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Effect of Reynolds Number on the Lift on a Steady Airfoil in Uniform Shear Flow[1] PATRICK HAMMER, Michigan State University, CALEB BARNES, MIGUEL VISBAL, Air Force Research Lab, AHMED NAGUIB, MANOOCHEHR KOOCHESFAHANI, Michigan State University — Current understanding of airfoil aerodynamics is primarily based on a uniform freestream velocity approaching the airfoil, without consideration for possible presence of shear in the approach flow. Early inviscid theory by Tsien (1943) shows that a symmetric airfoil at zero angle of attack (AoA) experiences positive lift, i.e., a shift in the zero-lift angle of attack, in the presence of uniform positive mean shear in the approach flow. Our previous 2-D computations at a chord-Reynolds number Re = 12,000 showed that the sign of the lift at zero AoA was unexpectedly opposite to that obtained from the inviscid theory. To examine if this discrepancy is connected to the low Reynolds number of the earlier work, the current investigation utilizes 2-D and 3-D computations over Re range of 2,000 – 1,000,000. The results show that, indeed as Re increases, the lift coefficient at zero AoA switches sign from positive to negative at $Re \approx$ 100k. Furthermore, while the overall trend with Reynolds number is non-monotonic, the magnitude of the lift coefficient appears to asymptotically approach the value obtained from inviscid theory. To better understand this Reynolds number effect, the flow characteristics are examined in detail.

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