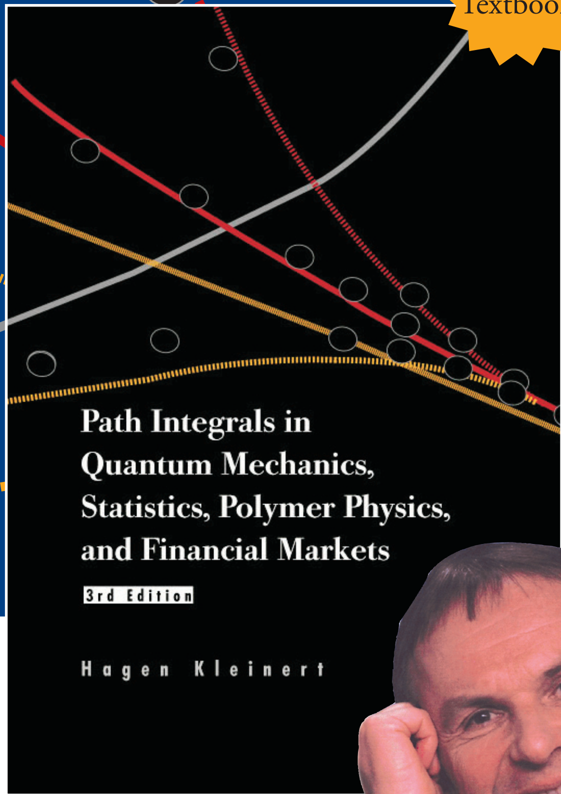
PATH INTEGRALS IN QUANTUM MECHANICS, STATISTICS, POLYMER PHYSICS, AND FINANCIAL MARKETS

3rd Edition

by **Hagen Kleinert** *(Freie Universität Berlin, Germany)*

New Textbook



> *Kleinert's book presents the reader with a very complete and very thorough discussion of path integration ... a new extensive and, again, rather complete chapter has been added on the use of path integration techniques in the analysis of financial markets. This chapter would do well in any high-level course on stochastic financial models and is a wonderful occasion for candidate mathematical and theoretical physicists to realize what great potential there hides still in the methodologies and techniques that have been developed ... It profits from the clarity and conciseness that is also a hallmark of Kleinert's scientific papers ... this volume is highly recommendable for any student considering majoring in theoretical physics or chemistry, and an absolute must for any lecturer in this area ... In fact, I don't know of any excuse not to have your own copy.*
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> Journal of Statistical Physics

This is the third, significantly expanded edition of the comprehensive textbook published in 1990 on the theory and applications of path integrals. It is the first book to explicitly solve path integrals of a wide variety of nontrivial quantum-mechanical systems, in particular the hydrogen atom. The solutions have become possible by two major advances. The first is a new euclidean path integral formula which increases the restricted range of applicability of Feynman's famous formula to include singular attractive $1/r$ and $1/r^2$ potentials. The second is a simple quantum equivalence principle governing the transformation of euclidean path integrals to spaces with curvature and torsion, which leads to time-sliced path integrals that are manifestly invariant under coordinate transformations.

In addition to the time-sliced definition, the author gives a perturbative definition of path integrals which makes them invariant under coordinate transformations. A consistent implementation of this property leads to an extension of the theory of generalized functions by defining uniquely integrals over products of distributions.

The powerful Feynman–Kleinert variational approach is explained and developed systematically into a variational perturbation theory which, in contrast to ordinary perturbation theory, produces convergent expansions. The convergence is uniform from weak to strong couplings, opening a way to precise approximate evaluations of analytically unsolvable path integrals.

Tunneling processes are treated in detail. The results are used to determine the lifetime of supercurrents, the stability of metastable thermodynamic phases, and the large-order behavior of perturbation expansions. A new variational treatment extends the range of validity of previous tunneling theories from large to small barriers. A corresponding extension of large-order perturbation theory also applies now to small orders.

Special attention is devoted to path integrals with topological restrictions. These are relevant to the understanding of the statistical properties of elementary particles and the entanglement phenomena in polymer physics and biophysics. The Chern–Simons theory of particles with fractional statistics (anyons) is introduced and applied to explain the fractional quantum Hall effect.

The relevance of path integrals to financial markets is discussed, and improvements of the famous Black–Scholes formula for option prices are given which account for the fact that large market fluctuations occur much more frequently than in the commonly used Gaussian distributions.

Readership: Students and researchers in theoretical physics.

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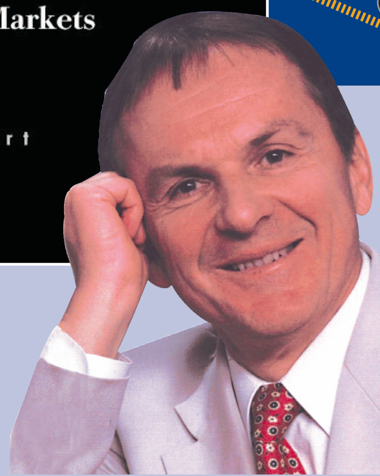

About the Author

Hagen Kleinert is Professor of Physics at the Freie Universitat Berlin, Germany. As a visiting scientist, he has spent extended periods of time at CERN, the European Organization for Nuclear Research in Geneva; at the California Institute of Technology in Pasadena; at the Universities of California in Berkeley, Santa Barbara, and San Diego; at the Los Alamos National Laboratories in New Mexico; and at Princeton University, New Jersey. He has made numerous contributions to our understanding of particle physics, mathematical physics, condensed matter physics, chemical physics, and nuclear physics. His two-volume book Gauge Fields in Condensed Matter, published by World Scientific, develops a new quantum field-theory of phase transitions on the basis of disorder fields. Such fields have since become a powerful tool to investigate the statistical properties of fluctuating line-like excitations in various many-body systems such as superfluids, superconductors, and crystals.

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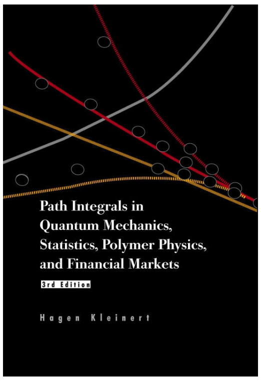

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