§9. 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. To know physical condition of plasma from the emission lines of Li ions, we need to know atomic processes in plasma and the reliable atomic data for the modeling. We aim to search atomic data relevant for this research and to make a list of recommended data.

In this experiment, important atomic processes are (1) charge transfer between all Li ions and neutral H; (2) excitation by electron collisions and proton collisions for all Li ions and atoms; (3) ionization by electron collisions for all Li ions and atoms; and (4) dielectronic recombination and radiative recombination for all Li ions. 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 listed above are required to be included in rate equations.

We have searched published atomic data for the processes. For neutral Lithium, evaluated data are published by Wutte *et al.* [1] for levels up to $n = 3$. Data for higher n levels are necessary to compile and evaluate.

For charge transfer process with neutral hydrogen, there are some calculations of state selective cross sections of Li^{3+} ion (e.g. Ref.[2,3]: Fig. 1), but not many for state selective cross sections of Li^{2+} ion. We might need to calculate the cross section for Li^{2+} ion.

For ionization and recombination processes, total cross sections or rate coefficients are obtained and compared by many authors but there are not many data for each exited level. For excitation by electron collisions, we need to compile and compare the data for evaluation.

We shall continue this project to present evaluated data and make a model for spectral lines of Li ions for the experiments in the LHD and CHS.

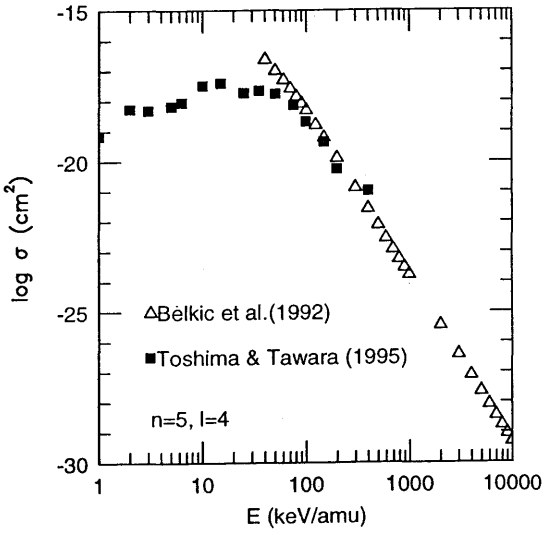

Figure 1: Cross section for the process Li^{3+} + H(1s) $\rightarrow$ Li^{2+}(nl) as a function of incident energy of H.

References

[1] D. Wutte *et al.* Atomic Data and Nucl. Data Tables **65** (1997) 155
[2] N.Toshima and H.Tawara, NIFS-DATA-26 (1995)
[3] D. Belkic *et al.* Atomic Data and Nucl. Data Tables **51** (1992) 59