The Role of the Electron Convection Term for the Parallel Electric Field and Electron Acceleration in the Io-Jupiter System

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Subcorotation of Iogenic plasma in the Io plasma torus has been understood as electric drift by a perpendicular electric field with respect to the Jovian magnetic field. A part of the radially integrated potential has been considered to be imposed along the magnetic field lines and would cause the Io's trailing tail aurora. The purpose of this study is to clarify where and how the actual electric fields arise in the Io-Jupiter system. In this study, we take notice of the electron convection term in the generalized Ohm's law. We applied a semi-discrete central scheme to extended multi-magneto-fluid equations that include the electron convection term and investigated the role of the electron convection term on the parallel electric field and electron acceleration in the Io-Jupiter system.

We find that the electron convection term works like the gradient of the negative pressure and it reduces the phase velocity of the ion sound mode. If the parallel current density exceeds the critical current density, the ion sound mode grows exponentially. This is the ion sound mode instability described in the fluid frame. If the sound mode of the cold ions is unstable and that of the hot ions is stable with a specific current density, the growth of the unstable sound mode saturates after a while. At this stage cold ions are evacuated from the small density region and the discrete parallel electric field appears at the boundary between the high- and low-density regions.

In the Io-Jupiter system, the discrete parallel electric field would appear above the altitude where the parallel current density equals the critical current density. In this presentation, we would discuss the timescale of the formation of the electron acceleration structure with one dimensional simulation results and would show initial results of two-dimensional simulations.