PURDUE FLUIDS SEMINAR SERIES

EXTENSIONAL RHEOLOGY AND THE SPATIO-TEMPORAL SIGNATURES OF ELASTO-INERTIAL TURBULENCE IN COMPLEX FLUIDS

FRIDAY MAY 2ND, 2025
SEMINAR 2:00PM-3:00PM WALC 2087
DISCUSSION 3:00PM-3:30PM WALC 2087

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Abstract

The addition of small amounts of polymers to a Newtonian solvent makes a fluid viscoelastic and can lead to significant modifications of high-speed turbulent flows. The interaction of viscoelasticity and inertia even in a very dilute polymer solution results in the emergence of unique inertioelastic instabilities that are still far from being understood, as well as significant modifications to frictional drag. The nonlinear evolution of these instabilities engenders a state of turbulence with significantly different spatiotemporal features compared to Newtonian turbulence, now termed elastoinertial turbulence (EIT). We systematically explore EIT by studying the dynamics of low-speed submerged jets of dilute aqueous polymer solutions injected through a nozzle into tanks of quiescent water or polymer solution. A key kinematic feature of such flows is the presence of extensional kinematics and streamwise stretching. Extensional flows of complex fluids are prevalent in many industrial applications such as spraying, atomization (sneezing), and microfluidic-based drop deposition. In this talk we use the distinctive kinematic features of such flows to understand the mechanics of how, and why, elasto-inertial turbulence is different to classical turbulence.

Biography

Gareth H. McKinley FRS is the School of Engineering Professor of Teaching Innovation and former Associate Head and Interim Head of the Department of Mechanical Engineering at MIT. His research interests include extensional rheometry, microfluidic rheometry and non-Newtonian fluid dynamics. He is a co-founder of Cambridge Polymer Group and a member of the Scientific Advisory Boards of Rheosense Inc. and ActNano Inc. He is the author of over 370 technical publications and has won the Publication Award of the Society of Rheology twice (2007; 2022) as well as the 2021 Walters Award from J. Non-Newtonian Fluid Mechanics. He was awarded the Bingham Medal of The Society of Rheology in 2013, the Gold Medal from the British Society of Rheology in 2014 and the G.I.Taylor Medal from the Society for Engineering Science (SES) in 2022. In 2019 he was elected to the National Academy of Engineering and also inducted as a Fellow of the Royal Society of London. He holds honorary professorships at the University of Swansea (Wales) and Monash University (Australia). In 2023 he was awarded an honorary degree from the Katholike University of Leuven (KU/Leuven) and in 2024 he became a Corresponding Member of the Australian Academy of Sciences (AAS).

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