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Energy and angular distributions of electrons emitted in ion collisions with atomic and molecular targets

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A detailed understanding of the principles underlying ion-atom and ion-molecule collisions is essential for plasma modelling and diagnostics. Recent advances in experimental techniques have resulted in detailed and highly accurate kinematically complete measurements. However, theory lags far behind and cannot describe the experiments on differential ionisation. In particular, the description of experimental data on energy and angular distributions of electrons produced in intermediate-energy ion collisions with simple atomic and molecular targets has remained an insurmountable problem for over five decades. We have developed a coupled-channel method that provides the first accurate solution to the problem. The method is based on an expansion of the total scattering wave function using a two-centre pseudostate basis. This allows one to take into account all underlying interdependent processes, namely, direct scattering and ionisation, and electron capture into bound and continuum states of the projectile. Wave packets are used to discretise the continuous spectrum of the target and projectile. The method is applied to calculate the doubly differential cross section as a function of the energy and angle of electrons emitted in proton-induced ionisation of H, He and H_2. Excellent agreement between the obtained results and the experimental data is found. This paves the way for an accurate description of the recent kinematically complete experiments.

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