Bubble oscillations in a constricted tube

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ABSTRACT

The control of bubbles in microfluidic devices is an essential element of microscale process engineering and emerging lab-on-a-chip technologies, but the development of efficient and effective control mechanisms requires a detailed understanding of the fundamental physics occurring in two-phase flows at the micro-scale.

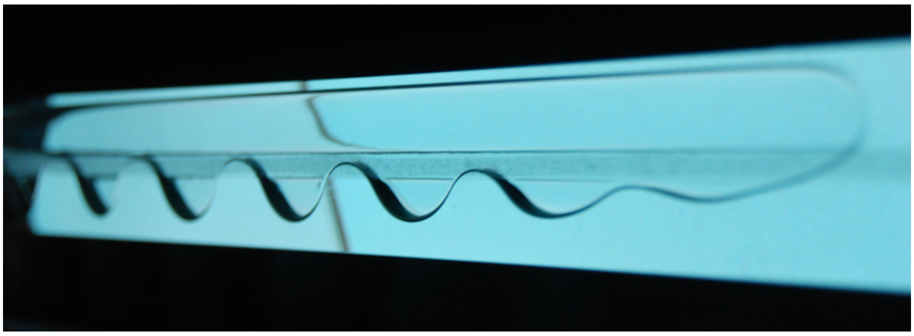

Figure 1: Oscillatory bubble propagation

We investigate geometry-induced control and find that an axially-uniform, centered constriction in the cross section of rectangular tubes can lead to new families of steadily propagating bubbles that localize in the least-constricted regions of the cross section [1]. Tuning the constriction geometry can cause a switchlike transition from centered to localized bubbles at a critical value of the capillary number, Ca, the ratio of viscous to surface tension forces. For wide channels and low values of Ca, typically 1.10^{-3}, bubbles localised between the obstacle and the edge of the tube, and symmetric, centered bubbles are both stable at the same values of Ca; and can be reached experimentally by using suitable initial perturbations. As the channel is narrowed with respect to a constriction of constant width, the switchlike transition is accompanied by bubble oscillations between the symmetric and localised state with a well defined spatial period (see Fig. 1). We investigate the physical mechanism that leads to these oscillations, and explain the switchlike transition in terms of a global bifurcation scenario.

REFERENCES

[1] A. de Lózar, A. Heap, F. Box, A.L. Hazel & A. Juel *Partially-occluded tubes can force switch-like transitions in the behavior of propagating bubbles*, Phys. Fluids. **21**, 101702; doi: 10.1063/1.3247879, 2009.