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Ion-Li collision dynamics studied with a MOTReMi

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Synopsis In a novel experimental approach a magneto-optical trap (MOT) is combined with a Reaction Microscope (ReMi) and implemented in an ion storage ring. Single ionization measurements were performed with 24 MeV O^{8+} and 6 MeV H^+ projectiles and a state prepared lithium target. We obtained single-, double- and fully differential cross sections and observed features that we attribute to the structure and polarization of target initial states.

The dynamics of target ionization in ion-atom collision has been extensively studied in past decades. The most detailed experimental data available to date are fully differential cross sections (FDCS) obtained with Reaction Microscopes for a helium target. Though many aspects of the collision dynamics for helium are basically understood, severe discrepancies between experiment and calculations persist until today, particularly for high perturbations (e.g.[1]) with $Z_P/v_P > 1$ (Z_P and v_P are projectile charge and velocity in a.u., respectively).
In our experiment we used a magneto-optical trap (MOT) for target preparation in a Reaction Microscope (ReMi) and implemented it in an ion storage ring. In this MOTReMi we used Lithium as target which is particularly interesting for its asymmetric electronic structure with one valence electron and two strongly correlated K-shell electrons.

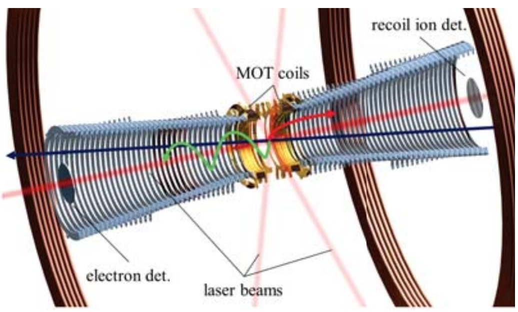

Figure 1. The MOTReMi apparatus

The design of the MOTReMi is shown in fig. 1 [2]. The trapping of atoms and the momentum resolved detection of electrons with the same setup requires a fast switching of the MOT magnetic field. Therefore, a special configuration of MOT coils is employed. A small inclination of the spectrometer by eight degrees allows simultaneously for a large aperture required for the orbiting projectile beam and for possibly small MOT coils.

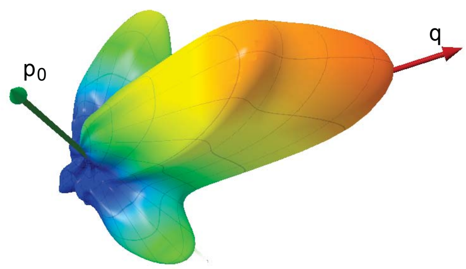

Figure 2. Three-dimensional, fully differential angular distribution of 2s electrons with 1.5 eV and a momentum transfer **q** of 1 a.u.. $\mathbf{p_0}$ is the momentum of the projectile.

In fig. 2 the FDCS for the ionization of 2s electrons due to 24 MeV O^{8+} impact is shown [3, 4]. The pronounced structure with one main peak and two side peaks has not been observed for the helium target. It is also absent for the ionization of 2p electrons, which we investigated by optically exciting our target with the cooling lasers. We attribute this observation to the mapping of the nodal structure of the 2s wavefunction. Details as well as results of ionization of polarized 2p electrons will be presented.

References

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