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Fluid Dynamics Laboratory

Toward Understanding Complex Flows

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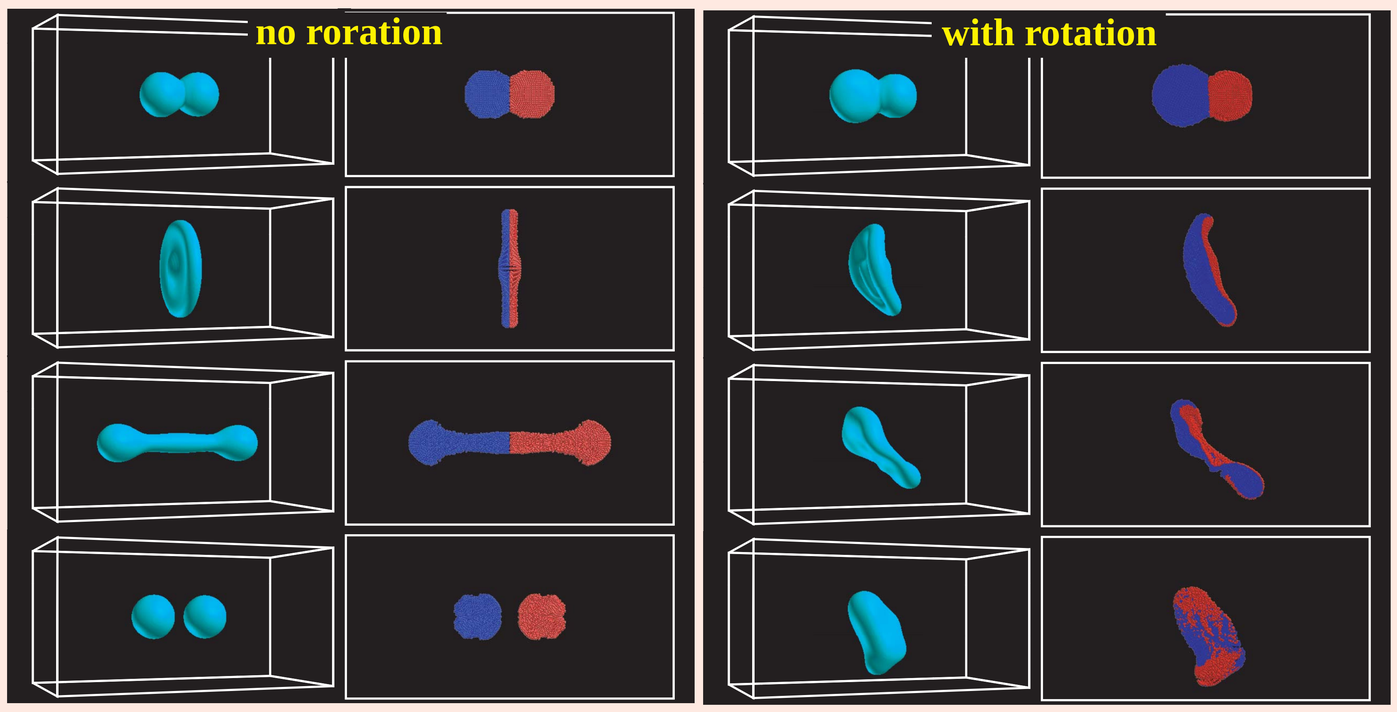
Complex flows such as two-phase flows in micro electro mechanical systems (MEMS), molecular gas flows in aerospace and vacuum engineering, flow phenomena of functional materials, and flows with evaporation and condensation are recently of great interest. We are aiming at investigating the complex flows from the point of view in micro and nano scales by using theoretical, experimental, and numerical approaches.

