identifies the centralizer of a non-scalar element of a free k-algebra, k being a field, as a polynomial ring in one variable, is proved. There is a lengthy discussion of automorphisms of polynomial rings and free algebras leading up to a brief treatment of the Galois correspondence for free algebras and to the work of V. K. Kharchenko on so-called X-inner and X-outer automorphisms.

At this stage the reader reaches Chapter 7 which, as in the earlier edition, is one of the most significant chapters of the book. It is concerned with the embedding of rings in skew fields of fractions and contains many results of the author. As before it is shown that a ring can be embedded in a field if and only if the ring is an integral domain and no non-zero scalar matrix can be written as a determinantal sum of non-full matrices. The results here are more extensive than previously. Thus there is now a slick proof (due to V. Dlab and C. M. Ringel) of the theorem of Bergmann and Dicks that if R is a left hereditary ring and Σ is any set of square matrices then the universal localisation R_Σ is also left hereditary. The eighth and final chapter treats of skew, and iterated skew, polynomial rings and Laurent series. One pretty result is that if G is a free group then every element of the ordered series ring $K(G)$ is conjugate to a Laurent series in a single variable. As in the first edition each chapter ends with a commentary providing historical and mathematical background and there is an appendix summarising some results from lattices and homological algebra.

It is hoped that the above gives some flavour of this book which is concise but usually clear. If there are criticisms to be made one might observe that while theorems etc. stand out from the text the same is not true of definitions so that, on occasion, one has to search for an unambiguous delination. Perhaps however the main criticism must be reserved for the sterling price which is surely beyond the reach of all but the highly committed buyer.

D. A. R. WALLACE

CRAIK, A. D. D., *Wave interactions and fluid flows* (Cambridge Monographs on Mechanics and Applied Mathematics, Cambridge University Press, 1986), 322 pp., £35.

Waves have long been an important part of the theory of fluid mechanics. In the nineteenth century the linear theory of sound and of surface waves on water was developed, a few other waves were discovered, and the nonlinear theory was initiated. This century many more kinds of waves have been discovered, the linear theory has been refined, and the nonlinear theory has burgeoned. Also the quality and quantity of observations has improved greatly, so that the relationship of theory and experiment is much closer. The early ideas of Stokes on water waves of finite amplitude and of Rayleigh on acoustic streaming have, especially in the last three decades, grown to form a comprehensive theory of weakly nonlinear interaction of waves, not only the self-interaction of one wave.

Introducing nonlinearity, Craik observes that nonlinear theories are essentially of three distinct kinds. The first is of rigorous mathematical results (of, for example, the energy method) about arbitrary disturbances, the second is of weakly nonlinear theory in which the linear theory is used as a first approximation to waves of small amplitude, and the third is of numerical simulations. Craik might have added "laboratory simulations" to his list! Although observation is, by definition, not a kind of theory, numerical experiments are increasingly used with theory as laboratory experiments have been and are. However, Craik does not forget that understanding natural phenomenona is the aim, many observations being reported and related to theory throughout the book.

Although the second kind of theory is in practice restricted, because it is confined to basic flows with plane or axial symmetry in order to reduce the linear problem to an ordinary differential system and thereby make the weakly nonlinear problem tractable, it has dominated nonlinear theory so far and is the subject of this monograph. Craik treats chiefly the interaction of waves in incompressible fluids, but also treats the analogous interactions of waves in plasma physics and optics. He wisely limits his subject, because no book can cover everything well, the

subject is unified, and not least because of his own original contributions to it. Also the book is timely, being, for example, the first to describe the generalized Lagrangian mean.

Craik's list also omits a fourth kind of theory, namely, the qualitative theory of differential equations. This covers, for example, the evolution of the type of dynamically similar flow as the Reynolds number increases slowly. The evolution from steady flow to steady flow, to time-periodic flow, to quasi-periodic flow, to phase-locked flow, to turbulence, say, is the broad canvas on which the weakly nonlinear theory paints some details. The modern theory of bifurcation and chaos indicates what routes to turbulence are possible and what are typical. This fourth kind of theory thus gives many insights and a conceptual framework by use of which laboratory and numerical experiments may be interpreted. However, Craik uses this kind only briefly in passing when he discusses some detailed results of the weakly nonlinear theory or of experiments.

The book is appropriately one of a series of monographs, for it is at a level suitable for research workers. The author typically begins his treatment of a topic with a short description of a relevant experiment, following with an authoritative statement of the key theoretical results and a short summary of some recent papers. A lot is assumed. The linear theory is usually taken for granted, although it may be extensive and difficult, describing complex physical mechanisms. Sometimes advanced results, like those of the inverse scattering transform, are casually mentioned. This is fair, but the reader needs to be warned what to expect. The chapter headings are symptomatic of the systematic development of the subject along theoretical lines, rather than according to its physical applications.

The author has neglected or ignored several topics (for example, double diffusion, flow in a porous medium, Saffman–Taylor instability), approached others, and chosen the balance of the book in ways which do not conform precisely with my prejudices. The indexing might be improved. But a reviewer demeans himself by admonishing an author for not writing the book the reviewer might have written, rather than welcoming the good points of and identifying the limitations of the book. So I welcome this monograph as an authoritative modern account of wave interactions.

P. G. DRAZIN

GJERTSEN, D., *The Newton Handbook* (Routledge and Kegan Paul, London and New York, 1986), pp. xiv + 665, £25.

The last few decades have witnessed a remarkable revival of Newtonian scholarship. On the textual side there is the Royal Society's 7-volume edition (1959–77) of the *Correspondence*, and D. T. Whiteside's monumental edition (1967–81) in 8 volumes of the *Mathematical Papers*, not to mention the great *variorum* edition of the *Principia* by Koyré and Cohen. An edition of the optical papers is in preparation. In addition there have been several fresh contributions to the long tradition of Newtonian biography, intended to supersede earlier work, which was often incomplete and biased. The volume under review falls into neither the textual nor the purely biographical category. An alternative descriptive title might be "A Newton Encyclopedia". It takes the form of more than 500 articles under alphabetically arranged headings, with many cross-references, varying in length from a few lines to the 47 pages devoted to the *Principia*. Out of this unusual method there emerges a survey of Newton's life and scientific work, his administrative work at the Royal Mint and his lucubrations on alchemy, chronology, theology, church history and many other topics. Biographical notices are given of persons connected in any way with Newton. Some of the articles are purely factual, some expository, while others offer informed critical comment. There are very full bibliographies of Newton's more important works, and of books and articles dealing with Newton, and an account of portraits, statues and medallions of Newton.

While the book does not set out to present new material it brings together for easy reference and in readable—or at least browsable—form an enormous amount of material in many cases not readily available elsewhere. Printing and binding are admirable.