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**Initial-state selective fully differential study on ionization of lithium by ion impact**

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The study of atomic break-up by charged particle impact gives insight into few body systems. Gaining kinematically complete information on simple systems is highly important as it provides the most fundamental and stringent test for state of the art theoretical models. Through the use of "Reaction Microscopes" (ReMi), fully differential data has become readily available for cold gas targets prepared via supersonic expansion. Here, we present a novel experimental improvement on the REMI by using laser-cooled atomic ensemble as the target prepared by a Magneto Optical Trap (MOT) for ion impact collisions. This new experimental setup, the MOTReMi, opens up new atomic systems previously unavailable using conventional techniques. Single ionization of the lithium states 2s, 2p, and 1s were investigated by 6 MeV $H^+$ and 1.5 MeV $amu^{-1}O^{8+}$ impact. In the measured doubly differential cross sections as a function of electron energy and transverse momentum transfer, significant initial state dependence was found. By comparison to several quantum mechanical models, there appear discrepancies for Li(2s) and Li(1s) while there is better agreement for the Li(2p) initial state. Futhermore, the three-dimensional angular distributions of the ejected electrons (i.e. the fully differential cross sections) show strong differences between lithium 2p ionization, lithium 2s ionization, and helium 1s ionization. For Li(2p) ionization, the differences are attributed to the $m_l$ = -1 sub-state being the predominant excited state. In this state, we observe orientational dichroism previously unobserved in ion-atom collisions. For Li(2s) ionization, there are pronounced interference effects which we ascribe to the nodal structure of the 2s wave function.