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Optimal pumping kinematics of a cilium[1] CHRISTOPHE ELOY, Aix-Marseille University, IRPHE, ERIC LAUGA, Department of Mechanical and Aerospace Engineering, UC San Diego — In a variety of biological processes, eukaryotic cells use cilia to transport flow. Although the internal molecular structure of cilia has been remarkably conserved throughout evolution, experimental observations report qualitatively diverse kinematics in different species. To address this diversity, we have determined numerically the kinematics of the most efficient cilium. Specifically, we have computed the time-periodic deformation of a wall-bound elastic filament leading to transport of a surrounding fluid at minimum energetic cost. Here, the energetic cost is taken to be the sum of positive works done by the internal torques, such that elastic energy is not conservative. The optimal kinematics are found to strongly depend on the cilium bending rigidity through a single dimensionless number, the Sperm number Sp, and closely resemble the two-stroke ciliary beating pattern observed experimentally.

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