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Quantum simulations with a trilinear Hamiltonian in trapped-ion system SHIQIAN DING, GLEB MASLENNIKOV, ROLAND HABLUTZEL, Centre for Quantum Technologies, National University of Singapore, DZMITRY MATSUKEVICH, Centre for Quantum Technologies, National University of Singapore; Department of Physics, National University of Singapore — A non-degenerate parametric oscillator, described by a trilinear Hamiltonian, is one of the most fundamental models in quantum optics. We experimentally realize this kind of interaction in fully quantum regime with three motional modes of three trapped ytterbium ions. This interaction is induced by the intrinsic anharmonicity of Coulomb potential and manifests itself by more than 100 cycles of coherent energy exchange at single quantum level between different motional modes. By exploiting this interaction, we simulate the process of non-degenerate parametric down conversion in a regime of depleted pump, demonstrate deviation from the thermal statistic for the ‘signal’ and ‘idler’ modes and discuss its relation with a simple model of Hawking radiation. We also present experimental results on simulation of Jaynes-Cummings model using this trilinear Hamiltonian.

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