



Post-doctoral Position

Isolated bubble growth and detachment in a shear flow in microgravity

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Context

Boiling is encountered in many engineering fields such as energy conversion, environmental applications, food and chemical process industries and space applications. There is consequently a great diversity of situations in which boiling processes are present and must be well understood. The correlations available in the literature are usually obtained in very specific conditions of pressure, heat flux or wall superheat, liquid mixtures, wall material, surface structure, etc. Consequently, these empirical laws are valid only when they are used in the range of parameters they were developed for. The main reason for this restriction is the huge number of physical phenomena governing the heat and mass transfer process, bubble vaporisation, unsteady conduction in the liquid after bubble departure, convection between the nucleation sites. Advanced heat transfer models take into account the different modes of heat transfers but require detailed analysis at the scale of individual bubbles. This is the objective of the Experimental set-up RUBI (Reference mUltiscale Boiling Investigation), which has been designed for more than a decade by several European teams involved in the ESA Project BOILING. In this experiment, IMFT is especially involved in the study of vapour bubble growth and detachment in a shear flow in the frame of a national programme supported by the French space agency CNES.

Objectives

The objective of the RUBI experiment is to investigate the dynamics of a bubble growth and the local heat transfer at the bubble foot in microgravity conditions. Low gravity environment allows the observation of effects that are too fast and too small to be measured under normal gravity conditions. Experiments will be performed in pool boiling conditions but also under the effect of external forces due to an electric field or a shear flow. Bubble growth and detachment will be filmed with a high speed camera and the local distribution of the heat flux at the bubble foot will be

determined from high speed, high resolution Infrared camera images. The data will be used for the validation of theoretical models and numerical simulations.

Previous experiments have been performed at IMFT on bubble injection of boiling in a shear flow (Duhar et al., 2006, Duhar et al., 2009, Colin et al. 2017) and theoretical models for bubble detachment have been developed. During the PhD Thesis of Michel Lebon (2016), experiments with the RUBI test cell were carried out on ground and in microgravity conditions during parabolic flight in aircraft (see fig.1). These recent experiments allowed the definition of the relevant parameters (liquid subcooling wall heat flux, liquid velocity) for the flight of the RUBI experiment aboard the International Space Station.

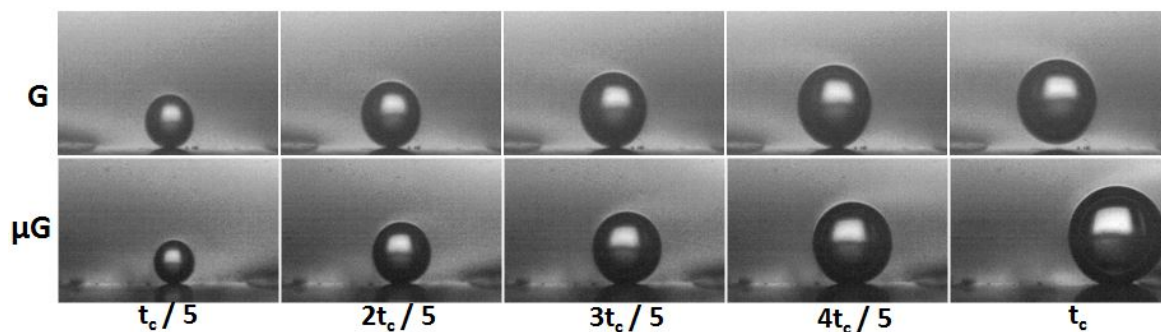


fig.1 :Snapshots of bubble during its growth in a shear flow ($Re=1485$) on earth ($t_c=86$ ms) and in microgravity ($t_c=147$ ms).

The post-doctorate will have a PhD thesis in fluid mechanics or thermal science, with an expertise on experimental techniques and signal/ image processing. He (she) will be in charge of following the preparation tests on ground with the Flight Model and process the data. During the experiments in orbit, starting in August 2018, he (she) will follow the experimental sequence for several months and process the downloaded data. He (she) will be contact with researchers of several foreign Universities (TU Darmstadt, University of Pisa, ENEA Roma, Université Libre de Bruxelles, ...).

The post-doc will be supported by CNES and start on September 1^{er}, 2017. The deadline for application is March 31, 2017.

References

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COLIN C., KANNENGIESER O., BERGEZ W., LEBON M., SEBILLEAU J., SAGAN M., TANGUY S., Nucleate Pool Boiling in microgravity: recent progress and future prospects, *Comptes Rendus Mécanique*, 345, 21-34, 2017. (<http://oatao.univ-toulouse.fr/17543/>)

LEBON M., Etude de la dynamique de bulles formées en paroi par injection ou ébullition: effet de la gravité et des forces hydrodynamiques, *PhD Thesis University of Toulouse, Institut National Polytechnique*, 2016. (<http://oatao.univ-toulouse.fr/17480/>)