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REVIEWS

The New Physics. Edited by P. DAVIES. Cambridge University Press, paperback edition, 1992. 516 pp. £16.95.

When I was studying physics as an undergraduate, our mentors combined the traditional fare of Heat, Light, Sound and Electricity with what was then called Modern Physics; it covered the period between J. J. Thomson's discovery of the electron in 1895 and Chadwick's discovery of the neutron in 1932. The book under review covers a post-modern period of similar length. As I started doing research in about 1950 and was approaching retirement when the hardcover edition first appeared, in 1989, this period neatly covers my active career. What dramatic developments I and my contemporaries have lived through and have tried – in my own case with rather limited success – to assimilate!

One has only to compare the shelf space occupied by a year's issues of *The Physical Review* c. 1950 with the corresponding shelf space today to appreciate one very significant development: there are very many more practitioners of physics now than there were 40 years ago. Perhaps that is why there seem to be fewer real giants among them. From so many extraordinarily clever and creative theorists it is hard to pick out individuals to compare with the likes of Einstein, Bohr, Dirac and others who dominated the modern physics of my youth, and it is almost equally hard to pick out, from a great mass of sophisticated and highly ingenious experimental work, individual discoveries which obviously rank in significance with those of say Michelson or Rutherford. But the editor of this book and his team of 18 contributors, all of them distinguished for their own research, have made a brave effort to pick out significant ideas. Their mission was not to encapsulate these ideas in tidy textbook form, but to convey some of the excitement which they have generated, and to stress the 'challenging legacy' (in Paul Davies's words) which each one of them bequeaths to the next generation of physicists. In this mission they have by and large succeeded.

If you are seriously interested in physics and have not yet read the book, you should certainly consider, now that a paperback edition is available, buying a copy to put on your own shelves. The subject is not moving so rapidly that the book is noticeably out of date after the passage of five years, and the physics in it is likely to seem almost equally 'new' in another five or ten years time from now. You will find the book a mine of stimulating information, and just what you need to lend to very bright students who show signs of getting bored with more basic material. Do not, however, expect an easy read. Most of the contributions are well written and admirably illustrated, but they will make serious demands upon your powers of concentration and comprehension, however much physics you think you know already. The editor's aim was evidently to achieve the level of exposition associated with articles in *Scientific American*, but by my estimation at least half the contributors have found it impossible to get their message across without going beyond that. If you really need the glossary which has been provided for the general reader, or if your mathematics is so weak that you need the explanation of the natural logarithmic function which is provided on p. 451, then heaven help you!

Readers of *Journal of Fluid Mechanics* who have spent decades in trying to unravel the mysteries of turbulence are likely to feel that their special interest is inadequately represented. Turbulence is naturally referred to in the chapter on chaos, which is illustrated by photographs of wake flow of various sorts as well as by spectacular (though by now fairly familiar) fractal patterns in full colour, but this chapter strikes me as less coherent and satisfying than most of the others. Convection cells make a brief appearance elsewhere, in a chapter entitled *Physics of far-from-equilibrium systems and self-organisation*, and some of the flow properties of liquid helium are discussed in the chapter on *Low temperature physics, superconductivity and superfluidity*. But that is just about it as far as fluid mechanics is concerned; look up the work 'soliton' in the index and you will find only two references, one of which is to a chapter on *Quantum optics* and the other to a section on string theory in Salam's *Overview of particle physics*. I can assure fluid dynamicists, however, that many readers who are solid-state physicists will feel equally neglected. In the editor's introductory survey he reviews the book's contents under three headings: The Small (quantum mechanics, grand unified theories, particle theories etc.); The Large (general relatively, cosmology, astrophysics etc.); and The Complex (everything else, especially all aspects of the physics of condensed matter). The Large and The Small occupy respectively the first 200 and the last 120 pages of the book, leaving a middle section of only about 160 pages for The Complex. That is not really enough.

In modern physics textbooks of the 1940s there was generally a chapter on the topic of X-ray diffraction. This was sober stuff compared with special relativity and quantum mechanics, but X-ray diffraction techniques were already of immense practical importance in the 1940s, and in due course they made possible an event which changed the way we think about the world we live in at least as dramatically as any of Einstein's theories: I mean the elucidation of the structure of DNA. A topic which has come to the fore during the post-modern era, which is comparable to X-ray diffraction in its practical importance, and which has the same potential to change the way we think about the world, is that of magnetic resonance; in the post-new era which lies ahead, magnetic resonance imaging may vastly increase our understanding of how the brain works. I suggest, therefore, that Paul Davies's book would have provided a more balanced view of what physicists have been up to since the Second World War, and of where they are going in the future, had space been found in it for a chapter on magnetic resonance. I could make a similar case for chapters on several other topics which are ignored in the book as it stands, including aspects of semiconductor physics, microelectronics and computing, and macromolecular physics. In short, The Small, The Large and The Complex should have been complemented by The Useful.

The book as it stands, however, is one to be grateful for. It is also, from a reviewer's point of view, quite long enough.

