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SIMULATED MOTILITY OF A BILOPHOTRICHOUS BACTERIUM

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Flagellated bacteria use common physical principles for locomotion but vary greatly in their morphology and control of flagellar motors. The bacterium *Magnetococcus marinus* has two complex flagellar bundles, each consisting of multiple flagella bound together by a sheath.

A recent study comparing experimental observations of *M. marinus* with simulations [1] suggested that one of the bundles pushes the cell from behind while the other pulls the cell from the front. This contrasts with the prior belief that both bundles pushed from behind, which was adopted in our earlier hydrodynamic model [2].

We re-examine the dynamics of swimming with two flagellar bundles, treating each sheathed bundle as a single flagellum. We quantitatively compare the trajectories obtained with two pushing flagella and those with a pushing–pulling combination. In addition to the configuration of the flagella with respect to the cell body, we investigate the influence of flexibility of the flagella, modelled using a Kirchhoff rod formulation. The elastic model of the filaments is coupled with a rigid body model for the cell and a regularized Stokeslet formulation is used to numerically solve the hydrodynamic equations.

Flexibility of the filaments allows the axes of the flagella to bend and align with the direction of swimming even when the bases of the pushing and pulling flagella are placed near each other on the cell body. We find that there is a relatively narrow range of filament stiffnesses that allow alignment of the flagella with the swimming direction without transitioning to "overwhirling" motion of the pusher flagellum.

REFERENCES

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