ChemE MIT Chemical Engineering

Seminar Series
Spring 2026

Multiscale Modeling of Soft and Living Matter: Transport, Rheology, and Dynamics

STYLIANOS VARCHANIS

Flatiron Research Fellow, Biophysical Modeling, CCB

Flatiron Institute

Thursday, February 12, 2026
4:15 pm, Reception 4pm
66-110

Complex fluids—including polymer solutions and melts, emulsions, foams, and living cells—exhibit rich rheological behavior such as viscoelasticity, yielding, and aging. These behaviors play a central role in transport, mixing, and processing operations across industrial manufacturing, materials science, and bioengineering. However, predicting and controlling complex-fluid transport under realistic conditions remains challenging due to nonlinear constitutive response, evolving interfaces, and multiscale coupling between microscopic structure and macroscopic flow.

In this seminar, I will present three case studies illustrating how theory, computation, and experiment are combined to address central challenges in processes involving complex fluids and biological transport. First, I will examine flows of polymer solutions through model porous media, showing how elasticity and shear-thinning generate flow asymmetries relevant to subsurface transport and filtration. Second, I will discuss polymer melt extrusion and resolve a long-standing puzzle regarding surface instabilities by linking extrudate distortions to intense polymer chain stretching and elastic recoil. Finally, I will leverage continuum modeling to describe centrosomal asters, revealing how cytoskeletal mechanics and intracellular transport interact to regulate eukaryotic cell division.

kbriana@mit.edu