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Stochastic dynamics of active Brownian spheres in linear flows

MARIO SANDOVAL, Universidad Autonoma Metropolitana, ERIC LAUGA, University of Cambridge — Most classical work on the hydrodynamics of low-Reynolds swimming addresses deterministic locomotion in quiescent environments. Thermal fluctuations in fluids are known to lead to a Brownian loss of the swimming direction and to effective long-time diffusion. As most swimming cells or synthetic swimmers are surrounded by external flows, we consider theoretically the stochastic dynamics of a model active particle (a self-propelled sphere) in a steady general linear flow. We derive a general formulation for all components of the long-time mean-square displacement tensor and apply our general results analytically to the case of a steadily-swimming particle in three different external linear flows (pure rotation, shear, and extension). Self-propulsion leads to the same long-time temporal scalings as for passive particles but with increased coefficients. By comparing the active terms with those obtained for passive particles we see that swimming can lead to enhancement of the mean-square displacements by orders of magnitude, and could be relevant for biological organisms or synthetic swimming devices in fluctuating environmental or biological flows.

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