Massachusetts Institute of Technology
Department of Physics

Condensed Matter Theory Seminar

"Chiral groundstate currents of interacting photons in a synthetic magnetic field"

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Abstract: The intriguing many-body phases of quantum matter arise from the interplay of particle interactions, spatial symmetries, and external fields. Generating these phases in an engineered system could provide deeper insight into their nature and the potential for harnessing their unique properties. However, concurrently bringing together the main ingredients for realizing many-body phenomena in a single experimental platform is a major challenge. Using superconducting qubits, we simultaneously realize synthetic magnetic fields and strong particle interactions, which are among the essential elements for studying quantum magnetism and fractional quantum Hall (FQH) phenomena. The artificial magnetic fields are synthesized by sinusoidally modulating the qubit couplings. In a closed loop formed by the three qubits, we observe the directional circulation of photons, a signature of broken time-reversal symmetry. We demonstrate strong interactions via the creation of photon-vacancies, or "holes", which circulate in the opposite direction. The combination of these key elements results in chiral groundstate currents, the first direct measurement of persistent currents in low-lying eigenstates of strongly interacting bosons. The observation of chiral currents at such a small scale is interesting and suggests that the rich many-body physics could survive to smaller scales. We also motivate the feasibility of creating FQH states with near future superconducting technologies. Our work introduces an experimental platform for engineering quantum phases of strongly interacting photons and highlight a path toward realization of bosonic FQH states.

12:00pm
Tuesday, June 14, 2016
Duboc Room (4-331)

Host: Liang Fu