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Multiple Solutions of Transonic Flow over NACA0012 Airfoil JUNTAO XIONG[1], YA LIU, FENG LIU[2], SHIJUN LUO, University of California, Irvine, ZIJIE ZHAO, XUDONG REN, CHAO GAO[3], Northwestern Polytechnical University — Multiple solutions of the small-disturbance potential equation and full potential equation were known for the NACA0012 airfoil in a certain range of transonic Mach numbers and at zero angle of attack. However the multiple solutions for this airfoil were not observed using Euler or Navier-Stokes equations under the above flow conditions. In the present work, both the Unsteady Reynolds-Averaged Navier-Stokes (URANS) computations and transonic wind tunnel experiments are performed under certain Reynolds numbers to further study the problem. The results of the two methods reveal that buffet appears in a narrow Mach number range where the potential flow methods predict multiple solutions. Boundary layer displacement thickness computed from URANS at the same flow condition is used to modify the geometry of the airfoil. Euler equations are then solved for the modified geometry. The results show that the addition of the boundary layer displacement thickness creates multiple solutions for the NACA0012 airfoil. Global linear stability analysis is also performed on the original and the modified airfoils. This shows a close relationship between the viscous unsteady shock buffet phenomenon of transonic airfoil flow and the existence of multiple solutions of the external inviscid flow.

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