Seminar/Talk

Transport in porous media modelling of intracellular diffusion and active bacteria suspensions

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Transport phenomena in biological systems are essential for life-sustaining functions. Here we propose to approach biological materials such as tissues, biofilms and cells as porous media.We will first focus on the passive transport of macromolecules in the intracellular space, involved in functions such as cell migration, blebbing and apoptosis. While intracellular crowding significantly impacts macromolecule mobility, the mechanisms by which cytoplasmic structures influence diffusion remain unclear. We propose a multiscale diffusion model based on an upscaling method developed for porous media. Model predictions, compared to experimental measurements in live cells, highlight two key diffusion reduction mechanisms: tortuosity and hydrodynamic drag. Importantly, we find that effective cytosolic diffusivity depends on intracellular obstacle volume fraction rather than specific cellular regions.We will then consider suspensions of motile bacteria in porous media, relevant for soil bioremediation and biomedical applications. In confined environments at high cell density, these suspensions behave as active fluids displaying self-sustained coherent or chaotic flows. We use a continuum framework derived from FokkerPlanck descriptions to predict emerging flows in channels with different pore geometries as a function of activity and pressure gradient. Numerical results show a deviation from Darcy law, which we relate to an activity enhanced permeability.Altogether, these results demonstrate the potential of porous media modeling to better understand transport phenomena in living matter across scales and systems.

Monday, June 29, 2026 02:00pm - 03:00pm
Moonstone Bldg / Ground floor / Seminar Room F (I24.EG.030f)

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