Quantum gas microscopy of triangular-lattice Mott insulators

Ultracold atoms in triangular optical lattices are a versatile platform to study strongly correlated systems in which exotic states of matter appear due to the interplay between charge and magnetic order. Large degeneracies in the many-body ground state of triangular lattices could result in a quantum spin liquid that has been numerically predicted to appear between the metallic and magnetically ordered phases [1]. Kinetic frustration leads to polarons in hole-doped regime even at elevated temperatures [2]. Here, we report on the observation of lithium-6 Mott insulators in a frustrated triangular Hubbard system. The Mott insulators are compared to Determinant Quantum Monte Carlo (DQMC) and Numerical Linked-Cluster Expansions (NLCE) calculations [3]. We observed temperatures of the system below the tunneling energy scale in the lattice, which are consistent with temperatures extracted from spin-spin correlations [4]. Finally, we demonstrate a doublon detection technique using a microwave transfer. We are planning to introduce nearest-neighbor interactions in the frustrated triangular system using Rydberg-dressing implementing an extended triangular Hubbard model which is predicted to host a variety of exotic quantum phases.


Funding
This work is supported by NSF CAREER award PHY-2047275, ONR DURIP award N00014-22-1-2681, the Thomas F. and Kate Miller Jeffress Memorial Trust and the Jefferson Trust. J. M. acknowledges support by The Beitchman Award for Innovative Graduate Student Research in Physics in honor of Robert V. Coleman and Bascom S. Deaver, Jr.