Multi-stable liquid funnel-like interfaces induced by optical radiation pressure

H. Chesneau[1], J. Petit, N. Bertin, H. Chraïbi[1], E. Brasselet[1], R. Wunenburger[2] & J.-P. Delville[1]

[1] Laboratoire Ondes et Matière d'Aquitaine, 351 cours de la libération, Talence, 33400
[2] Institut Jean le Rond d'Alembert, Place Jussieu, Paris, 75252
hugo.chesneau@u-bordeaux.fr

We present a numerical study about non linear deformation and metastability of soft liquid-liquid interfaces actuated by optical radiation pressure (RP). We perform Ab Initio simulations based on boundary element method which solves simultaneously Stokes and Hemlholtz equations to investigate the coupling between wave propagation and interface deformation. We also compare with experimental results obtained by focusing a continuous wave laser beam on a soft ($\sigma \approx 10^{-6} N.m^{-1}$) liquid-liquid interface. At first, we show that above a threshold power, reflections of the wave within the deformation and then total internal reflection modify drastically the shape of the interface. The induced liquid structure becomes then guiding and form liquid-core liquid-cladding waveguides with a funnel-like shape [1,2]. In a second part, we point out and discuss the stability of these liquid waveguides which seem to present hysteretic behavior [3] and we compare them to numerically induced morphologies. Our numerical tool allow us to unravel the guiding properties of these liquid objects responsible of their stability. In fact, the RP exerted by the wave propagating into the deformation, counter-balance the Laplace pressure and stabilizes the liquid object formed. It keeps its shape when the power is continuously decreased until a second lower threshold is reached. Finally we demonstrate that this statement is true for multiple states of the funnel-like structure, showing the multi-stability of our liquid waveguides.

Références

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