

# Parallelization of the Two-Dimensional Wigner Monte Carlo Method

J. Weinbub, P. Ellinghaus, S. Selberherr

Conducting Wigner Monte Carlo simulations remains highly challenging primarily due to the method's critical annihilation step, required to counter-balance the continuous generation of particles to keep the simulation computationally feasible. The memory demands of the annihilation algorithm itself is proportional to the dimensionality and resolution of the phase space represented in the simulation, which can lead to exorbitant memory consumption. All in all, Wigner Monte Carlo simulations suffer not just from compute intensive operations - inherent to all Monte Carlo methods - but also from vast memory demands; the latter is much more severe, as more realistic simulations are beyond reach on single workstations with their limited memory.

Conventional parallelization approaches for Monte Carlo methods, using domain replication, are *embarrassingly parallel*. The particle ensemble can be split amongst computational units, where each sub-ensemble is treated completely independently, resulting in excellent parallel efficiency. Domain replication, however, is not feasible for the Wigner Monte Carlo method due to the huge memory demands associated with the annihilation algorithm. Since particle annihilation must be performed in unison across the global simulation domain, a synchronization step between each individual time step is required, impeding parallel efficiency.

We present a message passing interface-based domain decomposition approach for two-dimensional problems, which avoids domain replications and thus drastically reduces the memory requirements within each computational unit. The algorithm to partition the simulation domain is discussed for the Wigner Ensemble Monte Carlo simulator which is part of the ViennaWD simulation package. The parallel efficiency is evaluated based on the execution times of representative two-dimensional examples. With our approach we not only tackle the challenge of reducing simulation times, but much more importantly, we pave the way for increasingly memory-intensive Wigner Monte Carlo simulations.

## Functional A Posteriori Estimates for Time-Periodic Eddy Current Problems

M. Wolfmayr

In this talk, we present functional type a posteriori estimates for eddy current problems and their corresponding optimal control problems in a time-periodic setting. More precisely, all functions are expanded into Fourier series in time. We prove existence and uniqueness for some weak space-time variational formulation of the state