks will be formed at about 150-200 ion inertial lengths from the neutral point. Then, we perform a large scale simulation enough to answer the suggestion. Our simulation results, for the first time, show the sharp bentness of magnetic field lines and the two-way current, which indicate the existence of slow shocks in collision-less magnetic reconnection. In this presentation, we will discuss the discontinuity formed along the reconnection layer in terms of MHD RH relations in anisotropic plasmas and, then, reveal the structure of the discontinuity in ion inertial scales.

Keywords: reconnection, shock, slow shock, temperature anisotropy, hybrid, reconnection layer