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Charge Transfer Cross Sections of Slow Singly Charged Lithium Ions in collisions with Hydrogen Isotope Molecules

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Synopsis Charge transfer cross sections of $^7Li^+$ ions in collisions with H_2, HD, and D_2 molecules have been measured in the energy range from 1.4 to 4.0 keV. Significant differences in these results between collisions with H_2 and other hydrogen isotope molecules, the so-called target isotope effect, are observed below 2 keV. These observed cross sections for H_2 target are compared with available experimental and theoretical data.

Lithium are sometimes used for the purpose of plasma diagnostics in fusion devices. Therefore, cross-section data and any knowledge of collision dynamics for the charge transfer processes of lithium ions colliding with hydrogen molecules at low energies are known to be important the plasma modeling in controlled thermonuclear fusion research. However charge transfer cross section measurements of $Li^+ + H_2$ collisions are sparse, particularly at low collision energies. To the best of our knowledge, Ogurtsov *et al*. [1], and Cabrera-Trujillo *et al*. [2] reported the cross section measurements below 10 keV. Furthermore, few theoretical studies, e.g., Elizaga *et al*. [3] and Cabrera-Trujillo *et al*. [2], treated this charge transfer process.

We previously investigated the isotope effect on charge transfer by slow hydrogen ions (H^+, D^+) from hydrogen molecules (H_2, HD, D_2) [4]. The cross section ratios $\sigma(D_2)/\sigma(H_2)$ for the charge transfer decreased to a value smaller than unity below a collision energy of 1keV/u, and reached a value of about 0.6 at 0.18 keV/u. To establish the cross section data and obtain more general understanding of the isotope effect on the charge transfer in ion-molecule collisions of the hydrogen family, we have measured the charge transfer cross sections of $^7Li^+$ ions colliding with H_2, HD, and D_2 molecules in the energy range from 1.4 to 4.0 keV [5].

The $^7Li^+$ ion beam extracted from a surface ionization ion source was mass-analyzed with a Wien filter and was introduced into a collision cell in which target hydrogen gases of high purity were filled. The Li^+ ions and product Li atoms emerging from the cell after the collisions were charge-separated and detected with a position-sensitive micro-channel plate detector. Charge transfer cross sections were derived based on the growth rate method.

Figure 1 shows the present charge transfer cross sections of $^7Li^+$ ions colliding with H_2, HD, and D_2 molecules. Both the present charge transfer cross sections of HD and D_2 molecules are almost the same, but they become gradually smaller with a decrease in incident energy than those of H_2 molecules.

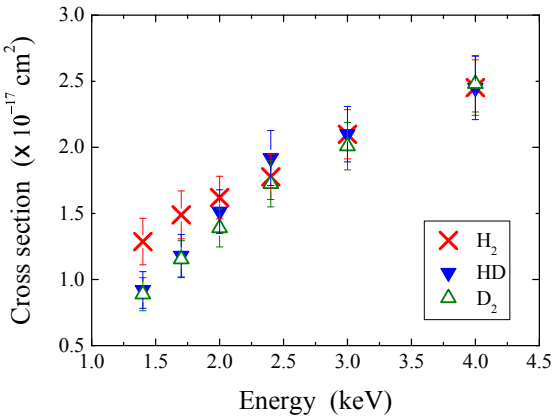


Figure 1. Charge transfer cross sections of $^7Li^+$ ions colliding with H_2, HD, and D_2 molecules [5].

The present charge transfer cross sections in collisions with H_2 molecules are found to reasonably agree with the theoretical results for the total charge transfer cross sections to Li ($1s^2$ $2l$) reported by Elizaga *et al.* [3]. The experimental results measured by Ogurtsov *et al*. [1] are about 50% smaller than the present experimental data. Both the experimental and theoretical results of Cabrera-Trujillo *et al*. [2] are larger than the present data.

References

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