

# Numerical Modeling of Biological Transport and Fluid Dynamics: From Brain to Bacteria

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**November 30, 2022, 11:00am to 11:45am**

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## **Abstract:**

In this talk, I will present my research on numerically quantifying reaction-advection-diffusion processes in physical and biological systems by leveraging high-fidelity computational fluid dynamics modeling and high-performance computing. I will begin by focusing on front propagation in chaotic Rayleigh-Bénard convection, where I will demonstrate a framework for manipulating complex fluid dynamics using a coupled reaction front similar to bacterial chemotaxis. I will then show experimentally realistic simulations of molecular transport around bacterial biofilms which demonstrate how slow viscous flows improve evolutionary fitness of biofilm colonies. Next, I will discuss transport in the brain due to cerebrospinal fluid (CSF) flow and excitable reaction-diffusion processes, which are important mechanisms in the development of cognitive decline and acute neurological disorders. I will demonstrate how the accumulation of toxic protein aggregates, which are the biomarkers of Alzheimer's disease, depends strongly on CSF flow and protein aggregation kinetics. Additionally, I will quantify alterations to CSF flow arising from spreading depolarization waves which occur during stroke, seizures, migraine, and cardiac arrest.

## **Biography:**

Saikat Mukherjee is a Postdoctoral Associate in Mechanical Engineering at the University of Minnesota. Prior to this, he obtained his PhD in Engineering Mechanics from Virginia Tech in 2020 and BE in Mechanical Engineering from Jadavpur University, India in 2015. His research answers pioneering questions in biological transport and fluid dynamics and has led to novel insights into transport in the brain under neurological disorders, microbial dynamics, and front propagation in chaotic fluid flows. Saikat is the recipient of Liviu Librescu Memorial fellowship and Manuel Stein fellowship at Virginia Tech, as well as the Marie Skłodowska-Curie Individual fellowship to pursue postdoctoral studies at Université Libre de Bruxelles. His research has been recently awarded an honorable mention in the impactful research category of the University of Minnesota's Postdoctoral Achievement Awards. Saikat's research has been published in Proceedings of the National Academy of Sciences, Journal of Fluid Mechanics, Physical Review E, and Physical Review Fluids. His research has also been highlighted in American Physical Society news, Alzforum, Yale News, and Burroughs Wellcome Fund news.

**\*This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.**

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