Optimized Particle Regeneration Scheme for the Wigner Monte Carlo Method

P. Ellinghaus, M. Nedjalkov, S. Selberherr

The signed-particle Monte Carlo method, for solving the Wigner equation, has made two-dimensional solutions numerically feasible. The latter is attributable to the concept of annihilation of independent indistinguishable particles, which counteracts the exponential growth in the number of particles due to generation. After the annihilation step, the particles which are regenerated within each cell of the phase-space should ideally replicate the same information as before the annihilation, albeit with a lesser number of particles. Since the semi-discrete Wigner equation allows only discrete momentum values, this information can be retained with regeneration, however, the (real-valued) position, where the particles are regenerated, should be chosen wisely. A simple uniform distribution over the spatial domain represented by the cell introduces a 'numerical diffusion' that artificially propagates particles simply through the process of regeneration. Furthermore, this simple regeneration technique destroys the purity of the quantum state. We propose an optimized regeneration scheme which counteracts these two (related) effects of 'numerical diffusion' and loss of purity in an efficient manner.

A Perturbation Formula as Universal Tool for Strong Approximations of Stochastic Differential Equations

Martin Hutzenthaler

The main object of this talk is a perturbation formula for stochastic differential equations (SDEs) which expresses the distance between the solution and any Itô process in terms of the distances of the local characteristics. Under suitable exponential integrability properties, this perturbation formula yields a sufficient condition for local Lipschitz continuity in the strong sense in the initial value, a sufficient condition for explicit numerical approximations of finite-dimensional SDEs and a sufficient condition for spatial discretizations of nonlinear SPDEs. We illustrate these conditions with example SDEs from finance, physics and biology. Moreover, we present an example SDE with a globally bounded and smooth drift coefficient and a constant diffusion coefficient whose solution is not locally Hölder continuous in the strong sense in the initial value.