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Hydrodynamics of elastic plates with external and internal actuation[1] ERSAN DEMIRER, ALEXANDER ALEXEEV, Georgia Institute of Technology — Fish are able to achieve swimming efficiencies and burst speeds far exceeding any man-made device through passive (flow induced) and active (muscles) deformations of membranes. The emergence of smart materials has allowed new approaches for efficient design of robotic fish. Using numerical simulations based on a coupled lattice Boltzmann and finite differences model and experiments we investigate different actuation methods on the hydrodynamics of elastic plates oscillating at resonance. We compare the conventional heaving actuation with an internal actuation mimicking smart materials, such as macro-fiber composites (MFC). We identify linear and nonlinear regimes of plate oscillations for a wide range of Reynolds numbers. We find that the actuation method drastically impacts the propulsion thrust and efficiency. Heaving plates significantly outperform plates with internal actuation. This result is explained based on the bending pattern of the plate and emerging flow structures. We also find that the inertia coefficient is a strong function of the actuation method, amplitude, aspect ratio and Reynolds number. Our results point to the need to develop methods for improving the hydrodynamic efficiency of propulsors made of internally actuated smart materials.

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