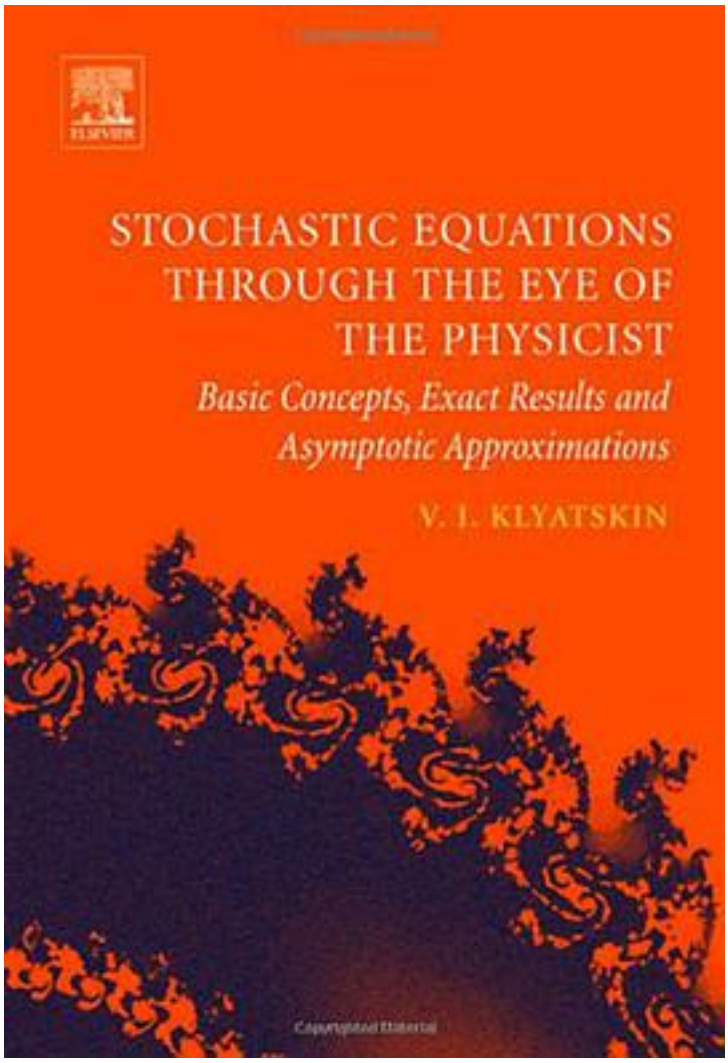
Stochastic Equations Through the Eye of the Physicist



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著者:Klyatskin, Valery I.

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Fluctuating parameters appear in a variety of physical systems and phenomena. They typically come either as random forces/sources, or advecting velocities, or media (material) parameters, like refraction index, conductivity, diffusivity, etc. The well known example of Brownian particle suspended in fluid and subjected to random molecular bombardment laid the foundation for modern stochastic calculus and statistical physics. Other important examples include turbulent transport and diffusion of particle-tracers (pollutants), or continuous densities ('oil slicks'), wave propagation and scattering in randomly inhomogeneous media, for instance light or sound propagating in the turbulent atmosphere. Such models naturally render to statistical description, where the input parameters and solutions are expressed by random processes and fields. The fundamental problem of stochastic dynamics is to identify the essential characteristics of system (its state and evolution), and relate those to the input parameters of the system and initial data. This raises a host of challenging mathematical issues. One could rarely solve such systems exactly (or approximately) in a closed analytic form, and their solutions depend in a complicated implicit manner on the initial-boundary data, forcing and system's (media) parameters . In mathematical terms such solution becomes a complicated 'nonlinear functional' of random fields and processes. Part I gives mathematical formulation for the basic physical models of transport, diffusion, propagation and develops some analytic tools. Part II and III sets up and applies the techniques of variational calculus and stochastic analysis, like Fokker-Plank equation to those models, to produce exact or approximate solutions, or in worst case numeric procedures. The exposition is motivated and demonstrated with numerous examples. Part IV takes up issues for the coherent phenomena in stochastic dynamical systems, described by ordinary and partial differential equations, like wave propagation in randomly layered media (localization), turbulent advection of passive tracers (clustering), wave propagation in disordered 2D and 3D media. For the sake of reader I provide several appendixes (Part V) that give many technical mathematical details needed in the book. For scientists dealing with stochastic dynamic systems in different areas, such as hydrodynamics, acoustics, radio wave physics, theoretical and mathematical physics, and applied mathematics the theory of stochastic in terms of the functional analysis. Referencing those papers, which are used or discussed in this book and also recent review papers with extensive bibliography on the subject.

作者介绍:

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