Can polymeric flows be the Drosophila of continuum mechanics?

Speaker

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Polymeric liquids provide a tunable testbed to explore unsteady, nonlinear continuum mechanics by systematically varying the amount and type of polymers. We explore how such systems can probe a continuum of behaviors from Newtonian flows to elastically dominated regimes, making polymeric flows effectively the "Drosophila" of unsteady continuum mechanics. This talk will demonstrate how adding polymers modifies instabilities in three canonical free-surface flows: sheets punctured by holes (Taylor-Culick retraction), bursting bubbles that emit droplets, and Worthington jets formed by impact. Elastic stresses either create new singularities or suppress known ones, leading to distinct regimes in parameter space. Numerical simulations and complementary experiments reveal how polymer relaxation time and modulus determine free-surface morphologies, droplet sizes, and jet velocities, with implications for aerosol generation and fluid processing. By unifying concepts from fluid and solid mechanics, these results provide broad insight into controlling interfacial flows in manufacturing, pathogen transport, and beyond.