SOUTENANCE DE THESE – **Edoardo PALADINI**

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Insight On Transonic Buffet Instability Evolution From Two-Dimensional Aerofoils To Three-Dimensional Swept Wings

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Résumé :

The transonic buffet is a complex aerodynamic instability which appears on wings and aerofoils in high subsonic regime for certain values of Mach number and angle of attack. The aim of the present study is to improve the understanding of the flow physics behind the instability and, in particular, to explain the evolution of the transonic buffet phenomenon from two-dimensional aerofoils to three-dimensional swept wings. First the work by Crouch et al. (2007, 2009) has been reproduced. Then, the two-dimensional transonic buffet is analysed to highlight the zones of the flow necessary for the persistence of the instability. The study has been conducted numerically through the coupling between two techniques based on different approaches: linear stability analysis and numerical simulations. The two different approaches give the same results: the shock foot is identified as the core of the instability, the shock and the detached boundary layer are also necessary zones. In order to outline the differences between two-dimensional and three-dimensional buffet, the analysis and comparison of four different experimental databases of three-dimensional wings is performed. The experimental analysis identifies the characteristic values of the buffet phenomenon such as Strouhal numbers, convection velocities, buffet onset etc. Three-dimensional buffet exhibits different characteristics in comparison with the two-dimensional one: higher Strouhal number, bump instead of peak in the power spectral density, lower shock amplitude oscillation and three-dimensional patterns in the detached boundary layer which are convected outboard. These differences suggest different physical mechanisms. Finally a three-dimensional global stability analysis of a wing is performed. The two and three-dimensional buffet phenomena appear as two different unstable modes in the spectrum. The phenomenon called in the literature three-dimensional transonic buffet corresponds to a "detached boundary" cells convection phenomenon with a zero-frequency unstable global mode, which becomes unsteady with the addition of sweep.

Mots clés : transonic buffet, global stability analysis, compressible flow, shock wave turbulent boundary layer interaction