served correspond to extremely fast radial-expansion velocities.

The book concludes with a rather sketchy review of theories of the origin of the solar system and an even briefer account of the origin of the chemical elements.

The style is direct, simple and quite attractive: Chapters are introduced by well written lead-ins and summaries. There are good tables and figures, a bibliography and two indices.

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S. Fred Singer, now deputy assistant secretary for scientific programs, Department of the Interior, is on leave from the University of Miami, where he organized, in December 1965, a symposium on observational aspects of cosmology.

Still more problems

PROBLEMS AND SOLUTIONS IN MATHEMATICAL PHYSICS. By Y. Choquet-Bruhat. 314 pp. Trans. by C. Peltzer. Holden-Day, San Francisco, 1967. $9.00

by Gerald C. Pomraning

The expression that necessity is the mother of invention can, with some degree of truth, be applied to this book by Madame Choquet-Bruhat. For several years there has been a clear need for the inclusion of a significant number of nontrivial examples, with solutions worked out in detail, in textbooks on contemporary applied mathematics. The "invention" in this case is a book of over 300 pages devoted entirely to such examples. Since the book gives no pretense of supplying the underlying theory necessary to fully understand these examples, it is essential, for the student at least, that it be used in conjunction with a standard text. The book recommended in the preface for this purpose is *Linear Algebra and Analysis* by A. Lichnerowicz. Fortunately for the American student, this French text has been translated into English (Holden-Day).

The areas covered in this book through 72 examples of about four parts each are best summarized by listing the eight chapter headings. These are: (1) linear mappings: operations on matrices; (2) proper values and proper vectors: reduction of matrices; (3) scalar product and norm: Hermitian operators; (4) vector calculus: multiple integrals; (5) function spaces and operators; (6) series expansions of functions; (7) differential equations; (8) partial differential equations. This list shows that, as far as examples are concerned, this book goes beyond the material supplied in Courant and Hilbert, Morse and Feshbach, and other books of similar hue. Nevertheless there are areas not included that would have made the book more interesting and complete. Problems involving probabilities always cause difficulties for students (as well as others), and a few well chosen examples using symmetry principles would have brought this book to the forefront of modern mathematical physics. An obvious omission is a chapter on variational and perturbation methods. However all books have to be ended more or less arbitrarily, and the author cannot be seriously faulted for her choice of subject matter in this case.

The examples in the book range from a few very elementary problems to more difficult and interesting ones. An example of the former is the orthogonalization and normalization of the first few polynomials with respect to a given weight function in a given interval (construction of Laguerre polynomials). Fortunately the latter type of problem is in the majority. In all cases the problems are well stated and the solutions constructed in sufficient detail to be useful to the student. At times the author finds it necessary or convenient to introduce certain definitions. This is generally integrated smoothly into either the statement of the problem or the discussion of the solution. When a more detailed discussion is required, as in the case of unitary operators, the author retains the basic tenet of the book by stating as a problem: "Give the . . . properties . . . of a unitary operation . . ." The solution is the discussion needed to understand the examples which follow and involve various properties of this class of operators.

This book originally appeared in French, and the present translation into English is an excellent job. Only in very occasional instances would this reviewer suggest any changes in the translation, such as the use of "eigenvalue" rather than "proper value" and "Dirac delta function" instead of "Dirac measure . . . limit in the sense of distributions . . .". Since this book is intended for applied scientists, it would seem desirable to use their jargon in the translation. From the overall quality of the translation, however, it is probably true that this was not an oversight but rather a deliberate choice on the part of the translator.

The book has one major fault. It contains far more misprints than can be excused as inevitable in the publishing process. For the experienced reader this is more a nuisance than anything else, but many of these could cause considerable difficulty for the student. It is hoped that the book will be carefully edited before any reprinting, and that an erratum will be distributed with those already off the press. Aside from this criticism, the book is well done. Although it is intended primarily for students, it should be of more than passing interest to the practicing scientist, engineer and applied mathematician.

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The reviewer is a physicist with the General Dynamics Corporation.

Best suited for nuclear physics

INTRODUCTION TO THE QUANTUM THEORY OF SCATTERING. By Leonard S. Rodberg, Roy M. Thaler. 398 pp. Academic Press, New York, 1967. $11.50

by John L. Gammel

The most startling thing about this book is that it contains no references to the literature other than a statement in the preface that references may be found in the book by M. L. Goldberger and K. M. Watson[1] and the one by T. Wu and T. Ohmura.[2] The authors excuse themselves on the grounds that the treatment is self contained and highly personal. I believe that a better reason is that the authors are lazy. What is self contained or highly personal about the following? A differential equation, numbered 5.10 on page 64 of the text, is "readily identified as a hypergeometric equation whose regular solution is. . . ." The result shown in equation 5.13 for the asymptotic form of the hypergeometric function came from somewhere: where?

Having disposed of this disquieting point, I suppose that it is best to proceed by comparing this book with those of Goldberger and Watson,[1] Wu and Ohmura,[2] and the recent one of Roger G. Newton.[3] The book can even be compared with the first edition of the book by N. F. Mott and H. S. W. Massey.[4] There is a great deal else available in book form, a

partial list of which is given in reference 5.

This book was a long time in the writing, as was Goldberger's and Watson's. Leonard S. Rodberg's and Roy M. Thaler's book was started and half finished quite a few years ago. Clear evidence of these facts is that the work of L. D. Faddeev is not mentioned in either book. Newton's book contains an account of Faddeev's work. Wu's and Ohmura's book predates Faddeev's work, of course. Rodberg's and Thaler's book contains nothing about dispersion relations, the Mandelstam representation, or Tullio Regge's work, even for nonrelativistic potential scattering. As one would expect from Goldberger's work, Goldberger's and Watson's book is quite strong on dispersion relations and the Mandelstam representation, but one can guess pretty well the period at which it was being written from the absence of material on Regge's work. Newton's book covers all areas. Wu and Ohmura cover dispersion relations and the Mandelstam representation, but predate Regge's work. Because of these omissions, Rodberg's and Thaler's book appears unsuited to students of particle and high-energy physics and best suited for nuclear physics.

