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Optimizing an undulating magnetic microswimmer for cargo towing[1] YIZHAR OR, EMILIYA GUTMAN, Technion - Israel Institute of Technology — One of the promising applications of robotic microswimmers is towing a cargo for controlled drug delivery, micro-surgery or tumor detection. This capability has been demonstrated by the magnetically-actuated microswimmer of Dreyfus et al [Nature 2005] in which a red blood cell was attached to a chain of magnetic beads connected by flexible DNA links. A key question is what should be the optimal size of the magnetic tail for towing a given cargo. This question is addressed here for the simplest theoretical model of a magnetic microswimmer under planar undulations - a spherical load connected by a torsion spring to a magnetized rigid slender link. The swimmer's dynamics is formulated assuming negligible hydrodynamic interaction and leading-order expressions for the resulting motion are obtained explicitly under small amplitude approximation. Optimal combinations of magnetic actuation frequency, torsion stiffness, and tail length for maximizing displacement or average speed are obtained. The theoretical results are compared with several reported magnetic microswimmers, and also agree qualitatively with recent results on cargo towing by screw rotation of magnetic helical tails [Walker et al, ACS Nano Letters 2015].

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