Limit Cycles and Bifurcations in a Biological Clock Model

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A three-variable dynamical system describing the circadian oscillation of two proteins (PER and TIM) in cells is investigated. We studied the saddle-node and Hopf bifurcations curves and distinguished four cases according to their natural period in a further article. Other bifurcation curves were determined in a simplified, two-variable model by Strain and Wilkens. Here we show a continuous bifurcation curves that divide the parameter plane into regions according to topological equivalence of global phase portraits, namely the global bifurcation diagram for the dim-reversible system. We determine the Beatie-Bifurcation point, the homoclinic bifurcation curve and fold bifurcation of cycles anaesthetically. We also investigate unstable limit cycles and the case when two stable limit cycles exist.

Wigner ENSeemble Monte Carlo: Challenges of 2D Nano-Device Simulation

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The Wigner formalism of the quantum statistical mechanics provides a convenient kinetic description of carrier transport processes on the nanometer scale, characteristic of novel nanoelectronic devices. The approach is based on the concept of phase
space and has been utilized in 2D device simulations. With deterministic methods an increase of the number of dimensions is infeasible due to prohibitive memory requirements. Recently, a stochastic model has been developed, where the quantum character of carrier transport is taken into account by generation and recombination of positive and negative particles. This model is now utilized for the development of a 2D Wigner-EV-Nondiagonal (WENN) device simulation approach. Here we discuss the first application of the approach, with an emphasis on the variety of raised computational challenges. The latter are large scale problems, introduced by the temporal and momentum variables involved in the task.

(a) Electrostatic potential profile
(b) Classical electron density
(c) QH electron density
(d) Current versus evolution time

(a) shows the potential of a MIMET structure of a model semiconductor used in the simulation. A comparison of the classical (midlines) and quantum recombined (Wigner) carrier densities in (b) and (c) illustrates the flexibility of the approach. (d) compares the currents as obtained from Bohm and Wigner simulations and demonstrates the much slower convergence of the quantum transport task.