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# Petascale simulations of compressible flows with interfaces

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**Abstract**

We demonstrate a high throughput software for the efficient simulation of compressible multicomponent flow on high performance computing platforms. The discrete problem is represented on structured three-dimensional grids with non-uniform resolution. Discontinuous flow features are captured using a diffuse interface method. A distinguishing characteristic of the method is the proper treatment of the interface zone as a mixing region of liquid and gas. The governing equations are discretized by a Godunov-type finite volume method with explicit time stepping using a low-storage Runge-Kutta scheme. The presented flow solver Cubism-MPCF is based on our Cubism library which enables a highly optimized framework for the efficient treatment of stencil based problems on multicore architectures. The framework is general and not limited to applications in fluid dynamics. We validate our solver by classical benchmark examples. Furthermore, we examine a highly-resolved shock-induced bubble collapse and a cloud of $\mathcal{O}(10^3)$ collapsing bubbles, which demonstrate the high potential of the proposed framework and solver.

*Keywords:* high performance computing, compressible multicomponent flow, shock-capturing methods, shock-induced bubble collapse, cloud collapse

## 1. Introduction

Cavitation refers to the rapid growth of vapor cavities in a liquid, followed by a violent collapse due to environmental pressure variations. It is known that cavitation causes material erosion on nearby surfaces, thus considerably reduces the expected lifespan of applications in marine propulsion, turbomachinery or fuel injection engines; see, e.g., [1]. Cavitating bubbles usually appear in a cloud which amplifies the destructive potential compared to the single bubble case. e.g., [2]. Nearby bubbles influence the dynamics of the collapse process

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