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Flexibility and Direction Reversal in Flapping Locomotion SAVERIO SPAGNOLIE, UC San Diego, MICHAEL SHELLEY, New York University — In order to better understand the role of flexibility in the flapping of wings and fins in Nature, experimentalists at NYU have studied a heaving foil with passive pitching. We analyze this system numerically, having constructed a high-order accurate numerical scheme to solve the full Navier-Stokes equations in two-dimensions to study the dynamics. We are able to reproduce qualitatively the results of the experiments: by increasing the flapping frequency, we find regions of improved performance when compared to a rigid wing, regions of under-performance, and a bi-stable regime where the flapping wing can move horizontally in either direction. The numerical simulations have led to predictions of other modes of flapping locomotion, which have subsequently been observed in experiments. We also find that a symmetry breaking transition to forward flapping flight, as observed in experiments of a heaving foil with no pitching, may be directed with only very slight flexibility.

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