SOFE05-011

STUDY OF ION STRIPPING AND CHARGE EXCHANGE FOR HEAVY ION FUSION

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In heavy ion fusion (HIF) beam ions are usually far more likely to lose electrons than to gain them. Projectile stripping on background gases or plasma in the chamber increases the charge state of the beam, and the diameter of the focus making the final focusing more complex. To accurately model transport in the chamber, it is necessary to know the evolution of beam charge state due to ionization or recombination. At present there is no accurate information for electron loss and capture from these fast, low-charge heavy ions. Moreover, the limited ionization and recombination cross section data measured or calculated to date is mostly restricted to specific energy categories. In addition, the theoretical model in the simulation codes, such as LSP is not accurate enough to describe the processes, especially multi-electron ionizations. Thus, it is very important to explore better theoretical approaches and to develop more accurate model to calculate cross sections of multi-electron losses especially ion stripping, charge exchange for near-term and driver scale HIF research.

Based on the investigation of different approaches on the heavy ion-atom collisions, a physical model will be established which emphasizes the features related with low-charged heavy ions, especially multi-electron processes. Then, quantum mechanical analysis will be performed on some important features such as screening and anti-screening effect, internuclear force, and so on. Based on the analysis, an improved classic trajectory Monte Carlo simulation model will be set up to solve the n-body ion-atom ionization problem in HIF's interest. After the calculation of the cross sections, the dependence will be studied on energy, projectile and target charges, and initial charge state to find scaling laws. Such conclusions will be utilized to check our model, expecting to obtain more accurate description of the collision processes. In addition, the calculation results will be benchmarked with the data obtained through finished experiments from the literature as well. Finally, the improved code will be implemented into LSP code as a subroutine to become an integral part of the code. A complete database for fast low-charged heavy ion will be produced to be used in HIF and High Energy Density Physics as well.