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Mixed Bose-Fermi Mott Phases and Phase Transitions[1]

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A recent experiment with an ultra-cold mixture of ^{1}74Yb and ^{1}73Yb atoms in an optical lattice [S. Sugawa e. al. Nature Physics 7, 642 (2011)] found a remarkable quantum phase that can be described as a mixed Mott insulator. Such a an incompressible state established at integer combined filling of the two species, must have residual low energy Fermionic degrees of freedom associated with relative motion of the two species. I will discuss the novel quantum states formed by the composite Fermions in the mixed Mott insulator as well as the unconventional phase transitions separating these states from the compressible Bose-Fermi mixture established at weak interactions. Finally I will propose to utilize the mixed Mott insulator as a quantum simulator for models of the doped Mott insulator relevant to high Tc superconductivity. The new approach, where the bosonic atoms play the role of doped holes offers significant advantages over direct simulation of the Hubbard model. In particular the mixed Mott plateau naturally provides a flat trap potential to the doped holes, while the hole doping is easily tuned by varying the relative fraction of the bosons.

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