Abstract Submitted
for the DAMOP20 Meeting of
The American Physical Society

Engineering Tunable, Nonlocal Heisenberg Spin Models in an Optical Cavity[1] ERIC S. COOPER, AVIKAR PERIWAL, EMILY J. DAVIS, Stanford University, GREGORY BENTSEN, Princeton University, JULIAN F. WIENAND, MONIKA H. SCHLEIER-SMITH, Stanford University — Photon-mediated interactions between atoms in an optical cavity promise to enable the study of quantum spin models with complex, nonlocal interaction graphs. In our system, the sign, strength and spatial structure of these interactions are controlled by magnetic and optical fields, and in situ imaging enables visualization of local spin dynamics. We have recently implemented a family of XXZ Heisenberg models with continuous tunability between XY (spin-exchange) and Ising interactions. This tunability enables access to a rich phase diagram, in which we explore a paramagnetic-to-ferromagnetic phase transition predicted by a collective spin model. We show that ferromagnetic XY interactions protect the coherence of the collective spin, opening prospects for designing robust squeezing protocols. Conversely, breakdowns of the collective spin model create complex many-body dynamics of theoretical interest. To better explore these dynamics, current directions include trapping single or small groups of atoms with optical tweezers and improving control over the spatial structure of interactions through the spectrum of a drive field. These advances will allow exploration of new forms of integrability, fast scrambling, and simulation of hard computational problems.

[1]Authors acknowledge support from the DOE and NSF.

Eric S. Cooper
Stanford University

Date submitted: 31 Jan 2020 Electronic form version 1.4