FOR APPLICATION, PLEASE CONTACT ADVISOR(S) BY EMAIL WITH COPY TO:
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Research Topic for the ParisTech/CSC PhD Program

Field : Materials Science, Mechanics, Fluids

Subfield: Mechanical Engineering – Fluid Dynamics

Title: Direct Numerical Simulation (DNS) of oil/water flows representative of oil spills in the ocean

ParisTech School: Arts et Metiers, Campus de Lille

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(Lab, website): LMFL (Laboratoire de Mécanique des Fluides de Lille)
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Short description of possible research topics for a PhD: After the Deepwater Horizon accident in the Gulf of Mexico in 2010, large funding has been mobilized for research activities devoted to oil spills and their effects. One question is about the interaction between the see water and the oil slicks and how the oil is mixed with the water and the atmosphere (creation of aerosols). Several experiments were conducted at Johns Hopkins university, including for example an oil plume at the bottom of a tank, with a water cross flow, or a rain drop falling on a water tank with oil slick at the surface, to mimic the effects of rain at the surface of the ocean, and oil slick at the surface of water in a wave tank. In the two first configurations, CFD has been already started at Arts et Metiers ParisTech. It is based on Direct Numerical Simulations of the oil/water/air mixture using the VOF (Volume of Fluid) approach available in the GERRIS code. The present research project is focused on the configuration of the wave tank. The challenge is to capture as well the large-scale dynamics of waves as the small-scale oil dispersion, especially the micro and nano droplets that are aerosolized in the air when dispersant is added to the oil. This last point is of primary interest for public health issues. The results will be validated by comparison with the experimental data obtained at JHU, and further investigation of the numerical results will enable to better characterize the small-scale mechanisms involved in the unsteady evolution of the oil/water/air mixture.

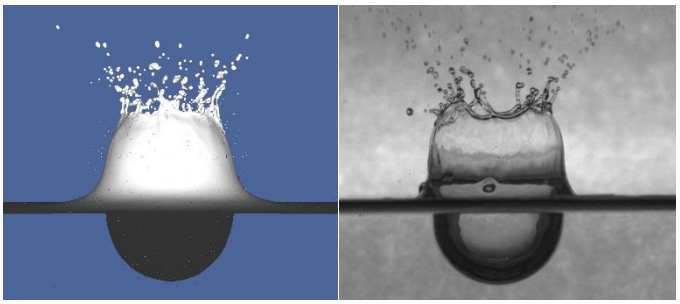

Fig. 1: A few ms after the impact of the rain drop at the surface of the tank: Comparison between the numerical result (on the left) and the experimental observation (on the right)

Required background of the student: fluid mechanics

A list of 5(max.) representative publications of the group: (Related to the research topic)

M. Ghandour, O. Coutier-Delgosha, D. Murphy & J. Katz (2016), Direct numerical modelling of raindrop impacting oil slicks, Presentation at the Gulf of Mexico Conference.

D. W. Murphy, L. Cheng, V. d'Albignac, D. Morra & J. Katz (2015), Splash behaviour and oily marine aerosol production by raindrops impacting oil slicks, J. Fluid Mech. **780**:536- 577.