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The effects of tonal and broadband acoustic excitation on the transition process within a laminar separation bubble[1] SERHIY YARUSEVYCH, JOHN KURELEK, University of Waterloo, MARIOS KOTSONIS, Technical University of Delft — The effects of controlled acoustic excitation on the transition process in a laminar separation bubble formed on the suction side of a NACA 0018 airfoil at a chord Reynolds number of 125,000 and an angle of attack of 4 degrees are studied experimentally. The investigation is carried out using time-resolved, planar, two-component Particle Image Velocimetry. Two types of excitation are considered: (i) tonal excitation at the frequency of the most unstable disturbances in the natural flow, and (ii) broadband excitation consisting bandpass filtered to the natural unstable frequency range, modelling two common types of airfoil self-noise production. For equal energy input levels, the results show that tonal and broadband types of excitation have equivalent effects on the mean flow field. Specifically, both cause the streamwise extent and height of the bubble to decrease. However, further analysis reveals notable differences in the underlying physics. For the tonal case, the transition process is dominated by the growth of disturbances at the excitation frequency that damps the growth of all other disturbances, leading to the formation of strongly coherent vortices in the aft portion of the separation bubble. On the other hand, broadband excitation promotes more moderate growth of all disturbances within the unstable frequency band, producing less coherent shear layer structures that experience earlier breakdown. Thus, the frequency content of acoustic excitation has a strong influence on the transition process in laminar separation bubbles.

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