**Bubble nucleation and jets inside a small droplet**

1,2Juan Manuel Rosselló\*; 1Hendrik Reese; 1K. Ashoke Raman and 1Claus-Dieter Ohl

*1Otto von Guericke University Magdeburg, Institute of Physics, Universitätsplatz 2, 39106 Magdeburg, Germany.*

*2Faculty of Mechanical Engineering, University of Ljubljana, Aškerčeva 6, 1000 Ljubljana, Slovenia.*

*\*e-mail: jrossello.research@gmail.com*

**Abstract**

The present study is centred on the mechanisms behind three different physical phenomena which take place after a bubble is nucleated by a focused laser pulse inside a water droplet of millimetric size in free-fall motion (at 2 m/s), i.e. the nucleation of tiny secondary bubbles caused by the acoustic emissions produced by the optical breakdown; the jetting of the laser-induced bubble due to the proximity of a free boundary; and the onset of shape instabilities on the liquid surface appearing with the bubble oscillations.

A spherical falling droplet represents an experimental case where the laser bubbles are subjected to the influence of a free boundary in all directions. Here, the rarefaction waves produced when the shock wave emitted during the laser-induced plasma formation reflects at the drop surface giving rise to three-dimensional clusters of cavitation bubbles. A value for the cavitation threshold pressure in the liquid was estimated by comparing the shape of such bubble clouds with the negative pressure distribution computed with a CFD model.

The effect of the curved free surface on the jetting dynamics of the bubbles was qualitatively assessed by contrasting the drop/bubble dynamics obtained from high-speed video recordings with numerical simulations of the temporal evolution of the velocity and pressure fields around the cavity (computed for the same initial conditions). Interestingly, we found that the curvature of the free surface does not play a determinant role on the jet dynamics when the bubble “seeding” depth is relatively small.

The mechanisms leading to the destabilisation of the droplet surface were identified through a careful inspection of the high-speed images. Specifically, the Rayleigh-Taylor and Rayleigh-Plateau instabilities observed after the bubble oscillations were studied by varying the maximum radius reached by the bubble while keeping the drop size fixed.