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Effect of Coulomb Collision on the Negative Ion Extraction Mechanism in Negative Ion Sources

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Negative hydrogen ion (H^-) beam has a wide range of applications, such as fusion plasma heating, accelerators for medical use and high energy particle physics. However, the extraction mechanism of negative ions from the ion sources has not been fully understood yet. To clarify the extraction mechanism of H^- ions is an important subject for optimizing the negative ion beam extraction. In our previous study, numerical simulations using the 2D3V-PIC (two dimension in real space and three dimension in velocity space)·(Particle In Cell), and 3D3V-PIC model have been carried out to understand the H^- extraction mechanisms[1-3].

In this study, for two purposes described below, Coulomb collisions such as electron-H^-, H^--H^+ have been taken into account to our 2D3V-PIC. The first aim is to estimate the detailed effect of electron transport across the filter magnetic field. Electron diffusion across the filter magnetic field is introduced by a simple model derived from diffusion equation with some approximations in the previous PIC model of the extraction region[4]. One of the main causes of the electron diffusion across the filter field is Coulomb collision. The detailed effect of Coulomb collisions on the diffusion process will be discussed in this paper. The second aim is to clarify the energy relaxation process of surface produced H^- ions. The energy of H^- ions produced on the PG surface is estimated to be ~ 1 eV from the theoretical formula[5]. However, the energy of H^- ions in the extraction region is estimated to be ~ 0.1 eV from the beam emittance calculated by using the PIC simulation[6]. This result indicates that the energy of surface produced H^- ions could be reduced by some physical mechanisms such as Coulomb collisions with lower energy particles.

References

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