

HELP IN KEEPING UP WITH THEORETICAL PHYSICS

Analysis, Manifolds, and Physics.

Yvonne Choquet-Bruhat and
Cécile DeWitt-Morette

Part I: Basics

North Holland, New York, 1989 [1982]. Revised edition. 449 pp. \$40.00 hc ISBN 0-444-87071-7

Part II: 92 Applications

North Holland, New York, 1989. 630 pp. \$36.00 hc ISBN 0-444-86017-7

Reviewed by Arthur S. Wightman

You go to the local theoretical physics seminar in 1989 or 1990 and hear some young sprout talking about what is presumably elementary particle theory. The speaker takes for granted that every literate theoretical physicist knows the definition and main applications of the following notions: principal fiber bundle, connection, Chern class, Stiefel-Whitney class, Pontrjagin class, Sobolev space, spin bundle, almost complex structure, Kähler manifold, Calabi-Yau manifold and holonomy.

What do you do if you do not have a clue? You could take one-year courses in algebraic topology and differential geometry, or you could try to catch up with the help of a good book. There are really no other alternatives if you want to follow current theoretical particle physics. For better or for worse, it is being expressed in the same geometrical language that one hears spoken in current mathematics seminars.

In the reviewer's opinion, the two volumes under review constitute precisely what is needed to catch up. The authors' clear intention is to make the

books useful to those who want to pursue what they call physical mathematics. They have provided excellent indexes. (You will find entries for all the above listed notions.) The names of new concepts are printed in boldface when introduced and are also printed in the margin. Crucial developments are elaborated in the context of significant applications. There are worked problems. Pains have evidently been taken to make the exposition clear. The book is the kind of mixed reference work and textbook that is most useful to the independent reader.

For what audience is the book intended? Although I have emphasized above the book's usefulness for ignorant old folks, I think that advanced graduate students with some preparation could also handle it. The authors have provided in the first 111 pages of the first volume a review (mostly without proofs) of the fundamentals of analysis (set theory, algebraic structures, topology, integration and functional analysis) and differential calculus in Banach spaces (foundations, calculus of variations, implicit function theorem and differential equations). If the volumes were used as the basis of a one year course in physical mathematics, this review could be presented with class participation to get things started. Used in this way, the books could be the basis for a lovely course in physical mathematics.

Here is a brief indication of the remaining contents: In the first volume there are three chapters on various aspects of the geometry of finite-dimensional differentiable manifolds, including one chapter on integration on manifolds and another on Riemannian manifolds, Kähler manifolds and connections on a principal fiber bundle. In the last two chapters of volume one, the emphasis is on functional analysis: distribution theory; Sobolev spaces and partial differential equations; differentiable manifolds of infinite dimension; and

the Wiener integral.

The chapter headings in the second volume are the same as those in the first, but the contents of these chapters are applications or further elaborations of the corresponding chapters of the first volume. An exception is the additional material on infinite dimensional manifolds that is incorporated in the six chapters of volume two.

The authors' long experience in research on the general theory of relativity and quantum theory shows throughout in their sure judgment on the selection of examples. I will not attempt to classify the 92 applications of the second volume, not to speak of listing them. Suffice it to say that there are many choice plums in this pudding. Of course, the books cannot include every mathematical idea that currently is being explored in the world of theoretical physics. For example, these volumes contain no discussion of Teichmüller space, conformal equivalence classes of Riemann surfaces and related matters.

I think these books will, in the course of the 1990s, come to be regarded as classics.

Atomic Collisions: Electron and Photon Projectiles

Earl W. McDaniel

Wiley, New York, 1989. 699 pp. \$74.95 hc ISBN 0-471-85307

The field of atomic collisions touches and influences other fields of science and engineering to an extent perhaps unrivaled among the areas of modern physics. As a field that has been studied for more than 80 years, its venerability doesn't bespeak its vitality: technological advances, continued discoveries of new phenomena and demands from evolving related fields insure change and growth. Such a wide-ranging field needs to be "scoped out" periodically, to put new ideas

Arthur Wightman has been teaching and doing research in mathematical physics at Princeton University for 41 years.