

A BOUNDARY-VORTICITY PERSPECTIVE ON LIFT ENHANCEMENT AT ULTRA-LOW REYNOLDS NUMBERS

N. Rashmi and M. Sivapragasam
Department of Aerospace Engineering
Faculty of Engineering and Technology
M. S. Ramaiah University of Applied Sciences
Bangalore-560 058, India
Email : sivapragasam.aae.et@msruas.ac.in

Abstract

The ultra-low Reynolds number flow over airfoils is considered from the perspective of boundary vorticity dynamics in this paper. The dynamic balance between the streamwise pressure gradient and vorticity creation rate at the wall is highlighted by the boundary vorticity flux. It is a localized feature with a high peak generally indicating impending boundary layer separation. Two interesting features of ultra-low Reynolds number flows are considered. Firstly, the higher values of lift coefficient with decreasing Reynolds number is seen to be due to delayed boundary layer separation. The peak in boundary vorticity flux clearly predicts the separation event. Secondly, the lift enhancement achieved by certain optimal airfoils due to a vortex trapped in the airfoil cavity is considered. An interesting double-peak in boundary vorticity flux seen for the optimal airfoil enhances the lift. An alternative interpretation of the lift enhancement is also provided by examining the Lamb vector-field.

Keywords: Ultra-low Reynolds Number, Lift Enhancement, Vorticity Dynamics, Boundaryvorticity Flux