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Book Review: *Functional Integration: Theory and Applications*

Functional Integration: Theory and Applications. Edited by J.-P. Antoine and E. Tirapegui. Plenum Press, New York, 1980, 355pp. $42.50.

Functional integration has become one of the essential mathematical tools used by theoretical physicists and chemists both for the conceptualization of problems and for computation. In the minds of many it is nevertheless surrounded with an aura of mystery. For many years the standard source for learning about this technique has been Feynman and Hibbs's *Quantum Mechanics and Path Integrals*. Nothing can surpass this text for the basic ideas, but there have been significant advances since its writing. Recently there have appeared several publications that survey these advances. The one of these that is reviewed here consists of the proceedings of a workshop held in Louvain-la-Neuve in 1979. Its title indicates that it deals both with the theory and applications of the functional integration technique. The emphasis of the proceedings is decidedly on the fundamental mathematical theory. In my opinion, this is unfortunate, because the present importance of functional integration derives from the wealth of newly developed practical approaches for evaluating and using functional integrals, all of which are closely tied to applications. I was sorry to see that there is little explicit discussion of the analogies between quantum field theory (particularly gauge theories) and classical statistical mechanics in the book. Therefore only passing mention is made of the powerful renormalization group ideas that have been so essential to utilizing the functional integration approach. There is no mention of any of the Monte Carlo methods for evaluation of functional integrals that have led to so much new information. Felicitously, however, some attention is paid to the use of semiclassical approaches (and solitons). An interesting article by Weiss and Häffner discusses the use of instantons for problems of diffusion in bistable potentials and Calvo discusses some aspects of the role of solitons in describing metastable phases. Yasue also discusses solitons from the viewpoint of optimal control theory. The few other applications-oriented articles deal with the polaron problem.

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Within the context of the formal rather than practical aspects of functional integration the book does contain some nice articles. One laudable aspect not offered by other books is that there are several articles on the use of functional integration ideas for nonequilibrium statistical mechanical problems. I wished, however, that the authors had not merely shown how to reformulate these problems but had also shown how this reformulation is computationally valuable.

There are also several articles showing how path integrals can be used to quantize systems for which the natural variables used are not suitable for canonical quantization. In the most enjoyable of this genre, Klauder discusses a simple model of quantum gravity. In this case an inequality constraining the classical variables makes the usual quantization problematic.

Many of the formal articles concern themselves with a variety of ways of defining functional integrals in a strict and rigorous manner. The practicing theoretician is reassured but not surprised that for most problems the rough-and-ready methods used in the past give the same results. One of the areas for which the appropriate definition *has* been controversial (and important) is for the case of functional integrals in curved spaces. The articles on this problem make interesting but dense reading.

In summary, this book has a few things to offer to the specialist who already appreciates and uses functional integration routinely, but because of its formal emphasis and mathematical style I cannot recommend it to persons who want to find out the basic ideas or who want to find out why functional integration is, at the moment, such an exciting mathematical method.

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