

MercuryDPM–SPH: Design and Implementation of an Open-Source Smoothed Particle Hydrodynamics Framework

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Abstract

We present MercuryDPM–SPH, a new Smoothed Particle Hydrodynamics (SPH) module embedded within the open source discrete particle framework MercuryDPM. The code is implemented in modern C++ under a BSD 3-clause licence and distributed with full documentation, examples, and tutorials. By reusing MercuryDPM’s hierarchical grid (hGrid) neighbour search algorithm, the solver maintains linear scaling even for highly polydisperse particle systems, offering substantial speed ups compared to conventional linked cell approaches. The modular architecture supports interchangeable kernels, rheological models (Bingham, Herschel-Bulkley), and regularisation schemes, while boundary conditions are implemented through ghost particles. Many standard SPH formulations (density summation, continuity equation, δ -SPH, artificial viscosity) are available. The distribution includes validation and application cases ranging from canonical dam break tests to rheometric and concrete flow benchmarks (slumpcone, V-funnel, L-box). The unified MercuryDPM–SPH framework thus provides a flexible, extensible, and open platform for fluid and granular flow simulations, and establishes a foundation for future SPH–DEM coupling.

Keywords:

SPH SPH DEM coupling OpenSource code development Concrete rheology modelling