GOBIERNO DE ESPAÑA · MINISTERIO DE CIENCIA E INNOVACIÓN · Ciemat Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas · Grupo de Modelización de Procesos de Combustión y Mecánica de Fluidos

PhD Position in Modeling Hydrogen Flame Dynamics

CIEMAT (*Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas*) is a Spanish Public Research Center, focusing on research related to energy and environment and the associated technologies. Its mission is to contribute to the sustainable development and to the quality of life of the citizens through the generation and application of scientific and technological knowledge.

The Fluid Mechanics and Combustion Modeling Group at CIEMAT (http://rdgroups.ciemat.es/web/grupocombustion) carries out research in thermal and reacting flows, including topics in clean combustion technologies, combustion at the micro-scale and combustion in solid energetic materials. Our studies involve the numerical analysis of fundamental problems combining fluid mechanics, heat and mass transport processes and chemical kinetics. We use in-house-developed numerical simulation tools and CFD tools (Open-Foam), ranging from asymptotic methods to direct numerical simulations, often involving high performance (parallel) computing.

Contact

Vadim Kourdioumov (vadim.k@ciemat.es)
Carmen Jiménez (carmen.jimenez@ciemat.es)

Motivation

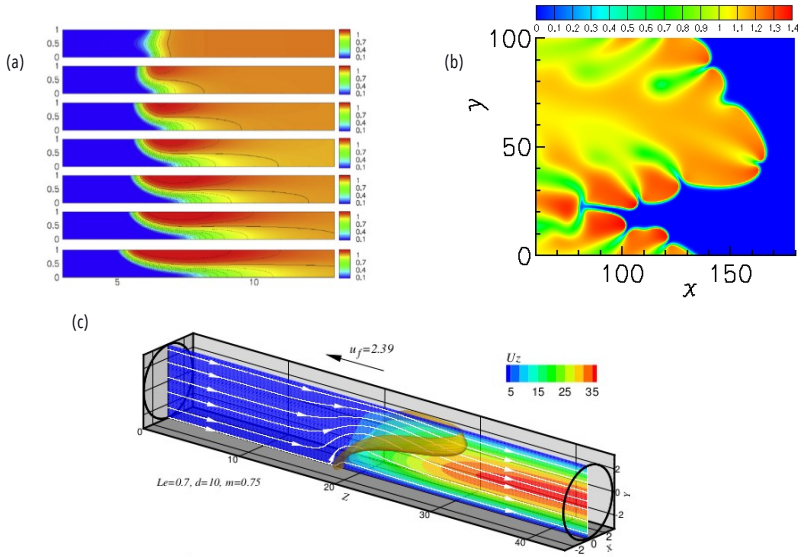
The Climate Emergency has imposed a decarbonization plan in Europe that involves reducing the Green House Gases emissions to 55% by 2030 and reaching carbon neutrality (zero-emissions) by 2050. With the gas grid share of hydrogen growing and green hydrogen being part of these decarbonization plans, there is a need in Europe for devices that can burn pure hydrogen or mixtures of hydrogen and other fuels. Substituting carbon-containing fuels by hydrogen represents, however a big challenge: the special characteristics of hydrogen (small ignition energy, wide flammability limits, very high mass diffusivity) make it an extremely complex fuel to burn in a stable and safe way. To enable advances in this field, there is a need for fundamental research on the physics of combustion of hydrogen and hydrogen-containing mixtures.

Project

The **Green-H2-CM project** aims at understanding and characterizing numerically and experimentally the physics of hydrogen combustion. Specific areas in need of deeper research include: control of mixing; ignition of H_2-containing mixtures in a flowing environment; impact of buoyancy in hydrogen flames; thermo-acoustic instabilities and strategies for their control; flame stabilization and propagation, including flashback; and NOx formation and emissions.

The project tasks cover the numerical analysis of fundamental aspects of hydrogen combustion in geometries that mimic the conditions found in domestic burners and boilers as well as in other small portable power generating systems (combustion in micro-channels emerges as an important field) and the use of experimental studies in simplified configurations to acquire knowledge that should contribute to improve future designs.

The final goal of **Green-H2-CM** is to develop a 100% H_2-ready, fully-premixed, low-NOx burner for the transition from 100% natural gas to 100% hydrogen, and the demonstration of its safe and stable operation. The project is financed by the Spanish and the Madrid Regional Government, and will be developed by a consortium formed by Carlos III University (UC3M), Madrid Polytechnical University (UPM), the National Institute of Aeronautical Technologies (INTA) and CIEMAT.



Examples of Direct Numerical Simulations (DNS) investigated in the Group. a) Asymmetric flames in lean hydrogen-air flames propagating in micro channels, b) Cellular structures in lean hydrogen-air mixtures propagating in confined geometries, c) Non-axisymmetric shapes in flames propagating in micro ducts.

Position

The PhD-student will join the Fluid Mechanics and Combustion Modeling Group at CIEMAT in Madrid as a pre-doctoral researcher (equivalent to National Plan pre-doctoral positions, FPI). Doctoral students are expected to engage in full-time study and research. The candidate should have finished or be about to finish his/her Masters studies. A solid background in Fluid Mechanics and Numerical Methods is highly desirable.

Academic details

The successful candidate is expected to join the Inter-University Program in Fluid Mechanics, a joint doctoral degree of the Carlos III University (Madrid) and several leading Spanish Universities:

https://www.uc3m.es/ss/Satellite/Doctorado/en/Detalle/Estudio_C/1371210621693/1371210298470/Fluid_Mechanics_Interuniversity_PhD_Program#home

Duration

4 years (full time). Starting date: end 2023/ beginning 2024.