The Department of Mathematical Sciences
Colloquium

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Thursday, April 13, 2017
Rm 240 WCharlton Hall
4 – 5 pm

Vesicle Transport into Dendritic Spines and the Lubricated Immersed Boundary Method

We use lubrication theory to model the fluid dynamics of vesicle transport into dendritic spines, which are micron-sized structures at which neuronal postsynapses are located. Dendritic spines are characterized by their thin necks and bulbous heads, and recent high-resolution 3D images show a fascinating variety of spine morphologies. Our model, which has been validated by 3D lattice Boltzmann simulations, reduces the dynamics of vesicle motion to two essential parameters representing the system geometry and elasticity and allows us to thoroughly explore phase space. Upon including competing molecular motor species that push and pull on vesicles, we observe multistability that we speculate neurons could exploit in order to control spine growth. The bifurcations of the resulting dynamical system illustrate the levers the cell may adjust in order to achieve different behaviors.

Problems such as this one involving the near-contact of elastic structures separated by thin layers of fluid are found all over the natural world, with examples including the transit of red blood cells through the narrow slits in the spleen. Motivated by such fluid-structure interaction problems, we introduce an immersed boundary method that uses elements of lubrication theory to resolve thin fluid layers between immersed boundaries. We applying this method to two-dimensional flows of increasing complexity, including eccentric rotating cylinders and elastic vesicles near walls in shear flow, to show its increased accuracy compared to the classical immersed boundary method.

Refreshments will be served 3:15 – 3:45 pm in the Faculty & Graduate Student Lounge
Rm 4118 French Hall West

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