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Disordered and deconfined: exotic quantum criticality with Dirac fermions

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Critical points of classical second-order phase transitions are thermodynamic phenomena of particular interest, driven by thermal fluctuations and characterized by emergent scale invariance and universal power-law correlations. At zero temperature quantum fluctuations can similarly drive sharp phase transitions between qualitatively distinct many-body ground states, but can potentially produce a richer phenomenology than at classical phase transitions due to intrinsically quantum effects such as quantum statistics, interference, and entanglement. A key problem in the field of quantum criticality is to understand the nature of quantum phase transitions in systems of interacting itinerant fermions, motivated by experiments on a variety of strongly correlated materials. In particular, much attention has been paid in recent years to materials in which itinerant fermions acquire a pseudo-relativistic Dirac dispersion, such as topological insulators and semimetals and certain spin liquids. In this talk I will discuss the rich phenomenology of quantum phase transitions in systems of two-dimensional Dirac fermions, which includes non-Fermi liquid behavior, emergent supersymmetry, finite-randomness quantum critical points in the presence of quenched disorder, and deconfined quantum criticality.

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