
Mathematical Modeling and Methods for High Performance Computing

Mathematic, mathematical modeling, mathematical methods, mathematical models, mathematical analysis, numerical method,
Computing systems, nonlinear partial differential equations, PDEs, computational mathematics
Numerical solving, numerical solution, numerical stability, numerical simulation
Calculus of variations, calculation
Matrix
High performance computing

Offer

- Expert analysis of interdisciplinary problems in physics, mathematics and high-performance computing
- Application of mathematical modeling in physics with particular focus to area of continuum mechanics
- Expert knowledge of mathematical analysis for problems in continuum physics and related areas
- Expertise in theory of numerical methods and their application in modern HPC environments
- Contact with wide network of local and international experts (EU-MATHS-IN, Nečas Center for Mathematical Modeling)
- Development of models for complex materials from the basic principles to an efficient numerical solution
- Consultancy services in the field of mathematical modeling, analysis, numerical software and calculations

Expertise

- Development of models for complex physical processes with analysis and numerical simulations
- Mathematical modeling of mechanical, thermal and chemical processes in continuum mechanics and thermodynamics
- Non-linear partial differential equations (PDEs) stemming from solid and fluid mechanics and analysis of relevant problems
- Modeling of flow problems in biomechanics for patient specific data
- Models and numerical methods for industrial problems in glass melting, geomaterials, shape memory alloys and electrochemical devices (fuel cells, batteries)
- Analysis of computational methods, numerical stability and scalability
- Computational mathematics related to numerical solving of challenging problems

Research Areas and Excellence

Mathematical modeling aims to describe and study various phenomena using the language of mathematics. It represents an indispensable tool in natural sciences, engineering, life and also social sciences.

The uniqueness of the research consists in the fact that it is able to cover – at a very high scientific level – all aspects of the mathematical modelling workflow, in particular development of mathematical models, mathematical analysis of their properties,

development of suitable numerical methods and their implementations optimally exploiting the available computational power of current and near future high performance computing systems.

Research and tutoring of young scientific generation in the given field is at Charles University also a subject of the group.

Main Recent Projects

- Charles University UNCE (University Centre of Excellence) project: University Center MathMAC (2012–2017) and its successor (2018–2023) titled University Center for Mathematical Modeling, Applied Analysis and Computational Mathematics: PI Josef Málek, other senior advisors Miroslav Bulíček, Ondřej Čadek, Vít Dolejší, Josef Durech, Jaroslav Hron, Luboš Pick, Vít Průša, Zdeněk Strakoš, Miroslav Tůma
- ERC-CZ project MORE : PI Josef Málek, senior members of the team Endre Süli, Eduard Feireisl, Zdeněk Strakoš, Martin Vohralík; Charles University, Prague, 2012–2017; see <http://more.karlin.mff.cuni.cz>

The collaborating members hold two ERC projects:

- ERC AdG project MATHEF: PI Eduard Feireisl; Institute of Mathematics, Academy of Sciences of the Czech Republic, 2013–2018

- ERC CoG project GATIPOR: PI Martin Vohralík, external collaborator Zdeněk Strakoš; INRIA Roquencourt, France, 2015–2019

Partnership and Collaboration

Academic Partners

The group closely collaborates with leading researchers from institutions all over the world, e.g.:

- University of Oxford,
- INRIA Paris
- University of Heidelberg
- TU Berlin
- University of Washington at Seattle
- Texas A&M University
- University of Warsaw

Industry Partners

The group has several ongoing partnerships and collaborations in applied areas, e.g.:

- Glass Service – modeling and simulating float glass process
- Masaryk Hospital Ústí nad Labem – investigation and numerical simulation of aneurysms
- RS Dynamics – electrical impedance tomography of soft tissues
- Preciosa – Image processing in quality analysis of jewelry stones
- SHM Šumperk – Thermodynamic analysis of high pressure physics. Simulation of motion of charged particles.

Are you interested in this expertise?

Please contact CPPT UK

Web: www.cppt.cuni.cz/

Mail: transfer@cuni.cz

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Experts and their department

Prof. RNDr. Josef Málek, Csc., DSc., Prof. Ing. Zdeněk Strakoš, DrSc.

Mathematical Institute and Department of Numerical Mathematics

Web: <http://ncmm.karlin.mff.cuni.cz>

Klíčová slova

Matematika, matematické výpočty, matematické modelování

Nelineární parciální diferenciální rovnice, numerika, numerické problémy

Parciální, parciální diferenciální rovnice, řešení parciálních diferenciálních rovnic

Numerická simulace, numerická stabilita, numerické řešení, numerické metody, implementace numerických metod

Matematické modely, matematická analýza

PDR