Preface to the Fifth Edition

Since the previous fourth edition has received quite a positive response from students as well as teachers, we have decided to extend the contents and improve some chapters for pedagogical reasons. In particular, we have rewritten Chap. 33, which is now entitled, “Classical Geometric Phases: Foucault and Euler.” However, most importantly, we have added a new chapter, Chap. 38: “The Usefulness of Lie Brackets: From Classical and Quantum Mechanics to Quantum Electrodynamics.” We emphasize the usefulness of the Lie brackets in classical and quantum mechanics up to quantum electrodynamics. Especially many dynamical systems with (gauge) constraints can equally be treated in the time development with noncanonical variables and Hamiltonians. This is convincingly demonstrated for the electron propagation function in a constant magnetic field in three and four dimensions. We also have attempted to remove the inevitable typos from the text and formulas.

Tübingen, Germany            Walter Dittrich
Mainz, Germany              Martin Reuter
April 2017
Preface to the Fourth Edition

During the past two decades, our monograph has served as an invaluable pedagogical source for students and teachers alike, who have used it to become more familiar with classical and quantum dynamics using path integrals, Schwinger’s quantum action principle, functional methods, Berry’s phase and Chern–Simons mechanics, to mention just a few topics. In addition to correcting some minor typos in the previous edition, we have added two more topics, namely a detailed study of quantum electrodynamics using path integrals and an introduction to the Schwinger–Fock proper time method to work out in all details the effective action of an electron in a harmonic classical electric field.

Tübingen, Germany
Mainz, Germany
February 2015

Walter Dittrich
Martin Reuter
Preface to the Third Edition

In this third edition, the major purposes and emphasis are still the same, but there are extensive additions. These consist mainly in the chapter on the action principle in classical electrodynamics and the functional derivative approach, which is set side by side to the path integral formulation. A further major augmentation is a chapter on computing traces in the context of the WKB-propagator. Finally, we have corrected some (not only typographical) errors of the previous editions.

Tübingen, Germany
Mainz, Germany
February 2001
Preface to the Second Edition

In this second enlarged edition we have supplemented the chapters on geometric phases. We have also added a new chapter on anyon physics in planar electrodynamics. Finally we have corrected some minor typographical errors. One of us (W.D.) wants to thank the “Volkswagen-Stiftung” for its generous financial support during his Sabbatical in the U.S., where the present improved version took shape.

Tübingen and Hamburg
October 1993

Walter Dittrich
Martin Reuter
Preface to the First Edition

This volume is the result of the authors’ lectures and seminars given at Tübingen University and elsewhere. It represents a summary of our learning process in nonlinear Hamiltonian dynamics and path integral methods in nonrelativistic quantum mechanics. While large parts of the book are based on standard material, readers will find numerous worked examples which can rarely be found in the published literature. In fact, toward the end they will find themselves in the midst of modern topological methods which so far have not made their way into the textbook literature.

One of the authors’ (W.D.) interest in the subject was inspired by Prof. D. Judd (UC Berkeley), whose lectures on nonlinear dynamics familiarized him with Lichtenberg and Lieberman’s monograph, *Regular and Stochastic Motion* (Springer, 1983). For people working in plasma or accelerator physics, the chapter on nonlinear physics should contain some familiar material. Another influential author has been Prof. J. Schwinger (UCLA); the knowledgeable reader will not be surprised to discover our appreciation of Schwinger’s Action Principle in the introductory chapters. However, the major portion of the book is based on Feynman’s path integral approach, which seems to be the proper language for handling topological aspects in quantum physics.

Our thanks go to Ginny Dittrich for masterly transforming a long and complex manuscript into a readable monograph.

Tübingen, Germany                        Walter Dittrich
Hannover, Germany                        Martin Reuter
January 1992
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