Efficiency of propulsion at low Reynolds by an internal helix

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I first discuss the now classic PNAS paper by the Nobel prize winner E. Purcell, "The efficiency of propulsion by a rotating flagellum" (http://www.pnas.org/content/94/21/11307), published posthumously. He estimates and optimizes the efficiency of self-propulsion of a spherical cell, by an external rigid flagellum powered by a rotary motor. Motivated by possible microrobotic applications, in the second part of the talk I estimate the efficiency in the case of an internal helical structure. There are two cases to consider. i) as in Purcell's paper, a rotary motor anchored in the cell produces a torque on a passive helical structure. ii) the helix is an active machine, emulating the spirochete mechanics. The robotic spirochete is then encapsulated by a passive spherical shell. Only high school algebra is required for rough estimates. We outline the analytical and computational effort required for a detailed study.