Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Nonlinear Stability Boundaries of Elastically Mounted Pitching Swept Wings[1] YUANHANG ZHU, KENNETH BREUER, Center for Fluid Mechanics, Brown University — We study the nonlinear stability boundaries of cyber-physically mounted pitching swept wings in a water tunnel. As the wing sweep, Λ, increases from 0° to 10°, the flow-induced limit-cycle oscillations (LCOs) become more stable and can sustain at higher pitching frequencies. In contrast, as Λ further increases to 25°, the LCOs become less stable and annihilate at lower pitching frequencies. We attribute this non-monotonic behavior to the competition between two mechanisms: (a) the stabilization of leading-edge vortices (LEVs) by the wing sweep, which promotes LCOs and thus destabilizes the system, and (b) the increasing fluid damping brought by the wing sweep, which damps out LCOs and thus stabilizes the system. Because the flow-induced LCOs are near sinusoidal, we use prescribed sinusoidal motions to map out the energy transfer between the wings and the ambient fluid over a large range of pitching amplitudes and frequencies. We observe that the amplitudes and frequencies of flow-induced LCOs match remarkably well with the neutral energy transfer curve generated by prescribed motions. Lastly, we compare flow fields and LEV dynamics for different swept wings.

[1]This work is supported by AFOSR.

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Date submitted: 30 Jul 2020 Electronic form version 1.4