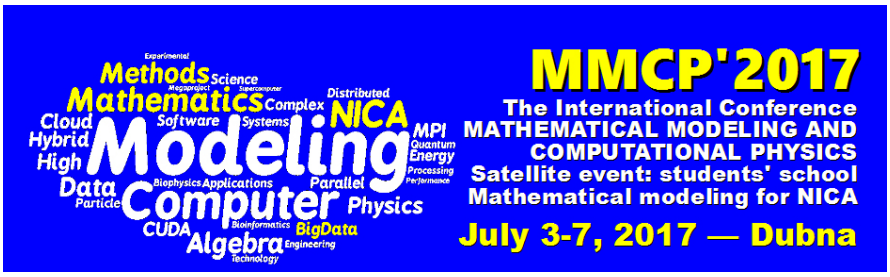

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Functional integral approach to system of stochastic differential equations

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Various physical, chemical, and biological systems with fluctuations or noise are described by stochastic differential equations (SDEs). Constructing a SDEs for the modeled system such that the stochastic part is related to the structure of the system is considered in [1, 2].
Evaluation of probability density function (PDF) and other quantities describing a solution of system of SDEs is considered in this work. To solve this problem we use the Onsager-Machlup functional [3] to represent a PDF through a functional integral. In the general case, we cannot find a PDF on a small time interval Δt corresponding to an arbitrary SDE. However, we can find an expression for a PDF on a small time interval Δt which is true up to summands of orders higher than one with respect to Δt. Using this expression we can write a PDF in the form of functional integral. Case of system of SDEs is more complicated than case of SDEs. Therefore we consider the Onsager-Machlup functional technique only for the flat space when the diffusion matrix for system of SDEs defines a Riemannian space with vanishing curvature.
A method for the approximate evaluation of the arising functional integrals is considered. Following this method we distinguish among all trajectories the classical trajectory for which the action takes the extreme value. The classical trajectory is found as the solution of the multidimensional Euler-Lagrange equation. Further, to compute the integral, we use the decomposition of action with respect to the classical trajectory.
For SDE that is for one-dimensional case this method is considered in [4].
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