X International Conference on Particle-based Methods, PARTICLES 2027
October 18-20, 2027, Barcelona, Spain

RECENT ADVANCES IN PARTICLE-BASED METHODS FOR SOLID MECHANICS AND COUPLED PROBLEMS

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ABSTRACT

Classical meshfree and particle approaches face several challenges in the simulation of multi-physics solids undergoing large deformations at high-rate dynamic loading, including contact-impact, spalling fracture, and FSI problems in extreme environments. Key difficulties arise in the accurate treatment of evolving interfaces, multi-material interactions, phase changes, and shock and discontinuity propagation. In addition, numerical issues such as pressure checkerboarding, locking, tensile instability, and inadequate stress and strain resolution can substantially compromise predictive accuracy. Recent advances [1] have introduced a range of robust and implementable formulations that address many of these limitations without relying on *ad hoc* numerical treatments that may undermine physical consistency. Despite these developments, there remains a strong need to develop stable and scalable particle-based methods for extreme deformation and strongly coupled problems, including efficient GPU implementations for large-scale simulations. This invited session aims to bring together researchers to discuss emerging solutions to these challenges. The objective is to advance numerically robust approaches with high predictive fidelity for systems undergoing inertia-dominated dynamics. Topics of interest include, but are not limited to, impact mechanics, fracture and fragmentation, FSI [2], multi-material and multi-phase systems, multi-physics coupling, geodynamics across a wide range of spatial and temporal scales, and HPC implementations. Contributions from industry and open-source software developers are strongly encouraged, as they provide valuable insights into practical challenges, validation, and deployment of advanced meshfree technologies.

REFERENCES

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