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Intertwined Orders and the Physics of High Temperature Superconductors

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Complex phase diagrams are generic feature of quantum materials that display high temperature superconductivity. In addition to d-wave superconductivity (or other unconventional states), these phase diagrams typically include various forms of charge-ordered phases, including charge-density-waves and/or spin-density waves, and electronic nematic states. In most cases these phases have critical temperatures comparable in magnitude to that of the superconducting state,and appear in a “pseudo-gap” regime. In these systems the high temperature state is not a good metal with well-defined quasiparticles but a “strange metal”. These states typically arise from doping a strongly correlated Mott insulator. With my collaborators we have identified these behaviors as a problem with “Intertwined Orders”. A Pair-density wave is a type of superconducting state which embodies the physics of intertwined orders. In this lecture I will discus the phenomenology of intertwined orders and the quantum materials that are known to display these behaviors.

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