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Mott transition as an organizing principle for high-temperature superconductivity (I)

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In the presence of strong electronic repulsion, a half-filled-band material can be insulating, instead of metallic as one would have expected from standard solid-state physics. Such a material is a Mott insulator. The first-order transition from metal to Mott insulator as a function of interaction strength in two-dimensions is well described by cluster generalizations of dynamical mean-field theory. In this talk we show, using that method, that an extension of the first-order Mott transition persists when the insulator is doped, and that this transition controls much of the phase diagram of the high-Tc cuprates. It leads to a temperature T*, near half-filling, below which density of states is lost. This is the so-called pseudogap regime. The T* line as a function of doping has a slope and an intercept that depend on pressure, band structure and magnetic field in ways that are consistent with experiments. In addition, the remnant of the first-order Mott transition away from half-filling also controls high-temperature superconductivity. The superfluid stiffness is highly non-BCS and is likely to control the value of the superconducting transition temperature in the pseudogap regime. Coexistence with other phases is more detrimental to superfluid stiffness than it is to the superconducting order parameter.

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