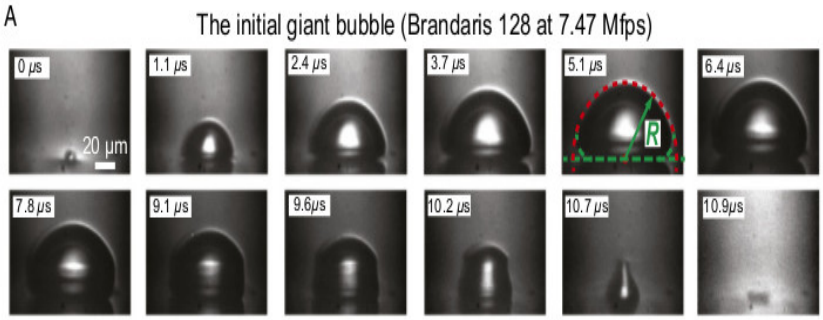
M2 Research internship 2018-2019

Giant vapor nanobubbles around heated nanoparticles

When irradiated with light, nanoparticles may be heated up by hundredths of Kelvins on a very short time scale. If the energy supplied to the nanoparticle is high enough, transient vapor nanobubbles may be generated around the hot particles. The very properties of these vapor nanobubbles make them tremendously interesting for a wide range of applications including cancer cell therapy and solar energy conversion. Yet, a fundamental understanding of their prime properties is still insufficient due to the different physical mechanisms that compete (surface tension, heat transfer, phase transition). Very recent experiments [1] have demonstrated the possibility to produce "giant " nanobubbles under continuous irradiation. Again, our understanding of this freshly discovered phenomenon is very uncomplete.



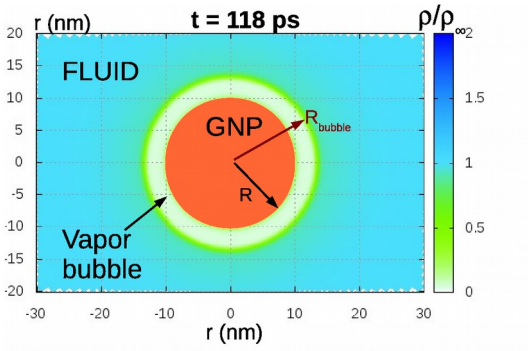


Figure: Left: Experimental observation of giant nanobubbles around plasmonic nanoparticles [1]. Right: Nanobubble simulated around a laser heated nanoparticle in water [2].

The aim of this internship is to interpret the above mentioned experiments by quantifying theoretically nanobubble growth following continuous irradiation with the help of a finite difference code, that we wrote to simulate the formation of nanobubbles around laser heated nanoparticles [2]. The work may combine numerical and analytical modeling, depending on the successful candidate preferences. Interactions with an experimental group working on this topic in Leiden (Netherlands) are possible. This topic is also of full interest for colleagues working at the CETHIL (Centre de Thermique de Lyon) laboratory on the campus INSA La Doua.

[1] Y. Wang et al., "Giant and explosive plasmonic bubbles by delayed nucleation", *PNAS* , 115 (2018) 7676

[2] J. Lombard, T. Biben and S. Merabia, « Kinetics of Nanobubble Generation Around Overheated Nanoparticles », *Phys. Rev. Lett.* 112 (2014) 105701 ; J. Lombard, T. Biben and S. Merabia, «Threshold for vapor nanobubble generation around plasmonic nanoparticles», *J. Phys. Chem. C,* 121 (2017) 15402

Opening toward a PhD : yes (funding with «bourse ministère»)

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