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### **Engineering Strongly Correlated States with Ultracold Atoms**

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Optical lattices containing ultracold alkali atoms represent nearly ideal manifestations of Hubbard models. As a result, they are being used to study poorly understood quantum states of matter. Some of the work in my group uses numerical modeling to help guide experiments in these searches. I will review our recent work that compares with ongoing optical lattice experiments trying to emulate the Fermi-Hubbard model in particular. The Fermi-Hubbard model is thought to capture some of the essential features of high temperature superconductors. I will discuss recent progress in using optical lattices to probe the controversial phase diagram of the Fermi-Hubbard model. I will also discuss a proposal to generalize current experimental setups beyond conventional Hubbard models to engineer exotic quantum states. We find that optical lattice experiments can use synthetic gauge fields to realize fractionalized collective excitations.