UPMC SORBONNE UNIVERSITÉS

Post-doc or PhD Position

Control of fire spread in spacecraft: role of ambient conditions

Laboratory: Institut Jean le Rond d'Alembert (CNRS UMR 7190)

Location: University Pierre-et-Marie Curie-Paris6 (Paris, France)

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Main collaborations:
Jean-Louis Consalvi - Associate Professor - IUSTI Marseille (France)
Grunde Jomaas - Associate Professor - Technical University of Denmark (Denmark)
Osamu Fujita - Professor - Univ. Hokkaido (Japan)

Context

For several decades, many sound scientific works on fire growth and the movement of smoke and heat have been providing the engineers with the information and tools that are necessary in the design of fire detection and the definition of the subsequent procedures. However, due to the specific conditions encountered in spacecraft, the usual tools for normal gravity fire detection design needs to be at least assessed into realistic space conditions and probably modified according to the discrepancies among detection thresholds in 1g and 0g, that could lead to unappropriate procedures, then disasters, following a misdetection -or a non-detection- in microgravity.

Along the post-doc/Ph.D. works, flame spread over small samples in microgravity will be investigated. The experiments will take place on board the Novespace zeroG airplane. The new experimental rig currently developped at UPMC allows these experiments. The project will especially focus on setting detection systems that deliver relevant inputs to a fire spread control device. A specific attention will be paid to the control of the ambient atmosphere conditions (chemical composition, flow). These conditions are especially expected to deliver means of soot production control. Soot has been shown to play a key role into the radiative heat transfer which governs fire spread in the absence of buoyancy.

Numerical simulations will be performed to complement the experimental analysis. The existing numerical tool is developed at the IUSTI UMR 7343 by Jean-Louis Consalvi and his co-workers. This code is well designed to model soot production and radiative heat transfer in microgravity laminar diffusion flames. It solves the elliptic governing equations in a low Mach formulation by using the finite volume method, considers detailed gas-phase chemistry and complex thermal and transport properties, and the soot production is computed by an advanced PAH-based soot model. Radiative heat transfer is calculated by using the Finite Volume Method coupled with the Full-Spectrum Correlated-k method to determine the radiative properties of the participating species. A reduced model including the radiative heat transfer and soot production will be considered to achieve "real-time" computations. This approach will rely on assumptions, therefore limitations that induce a level of uncertainties. These need to be decently quantified.

This position is expected to contribute to two international projects. "Evaluation of gravity impact on combustion phenomenon of solid material toward higher fire safety" (FLARE) is a project lead by Prof O. Fujita on standard tests for spacecraft fire safety. "Spacecraft Fire Safety Demonstration" (SAFFIRE) is lead by NASA.[1] Within the framework of this latter project, fires will spread over samples of real length scale (~1m) within real time scale (~20 minutes) into three actual spacecraft, i.e. Cygnus supply vehicles. These extraordinary experiments are a worldwild première to date into the challenging Mission To Mars.

Complementary information can be found on the webpage of the French contributors:

http://www.dalembert.upmc.fr/home/legros/index.php/publications

[1] members of this international group: http://www.spacefiresafety.byg.dtu.dk/People.aspx