

Modeling synchronization processes in nonlinear oscillators

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The thesis explores synchronization processes in nonlinear dynamical systems using the examples of the Van der Pol oscillator, the Adler equation, and the FitzHugh–Nagumo model. Mechanisms of phase and frequency synchronization are investigated through both theoretical approaches and numerical simulations. The study presents various cases of synchronization, associated bifurcation transitions, and their influence on the system's dynamic behavior. In addition, the significance of synchronization is analyzed across different fields, including neurobiology, particularly in the context of understanding epileptic processes.

The objective of the research is to identify the fundamental mechanisms of synchronization using analytical and numerical methods and to demonstrate their applicability to other complex systems. The results highlight the role of nonlinear modeling in contemporary scientific research, especially in data analysis and interpretation.

Furthermore, the thesis discusses noise-induced spiking activity and the effect of coherence resonance, drawing analogies with neurobiological mechanisms, including epilepsy simulation. It is shown that noise can become a source of regular or chaotic spiking, indicating transitions in the system's dynamics from passive states to active and pathological regimes.

ლიტერატურა

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