Talk

Phases of the cuprates from the confining transitions of a quantum spin liquid

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The pseudogap metal phase of the hole-doped cuprates can be described by small Fermi surfaces of electron-like quasiparticles, which violates the Luttinger relation and suggests additional fractionalized excitations. We propose that the low-temperature instabilities of the pseudogap state can be understood through the confining transitions of a quantum spin liquid. The spin liquid is the \pi-flux state described by N_f=2 SU(2) fundamental Dirac fermions, which will confine at low energies to the Néel state. At non-zero doping (or smaller Hubbard repulsion U at half-filling) we argue that the confinement occurs via the Higgs condensation of SU(2) fundamental bosonic chargons also moving in the \pi-flux background. At half-filling, the low energy theory of the Higgs sector has N_b = 2 relativistic bosons with a possible emergent SO(5)_b global symmetry describing rotations between a d-wave superconductor, period-2 charge stripes, and the time-reversal breaking ‘d-density wave’ state. At half-filling, we further examine the zero temperature phase transitions between the Néel state, the d-wave superconductor, and the charge order, using a conformal SU(2) gauge theory with fundamental N_f = N_b = 2 and a SO(5)_f ×SO(5)_b global symmetry. At large N_b and N_f, we present computations for the scaling dimensions of various order parameters.

References:

[1] Maine Christos, Zhu-Xi Luo, Henry Shackleton, Ya-Hui Zhang, Mathias S. Scheurer, and Subir Sachdev, https://doi.org/10.1073/pnas.2302701120

[2] Maine Christos, Henry Shackleton, Subir Sachdev, and Zhu-Xi Luo, to appear.

Poster

Average symmetries: anomalies, entanglement and monitored circuits

Symmetry is a powerful tool in understanding quantum systems. Real-world systems can be disordered, decohered and dissipating, such that symmetries are often not exact but only hold on average. For a generic mixed state \rho, a natural definition of average symmetry is U \rho U^{-1} = \rho. The first part of this poster examines the anomalies of such average symmetries as well as their implications for density matrices and reduced density matrices, which further constrains the entanglement in the system. [Ref: Po-Shen Hsin (UCLA), ZXL and Hao-Yu Sun (UT Austin), to appear.]

The second part of this poster concerns quantum circuits with random measurements and post-measurement feedbacks, and provides an understanding from the symmetry perspective. We design a simple (2+1)d random circuit which hosts an ordering transition in the 2d Ising class, in addition to a separate entanglement transition in the 3d percolation class. The order-to-disorder transition can be viewed as the restoration of average symmetry in the system, while at the entanglement transition, the exact symmetry is further restored. The circuit can be understood via mapping to the 2d majority vote model. [Ref: Zhi Li (Perimeter Institute) and ZXL, to appear.]