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An emergent phase transition as an organizing principle for strongly correlated superconductors

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Band theory and BCS theory are arguably the most successful theories of condensed matter. Yet, both of them fail miserably for high-temperature cuprate superconductors and layered organic superconductors. New theoretical methods are required. In this talk, I compare experiment in cuprates and layered organics with theoretical results obtained from extensions of dynamical mean-field theory for the Hubbard model. In the presence of electronic repulsion strong enough to lead to a Mott insulator at half-filling, both the normal state and the superconducting state are unusual. In the normal state, a first-order transition between a metal and a pseudogap emerges from the Mott insulator. That first-order transition ends at a critical point. In the supercritical region, a Widom line and its precursor determine the crossovers seen experimentally. We demonstrate that much or the phase diagram, including superconductivity, is controlled by this first-order transition, a finite-doping signature of the Mott transition. In this strongly correlated regime, the maximum Tc is not concomitant with an antiferromagnetic quantum critical point, contrary to what is sometimes observed, for example in heavy fermions.

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