Master/Batchelor thesis proposal

Stability analysis of a compressible whistling jet

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Description The active cooling of structures is of great importance in many industrial applications. An impinging jet impacting a hot structure will produce vorteces that will efficiently affect the temperature by convection. Some studies suggest that an optimal frequency of vortex shedding can increase this cooling phenomenon by as much as 13% (see [1]). The question raises as of the mean to produce such optimal jet. One way to do so is to force the flow through a cavity delimited by two walls each perforated by a cylindrical aperture (figure 1). This geometry produces a Kármán vortex street that emits a whistling tone.

Objective The proposed thesis project is to investigate numerically such phenomenon using linear stability methods. The open source project FreeFEM++ will be used to provide a full parametric study of the system. The dominant modes will be characterised as well as the influence of the geometry on their stability. (see [2] for similar work)

Requirements Intermediate programming skills, knowledge of the numerical analysis, fluid dynamics and computational fluid dynamics (CFD) are appreciated. Prior knowledge of one or more of the following programming languages/softwares is considered particularly advantageous: `FreeFEM++`, `Matlab`, `Julia`, `Python`.

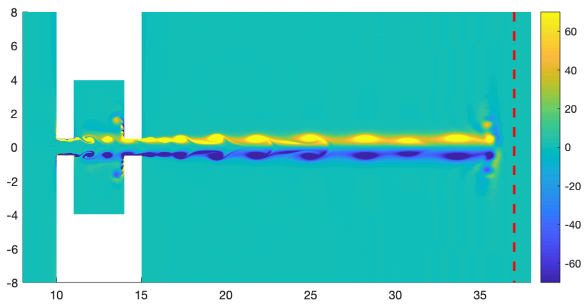

Figure 1: Vorticity field: $Ma = 0.099$, $Re = 2184$, $t = 1.9$ s. Geometry of the whistle: diameter of the cavity $D = 8$ mm, plate separation $h = 3$ mm and hole diameter $\delta = 1$ mm. Dotted red line (- - -) shows where the outlet starts.

Contact

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References

[1] T. Dairay, V. Fortuné, E. Lamballais, and L. Brizzi. Direct numerical simulation of a turbulent jet impinging on a heated wall. *Journal of Fluid Mechanics*, 764:362, 2015.

[2] D. Fabre, R. Longobardi, P. Bonnefis, and P. Luchini. The acoustic impedance of a laminar viscous jet through a thin circular aperture. *Journal of Fluid Mechanics*, 864:5–44, 2019.