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REVIEWS

Envisioning Information. By E. R. TUFTE. Graphics Press, 1990. 126 pp. $48.
The Elements of Graphing Data. By W. S. CLEVELAND. Wadsworth Advanced Books and Software, 1985. 323 pp. $27.95 (hardback) or $18.95 (paperback).

Data sets are usually acquired for some purpose – to show trends, support theories, investigate causal relationships. The graphical presentation of data should enlighten, serving as enticement and complement to the embedding text. The process of thinking about good presentation of data can itself generate new insights and guide the planning of future endeavours.

We all know how to plot this versus that, to construct tables, make scatter diagrams, use error bars. Do we really need these books? Well, maybe not, but I certainly learned much from Cleveland's book. Simple techniques, like removing the clutter of excess information, or occasionally using $\log_2$ rather than $\log_{10}$, were good quick reading, easily remembered. It was surprisingly enjoyable to read about really useful graphical presentation of error and about percentile comparisons. One of the best sections concerned the scatter-plot matrix method for investigating/demonstrating correlations among many variables. The book's example concerned measurements, at one city location, on many successive days, of ozone concentration, wind speed, sunlight, and temperature. In addition to the useful hints and recipes the book also has an interesting and useful section on the theory of graphical perception. It relates what we look at to what we see and what we can discriminate. In summary, Cleveland's book is good, painless education and a great addition to any shelf of reference works.

Faults? There is no advice on presentation of theoretical results, nor on correlating data with a mathematical theory. Very little space is allocated to computer techniques, although these are implicit in much of the discussion. One recent book concerned with this subject is *Scientific Visualization and Graphics Simulation*, edited by D. Thalmann, Wiley, 1990.

What about the aesthetics of graphical representation? If a picture which intends to convey quantitative information is extraordinarily beautiful, its aesthetics may capture the onlooker and make him want to unravel even the most complex interweavings of information. The book by Tufte is about graphical effectiveness through aesthetics. It includes graphic inventions, designs, and instructions developed over many centuries. There are beautiful examples of Japanese and Chinese presentations of data constructs, such as timetables. The use of colour in many of the techniques shown and recommended is not realistic for most scientific publications. However, the book is recommended highly for showing quantitative graphics as art, and as a repository of nuggets, such as a splendid, approximately 2000-year-old Chinese proof of the pythagorean theorem, graphics enhancement by edge effects and illusion, and the use of sequences of computer-generated perspective diagrams, associated with contour plots, to present a truly graphic view of developing plasma instabilities.

J. O. KESSLER

Quantized Vortices in Helium II. By R. J. DONNELLY. Cambridge University Press, 1991. 346 pp. £50 or $95.

The absence of viscosity and heat conduction of helium II attracted the great interest of eminent physicists in the study of the properties of superfluids. Soon it was noticed that helium II possesses another remarkable property compared with classical liquids, namely the appearance of quantized vortices manifesting effects at the macroscopic continuum flow scale.

It is now realized that these properties are not limited to helium II but are also of importance in less-known or accessible superfluids or superfluid-like media such as 3He, superconductor electron fluid, monoatomic hydrogen and the neutron fluid of stars. Experimental research is conducted mostly with the more readily available He II, and the experimental methods and theoretical models developed offer unmatched testing possibilities. However, a macroscopic theory of superfluids with as firm a background as that of classical fluids is still awaited.

This book is an account of the properties and motion of quantized vortices in superfluids. It contains eight chapters, an extensive 10-page list of references and an index.

The first chapter is an attempt to squeeze into about 40 pages a review of disparate topics of classical fluid dynamics which may make it easier to follow and understand analogous problems encountered in superfluids. The next chapter contains a brief background on liquid helium II. The two-fluid model is introduced and the interaction of vortices with inclusions is described. Although there is no fundamental microscopic theory, the known relations between quantum mechanics and superfluidity which are needed for the understanding of quantum vorticity are given.

The next four chapters are devoted to the main subject of the book: the dynamics of quantized regular vortex lines, vortex arrays and vortex rings, micro- and macroscopic friction and interaction between ions, 3He and vortex cores, vortex pinning and vortex waves.

Chapter 7 covers the irregular and more common stage of evolution of vortex lines into a vortex tangle which, by remote analogy with classical turbulence, is called superfluid turbulence. The important dynamical similarity property based on Schwarz's model of evolution of vortex lines and the anisotropy of vortex fields is deduced. The classification of stationary superfluid turbulent flows in channels is described, and counterflow second-sound shock waves are very briefly discussed.

The final chapter is concerned with the less explored and understood problem of thermal activation and nucleation of quantized vortices. The closely related topics of vortex motion in porous media, effects due to dissolved 3He atoms and finally vortex dynamics of thin films end this chapter.

