The mathematical model consists of three parts — dynamical, electrical, and thermal. The energy from the applied AC voltage is determined, by solving the Laplace equation to find the potential distribution. After that, the electric field intensity and the current density are directly calculated. Finally, the heat transfer equation is solved to determine the temperature distribution.
A 3D image of the patient's liver is obtained from a magnetic resonance imaging scan. Then, the geometry for the needle is added. The CGAL library is used to obtain an unstructured mesh in the computational domain. We use the finite element method in space, to obtain both the current density and the created temperature field. An unstructured mesh parallel solver is developed for the considered problem. The parallelization approach is based on partitioning the meshes using ParMETIS. Numerical tests show good performance of the developed parallel solver.

On Tensor-Train Ranks of Tensorized Polynomials

L. Vysotsky

Sampling followed by tensorization (mapping from low-dimensional data to high-dimensional data) can be used to construct low-parametric approximations of functions. For example, function f defined on $[0,1]$ may be mapped to a d-dimensional tensor $A \in \mathbb{R}^{2\times\cdots\times 2}$ with elements $A(i_1,\ldots,i_d) = f(i_1 2^{-1} + \ldots + i_d 2^{-d})$, $i_k \in \{0,1\}$. The tensor A can now be compressed using one of tensor formats, e.g. tensor-train format. It has been noticed in practice that approximate TT-ranks of tensorizations of degree-n polynomials grow very slowly with respect to n, while the exact TT-ranks are only known to be bound by $n+1$. In this talk I will try to explain the observed effect. A new bound of the described TT-ranks will be presented. Moreover, I will show the new bound quite successfully captures the practically observed distribution of ranks.

Electron Interference in Single- and Double-Dopant Potential Structures

J. Weinbub, M. Ballicchia, M. Nedjalkov

We present analyses of interference effects as a result of the electron evolution within coherent transport media, offering single- or double-dopant Coulomb potential structures. Injection of coherent electron states into the structures is used to investigate the effects on the current transport behavior within the quantum Wigner phase space picture. Quantum effects are outlined by using classical simulations as a reference frame, a unique feature of Wigner function based transport simulations. In particular, the utilized signed particle approach inherently provides a seamless transition between the classical and quantum domain. Based on this we are able to identify the occurring quantum effects caused by the non-locality of the action of the quantum potential, leading to spatial resonance which are a manifestation of quantum interference.

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Self-duality in Fully Convex Bolza Problems with State Constraints and Impulses

P. R. Wolenski

A Fully Convex Bolza (FCB) problem has the appearance of the classical calculus of variations Bolza problem

$$\min \int_0^T L(x(t), \dot{x}(t))dt + l(x(0), x(T)),$$

where the minimization is over $x(\cdot)$ belonging to some class of arcs. The distinguishing features of FCB are that the data $L(\cdot,\cdot)$ and $l(\cdot,\cdot)$ (i) may take on the value $+\infty$ and (ii) are convex functions. Allowance of (i) provides great flexibility incorporating constraints so that most standard control problems come under its banner. However, broad generality is restrained by (ii), which although quite special, nonetheless includes the classical linear quadratic regulator and many of its generalizations. Moreover, the speciality of (ii) opens up the possibility of using convex dual formulations. We shall review the Hamilton-Jacobi (HJ) theory for FCC problems when the data has no implicit state constraints and is coercive, in which case the minimizing class of arcs are Absolutely Continuous (AC). When a state constraint $x(t) \in X$ is added to the problem formulation, the dual variable is likely to exhibit an impulse or jump when the constraint is active. The two properties of a state constraint and allowing impulsive arcs are in fact dual to each other, and the minimizing class becomes those of bounded variation. We shall describe Rockafellars optimality conditions for these problems and a new technique for approximating them by AC problems that utilizes Goebels self-dual envelope. The approximating AC problems maintain du- ality and the existing theory can be applied to them. It is proposed that an HJ theory can be developed for BV problems as an appropriate limit of the approximating AC problems. An explicit and motivating example will be provided to illustrate this.