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Transient Crossings of a NACA0012 Wing into a Streamwise-Oriented Vortex DANIEL GARMANN, MIGUEL VISBAL, Air Force Rsch Lab - WPAFB — High-fidelity numerical simulations are conducted to examine the unsteady interactions of a finite NACA0012 wing maneuvering into a streamwise-oriented vortex as a representative problem of wake encounters. Three crossing speeds are examined at a Reynolds number of $Re = 2.0 \times 10^5$, and a mostly quasi-stationary response is revealed with vortex position as each encounter traverses a similar range of flow regimes, including instances of vortex pairing of the tip and incident vortices with mutual induction/attenuation, tip vortex suppression as the impingement passes inboard of the wingtip, and induced separation that precipitates an abrupt transition at the leading edge. However, an advanced upstream development of a spiraling mode instability is observed in the incident vortex with slower encounters, which is attributed to prolonged exposure of the vortex to the adverse pressure gradient on the underside of the wing that decelerates the core axial flow below known stability bounds of the vortex, and precipitates a more pronounced spiraling mode. A dynamic loading effect is also identified prior to the vortex crossing inboard of the wingtip, whereby the incident structure's relative position at peak loading shifts outboard with higher speeds due to a strengthened tip vortex.

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