# 2D momentum distribution of electron in transfer ionization of helium atom by fast proton


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We present the experimental 2D momentum distribution of the escaped electron in the scattering plane and the corresponding Plane Wave First Born Approximation (PWFBA) calculations. By comparing these calculations to our high-resolution experimental data, we separate ionization due to shake-off (SO) or binary encounter (BE) collision leading to distinct islands in the momentum space. These data are extremely sensitive to the initial-state correlation.

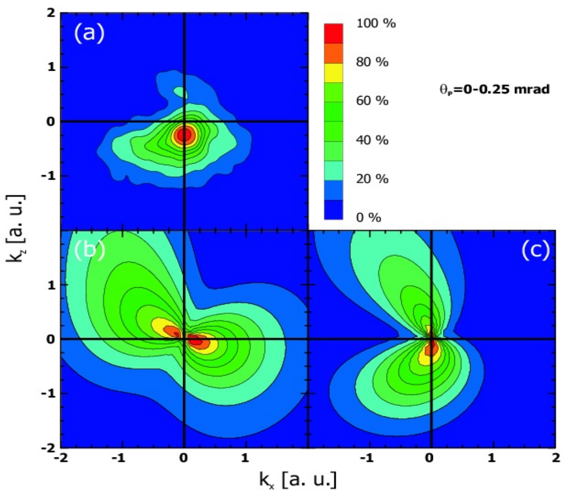


*Fig. 1: Experimental and theoretical data for 630 keV proton energy and for $\theta_p \le 0.25$ mrad. (a) experiment, (b) calculations with $1s^2$ trial helium wave function, (c) the same with highly correlated wave function.*

We have used the COLTRIMS reaction microscope technique to determine the momentum vectors of all final-state products. From the positions of impact on the detectors and the time-of-flight we can derive the initial momentum vectors of the $He^{++}$ and the electron. A momentum resolution of 0.1 a.u. was achieved for all particles in all directions. Energy and momentum conservation were used for off-line background suppression. Furthermore the high resolution data allow to distinguish data where hydrogen is found in an excited state from those, where the hydrogen is in its ground-state [1].

In the presented experiments, $(k_x,k_y,k_z)$ are the electron momentum components, the scattering plane {z,x,y=0} formed by the momentum vectors $\vec{p}_p$ (z-axis) and $\vec{p}_H$ is fixed in space, and we put its polar angle φ=0. The PWFBA amplitude includes the matrix elements describing both shake-off and binary encounter mechanisms. One sees that the FBA even with highly correlated trial helium wave function overestimates the experiment for $k_z>0$. We need higher Born terms to correctly reproduce this BE domain.

References:


[1] H.-K. Kim *et al*, Phys. Rev. A 85, 022707 (2012).