

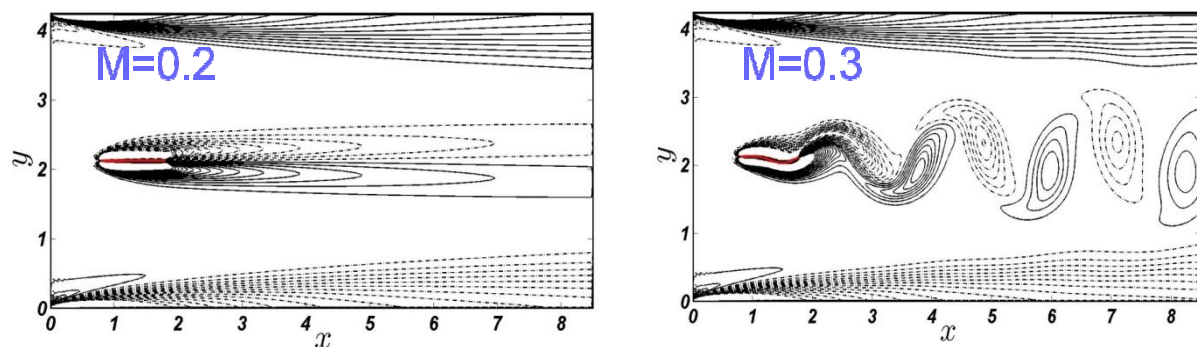
A momentum exchange-based immersed boundary-lattice Boltzmann method for simulating fluid-structure interaction problem in an incompressible flow

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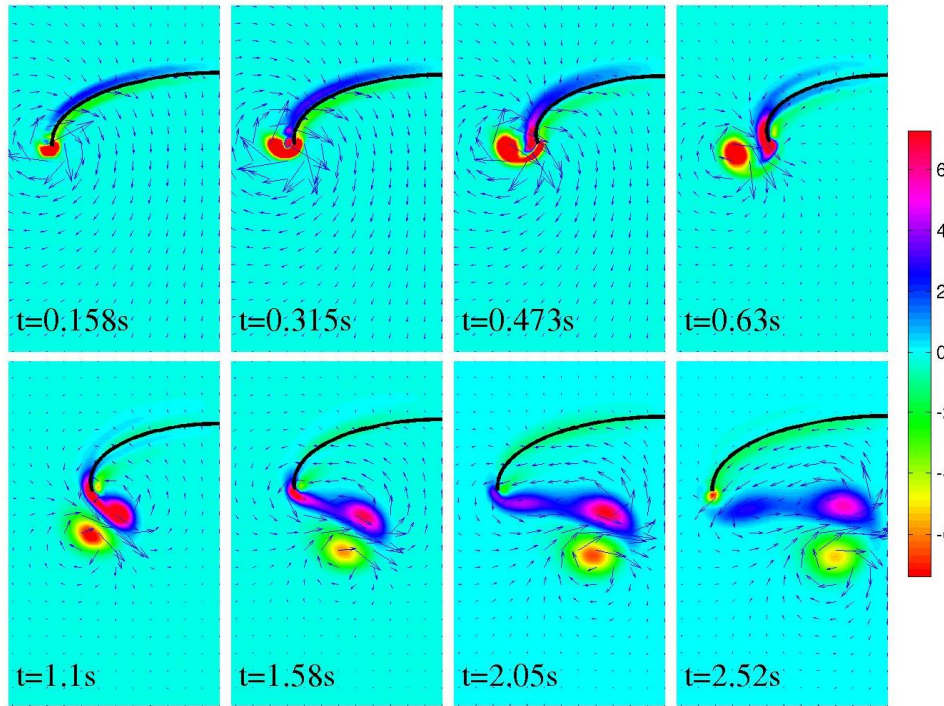
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Fluid-structure-interaction (FSI) problems are found in many engineering applications and biology kinematics. In mechanical engineering, e.g. the design of pumps, aircraft, artificial heart valves and many other efficient heat transfer devices require the thorough understanding of FSI mechanisms. In order to study FSI phenomena, we recently developed an efficient lattice Boltzmann method based on a momentum exchange-based immersed boundary idea (MEIB-LBM)[1-5], which calculates the FSI force on the immersed Lagrangian boundary points by using the momentum exchanging idea. In this talk, we will introduce our recent progresses on the improving the MEIB-LBM and its several applications. The work will includes that employing an iterative technique for calculating FSI forces to satisfy the non-slip boundary condition, studying a flexible filament and a jellyfish movement in an incompressible flow, investigating leap-frog phenomena for a three-particle aligned moving in a slant channel, and a FSI enhancing heat transfer for a natural convection in a square cavity.



