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Fully Differential Study of Fragmentation Dynamics of Li by Ion Impact Using a MOTRemi Apparatus

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The study of atomic fragmentation processes due to charged particle impact provides insight in the dynamics of correlated few-particle Coulomb-systems, and thus advances our understanding of the fundamentally important few-body problem. In this respect, fully differential data represent the most sensitive test of theoretical models. For ion-atom collisions such data became available only in the last decade exploiting the technique of "Reaction Microscopes," often referred to as cold target recoil ion momentum spectroscopy (COLTRIMS). These kinematically complete experiments almost exclusively focussed on the fragmentation of helium and other rare gas atoms, because these targets can easily be prepared with temperatures below 1K using supersonic gasjets. Magneto-optically trapped (MOT) targets of alkaline metals have also been used. However, so far complete studies of ionization have not been possible as magnetic stray fields in the MOT hampered the momentum resolved electron detection. Here we report on the first fully-equipped and functional MOTRemi, i.e. a Reaction Microscope with a MOT target. This setup is currently implemented in the ion storage ring TSR at the MPIK in Heidelberg that can provide ion beams with high intensities and very low emittances. Lithium is used as a target which is particularly interesting for its simple, but at the same time asymmetric structure with only one weakly bound outer shell electron and two strongly correlated K-shell electrons. Due to the low temperatures ($<$ 1mK) in the MOT, the momentum resolution achieved in our experiment is drastically improved compared to earlier measurements. We studied single ionization of lithium in collisions with 3 Mev protons and 1.5 Mev/amu O^{8+} ions. Due to the high resolution and by means of optical excitation, for the first time initial state selective cross sections for ion impact ionization became available. Fully differential cross sections of the ionization of 1s, 2s and 2p electrons will be presented.