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On the onset of nonlinear oscillations in a separating bounday-layer flow. (English)

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Summary: The stability of a separating boundary-layer flow at the rear of a two-dimensional bump mounted on a flat plate is numerically investigated. Above a critical Reynolds number, the flow field is shown to undergo self-sustained two-dimensional low-frequency fluctuations in the upstream region of the separation bubble, evolving into aperiodic vortex shedding further downstream. The computed steady flow states below the critical Reynolds number are shown to be convectively unstable. On extrapolating the flow field to Reynolds numbers above criticality, some evidence is found that the onset of the oscillatory behaviour coincides with topological flow changes near the reattachment point leading to the rupture of the (elongated) recirculation bubble. The structural changes near reattachment are shown to trigger an abrupt local transition from convective to absolute instability, at low frequencies. On preventing the separation bubble from bursting by reaccelerating the flow by means of a second bump further downstream, the separated flow remains steady for increasing Reynolds numbers, until a local region of absolute instability in the upper part of the geometrically controlled recirculation bubble is produced. The resulting global instability consists of self-sustained nonlinear saturated perturbations oscillating at a well-defined frequency, very distinct from the the low-frequency motion of the elongated recirculation bubble in the single-bump geometry. A frequency selection criterion based on local absolute frequencies, which has been successfully applied to wake flows, is shown to accurately predict the global frequency.

MSC:

76D10	Boundary-layer theory, separation and reattachment, higher-order effects	Cited in **31** Documents
76M20	Finite difference methods applied to problems in fluid mechanics	

Full Text: DOI