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3D steady and unsteady bifurcations in a shock-wave/laminar boundary layer interaction: a numerical study. (English) Zbl 1112.76350

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Summary: The principal objective of this paper is to study some unsteady characteristics of an interaction between an incident oblique shock wave impinging a laminar boundary layer developing on a plate plane. More precisely, this paper shows that some unsteadiness, in particular the low frequency unsteadiness, originate in a supercritical Hopf bifurcation related to the dynamics of the separated boundary layer and not necessarily to the coherent structures resulting from the turbulent character of the boundary layer crossing the shock wave. Numerical computations of a shock-wave/laminar boundary-layer interaction (SWBLI) have been compared with a classical test case (Degrez test case) and both two-dimensional and three-dimensional (3D) unsteady Navier-Stokes equations are numerically solved with an implicit dual time stepping for the temporal algorithm and high order AUSM+ scheme for the spatial discretization. A parametric study on the oblique shock-wave angle has been performed to characterize the unsteady behaviour onset. Finally, discussions and assumptions are made about the origin of the 3D low frequency unsteadiness.

MSC:

76E99 Hydrodynamic stability
76N25 Flow control and optimization for compressible fluids and gas dynamics
76L05 Shock waves and blast waves in fluid mechanics
76M12 Finite volume methods applied to problems in fluid mechanics

Software:

AUSMPW+

Full Text: DOI

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