"Sensitivity of the forced nonlinear oscillators: how to predict transition to chaos "

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Many nonlinear systems have periodic oscillations as an essence of its dynamics. Stochastic fluctuations of periodic processes play an important role for understanding of the corresponding phenomena for lasers, radiofrequency generators, chemical and biological systems. The various transitions ("bifurcations") through periodic to more complicated regimes are a central problem in modern nonlinear dynamic theory. There are many papers devoted to a qualitative analysis of the forced oscillations.

We suggest a new techniques [1] for investigation of the local stochastic dynamics near limit cycles. This techniques is based on nonequilibrium quasipotential [2]. An approximation of quasipotential is expressed by some function. This function (sensitivity function) is introduced as a base tool of a quantitative description for a system response on the external disturbances [4].

The new cycle numerical characteristics (sensitivity factor, parameter of stiffness) are suggested. The possibilities of sensitivity function to predict some peculiarities of dynamics for stochastically and periodically forced oscillators are shown.

From sensitivity analysis, the critical (chaotic) values of Brusselator parameter are found [3]. The detailed investigation of multiscroll cycles of the Lorenz model is given. The thin effects observed in stochastic Lorenz model near chaos in a period-doubling bifurcations zone is presented [5].
Thus, the function of sensitivity is the effective tool for a prediction of singular responses of a non-linear system to external disturbances.

References

1. Bashkirtseva I.A., Isakova M.G., Ryashko L.B. Quasipotential in stochastic stability analysis of the nonlinear oscillator orbits. J. Neural, Parallel & Scientific Computations, V.7, N3, pp.299-310, 1999.
2. Graham, R., Tel, T. Nonequilibrium potential for coexisting attractors. Physical Review A, v.33, 1322-1337,1986.
3. Bashkirtseva I.A., Ryashko L.B. Sensitivity analysis of the stochastically and periodically forced Brusselator. Physica A, v.278, pp.126-239, 2000.
4. Bashkirtseva I.A., Ryashko L.B. Quasipotential method for local stability analysis of stochastically forced limit cycles. J. Appl. Nonlinear Dynamics, N.6,2001.
5. Bashkirtseva I.A., Ryashko L.B. Sensitivity analysis of stochastically forced Lorenz model cycles under period doubling bifurcations. Dynamic Systems and Application, 2002 (accepted).