Postdoc position at PC2A

Development of laser spectroscopic diagnostics in hydrogen flames

In 2021, the French government launched a broad investment plan “France 2030”, in connection with the ecological transition. This plan aims to decarbonize French industry in order to reduce greenhouse gas emissions by 35% by 2030. Hydrogen combustion is a promising energy source to reach the carbon neutrality in many applications, including transport, industrial processes and energy conversion. In particular, the French acceleration strategy on decarbonized hydrogen is supported by the Priority Research Program and Equipment (Programme et Equipements Prioritaires de Recherche) PEPR-H2 of the plan “France 2030”.

The MONTHY project is funded by PEPR-H2 for a period of 4 years from 01/10/2022. This project brings together three French laboratories internationally recognized for their research in combustion and laser diagnostics (CORIA, EM2C, PC2A) and allows the recruitment of several PhD and postdocs on fundamental research on H_2 combustion.

The objectives of MONTHY project are to understand through a joined experimental and numerical analysis the nitrogen oxides formation in an environment representative of future hydrogen-air industrial combustion chambers. Results will lead to the first understanding and modeling of the impacts of H_2O dilution on NO_x production during turbulent hydrogen combustion

PC2A laboratory is offering a 18-21-month postdoc position, mainly experimental, on the development of laser spectroscopic diagnostics to obtain quantitative measurements of several key species for understanding of NO formation in laminar and turbulent H_2 flames, building on the expertise of PC2A in the field [1].

One aspect of the project aims to complete the database obtained in the first part of the project in several low pressure laminar H_2 flames selected over a judicious range of pressures and equivalence ratio to cover the various chemical pathways of NO formation in H_2 flames. The measured quantitative profiles of OH, NO were compared with modelling and have been disseminated with the community through several communications and publication [2-3]. In order to refine NO formation kinetics, quantitative measurements of H and O atom profiles are highly desirable. One of the postdoc's tasks will therefore be to implement for the first time the calibrated two-photon Laser induced fluorescence (TPLIF) technique in H_2 flames, drawing on the expertise of PC2A [4-5]. Other species, including minor, are also being considered by LIF, Cavity Ring-Down Spectroscopy (CRDS), FTIR [6].

The second aspect focuses on the implementation of an experimental and numerical strategy dedicated to the determination of OH and NO collision cross sections in H_2 flames. These data need to be re-evaluated in a collisional context typical of H_2 flames, especially under H_2O dilution, and are crucial for quantifying 2D-LIF imaging of species in turbulent flames, such as those studied in the project at the CORIA and EM2C laboratories. To this end, in addition to the strategy developed at PC2A to determine cross sections, a close collaboration with the CORIA laboratory will be set up to measure the concentrations of the main species in laminar H_2 flames by Spontaneous Raman Spectroscopy [7], as required to determine the quenching. A wide range of flames offering different collision environments will be explored, enabling us to test the robustness of the quenching determination and model before transferring it to turbulent flames.

The project is anticipated to contribute to both realization of industrial-scale hydrogen combustion and the advancement of fundamental scientific knowledge regarding spectroscopic principles.

Keywords: Laser-based spectroscopic diagnostics, Combustion, NOx emissions

Academic requirements: PhD in the field of chemical or mechanical engineering/spectroscopy/laser techniques/combustion and a strong aspiration to perform experimental work are required. Experience in tunable laser metrology is appreciated. Knowledge of LIF, laser absorption. Data post processing techniques will be considered an asset.

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How to apply? Send a letter to the postdoc supervisors (Pascale Desgroux and Nathalie Lamoureux) before the 8th of November 2024, CV and motivation letter, and recommendation letters.

Laboratory: PC2A https://pc2a.univ-lille.fr/
Supervisors: Pascale Desgroux, Nathalie Lamoureux,
Duration: 18-21 months, from January 2025
Funding: 100% PEPR MONTHY. The gross salary is approximately 2800-3100 €/month (depending on experiences)
Contact e-mail: pascale.desgroux@univ-lille.fr, nathalie.lamoureux@univ-lille.fr,

References

[1] *Modeling of NO formation in low pressure premixed flames*, Combustion and Flame, 163, 557-575 (2016), Lamoureux et al.
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[7] *Insights into the flow and scalar structures when shifting from methane to hydrogen turbulent flames using simultaneous PIV – OH PLIF and spontaneous Raman scattering*, PROCI 40 (2024) 105708, Rajamanickam K. et al.