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Can ideal polymer chain possess non-Gaussian fluctuations?

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Abstract

We are habitually accustomed that the concept of an "ideal polymer chain" of length L is the synonym of a random walk with Gaussian fluctuations controlled by the exponent = 1/2 for the mean-square displacement r2 ~ L2. In the talk I demonstrate that it is not true when ideal polymer is pushed by external geometric constraints to the subset of configurational space which typically is highly improbable. As an example, I consider an ensemble of 2D random paths of length L stretched over a forbidden void (semicircle of radius R). Such a stretching forces random paths to stay in the vicinity of the semicircle boundary, which influences drastically the typical path's span, d, above the semicircle. Stretching is ensured by the condition L ~ R. The resulting paths' conformations are "atypical" since their realizations is highly improbable in the ensemble of unconstrained Gaussian trajectories. Statistics in such a tiny subset of the Gaussian ensemble is controlled by collective behavior of correlated modes, which results in a scaling for fluctuations, different from Gaussian: at large R we have d ~ R with = 1/3. Simple dimensional analysis and direct analytic computations support this result. There are many examples of correlated one-dimensional stochastic processes, the standard deviation of which is characterized by a critical exponent = 1/3, but not = 1/2 (as for the distribution of independent random variables). Such processes include ballistic aggregation, traffic models, stochastic growth etc. The behavior of these models is related to the solutions of so-called Kardar-Parisi-Zhang (KPZ) equation. The goal of my talk is to demonstrate that the one-dimensional KPZ scaling = 1/3 can occur in the model of simple two-dimensional stretched wandering above an impenetrable curved void.

Biography

In 1989 Sergei Nechaev received PhD as a theoretical physicist at the Moscow State University, and 7 years later, at the age 34 he got the degree Dr. Sci. at the Landau Institute for Theoretical Physics (Moscow). Since 1998 S. Nechaev is a CNRS researcher (France). Currently he is the director of the J.-V. Poncelet Interdisciplinary Scientific Center (CNRS) located in Moscow. S. Nechaev has published about 120 scientific papers. Together with A. Grosberg and E. Shakhnovich, he is the co-author of the "crumpled globule" concept, which provided important contribution for understanding of DNA folding in chromatin.

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