

## **Realizing a Fermi Gas with Strong Non-Local Interactions Using Rydberg Dressing**

**Waseem Bakr**

**Department of Physics, Princeton University, USA**

**Email: [wbakr@princeton.edu](mailto:wbakr@princeton.edu)**

Itinerant quantum gases with strong, non-local interactions can be used for the quantum simulation of many interesting quantum many-body phenomena including quantum magnetism, topological superfluidity and supersolidity. This has spurred the development of various experimental systems with non-local interactions including magnetic atoms and polar molecules, but reaching the regime of non-local interactions strong compared to the kinetic energy has been elusive to date. In this talk, I will present experiments where we induce such interactions in a 2D Fermi gas of lithium-6 atoms using Rydberg dressing. We achieve this by off-resonantly coupling our neutral atoms to a highly excited Rydberg state via a single-photon transition. We measure the interactions using many-body Ramsey interferometry and study the lifetime of the gas in the presence of tunneling, finding that tunneling does not reduce the lifetime. The system is approximately described by a  $t$ - $V$  model on a square lattice where the fermions experience isotropic nearest-neighbor interactions and are free to hop only along one direction. To probe the interplay of non-local interactions with tunneling, we investigate the short-time relaxation dynamics of charge density waves in the gas. We find that strong nearest-neighbor interactions slow down the relaxation due to kinetic constraints. Our work opens the door for quantum simulations of other lattice systems with strong non-local interactions such as extended Fermi-Hubbard models.