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Comparison of Experiment and Theory for Electron Impact Ionization of Isoelectronic Atoms and Molecules

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Synopsis Experimental and Theoretical Triply Differential Cross sections will be presented for low energy electron impact ionization of Ne, CH_4, and NH_3. The collision mechanisms responsible for the various structures found in the cross sections will be discussed.

The study of electron impact single ionization of atoms and molecules has provided valuable information about fundamental collisions. The most detailed information is obtained from triple differential cross sections in which the energy and momentum of all three final state particles is determined. In the early days, experiments were typically performed for which both final state electrons were detected in the scattering plane. These experiments normally found two peaks – one called the binary peak which was attributed to a classical binary collision between the projectile and an electron at rest and one called the recoil peak which was attributed to a binary collision plus a back scattering from the nucleus.

More recently, experiments are being performed out of the scattering plane and these results provide a more sensitive test of theory and provide more insight into the scattering mechanisms. One plane that has proved to be particularly useful is the plane perpendicular to the incident beam direction. Al-Hagan *et al.*[1] recently compared experimental and theoretical results for low energy electron impact ionization of atomic He and molecular H_2 (same number of electrons and protons) in the perpendicular plane. For both He and H_2, peaks were found for 90^0 angular separation between the electrons. On the other hand, for 180^0 back-to-back scattering, a strong peak was found for He while a strong minimum was found for H_2. Al-Hagan *et al.*[1] showed that the 90^0 peak found for both H_2 and He resulted from elastic scattering from the target plus a binary electron-electron collision. The strong difference found for 180^0 scattering was caused by the different nuclear configurations. The elastic collision produces very small impact parameters after the initial collision. For He the projectile electron is very close to the He nuclei following the binary collision, and the strong attraction produces a high probability for backscattering. For H_2, on the other hand, the projectile electron finds itself between the two nuclei with a small net attractive force which causes very little back scattering.

In this work, we report a similar study for scattering from targets with ten electrons and protons – atomic Ne and molecular CH_4 and NH_3. Figure 1 compares experiment with theoretical 3-body distorted wave (3DW) results for ionization of Ne. For this case, Ne looks very similar to He except the 90^0 peaks are missing. Results will be presented for energy pairs from to 2.5 eV to 25 eV for Ne, CH_4 and NH_3.

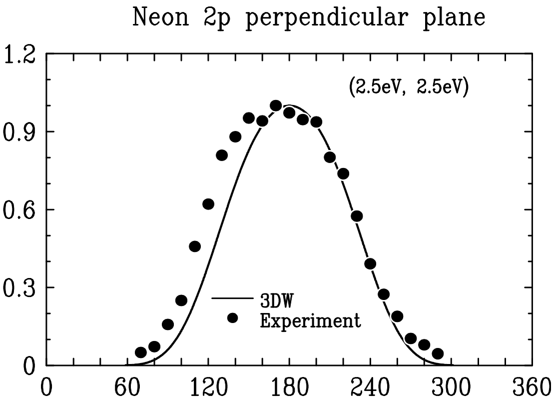

Figure 1. Triple differential cross sections for electron impact ionization of Ne in the perpendicular plane for the case of both final state electrons having an energy of 2.5 eV. The horizontal axis is the angle between the electrons.

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References

[1] O Al-Hagan *et al.* 2009, *Nature Physics* **5**, 59

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