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Applications of the trilinear Hamiltonian with three trapped ions[1] ROLAND ESTEBAN HABLUTZEL MARRERO, SHIQIAN DING, GLEB MASLENNIKOV, JAREN GAN, STEFAN NIMMRICHTER, ALEXANDRE ROULET, JIBO DAI, Centre for Quantum Technologies, National University of Singapore, VALERIO SCARANI, DZMITRY MATSUKEVICH, Centre for Quantum Technologies, National University of Singapore; Department of Physics, National University of Singapore — The trilinear Hamiltonian $a^\dagger bc + ab^\dagger c^\dagger$, which describes a nonlinear interaction between harmonic oscillators, can be implemented to study different phenomena ranging from simple quantum models to quantum thermodynamics. We engineer this coupling between three modes of motion of three trapped $^{171}Yb^+$ ions, where the interaction arises naturally from their mutual (anharmonic) Coulomb repulsion. By tuning our trapping parameters we are able to turn on / off resonant exchange of energy between the modes on demand. We present applications of this Hamiltonian for simulations of the parametric down conversion process in the regime of depleted pump, a simple model of Hawking radiation, and the Tavis-Cummings model. We also discuss the implementation of the quantum absorption refrigerator in such system and experimentally study effects of quantum coherence on its performance.

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