A Mass Preserving SIM for SPH

Mingyu Zhang*, Xiaolong Deng†

* Institute of Applied Physics and Computational Mathematics, Beijing, China
e-mail: zhang_mingyu@iapcm.ac.cn

† Beijing Computational Science Research Center, China
e-mail: xiaolong.deng@csrc.ac.cn

ABSTRACT

Multiphase flows exist widely in daily life and many industrial processes, such as soap bubbles, rain drops, internal combustion engines, thermal spray coating, and ink-jet printing, et al. In the numerical study of multiphase flows with clear interfaces, it is extremely important to accurately track the interfaces. Many numerical methods have been developed to treat the interface, including Level set method (LSM) [1], volume of fluid (VOF) [2], front tracking method (FT) [3], and phase field method [4], et al. As a full Lagrangian particle method, Smoothed Particle Hydrodynamics (SPH) can easily handle complex flows involving two or more fluids.

In Zhang's previous work [5, 6], an interface is reconstructed upon the geometrical information of the particles near the interface. In our previous work [7], a sharp interface method (SIM) for SPH is developed. The level set method is used to track the interface position. The level set function can be used to calculate the interface curvature more accurately. And the ghost fluid method is introduced to handle the discontinuity. The interface states are calculated by using the jump conditions and are extended to the ghost fluid particles [8]. The ghost fluid method helps to get smooth and stable calculation near the interface.

Mass conservation for each phase is one of the key parts in the simulation of multiphase flows. Based on the previous SIM for SPH, a new method to locate the interface is developed. The modified SIM for SPH will guarantee mass conservation.

In this talk, the developed mass preserving SIM for SPH will be presented in detail. The performance of the developed method will be shown by benchmark tests. The developed method and its future version will be applied to complex flows.

REFERENCES

[1] D. Adalsteinsson and J.A. Sethian, The fast construction of extension velocities in level set methods, *J. Comput. Phys.*, 148, pp.2–22, (1999)
[2] H.-K. Zhao, T. Chan, B. Merriman, S. Osher, A variational level set approach to multiphase motion, *J. Comput. Phys.*, 127, pp.179–195, (1996).
[3] G. Tryggvason, B. Bunner, A. Esmaeeli, D. Juric, N. Al-Rawahi, W. Tauber, J. Han, S. Nas and Y.-J. Jan, A Front-Tracking Method for the Computations of Multiphase Flow Journal of Computational Physics, 169 (2), pp.708-759, (2001).
[4] D. Jacqmin, Calculation of Two-Phase Navier-Stokes Flows Using Phase-Field Modeling, Journal of Computational Physics, 155 (1) (1999) 96-127.
[5] M.Y. Zhang, Simulation of surface tension in 2D and 3D with smoothed particle hydrodynamics method, *J. Comput. Phys.*, 229, pp.7238-7259, (2010)
[6] M.Y. Zhang, S.D. Zhang, H. Zhang and L.L. Zheng, Simulation of surface-tension-driven interfacial flow with smoothed particle hydrodynamics method, *Computers and fluids*, 59, pp.61-71, (2012)
[7] M.Y. Zhang, X.L. Deng, A sharp interface method for SPH, *J. Comput. Phys.*, submitted (2015)
[8] L. Xu, T.G. Liu, Accuracies and conservation errors of various ghost fluid methods for multi-medium Riemann problem, *J. Comput. Phys.*, 230, pp.4975-4990, (2011)