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Coherent control of angular momentum states in a two-ion Coulomb crystal[1] NEIL GLIKIN, ERIK URBAN, SARA MOURADIAN, HARTMUT HAEFFNER, University of California, Berkeley — Coherent control of the motional modes of trapped-ion Coulomb crystals is fundamental to their versatility as a platform for quantum control. Typically, these modes are well-modeled as harmonic oscillators. We demonstrate the preparation and coherent control of a mode of motion which instead can be described as a 2D rotor. Such control could provide access to rich previously-unexplored dynamics in trapped ions. We realize this system using a surface-electrode Paul trap with annular electrodes to trap two $^{40}Ca^{+}$ ions in a cylindrically symmetric trapping potential, forming a Hamiltonian that is well-modeled as a confined two-dimensional semirigid rotor. The ions are prepared in a high angular momentum state at rotational frequencies on the order of 100 kHz, allowing us to address individual rotational sidebands. Coherent Rabi oscillations on these sidebands demonstrate the creation of superpositions of states separated by up to four angular momentum quanta, with oscillation contrasts exceeding 90%. Dynamically decoupled Ramsey experiments show coherence times of a few milliseconds, inversely correlated with the size of the angular momentum superposition.

[1]NSF, ONR

Neil Glikin
University of California, Berkeley

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