IX International Conference on Particle-Based Methods, PARTICLES 2025
October 20-22, 2025, Barcelona, Spain

INNOVATIONS IN PARTICLE METHODS:

EXPLORING THE SOFTWARE LANDSCAPE

ERIC LEQUINIOU[*], POOYAN DADVAND[†]

[*] Altair
Sophia-Antipolis, France
elequiniou@altair.com and openradioss.com

[†] Altair
Barcelona, Spain
pooyan@altair.com and altairengineering.com

ABSTRACT

In this session, we will explore the diverse landscape of particles software, with a deep focus on Smooth Particle Hydrodynamics (SPH), showcasing a range of approaches from commercial solutions to open-source research codes. Our aim is to highlight the synergy between cutting-edge research and industry challenges, and how collaborations foster innovation in this dynamic field.

Session Outline

We will first investigate open-source research codes with at least 2 examples:

- **DualSPHysics**: Developed collaboratively by researchers, DualSPHysics provides a flexible platform for simulating fluid dynamics, supporting extensive customization and community-driven enhancements, optimized for GPU and CPU platforms.
- **Kratos Multiphysics**: This modular framework supports various simulation techniques, including particles, offering a versatile environment for advanced multiphysics modelling, including a powerful coupling interface.

Then, look at commercial software (some additional references can be added depending on session duration)

- **Altair nanoFluidX**: A robust tool for particle-based fluid dynamics, nanoFluidX excels in simulating complex multiphase fluid flows, particularly in automotive and aerospace applications, such as oiling in powertrain systems, able to handle very large models leveraging state-of-the-art GPU acceleration.
- **Altair Edem**: A leading Discrete Element Method (DEM) software that simulates and analyzes the behavior of bulk materials, such as coal, ores, soil, and grains, widely used in mining, agriculture and pharmaceuticals, to optimize equipment design and improve operational efficiency.

The last example will illustrate a novel approach combining commercial and open-source with Radioss:

- **Altair Radioss**: Known for its high-performance crash and impact simulations, Radioss integrates SPH to handle extreme deformation and fluid-structure

interactions efficiently. Now also available as open-source package under the name **OpenRadioss**, it combines the strengths of open-source development by making the software accessible to researchers, students, start-ups, …, democratizing the usage of explicit dynamics while keeping proven industrial standard.

We plan also to highlight the importance of postprocessing with the example of:

- **Paraview**: Essential for particle method simulations, Paraview enables detailed visualization and analysis, offering deep insights to analysts and designers.

Objectives

- **Showcase versatility**: Demonstrate the broad applicability of particles & SPH methods across different software solutions, highlighting their strengths in various domains.
- **Promote Collaboration**: Encourage dialogue between developers and users, emphasizing the importance of integrating state-of-the-art research with industry requirements.
- **Address Challenges [2]**: Discuss the computational costs and optimization strategies, particularly the use of multi-core and GPU architectures to enhance scalability.

Background

Particles & SPH methods, introduced in the 1970s [1], have evolved as cost-effective alternatives to traditional Finite Element Analysis (FEA). Their mesh-free nature simplifies the workflow, making them particularly suited for complex multiphysics problems, such as fluid-structure interactions. These capabilities are crucial for answering key challenges such as advancing net-zero technologies, optimizing systems for renewable energy, and promoting green manufacturing.

Call to Action

Leveraging our network, we will invite key developers and scientists from leading software projects to share their insights. This session aims to bridge the gap between research innovations and industrial applications, ensuring that cutting-edge developments meet real-world challenges effectively.

REFERENCES (Not mandatory, maximum 2 references)

[1] Gingold, R. A., & Monaghan, J. J. (1977). *Smoothed particle hydrodynamics: theory and application to non-spherical stars. Monthly Notices of the Royal Astronomical Society, 181(3), 375-389.*

[2] Domínguez, J. M., Crespo, A. J. C., & Gómez-Gesteira, M. (2013). *Optimization strategies for CPU and GPU implementations of a smoothed particle hydrodynamics method.* Computer Physics Communications*, 184(3), 617-627.*