

SPHERA v.8.0 documentation

This documentation file accompanies SPHERA v.8.0 for the official software registration at SIAE (Italy)

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1. Description and references

SPHERA v.8.0 (RSE SpA) is free research software (FOSS) based on the SPH (“Smoothed Particle Hydrodynamics”) method, which represents a mesh-less Computational Fluid Dynamics technique for free surface and multi-phase flows. So far, SPHERA has been applied to represent: several types of floods (and landslides) with transport of solid bodies and bed-load transport; sloshing tanks;...

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The main numerical developments featuring SPHERA (so far) are listed in chronological reverse order:

- 3D SPH numerical scheme for the transport of solid bodies in free surface flows. Reference: Amicarelli et al. (2015, CAF):
Amicarelli A., R. Albano, D. Mirauda, G. Agate, A. Sole, R. Guandalini; 2015; A Smoothed Particle Hydrodynamics model for 3D solid body transport in free surface flows; Computers & Fluids, 116:205–228, DOI 10.1016/j.compfluid.2015.04.018
- 3D SPH numerical scheme for a boundary treatment based on discrete surface and volume elements, and on a 1D Linearized Partial Riemann Solver coupled with a MUSCL (Monotonic Upstream-Centered Scheme for Conservation Laws) spatial reconstruction scheme. Reference: Amicarelli et al. (2013, IJNME):
Amicarelli A., G. Agate, R. Guandalini; 2013; A 3D Fully Lagrangian Smoothed Particle Hydrodynamics model with both volume and surface discrete elements; International Journal for Numerical Methods in Engineering, 95, 419–450, DOI: 10.1002/nme.4514.
- SPH numerical scheme for a 2D erosion criterion. Reference: Manenti et al. (2012, JHE):
Manenti S., S. Sibilla, M. Gallati, G. Agate, R. Guandalini; 2012; SPH Simulation of Sediment Flushing Induced by a Rapid Water Flow; Journal of Hydraulic Engineering ASCE 138(3): 227-311.
- 3D SPH numerical scheme for a boundary treatment based on volume integrals, which are numerically computed outside of the fluid domain (semi-analytic approach). Reference: Di Monaco et al. (2011, EACFM):
Di Monaco A., Manenti S., Gallati M., Sibilla S., Agate G., Guandalini R., 2011; SPH modelling of solid boundaries through a semi-analytic approach; Engineering Applications of Computational Fluid Mechanics, 5, 1, 1–15.

Other major numerical developments are available in SPHERA v.8.0 (i.e. 3D erosion criterion with mixture-fixed bed interactions; bed-load transport), but their validation only preliminary (manuscript submitted to CAF).

Since its SPHERA v.7.0 branches, SPHERA has being developed under a Git repository. Its current version contains the folders of Table 3.1.

2. Theory

For this release, no additional information is relevant, beyond SPHERA main references (Sec.1).

3. Installation

SPHERA files are distributed on a dedicated Git repository (please refer to SPHERA contact email address of Sec.1). SPHERA executable files are released for Linux OS. The only mandatory argument of the executable file (in the command line) is the name of the main input file (with no format extension “.inp”).

Folder	Description
doc	Documents on SPHERA registration. The present documentation file.
src	SPHERA source code (with makefile)
bin	SPHERA executable files compiled with both gfortran and ifort
input	Input files for validated test cases. A template for the main input file with comments.

Table 3.1. Folders in SPHERA Git repository.

