DAMOP05-2005-000073

Abstract for an Invited Paper
for the DAMOP05 Meeting of
the American Physical Society

Tailoring Rydberg Wavepackets[1]

F. BARRY DUNNING, Rice University

Advances in experimental technique now allow study of the behavior of Rydberg atoms subject to one, or more, pulsed unidirectional electric fields, termed half-cycle pulses (HCPs), whose duration is much less than the classical electron orbital period. In this limit, each HCP simply delivers an impulsive momentum transfer or "kick" to the excited electron. The application of a carefully-tailored sequence of HCPs provides a powerful means to control and manipulate atomic wavefunctions. This task is greatly simplified if the initial wavefunction is first localised in phase space. This can be achieved by exciting quasi-one-dimensional (quasi-1D) Rydberg Stark states and applying a periodic train of HCPs. The phase space for such kicked atoms contains a series of stable islands embedded in a chaotic sea. Only that portion of the initial wavefunction positioned within a stable island survives leading to creation of a non-dispersive wavepacket that undergoes transient phase space localization and that can be steered toward different regions of phase space by "chirping" the frequency and/or amplitude of the HCP train. Application of a single HCP to a quasi-1D atom can also lead to strong transient phase space localization that can be trapped for extended periods using a train of subsequent HCPs. Once localized, further HCPs can be used to engineer a desired final state. For example, a HCP might be used to launch the electron into a near circular orbit or into a highly-elliptical orbit. Although this leads to population of a distribution of higher-n states, this distribution can be narrowed using additional HCPs. These approaches to atomic engineering will be discussed with the aid of recent results.

[1]Research supported by the NSF and Robert A Welch Foundation and undertaken in collaboration with J.C. Lancaster, W. Zhao, J.J. Mestayer, C. Reinhold, E. Persson, S. Yoshida, and J. Burgdorfer.