Having formed the opinion that the book of Rodberg and Thaler does not compete with Newton's book or Goldberger's and Watson's book (Wu and Ohmura being somewhat out of date now), I asked Rodberg what his opinion is. He thinks that Newton's book is somewhat too mathematical. He also thinks that Goldberger's and Watson's is too difficult to read. He wants it said of his and Thaler's book that it is the most readable account of scattering theory available.

In defense of Rodberg's remarks I note the following. Newton's book starts with 120 pages on scattering of electromagnetic waves. I really admire his erudition, and I am very pleased to see the Hanbury Brown and Twiss effect discussed. Yet one might admit that if he were trying to teach scattering theory to graduate students he might find he had not the time to cover this material. Rodberg and Thaler get directly to the scattering problem of quantum mechanics, while Goldberger and Watson require 60 pages to come to the point after admirable reviews of quantum mechanics and symmetry operations in quantum mechanics. Newton devotes an additional 20 pages to particle scattering in classical mechanics, and suddenly arrives at time-dependent formal scattering theory. He is still 30 pages from time-independent formal scattering theory. Newton's presentation really is almost shockingly formal. Rodberg and Thaler and Goldberger and Watson base their formal theory on the wave-packet approach. Rodberg and Thaler have a nice chapter 2 on wave packets, but they do not really make much use of wave packets until chapter 6. I might have put chapter 2 just before chapter 6. Chapters 3 through 5 are rather like Mott and Massey, but with effective-range theory and more detail on noncentral forces. Having arrived at the subject, Goldberger and Watson in 140 pages fully develop formal scattering theory, and they do it very well. Even 40 pages earlier, the development is essentially complete. I do not agree with Rodberg that this is very difficult reading. The contrast with Rodberg and Thaler is that the effective-range theory, noncentral forces and so on are developed after the formal theory. Newton's arrangement is similar to Goldberger's and Watson's.

In many ways, as Rodberg would want, I prefer the subject arrangement of Rodberg and Thaler. I really do not understand why they put chapter 11 on spin and angular momentum so far to the rear of the book. Certainly this subject has nothing to do with formal scattering theory. I would have arranged their chapters 1, 3, 4, 5, 11, 2, 6, . . .

Spin-orientation phenomena, such as triple-scattering experiments and spin-correlation experiments, are of great importance in physics. Newton's book is very weak in this area; Goldberger and Watson are not better. Rodberg and Thaler have quite a bit of material on polarization and asymmetry, but fall short of discussing triple-scattering and spin-correlation experiments. Perhaps a reference to L. Wolfenstein's article in *Annual Reviews*[6] would help!

Finally, Rodberg's and Thaler's book, like Newton's, is free of figures showing differential cross sections! Goldberger and Watson mar their text in several places with differential cross sections. Even the 1933 edition of Mott and Massey is vastly superior to these recent texts in this respect.

My colleague Leon Heller suggested that I look more closely at the third edition (1965) of Mott and Massey:

One finds there excellent coverage of triple-scattering experiments and also Regge's work. The coverage of experimental data and detailed calculations for comparison with experiment is far superior to the coverage found in the other books referred to above. Not much use is made of formal scattering theory in the book, and the subject is hardly developed. I would like to see Mott's and Masey's derivation of the Faddeev equations for three-body scattering. I have always thought about the three-body problem along the lines set out by Mott and Masey in chapter 20, paragraph 7.1. Yet the Faddeev equations arise most naturally from formal scattering theory (see equations 178 on page 156 of Goldberger and Watson, from which equations arise the Faddeev equations).

* * *

J. L. Gammel collaborated with Roy Thaler in work on the nucleon–nucleon interaction resulting in the notorious Gammel–Thaler potential. He was at Los Alamos from 1950 to 1963, professor of physics at Texas A and M, 1963–67, and has now retired to Los Alamos. He has also collaborated with R. S. Christian, D. C. Dodder and Roy Thaler in work on spin-orientation phenomena in the few-nucleon problem. Lately he ran afoul of the Padé approximant, and this, fortunately, has nearly ended his scientific career.

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Social foundations

THE ORGANIZATION OF INQUIRY. By Gordon Tullock. 232 pp. Duke U. Press, Durham, N. C., 1966. $5.50

by Donald J. Montgomery

"Practical Suggestions" for improving the organization of science are offered in the final chapter of Gordon Tullock's analysis. This chapter is incisive and provocative, and many a physicist will come out fighting. For, though a physical scientist may find himself in agreement with the arguments on the impossibility of stopping scientific progress or on the undesirability of transferring resources from physical sciences to social studies, he is not so likely to embrace the implication that the scientist's pleading for additional funds is not much more than bureaucratic backscratching. Limitations of space preclude stating the details of the author's comments on the case for financial prizes and awards for scientific discovery, the role of teaching versus that of research in universities, desirability of restricting large organizations to cataloging knowledge and supporting only grandiose scientific projects, skepticism about the value of academic tenure, virtue of amateur science. Few readers will find themselves neutral on most of these items.

Most of the points raised by Tullock in this final chapter merit looking into, and certainly the physical scientist will be chastened upon gleaning some idea of how he is viewed by students from other fields. The stated theme of the book, however, is not so exciting. The description on the dust jacket asks