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Single Electron Capture in Doubly-Excited Triply-Open-Shell Dynamical Atomic Systems

Content

The problem of how multi-unpaired electron ion cores behave while undergoing single electron capture (SEC) during fast ion-atom collisions is inherently complex to understand and model. Fundamental aspects such as, the preservation or change of the initial electronic configuration of the projectile ion during the collision or the spin statistical populations of similarly configured final states corresponding to different spins, are at the heart of the correct description of the SEC process, recently reported by us [1]. We considered the $2p$ SEC channel in collisions of 2-18 MeV $C^{4+}(1s2s^3S)$ with He and H_2 targets in which the $1s2s2p$ ^4P,$^2P_\pm$ levels are populated, and obtained their cross sections ratio $R = [^4P]/([^2P_+] + [^2P_-])$, which bears the corresponding population spin statistics signature. Using zero-degree Auger projectile spectroscopy and ab initio dynamical calculations involving three active electrons within a full configuration interaction approach [2], we resolved a long-standing puzzle and controversy on the value of R and the effect of cascades. Our results invalidate the frozen core approximation generally used in the past when considering electron capture in multi-electron multi-open shell quantum systems [3-5]. In addition, we proposed an elegant Pauli shielding mechanism related to strong exchange effects, which selectively obstructs specific reaction channels. Here, we present details of this work focusing on the Pauli shielding mechanism and the cascade effects [6], and also report new results on the ratio R from collisions with heavier gas targets.

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