§33. Construction and Update of Atomic and Molecular Database for Light Elements of the 2nd Period

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Atomic and molecular processes play an important role in fusion plasmas. The cross section database for collision processes including the elements consisting the plasma facing materials are crucial demands to model the transport of eroded atoms and molecules. Considerable number of experimental cross section data for atomic and molecular collisions has been reported, since the cross-section data concerning atomic and molecular processes are important in the understanding of the fundamental physics of atomic and molecular collisions, which is the fundamental knowledge in many fields such as electron and ion driven processes in the Earth and planetary phenomena, radiation chemistry, gaseous discharges, weak and strong plasmas, and so on. Due to its importance, theses cross-section data are also compiled in the atomic and molecular databases around the world, and can be accessed online. The Japanese National Institute of Fusion Science, NIFS, provides one of the most relevant online databases on atomic and molecular cross sections in numerical data and bibliographic information. The database AMDIS for electron collisions and CHART for heavy particle collisions, respectively, were constructed over decades ago, and have been continuously updated from time to time. There also are databases for electron collisions and heavy particle collisions with molecules, so called AMOL and CMOL respectively. Data compilation and evaluation of these databases at NIFS have been continuously proceeding.

The present working group continuously supports the update of the atomic and molecular databases of NIFS by comprehensive data compilation of atomic and molecular cross sections. The collaborations of updates and extension for these NIFS atomic and molecular database had been continuously proceeding by selecting topics, such as atomic process with high Z elements, which were relevant for the LHD peripheral plasma.[1)] The collaboration also worked for the comprehensive data mining and compilation of atomic and molecular cross sections for the atomic and molecular processes including hydrogen isotopes and small hydrocarbons, since it was found that atomic and molecular data for electron impact and heavy particle impact cross section data on hydrogen isotopes and hydrocarbons are the urgent issue, during the previous collaboration for the collection and compilation of atomic and molecular data for high Z elements.

In the present collaboration, a comprehensive data mining and compilation of atomic and molecular cross sections for light elements of the 2nd period such as Li, Be, B, C, N, O, F and Ne have been attempted. Electron impact cross section data and heavy particle impact cross section data for small atoms and molecules such as hydrogen, hydrogen isotopes, nitrogen, oxygen, hydrocarbons, Water and Carbon Oxide have been continuously surveyed in our previous collaboration and stored into the database, up to year 2000.[2)] However, new experimental as well as theoretical data for various processes by electron impact and heavy particle impact on these atoms and molecules have been reported from since we have carried out data survey. A complete survey for the existing literature and extraction of the cross section data sets were carried out in the present project.

In addition to the survey for the cross section data in the literature, we also have conducted a new measurement on electron - atom collision cross sections in the energy region from 20 eV down to very low energies with very high energy resolution.[3,4,5)] Our results resolved a number of issues in the literature and assessed various published theoretical results. We also have validated the theoretical electron impact cross section of He which has been regarded as a "standard" cross sections, to which a majority of experimental cross sections for atoms and molecules reported in the literature were normalized.

1) Kitajima M. et al. : NIFS-DATA, to be published.
2) Kimura M. et al. : NIFS-DATA-98 (2006)
3) Kurokawa M. et al. : Phys. Rev. A **84**, 062717 (2011)
4) Kitajima M. et al. : Eur. Phys. J. D, (2012) 130.
5) Shigemura K. et al. : Phys. Rev. A **89**, 022709 (2014)