

Abstract Submitted  
for the DAMOP19 Meeting of  
The American Physical Society

**Phonon Tomography with Ancilla Modes in Trapped Ion System** KIHWAN KIM<sup>1</sup>, YAO LU, SHUAINING ZHANG, Institute for Interdisciplinary Information Sciences, Tsinghua University, LEONARDO BANCHI, QOLS, Blackett Laboratory, Imperial College London, GUANHAO HUANG, JINGNING ZHANG, Institute for Interdisciplinary Information Sciences, Tsinghua University, MYUNGSHIK KIM, QOLS, Blackett Laboratory, Imperial College London, WENTAO CHEN, Institute for Interdisciplinary Information Sciences, Tsinghua University — Boson tomography is a fundamental physical problem which has a capacity to show the power of quantum computation. While it has been considered mostly for linear optical systems with photons, phonons for trapped ions are also a good candidate to realize the full tomography of their quantum states. A recent proposal by L. Banchi et al. (PRL 121, 250402 (2018)) shows that with ancilla vacuum modes, the number of measurement settings required for the experiment can be reduced. Here, we demonstrate, for the first time, a full phonon tomography of a two-mode number-restricted input phonon state with a beam splitter operation and projective measurements. Then we use up to two ancilla vacuum modes to realize the reduction of settings for the tomography of this two-mode input state. Our experiment demonstrates a new way to realize boson tomography with minimal resources for a trapped ion system which can be generalized to other physical systems.

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Date submitted: 13 May 2019

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