Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Coupled dynamics and stability of cantilever beams at low Reynolds number: application to whisker dynamics SHAYAN HEYDARI, University of British Columbia, THOMAS L. JANSSEN, NEELESH A. PATANKAR, MITRA J. Z. HARTMANN, Northwestern University, RAJEEV JAIMAN, University of British Columbia — Fluid-structure interaction between a flexible cantilever beam and the surrounding flow is ubiquitous in nature and engineering systems. For instance, a rat's whisker – approximated as a cantilever beam with a constant circular cross-section – is shown to undergo oscillatory motion even at very low Reynolds numbers (Re). To study the coupled dynamics and self-excited stability of a flexible cantilever beam, we carry out high-fidelity 3D numerical experiments at Reynolds numbers $Re<50$ for varying angles of attack and aspect ratios. Our goal is to investigate the exact origin of the self-excited oscillations at low Reynolds numbers and highlight critical fluid-structure interaction aspects of the coupled system. In this study, we attempt to answer four key questions: (i) How can a flexible beam undergo a synchronized high-amplitude oscillation below critical Reynolds number (i.e., no periodic vortex shedding)? (ii) What is the intrinsic relationship between the steady wake flow and the oscillatory modes of the beam? (iii) How do the structural and/or wake nonlinearities contribute to the onset of fluid-elastic instability? and (iv) What is the optimal range of bending stiffness to sustain the fluid-elastic instability?

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Date submitted: 03 Aug 2020

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