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BOOK REVIEWS

The Padé approximant in theoretical physics,
eds. G. A. Baker Jr. and J. L. Gammel, Academic Press, £ 8.15.

With the rapid advance of computers over the last ten years, attention has increasingly focused on new techniques for the numerical solution of physical problems. The approach introduced by Padé (Sur la représentation approchée d'une fonction par des fractiones rationelles, Thesis, Ann. Ecole. Nor. 9, 1–93, 1892) is hardly new, but its application to the wide variety of problems in theoretical physics discussed in this book marks an important milestone in the development of computing techniques in physics.

The principle applications of the Padé approximants fall into two classes (a) the provision of efficient rational approximations to special mathematical functions and (b) the acquisition of quantitative information about a function for which only power series coefficients are known. The emphasis in this book is mainly in the second area. Typically, the examples given concentrate on using the Padé approximant to obtain information about the exact solution from its perturbation expansion which is of course much easier to obtain.

The book opens with an introductory chapter by Baker which provides a summary of earlier reviews by the same author and then considers in more detail advances that have been made subsequently. This is followed by a chapter by Langhoff and Karplus which examines the application of Padé approximants to dispersion forces and optical polarizability calculations. It provides a very useful review of the subject, special emphasis being given to the calculation of upper and lower bounds on the polarizability. The discussion of bounds is also the subject matter of the next chapter by Wheeler and Gordon which demonstrates the construction of bounds for averages using power moment constraints. Then there follow chapters by Kraichnan on the application of Padé approximants to turbulent diffusion, by Chisholm on their relevance to the solution of certain integral equations and by Chisholm and Common who investigate their application to the series of derivatives of δ-functions. A study of the general role which they play as an approximation technique in Hilbert space is discussed by Masson. The remaining seven chapters concentrate mainly on applications to a number of problems in scattering theory. This reviewer agrees with the opinion expressed by Nuttall, that the Padé method is not likely to be the most efficient way of providing numerical solutions of integral equations of the Lippmann–Schwinger type, including the Bethe–Salpeter equation. Nevertheless, the examples discussed by the remaining authors indicate that it can be a very useful technique. In particular the results of Haymaker and Schlessinger who applied the method in this area were most encouraging. However, the much hoped for major applications of Padé approximants to the solution of problems in quantum field theory and relativistic S-matrix theory, where an integral equation formalism is not available and more convential methods cannot be used, must still wait for the future.

In conclusion this reviewer found the book useful and stimulating and recommends it to anyone who is involved in computational methods in theoretical physics.

P. G. BURKE
The Queen's University of Belfast, Belfast, Northern Ireland.

Proceedings of the Symposium on Computer Processing in Communications, New York 1969,
ed. J. Fox, Polytechnic Press £ 9.50.

This interesting book contains 52 papers which were presented at the Symposium on Computer Processing in Communications at the Polytechnic Institute of Brooklyn, New York, in April 1969. The main theme of the Symposium is the interaction between computers and communications, and the increasing role which high-speed digital processing techniques are playing in the communications field. In particular communications theorists and designers are interested in improved methods of implementing algorithms for optimization of design parameters, storage requirements and computation time. Problems involving round-off errors, convergence of search techniques and iterative procedures which previously were considered to belong to the applied mathematician specializing in numerical analysis, now begin to penetrate the communications field.

Most of the 52 papers, which are divided into ten main topics, clearly describe particular specialist subjects. The discontinuity between the papers and the omission of many obvious titles make the book unsuitable as a general reference work on the subject. However, the papers are generally of sufficient standard to make the book a useful acquisition to anyone working in one of the major areas covered. These are:

Fast Fourier Transforms and Applications
Data Compression and Processing of Pictorial Information
Pattern Recognition
Digital Filters
Discrete-Time Techniques and Digital Receivers
Computer Simulation Techniques
Computer Simulation and Control of Large Systems
Adaptive Systems I – Detectors and Equalisers
Adaptive Systems II – Array Processing
Signal Processing in Seismology, Acoustics and Sonar.

The introduction to the papers includes comments on the question of the roles to be played by special purpose and general purpose computers in communication systems of the future, a theme which can be followed, at least implicitly, in many of the papers.

D. C. S. ALLISON
D. Q. M. FAY
The Queen's University of Belast, Belfast, Northern Ireland.

Lecture Notes in Physics 8, Proceedings of the Second International Conference on Numerical Methods in Fluid Dynamics,
ed. M. Holt, Springer–Verlag $7.70.

This volume contains the text of the papers presented at the second International Conference on Numerical Methods in Fluid Dynamics held at the University of California in September 1970. None of the discussion following presentation of the papers is given but the editor is to be congratulated on the speed of publication. This has been made possible by its inclusion as one of the series of Lecture Notes in Physics published by Springer–

Verlag. The conference was divided into seven sessions with two devoted to new fundamental techniques, two to viscous flow problems, two to high speed compressible flow and one to incompressible flow. In practice the division is rather arbitrary and the study of incompressible flow formed a more important part of the conference than these divisions would indicate.

The large number of papers (65) and the wide distribution of authors (from 8 countries) indicate the interest being taken in this subject at present and the proceedings form an excellent survey of the current state of the art. Each paper is necessarily short but in general each is well presented and easy to follow: in only a few cases is specialized knowledge required by the reader. It would have been an improvement if all the authors had given captions with their figures to avoid continually having to cross-reference with the text. There are papers by many of the world's specialists giving their latest refinements and practical points for other would be users. Many of the papers do not present basically new ideas but extensions and applications of the methods developed in recent years. There are, for instance, several extensions of the well known Marker and Cell techniques for incompressible flows. This fact does not detract from the value of the book, in fact for many readers it may have advantages over purely theoretical presentations.

The concept of splitting Nth-order equations into N first-order equations is widespread and occurs in several papers. Techniques examined by a range of authors are the effects of approximations, accuracy of methods, the use of high order difference schemes and the representation of shocks in finite difference methods. Clearly the best approach on some of these topics depends on the nature of the problem. Some authors, however, are able to produce exact numerical solutions!

It is impossible to consider all the papers individually but the wide interest in multidimensional unsteady flow is illustrated by several papers in the section on new techniques. Some interesting ideas are examined as ways of improving calculational methods in problems of increasing complexity. There is a paper by W. P. Crowley on a free Lagrange method for numerically simulating hydrodynamic flow in two-dimensional compressible or incompressible fluids in which a Lagrangian mesh is adopted but the meshes are not tied together for the duration of the calculation. As each cycle begins the mesh is optimized by an algorithm which links nearest neighbours. In this way the mesh constraints normally associated with Lagrangian methods can be avoided. If generally practicable the approach has much to commend it; some test examples are presented but no comments are made about the computer time penalty introduced by this approach.

For incompressible flows Hirt introduces an arbitrary Lagrangian–Eulerian technique which combines the advantages of the two methods and includes sufficient generality to deal with a range of problems. Mesh points may either (a) move with the fluid (b) remain fixed for Eulerian computing or (c) move in an arbitrary prescribed way to give continuous rezoning.

The papers in this book cover a wide range of problems and present the latest techniques for their solution. It will prove useful both to established workers and also to newcomers to the field. This was the second conference in a series starting at Novosibirsk in 1969 and continuing with the third at Paris–Orsay in 1972. It is to be hoped that the next conference produces presentations as useful and interesting as those given in the present volume.

I. G. CAMERON
Atomic Weapons Research Establishment Aldermaston, Berkshire, UK