Preface

This four-part "methods-oriented" book covers analytical and numerical methods for describing the motion of small particles suspended in viscous fluids, at a level suitable for graduate students in engineering and applied mathematics. The first three parts cover the fundamental principles of low-Reynolds-number flow: the mathematical foundations, the dynamics of a single particle in a flow field, and hydrodynamic interactions between suspended particles. The fourth part of the book covers some recent advances in the mathematical and computational aspects of viscous particulate flows that point to new directions for large-scale simulations on parallel computers.

In the past 20 years, the literature on this subject (low Reynolds number hydrodynamics) and its applications have grown enormously. Instead of reviewing these advances in a complete and exhaustive fashion, our aim is to build a coherent framework that unifies the subject, thereby making the literature more accessible, especially for those wishing to build mathematical models of particulate systems.

Microhydrodynamics can be a very mathematical subject, for the fundamental equations are well established and have been studied in great depth. A student familiar with mathematical analysis will appreciate and understand the steps needed in establishing that a model is well posed and has a unique solution before attempting to find the solution, or that an iterative scheme like the method of reflections converges with respect to a norm in a suitably defined Hilbert space. On the other hand, the purely mathematical viewpoint of establishing existence, uniqueness, or convergence of solutions does not go far enough. For scientists and engineers the models provide the basis for quantitatively understanding the particulate phenomena — the numbers from microhydrodynamics are, in a sense, intermediate results. In this book, we attempt to blend these ideas. We hope that the more mathematical sections of this book will encourage and motivate students to learn the mathematical foundations from course material elsewhere, since even an introductory treatment of that material is beyond the scope of this book.

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The term *microhydrodynamics* was suggested in 1974 by G.K. Batchelor as a way of defining a subject that retained its focus on fluid mechanics while keeping its spread into other fields within manageable proportions. Our perspective in this field has been greatly influenced, in chronological order, by Gary Leal (U.C. Santa Barbara), Howard Brenner (MIT), Bill Russel (Princeton), John Hinch (Cambridge), and David Jeffrey (Western Ontario). This book has greatly benefitted from our professional association with them.

We thank Howard Brenner, again, for encouragement and advice in his role as series editor. Also, it has been our pleasure to work with a very understanding staff at Butterworth-Heinemann Publishers. Finally, in this age of high-speed electronic communications, we feel that the communication between authors and readers does not stop at the printing press. We encourage readers to send (by e-mail, of course) corrections and suggestions for improvement. Readers may also log on to Flossie (as described on the following pages) for news on the latest corrections and updates to the program listings. With active participation from the readers, we hope to initiate a "microhydrodynamics program exchange."

Sangtae Kim
University of Wisconsin
Madison, Wisconsin
sang@flossie.che.wisc.edu

Seppo J. Karrila
Finnish Pulp and Paper Research Institute
Espoo, Finland
skarrila@aboy2.abo.fi