



Nachdiplom Lecture
Prof. Dr. Kaibo Hu
University of Oxford



Thursdays, 10:15 to 12:00 (from 24.09.2026) | ETH HG, G 43

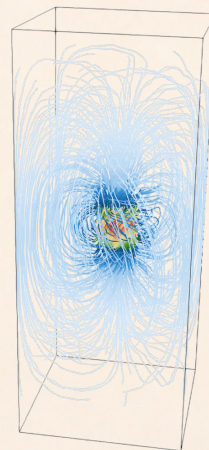
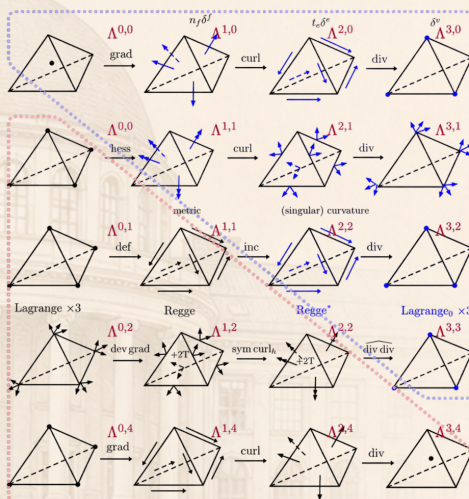
Finite Element Tensor Calculus

Discrete Structures and Structure-preserving Discretization

Abstract

Discrete structures lie at the foundation of modern scientific computation. In electromagnetism, fluid dynamics, and continuum mechanics, governing laws are expressed through geometric and topological structures rather than mere functions. Preserving these structures is essential for reliable computation.

Finite Element Exterior Calculus (FEEC) preserves intrinsic topological structures in numerical PDEs by discretizing differential complexes. Finite Element Tensor Calculus (FETC) extends FEEC to tensor-valued fields, capturing the algebraic and differential structures underlying tensorial and geometric objects and PDEs. Applications include computational topological fluid and magnetohydrodynamics, continuum mechanics, and discrete differential geometry.



Content

- Mixed finite element methods: *differential complex perspective*
 - inf-sup conditions
 - electromagnetism, fluids, & elasticity
 - metric and curvature
 - spectra and pseudospectra
- Discrete Structures
 - discrete differential forms
 - discrete Hodge Laplacian
 - Lie transport
 - topological hydrodynamics
 - BGG machinery
 - Finite Element Periodic Table
 - graphs and networks

Targeted Audience

MSc & PhD students in applied mathematics and computational science, and scientists and engineers interested in structure-preserving methods.

Biography

Kaibo Hu is an Associate Professor and Royal Society University Research Fellow at the University of Oxford's Mathematical Institute. He earned Ph.D. from Peking University in 2017. His research develops structure-preserving numerical discretizations by bridging numerical analysis with differential geometry and homological algebra. A recipient of an ERC Starting Grant (2024), Dr. Hu's honors include the Stephen Smale Prize (2026), the SIAM CSE Early Career Prize (2023), and the Frontiers of Science Award (2025).