JOURNAL CLUB: Quantum coarsening and collective dynamics on a programmable simulator

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Understanding the collective quantum dynamics of non-equilibrium many-body systems is an outstanding challenge in quantum science. In particular, dynamics driven by quantum fluctuations are important for the formation of exotic quantum phases of matter1, fundamental high-energy processes2, quantum metrology3,4 and quantum algorithms5. Here we use a programmable quantum simulator based on Rydberg atom arrays to experimentally study collective dynamics across a (2+1)-dimensional Ising quantum phase transition. After crossing the quantum critical point, we observe a gradual growth of correlations through coarsening of antiferromagnetically ordered domains<a id="ref-link-section-d2856693e703" title="Samajdar, R. & Huse, D. A. Quantum and classical coarsening and their interplay with the Kibble-Zurek mechanism. Preprint at https://arxiv.org/abs/2401.15144

(2024)." href="https://www.nature.com/articles/s41586-024-08353-5#ref-CR6" data-track="click" data-track-action="reference anchor" data-track-label="link" data-test="citation-ref">6. By deterministically preparing and following the evolution of ordered domains, we show that the coarsening is driven by the curvature of domain boundaries, and find that the dynamics accelerate with proximity to the quantum critical point. We quantitatively explore these phenomena and further observe long-lived oscillations of the order parameter, corresponding to an amplitude (?Higgs') mode7. These observations offer a viewpoint into emergent collective dynamics in strongly correlated quantum systems and non-equilibrium quantum processes.

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