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Coherent control of Wannier-Stark states via interference between one- and two-phonon excitation CHAO ZHUANG, CHRISTOPHER R. PAUL, SAMANSA MANESHI, LUCIANO S. CRUZ, AEPHRAIM M. STEINBERG, CQIQC, IOS, and Department of Physics, University of Toronto, Canada — We demonstrate that the control of quantum vibrational states in an optical lattice may be achieved by using interference between two-phonon excitation at ω and one-phonon excitation at 2ω. We use this technique to improve the ratio of coherent coupling to loss in our system. In our experiment, ^{85}Rb atoms are trapped in a vertical optical lattice, leading to a tilted-washboard potential when the effect of gravity is considered. While neighboring Wannier- Stark states may be coherently coupled by sinusoidal drive of the lattice displacement at the secular frequency ω, this also leads to leakage into higher excited states and eventual loss from the lattice. We use coherent control to mitigate this problem, by adding a simultaneous parametric drive at 2ω, directly coupling states of the same parity. The resonant drive corresponds to Raman scattering of laser beams phase-modulated (PM) at ω, while the parametric drive corresponds to Raman scattering of laser beams amplitude-modulated (AM) at 2ω. We demonstrate experimentally that quantum interference between the absorption of two PM quanta and one AM quantum can be used to control the branching ratio, and specifically, to improve the ratio of coherent coupling to loss.

Chao Zhuang
CQIQC, IOS, and Department of Physics, University of Toronto, Canada

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