Contribution ID: **47** Type: **Poster**

Electron-ion collision with optically controlled quantum state

Electron-atom collision experiments are widely used to study the structure of bombarded objects. The experimentally determined scattering amplitudes associated with measured cross-sections complement the data obtained in spectroscopic studies. The measurement usually involves the bombardment of the target with a monochromatic electron beam and the detection of non-scattered or scattered electrons. While such experiments are relatively simple to perform with neutral targets, ions are an experimental challenge. Therefore, there is a lack of experimental data (particularly cross-sections) concerning the collisions of electrons with singly charged ions.

In our recent paper [1] we showed that it is possible to measure integral cross-sections for electron-ion collision using a set of ions in a Paul trap. Moreover, the proposed experimental method enabled the determination of the cross-sections for various quantum states of the collision target. The technique's disadvantage was the measurements' relatively low energetic resolution.
One of the goals of such studies is to observe narrow structures in the cross-section functions, related to the formation of autoionizing states during the collisions. It is required to increase the energy resolution of the measurements to make it possible, which is related to the precise control and guidance of the electron beam. We present a new apparatus using a monochromatic electron beam introduced along the axis of the ion trap, which will overcome described problems. Details of the experimental setup and methodology will be discussed.

[1] Ł. Kłosowski, M. Piwiński, „ Experimental method for determination of the integral cross-section for electron impact ionization of ions with optical control of the target's initial quantum state", J. Electron. Spectrosc. Relat. Vol. 260, 147239 p. 1-8, DOI: 10.1016/j.elspec.2022.147239, (2022),

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Session Classification: Monday Poster