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Quantum control of ultracold atomic collisions in optical lattices
IVAN DEUTSCH, RENE STOCK, University of New Mexico — We present a new method for robustly controlling collisions of ultra-cold atoms in optical lattices based on the "trap-induced shape resonance" (TISR) [1]. Like the magnetic Feschbach resonance, in the TISR a weakly-bound molecular state is made resonant with a trap vibrational state through the trapping potential energy. The TISR allows for strong interaction between trapped but separated atoms, providing new avenues for robust encodings of quantum information, protected from fluctuations in control parameters. A particularly promising candidate species is ^{133}Cs, whose dimer potential posses an extremely weakly bound state near dissociation. Scattering lengths on the order of 100nm are possible for appropriate choices of encodings, larger that the typical trapped wavepacket, and thus leading to very strong interaction. To deal with the complexity of the multichannel scattering problem at short range, and the trapping potential at long range, we have developed a generalized multichannel energy-dependent Fermi pseudo-potential, including higher partial waves, and second order spin-orbit coupling [2]. [1] R. Stock *et al.*, Phys. Rev. Lett. **91**, 183201 (2003). [2] R. Stock *et al.*, Phys. Rev. Lett. **94**, 023202 (2005).

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