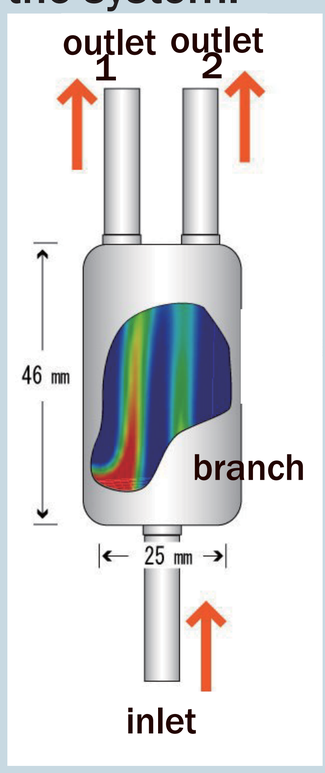
Simulation of binary droplet collision

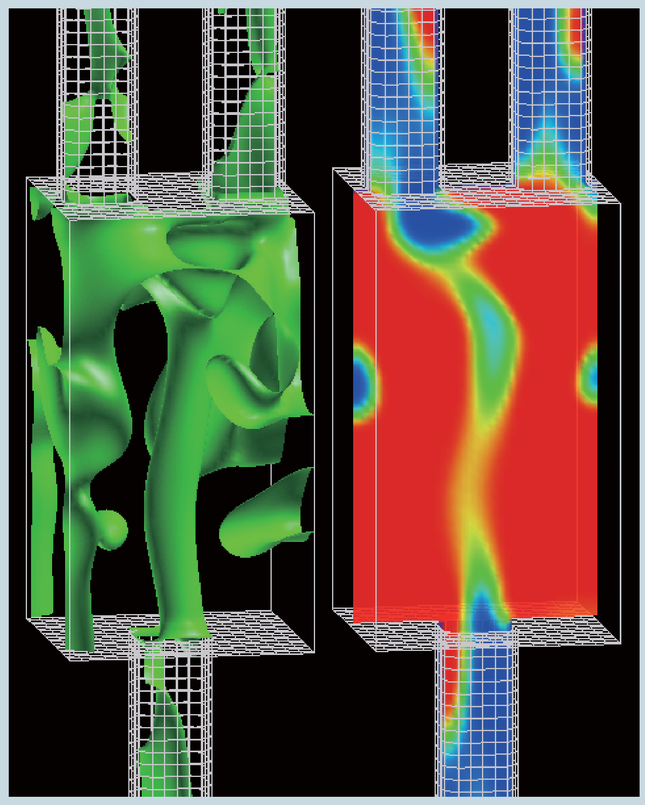
The phenomena of binary droplet collision are of fundamental importance in the studies of raindrop formation, spraying processes, dispersed phase systems, and so on. We investigate the collision dynamics by using the lattice Boltzmann method (LBM) for two-phase flows with large density ratios. The effects of droplet rotations on the collision and mixing processes are shown in the figure below.



Two-phase flow simulation in a branch

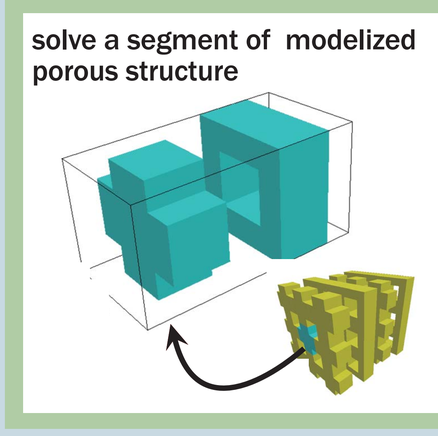
We investigate two-phase flows in a branch of air conditioning systems by LBM. The equal divergence of liquid through outlets is an important issue of the system.

