Test particle simulation of 500eV-50keV electron-neutral H_2O elastic collision around Enceladus

Hiroyasu Tadokoro[1] and Yuto Katoh[2]
[1] *Musashino University, Tokyo, Japan*
E-mail: hirotado@musashino-u.ac.jp
[2] *Tohoku University, Miyagi, Japan*

1 Introduction

The observations of injected electrons and ions in Saturn's inner magnetosphere suggested that these particles do not survive very long time due to the neutral cloud originated from Enceladus (~3.95 Rs) [e.g., Paranicas et al., 2007; 2008]. These neutrals in the inner magnetosphere play the dominant role in a loss process of energetic electrons and ions [e.g., *Paranicas et al.,* 2007; *Sittler et al.,* 2008]. However, little has been reported on a quantitative study of the electron loss process due to electron-neutral collisions. In this study, we focus on the elastic collisional loss process with neutrals. Conducting one dimensional test-particle simulation, *Tadokoro et al.* [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 when the electron flux tube passes the region of the dense H_2O molecules in the vicinity of Enceladus (~380 sec). The result showed that the electrons of 11.4 % are lost in ~380 sec. Next remaining issue is loss rate of electrons with other energy. In this study, we show a preliminary result of the loss rate of electrons with 500eV-50keV.

2 Simulation model

Following the method of *Tadokoro et al.* [2014], we conduct one dimensional test-particle simulation for monoenergetic electron along Saturn's dipole magnetic field line around Enceladus (*L*=3.95). The number of electron used in this simulation is 500,000. We assume that the boundary condition is in the magnetic latitude range of -10 – 10 degrees and the loss cone angle at the equator is 7.3 degrees. A trajectory trace is terminated when a pitch angel of each article at the boundary is smaller than the loss cone angle. We assume that the electrons precipitate into the atmosphere since the collisional frequency at the boundary is smaller than the bounce frequency. 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. To examine the variation of pitch angle distribution we assume that the initial pitch angle distribution is isotropic distribution.

With regard to the elastic collision process, if the collision occurs, then we conduct a calculation of scattering angle based on the differential cross sections. The collision is solved by the Monte-Carlo method. 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 cross section, and v is the relative velocity between an electron and neutral H_2O. The total and differential cross sections for elastic collisions based on the experimental data are given by *Katase et. al.* [1986].

3 Result and Summary

The red line in Figure 1 shows the loss rate of electrons with 500 eV - 50 keV. The blue line indicates the total cross section as a function of energy based on *Katase et. al.* [1986]. N_{lc} is the amount of electrons into the loss cone, N_{0eq} is the total number of equatorial electrons at the initial condition. It is found that the 1keV electrons of ~11.4% to N_{0eq} are lost in ~380 seconds. The electron loss rate decreases with electron energy.

Our future works are as follows:

1. estimation of auroral brightenss,
2. examination of 500eV-50keV electron elastic collision within off-plume.

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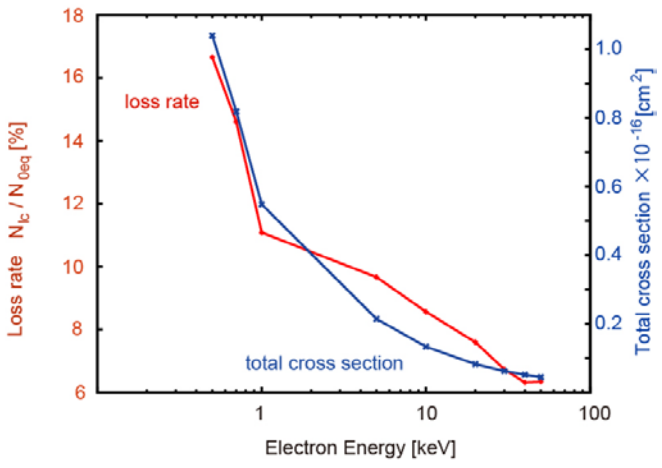

Figure 1. Loss rate as a function of electron energy (red). N_{lc} is the number of electrons into the loss cone. N_{0eq} is the total number of equatorial electrons at the initial condition. N_{slc} is the small equatorial pitch angle electrons (<20 and >160 degrees) at the initial condition into the loss cone. The blue line indicates the total cross section as a function of electron energy based on *Katase*, et al. 1984.