CFEL SCIENCE

SEMINAR

5th December 2011 – 11:00

Bld. 222 - Seminar Room 013

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Investigation of Coherence and its Decay Mechanisms in an Optical Lattice

In this talk, I present experiments with cold 85Rb atoms in a far-detuned one-dimensional optical lattice. These experiments are motivated by the important role that control of coherent quantum states plays in the field of quantum information processing. For experiments that aim to control quantum systems, characterization of de-coherence mechanisms becomes a crucial task. As a model system, we study quantum vibrational states of atoms in an optical lattice.

I present an experimental study of the application of simple and compound pulses consisting of time-dependent spatial translations to coupling vibrational states of atoms in the optical lattice. Experimental results in strong agreement with numerical simulations show that a square pulse consisting of lattice displacements and a delay is more efficient than single-step and Gaussian pulses. The square pulse can be seen as an example of coherent control [1]. We also compare the effectiveness of these pulses in reviving oscillations of atoms in vibrational superposition states using a pulse-echo technique. The improved echo pulses allow us to probe coherence at longer times than in the past, where a surprising coherence freeze (plateau) is observed. Motivated by this observation, we developed a new two-dimensional pump-probe spectroscopy technique to monitor the evolution of frequency-frequency correlations in the system, a necessary input for understanding the decay of coherence. Through this 2D technique, we monitor the time-dependent changes of frequencies experienced by atoms and characterize the probability distribution of these frequency trajectories. We show that the inferred distribution, unlike a naive microscopic model of the lattice, correctly predicts the main features of the observed echo decay [2].

[1] S. Maneshi, et al., Phys. Rev. A 77, 022303 (2008)

[2] S. Maneshi, et al., Phys. Rev. Lett. 105, 193001 (2010).

Host: R J Dwayne Miller, CFEL/ MPSD