Emerging Fermions in a Quantum Spin Liquid

Georg M. Bruun
Department of Physics and Astronomy, Aarhus University

e-mail: *bruungmb@phys.au.dk*

ABSTRACT

We explore the dynamics of holes in a single band extended tJ model where the background spins form a quantum spin liquid (QSL). Using a field theory approach based on a parton construction, we show that while the electrons for most momenta fractionalize into uncorrelated charge carrying holons and spin carrying spinons as generally expected for a QSL, they can form long lived spinon-holon bound states for certain momenta. We then show that quantum gas microscopy with atoms in optical lattices provides an excellent platform for verifying and probing the internal spatial structure of these emergent fermions. The fermions will furthermore show up as clear quasiparticle peaks in angle-resolved photoemission spectroscopy with an intensity determined by their internal structure. For a non-zero hole concentration, the fermions form hole pockets with qualitatively the same location, shape, and intensity variation in the Brillouin zone as the so-called Fermi arcs observed in the pseudogap phase. Our results provide a microscopic mechanism for the conjectured fractionalized Fermi liquid and open up new pathways for exploring the pseudogap phase and high temperature superconductivity as arising from a QSL.