Nonperturbative RG treatment of amplitude fluctuations for $|\varphi|^4$ topological phase transitions

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(Dated: June 1, 2017)

The study of the Berezinskii-Kosterlitz-Thouless (BKT) transition in two-dimensional $|\varphi|^4$ models can be performed in several representations, and the amplitude-phase (AP) Madelung parametrization is a natural way to study the contribution of density fluctuations to non-universal quantities. We show how one can obtain a consistent phase diagram in the AP representation using the functional renormalization group scheme. Constructing the mapping between $|\varphi|^4$ and the XY models allows us to treat these models on equal footing. We estimate universal and non-universal quantities of the two models and find good agreement with available Monte Carlo results. The presented approach is flexible enough to treat parameter ranges of experimental relevance.