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Simulation study on asymmetrical features of intensity and frequency in the Io-related decametric radio sources

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Jovian decametric radiation that is called Jovian DAM was first discovered in 1955. From its discovery, a variety of observational characteristics in various time scales have been revealed. DAM's component related to Io is called Io-DAM. It is generally believed that a part of Io-DAM is excited in quasi-steady state acceleration region near the footprint of the Io flux tube (Su et al., 20 03, JGR).
Characteristics of radio emission are determined by source structure, in other words, magnetic field and plasma conditions. This study addressed the quasi-steady state source structure and its dependence on the plasma conditions of the Jovian ionosphere.
To investigate quasi-steady state source structure, we developed an original static Vlasov code (Ergun et al., 2000, GRL) and applied it to the Io-Jupiter system. Simulation region is one dimensional in space along the field line based on the aligned dipole field model.
Generally, there are many solutions that satisfy the quasi-neutrality condition on the same boundary condition. On the boundary condition without ionospheric soft electrons, solutions are classified into two types; single potential jump structure and double potential jump structure. Potential jumps appear within the possible existence ranges to satisfy the quasi-neutrality condition. Concerning double potential jump structure, we found that the auroral cavity also can be formed on the boundary condition without soft electrons. There is the dependence of amount of potential jump and current density on the source structure: i.e., if lower jump altitude is lower, potential jump at lower jump is larger and ionospheric proton current density is larger. On the other hand, if higher jump altitude is higher, potential jump at higher jump is larger and magnetospheric electron current density is larger.
It has been already suggested that variation of the Jovian ionosphere by solar EUV contributes to the long term variation of occurrence probability of Jovian DAM (Kawauchi, 2002). Since Io is located in nearly common longitudinal range for Io-A and Io-B sources, local time effect is expected to appear as difference in observational characteristics between Io-A and Io-B events. Actually, Misawa (1998) implied that density near the Io-B source region would be smaller than that near the Io-A source region based on the difference of their polarizations. In addition, solutions of our static Vlasov code indicate that the differences in intensity and high frequency limit between Io-A and Io-B events (i.e., stronger and higher for Io-B events than for Io-A events) are also the results of local time effect. We confirmed that previously observed data for Io-DAM exhibited same asymmetries as our expectations qualitatively.
The Jovian ionospheric model (Tao, 2009) revealed larger density by a factor of 1.5 at the exobase for the Io-A source region than for the Io-B source region. In this case, if we assume that the lower jumps for Io-A and Io-B sources appear at the altitudes of same density, the altitudes are different. However, the different altitudes can't explain the observed asymmetry of high frequency limits quantitatively. On the other hand, the amount of potential jump at higher jump increases dramatically in some cases as a result of decrease in the ionospheric density. In these cases, electron kinetic energy in the auroral cavity is larger and excited stronger emissions could be detected up to higher frequency. It is likely that the origin of the observed asymmetries is due to

the asymmetry of assignment of potential jump to the higher jump.

Keywords: Io, Jovian decametric radiation, static Vlasov code