Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

PEM022-16 Room: 201A Time: May 23 16:15-16:30

Feedback instability analysis with extended MHD effects

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For studying spontaneous excitation of quiet auroral arcs and their nonlinear evolution, we have constructed a magnetosphere-ionosphere (M-I) coupling model by means of the magnetohydrodynamic (MHD) equations for the magnetosphere and the two-fluid equations for the ionosphere. Nonlinear simulations of the feedback instability in the M-I coupling system reveal that the secondary instability growth of the Kelvin-Helmholtz-like mode leads to deformation of vortex, current, and density profiles associated with auroral arcs [1]. We have also developed a linear analysis method for the feedback instability with an inhomogeneous density profile and the dipole magnetic field.
It is known that a variety of non-MHD effects appears in the magnetosphere with low-density and high-temperature plasma. For example, effects of finite ion and/or electron skin depth in comparison to the perpendicular wave length may play non-negligible roles in characterizing the dispersion relation of the shear Alfven mode. The finite ion gyroradius effect is also unignorable in the vicinity of the magnetic equator region with the weak magnetic field and the high ion temperature. These effects are properly included in kinetic models. Nevertheless, a fluid approach with extended MHD effects should be still useful for qualitative understandings of basic properties of the M-I coupling system.
In the presentation, we discuss theoretical and numerical models for the feedback instability, and evaluate effects of an inhomogeneous density profile, the electron inertia, and the finite ion gyroradius.

[1] T.-H. Watanabe, "Feedback instability in the magnetosphere-ionosphere coupling system: Revisite", Phys. Plasmas, Vol.17, in press (2010).

Keywords: magnetosphere-ionosphere coupling, aurora, simulation