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Forum de Physique Statistique @ ENS

Mercredi 29 Juin 2022, 12 :00
LPENS, Conf IV
Domaines : cond-mat.stat-mech

Titre : *Unconventional criticality and Fermi-surface reconstruction without symmetry breaking in a simple lattice model of gauge and matter fields*

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Résumé : *Gauge theories play a central role in the theoretical description of unconventional phases of matter that go beyond the standard paradigms of quantum statistical mechanics. While in high-energy physics, gauge fields correspond to fundamental particles, in condensed matter theory they are typically emergent and are invoked as an effective description of the low-energy degrees of freedom. Notable examples include spin-liquids, doped Mott insulators, and the fractional Hall effect, among others. In my talk, I will present a sign-problem free quantum Monte Carlo study of a lattice model hosting 'orthogonal' fermions coupled to an Ising-Higgs gauge theory. Our model provides a simple yet highly non-trivial example of electron fractionalization, which, crucially, remains numerically tractable. We uncover a particularly rich phase diagram arising from strong correlations between gauge and matter fields. In particular, we find that in the background of pi-flux lattice an orthogonal semi-metal (OSM) forms with gapless Dirac fermion excitations. With the tuning of parameters, the OSM undergoes a confinement transition, in which symmetry breaking and confinement are coincident. We construct a field-theoretical description of the transition involving condensation of a matrix Higgs field. The critical theory is predicted to sustain emergent and enlarged local (gauge) and global symmetries. We provide numerical evidence supporting this prediction. We also find that the physical (gauge-neutral) spectral function in the OSM phase comprises four fermion pockets, which smoothly evolve to a 'large' Fermi surface upon approach to a Fermi liquid phase. The reconstruction of the Fermi surface does not involve any form of translational symmetry breaking, in violation of the Luttinger sum rule.*