PhD Advert Template

Project title: Numerical investigation of conjugate heat transfer during interaction of high-Hydrogen content flames with cooled walls using Direct Numerical Simulations

Project ID *(optional)*: *Please leave blank*

Accept all year-round applications

Funding information: Self-funded students only

Project description: Wall-bounded turbulent flows have been studied extensively under isothermal conditions and principally from the point of view of drag reduction. A relatively limited effort has been made to analyse the turbulent boundary layer in reacting flows. The expansion of gases induced by heat release due to chemical reactions significantly affects the velocity and heat transfer pattern within the turbulent reacting flow boundary layer, which can be very different from those obtained in turbulent isothermal wall-bounded flows. Understanding this behaviour for premixed flames involving high hydrogen content sustainable and e-fuels is pivotal to designing next-generation combustors to meet net-zero targets in propulsion and power generation sectors. The heat loss through the wall during flame-wall interaction can lead to flame quenching and can give rise to unburned fuel pockets. Heat loss and unburned fuels act to reduce the efficiency of propulsion and power generation devices and the heat transfer through the wall determines cooling load and temperature distribution in the wall ultimately determining the thermal fatigue of the combustor material. Thus, a thorough understanding of flame-wall interactions is essential for designing new-generation combustors including the conjugate heat transfer effects. In industry numerical simulations are often carried out using Reynolds Averaged Navier Stokes (RANS) and Large Eddy Simulations (LES) where the physical processes associated with length scales smaller than computational grid spacing needs to be approximated using turbulence models. However, the unavailability of reliable data for flame-wall interaction often compromises the predictive capability of these models and often the boundary layers involving turbulent reacting flows are modelled (inaccurately) using isothermal flow conditions. In the last decade or so, the availability of increased computer power has offered an important research avenue to investigate the effect by providing the means for Direct Numerical Simulations (DNS) where all the relevant turbulent length and time scales are adequately resolved. The purpose of this project is to carry out DNS of turbulent premixed flame-wall interaction including the effects of differential diffusion induced by light radicals (e.g. H and H2) high-hydrogen content premixed flames and conjugate heat transfer effects. This DNS data will subsequently be explicitly Reynolds averaged/ LES filtered to assess the performances of existing models with respect to the corresponding quantities extracted from DNS data. Based on this a-priori DNS analysis modifications to the existing models will be suggested and new models will be proposed wherever necessary.

The industrial partners will be kept involved during this project and they will attend the progress review meetings. We expect to publish project outcomes in reputed journals (eg Combustion and Flame, Physics of Fluids, Proceedings of the Combustion Institute) and conference proceedings (eg International Symposium on Combustion, European Combustion Meeting). The student will also have the opportunity to work with combustion groups at the University of Cambridge, as well as reputed combustion researchers in the USA, France and Germany.

The applicant for this project is expected to have a 1st class or 2:1 degree in Aerospace, Mechanical and Chemical Engineering, Applied Mathematics, or Applied Physics.

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Application enquires: *Prof. Nilanjan Chakraborty, Email:* [*nilanjan.chakraborty@ncl.ac.uk*](mailto:nilanjan.chakraborty@ncl.ac.uk) *, weblink:* [*https://www.ncl.ac.uk/engineering/staff/profile/nilanjanchakraborty.html*](https://www.ncl.ac.uk/engineering/staff/profile/nilanjanchakraborty.html)

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theatre studies

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microeconomics

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secondary education

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chemical engineering

civil engineering

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dynamics

electrical engineering

electronic engineering

energy technologies

environmental engineering

fluid mechanics

gas engineering

geotechnical engineering

integrated engineering

manufacturing engineering

marine engineering

mechanical engineering

mechanics

mechatronics

nanotechnology

offshore engineering

petroleum engineering

robotics

solid mechanics

structural engineering

structural mechanics

systems engineering

thermodynamics

other

Environmental Sciences

climate science

hydrology

marine sciences

meteorology

pollution

soil science

other

Finance

actuarial science

banking

financial management

insurance

investment

taxation

other

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physical geography

political geography

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social geography

transport geography

urban geography

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geophysics

geoscience

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seismology

volcanology

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american history

ancient history

archaeology

asian history

australasian history

british and irish history

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history of science

medieval history

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modern history

russian history

social history

world history

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information systems

librarianship

other

Languages, Literature & Culture

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american studies

asian studies

australasian studies

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danish

dutch

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finnish

french

german

italian

japanese

middle eastern studies

norwegian

portuguese

russian

spanish

swedish

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Law

criminal law

commercial law

contract law

property law

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Linguistics & Classics

ancient greek

celtic studies

classics

latin

linguistics

other

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ceramics

glass

metallurgy

polymers

textiles

other

Mathematics

applied mathematics

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mathematical modelling

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probability

pure mathematics

statistics

stochastic processes

other

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anatomy

audiology

biomechanics

cardiology

complementary medicine

dentistry

endocrinology

epidemiology

neural engineering

neurology

nutrition

ophthalmology

optometry

pathology

pharmacology

pharmacy

physiology

physiotherapy

podiatry

radiology

speech science

tissue engineering

toxicology

other

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community nursing

counselling

dental nursing

environmental health

health informatics

medical nursing

mental health nursing

midwifery

occupational health

occupational therapy

paediatric nursing

paramedical science

surgical nursing

other

Philosophy

ethics

metaphysics

philosophy of science

other

Physics

acoustics

astronomy

astrophysics

chemical physics

computational physics

electromagnetism

environmental physics

experimental physics

medical physics

nuclear physics

optical physics

particle physics

quantum mechanics

solid state physics

space science

theoretical physics

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development studies

government

international relations

politics

public policy

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child psychology

clinical psychology

community psychology

counselling psychology

developmental psychology

educational psychology

forensic psychology

health psychology

neuropsychology

occupational psychology

organisational psychology

psychotherapy

sport psychology

other

Sociology

criminology

disability studies

gender studies

socio economics

social work

other

Sport & Exercise Science

sport coaching

sport development

sport performance

sport technology

sport therapy

other

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divinity

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theology

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animal welfare

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veterinary nursing

veterinary nutrition

veterinary pathology

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