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Two Electrons Far From Home[1]

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We have developed a computational method that allows us to solve the time dependent Schrodinger equation for two electrons where the number of coupled angular momentum is large. The ability to include a large number of coupled angular momentum is necessary when the two electrons strongly interact at large distances from the nucleus. We have performed test calculations that demonstrated the stability of the method and the convergence with increasing number of angular momenta; the method was stable through the largest number of coupled angular momenta we attempted (approximately 200). We have used this method to perform quantum calculations for the system described in A.L. Landers et al, PRL 102, 223001 (2009). In this experiment, a photon is absorbed by a Ne 1s electron leaving a core hole; the outgoing electron has low energy (order 1 eV). The Ne+ subsequently decays which usually gives an Auger electron of approximately 800 eV. The interaction between the Auger electron and photo-electron gives an interesting pattern in the distribution with respect to the angle between the electrons. A classical calculation gave qualitative agreement with experiment but substantive differences remain. We have also used this computational method to investigate the interaction between two Rydberg electrons. In recent experiments (private communication R.R. Jones), two electrons were placed in similar energy Rydberg states for an alkaline-earth atom. Using a pulsed laser, one electron is placed in a Rydberg wave packet with the other valence electron left in a tightly bound state. A subsequent laser excites the tightly bound electron to a similar radius orbit. This system can be partly controlled by varying the time between the laser pulses and by varying the energies of the two Rydberg electrons. The quantum calculation can study the ionization of this system as a function of time.

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