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Bistable flapping of flexible flyers in oscillatory flow YANGYANG HUANG, EVA KANSO, University of Southern California — Biological and bio-inspired flyers move by shape actuation. The direct control of shape variables for locomotory purposes is well studied. Less is known about indirect shape actuation via the fluid medium. Here, we consider a flexible Λ-flyer in oscillatory flow that is free to flap and rotate around its fixed apex. We study its motion in the context of the inviscid vortex sheet model. We first analyze symmetric flapping about the vertical axis of gravity. We find that there is a finite value of the flexibility that maximizes both the flapping amplitude and elastic energy storage. Our results show that rather than resonance, the flyer relies on fluidic effects to optimize these two quantities. We then perturb the flyer away from the vertical and analyze its stability. Four distinct types of rolling behavior are identified: mono-stable, bistable, bistable oscillatory rotations and chaotic dynamics. We categorize these types of behavior in terms of the flyers and flow parameters. In particular, the transition from mono-stable to bistable behavior occurs at a constant value of the product of the flow amplitude and acceleration. This product can be interpreted as the ratio of fluidic drag to gravity, confirming the fluid role in this transition.

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