Electronic Supplementary Material (ESI) for Soft Matter.

Electronic Supplementary Information for: Dynamics of Self-Propelled Filaments Pushing a Load

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DESCRIPTION OF THE VIDEOS

The six videos in the ESI show example simulations of the self-proprelled filaments swimming against rigid bodies from the different phases. The filament is in greyscale with the leading tip coloured black. The rigid body is green. The camera moves with the filament; the red points indicate a spatially fixed reference system as a guide to the eye.

S1.mp4: Rod swimmer in the elongated phase with $F = 50$, $\xi_P/L = 2$, and $\gamma_F/\gamma_B = 5$. The length of the video is $12.5\,\tau$.

S2.mp4: Rod swimmer in the beat phase with $F = 5000$, $\xi_P/L = 2$, and $\gamma_F/\gamma_B = 1.67$. The length of the video is $0.075\,\tau$.

S3.mp4: Rod swimmer in the beat-and-circle regime with $F = 5000$, $\xi_P/L = 2$, and $\gamma_F/\gamma_B = 5$. The length of the video is $0.5875\,\tau$.

S4.mp4: Hexagon swimmer in the rotation phase with $F = 250$, $\xi_P/L = 2$, and $\gamma_F/\gamma_B = 1.64$. The length of the video is $6.875\,\tau$.

S5.mp4: Hexagon swimmer in the rotation phase at low thermal noise with $F = 150$, $\xi_P/L = 2000$, and $\gamma_F/\gamma_B = 1.1$. The length of the video is $6.25\,\tau$.

S6.mp4: Hexagon swimmer in the beat phase at low thermal noise with $F = 1000$, $\xi_P/L = 2000$, and $\gamma_F/\gamma_B = 1.1$. The length of the video is $2.5\,\tau$.

The videos correspond to the simulation snapshots in Fig. 2 in the main text. Note that the videos S1, S4, S5, and S6 are played ten times faster than the videos S2 and S3.

IMPACT OF THE BENDING RIGIDITY OF THE LINK BETWEEN THE FILAMENT AND THE RIGID LOAD

Additional simulations were performed to study the impact of the bending rigidity of the link between the filament and the rigid load, because this parameter might be difficult to controll when studying experimental realizations of our model. Filaments pushing the rod-shaped load with $\gamma_F/\gamma_B \approx 3.3$ and low thermal energy were used as a model. The bending rigidity of the angle that links the filament and the load κ_{link} and the propulsion force were varied.

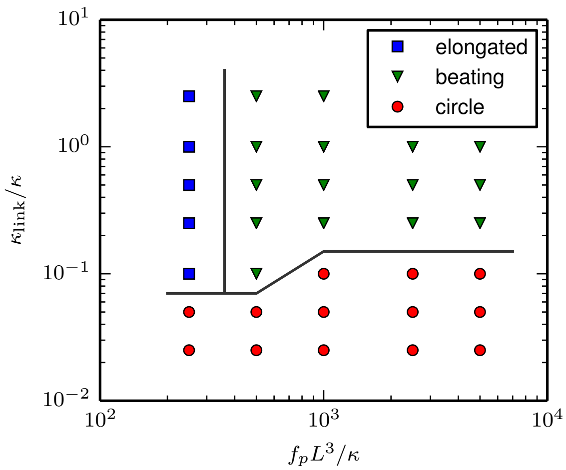
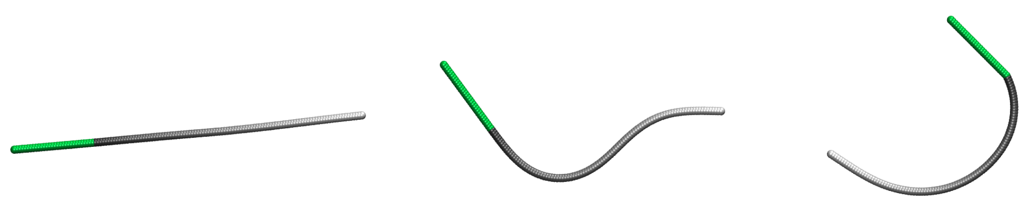


FIG. S1: Phase diagram for varying propulsion strength and bending rigidity of the link between the filament and the load.



(a) elongated (b) beating (c) circle

FIG. S2: Snapshots of propelled filaments with reduced bending rigidity at the link to the head. (a) and (b): At moderate reduction, the phases observed in the main article are recovered. (c): For a stronger reduction of κ_{link}, the load tilts to the side and the filament swims in a circle. Parameters for the depicted filaments are (a) $f_p L^3/\kappa = 250$, $\kappa_{\text{link}}/\kappa = 0.25$, (b) $f_p L^3/\kappa = 1000$, $\kappa_{\text{link}}/\kappa = 0.25$, and (c) $f_p L^3/\kappa = 250$, $\kappa_{\text{link}}/\kappa = 0.1$.

The results are depicted in a phase diagramme in Fig. S1. For low κ_{link}, the rigid load bends down and the filament starts to swim in a circle (see snapshot in Fig. S2). This circle swimming for rod-shaped loads was not observed in any simulation described in the main article. It is important to realize that this effect only occurs for $\kappa_{\rm link} \ll \kappa$.