XIX International Conference on Computational Plasticity, COMPLAS 2027
September 6-10, 2027, Barcelona, Spain

EMERGING TRENDS IN DISCRETIZATION AND COMPLEXITY REDUCTION METHODS IN FRACTURE, PLASTICITY AND MULTISCALE MECHANICS

ELENA BENVENUTI*, GIANMARCO MANZINI† AND NATARAJAN SUKUMAR‡

* Engineering Department, University of Ferrara
via Saragat 1, 44122 Ferrara, Italy
elena.benvenuti@unife.it

† Theoretical Division, Los Alamos National Laboratory,
Los Alamos, NM, United States of America
gm.manzini@gmail.com, gmanzini@lanl.gov

‡ Dep.Civil and Environmental Engineering, UC Davis,
One Shields Avenue, Davis, CA 95616
nsukumar@ucdavis.edu

ABSTRACT

The simulation of complex physical phenomena in heterogeneous media presents major computational challenges. Traditional discretization methods frequently encounter limitations related to mesh generation and distortion, artificial directional bias, topological re-meshing, and prohibitive computational costs associated with fine-scale and repetitive Representative Volume Element evaluations. This Minisymposium focuses on the integration of novel spatial discretization schemes and complexity reduction strategies to construct high-fidelity, computationally efficient formulations for non-linear physical processes across spatial and temporal scales.

Advanced schemes for complexity reduction include, for instance, Model Order Reduction (MOR) and Reduced Basis (RB) methods, as well as low-rank and tensor decompositions for high-dimensional parametric spaces. Their field of application overlaps with numerical acceleration paradigms such as as Quantum Computing, data-assisted, surrogate, and operator-learning multiscale solvers.

Novel discretization methods encompass unfitted and cut background mesh methods, polyhedral elements with hanging nodes, advanced interface formulations, Virtual Element Methods (VEM, CutVEM), and Hybrid High-Order (HHO) formulations on general polytopal meshes.

Contributions to this Minisymposium will showcase the application of these or any other novel discretization and complexity reduction frameworks to:
- regularized fracture and damage models (nonlocal, peridynamics, phase-field, cohesive zone modeling).
- Elasto-plasticity, viscoplasticity, shear band formation, and plastic dissipation.
- Multiscale composite failure, delamination, grain-boundary sliding in polycrystals, thermo-plasticity, chemo-mechanical degradation, and real-time failure assessment within digital twin architectures.