18[65-02, 76-02, 76M25].—KARL E. GUSTAFSON & JAMES A. SETHIAN (Editors), *Vortex Methods and Vortex Motion*, SIAM, Philadelphia, PA, 1991, viii + 212 pp., $25\frac{1}{2}$ cm. Price: Softcover \$48.50.

The SIAM Frontier series, within which format the present book was invited, is aimed at providing a forum for modern, and possibly provocative, views of a subject area. The editors of the eight essays on vortex methods and vortex motions have taken this brief seriously and have produced an interesting volume on the subject.

The subject of vortex dynamics is a classical field of mechanics, having been studied in considerable depth by nineteenth-century mathematicians. Kelvin, in particular, made significant contributions to the field, many of which still have a modern ring, and there is an enormous body of literature associated with the subject. It is not surprising, therefore, that the present volume addresses a rather narrow, albeit important, aspect of the subject, concerning itself largely with the now familiar vortex method for computing the dynamics of inviscid and slightly viscous fluid motions.

The development of the subject matter is nicely structured, with the opening chapters providing a summary of the current theoretical standing of particle methods for large and infinite Reynolds number flows, followed by four chapters concerning applications (or potential applications) of the vortex method, and finishing with two theoretical chapters, one discussing vortex models for the flow of superfluid helium, and the other discussing some particular aspects of vortex dynamics and their relation to turbulent flows. In keeping with the philosophy of the Frontier series, the book has a good mixture of carefully argued sections, applications, and some chapters of a more speculative nature. The blend seemed to work quite well except for a few instances when the license to speculate and be provocative was treated too liberally. I think it is a wonderful idea for authors to have an opportunity to discuss in print some of their ideas which, under normal refereeing methods, might never see the light of day. Thus, in the final article of the book, Chorin takes the opportunity to outline ideas concerning vortex motions and turbulent flows, and analogues with statistical mechanics, some of which present some interesting speculation about, for example, intermittancy and the inertial range. I found the essay by Chorin a rather enjoyable article whereas, by contrast, I had great difficulty in coming to terms with the speculation presented in the long essay by Gustafson. Here the discussion was just too woolly and diffuse to allow one to sort out the firm ground from the quicksand.

The first chapter by Sethian provides a fairly comprehensive review of recent work in particle methods and closely related areas, and the second (Hald) gives a nice assessment and summary of the status of convergence results for the discrete approximation. The next four chapters describe applications relating computational studies to laboratory flows. To my taste, the applications described here did not work well. For the most part, the phenomena were too complicated to admit detailed quantitative comparisons with numerical computations, so that we were not able to see the value of the computational schemes when they were asked to perform against a practical problem. The qualitative pictures looked very encouraging, but it is only under the microscope of careful quantitative comparisons that the real strengths and weaknesses of numerical schemes come to light. The above comments are not meant to belittle the ingenuity of the studies described, especially not the very interesting hovering motion discussed in the article by Freymuth, Gustafson and Leben, but, given the present state of development of the field, it might be necessary to consider less complicated flows to allow a careful, scientific assessment of the modelling process. The book rounds off with two essays of a more theoretical nature. The penultimate chapter by Buttke gives a nice introduction to the theory of vortex motions in superfluid helium, and the final chapter is the aforementioned essay by Chorin.

A very important practical issue with regard to particle methods is that of computational complexity as, all too often, this can limit the scope of a particular computation. The workload becomes just too time-consuming to allow properly converged solutions to be obtained. There are many very attractive features associated with using the vortex method, and thus the reduction of the computational complexity is an issue of central importance if the methods are to be used on complicated practical problems. Several advances in this direction have been made in recent years, and more emphasis could have been placed on these issues. Nevertheless, I found the book to present an interesting and provocative view of the subject. I think it will provide a very useful introduction for people who wish to get a good overall view of the current status of the area associated with vortex and particle methods.

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19[35-06, 35A20, 35B25, 35B40, 65-06, 65N06, 65N12].—HANS G. KAPER & MARC GARBEY (Editors), *Asymptotic Analysis and the Numerical Solution of Partial Differential Equations*, Lecture Notes in Pure and Appl. Math., Vol. 130, Dekker, New York, 1991, viii+271 pp., $25\frac{1}{2}$ cm. Price: Softcover \$99.75.

This book is the proceedings of a Workshop on both asymptotic analysis and numerical solution of partial differential equations held at Argonne, Illinois in February, 1990. The Workshop (and resulting proceedings) had an ambitious objective of stimulating the combination of numerical and analytical techniques for studying differential equations, especially singularly perturbed ones. The book succeeds quite well by displaying different problems where singular perturbations arise, and by giving substantial evidence that progress can be made by combining both approaches.

The combination of numerical and analytical techniques could occur in various ways. One would be to use analytical techniques to handle the more singular part of the problem and thereby simplifying the numerical solution. A variant of this is to use asymptotic techniques to derive novel discretization schemes. Another is to use analytical techniques to analyze the limiting behavior of numerical methods for differential equations which become singular as some parameter tends to a limit. All of these combinations (and more) are well represented in the volume.