Geophysical Research Abstracts
Vol. 14, EGU2012-5210, 2012
EGU General Assembly 2012

Stability of a compressible shear flow

N. Bakas
National and Kapodistrian University of Athens, Athens Greece (nikos.bakas@gmail.com)

A comprehensive understanding of the stability of compressible shear flows has been the subject of both theoretical and practical interest in astrophysics. Applications include the maintenance of turbulence in accretion disks around massive bodies and stability of supersonic shear layers in astrophysical jets. In this work, we study non-modal mechanisms underlying transient growth of propagating acoustic waves and non-propagating vorticity perturbations in an unbounded compressible shear flow, and investigate their potential of instigating a transition to turbulence. Propagating acoustic waves amplify mainly due to two mechanisms: growth due to advection of streamwise velocity and growth due to the downgradient irrotational component of the Reynolds stress. Synergy between these mechanisms along with the downgradient solenoidal component of the Reynolds stress produces large and robust energy amplification. On the other hand, non-propagating vorticity perturbations amplify due to kinematic deformation of vorticity by the shear flow. For moderate Mach numbers, a strong coupling between vorticity perturbations and acoustic waves is found with the energy gained by vorticity perturbations being transferred to acoustic waves that are abruptly excited by the vortex. Calculation of the optimal perturbations for a viscous flow showed that for low Mach numbers, acoustic wave excitation by vorticity perturbations and the subsequent growth of acoustic waves leads to robust energy growth of the order of Reynolds number, while for large Mach numbers, synergy between the lift-up mechanism and the downgradient solenoidal component of the Reynolds stress dominates the growth and leads to a comparable large amplification of streamwise velocity.