Internship (F/M)

Title	Direct and large-eddy numerical simulations of a turbulent flow over a bump in the presence of slippery surfaces
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Location	Laboratoire PRISME Université d'Orléans 8 rue Léonard de Vinci 45072 Orléans Cedex 2 http://www.univ-orleans.fr/prisme
Duration	6 months

Topic description (English):

Amongst the large variety of innovating coatings addressing industrial needs, **Super-Hydrophobic Surfaces** (SHS) have received a particular attention for the last twenty years [7,9]. Controlling the physicochemical properties of these bio-inspired surfaces allows for allows for encapsulating a gas layer inside the roughness elements, within the coating. This plastron thereby acts a lubricating layer reducing the contact between the liquid and the solid. This particular characteristic, also called the “Lotus effect”, may turn out to be particularly interesting when wetting matters. A growing number amount of studies showed that SHS can allow for reducing friction drag at the laboratory scale within a well-controlled environment. However, **extrapolating these performances towards extreme conditions**, for instance met in strongly turbulent flows, representative of industrial applications (i.e. water-repellent clothing, ships' hull, anti-fogging and anti-icing coatings in the aeronautical industry...), is a key challenge. In particular, understanding how the slip length should be designed in order to improve the aerodynamic properties is still an open question [2,3,5,6].

This internship aims at **understanding how the slip length affects the aerodynamic properties of a separated flow over a bump [10-14] in a turbulent channel**. The objective of **this approach is to analyse the hydrodynamic performances of super-hydrophobic coatings over a simple bump and the sound-pressure level radiated by the turbulence**. A particular attention will be dedicated to the numerical methods used to simulate accurately wall-bounded turbulence with a pressure gradient and roughness elements, and predict the acoustic field using Lighthill's analogy [15].

This internship will hence be undertaken **at PRISME laboratory** at the University of Orleans. **The internship will focus on the implementation of high-performance mixed numerical methods blending pseudo-spectral, Chebyshev polynomials and compact finite-difference discretization.** The first part of the internship will consist in a literature review on the topic and the strength and weaknesses of the numerical methods. The second part of the internship will consider the implementation of the different numerical methods into a two- and three-dimensional code in MATLAB. **Once validated, the method will be further implemented in FORTRAN in a Hybrid Open-MPI code**, based on the same numerical methods. The third part of the internship will consider the prediction of the acoustic pressure level radiated by the separated flow region and the effect of slippery surfaces.

Work Environment:

The person recruited for this internship will become part of the Aerodynamics group (ESA) of PRISME laboratory at the University of Orleans. In this group, research activities are carried on the understanding, the physical modelling and control of turbulent shear flows, representative of industrial applications. The team gathers experts in numerical simulations, the physical modelling of turbulent and two-phase flows, Lagrangian-based optimisation, together with remarkable experimental facilities and equipment making a unique environment for this internship and the following PhD thesis.
In particular, this work will build on the knowledge developed within the department for the last ten years on SHS [1,3,5] and numerical simulations of turbulent separated flows. For this internship, numerical simulations will be carried out on the regional super-computing facilities (CaSciMoDot). **Further, the internship can be followed by a PhD program on the same topic, where the code will be extended to include compliant walls. Pursuing towards a PhD program will be decided upon satisfactory results obtained during the internship**. Complementary, an experimental rig, will be adapted to answer to the objectives of this PhD thesis.

This thesis fit in a large collaborative project, ANR LOTUS (ANR-23-ASTR-0017-01), coordinated by PRISME laboratory and where ENSTA-Paris is a partner. The person recruited for this project will benefit from a strong and stimulating scientific environment and will be part of a dynamic consortium, recognized for its international expertise on the topic. Interactions and innovating work with the other members of the consortium are also encouraged.

Skills:

We are looking for a strongly motivated individual (F/M), with a Master's thesis or an engineering degree with strong knowledge in fluid mechanics and numerical methods. The selected candidate will demonstrate a particular interest for numerical simulations as well as experimental research, including measurement techniques. A good expertise in MATLAB, but also Fortran or C++ is also recommended. The selected PhD student will be strongly involved in the diffusion of the results through scientific reports, publications in international journals, and presentations in nationals and international conferences. The candidate will thereby demonstrate a capacity for writing and communicating in both French and English.

Application:

Documents to send for the application:

- Curriculum Vitae
- Cover lettre
- Grades for the last two years of Master
- Contacts for two scientific advisors
- **French Citizenship is mandatory to pursue in the PhD program**

The application is to be sent to Dr. Pierre-Yves Passaggia (pierre-yves.passaggia@univ-orleans.fr), including Prof. Nicolas Mazellier (nicolas.mazellier@univ-orleans.fr), and Prof. Azeddine Kourta (azeddine.kourta@univ-orleans.fr), in carbon copies. Applications with missing documents will not be considered.

Bibliography

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