Department of Mathematics

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Scientific Computing Seminar

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A 3D immersed boundary method for fluid-thin-walled-structure interaction

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1:30 PM- 2:30 PM
Room 646 PGH

Abstract: Fluid-thin-walled-structure interactions are very common in science and engineering: parachutes falling in the air, leaves swaying in the wind, fish fins/tails waving in the water, street signs vibrating in strong winds, blood flows in blood vessels, etc. In the immersed boundary method originated by C.S. Peskin the immersed deformable structure is in general modeled as collections of interacting elastic fibers. An alternative approach is to model the immersed structure as a continuum by way of finite element methods (FEM). Both modeling approaches are not efficient for thin-walled structures with small yet finite thickness such as human blood vessels.

In this talk we introduce a new 3D IB method that adopts a classic approach (shell as an assembly of plate elements) to model a thin-walled structure and a special finite element method (the corotational scheme) to solve numerically the partial differential equations governing the motion of the thin-walled structure. The Navier-Stokes equations are solved for numerically by the lattice Boltzmann method. The coupling of the fluid and thin-walled structure is through the penalty approach. As an application, the new IB method is applied to simulation of a 3D viscous flow past a deformable circular thin plate. Our numerical results are in very good agreement with the laboratory experiments.