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Unsteady fluid-structure interactions with a heaving compliant membrane wing GALI ALON TZEZANA, KENNETH BREUER, Brown University — Membrane wings have been shown to provide some benefits over rigid wings at the low Reynolds number regime ($Re \sim 10^3$ to 10^5), specifically improved thrust in flapping flight. Here we present results from a theoretical framework used to characterize the unsteady aeroelastic behavior of compliant membrane wings executing a heaving motion. An analytical model is developed using 2D unsteady thin airfoil theory, coupled with an unsteady membrane equation. Chebyshev collocation methods are used to solve the coupled system efficiently. The model is used to explore the effects of wing compliance, inertia (including added mass effect) and flapping kinematics on the aerodynamic performance, identifying optimal conditions for maximum thrust and propulsive efficiency. A resonant frequency of the coupled system is identified and characterized for different fluid-structure interaction regimes. Extensions to pitching kinematics are also discussed.

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