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Buckley Prize Talk: The Suprerconductor-(Metal)-Insulator Transition

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While the classical theory of phase transitions has been extraordinarily successful, there are several reasons to exercise caution when applying this approach to the zero temperature superconducting transition. First, experimental identification of the relevant phases requires extrapolation to zero temperature, which becomes complicated, especially when one needs to identify sources of dissipation. In addition, since superconductivity may be highly inhomogeneous as appreciable superconducting order parameter may be concentrated in "superconducting puddles" due to disorder and/or spontaneous phase separation, the nature of the quantum phase transition to a superconducting state may be highly anomalous, where the system attempts to optimizes the formation of puddles with the Josephson coupling among them to obtain global superconductivity. In this talk we will review some of the consequences of these considerations, emphasizing the possible emergence of anomalous metallic phases close to the superconductor-insulator transition.