Simulation of nonlinear instabilities in an attachment-line boundary layer

Ronald D Joslin

Fluid Mechanics and Acoustics Division, NASA Langley Research Center, Mail Stop 170Hampton, VA, 23681-0001USAUSA

Received 30-AUG-95
in revised form 24-JAN-96

The linear and the nonlinear stability of disturbances that propagate along the attachment line of a three-dimensional boundary layer are considered. The spatially evolving disturbances in the boundary layer are computed by direct numerical simulation (DNS) of the unsteady, incompressible Navier–Stokes equations. Disturbances are introduced either by forcing at the inflow or by applying suction and blowing at the wall. Quasi-parallel linear stability theory and a nonparallel theory yield notably different stability characteristics for disturbances near the critical Reynolds number; the DNS results confirm the latter theory. Previously, a weakly nonlinear theory and computations revealed a high wave-number region of subcritical disturbance growth. More recent computations have failed to achieve this subcritical growth. The present computational results indicate the presence of subcritically growing disturbances; the results support the weakly nonlinear theory. Furthermore, an explanation is provided for the previous theoretical and computational discrepancy. In addition, the present results demonstrate that steady suction can be used to stabilize disturbances that otherwise grow subcritically along the attachment line.

Copyright (c) 1998 Elsevier Science B.V. All rights reserved.