Metal-Insulator Crossover in the 2D Hubbard Model

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The interaction is driven metal-insulator transition (MIT) has been for many years a problem of central focus for the field of strongly correlated electrons, where it plays a key role in the quest for understanding high-temperature superconductivity. The basic microscopic model – the single-band Hubbard model with nearest-neighbour hopping on the square lattice – can nowadays be accurately emulated and probed with ultracold atoms in optical lattices at ever-decreasing temperatures. However, quantitative and even qualitative theoretical understanding of the MIT in this system has remained a challenge due to nontrivial long-range correlations. I will present a controlled description of the problem in the thermodynamic limit enabled by the diagrammatic Monte Carlo approach, focusing on signatures of the emerging insulating state, the transitional non-Fermi-liquid regime, and the underpinning spin and charge correlations. The rich physics is predicted in a range of parameters amenable to experimental verification with ultracold atoms in optical lattices.