Chapter 5

Conclusions

We conclude this dissertation with a brief overview of the experiments, and the implications of the associated results. In general, we have used an imaging technique to measure the momenta of low energy continuum electrons for a variety of collision systems, and as development of our apparatus progressed, we were able to do increasingly detailed measurements. We have presented the measurements in three distinct sections, distinguished by changes in the apparatus and focus of the research.

The first group of experiments (chapter 2) was made possible by the use of the linear accelerator to time-focus the projectile bunch. This allowed us to accurately measure of the short flight times of the low energy electrons. This flight time measurement was necessary to determine the complete electron momentum vector. Comparison between our results and those of Tribedi *et al.* showed good agreement.

The next major improvement to the apparatus was the addition of a localized target (gas jet). For the second set of experiments (chapter 3), we measured the molecular fragments in coincidence with the low energy electrons ejected in collisions between 30 MeV bare carbon projectiles and deuterium molecules. Fragment distributions in energy indicated that the dominant dissociative process was ionization-excitation. Cross section measurements differential in fragment angle showed evidence that energetic dissociation is more likely for molecules oriented parallel to the projectile beam. For parallel alignment, the projectile more likely to interact *both* electrons in the molecule and the dissociative states are formed via two electron transitions. The low energy electrons were primarily ejected perpendicular to the projectile beam, and showed a slight enhancement for perpendicular molecule orientations, particular for momenta larger than one atomic unit.

The final group of experiments (chapter 4) was kinematically complete measurements of the single ionization of helium. The longitudinal momentum exchange between the three bodies (projectile, electron, and recoil ion) was restricted by the kinematics due to small scattering angles. Our results showed good agreement with CDW theory, and showed clear evidence for increasing post-collision interaction strength with increasing projectile charge. The transverse momentum distributions showed evidence for a large momentum exchange between the projectile and target nucleus (nuclear scattering). The electron-recoil ion momentum exchange has an apparent minimum in the data (for the few systems we have measured) for varying projectile charge to velocity ratio.

There is a wealth of possibilities available for future exploration. A more complete systematic study of the single ionization of He is needed to understand the trends for varying projectile charge and velocity. The inclusion of the internuclear interaction in theoretical models will enable theoreticians to provide insight into the ionizing mechanisms involved in these collisions. In addition, improvements in the apparatus are already underway in our laboratory as well as others. Examples include the introduction of two-stage gas jets for reduced background signal and multi-hit detectors for complete measurements of double (or multiple) ionization. Although we have put a significant amount of effort into the present work, it seems we have only scratched the surface of the possibilities.