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Gyrokinetic approach to Alfvenic coupling of magnetosphere and ionosphere plasmas

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The magnetosphere-ionosphere (M-I) coupling through the shear Alfven waves plays a key role in spontaneous growth of quiet auroral arcs in polar regions. The feedback instability in the M-I coupling system, which explains simultaneous growth of ionospheric density, field-aligned current, and electric field perturbations, has often been analyzed by the MHD or two-fluid equations. For a more realistic analysis under the magnetospheric condition, however, kinetic effects of ions and electrons are necessary to be incorporated in the theoretical model.

The gyrokinetic (GK) equations for magnetized plasmas have been derived for describing the Alfven and drift waves of which frequency is much lower than the gyro-frequency. Using a theoretical model reduced from the GK equations, we have developed a linear formulation of the feedback instability in a flux tube geometry, where the finite Lamor radius (FLR) effect of ions can be accurately incorporated. The FLR effect leads to increase of the real frequency of the feedback coupling in a large perpendicular wavenumber region. The dispersive Alfven wave is also described by the gyrokinetic equations for electrons and the ion polarization effect. The feedback instability analysis will also be addressed in case with the kinetic electrons.

Keywords: gyrokinetics, magnetosphere-ionosphere coupling