Electron capture and excitation in Be4+-hydrogen collisions

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Synopsis We present total and state-selective electron capture and excitation cross sections in collision between Be^{4+} and hydrogen atom. A standard three-body classical trajectory Monte Carlo (CTMC) and quasi-classical trajectory Monte Carlo (QCTMC) models were employed for impact energies between 10 and 200 keV/am. We found that the QCTMC model, including the potential correction term to mimic the Heisenberg uncertainty principle in the classical Hamiltonian, provide a fast and reliable cross sections in a wide projectile energy range in good agreement with the results obtained by quantum-mechanical approaches

In recent decades, ITER has been developed to take a significant step towards supplying energy cleanly and safely. However, ionic impurities are one of the main problems in controlled thermonuclear fusion plasmas. Beryllium is attractive as a plasma facing reactor material because of its low atomic number (i.e. low potential for radiative plasma power losses), excellent gettering properties with respect to oxygen (unavoidably present in any fusion plasma). Chemical and physical erosion of the first wall releases beryllium atoms and several molecular species, which eventually lead to the presence of fully stripped beryllium ions in the plasma core.

Therefore, the inelastic collision processes between Be^{q+} ions and H are particularly important when energetic neutral hydrogen are injected into the plasma for heating and diagnostic purposes. Along this line, in this work, the interaction between Be^{4+} and hydrogen atom is studied using the 3-body CTMC and the 3-body QCTMC models in the projectile energy range between 10 and 200 keV/amu. The QCTMC model is an improved version of the standard CTMC model [1]. In the QCTMC scheme the effective potential was introduced to mimic the Heisenberg uncertainty principle and the Pauli Exclusion Principle for multi-electronic systems. Despite the fact that our calculation system is the simplest system, we used the Heisenberg correction term in the description of the hydrogen atom. The effectiveness of our QCTMC model is elaborated in several studies [2-6].

In this work, we present total and state-selective electron capture and excitation cross sections in collision between Be^{4+} and hydrogen atom. As an example, Figure 1 shows the projectile energy dependent charge exchange cross sections into $Be^{3+}(n = 3)$ state. Due to lacking the experimental data for Be^{+4}+H collision system, we have compared our classical calculations with the previous results using quantum-mechanical approaches.

We show that using the quantum feature in the classical method is essential to describe the accurate cross sections. We believe that our model, with its simplicity, may have an alternative of the quantum-mechanical models providing the same results with maybe low computation efforts.

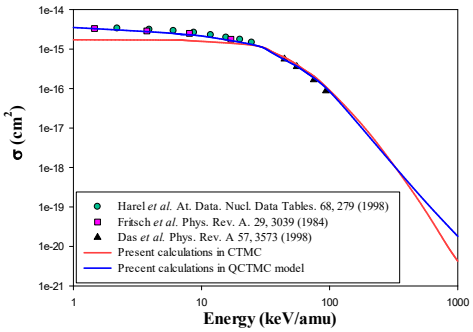

Figure 1. Projectile energy dependent charge exchange cross sections into Be^{3+} ($n = 3$) state.

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