

## Report on Short Research Visit: Numerical Modelling of Three-phase Flows

**Researcher:** Dr. Zhihua Xie, School of Engineering, Cardiff University

**Host:** Dr. Jie Li, BP Institute/Department of Engineering, University of Cambridge

**Report:** Multiphase flows where two or more fluids have interfacial surfaces are often found in industrial engineering applications. Despite the fact there are a number of numerical studies on two-phase flows, research on three-phase flows (gas-liquid-liquid) is still limited. Dr. Li at University of Cambridge has expertise on interface tracking methods and recently he has developed a highly accurate and efficient adaptive mesh method which is tailored for the study of moving boundary problems. My expertise is in computational fluid dynamics and development of interface capturing methods. The aim of the short research visit (SRV) was to facilitate collaboration between us on various multiphase flows problems, such as bubbles, droplets and jets.

With the award of the SRV, Dr. Li visited Cardiff University on 15/05/2018 and gave a seminar on “Macroscopic model for head-on binary droplet collisions in a gaseous medium” at the Cardiff School of Engineering. We exchanged ideas on how to simulate interfacial flows using adaptive meshes (either adaptive mesh refinement or adaptive fully unstructured mesh).

I spent one-week (21-26/04/2019) SRV in the Department of Engineering at University of Cambridge. Dr. Li and I had many fruitful discussions in his offices in the department and Downing College. We discussed various numerical methods to solve the Navier-Stokes equations and the advantages to use conservative or non-conservative forms. We also focused on parallel computing and how to improve load balancing for adaptive mesh methods. We proposed to test both the interface capturing and moving mesh method for the three-phase flow validation case and the preliminary results for the adaptive unstructured mesh with Volume-of-Fluid method are shown in Figure 1. During last two days, Dr. Li also helped me to improve my 3D finite volume two-phase flow code with the multigrid method for the Poisson solver.

During the SRV, I also had the opportunity to visit BP Institute for Multiphase Flows and attended a weekly seminar there. On Friday, I also attended the Fluid Dynamics seminar in the Department of Engineering before heading back to Cardiff.

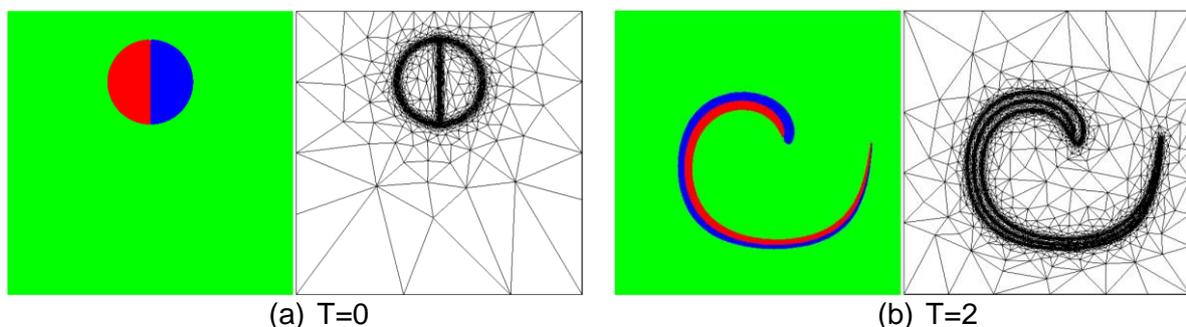


Figure 1. Volume fraction fields and associated mesh for the single-vortex shearing flow test case. Two time levels are shown at (a)  $T = 0$  and (b)  $T = 2$ . The adaptive mesh with minimum length  $h_{\min} = 1/512$  provides a fine resolution equivalent to that of a  $512 \times 512$  uniform mesh.