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APPLIED MATHEMATICS SEMINAR 291

From bacteria to chromosomes: hydrodynamic self-organization of biological active matter

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Date: **10/19/18**
Time: **3:00 PM**
Location: **COB 1 265**

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ABSTRACT

The spontaneous emergence of large-scale coherent motions and patterns is a striking feature of many active soft matter systems and often results from long-ranged hydrodynamic interactions driven by internal active forces. In the first part of my talk, I will focus on bacterial suspensions, where hydrodynamic instabilities are known to arise due to the force dipoles exerted by motile microorganisms which couple to their orientations through the flows they generate. Using both models and simulations, I will analyze the interplay between these instabilities and geometrical confinement, where an apparent transition to superfluidity can be harnessed to drive unidirectional streaming flows. The second part of the talk will address the seemingly very different – yet perhaps related – case of chromosomal dynamics inside the nucleus during cell interphase, where experiments recently revealed coherent motion on large length and time scales. A model of chromatin dynamics as a confined polymer chain acted upon by molecular enzymes exerting force dipoles will be discussed, where hydrodynamic interactions emerge once again as a potential mechanism for coherent motions and large-scale self-organization.

BIO:

David Saintillan is a Professor of Mechanical and Aerospace Engineering at the University of California San Diego. He received his B.Sc. from Ecole Polytechnique in France in 2003 and his Ph.D. in Mechanical Engineering from Stanford University in 2006. Prior to joining UCSD, he worked as a Research Scientist at the Courant Institute of Mathematical Sciences of New York University and as an Assistant Professor at the University of Illinois Urbana-Champaign. His research focuses on the theory and simulation of complex fluids, transport phenomena, active soft matter, and biophysical systems. He was the recipient of the 2007 Andreas Acrivos Dissertation Award in Fluid Dynamics and of the 2011 Pi Tau Sigma Gold Medal in Mechanical Engineering, and is a Fellow of the American Physical Society.