

Research internship : Experimental investigation of turbulence-induced broadband noise in a pre-Hispanic Andean flute mockup

Keywords

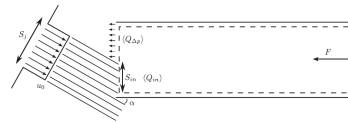
Musical Acoustics, Experimental Aeroacoustics, Fluid Dynamics, Turbulent Flows

Context and objectives

From the mechanical point of view, flute-like instruments is a class of musical instruments in which the sound oscillation is generated and sustained by a coupling that involves on one hand a non-linear fluid interaction between an air jet and an edge, and an acoustic resonator on the other hand.



(a) Traditional cane siku composed of two rows of stopped pipes of different lengths and diameters (Figure from Auvray *et al.*).



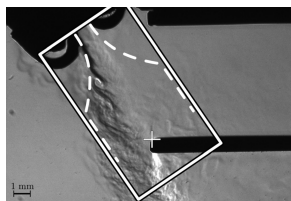
(b) Schematic representation of a panflute pipe

Flute-like instruments have existed for thousands of years in many parts of the world. Consequently, their design meets certain aesthetic criteria that may vary drastically from one instrument to the other, partly for cultural reasons. For instance, some pre-Hispanic Latin American panflutes (Figure above) are specifically crafted for being played in outdoor spaces during ceremonies, which requires a substantially higher jet flux than for comparable Western instruments. Physically, this means that the Reynolds number can reach sufficiently high values in the instrument for the jet to transition to turbulence.

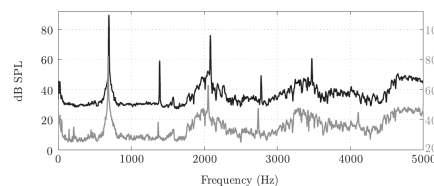
In a recent study, it has been shown that the presence of turbulence in the instrument induced a characteristic broadband noise on top of the pipe natural resonant frequencies. While broadband noise is a characteristic in its own right of the Andean flute and other non-Western musical expressions, this phenomenon has been the subject of very little research as of today. Thus, the aim of this internship is to set up a controlled experiment allowing to study the relationship between turbulence within the instrument and broadband noise generation.

Main steps and methods

To this end, after a bibliographical review, the applicant will conduct measurements on an experimental apparatus similar to the one used in a study conducted by Auvray *et al.* at d'Alembert (Figure below). They will thoroughly characterise the jet aerodynamic quantities with special emphasis on unsteady components associated to turbulence and will develop post-processing tools to extract the broadband noise. A tentative modelling of this broadband noise will be made using an aeroacoustic analytical model.



(c) Turbulent jet impinging on a panflute pipe edge



(d) Associated sound spectrum

Practical information

Time : 5 to 6 months, start expected about March 2024.

Location : Institut Jean le Rond d'Alembert, Sorbonne Université, campus Pierre et Marie Curie, Paris, France.

Salary : Legal internship stipend (\simeq 570 euros / month).

Profile : The candidate should be a Master's student in applied mathematics, acoustics, fluid mechanics or related fields. Knowledge of aeroacoustics would be much appreciated. They should have a taste for experimental work.

How to apply : The candidates must send CV (including recommendations if possible), grade records and a cover letter.

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