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Theoretical and data-driven models for the lift on an airfoil due to idealized synthetic jet actuation[1] KATHERINE ASZTALOS, SCOTT DAWSON, DAVID WILLIAMS, Illinois Institute of Technology — The response to burst-type momentum-injection actuation near the leading edge of an airfoil in stall can be decomposed into two components: a short-time response that is characterized by an initial decrease followed by an increase in the lift, and a long-time response that can be sensitive to the instantaneous wake state at the onset of actuation. In this work, we develop both theoretical and data-driven models for these dynamics. We develop a theoretical model following classical unsteady aerodynamic theory, where the effect of actuation is modeled through a combination of sources/sinks, doublets, and vortex elements to capture the short-time response to actuation. We find that the lift response consists of a component directly proportional to the rate of change of actuation strength, and a circulatory contribution that persists after the actuation burst. Comparisons are presented between the theoretical results and direct numerical simulations for flow over a NACA0009 airfoil. We additionally demonstrate the capabilities of data-driven reduced-order models to model both the short- and long-time behavior of the system, utilizing insight from the theoretical model to specify and interpret the form that this model takes.

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