ABSTRACT

We have employed a momentum imaging technique to measure low energy continuum electrons produced in collisions between fast bare projectile ions and helium and deuterium targets. The research presented is a compilation of three experiments: measurements of electron cross sections singly differential in momentum, measurements of electron production from aligned molecules, and kinematically complete measurements of the single ionization of helium. In the first series of experiments, we measured cross sections differential in each component of the ejected electron momentum vector. This was facilitated by the advent of accelerator technology which allows the time focusing of ion projectile bunches to less than one nanosecond needed to measure the short electron flight times. These data show good agreement with conventional electron spectroscopy as well as theoretical calculations. In the remaining experiments we have taken full advantage of the momentum imaging technique by measuring the ejected target (recoil) ion momentum in coincidence with the electron momentum for both deuterium and helium targets. For the deuterium experiment, the recoil measurement directly inferred the alignment of the internuclear axis of the molecule relative to the beam axis. Our data show an increased dissociative ionization probability for molecules aligned parallel to the beam, as well as an enhanced transverse emission of electrons from molecules aligned perpendicular to the beam. Finally, we have measured the full momentum vector of both the ejected electron and the recoil ion for singly ionizing collisions between bare projectiles and helium. This leads to complete information on the dynamics of all three bodies (projectile, electron, and recoil ion) in the collision, allowing us to determine the dominant two-body momentum exchange(s). Our results indicate that momentum is exchanged between all participants in the collision, and are placed in the context of other collision systems for which this is not the case.