Post Doctoral position on the simulation of droplet combustion in laminar and turbulent flows.

A position is available for 24 months at CORIA Lab. associated with a new collaborative initiative between INSA (National Institute of Applied Sciences) Rouen Normandie, France and the University of Cambridge, UK. The project is part of a multi-investigator team involving experimental and numerical investigations on the effect of fuel droplets on the flame speed and structure, and how these effects might affect combustion in devices such as gas turbines. This project is funded by the Région Normandie under the Grant “Chaire d’Excellence DOLFIN, DrOplet-Laden Flame Interactions”.

The post-doctoral fellow will be located in CORIA laboratory (Normandie, France) at INSA Rouen Normandie. The scientific work will be conducted under the supervision of Prof. Simone Hochgreb, with the support of members of the combustion modelling group (Dr. Vincent Moureau and Dr. Ghislain Lartigue) as well as the experimentalists involved in the project (Dr. Armelle Cessou, Prof. Frédéric Grisch and Prof. Bruno Renou). Several monthly stays in France of Prof. Hochgreb (3/years) are planned and regular trips to Cambridge for the post-doc are supported by the project.

The objective of the post-doctoral position is to complete the experimental investigations on the droplets/flame/flow interactions in academic configurations (Cambridge burner [1] and CORIA burner [2] and build a unique understanding of the project two-phase flames. These simulations will target two scales: the droplet scale and the spray scale. All these high-fidelity simulations including detailed transported chemistry and radiation, when necessary, will be performed within the YALES2 platform. YALES2 is an unstructured low-Mach number code for the DNS and LES of reacting two-phase flows in complex geometries. It solves the unsteady 3D Navier-Stokes equations on massively parallel machines [3].
At the **droplet scale**, DNS simulation of individual evaporating and burning droplets will be conducted. To this aim, the front capturing approach based on the conservative level-set will be extended to phase change [4] with complex transport and multiple species in the liquid and gas. Dynamic mesh adaptation will be used to ensure a proper resolution of the heat and mass transfer with a proper discretization of the thin boundary layer at the gas/liquid interface. Preliminary work on this topic has already been carried out in YALES2 at CORIA and LEGI in Grenoble.
At the **spray scale**, the DNS simulations at the droplet scale will help improving the Discrete Particle Method (DPM) models of YALES2 that are based on a multi-component Abramzon-Sirignano model which considers differential evaporation and mixing. With these new calibrated models, LES of the experimental configurations (Cambridge burner and CORIA burner) will be carried out and compared to the measured data. The recently developed numerical OH-PLIF model of the PhD thesis of Patricia Domingo-Alvarez will also be used to help in the comparison. Additional closures depending on the two-phase combustion regime may have to be developed and assessed.

Excellent communication and interpersonal skills required, including day-to-day interaction with technicians, scientists and PhD students as part of the team, as well as superior presentation and written communication in English and if possible, also in French.

The key responsibilities and duties are: i) to study the relevant literature, ii) to develop models and numerics for two-phase combustion with other researchers on the topic, iii) to perform and analyze high-fidelity simulations, iv) to plan, prepare and write publications for journals and conferences, possibly jointly with the other members of the group.

Appointment (net salary ~ 3200 – 3400 €/month).

Fixed-term: The funds for this post are available for 24 months, ideally from November 2021 - January 2022.

How to apply? Send your detailed Curriculum Vitae (CV) and reference letters to **Dr. Vincent Moureau (vincent.moureau@coria.fr),** and cc. Prof. Professor Simone Hochgreb (sh372@cam.ac.uk) and Prof. Bruno Renou (renou@coria.fr).

For any administrative questions about the application process, and about the organization of the project in France, please contact Prof. Bruno Renou (renou@coria.fr).

Deadline for application: August 31st, 2021

References

[1] Fan, L., C.T. Chong, K. Tanno, D. McGrath, Y. Zheng, and S. Hochgreb, *Measurement of the effect of water droplets on strained laminar flames using two-phase PIV.* Proceedings of the Combustion Institute, 2020 (https://doi.org/10.1016/j.proci.2020.07.010)

[2] Verdier, A., J. Marrero Santiago, A. Vandel, G. Godard, G. Cabot, and B. Renou, Local extinction mechanisms analysis of spray jet flame using high speed diagnostics. Combustion and Flame, 2018. 193: p. 440-452.

[3] Domingo-Alvarez, P., P. Bénard, V. Moureau, G. Lartigue, and F. Grisch, Impact of Spray Droplet Distribution on the Performances of a Kerosene Lean/Premixed Injector. Flow, Turbulence and Combustion, 2019 (https://doi.org/10.1007/s10494-019-00073-5)

[4] Rochette, B., E. Riber, and B. Cuenot, Effect of non-zero relative velocity on the flame speed of two-phase laminar flames. Proceedings of the Combustion Institute, 2019. 37(3): p. 3393-3400.

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