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An Experimental Study of Vortex Flow Formation and Dynamics in Confined Microcavities REEM KHOJAH, DINO DI CARLO, UCLA — New engineering solutions for bioparticle separation invites revisiting classic fluid dynamics problems. Previous studies investigated cavity vortical flow that occurs in 2D with the formation of a material flux boundary or separatrix between the main flow and cavity flow. We demonstrate the concept of separatrix breakdown, in which the cavity flow becomes connected to the main flow, occurs as the cavity is confined in 3D, and is implicated in particle capture and rapid mass exchange in cavities. Understanding the convective flux between the channel and a side cavity provides insight into size-dependent particle capture and release from the cavity flow. The process of vortex formation and separatrix breakdown between the main channel to the side cavity is Reynolds number dependent and can be described by dissecting the flow streamlines from the main channel that enter and spiral out of the cavity. Laminar streamlines from incremented initial locations in the main flow are observed inside the cavity under different flow conditions. Experimentally, we provide the Reynolds number threshold to generate certain flow geometry. We found the optimal flow conditions that enable rapid convective transfer through the cavity flow and exposure and interaction between soluble factors with captured cells. By tuning which fraction of the main flow has solute, we can create a dynamic gate between the cavity and channel flow that potentially serves as a time-dependent fluid exchange approach for objects within the cavity.

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