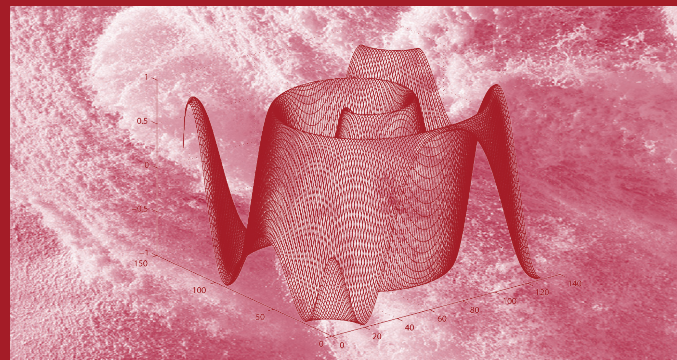```
else

  for (int i=0; i<NuCoarse; i++) {

    if (useILU)

      ILU (A,L,U,f,x) ;

    else

      symmetricGaussSeidel (A,L,U,f,x);
```

## Scientific Computing

Scientific computing is a branch of applied mathematics that is concerned with mathematical modeling and computer-based numerical simulations as a means to analyze and understand complex real world phenomena from science, economics, medicine and engineering. The numerical simulation supplements the two classical pillars of knowledge acquisition, namely the theoretical analysis and the laboratory experiment.

In particular the tremendous technological progress over the past decades together with significant advances in the development of efficient and reliable numerical algorithms have enabled Scientific Computing to develop to a key technology of modern sciences.
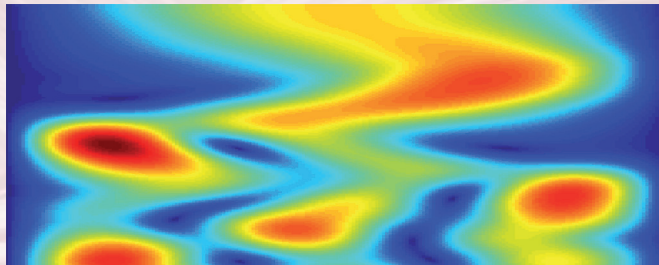
Nowadays Scientific Computing is an indispensable tool to efficiently solve sophisticated problems such as, e.g., the evaluation of financial products, the design and control of nano devices, the modeling of bio-chemical reactions, or the development of imaging techniques in medicine.



**ROENOBIO**

$$\dot{E} = \beta_{max}(T)\frac{1}{K_S}\frac{K_E(T)}{S\,K_E(T)+E}X$$

Scientific Computing allows for new insights into complex systems, and to validate or reject theoretical hypothesis without the efforts and costs of real world experiments in a laboratory.

## Research at the Chair

The research activities at the Chair of Scientific Computing of the Institute of Mathematics at the University of Würzburg are mainly focused on the development, analysis and implementation of algorithms for high-performance computing with a particular emphasis on multigrid methods and parallel computing, on design optimization control, and parameter identification with partial differential equations and stochastic processes, as well as on the control of technical processes with applications, e.g., in the bio and nano sciences. There is also a significant activity in inverse problems with partial differential equations. These scientific interests are reflected in the teaching activities of the chair.
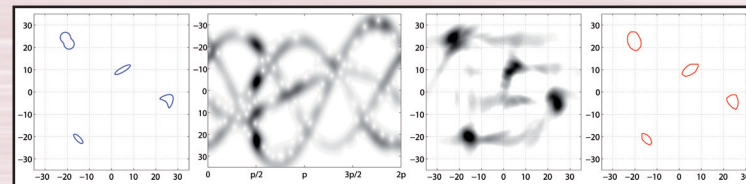


Pictures: Shape reconstruction in Inverse Scattering

## Projects and Cooperations

### Academic Projects

- Marie Curie International Training Network: Multi-ITN STRIKE - Novel Methods in Computational Finance, Supported by the European Commission.
- ROENOBIO: Robust energy optimization of fermentation processes for the production of biogas and wine. Supported by the Federal Ministary of Education and Research BMBF
- Parallel Multigrid Imaging and Compressed Sensing for Dynamic 3D Magnetic Resonance Imaging, supported by the Interdisciplinary Center for Clinical Research IZKF of the University of Würzburg
- Controllability and Optimal Control of Interacting Quantum Dynamical Systems (COCIQ) supported by the German research funding organization DFG

### Industrial Projects

- Parallel algebraic multigrid methods for multipurpose CFD simulation (with AVL List GmbH)
- Modeling of partially-open pipe-ends in gas dynamics systems for engine simulation (with AVL List GmbH)
- Multigrid methods for solving Reynolds lubrication problems (with AVL List GmbH)

### WWCSC

The "Würzburg - Wroclaw Center for Stochastic Computing" (WWCSC) provides an organizational and scientific platform to support scientific cooperation and the exchange of students between the Hugo Steinhaus Center (Wroclaw University of Technology) and the Chair of Scientific Computing (University of Würzburg).



# WiReMIX - Wissenschaftliches Rechnen Mathematik IX

## Teaching Activities at the Chair

- Mathematical modeling
- Numerical analysis
- Applied analysis and partial differential equations
- High performance computing
- Optimization
- Inverse problems

## Requirements

- A passion for science
- A pleasure of learning, applying and creating mathematics
- A basic interest in scientific programming and applications of mathematics

## Career Opportunities

The career opportunities of mathematicians are generally considered to be excellent. In particular the Computational Mathematics degree prepares students for a wide variety of occupations in the public and private sector. For instance graduates could pursue a career in the automotive or medical industries, in banking and insurance companies, as well as in many forms of engineering or IT. There are also opportunities for employment with publicly funded research institutes and universities.

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DFG

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Lehrstuhl für
MATHEMATIK IX

# Scientific Computing in Würzburg

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## Chair of Mathematics IX

$$\min_{f \in L^2(Q)} J(u(f), f)$$

$$-\partial_t u + \Delta u + \delta e^u = f$$

$$u = 0 \quad \text{on } \partial\Omega \times (0, T)$$

**www9. mathematik.uni-wuerzburg.de**