Chair of Aerodynamics and Fluid Mechanics
Department of Mechanical Engineering
Technical University of Munich

Weakly Compressible Fluid Modeling for Bubble Flows

Semester's Thesis, Master's Thesis

Contact: Felix Schranner Mail: schranne@tum.de Start date: As of now

Motivation

The two images in figure 1 depict types of bubbles evolving in a denser (left) respectively lighter (right) fluid. Flows of air bubbles in water are two phase flows similar to the left image and common for many academic, industrial and natural environments or applications.

Studying two phase flows such as air bubbles in water is highly interesting and quite challenging due to the complexity of the interfacial physics. Only by means of high-fidelity numerical simulations the interface physics can be studied and knowledge gained.

High-fidelity modeling of these interface physics is ongoing research at the Chair of Aerodynamics and Fluid Mechanics, see e.g. [1–4]. The in-house CFD solver ALPACA incorporates state-of-the-art numerical models, algorithms and software design.

Objectives

Currently ALPACA is optimized for the simulation of compressible flows. Yet, gas bubbles evolving in water are incompressible flows. To allow for the representation of small scale turbulent structures a Riemann-solver needs to be employed. Within this thesis you will implement and evaluate two potential weakly compressible fluid models for a Riemann solver. For the evaluation of their capabilities and limitations you will select and simulate appropriate single and two phase scenarios.

Requirements

- Interest in two phase flows
- Interest in Riemann solvers and fluid modeling
- Experience with unix systems and the C++ programming language is helpful, but not required

What you learn during this thesis

- Deeper understanding of fluid modeling and Riemann solvers
- Insights into the simulation of complex flows with a state-of-the-art CFD code
- Working on modern HPC computing systems of the Leibniz-Rechenzentrum (LRZ)
- State-of-the-art software development

References

[1] Kaiser, J. W. J., Adami, S., and Adams, N. A. "Three-Dimensional Direct Numerical Simulation of Shock-Induced Bubble Collapse Near Gelatin". In: *11th International Symposium on Turbulence and Shear Flow Phenomena*. 2019.

[2] "Numerical Symmetry-Preserving Techniques for Low-Dissipation Shock-Capturing Schemes". In: *Computers & Fluids* 189 (2019), pp. 94–107. ISSN: 00457930. DOI: 10.1016/j.compfluid.2019.04.004.

[3] Schranner, F. S. "Weakly Compressible Models for Complex Flows". Dissertation. München: Technische Universität München, 2017.

[4] Winter, J. M., Kaiser, J. W. J., Adami, S., and Adams, N. A. "Numerical Investigation of 3D Drop-Breakup Mechanisms Using a Sharp Interface Level-Set Method". In: *11th International Symposium on Turbulence and Shear Flow Phenomena*. 2019.

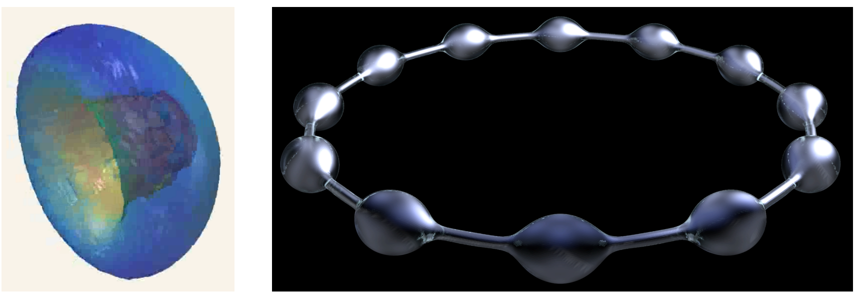

Figure 1: Bubble evolution scenarios