Master 2 internship proposal, year 2021-2022

Numerical simulation and modelling of an oscillating acoustic boundary layer in the turbulent regime

Laboratory: Institut P' (UPR CNRS 3346), 2AT Team (Acoustic, Aerodynamic Turbulence)
Place : Université de Poitiers, Campus, Bât B17, Poitiers, France.
Duration : 5 months
Grant : around 550€ / month (the imposed regular grant)
Starting date : ~ avril 2022
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Keywords :
Oscillating boundary layer, duct acoustics, numerical simulation, turbulence modelling

Subject :

The proposed work concerns the study of the transition to turbulence of oscillating flows (without mean flow), the oscillation being linked to the resonance of an acoustic wave in a waveguide. The transition to turbulence, well documented for steady flows, is not yet satisfactorily described in acoustics, and more generally in oscillating flows. Velocity profiles within half an osacillation cycle were obtained in the team thanks to measurements by Laser velocimetry, they are shown in figure 1. A departure from the laminar Stokes boundary layer formed in the region close to the wall has been observed when the acoustic level increases. This deviation can be interpreted as the consequence of the development of a turbulent boundary layer. Similar results have been obtained in direct numerical simulations of this type of flow.

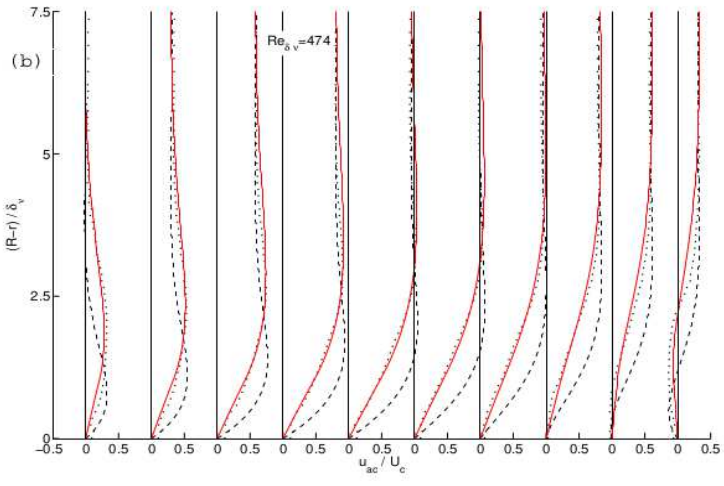

Figure 1 : Oscillating boundary layer in high level waveguide. LDV measurements (dotted lines) and mixing length modeling (red line) for 10 phases of an acoustic half-cycle. The dashed curves correspond to Stokes theory. Uc is the amplitude of the acoustic velocity, R the radius of the guide, δ_v the acoustic boundary layer thickness.

The work proposed as part of this internship consists in modeling the oscillating flow in a pipe by using the free software OpenFoam and testing different turbulence models to account for the experimental observations. The main challenge is the analysis of the physics of the oscillating flow which should lead to the development of behavioral models which are currently lacking.

References

Oscillating viscous boundary layer at high Reynolds number: Experiments and numerical calculations, ISNA 2015, I. Reyt, H. Bailliet , E. Foucault and J.-Ch. Valière.