PhD Proposal

Effect of combustible and flame-flame interaction on thermo-acoustic response of swirl flames to longitudinal and transversal acoustic modes

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Keywords	Acoustic forcing, two-phase flows, swirl flames, evaporation rate, flame-flame interaction.
Period	Oct. 2018- Oct. 2021
Monthly wage	Around 1400€ net

Abstract:
The control of combustion thermo-acoustic instabilities remains a crucial scientific challenge in the context of technological constrains impose to the engines of the future. Few studies are devoted to the coupling mechanisms involving swirling two-phase reacting flows in lean conditions whereas this type of energetic system, strongly unstable, is becoming generalized. In that context, the objective of this PhD proposal is to answer two major questions in the case of multi-injection: what is the impact of flame-flame interaction and what is the influence of the liquid fuel on combustion dynamics when controlled transverse acoustic flames are imposed?

Context and Objectives:
Combustion instabilities are responsible for a loss of energetic efficiency in engines and turbines. The coupling between fluctuating heat release rate and pressure can induce resonance that may lead to engine failure. To limit pollutant emission in practical applications, multi-injection of swirling two-phase flows work in LPP (Lean Premixed Prevaporized) regime, prone to acoustic modes development. In that context, the objective of this PhD proposal is to answer two major questions in the case of multi-injection: what is the impact of flame-flame interaction and what is the influence of the liquid fuel on combustion dynamics when controlled transverse acoustic flames are imposed?
Crossing these two effects may enhance the heat release rate fluctuations and modify the behavior response of the energetic system to acoustics.
The study will use an original experimental setup conceived by CORIA team, simulating a sector of an annular chamber. From 3 to 5 swirled flames implemented in this setup are submitted to transverse or longitudinal acoustic modes controlled by an external forcing. Several measurement techniques will be applied to these flows: the spray and gas flow structure will be analyzed by statistical and high speed imaging; the fluctuating heat release rate will be qualified through CH* and OH* chemiluminescence; the velocity field will be determined with LDA or PIV techniques; the flame will be characterized by LIF-OH and the temperature field by thermocouples.
The experimental results will participate in the development of a low-order model describing the acoustic response of annular combustion chambers.

References:

[1] F. Lespinasse, F. Baillot T. Boushaki, “Responses of V-flames placed in a HF transverse acoustic field from a velocity to pressure antinode”, C-R Mécanique (Elsevier), Vol. 341, 110-120, (2013)
[2] F. Baillot, F. Lespinasse “Response of a laminar premixed V-flame to a high frequency transverse acoustic field”, Combustion and Flame, Volume 161, Issue 5, May 2014, Pages 1247-1267.
[3] M. Cáceres, F. Baillot, E. Domingues, J-B. Blaisot, G. Godard, C. Gobin, “New experimental setup for thermoacoustic instabilities investigation in two-phase flow swirled combustion”, Proceed. of the European Combustion Meeting 2017, Dubrovnik 18-21 April 2017
[4] M. Cáceres, F. Baillot, F. Lespinasse, E. Domingues, Comparative study of transverse acoustic modes and longitudinal acoustic modes on a premixed V-Shape flame, Proceed. of the European Combustion Meeting 2015, Budapest, 1st - 3rd April, 2015

Application: Funding for the PhD thesis is conditioned by the quality of the applicant**.** The candidate's experience must align with some of the project thematic fields, namely theoretical modeling, multiphase flows or image processing. A strong background in fluid mechanics is required. A master degree or in progress is required. Applicants will send a CV and a motivation letter.