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Robustness and Sensitivity of Streaming Flow Patterns PARTHA KUMAR DAS, SASCHA HILGENFELDT, Mechanical Science and Engineering, University of Illinois at Urbana-Champaign — Steady streaming flows result from rectification of periodic flow induced by an oscillating interface, and have been used extensively in microfluidic device design. Even simple objects executing simple motion can give rise to complex streaming patterns that sensitively depend on parameters, such as the prototypical case of a cylinder oscillating translationally. We argue that this complexity and sensitivity is not typical for vigorous streaming flows encountered in microfluidic applications, chiefly relying on mixed-mode oscillations of deformable objects with pinned contact lines, such as bubbles or droplets. Experiments varying the modality, channel geometry, and the dynamic boundary condition at the interface (no-stress, tangential stress continuous, no-slip) find an extremely robust vortex-pair streaming pattern independent of frequency or viscosity contrast. Comparing and contrasting the theoretical modeling of these flows with that of classical single-mode streaming patterns, we identify the conditions under which robust or sensitive streaming is expected. These results allow for the design of microfluidic devices guided by physical principles and tailored to applications that either require unvarying, robust flows or easily tunable changes in the streaming.

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