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Observation of a Dynamical Phase Transition in a Quantum Degenerate Fermi Gas[1]

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Out-of-equilibrium quantum systems can display fascinating phenomena that cannot exist in equilibrium and that fall outside the typical framework of statistical mechanics. Testing conjectured universal behaviors and new organizing principles of dynamical quantum matter is therefore in high demand. One emerging new paradigm is the dynamical phase transition (DPT) characterized by the existence of a long-time-average order parameter that distinguishes two non-equilibrium phases. In this talk we report the observation of a DPT in a trapped quantum degenerate Fermi gas[1]. Above a critical interaction strength, a non-equilibrium magnetization is long lived, and protected by an energy gap against inhomogeneous field-induced dephasing. Through detailed comparisons to theory and by testing the reversibility of the collective many-body dynamics, we identify a regime in which the complex far-from-equilibrium dynamics of interacting fermions is quantitatively described by a collective Heisenberg model with an inhomogeneous axial field, a canonical model for magnetism recently used to describe quenched superconductors. Our quantum simulation of this model reveals the "phase-I" to "phase-II" transition predicted to exist but not yet directly observed in *s*-wave superconductors. [1] Observation of a Dynamical Phase Transition in the Collective Heisenberg Model,S.Smale, P. He, B. A. Olsen, K. G. Jackson, H. Sharum, S. Trotzky, J. Marino, A. M. Rey and J.H. Thywissen, arXiv:1806.11044

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