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A MULTIPLE MARKER LEVEL-SET METHOD FOR SIMULATION OF BUBBLY FLOWS

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Gravity-driven bubbly flow is a complex phenomenon which is difficult to understand, predict and model. The practical implications of a better understanding and predictive capabilities of this kind of flows is enormous. Thus, the main emphasis of this work is on the most fundamental level of modelling, namely the Direct Numerical Simulation (DNS) of multiphase flows. For this purpose, a multiple marker level-set (MLS) method is introduced for DNS of bubbles and droplets, which is integrated in a finite-volume framework on collocated unstructured grids of arbitrary element type. The MLS method introduce the novel approach of describing separate interfaces with different level-set functions to prevent numerical and potentially unphysical coalescence of bubbles or droplets without execessive refinement. The advantage of the MLS method is that bubbles or drops are able to approach each other closely (within the size of one grid cell) and can even collide, while preventing (artificial) merging of the interfaces. Therefore, the volume of the bubbles or droplets remains constant throughout the simulation. Especially for bubble swarm simulations this is an important aspect. In order to avoid mass conservation errors, the location, geometry and the movement of the discontinuities are described by the conservative level-set (LS) method [3], which is a useful alternative to numerically approximating the solutions of continuum equations describing two-phase flow [4]. The LS method was chosen over volume-of-fluid or front-tracking methods because of its computational efficiency and capabilities for accurately representing the interface.

The accuracy of the computational method implemented in this work was examined for the problem of a single bubble rising in quiescent liquid [4]. Computations of bubble shapes and terminal Reynolds number are in excellent agreement with experimental data reported by [1] (see Fig. 1a). For the validation of the multiple marker level-set method we study two cases. First, it is applied to gravity-driven impact of a droplet on a liquid-

liquid interface (see Fig. 1b), and results are compared with numerical data reported by [2]. Second, it is applied on simulation of gravity-driven bubbly flow in a vertical pipe (see Fig. 1c). In the final paper the main features of gravity-driven bubbly flow in a pipe, including statistics of a set of selected monitoring variables will be discussed in detail.

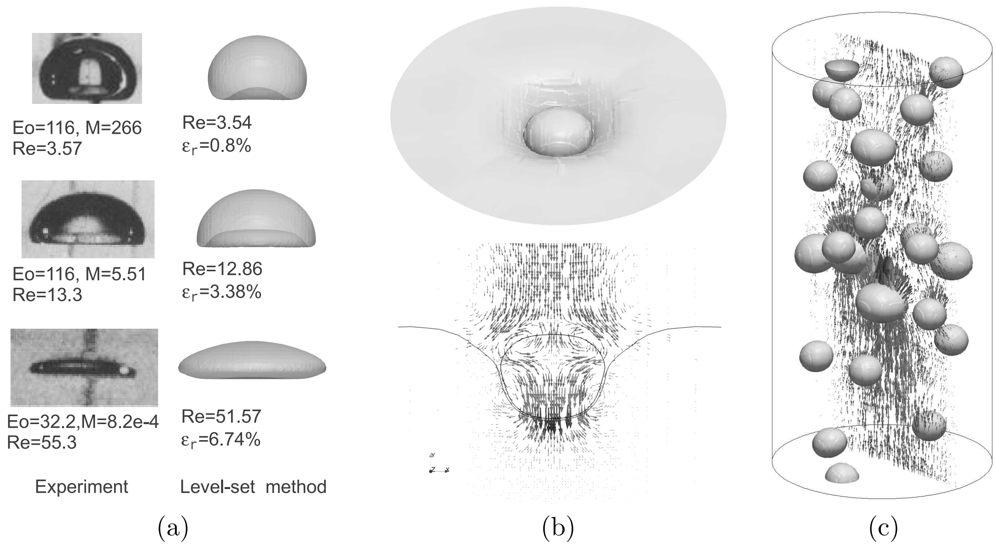

Figure 1: (a) Comparison of terminal bubble shape and relative error (ε_r) of Reynolds number observed in experiments reported by [1] against numerical prediction by using LS method, where Eo is the Eotvos number and M is the Morton number. (b) DNS of drop impact on a liquid-liquid interface using MLS method. (c) DNS of gravity-driven bubbly flow (deformed bubbles) in a periodic domain.

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