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Cluster Methods for Dissipative Phase Transitions OSCAR VIYUELA GARCIA, Massachusetts Institute of Technology, JIASEN JIN, Dalian University of Technology, ALBERTO BIELLA, NEST Scuola Normale Superiore di Pisa, LEONARDO MAZZA, Ecole Normale Suprieure de Paris, JONATHAN KEELING, University of St. Andrews, UK, ROSARIO FAZZIO, ICTP Trieste, DAVIDE ROSSINI, NEST Scuola Normale Superiore di Pisa — We show that short-range correlations have a dramatic impact on the steady-state phase diagram of quantum driven-dissipative systems. This effect, never observed in equilibrium, follows from the fact that ordering in the steady state is of dynamical origin, and is established only at very long times, whereas in thermodynamic equilibrium it arises from the properties of the (free) energy. To this end, by combining the cluster methods extensively used in equilibrium phase transitions to quantum trajectories and tensor-network techniques, we extend them to non-equilibrium phase transitions in dissipative many-body systems. We analyse in detail a model of spin-1=2 on a lattice interacting through an XYZ Hamiltonian, each of them coupled to an independent environment that induces incoherent spin flips. In the steady-state phase diagram derived from our cluster approach, the location of the phase boundaries and even its topology radically change, introducing reentrance of the paramagnetic phase as compared to the single-site mean field where correlations are neglected. Furthermore, a stability analysis of the cluster mean field indicates a susceptibility towards a possible incommensurate ordering, not present if short-range correlations are ignored. Phys. Rev. X 6, 031011 (2016)

Oscar Viyuela
Massachusetts Institute of Technology

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