

Massachusetts Institute of Technology  
Department of Physics

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Condensed Matter Theory Seminar

"Quantum valence bond ice theory for proton-driven quantum spin-dipole liquids"

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**Abstract:** We present a theory of a hybrid quantum liquid state, quantum spin-dipole liquid (QSDL), in a hydrogen-bonded electron system, by combining a quantum proton ice and Anderson's resonating valence bond spin liquid, motivated by the recent experimental discovery of a proton-driven QSDL in kappa-H<sub>3</sub>(Cat-EDT-TTF)<sub>2</sub> (a.k.a. H-Cat). In our theory, an electron spin liquid and a proton dipole liquid are realized simultaneously in the ground state called quantum valence bond ice, while neither of them can be established independently of the other. Analytical and numerical calculations reveal that this state has a volume-law entanglement entropy between spins and dipoles, which is far beyond the (crude) Born-Oppenheimer approximation. We also examine the stability of QSDL with respect to perturbations and discuss implications for experiments in H-Cat and its deuterated analog D-Cat.

[1] M. G. Yamada and Y. Tada, arXiv:1903.03567

**12:00pm**  
**Tuesday, April 2, 2019**  
**Duboc Room (4-331)**

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Host: Debanjan Chowdhury