J. Fluid Mech. (1977), *vol.* 83, *part* 3, *pp.* 605–608
Printed in Great Britain

REVIEWS

Theory of Simple Liquids. By J. P. HANSEN and I. R. McDONALD. Academic Press, 1976. 395 pp. £14 or $30.65.

Molecular Fluids. Edited by T. BALIAN and G. WEIL. Gordon & Breach, 1976. 459 pp. $48.00.

Liquid-state theory and fluid mechanics have developed almost independently. Hydrodynamics came into existence in the Newtonian era, when the molecular structure of matter was only a vague speculation. Perhaps the first result in liquid-state theory is due to Laplace, who drew some very interesting conclusions about surface tension and latent heat on the basis that intermolecular forces act over only very short distances. Even today only very few situations in fluid mechanics, for example Knudsen flow of highly rarefied gases, need explicit use of a molecular hypothesis. As one might expect, it is often profitable in liquid-state theory, particularly when discussing correlations and transport processes, to go to the 'hydrodynamic limit', that is to say to discuss compressional and shear waves of wavelengths long compared with intermolecular distances.

Theory of Simple Liquids gives an excellent and readable account of the present state of the subject. Chapters 2–6 describe the various approaches, via the liquid distribution function and integral equations, via 'computer experiments' and via successive approximations systematized by means of diagram expansions. Chapters 7–9 describe time-dependent effects and transport processes and give some material that is of great interest but difficult to find except in original papers. The use of the hydrodynamic limit in these chapters provides a link with fluid mechanics.

The final chapter, on phase transitions, can only be described as disappointing and sketchy, and shows signs of having been compressed (probably from considerations of space).

Molecular Fluids is a transcript of lectures given at a summer school at Les Houches in 1973. Despite the delay in publication the material is very much up to date. It consists mainly of lectures on polymer solutions and liquid crystals, though the very interesting introductory chapters on linear response theory and the interesting and comprehensive chapter (in French) on correlation functions covers ground similar to that of chapters 7–9 of *Theory of Simple Liquids*. Despite the difficulties of dealing with a 'simple' liquid, the chapters on polymer solutions and liquid crystals give interesting accounts of the impressive progress that has been made in recent years in discussing both equilibrium and transient effects.

Apart from very important contributions by Berthelot (cohesion of liquids) and by van der Waals (the equation of state), little real progress was made in liquid-state physics until 1935. Kirkwood then realized that the molecular distribution function, that is to say the local variatons in liquid density in the immediate neighbourhood of a typical molecule, could in principle be determined by solving an integral equation and the results could be compared with the results of X-ray scattering, which are also related to the distribution function. Progress was interrupted by the second world war and was slow afterwards until 1957, in which year it was conclusively shown that large computers are capable of handling the considerable mathematical problems posed by Kirkwood's integral equations and by related approaches. Time-dependent effects can also be followed by computer but are always difficult to handle analytically.

The modern approach, described in chapters 2–6 of *Theory of Simple Liquids*, is roughly a combination of analytic methods (whose day is very far from over) and 'computer experiments' on idealized systems like the rigid-sphere gas. Why computer experiments? The answer is that even atoms as 'simple' physically as atoms of liquid argon are now known to have quite a complicated interaction function and quite appreciable interactions involving three or more atoms at a time. In practice, it has proved almost impossible, when comparing the predicted properties of liquid argon with experiment, to distinguish between the results of approximations in the theory and the effects of three-body interactions (which cannot yet be predicted analytically). Hence the present tendency is to compare the results of analytic theory with computer experiments on comparatively small assemblies (10–100 molecules) whose only interactions are between pairs of molecules.

The books are both beautifully printed and well indexed.

H. N. V. TEMPERLEY

Foundations of Aerodynamics. 3rd Edition. By A. M. KUETHE and C.-Y. CHOW. Wiley, 1976. 527 pp. £17.50 or $28.00.

This is the third edition of a book of which the previous editions were by Kuethe and Schetzer in 1950 and 1959.

The changes introduced in this edition have been mainly in the form of rearrangements, some updating and additions, the most notable addition being an elementary discussion of the use of panel methods for computing velocity and pressure distributions on shapes of aerodynamic interest.

The book is designed for undergraduate and first-year postgraduate courses and clearly reflects the years of experience of the authors and their colleagues in teaching such courses.

The first four chapters are devoted to the basic topics of inviscid fluid mechanics, and the next two deal with the elements of thin-aerofoil theory and lifting-line theory. These are followed by five chapters introducing the effects of compressibility and the remaining six chapters deal with the effects of viscosity, boundary-layer theory and control. Two appendices follow on dimensional analysis and on the derivation of the Navier–Stokes and energy equations. Some two hundred problems are provided as well as a set of useful tables and a shock chart.

