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Optimal shapes of surface-slip driven self-propelled swimmers ANDREJ VILFAN, NATAN OSTERMAN, J. Stefan Institute — If one defines the swimming efficiency of a microorganism as the power needed to move it against viscous drag, divided by the total dissipated power, one usually finds values no better than 1%. In order to find out how close this is to the theoretically achievable optimum, we first introduced a new efficiency measure at the level of a single cilium or an infinite ciliated surface and numerically determined the optimal beating patterns according to this criterion [1]. In the following we also determined the optimal shape of a swimmer such that the total power is minimal while maintaining the volume and the swimming speed. The resulting shape depends strongly on the allowed maximum curvature. When sufficient curvature is allowed the optimal swimmer exhibits two protrusions along the symmetry axis. The results show that prolate swimmers such as Paramecium have an efficiency that is $\sim 20\%$ higher than that of a spherical body, whereas some microorganisms have shapes that allow even higher efficiency.

[1] N. Osterman and A. Vilfan, Finding the ciliary beating pattern with optimal efficiency, Proc. Natl. Acad. Sci. USA, 108 15727-15732 (2011)

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