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Book Review: *Path Integrals in Physics*

Path Integrals in Physics, Vol. I: Stochastic Processes and Quantum Mechanics (336 p.), Vol. II: Quantum Field Theory, Statistical Physics and other Modern Applications (345 p.). M. Chaichian and A. Demichev, Institute of Physics Publishing Ltd 2001, Bristol and Philadelphia.

The authors are perhaps best known for their book on quantum groups[1] published by World Scientific in 1996. Now (2001), they pay tribute to one of the most ingenious and revolutionary ideas of Feynman, formulated 60 years ago, which later, after intensive studies in the 50s and 60s, provided a unified approach to many branches of theoretical physics. The key purpose of the present book is stated as to "present and explain the concept of the path integral," but "not pursue the history of the subject past the 1970s, even briefly." The implied limitation is clearly evidenced by the bibliography at the end of each volume and may come as a surprise to those who expect an up-to-date presentation of the subject.

As stated by the authors, the text is targeted at physics students with some basic knowledge in quantum mechanics (first volume) and field theory (second volume). More educated users and experts are guided to their preferred topic in advanced areas, be it in quantum or statistical physics. Both the contents and the style of the books fit this plan very well. The readership is even free to pick up any one of the four chapters for a separate study: 1. Path integrals in classical theory; 2. Path integrals in quantum mechanics; 3. Quantum field theory: The path-integral approach; 4. Path integrals in statistical physics. Contrary to most texts on the subject (Schulman,[2] Dittrich and Reuter,[3] and Kleinert,[4] to mention just a few), the present monograph introduces the path integral concept in a deductive way, starting from random walk, then passing on to Brownian motion and the infinite-dimensional Wiener integral. It thereby puts the theory into the context of stochastic processes, which is one of the most gratifying features of this book since it opens the way to a sound mathematical treatment, though mathematical rigor is not the main goal of this book. Instead, its

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user-friendly character is achieved by a carefully selected set of problems and applications.

Yet no attempt is made to define path integrals outside the domain of discrete approximations, i.e., the time-slicing procedure. The complete absence of such attempts, though existing in the literature, constitutes one of the weaker parts of this compendium. Admittedly, it is impossible to construct a measure for path integrals of the Feynman type (though possible for those of the Wiener–Kac type). On the positive side, the book covers a number of topics essential for practical purposes: Path integrals in polar coordinates, in phase space, even on group manifolds, the use of coherent states, and Berezin integrals using Grassmann variables in order to extend the formalism to the fermionic world. Then there come the first milestones of modern field theory: Yang–Mills theories, $1/N$ expansions, spontaneous breakdown of gauge symmetries, BRST symmetry and anomalies as interpreted by Fujikawa.[5] Last but not least, solitons, instantons and the polaron are encountered, and some emphasis is given to the problem of implementing the statistics (Bose, Fermi, Parastatistics) in few-body problems. Not surprisingly, the methods of path integration work equally well in thermal field theory, a subject developed by Matsubara[6] in 1955. To summarize, the text is very well written, very well targeted, focusses (with few exceptions) on the right points, and thus provides a valuable introduction suggesting further reading.

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