

An MHD Simulation on Nonlinear Evolution of Ballooning Instability in the Earth's Magnetotail

Yasuto Kajiwara[1]; Seiichiro Nii[2]; Tatsuki Ogino[1]

[1] STEL, Nagoya Univ.; [2] STE Laboratory, Nagoya Univ

Ballooning instability is one of the potential models as a trigger mechanism of substorms. Because of the ballooning instability, irregular structure of plasma locally grows in perpendicular direction to the magnetic field line and gradient of plasma pressure in near-Earth tail. Due to the plasma structure, cross-tail currents are suppressed and change to field-aligned currents. Then a substorm occurs when a part of field-aligned currents flows into the polar ionosphere. In this study, we have investigated nonlinear behaviors of ballooning instability by a 3D MHD simulation.

In the MHD simulation of the quiet time and the growth phase, we obtained growth rate of the ballooning instability expected from linear analysis (Cheng and Zaharia, 2004). Vortical structure and tailward deformation of plasma distribution occurred for nonlinear evolution of the instability. In the modal analysis of Vortical structure, we obtained that $m=6-8$ (wave number $k_y = 12\pi - 16\pi$) components of vortical structure evolves and are similar to those of linear theory by Zhu et al., 2004.

We conclude that these phenomena are excited by ballooning instability. We showed that current disruption due to the ballooning instability becomes a key feature a trigger mechanism of substorms from realistic MHD model.