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Orbital ice: an exact Coulomb phase on the diamond optical lattice[1] GIA-WEI CHERN, University of Wisconsin at Madison and Los Alamos National Lab, CONGJUN WU, University of California, San Diego — The rapid advances in loading and controlling alkali atoms on the excited bands of optical lattices have made it possible to investigate orbital-related many-body physics in new settings. Here we demonstrate the existence of orbital Coulomb phase as the exact ground state of p-orbital exchange Hamiltonian on the diamond lattice. The Coulomb phase is an emergent state characterized by algebraic dipolar correlations and a gauge structure resulting from local constraints (ice rules) of the underlying lattice models. For most ice models on the pyrochlore lattice, these local constraints are a direct consequence of minimizing the energy of each individual tetrahedron. On the contrary, the orbital ice rules are emergent phenomena resulting from the quantum orbital dynamics. We show that the orbital ice model exhibits an emergent geometrical frustration by mapping the degenerate quantum orbital ground states to the spin-ice states obeying the 2-in-2-out constraints on the pyrochlore lattice. We also discuss possible realization of the orbital ice model in optical lattices with p-band fermionic cold atoms. [1] Gia-Wei Chern and Congjun Wu, arXiv:1104.1614 (2011).

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