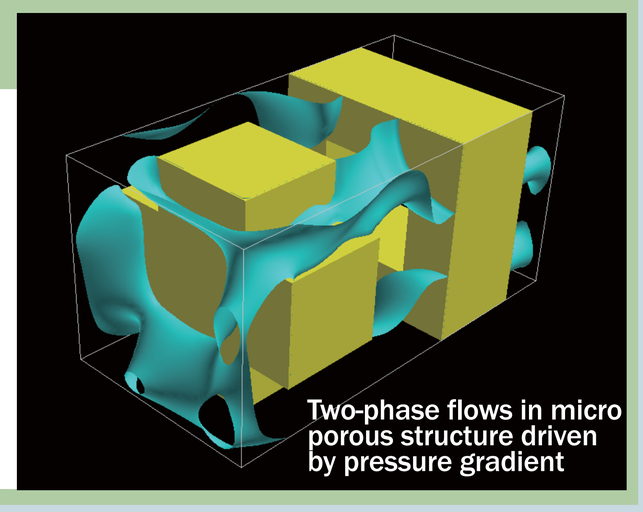




Two-phase flow simulation in a micro porous structure

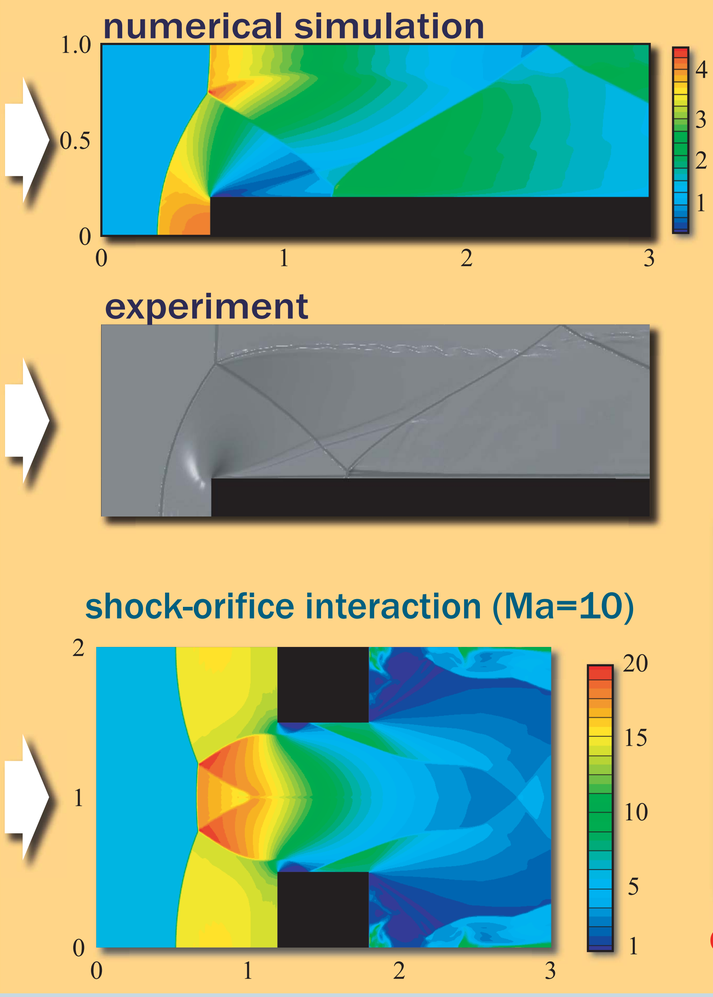
The investigation of two-phase flows in micro porous structure is important issue in connection with the development of fuel cells. The results below show two-phase flows through a micro lattice structure. We focus on the behavior of water in the structure and obtain the permeability of water through the structure.



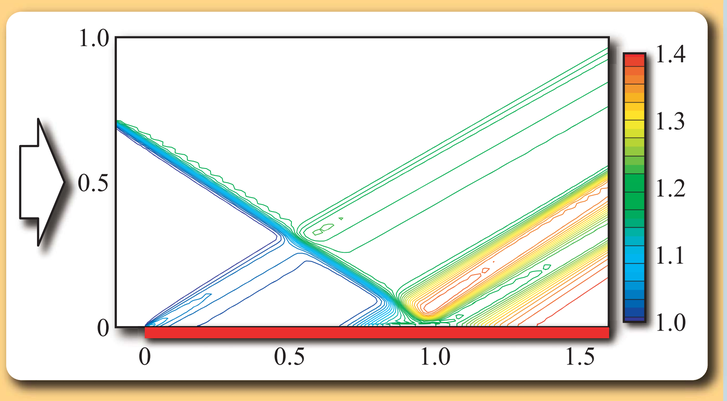


High-resolution schemes for compressible flows by kinetic approach

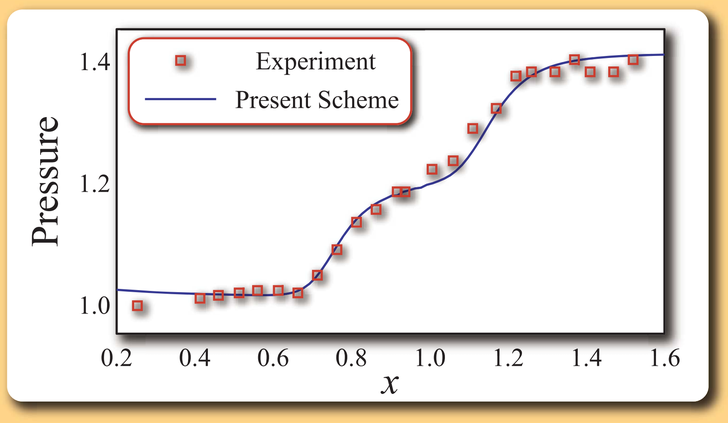
supersonic flows around a forward-facing step (Ma=3)



shock boundary layer interaction ($Ma=2$, $Re=2.96\times10^5$)



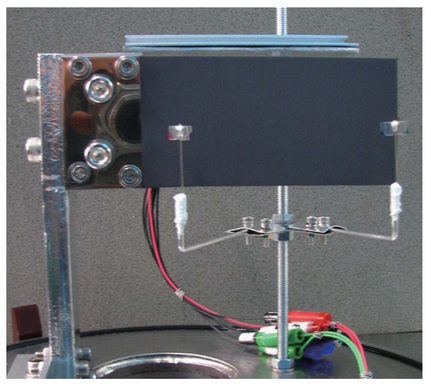
shock-orifice interaction (Ma=10)



distribution of pressure at the plate surface

Rarefied gas flows induced by temperature field

In rarefied gases, various flows are induced by the temperature field of the gas even if there is no gravitational force. We research the engineering application of these phenomena by experiments and theory of rarefied gas dynamics.



Experimental apparatus of the thermal transpiration and thermal edge flows

The gas separator. A mixture of gases is confined in a channel equipped with heated and unheated plates. The smaller molecules concentrate to one end of the channel.