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Internship opportunity

Title: Numerical simulation of bulb formation on a polymer rod submitted to an intense heating: application to a flame spreading over an electrical wire in microgravity

Terms: Applicants should be motivated individuals and pursue a graduate degree in Mechanical Engineering and/or Physics.
The position is expected to start in Spring 2020 and will last 5/6 months.

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Topic context: The main objective that drives the current projects dealing with spacecraft fire safety is to create a comprehensive data set to enable a suitable paradigm for fire safety in spacecraft. To face this challenge within the context of the future manned mission to Mars, a topical team gathering experts from ESA, NASA, JAXA and ROSCOSMOS, has worked on the definition of a complete series of demonstration and validation experiments. The French contribution,[1] lead by Sorbonne Université, is especially focused on the configuration illustrated in Fig.1(a), i.e. a flame spreading in microgravity over the polyethylene coating of an electrical wire in an opposed laminar flow.

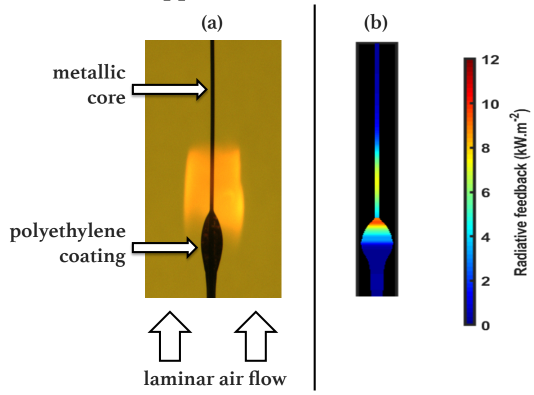

Figure 1:
(a) Image of a flame spreading in microgravity.[2]
The diameter of the metallic core is 0.5 mm.
(b) Distribution of radiative flux from the flame to the wire surface.[2]

Scientific objectives: Due to the intense heating by the flame, the coating is melting. While at normal gravity this leads to dripping, capillarity effects are revealed in microgravity, leading to the formation of a persistent bulb. As shown in Fig.1(b), the exposure of the burning bulb to the radiative flux from the flame is then significant and may enhance the flame spread. Simulating the coupling between the flame and the burning bulb is a challenging multiphase problem that requires a few preliminary steps.

Expected progress: Within the context of the internship, the student will conduct numerical simulations using basilisk,[3] a code developed at Inst. ∂'Alembert (Sorbonne Université). This DNS tool is expected to enable the simulation of the polymer deformation due to a gradient of viscosity that will be first imposed to the polymer sample. Then an intense heating of the polymer will be applied to its surface. Eventually, a fixed heating source will be modeled and the deformation of the polymer due to the subsequent exposure simulated. At every step, the effect of the gravity level will be assessed.

References:
[1] Webpage: http://www.dalembert.upmc.fr/home/legros/index.php/publications
[2] A. Guibaud, 'Flame spread in microgravity environment: influence of ambient flow conditions', Ph.D. thesis defended on 10/25/2019 at Sorbonne Université (Paris, France).
[3] G. Tryggvason, R. Scardovelli, & S. Zaleski. *Direct numerical simulations of gas–liquid multiphase flows*. Cambridge University Press (2011).