DAMOP09-2009-000026
Abstract for an Invited Paper
for the DAMOP09 Meeting of
the American Physical Society

Generation of localized "Bohr-like" wavepackets in near-circular orbit about the nucleus

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Atoms in high-lying (n $\sim$ 300) Rydberg states provide a valuable laboratory in which to explore the engineering of electronic wavefunctions using carefully-tailored sequences of short electric field pulses whose characteristic times (duration and/or rise/fall times) are less than the classical electron orbital period. The level of control that can be exercised is illustrated with reference to the generation of localized wavepackets in "Bohr-like" near circular orbits. While such wavepackets slowly dephase and undergo dispersion, their localization can be maintained for extended periods (many hundreds of orbits) through external driving using a periodic train of pulses. The wavepackets can be further manipulated by slowly varying, or "chirping," the pulse repetition frequency. The physics underlying these control protocols is explained using classical trajectory Monte Carlo simulations. Even in the absence of external driving, however, wavepacket relocalization is expected at late times due to quantum revivals. The observation of such relocalization is described and demonstrates that quantum phenomena can be seen even in mesoscopic very-high-n atoms. Research undertaken in collaboration with J. J. Mestayer, B. Wyker, C. O. Reinhold, S. Yoshida and J. Burgdörfer.