§1. Evaluation of Atomic Data for Lithium Ions

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Injection of tracer encapsulated solid pellets has been proposed to diagnose particle transport in plasma of the LHD and the CHS. Lithium is used as a tracer and the pellet consists of polystyrene shell and LiH core. When the pellet is injected into a plasma, it is ablated at around the central region of plasma and Lithium is ionized in a short period. Simultaneous injection of a hydrogen neutral beam (NBI) causes the charge transfer process between Li^{3+} ion and H atom, producing Li^{2+} ion or between Li^{2+} ion and H atom, producing Li^{+} ion. Measurement of emission lines from lithium ions can be used to diagnose particle transport as well as plasma parameters. we need reliable atomic data for the modeling and aim to search atomic data relevant for this research and to make evaluated data.

The spectral lines used for the measurement are Li I λ 670.8nm ($2p\ ^2P \rightarrow 2s\ ^2S$), Li II λ 548.5nm ($2p\ ^3P \rightarrow 2s\ ^3S$), and Li III λ 449.9nm ($5g\ ^2G \rightarrow 4f\ ^2F$), and the last transition is from high n (principal quantum number) level. To model these spectral lines, state selective rate coefficients of all atomic processes are required.

We have carried out almost complete search for charge transfer cross section data of Li ions with H(1s) and H(2s). Searched numerical data are stored into the NIFS numerical database "CHART".

Charge transfer process of Li^{3+} ion with neutral hydrogen H(1s) mainly dominates emission lines of Li^{2+} ion. The state selective cross sections of up to $5l$ states were calculated for wide energy range by many groups. But for higher states, only data are published for high energy region. The $3l$ states have large cross sections and other states have smaller cross sections. The cross sections of the $5l$ states is about 1/10 - 1/100 of those of the $3l$ states at energy of LHD NBI (Fig.1).

For Li^{2+} and Li^{+} ions, small number of state selective cross sections are pubslihed. We need to calculate them by ourselves or ask other speciallists who published only total cross section about state selective cross sections.

For the excitation processes by electron impact, semi empirical formulae for Li^{2+} ion exist up to $5l$ states or up to $n = 8$ levels. For Li^{+} ion, evaluated data [1] exists for $1\ ^1S \rightarrow 2^{1,3}S$, $2^{1,3}P$ states. Recent calculations for collision strengths at low energy region by R-matrix method show complicated resonances and these resonances would cause larger rate coefficients at low electron temperature [2, 3, 4]. We need to estimate the rate coefficients including these new data.

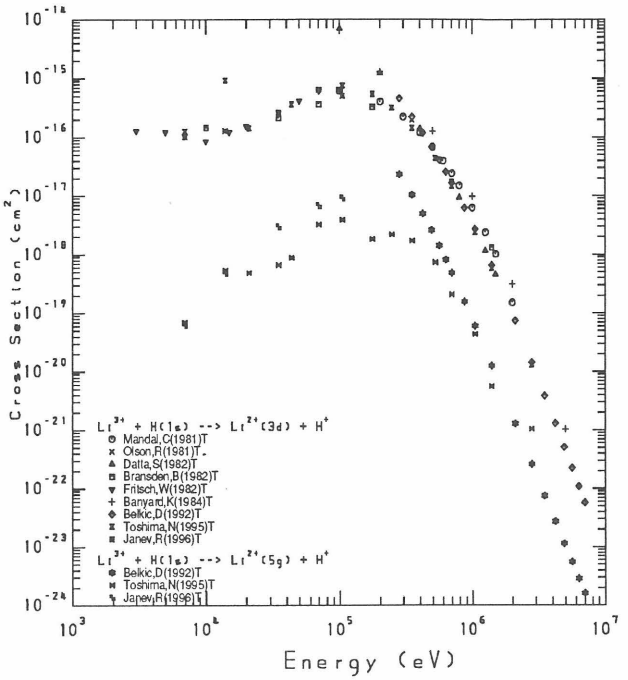

Fig. 1: Charge transfer cross sections for $Li^{3+} + H(1s) \rightarrow Li^{2+}$(3d and 5g) as a function of incident energy of H.

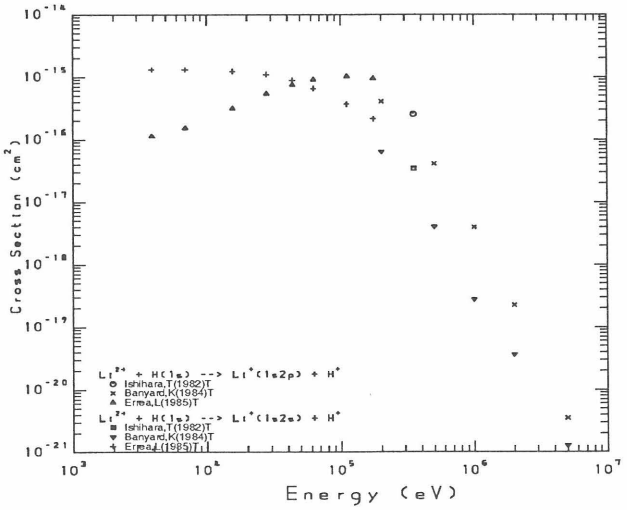

Fig. 2: Charge transfer cross sections for $Li^{2+} + H(1s) \rightarrow Li^{+}$(1s2s and 1s2p) as a function of incident energy of H.

References

[1] Kato,T. and Nakazaki,S. IPPJ-AM-58 (1988)
[2] Badnell,N. and Gorczyca,T.W. *J. Phys. B* **30** (1997) 2011
[3] Gorczyca,T.W. *et al.*, *Phys. Rev. A* **52** (1995) 3877
[4] Brown,G.J.N. *et al.*, *J. Phys. B* **32** (1999) 737