.Fig. 1 A single elastic filament with upstream end(mass effect)



.Fig. 2 Vorticity distribution of 2D Jellyfish movement at different time

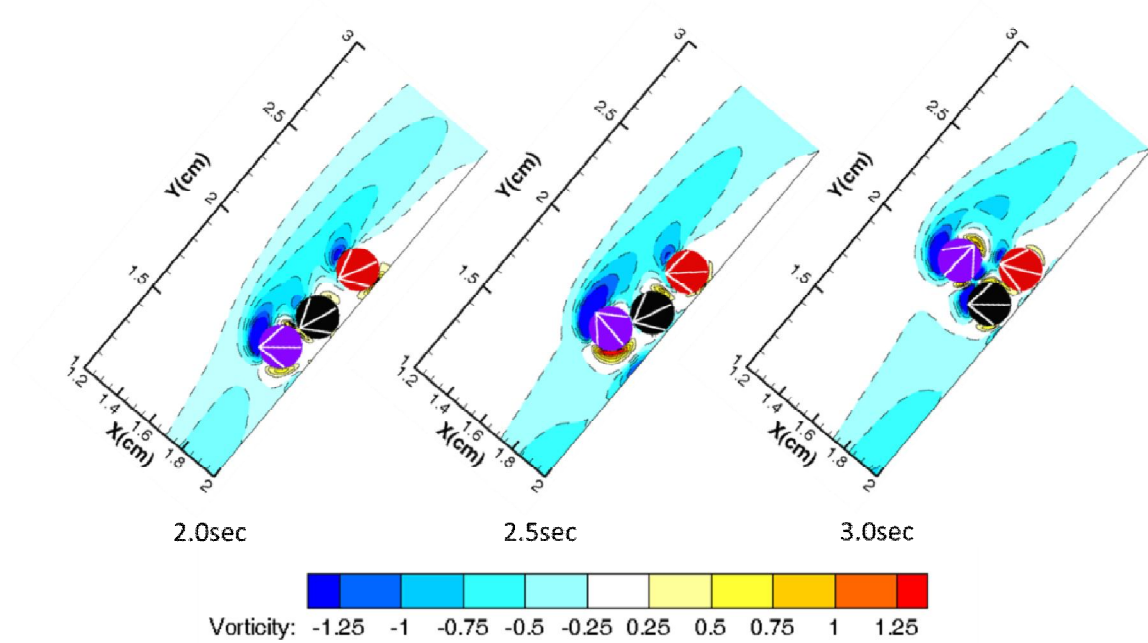


Fig. 3 Vorticity distribution of Frog-leap process of three-particle aligned movement in a slant channel

REFERENCES

- [1] X.D. Niu, C. Shu, Y.T. Chew, Y. Peng, 2006, A momentum exchange-based immersed boundary-Lattice Boltzmann method for simulating incompressible viscous flows, Phys. Lett. A 354 (3), 173 – 182.

- [2] H. Yuan, X.-D. Niu, S. Shu, M. Li, 2013, Natural Convection in a concentric annulus: A Lattice Boltzmann method study with boundary-condition-enforced immersed boundary method, *Advanced in Applied Mathematics and Mechanics*, 5(3), 321-338.
- [3] Y. Hu, H. Yuan, S. Shu, X.-D. Niu, M. Li, 2014, An improved momentum exchanged-based immersed boundary-lattice Boltzmann method by using an iterative technique, *Computers & Mathematics with Applications*, In Press, Corrected Proof, Available online 4 June 2014
- [4] H. Yuan, X.-D. Niu, S. Shu, M. Li, H. Yamaguchi, 2014, A momentum exchange-based immersed boundary-lattice Boltzmann method for simulating a flexible filament in an incompressible flow, *Computers & Mathematics with Applications*, Volume 67, Issue 5, March 2014, Pages 1039-1056
- [5] H.-Z. Yuan, S. Shu, X.-D. Niu, M. Li and Y. Hu, 2014, A Numerical Study of Jet Propulsion of an Oblate Jellyfish Using a Momentum Exchange-Based Immersed Boundary-Lattice Boltzmann Method, *Adv. Appl. Math. Mech.*, 6, pp. 307-326