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Echo pulses and temporal decay of motional coherence in optical lattices S. MANESHI, C. ZHUANG, M. PARTLOW, A.M. STEINBERG, CQIQC, IOS and Department of Physics, University of Toronto — We study the quantized centre-of-mass motion of ^{85}Rb atoms trapped in an optical lattice. We have measured the coherence between the quantum vibrational states of the atoms in the lattice wells, and observe a decay of coherence. Here we present studies optimizing echo pulses and using the resulting echoes to study the properties of the sources of decoherence. To generate echo pulses, we use a combination of lattice displacements and delays in order to couple the vibrational states. Experimental results, in agreement with simulations, demonstrate that square pulses are preferable to both single-step and gaussian pulses. We also study the coupling efficiency as a function of lattice depth, finding that this process is more efficient in shallow lattices. We will discuss a number of other avenues for further improving state coupling, including coherent control via interfering pathways, and adiabatic passage. We study the decay of echo amplitude over time in both 1D and 3D lattices. In both cases, we observe an initial exponential decay of echo amplitude followed by a plateau before a final decay. We will discuss the relationship of these features to the time-correlation function of the well-depth fluctuations experienced by the atoms.

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