Institute for Research in Fundamental Sciences

Title:

Active Spheroidal Particles in Confined Flow Subject to External Stimuli

Candidate:

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Abstract:

Active particles include a wide range of artificial self-propellers and biological swimmers that consume ambient free energy to facilitate their persistent, active, motion. Active Brownian particles constitute a basic model to approximate the swimming motion. This work explores the nonequilibrium, steady-state, dynamics of non-interacting, active and passive, spheroidal Brownian particles subject to channel flow and external fields. We use a continuum probabilistic approach, by studying the solutions of a Smoluchowski equation, governing the joint position-orientation probability distribution function of the spheroidal particles. Through exhaustive analysis of dynamical fixed points within the orientation space of active and passive spheroids, we analyze, explain and predict the stable patterns of particle distributions obtained through our numerical studies.

We study three cases of active and passive Brownian spheroids, with prolate and oblate shapes and different dipolar/chiral structures, subject to different conditions in a planar channel. These cases include: (1) active magnetic spheroids in Couette flow, subject to transverse, downward, magnetic field; (2) nonmagnetic, chiral active spheroids, subject to Couette as well as Poiseuille flow; and (3) passive magnetic spheroids subject to Poiseuille flow and inclined magnetic fields. The results of case (1) can be applied to a variety of swimmers in microfluidic channels subject to different forms of external stimuli; thus, it adds to the insight into motility- and shape-based separation of dipolar swimmers. The results of case (3) can be used directly for lab-based applications, regarding the shape-based separation of magnetic spheroids using high throughput microchannels.

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