§9. Electron-Loss Cross Section of H^- Colliding with Neutral Atoms

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Neutral-beam heating of plasma is known to be needed in nuclear fusion. In order to make neutral beams before injecting into a plasma, it takes advantage to utilize the charge exchange reactions such as

$$H^- + A \rightarrow H^0 + A^* + e^- \quad (1)$$
$$\rightarrow H^0 + A + e^- \quad (2)$$

where a target atom A will be ordinarily excited to A* as well as remains in the ground state. In order to discuss this probability, we estimate the cross section for the process (2) but, as a first step, a neutral target atom A still remains in the ground state. The method of calculation is based on the first Born approximation. The initial state of two electrons on a H^- projectile is described by the wavefunction obtained by Schull and Lowdin for the $1s1s'$ configuration1). On the other hand, the final state is a product of the ground-state wavefunction of a hydrogen and the continuum-state wavefunction for an ionized electron. The target electrons are described by the statistical Thomas-Fermi- Moliere form factor from the corresponding spatial distribution. On the other hand, for light target atoms, the bound electrons are described quantum-mechanically.

Using the first Born approximation, the calculated results for the electron loss cross sections of H- colliding with a helium atom is shown in figure 1. The calculated energy range is from 10 keV/amu to 104 keV/amu, and two target electrons are assumed to be in the 1s state.

The calculated results are in relatively good agreement with the existing data, on the whole, while at high energies there is some discrepancy between the present results and the data. At higher energies, this is due to neglect of the target-inelastic process (1) and now inclusion of it is under consideration. In addition, calculation for heavier target atom than helium is in progress.

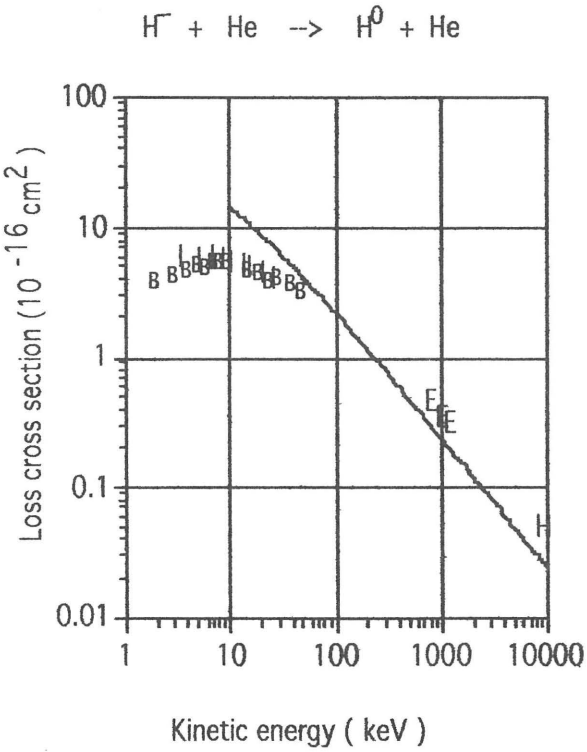

Fig.1. Electron-loss cross section of H^- colliding with a helium atom.

Reference
1) H. Shull and P.O. Lowdin, J.Chem.Phys. 25, 1035(1956).