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The effect of projectile wave packet width on the fully differential ionization cross sections[1]

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In the last years a debate arose concerning the effect of the projectile coherence on the fully differential ionization cross sections in ion-atom impact. Some experimental data show, that the measured cross sections depend on the coherence width of the wave packet associated to the projectile. However, other experiments did not reveal such an effect. The goal of the present paper is to perform a systematic study on the dependence of the cross section on the coherence properties of the projectile. In the theory of atomic collisions there are two alternative ways in describing the ionization by fast ion projectiles. The impact parameter (or the semiclassical) model, assumes a classical trajectory of the projectile, and treats with quantum mechanics only the electrons. The other model, based on quantum scattering theory, includes also the projectile into the quantum system. In this model usually it is assumed that the projectile wave packet in momentum space is sufficiently well peaked about its mean momentum, and a plane wave with infinite coherence width is associated to the projectile. In the present model we have assigned to the projectile a wave packet with a Gaussian profile characterized by a finite coherence width. The position of the wave packet's centre is obtained on the basis of classical scattering. The scattering amplitude is calculated as an inverse Fourier transform of the impact parameter dependent probability amplitude, weighted by the Gaussian profile of the projectile. We study the dependence of the cross sections on the wave packet's width for the ionization of helium by fast ions (100 MeV/amu C^{6+} and 3 MeV protons). The results of our calculations support the importance of the projectile coherence effects in fully differential cross section measurements.

[1]This study was done in collaboration with Ferenc Járai-Szabó and Sándor Borbély.