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On the propulsive efficiency of rotating elastica. MARC FERMIGIER, NICOLAS CHAMPAGNE, ERIC LAIK, JOEL MARTHELOT, OLIVIA DU ROURE, PMMH-ESPCI, Paris — A majority of microorganisms propel themselves with long flexible cilia or flagella. Understanding in detail the hydrodynamics of such propulsion mechanisms is important both from biological and engineering point of views, in particular to design artificial microswimmers. We report an experimental investigation of the propulsive force delivered by a rotating elastic filament. Macroscopic filaments made of an elastomer (Young's modulus E) loaded with solid particles to match the density of the suspending liquid are rotated at constant velocity ω in a bath of glycerin. Their three dimensional shape is time independent but varies with ω and aspect ratio L/a. The force on the filament is computed from the experimental shape using a slender body approximation (ratio of perpendicular and parallel friction coefficients : $\zeta_\perp = 2\zeta_\parallel$). The evolution of axial force is captured by a single dimensionless parameter comparing viscous and elastic stresses: $Sp = (\eta\omega/E)(L/a)^4$. As for a planar oscillating flexible tail a maximum force is found at $Sp \approx 1$.

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