イオフラックスチューブの沿磁力線加速領域における電子の速度分布

松田 和也 [1]; 三澤 浩昭 [2]
[1] 東北大・理・PPARC; [2] 東北大・理・惑星プラズマ大気

Electron velocity distribution at the acceleration region along the Io flux tube

kazuya matsuda[1]; Hiroaki Misawa[2]
[1] PPARC, Grad. School of Sci., Tohoku Univ.; [2] PPARC, Tohoku Univ.

The Jovian decametric radio emissions (DAM) are observed in some CML ranges (Carr et al., in Phys. Jovian Mag., 1983). This infers DAM's source regions are confined to specific magnetic longitude ranges. A generation mechanism of DAM is thought to be the CMI (cyclotron maser instability) on the analogy of AKR that are the Earth's auroral related radio phenomena. To find what parameters determine DAM's source region, we are going to try a CMI simulation with the parameters expected in the source environment. It is expected that such a simulation study relating to generation process of auroral particles and waves can propose important observation subjects that should be confirmed in future Jovian missions.

In a CMI simulation, we need an electron velocity distribution function at DAM's source region. There is a method to predict it self-consistently that succeeded in reproducing it in the AKR source region (Ergun et al., 2000, GRL; Su et al., 2003, JGR). It is called Static Vlasov code (SV code). In this study, we tried to obtain an electron velocity distribution along the Io flux tube (IFT) with the SV code developed by ourselves.

SV code treats steady state. Density profiles and velocity distributions of each species of ions and electrons originated from the boundaries, the ionosphere and the Io plasma torus, are derived along a magnetic field line using the SV code; these are estimated from Liouville's theorem by tracing the particle's orbit in 6D phase space to the boundaries under the constraint of quasi-neutrality. The forces taken into account are gravitation, centrifugal force, and electrostatic force. In this study, the potential difference between two boundaries was chosen to be 30kV, which is based on the color ratio observation of UV aurora of Io's footprint and its trailing tail (Gerard et al., 2002, JGR). The problem results in nonlinear simultaneous equations, and we solved them using Newton method. The number of grid point along a field line is 64.

As a preliminary result, it was confirmed that the electric potential profile which satisfied quasi-neutrality showed a large potential change near the ionospheric boundary. The preceding study by Su et al. (2003) showed large potential jump thought of DL (double layer) was always formed in two grid points. On the other hand, in this study, large potential change was not constrained to be in two grid points. Although DLs in Earth's inverted V acceleration region are actually confirmed, the abrupt potential jump seems to be somewhat questionable because a SV code doesn't treat wave-particle interactions. Therefore we think the smooth potential change is a reasonable result.

Concerning the electron velocity distribution of the DAM's source region near large potential change, it is suggested that it is mainly formed by the cold torus population, but the hot torus population dominates the CMI. Because of the conservation of first invariant, the cold population that is accelerated parallel to a magnetic field line can't be reflected by magnetic mirror, and therefore it exists as a beam. On the other hand, hot population can have relatively large pitch angle, and therefore they can become the horseshoe distribution. So, as suggested by Pritchett (1986, JGR), hot population is thought to be important for the CMI.

In comparison between the preceding study by Su et al. (2003) and this study, there is difference in density profiles of each species. The increase of density from a particle source boundary to the opposite boundary which was showed by Su et al. (2003) is not self-consistent with the Liouville's theorem. We think the reason may be incomplete implementation of accessibility or the Liouville's theorem.