Department of Applied and Computational Mathematics and Statistics Colloquium

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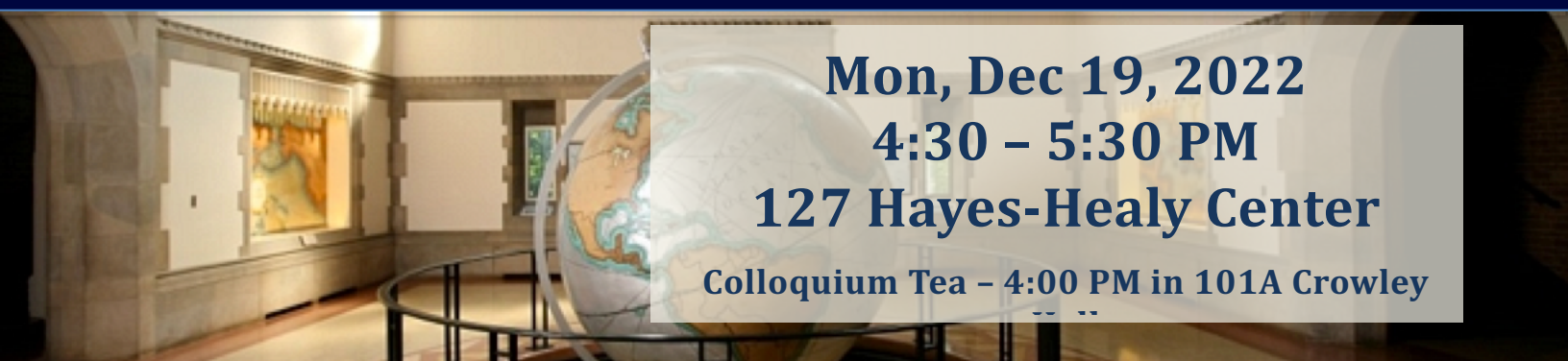
A PDE perspective on the hydrodynamics of flexible filaments

Many fundamental biophysical processes, from cell division to cellular motility, involve dynamics of thin structures immersed in a very viscous fluid. Various popular models have been developed to describe this interaction mathematically, but much of our understanding of these models is only at the level of numerics and formal asymptotics. Here we seek to develop the PDE theory of filament hydrodynamics.

First, we propose a PDE framework for analyzing the error introduced by slender body theory (SBT), a common approximation used to facilitate computational simulations of immersed filaments in 3D. Given data prescribed only along a 1D curve, we develop a novel type of boundary value problem and obtain an error estimate for SBT in terms of the fiber radius. This places slender body theory on firm theoretical footing.

Second, we consider a classical elastohydrodynamic model for the motion of an immersed inextensible filament. We highlight how the analysis can help to better understand undulatory swimming at low Reynolds number. This includes the development of a novel numerical method to simulate inextensible swimmers.



Mon, Dec 19, 2022
4:30 – 5:30 PM
127 Hayes-Healy Center

Colloquium Tea – 4:00 PM in 101A Crowley