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Building Blocks for Cluster Mott Insulators

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The Hubbard model provides a playground for investigating the physics of a wide range of strongly correlated systems. An important feature of these systems is the Mott insulator phase, where at half-filling, an electron gets localised on a single lattice site. In this work, we extend the idea to cluster Mott insulators– where an electron is now localised on clusters of sites. To that end, we study the Hubbard model on a plethora of two-dimensional clusters, at different select fillings. Since strong electron correlations often occur in proximity to a Mott insulating state, we write down a general interaction term for such a cluster Mott insulator. We then explore different regimes of the interplay of strong correlations and hopping within these clusters, and their respective effective degrees of freedom. It is also possible to go beyond the single-orbital “cluster” Hubbard model and include multiple orbitals and/or interactions among them. This makes it closer to real materials. Once a blueprint for these building blocks has been established, they can be connected through inter-cluster terms, giving rise to novel Hamiltonians.

Category

Solid State (Theory)

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