Canadian Association of Physicists

Association canadienne des physiciens et physiciennes

Contribution ID: **3929** Type: **Invited Speaker / Conférencier(ère) invité(e)**

(I) Hydrodynamic interactions of swimming microorganisms with particles and surfaces

Tuesday 20 June 2023 13:15 (30 minutes)

A remarkable diversity of morphologies exists among flagellated bacteria and, more broadly, motile microorganisms. To understand some of the consequences of these design choices, we numerically simulate the swimming motion of flagellated bacteria and model squirmers using a boundary element method. We show that interactions with solid surfaces bounding their fluid environment are particularly sensitive to parameters such as the cell body aspect ration, the length, number and placement of flagella on the cell, and the effective stiffness of the flagellar hook. The behaviour of a bacteria-like swimmer near surfaces can be tuned by choosing particular configurations and varying the motor torque. We then characterize the interaction of swimmers with neutrally buoyant spherical particles in unbounded fluid. Interestingly, we find that large particles (e.g., 10 times the radius of the swimmer) can have a larger net displacement due to an encounter with a swimmer than smaller particles at the same impact parameter. This has implications for the effective enhancement of the diffusion coefficient of suspended particles in a bacteria-laden fluid. Based on numerical results, we estimate the effective diffusivity of a particle in a dilute bath of swimmers and show that there is a non-monotonic dependence on particle radius. Similarly, we show that the effective diffusivity of a swimmer scattering in a suspension of particles varies non-monotonically with particle radius. As with interactions with a planar surface, the details are highly dependent on the chosen swimmer, allowing the enhancement of diffusion to selectively affect particles of a specific size more or less.

Keyword-1

Microswimmers

Keyword-2

Bacteria

Keyword-3

Hydrodynamic interactions

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Session Classification: (DPMB/DCMMP) T3-1 Soft Matter and Biological Physics Symposium | Symposium sur la matière molle et la physique biologique (DPMB/DPMCM)

Track Classification: Symposia Day (Tues. June 20) / Journée de symposiums (mardi, le 20 juin):