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Deterministic Generation of High NOON States in Phonon Modes of a Trapped-Ion System JUNHUA ZHANG, MARK UM, LUMING DUAN, KIHWAN KIM, Tsinghua Univ — We deterministically generate high NOON states (up to N=8) in two motional modes of a single 171Yb+ ion trapped in a three-dimensional harmonic potential. We develop a composite-pulse sequence that creates an arbitrary multi-mode phonon state. We implement anti-Jaynes-Cummings interaction between internal levels and multiple motional modes in a trapped ion system by stimulated Raman laser beams. We apply the scheme to generate a highly entangled NOON state and verify it by observing the characteristic N parity oscillations within a phase range of 2 π. The NOON states can be applied to quantum information processing, quantum metrology including phase sensitive measurements of mechanical oscillations. Moreover, our generation scheme is not limited to the NOON state and can be used to prepare other useful entangled phonon states.

Junhua Zhang
Tsinghua Univ

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