AUFRANDE   ÉCOLE CENTRALE LYON   THE UNIVERSITY of ADELAIDE

Position Description

1. General Information

Name of the position	**Modelling wall pressure fluctuation spectrum beneath a boundary layer submitted to pressure gradient**
Foreseen date of enrolment	1 July 2024
Position is funded by	• COFUND, Marie Skłodowska-Curie Actions (MSCA), Horizon Europe, European Union • École Centrale de Lyon (EC Lyon) • The University of Adelaide (UoA)
Research Host	École Centrale de Lyon (Fluid Mechanics and Acoustics Laboratory, UMR 5509)
PhD awarding institutions	École Centrale de Lyon & The University of Adelaide
Locations	Primary: Lyon, France Secondary: Adelaide, Australia
Supervisors	Prof. Christophe Bailly (EC Lyon, LMFA), Christophe Bogey (Senior Scientist CNRS, LMFA) Prof. Rey Chin (UoA)
Group of discipline	Turbulence modelling, Computational Fluid Dynamics, signal processing, wall-bounded flows

2. Research topics (only one of these projects will be funded)

Project 1: *Wall pressure spectra modelling beneath a boundary layer submitted to pressure gradient*
The study of wall pressure fluctuations beneath a turbulent boundary layer has drawn the attention of researchers for decades due to their importance in a wide range of applications dealing with vibro-acoustics or aero-acoustics. Applications can be found in the automotive and aeronautical industries, as well as in hydroacoustic studies focused on marine technology, to cite only a few. Intensive research has been carried into the field over the past seventy years or so, at first mostly in the absence of pressure gradient. Contrary to what can be obtained for the turbulent velocity spectra, we observe a significant disparity in the measurements. These measurements are indeed difficult to perform, with sensors that do not allow to resolve the spectra to viscous scales. Moreover, pressure is a non-local quantity that probably integrates various installation effects. There are still open questions and ongoing research linked to the experimental or numerical characterisation of wavenumber - frequency spectra, and the ability to account for pressure gradient effects. We propose to make progress in the modelling, in the context of naval applications with a convection Mach number quite distinct from that of acoustics, and by focusing on the convective spot in the wavenumber - frequency space. A review of the measurements available for both the pressure spectra and the spectral velocity tensor inside the boundary layer, key data that appear in the analytical developments, will be performed, as well as a critical state of the art of fluctuating parietal pressure spectra models. A rational modelling will be developed by validating each intermediate step with numerical or experimental data, and numerical simulations will complete missing data required for assessing the analytical developments. Turbulent flow simulations where a constant pressure gradient can be applied to the established turbulent boundary layer will be privileged.

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Supervisors: Prof. Christophe Bailly (EC Lyon, LMFA), Christophe Bogey (Senior Scientist CNRS, LMFA) Prof. Rey Chin (UoA) Gilles Serre (Naval Group)
Research Fields: Turbulence modelling, Computational Fluid Dynamics, signal processing, wall-bounded flows

Project 2: *Numerical modelling wall pressure fluctuation spectrum beneath a boundary layer submitted to pressure gradient*
The study of wall pressure fluctuations beneath a turbulent boundary layer has drawn the attention of researchers for decades due to their importance in a wide range of applications dealing with vibro-acoustics or aero-acoustics. Applications can be found in the automotive and aeronautical industries, as well as in hydroacoustic studies focused on marine technology, to cite only a few. Intensive research has been carried into the field over the past seventy years or so, at first mostly in the absence of pressure gradient. Contrary to what can be obtained for the turbulent velocity spectra, we observe a significant disparity in the measurements. These measurements are indeed difficult to perform, with sensors that do not allow to resolve the spectra to viscous scales. Moreover, pressure is a non-local quantity that probably integrates various installation effects. There are still open questions and ongoing research linked to the experimental or numerical characterisation of wavenumber - frequency spectra, and the ability to account for pressure gradient effects. A special emphasis will be placed on controlling the pressure gradient applied to turbulent boundary layers in equilibrium in pipes or channel flows to obtain reliable numerical data. We then propose to make progress in the modelling of the convective spot in the wavenumber - frequency space, and to obtain wall pressure spectra as a result of their integration in Fourier space.
Supervisors: Prof. Christophe Bailly (EC Lyon, LMFA), Christophe Bogey (Senior Scientist CNRS, LMFA) Prof. Rey Chin (UoA) Gilles Serre (Naval Group)
Research Fields: Turbulence modelling, Computational Fluid Dynamics, signal processing, wall-bounded flows

