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Surface adsorption and collapse transition of linear polymer chains

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Abstract. The critical behaviour of surface adsorption and collapse transition of a flexible self-attracting self-avoiding polymer chain is examined. Depending upon the underlying lattice and space dimensionality, phase diagrams that exhibit many different universality domains of critical behavior are found. We discuss these phase diagrams and the values of the critical exponents found from different theoretical methods.

Keywords. Surface adsorption; polymers chains; fractal lattice; Euclidean lattice.

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1. Introduction

Long neutral flexible polymers in solutions often exhibit remarkably universal properties essentially independent of the chemical nature of the polymer and of the solvent. The universality has found its full recognition and usefulness when polymers have been shown to behave, in the asymptotic limit of infinite molecular weight, as scale invariant critical objects and when the renormalization group ideas have been introduced to polymer theory. The criticality of chain conformation implies not only the existence of critical indices but also of scaling laws for thermodynamic quantities characterizing polymer solution, such as for instance, the osmotic pressure. Since the introduction of an analogy between the polymer theory and a Lagrange field theory of Ginzburg–Landau–Wilson type in the limit where the number of components of the field n goes to zero, many renormalization procedures have been proposed [1].

The physical properties observable on a polymer chain are calculated as statistical averages over all possible configurations of the polymer and these configurations are obtained by mapping the polymer chain onto a walk embedded in an appropriate lattice. Depending upon the physical situation, approximate geometrical restrictions are imposed on these walks. For example, a model of self-avoiding walk (SAW) simulates a polymer chain in a good solvent, while the model of a self-attracting self-avoiding walk (SASAW) represents a polymer chain in a poor solvent that can undergo a collapse transition when the chain contracts from an extended state to a globule state when the temperature is lowered. In a good solvent, monomer–monomer interaction is dominated by short range repulsion (excluded volume interaction), while in a poor solvent the short range repulsion and attraction between monomers at relatively large separation compete with each other.

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