Charge exchange cross sections in nitrogen ions and hydrogen collisions

Congcong Jia, Junwen Gao, Yong Wu, Alain Dubois, Nicolas Sisourat

Impurity ions are deliberately injected into fusion plasmas for several reasons: for diagnosis using the photon emission spectra of light impurity ions, to redistribute the power transported from the plasma core to the reactor wall and to improve the control of the plasma. In order to interpret and predict the behaviour and properties of impurities in fusion plasma, a significant amount data on the collisional-radiative characteristics of the impurities and their environment is required.

In this context, we plan to compute the cross sections for charge exchange between nitrogen ions and hydrogen atoms. Ions in ground and metastable electronic states and a broad range of collision energies (from 1eV/u to 100keV/u) will be considered. The different charge states of nitrogen, especially N II and N III ions, will be investigated. The outcome of our project is a complete and consistent set of cross sections that can be used in modeling fusion plasmas:

1. State-resolved cross-sections for N^{2+} - H
2. State-resolved cross-sections for N^{3+} - H and N^{2+*} - H
3. State-resolved cross-sections for N^{3+*} - H

In order to obtain accurate cross sections for charge exchange between nitrogen ions and hydrogen atoms in a wide range of collision energies, we will employ several theoretical approaches: the semi classical and quantum Molecular Orbital Close Coupling (MOCC) at low collision energies and the Asymptotic States Close Coupling (ASCC) at high collision energies. The Landau-Zener Surface Hopping (LZSH) approach will be used to bridge between the low and high collision energy ranges.

During the talk, I will first discuss the motivation of this project, and in particular why we will focus on nitrogen ions and hydrogen collisions. The workplan, in terms of systems, schedule and employed theoretical approaches, will then be presented. After this introduction, I will shortly describe the straight-line impact parameter method (IPM) which will be used to compute cross sections for electronic processes in ion-atom collisions in the collision energy range going from 1 keV/u to 100 keV/u. After introducing the IPM, our implementation will be presented in details.