Preface

SPAM, "Smooth Particle Applied Mechanics", is a simple and transparent computational approach to simulating macroscopic nonequilibrium flows. Simple in concept and structure, but broad in scope, it is nicely suited to teaching, to research, and to real applications. SPAM blends the ordinary differential equations of particle mechanics with the partial differential equations and conservation laws of continuum mechanics. It is interesting that continuum mechanics, originally developed in order to avoid the details associated with particles, is itself most easily implemented by particle-based methods, of which SPAM is the simplest.

I expect this book about SPAM to be most useful to researchers who seek to understand and enjoy to learn by doing: writing their own software, dreaming up their own test problems, and challenging the current wisdom. My own experience suggests that careful intercomparisons of results with those of colleagues who write their own independent computer programs is the best way to find and correct errors. I have tried hard to state precisely what is done in the examples given in the book. I intend that others can reproduce these examples, not just qualitatively, but entirely and precisely.

This book is designed to be self-contained, and accessible to both students and researchers. Thoreau's admonition—"Simplify, simplify, simplify"—is specially appropriate to the description and study of smooth particles, for which so many alternative approaches and ideas have been promoted. I have used a "bare bones" notation in writing equations, omitting obvious subscripts and leaving it to the reader to distinguish scalars, vectors, and tensors from the context. Likewise in pursuit of simplicity, I have chosen to omit equation numbers and detailed references to the literature. The recent Liu-Liu book "Smooth Particle Hydrodynamics", published by World Scientific in 2003, can be consulted for a more comprehensive set of references.

Because SPAM has strong links to Newtonian particle mechanics and to statistical mechanics, as well as to the computational simulation of both particulate systems and continua, this book spans a variety of fields. I start out by discussing how fast computers helped SPAM simulations to develop from its roots in particle and continuum mechanics, made possible by computers. This is followed by an analysis of computational methods, along with an assessment of convergence and stability, emphasizing Lyapunov instability, the exponential growth of small perturbations. The details involved in graphics and parallel computing using SPAM bring the subject to the current state of the art. I have included several pedagogical example problems in the text. For clarity and simplicity, these problems treat one-dimensional or two-dimensional systems. The reader should have only a little difficulty in extending these ideas to applications in three dimensions.

The work leading me to write this book began nearly fifteen years ago, at the Lawrence Livermore Laboratory in California, where I formulated and defended a modest proposal to study computer simulations of high-strain-rate deformation. Tom Weaver, a member of the evaluation committee, asked me whether or not I had considered using "smooth-particle" methods. I had not. One thing led to another: reading the literature, most of it in the form of government sponsored laboratory reports; teaching the technique to students; traveling to visit a sampling of the many experts interested in practical applications of SPAM; collaborations, with Harald Posch and Oyeon Kum, on many applications; and, finally, the writing of this book with the help, inspiration, and support of my wife Carol. Chapter 4, "Computer Programming", in particular, reflects her work. The luxury of retirement, coupled with the generous support of Peter Raboin and Bob Ferencz (Methods Development Group), Rob Sharpe (Center for Computational Engineering), and Son Nguyen (Technical Information Department) in making the research facilities of the Department of Energy's Lawrence Livermore Laboratory available to me, made this book possible.

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