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Relativistic Calculations of Electron Ionization of Xenon

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We are interested in the ionization of heavy atoms by electrons of intermediate energy. Since the incident particles do not have relativistic energies, the question arises as to why a relativistic treatment of this process is preferable. The answer lies both in the treatment of the target as well as the incident particle. In our case, a relativistic treatment of the target system is done within the j-j coupling scheme where the spin and angular momenta of each electron are coupled to a total angular momentum j. Thus the valence p shell of xenon is split into two subshells, one with $j = 3/2$ and one with $j = 1/2$. Calculations of the target wave functions can be readily carried out using an available program [1]. There is a fine structure splitting of 1.31 eV between these two subshells. Thus the energy required to ionize these two subshells is sufficiently different that they can be distinguished experimentally. The Dirac equations which describe the free electrons in a distorted-wave approximation with non-local exchange explicitly contain the spin of the electron. Thus the treatment of spin-polarized scattering is straightforward and does not require any recoupling of angular momenta as in a non-relativistic scheme. Recent experiments [2,3] have measured the ionization of the $j = 3/2$ valence electrons of xenon when the incident electron makes an arbitrary angle with the plane containing the outgoing electron which have identical energies. We will present calculations for this process to compare with the measurements and discuss the results in terms of the models proposed for the scattering mechanisms giving rise to these non-coplanar events.

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