Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

Quantum criticality and fractional charge excitations in itinerant ice-rule systems MASAFUMI UDAGAWA, HIROAKI ISHIZUKA, YUKITOSHI MOTOME, Dept. of Applied Physics, Univ. of Tokyo — "Ice rule" is a configurational constraint on Ising-type variables defined on tetrahedron-based lattices, such as a pyrochlore lattice, so that two out of the four sites on a tetrahedron are in the opposite state to the other two. This concept plays an important role in many systems, such as water ice I_h, magnetite Fe_3O_4, and spin ice materials $Ho(Dy)_2Ti_2O_7$. Under the ice-rule constraint, the ground state is disordered and retains macroscopic degeneracy. Nevertheless, the ice-rule configuration is not completely random but has a peculiar spatial structure with quasi-long-range correlation. It is interesting to ask how itinerant electrons change their properties by coupling to this anomalous spatial structure. To answer this problem, we adopt an extended Falicov-Kimball model as a minimal model, in which itinerant electrons interact with localized charge degrees of freedom under the ice rule. We exactly solve this model on a loop-less variant of the tetrahedron-based lattices, a tetrahedron Husimi cactus and clarify the ground-state phase diagram. The exact solution reveals a quantum critical point separating two insulating phases, where a novel non-Fermi-liquid behavior emerges. We also discuss the nature of fractional excitations breaking the ice-rule manifold.

Masafumi Udagawa
Dept. of Applied Physics, Univ. of Tokyo

Date submitted: 04 Dec 2012 Electronic form version 1.4