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Quantum criticality in the Hubbard model¹

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In large scale dynamical cluster quantum Monte Carlo simulations of the two-dimensional (2D) Hubbard model with only nearest neighbor hopping, we find a quantum critical point (QCP) at finite doping separating a Fermi liquid region at low filling from a non-Fermi liquid pseudogap region near half-filling. Marginal Fermi liquid behavior is seen in the thermodynamics and single-particle properties for a wide range of doping and temperatures above the QCP. The QCP is due to the second-order terminus of a line of first order phase separation transitions that is driven to zero temperature as the next near-neighbor hopping t' vanishes. The superconducting dome surrounds the QCP. The proximity the QCP and the dome is due to an algebraic divergence, replacing the BCS log divergence, of the bare pairing polarization. This behavior is captured with a simple variation of the quantum critical BCS formalism.

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