§1. The Partial Cross Sections of Neutral Hydrogen Atoms Formed in Electron Detachment from Negative Hydrogen Ions in Collisions with Positive Ions at High Energies

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Neutral hydrogen atom beams are used in the plasma heating. In order to obtain the high energy ($\sim$ MeV) and powerful ($\sim$ MW) neutral hydrogen atom beam for NBI, H^- ions have to be converted into neutral hydrogen atoms, H^0, with better efficiencies.

We have calculated the partial cross sections for the electron detachment from negative hydrogen ions colliding with protons,

$$H^+ + H^- \quad \rightarrow \quad H^+ + H^0(1s \text{ and } 2s) + e^-. \tag{1}$$

In the present work, we consider not only the ground state $H^0(1s)$ but also the excited state $H^0(2s)$ in the exit channel.

In order to calculate the electron detachment cross sections, we used the Four-Body Continuum-Distorted-Wave (4B-CDW) approximation [1 $\sim$ 4].

There are two electrons with different binding energies in H^- ions in the ground state: one is the tightly bound 1s electron (ionization energy $\simeq$ 13.6 eV) and the other is the loosely bound 1s' electron (ionization energy $\simeq$ 0.75 eV) in the Hylleraas-Eckart function [5], and these energies are reflected on the detached electron wave function in the exit channel [6].

Figure 1 shows the calculated partial cross sections for the reaction (1). The solid line denotes those for production of the ground state neutral hydrogen atoms, $H^0(1s)$, and the dotted line those of the excited state neutral hydrogen atoms, $H^0(2s)$, in the exit channel. The calculated results show that the cross sections of production of $H^0(1s)$ is far larger than those of $H^0(2s)$.

The excited state H^0 atoms are easily ionized before reaching the main plasmas, thus reducing the conversion efficiencies in applications to NBI. Thus, the present results suggest that collisions with positive ions are much better than those for neutral atoms [5] because fractions of the excited state $H^0(2s)$ atoms are very small.

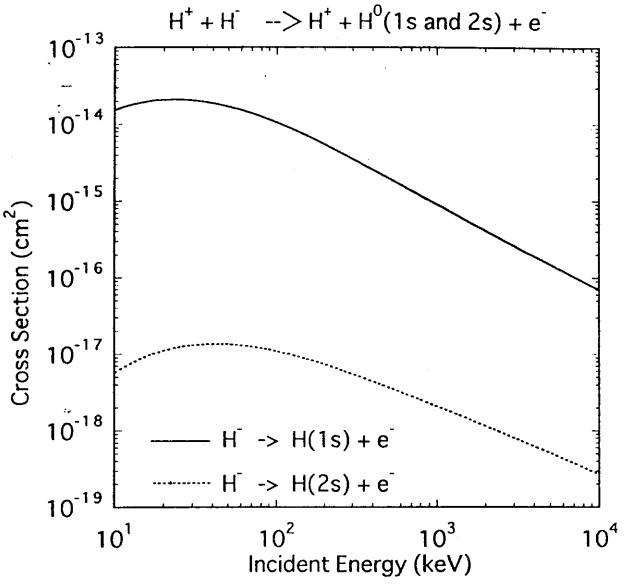

Fig. 1. Calculated partial cross sections for electron detachment of the reaction (1). The solid and the dotted lines represent those for hydrogen atoms in the ground state, $H^0(1s)$, and those with hydrogen atoms in the excited state, $H^0(2s)$, respectively.

References

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