Paths counting on simple graphs: from escape to localization

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Abstract

There is a variety of statistical problems in physics of wave and heat distribution in non-homogeneous media, for which solutions of corresponding hyperbolic or parabolic equations are localized in the vicinity of some spatial regions. The questions related to localization occur often in polymer physics, where such localization occur due to the inhomogeneity of specific point-wise covalent interactions of the polymer chain with the underlying background. However, there is a class of problems for which the origin of localization is purely entropic and is caused exclusively by geometrical reasons.
We consider in details this phenomenon for polymer systems on graphs of specific topology. We study the localization of trajectories on tree-like regular graphs with a special vertex at the origin which has a coordination number (root degree)different from those of other vertices. The singularity analysis of the respective partition function of all paths leads to the dependence of the critical root degree on the degree of other vertices. The same results can be received by studying the spectrum of the adjacency matrix of these graphs.
We also ask the question whether one can expect localization in path counting problem on decorated star graphs, which are topologically very similar to star tree-like graph with one principal difference: all vertices of the decorated graph have the same vertex degree, being multiply linked to the neighbors.

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