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Mott Transition, Antiferromagnetism, and d-wave Superconductivity in Two-Dimensional Organic Conductors and in Cuprates Using Cluster Dynamical Mean Field Theory[1]

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The main features of the phase diagram of high-temperature superconducting cuprates are a Mott insulator at half-filling, a pseudogap at finite doping and, in the ground state, the competition between antiferromagnetism, d-wave superconductivity and possibly other inhomogeneous phases. In the layered organics of the κ-BEDT-X family, it is pressure instead of doping that is varied but the competing phases and the Mott insulating behavior are similar to the cuprates. Approaches that claim to explain d-wave superconductivity in the cuprates must also explain this phenomenon in all other related classes of compounds described by the Hubbard model. Using Cluster Dynamical Mean-Field theory, we show that the main features of both phase diagrams, cuprates and organics, can be understood from the one-band model with hopping parameters taken from band structure and interaction of the order of the bandwidth. We emphasize the case of the organics, studying the Mott transition, antiferromagnetism and superconductivity on the anisotropic triangular lattice. The Mott transition in the normal phase can be continuous or first order depending on the value of the frustrating hopping t'/t. A d-wave superconducting phase appears between an antiferromagnetic insulator and a metal for $t'/t = 0.3 - 0.7$, or between a nonmagnetic Mott insulator (spin liquid) and a metal for $t'/t \geq 0.8$, in agreement with experiments on layered organic conductors including κ-$(ET)_2Cu_2(CN)_3$. These phases are separated by a strong first order transition. The phase diagram gives much insight into the mechanism for d-wave superconductivity and on the question of the glue.

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