Abstract Submitted
for the DAMOP18 Meeting of
The American Physical Society

Tunable-Range, Photon-Mediated Atomic Interactions in Multimode Cavity QED YUDAN GUO, VARUN VAIDYA, RONEN KROEZE, Stanford University, KYLE BALLANTINE, School of Physics and Astronomy, University of St. Andrews, ALICIA KOLLAR, Stanford University, JONATHAN KEELING, School of Physics and Astronomy, University of St. Andrews, BENJAMIN LEV, Stanford University — Optical cavity QED provides a platform with which to explore quantum many-body physics in drivendissipative systems. Single-mode cavities provide strong, infinite-range photon-mediated interactions among intracavity atoms. However, these global all-to-all couplings are limiting from the perspective of exploring quantum many-body physics beyond the mean-field approximation. The present work demonstrates that local couplings can be created using multimode cavity QED. This is established through measurements of the threshold of a superradiant, self-organization phase transition versus atomic position. Specifically, we experimentally show that the interference of near-degenerate cavity modes leads to both a strong and tunable-range interaction between Bose-Einstein condensates (BECs) trapped within the cavity. We exploit the symmetry of a confocal cavity to measure the interaction between real BECs and their virtual images without unwanted contributions arising from the merger of real BECs. Atom-atom coupling may be tuned from short range to long range. This capability paves the way toward future explorations of exotic, strongly correlated systems such as quantum liquid crystals and driven-dissipative spin glasses.

Yudan Guo
Stanford University

Date submitted: 26 Jan 2018 Electronic form version 1.4