Test case	Reference	First author
2D_erosional_dam_break_SPHERA_demo	simple test case (rough resolution)	Amicarelli
2jets_plate_DBSPH_high_res	Amicarelli et al. 2013 (IJNME)	Amicarelli
2jets_plate_DBSPH_low_res	Amicarelli et al. 2013 (IJNME)	Amicarelli
2jets_plate_SASPH_low_res	Amicarelli et al. 2013 (IJNME)	Amicarelli
Archimede	simple test case (rough resolution)	Amicarelli
asymmetric_wedge_20deg_light	Amicarelli et al. 2015 (CAF)	Amicarelli
asymmetric_wedge_20deg_medium	Amicarelli et al. 2015 (CAF)	Amicarelli
body-body_impact_asymmetric	Amicarelli et al. 2015 (CAF)	Amicarelli
body-body_impact_low_vel	Amicarelli et al. 2015 (CAF)	Amicarelli
body-body_impact_symmetric	Amicarelli et al. 2015 (CAF)	Amicarelli
body-boundary_impact	Amicarelli et al. 2015 (CAF)	Amicarelli
body-boundary_impact_low_vel	Amicarelli et al. 2015 (CAF)	Amicarelli
dam_break_2_bodies	Amicarelli et al. 2015 (CAF)	Amicarelli
dam_break_2D_demo	simple test case (rough resolution)	Amicarelli
dam_break_multi-body	Amicarelli et al. 2015 (CAF)	Amicarelli
jet_body-plate	Amicarelli et al. 2015 (CAF)	Amicarelli
jet_plate_DBSPH	Amicarelli et al. 2013 (IJNME)	Amicarelli
jet_plate_DBSPH_low_res	Amicarelli et al. 2013 (IJNME)	Amicarelli
jet_plate_SASPH_low_res	Amicarelli et al. 2013 (IJNME)	Amicarelli
symmetric_wedge_20deg_light	Amicarelli et al. 2015 (CAF)	Amicarelli
symmetric_wedge_20deg_medium	Amicarelli et al. 2015 (CAF)	Amicarelli
water_box_free_surface	simple test case (rough resolution)	Amicarelli
water_tank-body	simple test case (rough resolution)	Amicarelli

Table 3.2. Input files in SPHERA repository.

4. Doxygen guide

For this release, no additional information is relevant, beyond SPHERA main references (Sec.1).

5. SPHERA v.8.0 test cases

SPHERA repository contains a sequence of input files, whose associated test cases are either reported on International Journal papers or represent analogous simplifications (Table 3.2).

6. FAQ

For this release, no additional information is relevant.

7. SPHERA v.8.0 acknowledgments

SPHERA has been entirely financed by the Research Fund for the Italian Electrical System (for “Ricerca di Sistema -RdS-”), at different stages:

- ✓ under the second period of RdS (2003-2005), where CESI SpA was the only beneficiary of the Research Fund for the Italian Electrical System;
- ✓ under the Contract Agreement between CESI Ricerca SpA and the Italian Ministry of Economic Development for the of RdS period 2006-2008, in compliance with the Decree of 8 March 2006;
- ✓ under the Contract Agreement between ERSE and the Ministry of Economic Development-General Directorate for Energy and Mining Resources (for the of RdS period 2009-2011) stipulated on 29 July 2009 in compliance with the Decree of 19 March 2009.
- ✓ under the Contract Agreement between RSE SpA and the Italian Ministry of Economic Development for the of RdS period 2012-2014, in compliance with the Decree of November 9, 2012.

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- ✓ HSPHMI14 - High performance computing for Lagrangian numerical models to simulate free surface and multi-phase flows (SPH) and the scalar transport in turbulent flows (Micromixing); June 2014 – March 2015; Amicarelli A., G. Agate, G. Leuzzi, P. Monti, R. Guandalini, S. Sibilla; HPC Italian National Research Project (ISCRA-C2); competitive call for instrumental funds;
- ✓ HPCEFM15 - High Performance Computing for Environmental Fluid Mechanics 2015 (Italian National HPC Research Project); instrumental funding based on competitive calls (ISCRA-C project at CINECA, Italy); 2015 - in progress; Amicarelli A., A. Balzarini, S. Sibilla, G. Agate, G. Leuzzi, P. Monti, G. Pirovano, G.M. Riva, A. Toppetti, E. Persi, G. Petaccia, L. Ziane, M.C. Khellaf.