Test particle simulation of electron energy loss by ionization around Enceladus -Initial result-

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1 Introduction

Saturn's inner magnetosphere is dominated by water group neutrals (H_2O, OH, and O) originated from H_2O plume in the south pole of Enceladus (~3.95 Rs). The water group neutrals in the inner magnetosphere play the dominant role in loss of plasmas [e.g., Paranicas et al., 2007; 2008, *Sittler et al.*, 2008]. Thus, the previous studies suggested that the neutrals contribute to loss processes of plasma in the inner magnetosphere. However, little has been reported on a quantitative study of the electron loss process due to electron-neutral collisions. Conducting one dimensional test-particle simulation, *Tadokoro and Katoh* [2014] examined the time variations of equatorial pitch angle distribution and electrons within loss cone through 1 keV electron pitch angle scattering due to electron-H_2O elastic collisions around Enceladus. Above several hundred eV, ionization cross section for electron electron-H_2O collision is greater than elastic collision. Quantitative understanding for keV electron-neutral collisions around Enceladus is required to examine elastic and ionization processes. In this study, we foucus on ionization process for 1keV electron-H_2O and examine the electron energy loss rate.

2 Simulation model

Following the method of *Tadokoro and Katoh* [2014], we use one dimensional test-particle simulation code for monoenergetic electron along Saturn's dipole magnetic field line around Enceladus. Trajectories of the electrons are computed by considering under a dipole magnetic field.

$$m\,dv/dt = q\left(\vec{E} + v \times \vec{B}\right),$$

where B is the magnetic field. We assume that the electric field (E) is zero in this study. In this study, we assume that the initial pitch angle distribution is isotropic distribution. The number of electrons used in this simulation is 500,000. A trajectory trace is terminated when a calculation time is over ~380s. The end of calculation time corresponds to the time scale of the co-rotating flux tube passing through the region of the dense H_2O around Enceladus.

The collision is solved by a Monte-Carlo procedure. The collisional frequency, f_{col}, between an electron and H_2O molecule can be given by

$$f_{col} = n\sigma v,$$

where n is the neutral H_2O density, σ is the ionization cross section, and v is the relative velocity between an electron and neutral H_2O. The H_2O density model used in this simulation is the same as the model based on observations used in *Tadokoro and Katoh* [2014]. The ionization cross section based on the experimental data is given by *Itikawa and Mason* [2005]. If the elastic collision occurs, then we conduct a calculation of electron energy loss. We assume that electron energy after ionization impact decreases by 12.6eV(ionization). We assume that the product ion after ionization is H_2O^+.

3 Result and Summary

Figure 1 shows the time variation of the normalized number of electron in ~380s as a function of electron energy. The electrons of a few % to the total equatorial electrons show energy loss from 1keV to 25eV due to ionization in ~380s. The number of 1keV electrons decrease by 54 % in ~380s.

Our future work is required for code development by addition of secondary electron and other ionization process.

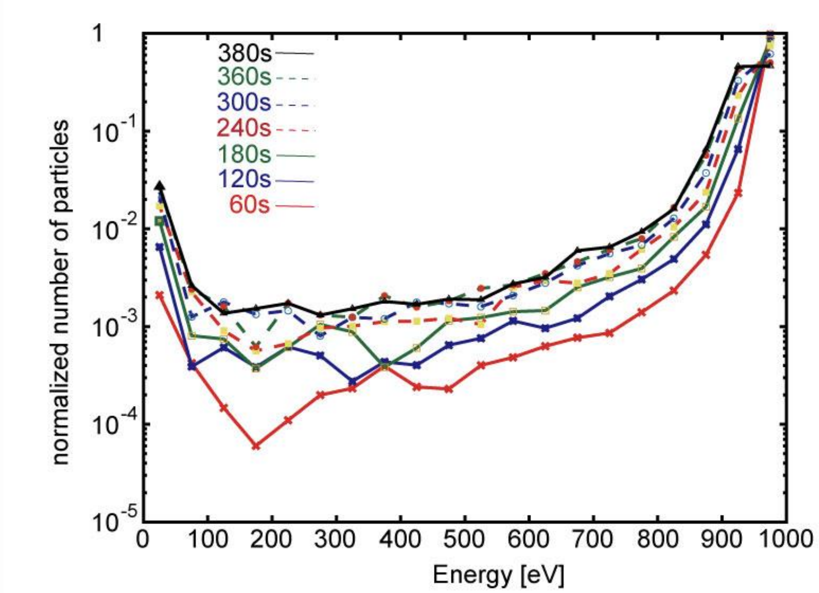

Figure 1. Variation of electron number due to ionization as a function of electron energy.

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