An Introduction to Renormalization Group and Critical Phenomeon

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1 Introduction

In modern physics, the concept of "low-energy effective theory" is very important.

2 General Theory of Renormalization Group

2.1 Basic Steps

2.2 β-function

2.3 Fixed point and renormalization flow

2.4 Scaling function and critical exponents

3 Example 1. Ising Model and ϕ^4 Theory: One-loop renormalization

3.1 Partition Function

3.2 One-loop renormalization

3.3 Rescaling and the critical exponents of Ising Model

4 Example 2. Kosterlitz-Thouless Transition and Topological Excitations

4.1 Classical XY model

4.2 The vortex excitation

4.3 First order renormalization

5 Example 3. Dilute Bose Gas and its renormalization analysis