Preface

It has been almost thirty years since the publication of the classic book with a similar title, written by Clift, Grace and Weber. During this time a vast body of literature on particles, bubbles and drops have been created. The field of Multiphase Flows has grown tremendously and is now regarded by some as a discipline. Engineering applications, products and processes with particles, bubbles and drops have grown exponentially. An increasing number of conferences, scientific fora and archival journals are committed to the dissemination of information on the flow, heat and mass transfer involving particles, bubbles and drops. Perhaps the most important development of the last thirty years is the emergence of the computer as a tool for scientific inquiry and engineering optimization. Numerical computations and "thought experiments" have almost replaced physical experiments. The literature on computational fluid dynamics with particles, bubbles and drops has grown at an exponential rate in the last twenty five years, giving rise to new results and theories, better understanding of the complex transport processes and has opened new fields of investigation.

There are many and important similarities in the flow behavior of particles, bubbles and drops. The objective of this book is to present the theories of these objects in a way which is as unified as the differences in the flow behavior allow. The unified treatment of particles, bubbles and drops involves a description of the similarities in the theory and results and an exposition of the limitations of the results. Significant differences in the flow behavior and transport properties are always pointed out. Another objective of the book is to present the final results on the transport properties of fluids with particles, bubbles and drops. Details of

the methods from which these results were derived are not described. The interested reader will be able to find all of these details by consulting the pertinent references, all of which are in the open literature.

In the exposition of the subject of flow, mass and heat transfer of dispersed multiphase fluids, it is important to present in detail the theory and results for a single particle, bubble or drop in a large fluid domain, which may be applied to dilute mixtures. The first five chapters of this book address this task. The next four chapters deal with interactions of these immersed objects with solid and fluid walls, effect of their interactions with fluid turbulence, electric and thermal influences and effects of higher concentration and collisions with boundaries, which may be applied to intermediate and dense mixtures. The last two chapters present the relatively modern ways of modeling of dispersed mixtures and several numerical methods that have been successfully used with particles, bubbles and drops.

Many have helped in the writing of this book: My former student and current research colleague, Prof. Zhi-Gang Feng supplied a great deal of the computational results and a good number of the figures. Prof. Zu-Jia Xu, also supplied some of the figures. Mr. Adam Baran and Mr. Lorenzo Craig conducted useful literature searches on unfamiliar topics. Ms. Valentina Tournier assisted greatly with some of the library work, the references, and some figures. I am very indebted to my own family, not only for their constant support, but also for lending a hand whenever it was needed. My wife, Laura, proofread some of the earlier publications this book is based on and was a constant source of inspiration. Emmanuel devoted a good part of his vacation time to check the format and accuracy of the references. Given that there are more than six hundred references in this book, this was a task of Olympian proportions. Dimitri has helped with the creation of the index and little Eleni was always there to help and encourage. I owe to all my sincere gratitude.

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