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Shape asymmetric particles self-assemble under flow in quasi-two-dimensional microchannels WILLIAM USPAL, Department of Physics, Massachusetts Institute of Technology, H. BURAK ERAL, PATRICK DOYLE, Department of Chemical Engineering, Massachusetts Institute of Technology — Emerging applications in microfluidics increasingly require the imposition of spatial and temporal order on flowing suspensions of particles. In on-chip flow cytometry, for instance, cells must be individually distinguishable and addressable as they flow through a scanning region. Via combined theoretical and experimental approaches, we consider how particle shape can be tailored for flow induced assembly in a shallow, "quasi-two-dimensional" microchannel. Our main finding is that when fore-aft symmetry is broken, a single rigid particle will spontaneously align with the external flow field and migrate laterally to the channel centerline. Via a simple theoretical model, quantitatively borne out by experiments, we show how assembly arises from the interplay of lateral confinement by side walls and a particle's hydrodynamic self-interaction. This mechanism is unique to the quasi-two-dimensional channel geometry: strong confinement in one spatial direction and weak confinement in another. Moreover, assembly does not require time reversal symmetry breaking, as is commonly supposed. Building on this understanding of a single particle, we show that clusters of multiple asymmetric particles likewise assemble into spatially ordered, "crystalline" states.

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