TOM FABER

Multiphase Flow and Fluidization. By D. GIDASPOW. Academic Press, 1994. 467 pp. ISBN 0-12-282470-9.

Formal treatment of the flow of fluid and particulate phases in fluidized beds through analysis of continuity and momentum balance equations began in the 1960s. The primary emphasis of the work till the mid 1970s was on issues such as the stability of the uniformly fluidized state and the different behaviours of gas- and liquid-fluidized beds upon loss of stability. These issues were addressed by a combination of linear and weakly nonlinear stability analyses of the volume-averaged equations of motion developed by Jackson and others in the 1960s. Over the last twenty years, Professor Gidaspow has done pioneering work on numerical solution of these equations to demonstrate that they capture phenomena seen in fluidized beds (such as formation of bubbles) and risers (such as formation of clusters and segregation of particles to the wall region). Computer codes developed by his research group and by his former students are now being used in many academic and industrial laboratories. Thus he is eminently qualified to write this book summarizing his contributions to this field.

The book is in a form intended for use as a graduate-level textbook as well as a reference for industrial researchers without prior training in this field. It is divided into 12 chapters and 7 appendices. Each chapter ends with a number of homework problems. The first chapter summarizes the derivation of transport equations. Chapters 2 and 3 focus on one-dimensional steady gas–solid flow, where the author introduces three different variations of the momentum balance equations (models A, B and C). Chapter 4 discusses granular flow problems neglecting the role of interstitial gas. It contains a brief discussion of the classical one-dimensional Jannssen analysis of stresses in a static granular bed, followed by a detailed treatment of critical ('sonic') flow of granular materials. Chapter 5 introduces the reader to the fluidized state and the Geldart classification of powders. It is postulated in chapter 6 that bubbles in fluidized beds are shocks and a criterion for bubbling is derived by examining the speeds of propagation of one-dimensional voidage waves in a fluidized bed.

In chapter 7, on inviscid multiphase flow, it is shown that the momentum balances of model A are ill-posed while those of model B are well-posed. This is followed by several bubbling-bed examples where inviscid models A and B are solved numerically and compared with experimental data. The advantages of model B over model A from the point of view of numerical analysis are discussed.

The need to include viscous stresses is introduced in chapter 8. Also described here are results of numerical simulation of gas–particle flow in risers, employing a Newtonian model for the viscous stresses, and their comparison with experimental data.

Constitutive models for particulate-phase stresses in a rapidly deforming assembly of monosized spherical particles are derived in chapter 9 using the kinetic theory of granular materials. This analysis is extended to mixtures of granular materials in chapter 11. Flow patterns in bubbling beds and circulating fluidized beds, computed through numerical solution of the volume-average equations of motion and the constitutive models of chapter 9, are described in chapter 10. The final chapter is devoted to a study of sedimentation and consolidation problems.

After reading the book, I am left with a feeling that it was assembled in a hurry. It contains a number of errors and omissions; to cite a few examples: (*a*) σ_{so} is defined in page 77 as the stress at $x = 0$ and it is stated that the stress σ_s is equal to zero at $x = H$. This is immediately followed by equation (4.10) where σ_{so} is now a function of x. This equation does not yield vanishing stress at $x = H$. (*b*) In the Nomenclature and in chapter 1, U and S are defined as thermodynamic quantities (internal energy and entropy, respectively). In section 4.4 on compressibility of an assembly of essentially incompressible powders, the intended meaning of U and S is different, but this difference is not properly noted. (*c*) There is no discussion of wall boundary conditions in the chapters on multidimensional flow modelling.

The conclusions in some sections are perhaps best viewed as opinions or plausible explanations. For example, the thesis of chapter 6 that bubbles are shocks is not established. The analysis of shock formation described in the book is strictly one-dimensional, while bubbles are not one-dimensional structures. Similarly the claim in chapter 4 that the independence of the rate of discharge from hoppers of the depth of the fill is a manifestation of criticality is an interesting idea, but is not proven.

The style of presentation is non-uniform. The derivation of the kinetic theory of granular materials is given in great detail. In contrast, the relative velocity model (model C) is simply stated in chapter 2 without documentation of its derivation, in spite of the fact that this model is used repeatedly in many places in the text to draw various conclusions. The advantages of model B over model A are discussed, but its limitation, namely over-prediction of centrifugal acceleration of particles in rotary and swirling flows, is not mentioned.

Given the strong emphasis of the book on numerical simulation of the time-dependent volume-averaged equations of motion, it would have been useful if a section on the numerical method used in generating the results had been included. Approximations associated with discretization methods sometimes introduce artifacts such as numerical viscosities and dispersion coefficients, so it is important to demonstrate that the numerically generated results truly reflect solutions of the original differential equations. This is of particular concern for the results described in chapter 7 on inviscid flows where there is legitimate reason to anticipate dependence of the computed results on grid size.

With a little more attention to details this book could have been much better. In its present form it lacks the rigour expected by readers of *JFM*. There is no doubt that it will be used as a reference in graduate level courses, but the instructors will have to supplement it with corrections and discussion separating conclusions from plausible ideas.

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