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Direct Numerical Simulation of Liquid-Vapor Phase Change. Applications to Leidenfrost Droplet and Nucleate Boiling

Monday, December 12, 2016 12:00 PM (30 minutes)

Studies on two-phase flows are of interest in many fundamental problems and industrial applications, as the spray formation in internal combustion engine, the bubble formation in heat exchangers, the fluid management in satellites or space launcher tanks, the spray cooling or the interaction of bubbles with acoustic waves. The Direct Numerical Simulation is a powerful tool, which is complementary to experimental measurements, to provide accurate results in complex situations. However, unlike single-phase flows, currently the direct numerical simulation of two-phase flows cannot be considered as a fully mature field, especially in most configurations involving strong coupling between the interface motion with heat and mass transfer, acoustic or shock waves, and/or a solid boundary where a contact line can be formed. This presentation will emphasize on the development of new numerical methods [1,2,3,4,5] to perform accurate Direct Numerical Simulations of two-phase flows with phase change in the framework of sharp interface capturing numerical methods. The presentation will focus mainly on two specific configurations involving liquid vapor phase change, i.e. Leidenfrost droplets and nucleate boiling. We will discuss about suited numerical strategy to succeed numerical simulations in these configurations. Accurate comparison between experiments and fully-resolved numerical simulations will be presented in order to bring out the relevance of the proposed algorithms.

[1] S. Tanguy, T. Menard, A. Berlemont, A level set method for vaporizing two-phase flows, J. Comput. Phys. 221 (2007) 837-853

[2] S. Tanguy, M. Sagan, B. Lalanne, F. Couderc, C. Colin, Benchmarks and numerical methods for the simulation of boiling flows. J. Comput. Phys. 264 (2014) 1-22.

[3] L. Rueda Villegas, R. Alis, M. Lepilliez, S. Tanguy. A Level Set/Ghost Fluid Method for boiling flows and liquid evaporation: Application to the Leidenfrost effect. J. Comp. Phys. 316 (2016) 789-813

[4] L. Rueda Villegas, S. Tanguy, G. Castanet, O. Caballina, F. Lemoine. Direct Numerical Simulation of the impact of a droplet onto a hot surface above the Leidenfrost temperature. Int. J. Heat Mass Transfer 104 (2017) 1090-1109

[5] G. Huber, M. Sagan, C. Colin, S. Tanguy. Direct Numerical Simulation of nucleate boiling at moderate Jakob number and high microscopic contact angle. In preparation to be submitted in Int. J. Heat Mass Transfer

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