Mathematical challenges in blood flow

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Mathematical modeling and numerical simulation have been recognized as important tools in understanding the human cardiovascular physiology and pathophysiology. On the course of developing models for cardiovascular applications, various novel mathematical and computational problems arise. In this talk we will discuss a couple of such examples. One is the fluid-structure interaction (FSI) between blood flow and vascular tissue, and the second one is modeling of the mechanical properties of cardiovascular devices called stents by using a novel approach based on hyperbolic nets.

In FSI problems, the highly nonlinear coupling between blood flow and elastic/viscoelastic arterial walls gives rise to the mathematically difficult nonlinear parabolic-hyperbolic moving boundary probems. We will show an existence result for a class of such problems and discuss stability of the related partitioned schemes.

Modeling of cardiovascular stents as hyperbolic nets gives rise to the mathematically difficult problems of wave interactions at nets vertices. More generally, this class of problems is interesting due to its capacity to capture the global mechanical properties of mesh-like structures such as the World Trade Center, tissue scaffolds, and cardiovascular stents, based on the local mechanical properties of each component, and on the way how the local components are put together. We will discuss the challenges related to the analysis and numerical simulation of this class of problems, and show how our results have helped cardiologists in the choice of a stent for a given lesion.

Projects discussed in this talk have been performed in part jointly with Martina Bukac (U of Pittsburgh), Boris Muha (U of Zagreb), Roland Glowinski (UH), Annalisa Quaini (UH), Josip Tambaca (U of Zagreb, Croatia) and Mate Kosor (U of Zadar, Croatia).

The lecture will take place in Thackeray 704 at 3:30pm.
Refreshments will start at 3:00pm.