Study of the plasma distribution along a field line between Jupiter and Io related to the auroral electron acceleration process

*Koseki Saito[1], Yuto Katoh[1], Atsushi Kumamoto[1], Tomoki Kimura[1], Yohei Kawazura[1]

1. Department of Geophysics, Graduate School of Science, Tohoku University

Observation NASA's spacecraft Juno revealed the downward electrons in the energy range from a few tens keV to hundreds keV in the Jupiter's auroral regions. The observed energy and pitch angle distributions suggested that Alfvenic acceleration process, which has been considered to be a minor acceleration mechanism on the Earth, plays significant roles in the formation of Jupiter's aurora [Mauk et al., 2017]. Despite the increasing attention to the Alfvenic acceleration process in considering the aurora formation of magnetized planets, physical process controlling the characteristic energy and pitch angle distributions have been still unclear. For the discussion of Alfvenic acceleration, the spatial distribution of multispecies ions and electrons along a field line is necessary to understand property of Alfven waves. In the present study, we have been developing a static Vlasov code [Ergun et al., 2000; Matsuda et al., 2010] for the steady state distribution of magnetospheric plasma along a magnetic field line between Jupiter and its satellite Io. Matsuda et al. (2010) used a static Vlasov code for the plasma distribution along a magnetic field line between Jupiter and Io to study the altitude distribution of the Io-related decametric radio sources. We develop a static Vlasov code by referring to Matsuda et al. (2010) and used the obtained plasma distribution for the study of the property of Alfven waves. In the developed code, assuming bi-Maxwellian distributions for the initial velocity distributions of both ions and electrons at the ionospheric end and at the magnetic equator, we solve the spatial variation of the velocity distributions of ions and electrons by considering the spatial distribution of the background magnetic field intensity, gravity and centrifugal forces as well as the electrostatic potential along a field line. We compute charge densities of ions and electrons by integrated the velocity distributions at each grid point along a field line and evaluate the electrostatic potential iteratively to obtain a solution satisfying the quasi-neutrality. We assume the boundary conditions that protons and electrons originate from the Jovian ionosphere, and hot electrons, cold electrons and ions (O^+, S^+, S^{2+}, H^+) from Io. The electrostatic potential difference between Jupiter and Io is initially assumed to be 30 kV. In the simulation result, we obtained a solution showing the electrostatic potential of almost 30 kV from the Jovian ionosphere to 0.029 RJ from Jupiter, and the potential gap from 30 kV to about 20.5 kV at 0.029 RJ and from 20.5 kV to about -20 V near 2 RJ, where RJ represents Jupiter's radius. We also computed the Alfven speed from the obtained distribution of ions and showed a peak close to the speed of light near 1 RJ. In this presentation, we show results of the developed static Vlasov code and discuss the comparison between Jupiter and the Earth, as well as our future study on the Alfvenic acceleration process under the plasma distribution obtained by the static Vlasov code.

Keywords: Jupiter-Io system, magnetized planets, Alfven waves