the Schur complement technique, an effective implementation of the weak Galerkin is developed a linear system involving unknowns only associated with element boundaries. In this talk, several numerical applications of weak Galerkin methods will be discussed.

Algorithmic and Implementation Advances in the EXA-DUNE Project

S. Müthing, P. Bastian

The EXA-DUNE project (P. Bastian, C. Engwer, D. Göddeke, O. Iliev, O. Ippisch, M. Ohlberger, S. Turek, J. Fahlke, S. Kaulmann, S. Müthing, and D. Ribbrock. EXA-DUNE: Flexible PDE solvers, numerical methods and applications. In *Euro-Par 2014: Parallel Processing Workshops*, Lecture Notes in Computer Science. Springer Berlin Heidelberg, to appear.) aims at extending the well-known DUNE framework for PDE simulations (see `http://dune-project.org`) to prepare it for computations on upcoming exascale HPC architectures. In this talk, we present some of the results of this project, focusing in particular on the scalability improvements achieved by incorporating advances at both the algorithmic and the implementation level.
We discuss their impact on a porous media application that employs a DG discretization based on a DGAMG solver and provide performance numbers for different accelerator architectures as well as some initial scalability results.

The Aharanov-Bohm Effect from a Phase Space Perspective

M. Nedjalkov, P. Ellinghaus, S. Selberherr

We consider a charged particle interacting with an electromagnetic medium. The classical motion of a particle is governed by forces, which are represented by the Lorentz force, comprised of the joint action of electric and magnetic fields. These fields are uniquely described by the Maxwell equations, and the description is facilitated by the introduction of electromagnetic potentials. These are the scalar and vector potentials, whose first derivatives determine the fields and in this way reduce the number of the unknown components from six to four. From this point of view the potentials are merely a mathematical construct to simplify calculations and have a rather auxiliary physical interpretation.
Quantum mechanics is based on potentials, which induces that the quantum state depends not only on the field part, but on all terms beyond the first derivative in the series expansion of a given potential. Such a dependence is known as the Aharonov-Bohm effect. In particular, if two solutions of the Schrödinger equation with zero and constant potential are compared, in the latter case the wave function acquires some

additional phase despite that in both cases there are no fields. This effect is analyzed from a phase space perspective with the help of the Wigner formulation of quantum mechanics. Simulation results show that the effect is revealed by the dependence of the interference part of the entangled electron state on the potential value. It is discussed, how the destruction of this interference part recovers the classical behavior.

Sensitivity Analysis of Checkpointing Strategies for Multimemetic Algorithms on Unstable Complex Networks

R. Nogueras, C. Cotta

The use of dynamic decentralized computational platforms such as, e.g., peer-to-peer networks, is becoming an increasingly popular option to gain access to vast computing resources. Making an effective use of these resources requires algorithms adapted to such a changing environment, being resilient to resource volatility. We consider the use of a variant of evolutionary algorithms endowed with a classical fault-tolerance technique, namely the creation of checkpoints in a safe external storage. We analyze the sensitivity of this approach on different kind of networks (scale-free and small-world) and under different volatility scenarios. We observe that while this strategy is robust under low volatility conditions, in cases of severe volatility performance degrades sharply unless a high checkpoint frequency is used. This suggest that other fault-tolerance strategies are required in these situations.

Spin Lifetime in MOSFETs: A High Performance Computing Approach

D. Osintsev, J. Ghosh, V. Sverdlov, J. Weinbub, S. Selberherr

We study spin properties in ultra-scaled silicon MOSFETs. To evaluate the spin relaxation time, a multi-dimensional integral over the energy and different directions of the wave vectors before and after scattering must be taken. The inner integrals over before- and after-scattering directions at a fixed energy require at least 1000 points each. The energy integration requires around 1400 points with a uniform grid. Thus, the scattering matrix elements and the Jacobian (the derivative of the dispersion energy over the wave vector) must be calculated numerically around a billion times. To compute the matrix elements, the eigenfunction problems for the 4×4 Hamiltonian matrix must be solved for the two wave vectors before and after scattering for a broad range of parameters, which makes the numerical spin relaxation time calculation prohibitively expensive. Indeed, when utilizing a standard adaptive integration technique we found that a month of calculations on 20 cores, or 15000