In general the book is scholarly and fairly comprehensive bearing in mind the level at which it is aimed, and care has been taken to advise the reader of the existence of further developments beyond the elementary treatment offered for certain of the topics. The text rightly reflects the growing importance of numerical methods of computation, and the discussion of the factors that determine transition from laminar to turbulent flow is particularly illuminating and helpful, as is the discussion of the transonic area rule.

The arrangement is perhaps open to criticism; for instance it could be argued that at least some outline of viscous phenomena and boundary-layer effects should have come early in the text if only to make clear in good time the limitations and corrections that one must bear in mind in using the results of inviscid flow calculations. The accuracy of the latter, including numerical techniques of solution, is somewhat oversold and the reader comes too late to the concept and effects of flow separation. One may also wonder why dimensional analysis continues to be relegated to an appendix as in the earlier editions, in view of the basic part this topic plays in the analysis and presentation of aerodynamic data. The treatment of methods of predicting boundary-layer characteristics, both laminar and turbulent, is somewhat sparse, bearing in mind their essential contribution to any overall calculation procedure; in particular there is no reference to differential methods of calculating the development of turbulent boundary layers.

However, none of the above points of criticism and other very minor ones that could be noted are such that a good teacher cannot make excellent use of this book, and it can be warmly recommended to students of aeronautical engineering. The printing and presentation are uniformly excellent and make reading it a pleasure.

A. D. YOUNG

The Second Law of Thermodynamics. Edited by J. KESTIN. Dowden, Hutchinson & Ross, 1976. $27.50.

This is volume 5 in a series, *Benchmark Papers on Energy*, and is intended to present by means of 15 articles, from Sadi Carnot onwards, the historical development of the second law. The memoirs of Carnot and Clapeyron are translated from the French, those of Clausius, Carathéodory and Planck from the German, and the rest, by W. Thomson, Gibbs, Born and Meixner, are in their original English. The whole is loosely bound together by the brief commentaries of the editor, Professor J. Kestin, who is responsible for the choice of material. Given the overall length, one must welcome a good two-thirds of the articles – Carnot and Clapeyron demonstrate the origins within the caloric theory of ideas so powerful as to destroy the idea of caloric, and lead in the hands of Clausius and Thomson to a new synthesis, with Gibbs as the great generalizer and Carathéodory as the ultimate tidier-up of loose ends. The articles by Planck, Born and Meixner are different in kind, being didactic rather than exploratory, and I should have been happy to see these replaced by others of greater historical significance, such as Thomson's on the thermoelectric effects, or Boltzmann's on black-body radiation.

There is more than personal taste implied in this criticism, for it calls into question the purpose of the compilation, which cannot be regarded as historical in any scholarly sense. It is a selective view whose emphasis on success gives the erroneous impression of an inexorable progress from inception to fruition – how erroneous can be appreciated from the bitter remarks in Planck's autobiography, directed not only at the rival 'energetics' school but unhappily also at Clausius and Boltzmann, who seem to have failed to appreciate the efforts of the young man who did more than most to get their ideas accepted and used. The book may therefore be successful in tempting a few readers to dig more deeply into the story of a great scientific achievement, but it does not in itself provide anything like a balanced picture. Moreover, like all pioneering work, it is very difficult reading; even where ample material is presented, in that selection of early papers by authors who believed in caloric at the time of writing, the editor does little to help resolve the paradox of correct and important conclusions emerging from erroneous premises. The casual reader, therefore, however glad he may be to sample the flavour of the work, is unlikely to feel at the end that he has much of an idea of how it was done.

Nor, it must be said, is he likely to understand thermodynamics better. There are modern textbooks, of which the editor recommends a generous selection, that improve in almost every respect on the original accounts; and I do not except Willard Gibbs, for all that his enormous monograph used to be, and probably still is, piously recommended to novices in universities on the Eastern seaboard of the United States. As for Carathéodory, however elegant and penetrating his analysis, I believe it would be healthier for the student to remain in ignorance of it, or at most to know that he put on a sound mathematical basis what physicists and engineers had by that time become convinced was true. Born's championship of Carathéodory is perfectly honest, of course, yet ultimately mischievous; it is the attitude of a mandarin who values economy of effort above sordid practical utility. Just as Hamilton's Principle will not displace Newton's laws of motion as the ordinary physicist's or engineer's approach to mechanics, so Carathéodory's Principle will not displace Clausius' or Kelvin's. Or, if it does, we shall find ourselves turning out a generation of practitioners who can only solve the problems at the end of the chapter, and not go on to use their knowledge in a new situation.

For a variety of reasons, then, I find it hard to recommend this book, and this is a pity since it is a collection of articles of great stature, which will be valued by a small number of readers. One cannot, however, overlook the fact that these excellent translations (by Mendoza) of Carnot and Clapeyron were published as recently as 1960 and have gone out of print already. The cynical thought is hard to resist, that it is the recent irruption of energy into the public consciousness that provides an incentive for the present publishers to go fishing in a new pool; but if any innocent fish take the bait, I fear they are going to be sadly disappointed.

A. B. Pippard