ME Seminar

Orchestrating Microfluidics through Whispers and Echoes

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ABSTRACT

Ultrasound offers a unique ability to whisper forces into microscale environments and echo programmable responses in cells and fluids. In this talk, I will present two complementary advances that illustrate how ultrasound fields can orchestrate matter within microfluidic systems. First, I introduce Programmable Acoustic Standing-wave Transfection (PAST), a platform that creates dynamically tunable acoustic potential landscapes to transiently permeabilize cell membranes and drive diffusion-based intracellular delivery. By cycling cells through controlled hydrodynamic and acoustic stresses, PAST enables reversible pore formation, carrier-free biomolecular transport, and high post-treatment viability, offering new opportunities for precision therapeutics and mechanistic studies. Second, I will discuss our discovery of how fluid viscoelasticity can be used to enhance, suppress, or even reverse acoustic streaming in microchannels. By expressing the competing viscous, inertial, and elastic contributions through a unified Streaming Coefficient, we reveal the critical conditions under which acoustic flows reorganize, including the emergence of viscoelastic shear-wave-mediated transitions. Together, these studies demonstrate how subtle acoustic cues whispers and echoes can pattern particles, modulate transport, and engineer fluid-structure interactions, underscoring the potential of acoustofluidics for next-generation drug delivery and microfluidic control.

ABOUT THE SPEAKER

Dr. Ashis K Sen is a Professor of Mechanical Engineering at IIT Madras. He holds degrees from NIT Rourkela, IISc Bangalore, and the USC-Columbia, and has held research and visiting positions at the University of Southampton, TU Darmstadt, and OIST Japan. Dr. Sen is well known for his contributions to micro- and nanofluidics, and miniaturized systems He has published over 150 journal papers, filed multiple patents, and supervised 25 research scholars. His work has earned several major recognitions, including the Swarna Jayanti Fellowship, NASI-Scopus Young Scientist Award, IITM IRDA Awards, INAE Young Engineer Award, and the GYTI Award. He is a Fellow of the Institute of Physics (UK) and the Royal Society of Chemistry (UK), and has served on the Board of the International Acoustofluidics Society. He is currently an Editor of the Journal of Fluids Engineering and Transactions of INAE.

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