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PREFACE

In nature and industrial processes, multiphase flow and materials are the rule rather than the exception. Rain, sandstorms, spray combustion and coating, boiling heat transfer, material microstructure, and living bodies are just a few examples. It is not surprising that attempts to predict the behavior of multiphase flows go back to the very beginning of computational fluid dynamics. For flows governed by the Navier–Stokes equations, the early MAC (marker and cell) method of the Los Alamos group provided a spectacular preview of what was to come, and boundary integral methods for free-surface inviscid flows allowed researchers to probe questions that could not be addressed any other way.

The approach pioneered by the MAC method has provided the foundations for a number of very successful methods developed during the past decade. In these Eulerian methods the fluid flow is computed on a stationary grid and the interface motion is computed using specialized techniques including volume-of-fluid, level-set, immersed-boundary, phase-field, CIP, and ghost-fluid methods. However, other approaches, such as specialized boundary integral/element methods for very viscous as well as inviscid flows and various Lagrangian, semi-Lagrangian, and boundary fitted mesh methods, have also been developed very successfully.

The present special issue of the *Journal of Computational Physics* contains articles by several of the world's leading authorities on the development of numerical methods for multiphase flows. Although not all approaches to multiphase flow computations are covered, it is our hope that this collection gives the reader a reasonably complete overview of the state of the art in simulations of multiphase flows.

Computation of multiphase flows, although lagging behind its single-phase counterpart, has already become one of the most exciting tools for researchers who need to understand the workings of nature. The opportunity to examine complex systems consisting of many different materials and covering a large range of scales promises to transform the way multiphase flows are examined. Modern computers are rapidly making it possible to conduct simulations including one billion grid points or more and the numerical methods described here make it possible to take advantage of this enormous computational power.

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