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Surface adsorption of a self-avoiding polymer chain on a family of finitely ramified fractals

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Abstract. We study the surface adsorption of a flexible self-avoiding polymer chain on a family of Sierpinski gasket-type fractals using the real space renormalization group technique. The members of this family are characterized by an integer scale factor b which runs from 2 to ∞. The Hausdorff dimension of these fractals tends to 2 from below as $b \to \infty$. We calculate the crossover exponent ϕ for the desorption transition exactly for $b = 2$ to 6. For $b \to \infty$, we use finite size scaling arguments to show that $\phi \to 1/4$.

1. Introduction

Critical phenomena at surfaces have been extensively studied in recent years in the framework of equilibrium phase transition [1–6]. These studies include several important physical problems such as wetting, surface reconstruction and polymer adsorption [7–8]. Here we are concerned with the phenomena of polymer adsorption on a rigid. impenetrable substrate. This problem has been the focus of much attention in recent years because of its technological importance in the stabilization of colloidal dispersions used in paints, pharmaceuticals and foodstuffs, in lubrication, adhesion and membrane- phenomena and in the development of artificial organs. While in practical applications one does not usually operate in the vicinity of the critical point, it is very desirable to understand how changes in the attractive interaction strength at the surface affect the adsorption behaviour of the polymer for all values of the interaction strength.

In most of the theoretical work reported in the literature, consideration is given to adsorption of an isolated long polymer chain in good solvent on an attractive wall [5–8]. For this case there is an unbinding temperature analogous to a tricritical point, and in its vicinity a crossover regime is observed, where a simple scaling law holds [4]. There is a formal equivalence between the problem of polymer adsorption on a surface and the problem of critical phenomena in the n-vector model of a magnet with a free surface which has been used in scaling analysis [9]. Both the surface and bulk critical exponents have been calculated using renormalization group methods [5, 10, 11], exact enumeration methods and Monte Carlo simulations [12, 6]. For a two-dimensional system exact values of the exponents have been found by using conformal invariance [13, 14].

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$$+57B^{13}+27B^{14}+7B^{15})$$
$$+S^5C(B^5+10B^6+20B^7+30B^8+54B^9+68B^{10}$$
$$+98B^{11}+94B^{12}$$
$$+86B^{13}+38B^{14}+16B^{15})$$

where for notational simplification the subscript r has been dropped from the right-hand side.

References

[1] de Gennes P G 1987 *Adv. Colloid Interface Sci.* **27** 189
[2] Napper D 1983 *Polymeric Stabilization of Colloidal Dispersions* (New York: Academic)
[3] Hammersley J M, Torrie G M and Whittington S G 1982 *J. Phys. A: Math. Gen.* **15** 539
[4] Bouchaud E, Auvray L, Cotton J P, Daoud M, Farnoux B and Janninko G 1988 *Prog. Surf. Sci.* **27** 5
[5] Diehl H W and Dietrich S 1981 *Phys. Rev.* B **24** 2878
[6] Eisenriegler E, Kremer K and Binder K 1982 *J. Chem. Phys.* **77** 3171, 6296
[7] de Gennes P G 1979 *Scaling Concepts in Polymer Physics* (Ithaca: Cornell University)
[8] Binder K 1983 *Phase Transition and Critical Phenomena* ed C Domb and J L Lebowitz vol 7 (New York: Academic)
[9] de Gennes P G 1976 *J. Physique* **37** 1445
[10] Kremer K 1983 *J. Phys. A: Math. Gen.* **16**, 4333
[11] Bouchaud E and Vannimenus J 1989 *J. Physique* **50** 2931
[12] Ischinabe T 1982 *J. Chem. Phys.* **77** 6296; 1984 *J. Chem. Phys.* **80** 1318
[13] Duplantier B and Saleur H 1987 *Phys. Rev. Lett.* **59** 539
[14] Burkhardt T W, Eisenrieglar E and Guim I 1989 *Nucl. Phys.* B 316 559
Guim I and Burkhardt T W 1989 *J. Phys. A: Math. Gen.* 22 1131
[15] de Gennes P G and Pincus P 1983 *J. Physique Lett.* **44** L-241
[16] Orlandini E, Seno F, Stella A L and Tesi M C 1992 Phys. Rev. Lett. **68** 488
[17] Hilfer R and Bluemen A 1984 *J. Phys. A: Math Gen.* **17** L537
[18] Elezovic S, Knezevic M and Milosevic S 1987 *J. Phys. A: Math Gen.* **20** 1215
[19] Dhar D 1988 *J. Physique* **49** 397
[20] Dhar D 1978 *J. Math. Phys.* **19** 5
[21] Derrida B and Herrmann H 1984 *J. Physique* **44** 1365
[22] Milosevic S and Zivic I 1991 *J. Phys. A: Math. Gen.* **24** L833