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Will Allis Prize Talk: Ionization Dynamics of Atoms in Intense, Ultra-short Laser Pulses

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The time-dependent dynamics of atomic electrons in an intense laser pulse can be determined by solving the time-dependent Schrodinger equation. Examination of the time-dependent wave function, obtained by numerical integration of this equation, shows how energy is transferred from the photon field to the most weakly bound electron(s) of the atom. An electron, once it gains sufficient energy to overcome its attraction to the remaining ion core, finds that its subsequent movement is controlled by the oscillating electromagnetic field. The amplitude of the electron's oscillatory motion is substantially greater than the size of the atom so that there is a high probability that the freed electron will experience additional interactions with its parent ion core before it escapes completely. Thus, substantial further transfer of energy from the field to the electron can occur. This leads to the emission of surprisingly high energy photons and electrons, ultra-short light pulses and possibly to further ionization. Results of several numerical studies will be presented to illustrate these processes.