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Three-dimensional streaming flow patterns in confinement

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ABSTRACT

Steady streaming flow exited by oscillating bubbles is an intriguing tool for transport, mixing, sorting, or force actuation applications in microfluidics. Often the geometry of the set-up is intended to encourage two-dimensional (2D) flows, keeping the flow pattern across the channel depth uniform. This condition cannot always be ideally fulfilled, and three-dimensional (3D) streaming effects may be greatly beneficial, e.g., in mixing applications. We demonstrate that a weak 3D streaming component can be combined with existing 2D streaming theory, resulting in a systematic description of 3D streaming flow patterns. We show that these patterns can indeed be observed in bubble microstreaming, using 3D trajectory tracking by astigmatic particle tracking velocimetry.