Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

The influence of the wall on the stability and transition to turbulence of a free shear layer at low Reynolds number.[1] MATTEO DI LUCA, KENNETH BREUER, Brown University — Laminar-to-turbulent transition is necessary to close the separation bubble that forms over airfoils at low Re numbers (typically Re below 50,000). The distance required for flow transition depends on the disturbance growth rate in the unstable shear layer. Using both stability calculations and experiments, we study the effects of wall proximity on the disturbance growth rate and the stability of a separated shear layer at Reynolds number approximately 10 (based on momentum thickness at separation). Viscous linear stability theory shows that, when far from the wall, shear layers are very unstable at Re as low as 5. Wall proximity, however, greatly reduces or eliminates instabilities and the wall stabilizing effect increases as the Re number decreases. Experiments using a thin flat plate with a thick half-cylinder leading edge allow us to control both the separation point and the distance of the shear layer to the wall. The shear layer separation angle, linear and non-linear disturbance growth, and shear layer reattachment are measured using hot wire anemometry for several values of Re and wall distance. We show that shear layer wall proximity can greatly increase the distance required for disturbance growth and laminar-to-turbulent transition.

[1]Brown University, Presidential Fellowship

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Date submitted: 29 Jul 2019 Electronic form version 1.4