STAGE M2, 2022

Bubble clouds in plunging jets, from waterfalls to Pelton turbines through table-top experiments

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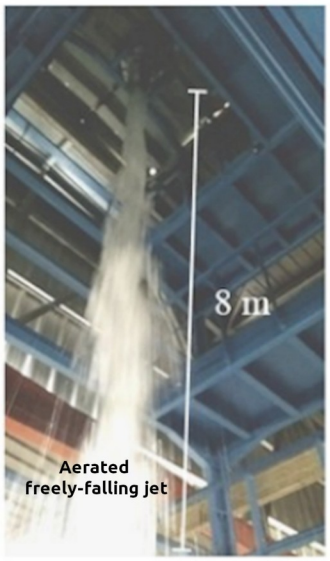
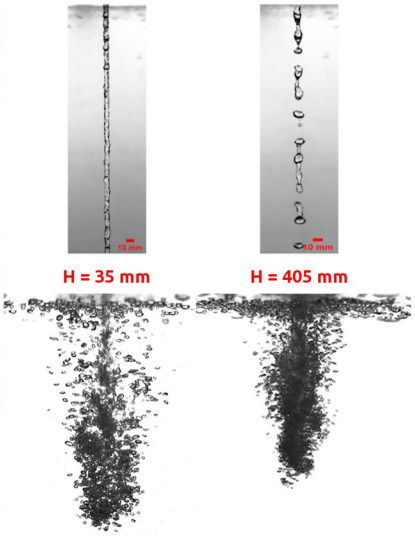
Poursuite en thèse *: Possible avec un financement ANR ou CDSN*

A jet impacting a liquid surface and thereby, entraining the surrounding gas to form a bubble cloud is among the most-common daily-life phenomena. Understanding and modeling such bubble clouds is crucial for multi-phase mixing processes in nature and in industrial techniques for pollution control, turbine operation and performance, oxygenation of water resources, among others. From a more fundamental point of view, the physics of such "bubbly" flows is at the margin of classical fluid dynamics wherein a lot is still open for theoretical modeling and innovative experimental tools to understand the mechanics of dispersed media.

(a) Micro-jets and bubble clouds in lab setup



(b) Jet high setup at Grenoble (EdF)



(c) Effect of jet fall height on jet fragmentation and cloud size

In this context, the internship aims to accurately characterize jet fragmentation, air entrainment across the surface and bubble cloud dynamics in a benchmark case, of a single round liquid jet, at small scale laboratory experiments. Recently, a powerful predictive model was developed [1] to scale bubble cloud size from micro-jets to huge waterfalls. The model is based simply on the momentum balance between the freely-falling jet and the two-phase mixing layer. However, the physics of the model's crucial ingredient, namely, the bubble cloud void-fraction (air-to-water) is not well-understood: therefore, the main

objective is to measure and to model the void-fraction in bubble clouds. Furthermore, depending on the work progress, the case of several freely-falling jets, as is the case in large falling water bodies could also be investigated.

Context: This project is a joint-effort between French labs (LMFA Lyon, LEGI Grenoble, CORIA Rouen) and Électricité de France (EdF). The experimental setup is well-developed but many tweaks are to be added during the internship, along with void-fraction measurement tools.

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References

[1] Guyot, G., Cartellier, A., & Matas, J. P. (2020). Penetration depth of a plunging jet: from microjets to cascades. *Physical Review Letters*, *124*(19), 194503.