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Charging a quantum spin network towards Heisenberg-limited precision

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We present a cooperative protocol to charge quantum spin networks up to the highest-energy configuration, in terms of the network's magnetization. The charging protocol leverages spin-spin interactions and the crossing of a phase transition's critical point to achieve superextensive charging precision.
The cooperative protocol guarantees a precision advantage over any local charging protocol and leads to fluctuations (standard deviation) of the magnetization that scale as $1/N$, with N being the number of spins in the network, i.e., the size of the spin battery.
This precision scaling mirrors the Heisenberg limit for parameter estimation in quantum metrology. We test our protocol on the D-Wave's Advantage quantum processing unit by charging sub-lattices with sizes ranging from 40 to $5\,612$ spins, achieving the highest-energy configuration with a sizeable superextensive charging precision scaling, and outperforming the local charging precision by four orders of magnitude.

Theme

Theme 2. Quantum effects in energy processes and materials

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