

# Physics & Astrophysics Colloquium

## Mechanics of Blood Flows from Multi-Scale Simulations

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4:00 PM Friday, November 4, 2022, Room 211, Witmer Hall

### **Abstract:**

Heart and heart valve diseases are the leading causes of death worldwide as the world population ages. In this talk, recent developments of numerical methods for blood flows are reviewed to demonstrate the feasibility of applying simulation for both phases: i) early diagnosis and ii) designing prostheses. Interests are made to the problems of aortic valve replacement and left heart dysfunctions as particular examples. In these examples, the combination of the immersed boundary method in curvilinear system and the standard finite element method are used to perform Fluid-Structure Interaction simulations under healthy and diseased conditions. In such cases, high resolution simulation results are compared with the measurements from laboratory experiments and in-vivo data. The simulation data show that hemodynamics of heart/valvular diseases are more complicated than previously thought. In these cases, transient phenomena such as vortex formation and breakups are ubiquitous. Quantifying such phenomena could lead to new ways of early diagnosing as well as monitoring the diseases. Design of prostheses and virtual surgery are demonstrated using the current computational framework with patient-specific inputs. New developments of integrating non-invasive modalities such as 4D-Flow MRI measurement with numerical simulation is also discussed. Finally, the dynamics of Red Blood Cells and their interactions with cancer cells during the metastasis process are briefly discussed.

**Refreshments at 3:30 PM in Witmer Hall, Room 215**

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