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Critical exponents of surface-interacting self-avoiding walks on a family of truncated n-simplex lattices

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Abstract

We study the critical behavior of surface-interacting self-avoiding random walks on a class of truncated simplex lattices, which can be labeled by an integer $n \geqslant 3$. Using the exact renormalization group method we have been able to obtain the exact values of various critical exponents for all values of n up to $n = 6$. We also derived simple formulas which describe the asymptotic behavior of these exponents in the limit of large n ($n \to \infty$). In spite of the fact that the coordination number of the lattice tends to infinity in this limit, we found that most of the studied critical exponents approach certain finite values, which differ from corresponding values for simple random walks (without self-avoiding walk constraint).

Keywords: Polymer adsorption; Fractals; Self-avoiding walks; Critical exponents; Renormalization group

1. Introduction

Configurational properties of a single polymer chain in the vicinity of an attractive impenetrable wall have been studied a long time ago (see, for instance, [1]), as a problem of great theoretical and practical importance. The general picture that springs from these studies [2–4] reveals that, under certain conditions, polymer chain can undergo an adsorption–desorption transition. The essential physics of a polymer chain near a surface can be captured by the self-avoiding random-walk (SAW) model on a semi-infinite lattice, with an energy contribution ε_w for each step (monomer) of the walk along the lattice boundary. This leads to an increased probability, characterized by the Boltzmann factor $w = \exp(-\varepsilon_w/k_B T)$, of making a step along the attractive wall

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$$F_{C_1B} = 2A_1^2A_2^3 + 18A_1^2A_2^2B_2 + 104A_1^2A_2B_2^2 + 296A_1A_2B_1B_2^2 + 428A_2B_1^2B_2^2 + 340A_1^2B_2^3 + 1712A_1B_1B_2^3 + 2940B_1^2B_2^3 + 708A_1^2B_2^2C_1 + 4168A_1B_1B_2^2C_1 + 12040B_1^2B_2^2C_1 + 28800B_1^2B_2C_1^2 + 47168B_1^2C_1^3, \tag{A.17}$$

$$F_{C_1C} = A_2^5 + 236A_2^2B_2^3 + 1042A_2B_2^4 + 2408B_2^5 + 14400B_2^4C_1 + 47168B_2^3C_1^2 + 541568C_1^5. \tag{A.18}$$

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