

NUMERICAL ANALYSIS OF NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS IN VECTOR AND TENSOR ANALYSIS

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ABSTRACT

This workshop addresses current frontiers in the numerical analysis of nonlinear partial differential equations (PDEs). The construction of efficient, reliable, and robust numerical methods for nonlinear systems is an active area of research. Applications span a wide range of models in electromagnetism, mechanics, fluid dynamics, and general relativity, including systems coupled with optimal control problems and geometric PDEs. Within this broad field, the workshop will emphasize nonlinear PDEs governed by algebraic and geometric structures and examine how these structures guide the development of computational methods.

Nonlinear PDEs involving vector and tensor fields are a central theme of the workshop. The numerical analysis of scalar-valued nonlinear PDEs has seen considerable progress in recent years. PDEs arising in vector and tensor analysis exhibit additional structures, such as compatibility conditions and geometric invariance, that are less prominent in the scalar-valued setting. Computational methods for linear PDEs treat these structures as foundational, and they are equally fundamental to the development of computational methods for nonlinear problems. Many nonlinear systems arise from physical models coupled with evolving geometries. The workshop will therefore emphasize connections with nonlinear and geometric PDEs on surfaces and manifolds. This workshop will be an opportunity to explore links between these research efforts.

We intend to invite speakers who address the theoretical analysis, the construction of discretizations, and computational algorithms. The broad scope of the program will

connect complementary methodologies actively researched in the numerical analysis of nonlinear partial differential equations, including mixed finite element methods, finite volume methods, and polytopal schemes. The program will address stationary elliptic problems and time-dependent problems of parabolic and hyperbolic nature. This workshop will contribute to ICOSAHOM 2027 by stimulating the exchange between communities that often address closely related structural questions using different mathematical languages.

SPEAKERS

1. Yakov Berchenko-Kogan (Florida Tech): *Finite element tensor fields on surfaces and manifolds*
2. Lars Diening (University of Bielefeld): *TBA*
3. Jérôme Droniou (CNRS): *Design and analysis of a polytopal scheme for nonlinear magnetostatics*
4. Masato Kimura (Kanazawa University): *LINE schemes for nonlinear parabolic equations and related schemes for unidirectional diffusion problems*
5. Philippe LeFloch (Sorbonne): *Hyperbolic nonlinear balance laws on manifolds: theory and approximation*
6. Yuwen Li (Zhejiang University): *High-order FEEC on sparse grids with applications to MHD*
7. Martin Licht (TU Dresden): *Numerical analysis for the Hodge p -Laplacian*
8. Rui Ma (Beijing Institute of Technology): *New Mixed Finite Element Methods for the Cahn–Hilliard Equation.*
9. Michael Neunteufel (TU Vienna): *Distributional Curvature and Tensor-Valued Finite Elements for Nonlinear Surface PDEs*
10. Simon Praetorius (TU Dresden): *More than a mesh: When geometry shapes discretization*
11. Thomas Sales (University College London): *Approximation of two-phase Stefan problems on evolving surfaces*