Day 2

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Title: Experimental Realization of Spin Liquids in a Programmable Quantum Device

Abstract:
We build and probe a Z_2 spin liquid in a programmable quantum device，the D-Wave DW-2000Q. To realize this state of matter，we design a Hamiltonian with combinatorial gauge symmetry using only pairwise-qubit interactions and a transverse field，i.e.，interactions which are accessible in this quantum device. The combinatorial gauge symmetry remains exact along the full quantum annealing path，landing the system onto the classical 8-vertex model at the endpoint of the path. The output configurations from the device allows us to directly observe the loop structure of the model. Moreover，we deform the Hamiltonian so as to vary the weights of the 8 vertices and show that we can selectively attain the 6-vertex (ice model)，or drive the system into a ferromagnetic state. We present studies of the phase diagram of the system as a function of the 8-vertex deformations and effective temperature，which we control by varying the relative strengths of the programmable couplings，and we show that the experimental results are consistent with theoretical analysis. Finally，we identify additional capabilities that，if added to these quantum devices，would allow us to realize Z_2 quantum spin liquids on which to build topological qubits.