Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Numerical evidence of quantum melting of spin ice: quantum-classical crossover YASUYUKI KATO, RIKEN Center for Emergent Matter Science, SHIGEKI ONODA, Condensed Matter Theory Lab., RIKEN; RIKEN Center for Emergent Matter Science — Unbiased quantum Monte-Carlo simulations are performed on the simplest case of the quantum spin ice model, namely, the nearest-neighbor spin-$\frac{1}{2}$ XXZ model on the pyrochlore lattice with an antiferromagnetic longitudinal and a weak ferromagnetic transverse exchange couplings, J and $J_\perp$. On cooling across $T_{\rm CSI} \sim 0.2J$, the specific heat shows a broad peak associated with a crossover to a classical Coulomb liquid regime characterized by a remnant of the pinch-point singularity in longitudinal spin correlations as well as the Pauling ice entropy for $|J_\perp| \ll J$, as in classical spin ice. On further cooling, the entropy restarts gradually decaying to zero for $J_\perp > J_{\perp c} \sim -0.104J$, as expected for bosonic quantum Coulomb liquids. With negatively increasing $J_\perp$ across $J_{\perp c}$, a first-order transition occurs at a nonzero temperature from the quantum Coulomb liquid to an XY ferromagnet. Relevance to magnetic rare-earth pyrochlore oxides is discussed.

Shigeki Onoda
RIKEN

Date submitted: 14 Nov 2014

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