Multifractal properties of self-avoiding walks on percolation clusters

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The model of self-avoiding walks (SAWs) on a regular lattice perfectly describes the universal scaling properties of polymer chains in a good solvent. We are interested in the scaling behaviour of SAWs on structurally disordered lattices, modelling polymers in porous media. Namely, we consider the case, when the concentration of defects is exactly at the percolation threshold and the SAW resides only on the incipient percolation cluster. Note that up to date there do not exist many studies dedicated to Monte Carlo simulations of this problem and they do still exhibit some controversies. In the case of three and four dimensions, no satisfactory numerical values have been obtained so far. We apply the pruned-enriched Rosenbluth method (PERM) and analyze the scaling properties of SAWs on the backbone of percolation clusters in two, three and four dimensions. Our results bring about the numerical estimates of critical exponents, governing the scaling laws of disorder averages of the end-to-end distance of SAW configurations.

The higher order correlations of SAWs on a percolation cluster, which has a fractal structure, suggest multifractality. Indeed, it was found in field-theoretical renormalization group studies [1,2], that the scaling properties of a SAW on a percolation cluster are described by a whole spectrum of multifractal exponents. We confirm these results numerically, obtaining estimates for exponents, that govern scaling laws of higher moments of weights of percolation cluster sites visited by SAWs.

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