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Studying decoherence of cold atoms in optical lattices through 2D pump-probe spectroscopy SAMANSA MANESHI, CHAO ZHUANG, XIAOXIAN LIU, LUCIANO CRUZ, AEPHRAIM STEINBERG, CQIQC, IOS and Department of Physics, University of Toronto — We study the quantized centre-of-mass motion of 85Rb atoms trapped in a 1D optical lattice. We have measured the coherence between the quantum vibrational states of the atoms in the lattice wells, and using pulse echo observe a striking "fidelity freeze" which has never before been observed in such systems. Pump-probe spectroscopy provides information about the temporal correlation properties of the instantaneous well depth experienced by the atoms as they drift through a spatially inhomogeneous lattice. In the 1D lattice, atoms are free to move in the transverse plane with their average transverse velocity. Our pump and probe pulses consist of sinusoidal spatial translations of the lattice. Our experimental data show a frequency drift towards lower values as we increase the time between the pump and probe pulses. This is consistent with the transverse expansion of atoms. We study the effect of transverse confinement (a 3D lattice) and different cloud parameters on the echo decay and on the 2D pump-probe spectra, in order to elucidate the connection between transverse motion, frequency correlation time, and decoherence.

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