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Hysteresis and wall-effects in low Reynolds number propulsion by driven elastic filaments SARAH CLARK, PRABHAKAR RANGANATHAN, JAMES FRIEND, Monash University — There is currently intense interest in developing micron-sized robots for uses such as minimally invasive surgery. Although progress has been made in miniaturizing the motor, the hydrodynamic behavior of associated propellers is far from being fully understood. An example is an elastic filament driven by a torque at one end where the shape assumed by the filament is strongly coupled to the hydrodynamics forces. Investigation of these dynamics has only recently commenced, for instance Manghi et al. [PRL 96, 068101 (2006)] uncovered an intriguing shape transition in an elastic filament spun in a bulk fluid. Since such transitions can be expected to have a crucial bearing on the operation of microbot swimmers we examine this behavior in detail with simulations. We also study the effect of planar no-slip walls on the propulsion characteristics. The slender filament is represented as a bead-spring chain and inter-bead hydrodynamic-interactions are described using the appropriate Greens functions. We study the origin of the shape transition and hysteresis in detail and show the relationship to sedimenting filaments. We show that the presence of a boundary either perpendicular or parallel to the axis of the applied torque has a significant effect on the overall motion. We also point out the possible detrimental consequences of these effects on operation of microbots in the vicinity of conduit walls.

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