by D. Olson, A. Naguib, M. Koochesfahani, in the same session.

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Lift on a Steady Airfoil in Low Reynolds Number Shear Flow[1]

PATRICK HAMMER, Michigan State University, MIGUEL VISBAL, Air Force Research Laboratory, 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. Inviscid theory by Tsien (1943) shows that a symmetric airfoil at zero angle of attack experiences positive lift, i.e. a shift in the zero-lift angle of attack, in the presence of positive mean shear in the approach flow. In the current work, 2D computations are conducted on a steady NACA 0012 airfoil at a chord Reynolds number of Re = 12,000, at zero angle of attack. A uniform shear profile (i.e. a linear velocity variation) is used for the approach flow by modifying the FDL3DI Navier-Stokes solver (Visbal and Gaitonde, 1999). Interestingly, opposite to the inviscid prediction of Tsien (1943), the results for the airfoil at zero angle of attack show that the average lift is negative in the shear flow. The magnitude of this lift grows as the shear rate increases. Additional results are presented regarding the physics underlying the shear effect on lift. A companion experimental study is also given in a separate presentation.

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