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(U*) Connection between non-analyticities and universal structures in many-body systems

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The study of many-body quantum systems undergoing non-equilibrium dynamics has received a lot of interest in the past few years. One way to characterize such systems is by monitoring non-analytic behavior of physical quantities that might occur as a function of time. This is precisely the aim of the theory of dynamical phase transitions. Another way is by looking at universal structures that generally form in many-body systems, as seen through the wavefunction. In this case, Catastrophe theory is a framework which allows one to mathematically describe universal features of wavefunctions via a set of scaling exponents. We found strong evidence suggesting that in fact both theories are related. By studying the transerve field Ising model with infinite range interactions, which can be simulated in ultra-cold atoms and trapped ions experiments, we were able to relate non-analyticities occurring at critical times to universal structures appearing in the wavefunction. More precisely, we numerically calculated a quantity called the Loschmidt rate function as a function of time, and found kinks occurring periodically in time that coincided with the universal structures of the time-evolved wavefunction, identified via scaling laws.

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