Project 3: *Wall pressure spectra beneath a boundary layer in equilibrium submitted to pressure gradient*
The study of wall pressure fluctuations beneath a turbulent boundary layer has drawn the attention of researchers for decades due to their importance in a wide range of applications dealing with vibro-acoustics or aero-acoustics. Applications can be found in the automotive and aeronautical industries, as well as in hydroacoustic studies focused on marine technology, to cite only a few. Intensive research has been carried into the field over the past seventy years or so, at first mostly in the absence of pressure gradient. Contrary to what can be obtained for the turbulent velocity spectra, we observe a significant disparity in the measurements. These measurements are indeed difficult to perform, with sensors that do not allow to resolve the spectra to viscous scales. Moreover, pressure is a non-local quantity that probably integrates various installation effects. There are still open questions and ongoing research linked to the experimental or numerical characterisation of wavenumber - frequency spectra, and the ability to account for pressure gradient effects. We propose to make progress in the modelling, in the context of naval applications with a convection Mach number quite distinct from that of acoustics, and by focusing on the convective spot in the wavenumber - frequency space. To be able to study the influence of various pressure gradients, but in a controlled environment, we will be interested in numerical simulations in channels with variable cross-section. The selection of a suitable design could guide an experimental part where pressure spectra in the wavenumber-frequency space are measured using MEMS antenna.
Supervisors: Prof. Christophe Bailly (EC Lyon, LMFA), Christophe Bogey (Senior Scientist CNRS, LMFA) Prof. Rey Chin (UoA) Gilles Serre (Naval Group)
Research Fields: Turbulence modelling, Computational Fluid Dynamics, signal processing, wall-bounded flows”

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3. Employment Benefits and Conditions

Ecole Centrale Lyon offers a 36-months full-time work contract (with the option to extend up to a maximum of 42 months). The employment contract includes a probation period of one month, which may be renewed once for a period not exceeding the initial duration. The total working hours per week is 35h.

The remuneration, in line with the European Commission's rules for Marie Skłodowska-Curie fellows, will consist of a gross monthly salary of EUR 2,142 in 2024. Of this amount, the estimated net salary to be received by the researcher is EUR 1,720 per month. However, the final amount to be received by the Researcher is subject to national tax legislation (approximately EUR 100 /month). This salary will increase during the thesis and should reach, on average, EUR 2,340 gross (i.e. EUR 1,870 net) per month.

Benefits include

- Becoming a Marie Skłodowska-Curie fellow and be invited to join the Marie Curie Alumni Association.
- Access to all the necessary facilities and laboratories at EC Lyon (LFMA) and UoA.
- Tuition fees exemption at both PhD awarding institutions.
- Yearly travel allowance to cover flights and accommodation for participating in AUFRANDE events.
- 10,000 EUR allowance to cover flights and living expenses for up to 12 months in Australia.
- 27 days paid holiday leave.
- Sick leave.
- Parental leave.

4. PhD enrolment

Successful candidates for this position will be enrolled by the following institutions and must comply with their specific entry requirements, in addition to AUFRANDE's conditions.

Applicants must hold a Master's degree and demonstrate sufficient background and experience in independent supervised research to successfully complete a PhD.

Applicants must demonstrate an English language proficiency equivalent to an overall IELTS score above 6.5. Note that the test needs to be completed no more than two years before enrolment. For more information about the tests accepted and scores required, visit: https://www.adelaide.edu.au/graduate-research/future-students/how-to-apply/english-language-requirements

More information on EC Lyon's requirements

Foreign degrees are examined by the doctoral schools to determine whether they are equivalent to a Master's.

Important: the authorisation of the Defence Security Officer may be required before admission. In case of denial, the enrolment will not be carried out.

Visit the website: https://www.ec-lyon.fr/en/research/doctorate/admission-enrolment-doctorate

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More information on The University of Adelaide's requirements

Visit the website: https://www.adelaide.edu.au/degree-finder/2023/hdrdoctor_philosophy.html

Short-listed applicants will need to demonstrate their suitability for entry to the program. More information: https://www.adelaide.edu.au/graduate-research/future-students/how-to-apply#step-4-apply-online

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