COMPTON IONIZATION OF HYDROGENBEAM BY TWISTED PHOTONS WITH USE OF THE COLTRIMS DETECTOR

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Cold-Target Recoil-Ion Momentum Spectroscopy (COLTRIMS) is currently the most advanced tool for detailed study of the processes of Compton ionization of atoms [1]. We have performed a theoretical analysis of the capabilities of this method as applied to Compton ionization of an atom by a twisted x-ray photon. Our analysis uses the nonstationary formalism of quantum scattering theory, which, unlike the generally accepted stationary formalism, allows one to take into account the specifics of real initial states (wave packets) of a photon and an atom. We have shown that the energy and angular distribution of ionized electrons measured in coincidence with recoil ions does not depend on the angular momentum projection of the twisted photon on the z-axis, but depends on its opening angle θ_k, which is one of the main twisted-photon characteristics [2].

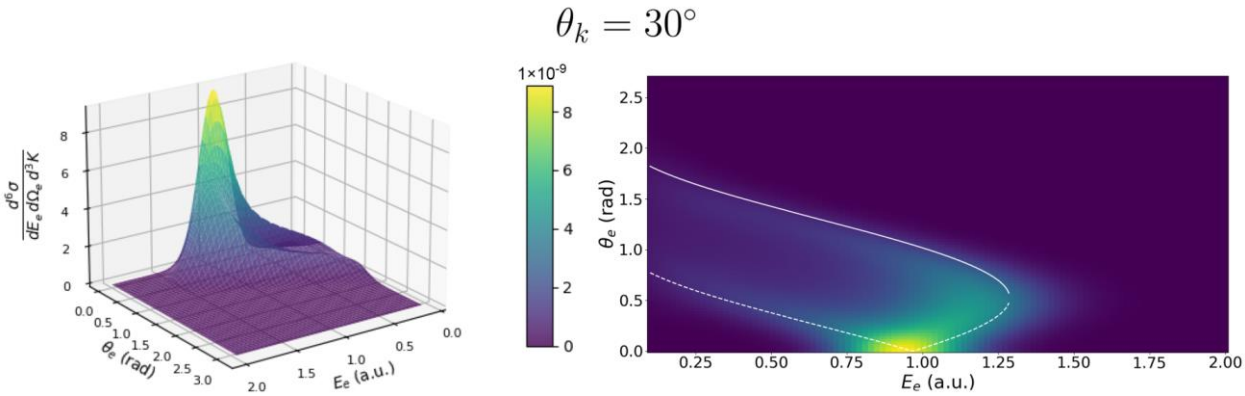

Fig. 1.The fully differentialcross section fora fixed final ion momentum $\mathbf{K}=\mathbf{K}_H$, where $\mathbf{K}_H$ is the average momentum of atoms in the hydrogen atomic beam,versus the electron energy and its scattering angle (left panel). The intensity distribution corresponding to the graph on the leftis shown in the right panel. The initial photonenergy is ω = 3 keV

As an illustration, in Fig. 1 the differential cross section is displayed fora fixed opening angle of twisted photons. The intensity distribution canbe qualitatively explained on the basis of the Klein–Nishinaformula for photon scattering on a free electron: the ionized electron is preferably emitted in the forward direction thatcorresponds to the photon scattering in the backward direction.

References

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[2]. Bornikov K. A., Kouzakov K.A., Popov Yu. V. *Phys.Rev. A* **112**(2) 022812 (2025).