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The Direct Numerical Simulation of the Deflected Wake Phenomenon around a Plunging NACA0012 Airfoil at Low Reynolds Numbers MEHMET SAHIN, SALIHA BANU YUCEL, Istanbul Technical University, MEHMET FEVZI UNAL, MEF University — The deflected wake phenomenon reported by Jones and Platzer (2009) is investigated in detail using direct numerical simulations around a NACA0012 airfoil undergoing harmonic plunging motion. An Arbitrary Lagrangian-Eulerian (ALE) formulation based on an unstructured side-centered finite volume method is utilized in order to solve the incompressible unsteady Navier-Stokes equations. The Reynolds number is chosen to be 252 and the reduced frequency of plunging motion ($k = 2\pi fc/U_\infty$) and the plunge amplitude non-dimensionalized with respect to chord are set to 12.3 and 0.12, respectively, as in the experimental study of Jones and Platzer (2009). The present numerical simulations reveal a highly persistent transient effect and it takes two orders of magnitude larger duration than the heave period to reach the time-periodic state. In addition, the three-dimensional simulation reveals that the flow field is highly three-dimensional around the leading edge. The calculation reproduces the deflected wake and shows a very good agreement with the experimental wake pattern. The instantaneous vorticity contours, Finite Time Lyapunov Exponent (FTLE) fields and particle traces are presented along with the aerodynamic parameters including the lift and thrust coefficients.

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