Transfer excitation reactions in fast proton-helium collisions

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Nowadays the modern experimental technique of COLTRIMS (Cold Target Recoil Ion momentum spectroscopy) allows to measure the final electronic states in electron transfer reactions even at high impact energies. As the total energy balance (Q-value) is encoded in the ion's longitudinal momentum $K_{||}=-Q/v_p - v_p/2$ an extreme high momentum resolution is necessary. They key to achieve a resolution of 0.04 a. u. (measured!) in the longitudinal direction was the construction of a three dimensional time and space focussing spectrometer. All electron transfer events were recorded in a two particle coincidence (He^+ and H). Momentum conservation was applied to get rid of false coincidences. During off-line analysis a certain gate on $K_{||}$ selects only those events where the He^+-ion is found in an excited state, while the neutral projectile H is in its ground state.

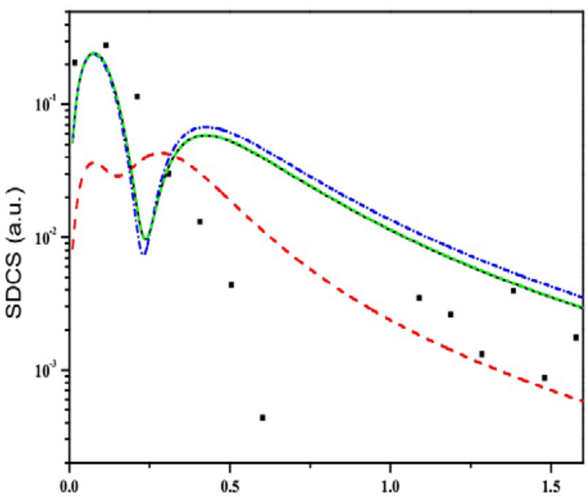

Fig. 1: Experimental (full circles) and theoretical data for transfer excitation 1 MeV p + He. Solid (black) line, highly correlated helium wave function [1]; dotted (green) line, Mitroy CI highly correlated wave function [2]; dash-and-dot (blue) line, SPM CI wave function [3]; dash line (red), $1s^2$ wave function.

A few trial helium wave functions are used for calculations. These are two highly angular correlated wave functions [1] and [2], the loosely angular correlated function [3] and one of $1s^2$ function. Results for E_p=1 MeV are presented in Fig. 1. At whole, shapes of curves obtained with correlated functions remind that for charge transfer case leaving the ion in the ground state [4]. We also see that Plane Wave First Born Approximation (PWFBA) is able to describe the experiment only at very small scattering angle around the peak, and only at energies E_p>0.6 MeV. At lower impact energies PWFBA fails.

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