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Strongly Correlated Quantum Gases Trapped in 3D Spin-Dependent Optical Lattices

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Optical lattices have emerged as ideal systems for exploring Hubbard model physics, since the equivalent of material parameters such as the ratio of tunneling to interaction energy are easily and widely tunable. In this talk I will discuss our recent measurements using novel lattice potentials to realize more complex Hubbard models for bosonic ^{87}Rb atoms. In these experiments, we adjust the polarization of the lattice laser beams to realize fully three-dimensional, spin-dependent cubic optical lattices. We demonstrate that atoms can be trapped in combinations of spin states for which superfluid and Mott-insulator phases exist simultaneously in the lattice. We also co-trap states that experience a strong lattice potential and no lattice potential whatsoever. I will discuss recent measurements revealing a mechanism similar to Kapitza resistance that leads to thermal decoupling in this latter combination. The implications for sympathetic cooling and thermometry using species-dependent lattices will be outlined.