Quantum Melting of Valence Bond Crystal Insulators and Novel Supersolid Phase

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Itinerant strongly correlated particles on frustrated lattices are at the heart of many recent theoretical developments. These are largely motivated by exciting new exotic experimental behaviors ; A number of electronic pyrochlore (a typical 3D frustrated lattice) systems show heavy fermion behaviors and proximity to a metal-insulator transition thought to be connected with the interplay between strong correlations and frustration. Taking into account the latter is also probably very important for describing the additional superconducting behavior in some of these systems (e.g. LiTi2O4).

In this presentation, I will consider both bosonic and fermionic Hubbard models on the checkerboard lattice, the two-dimensional analog of the pyrochlore lattice, for infinite on-site repulsion. At fractional particle density n=1/4 and strong nearest-neighbor repulsion, insulating Valence Bond Crystals (VBC) of resonating particle pairs are stabilized. Melting of these bosonic/fermionic crystals into superfluid/metallic phases under increasing hopping will be dicussed at T=0K. More specifically, I will show the presence of an unconventional commensurate VBC supersolid region, precursor to the melting of the bosonic mixed-anisotropic crystal. Finally, the optical properties of these systems will be presented.

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