Quantum Domain Melting in an Electronic Crystal and Its Simulation with a Quantum Computer

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The ordering of systems emerging through non-equilibrium symmetry breaking transitions is commonly accompanied by domain formation which strongly modifies the bulk materials' properties. The underlying microscopic physics that defines the system's energy landscape for tunneling between domain configurations is of interest in many different areas [1-8]. Domains may reconfigure by thermally-driven microscopic processes[9, 10], or - in quantum systems - by macroscopic quantum tunneling (MQT). Here, we report quantum domain melting in two embodiments: an electronic crystal 1T-TaS_2, and its matching simulation on a quantum computer. We use scanning tunneling microscopy to measure the time-evolution of electronic domain reconfiguration dynamics, and compare this with the time evolution of domains in an ensemble of entangled correlated electrons in simulated quantum domain melting. The domain reconfiguration is found to proceed by tunneling in an emergent, self-configuring energy landscape, with remarkable correspondence between a quantum charged lattice gas model and experiment exhibiting characteristic ragged time evolution and temperature-dependence observed macroscopically. Understanding the quantum processes involved in electronic domain melting opens the way to experimental observation and modelling mesoscopic emergent behaviour in non-equilibrium interacting many-body quantum systems at the microscopic level.

References

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