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Vibration Amplitude of a Flexible Filament Changes Non-Monotonically with Angle of Attack H. DOGUS AKAYDIN, Stanford University, CEES J. VOESENEK, Wageningen University, DAVID LENTINK, Stanford University, LENTINK LAB TEAM — Certain animals exploit the interaction of their flexible, foil-like appendages with vortices to propel themselves effectively in surrounding fluids. The interaction is reciprocal because the fluid forces deform the appendage while the appendage alters the flow. As the flow separates from a foil-like structure, it rolls-up into a vortex with a low-pressure core, which deforms the structure until the vortex is shed into the wake. A control over this interaction can provide a robust aerodynamic performance. To identify the salient parameters that control fluid-structure interactions on a deformable structure, we varied the thickness, length and angle of attack of a rubber filament in a quasi-two-dimensional flow generated using a soap-film tunnel. We resolved fluid-structure interaction by simultaneously measuring deformation of the filament and motion of particles in the fluid using high-speed cameras. We show that increasing length or decreasing diameter of the filament increases its vibration amplitude monotonically. In stark contrast, the angle of attack of the filament may alter the amplitude of vibrations in a non-monotonic way: Within a certain range of angle of attack, the filament motion and vortex shedding lock-in, i.e. become synchronized, and result in a violent flapping behavior. This response can therefore be ceased not only by decreasing but also by increasing the angle of attack at the leading edge. Such an insight can help us engineer more effective bio-inspired robots, energy harvesters, and flow control devices with vibration control.

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