The author has contributed personally to research on superfluid vorticity, and is well placed to present the state of the art on this special subject. He has largely succeeded in the purpose, stated in the introduction, 'to acquaint the reader with modern research in vortices in liquid helium' and to reflect the 'modern research in 4He as pertinent to the development of certain specialized topics'.

Inevitably a book concerned with a field of current research cannot be a closed monograph but must be a review of selected topics summarizing the present state of knowledge and indicating the existing gaps or uncertainties. Naturally the author has omitted some problems which perhaps he was not directly concerned with, e.g. the propagation and evolution of second-sound shock waves in a turbulent environment, or recent extensions of the vortex-line-density evolution equation.

However, writing a book like this undoubtedly requires a great effort, which deserves the gratitude of its readers.

There are relatively few misprints and the printing and editing are excellent.

The reviewer can recommend this book strongly to physicists interested in liquid helium. It is also of great interest to fluid dynamicists involved in vorticity and turbulence research. Although it seems that at present research on turbulence in classical fluids and on vortex dynamics in superfluids is developing in different directions, a closer interaction may be useful for both fields.

W. FISZDON

Nonequilibrium Hypersonic Aerothermodynamics. By C. PARK. Wiley, 1990. 358 pp. £47.50.

Hypersonic aerothermodynamics is a subject in which developments have taken place in two distinct phases. A peak of activity in the 1960s has been followed by a resurgence of international interest in the 1980s in support of aerospace plans, space transportation systems, re-entry vehicles and a variety of super-orbital aero-manoeuvring and aerobraking space vehicle projects. The flight trajectories of such vehicles generally encompass a regime of altitude and velocity in which the physical and chemical phenomena affecting the hypersonic flight performance do not occur in equilibrium.

The appearance of this comprehensive text on nonequilibrium hypersonic aerothermodynamics by Chul Park is both timely and important as it embraces the work of both periods of activity and addresses a problem of central importance to the subject. It is an advanced text and is suitable for graduate students with prior knowledge of equilibrium gas dynamics and supersonic aerodynamics and for research workers in the aerospace industry, research establishments and academia. The books entitled *Introduction to Physical Gas Dynamics* by Vincenti & Kruger (Wiley, 1965) and *The Dynamics of Real Gases* by Clarke & McChesney (Butterworth, 1964) would provide a suitable background from which to embark on this new text. Both of these works were published in the mid 1960s and the importance of Park's book is that it contains a comprehensive and yet readable treatment of many of the important developments in the subject of the last two decades, some of which have not previously appeared in textbook form. Indeed, it is significant that many of the cited references originated from the 1960s and 1970s and the modern perspective which is given to these is a feature of value to younger workers entering this subject area for the first time.

The book is structured to cover both theoretical treatment (chapters 1–5) and practical application and experimental aspects (chapters 6–8). Chapter 9 provides an account of gas–surface interactions.

A succinct yet comprehensive review of the structure of atoms and molecules is given in the first chapter, but significant prior knowledge of statistical and classical mechanics has been assumed. This is followed by a chapter dealing with internal state transitions and energy transfer which covers rotational, vibrational and electronic excitation and de-excitation and the related relaxation phenomena. Radiative transitions also feature.

Chapter 3 builds on this physical framework to derive the master equation for relaxation in atomic and molecular systems. The concept of quasi-steady-state rate coefficients is described and their limitations discussed. Chapter 4 introduces the

conservation equations and boundary conditions for high-enthalpy nonequilibrium flow to include internal energy transfers, diffusion and chemical reactions. Computational procedures for flows with chemical reactions and some cautionary remarks on the related 'tricks and pitfalls' are described in chapter 5.

Practical applications, experimental facilities and experimental data in the field of nonequilibrium hypersonic aerothermodynamics are reviewed in chapters 6–8. The topics covered are extensive and include the effects of nonequilibrium on compressive (normal shock waves) and expanding flows, pressure distributions and flow fields over simple body shapes, base flow and wakes, and convective heat transfer including wall catalysis. A feature of these chapters is the critical review and, in some cases, reassessment of reaction rate data for air using Park's two-temperature model, complemented by tabulated data and extensive referencing. Radiative data for air evaluated using the author's work at the NASA Ames Research Centre also feature prominently.

The final chapter includes a description of the special phenomena associated with gas–solid interactions involving the nonequilibrium kinetics of processes of adsorption, desorption, evaporation and condensation. Surface catalysis and gas–surface reactions are considered.

In summary, this book is a welcome addition to the literature on hypersonic aerothermodynamics. It is a well balanced and comprehensive mixture of mathematical analysis, physical reasoning and experimental data and although significant background knowledge is required the reader is aided by well selected references and some extremely useful tabulations of appropriate data. It is not free from typographical errors but these do not detract from the overall value of the work. In collecting together the developments in this subject during the past 30 or so years and reviewing them in the light of recent experience the author has produced a textbook likely to be of great value for many years ahead.

R. A. East