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Quantum Water Ice NIC SHANNON, OWEN BENTON, Okinawa Institute of Science and Technology Graduate University, OLGA SIKORA, Jagiellonian University, Krakow — There is now a growing body of evidence, from both simulation [1] and experiment [2], that the protons in common, hexagonal water ice are not merely disordered, but mobile, collectively tunnelling from one configuration to another. In this talk we revisit the theory of proton correlations in hexagonal water ice, showing how the disordered state selected by the ice rules changes, once collective quantum tunnelling is taken into account [3]. We find that correlations are governed by a lattice-gauge theory with exactly the same structure as electromagnetism, in which the low–energy excitations of protons have the character of "photons". The predictions of the quantum theory are shown to be in quantitative agreement with the results of quantum Monte Carlo simulations of hexagonal water ice, and to reproduce the "wings" of incoherent inelastic neutron scattering observed by Bove et al. [2]. These results raise the intriguing possibility that the protons in hexagonal water ice could form a quantum liquid with many of the same properties as the quantum spin liquids sought in frustrated magnets. [1] C. Drechsel-Grau and D. Marx, Phys. Rev. Lett. 112, 148302 (2014). [2] L. Bove et al., Phys. Rev. Lett. 103, 165901 (2009). [3] O. Benton, O. Sikora and N. Shannon, arXiv:1504.04158.

Nic Shannon
Okinawa Institute of Science and Technology Graduate University

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