Decorated domain wall construction for quantum phase transitions in 2+1D

March 21, 2023

Whereas the classification of topological phases of matter is by now well-established, the study of quantum phase transitions (QPT) between them is still largely unexplored, and far more challenging. We introduce a solvable model in this class which describes a triangular lattice Ising antiferromagnet for which each domain wall is decorated by a gapless spin chain. The macroscopic degeneracy between antiferromagnetic configurations is only split by the Casimir energy of each decorating spin chain, i.e. the finite-size corrections to their ground state energy. Remarkably, we found a decorating spin chain for which the Casimir energy is positive, which makes it favorable for domain walls to coalesce into a single, macroscopically long 1D "snake" lacing the whole 2D system. By using a Jordan-Wigner transformation along the snake, we obtain a fermionic description of this (two-dimensional!) model and calculate its two-point correlators and entanglement entropy S. We observe a transition from an area law in the snake phase to an $S \sim L \log(L)$ law in a competing stripe phase.