Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM28-18 Room:413 Time:April 29 17:15-17:30

Auroral vortex street formation and cavity trapping of Alfven waves

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The structuring of auroral arc has been studied to be understood in the context of magnetohydrodynamic (MHD) instabilities and their nonlinear evolution in the magnetosphere-ionosphere (MI) coupling system. It was demonstrated that feedback instability of field-line resonant and ionospheric Alfven resonant modes occurs, by means of linear analysis with non-uniformity of the Alfven velocity (v_A) in the dipole magnetic field and the convection electric field [Hiraki and Watanabe, 2011; 2012, Hiraki, 2013]. We performed 3D reduced-MHD simulations in the MI coupling system to examine nonlinear behavior of the initially assumed arc structure, where v_A is constant along the field line. Results show that i) the initial arc splits, intensifies, and just after that deforming into a vortex street, and ii) the transition of the growth pattern exists at the convection electric field of 20-40 mV/m. We also performed 3D simulations with non-uniformity of v_A, though without the initial arc, to examine changes in auroral structure and properties of Alfven waves due to the magnetospheric and ionospheric cavities. It was found that, if the ionospheric cavity becomes deep, the secondary instability in the magnetic equator side [Watanabe, 2010] is suppressed, alternatively, large-amplitude waves are trapped in the ionospheric cavity. In this talk, we report the initial results of the above two simulations. Furthermore, we would discuss on auroral electron acceleration in the cavity region, by means of extended analyses with two-fluid effects and parallel electric field.

Keywords: Auroral vortex street, Alfven wave, Ionospheric Alfven resonator, Electron acceleration, MHD simulation