Abstracts

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disaster on human behavior is proposed. It is confirmed that temporal variation in the regional share of available hotels before and after a natural disaster may be an indicator to measure the socio-economic impact at each district. I further propose a procedure to estimate regional risks of tsunami run-up events based on 1 km square grid statistics of data on Japanese landscape and population census with the generalized Pareto distribution. This method computes physical exposures defined by both exposed value and hazard frequency. I estimate regional risks of tsunami turmoils in Japan.

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Memory-induced sign reversals of the spatial cross-correlation for particles in viscoelastic shear flows

A. Sauga, K. Laas, R. Mankin

Institute of Mathematics and Natural Sciences, Tallinn University, Estonia

Recently, several studies have focused on the dynamics of underdamped Brownian particles trapped by harmonic potentials and exposed to shear flows [1-4]. However, in most papers it is assumed that the interaction of Brownian particles with shear flow is characterized by Stokes friction [1-3]. The latter is irrelevant for shear flow in viscoelastic media, where anomalous diffusion occurs (e.g., in the cytoplasm of living cells, in colloidal suspension and dusty plasmas) [4]. Moreover, the previous calculations are based on models without using multiplicative noise. It is important to note that multiplicative noise arises in a natural way in quantitative measurements with laser-optical tweezers, where the stiffness of the effective trapping potential may fluctuate.
Motivated by the experimental results of Ref. [1] and by the theoretical results in [4], we study the behavior of shear-induced cross-correlation functions between particle fluctuations along orthogonal directions in the shear plane for harmonically trapped Brownian particles in a viscoelastic shear flow. A generalized Langevin equation with a power-law-type memory kernel is used to model the system dynamics. The interaction with fluctuations of environmental parameters is modeled by a multiplicative white noise (fluctuations of the stiffness of the trapping potential), by an internal fractional Gaussian noise, and by an additive external white noise. It is shown that the presence of a memory has a profound effect on the behavior of the cross-correlation functions. Particularly, memory-induced reentrant sign reversals of the spatial cross-moment between the orthogonal random displacements of a particle are established, i.e., an increase of the memory exponent can cause a sign reversal from positive to negative, but by further increase of the memory exponent a reentrant transition from negative to positive values of the cross-correlation appears. Let us note that in the case of Stokes friction the corresponding cross-moment is always positive. Moreover, the dependence of the cross-correlation functions on the lag time is analyzed. It is shown that additive external and internal noises cause qualitatively different dependences of the cross-correlation functions on the time lag. The occurrence of energetic instability due multiplicative noise is also discussed.
We believe that our results suggest some possibilities for interpreting experimental data in applications where the issues of viscoelasticity and multiplicative noise can be crucial.

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The Gonihedric Paradigm. Extensions of the Ising Model

G. Savvidis

Demokritos National Research Center

We suggested a model of random surfaces demanding that geometrically nearby configurations of the triangulated surfaces must have close probabilities. This principle leads us to a new energy functional, which is called Gonihedric functional [1]. The model can be considered as a natural generalization of the Feynman integral over the random walks to an integral over the random surfaces because these probabilities, for a random walk and a random surface, coincide when a surface degenerates into a single path. The partition function is defined as an integral over all random surfaces of a given triangulation and a summation over all topologically different triangulations. We analyze the properties of the partition function and its convergence. We prove that the contribution of a given triangulation to the partition function is finite and have found the explicit form for the upper bound [2].
The original model of gonihedric random surfaces was formulated as embedding of random surfaces into the Euclidean space. It can also be formulated as a model of random surfaces embedded into the hypercubic lattice [3]. The advantage of the lattice formulation is that one can construct a spin system, which is a generalization of the Ising model with ferromagnetic and antiferromagnetic interactions, such that its interface energy is equal to the gonihedric energy. These spin systems have very high symmetry, one can flip the spins on any flat hypersurface without changing the energy of the system. The lattice formulation the partition function of the random surfaces is exactly equal to the partition function of the corresponding spin system and can be studied by powerful analytical methods, as well as by Monte-Carlo simulations.
It is well known that the two-dimensional Ising model is self-dual system and that three-dimensional Ising model is dual to the gauge spin system. This duality was an important fact allowing to find the exact solution of the Ising model in two-dimensions. We were able to construct dual systems for the gonihedric spin systems in three and four dimensions [4]. These results allows to construct the corresponding transfer matrix, to prove that is describe the propagation of closed loops and to find its spectrum [5]. This is a unique exact solution of the tree-dimensional statistical spin system [6].
Because gonihedric spin systems have exponentially degenerated vacuum states, which are separated by the potential barriers, one can suggest to use such systems as storages of the binary information. There is no interface energy proportional to the area in these systems therefore one can store a one bit of information in a very small region of the lattice [7].