Stochastic Resonance: A Mathematical Approach in the Small Noise Limit (Mathematical Surveys and Monographs)

By Samuel Herrmann, Peter Imkeller, Ilya Pavlyukevich, Dierk Peithmann

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Stochastic resonance is a phenomenon arising in a wide spectrum of areas in the sciences ranging from physics through neuroscience to chemistry and biology. This book presents a mathematical approach to stochastic resonance which is based on a large deviations principle (LDP) for randomly perturbed dynamical systems with a weak inhomogeneity given by an exogenous periodicity of small frequency. Resonance, the optimal tuning between period length and noise amplitude, is explained by optimizing the LDP's rate function. The authors show that not all physical measures of tuning quality are robust with respect to dimension reduction. They propose measures of tuning quality based on exponential transition rates explained by large deviations techniques and show that these measures are robust. The book sheds some light on the shortcomings and strengths of different concepts used in the theory and applications of stochastic resonance without attempting to give a comprehensive overview of the many facets of stochastic resonance in the various areas of sciences. It is intended for researchers and graduate students in mathematics and the sciences interested in stochastic dynamics who wish to understand the conceptual background of stochastic resonance.

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