Proposal for 3 year PhD grant application

Study of turbulent flow in a complex time-varying waveguide.
Application to the human respiratory airways.

PhD-subject

Objective:
The objective of this PhD thesis is to study through modeling, experiment and simulation the generation, development and decay of turbulence and aero-acoustics in a complex and time-varying channel geometry for conditions representing normal and pathological respiratory flow through parts of the human upper airways.

Context:
Turbulent flow in the human upper airways plays a significant role in daily life since it intervenes in basic features of human life, e.g. during fricative speech sounds production or during breathing. Despite this prevalence, few studies are dedicated to the physical understanding of turbulence creation, development and decay and hence laminar-turbulent flow transitions for conditions pertinent for the human upper airways. This implies the study of low to moderate Reynolds number ($Re < 10^5$) flow through complex waveguides with time-varying boundaries. In term, proposed studies thereby contribute to increased understanding of the role of turbulence in phenomena such as respiratory health and fricative speech sound production.

Methods:
Turbulent flow in the human upper airways plays a significant role in daily life since it intervenes in basic features of human life, e.g. during fricative speech sounds production or during breathing. Despite this prevalence, few studies are dedicated to the physical understanding of turbulence creation, development and decay and hence laminar-turbulent flow transitions for conditions pertinent for the human upper airways. This implies the study of low to moderate Reynolds number ($Re < 10^5$) flow through complex waveguides with time-varying boundaries. In term proposed studies thereby contribute to increased understanding of the role of turbulence in phenomena such as respiratory health and fricative speech sound production.

Expected results:
Performed research is expected to result in fundamental results in the fields of channel flow regimes for low to moderate Reynolds number flows. In addition, fundamental results are then applied to flow through the upper airways aiming health-related applications (respiration) and understanding of human speech sound production.

References:

[1] Van Hirtum A., Blandin R., Pelorson X., 2016. A setup to study aero-acoustics for finite length ducts with time-varying shape. Applied Acoustics, 105:83-92.
[2] Van Hirtum A., Grandchamp X., Cisonni J., 2012. Reynolds number dependence of near field vortex motion downstream from an asymmetrical nozzle. Mechanics Research Communications, 44:47-50.
[3] Grandchamp X., Van Hirtum A., Pelorson X., 2013. Centreline velocity decay characterisation in low-velocity jets downstream from an extended conical diffuser. Meccanica, 48:567-583.
[4] Van Hirtum A., 2017. Analytical modeling of constricted channel flow. Mechanics Research Communications, 83:53-57.

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[5] Van Hirtum A., Wu B., Gao H., Luo X.Y., 2017. Constricted channel flow with different cross-section shapes. European Journal of Mechanics - B/Fluids, 63:1-8.

PhD candidate requirements:

Education:
The PhD candidate should have strong competences (Research Master 2) in Physics, Fluid Mechanics or (Aero-)Acoustics. In addition a strong interest for applications related to physiological flows and health related applications.

Language skills:
- English
- French (optional)

PhD work environment:
LEGI (Laboratoire des Écoulements Géophysiques et Industriels) in Grenoble, France.

How to apply:

1. send CV and motivation letter to Annemie Van Hirtum (PhD supervisor) (deadline: 1 September 2018) (annemie.vanhirtum@univ-grenoble-alpes.fr)

2. online (ADUM) application to the website of the IMEP2 doctoral school (ED) (deadline : beginning September 2018) (https://www.adum.fr/as/ed/page.pl?site=edimep2&page=integrer_ed#procedure)

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