Preface

This book is aimed primarily at theoretical physicists as well as graduate students working in quantum field theory, quantum gravity, gauge theories, and, to some extent, general relativity and cosmology. Although it is not aimed at a mathematically rigorous level, I hope that it may also be of interest to mathematical physicists and mathematicians working in spectral geometry, spectral asymptotics of differential operators, analysis on manifolds, differential geometry and mathematical methods in quantum theory. This book will certainly be considered too abstract by some physicists, but not detailed and complete enough by most mathematicians. This means, in particular, that the material is presented at the "physical" level of rigor. So, there are no lemmas, theorems and proofs and long technical calculations are omitted. Instead, I tried to give a detailed presentation of the basic ideas, methods and results. Also, I tried to make the exposition as explicit and complete as possible, the language less abstract and have illustrated the methods and results with some examples. As is well known, "one cannot cover everything", especially in an introductory text. The approach presented in this book goes along the lines (and is a further development) of the so-called background field method of De Witt. As a consequence, I have not dealt at all with manifolds with boundary, non-Laplace type (or nonminimal) operators, Riemann–Cartan manifolds as well as with many recent developments and more advanced topics, such as Ashtekar's approach, supergravity, strings, membranes, matrix models, M-theory etc. The interested reader is referred to the corresponding literature.

These lecture notes are based on my Ph.D. thesis at Moscow State University. Although most of the results presented here were published in a series of papers, this book allows for the much more detail and is easier to read. It can be used as a pedagogical introduction to quantum field theory and quantum gravity for graduate students with some basic knowledge of quantum field theory and general relativity. Based on this material, I gave a series of lectures for graduate students at the University of Naples during the fall semester of the 1995.

It should be noted that no attempts have been made to make the book completely self–consistent nor to give a fully comprehensive list of references. The bibliography reflects more or less adequately the situation of the late

1980s, when my original Ph.D. thesis was written. A complete update of the bibliography was obviously beyond my scope and capabilities. Nevertheless, I updated some old references and added some new ones that are intimately connected to the material of this book. I apologize in advance for not quoting the work of many authors who made significant contributions in the subject over the last decade. Besides, I believe that in an introductory text such as this a comprehensive bibliography is not as important as in a research monograph or a thorough survey.

I would like to express my sincere appreciation to many friends and colleagues who contributed in various ways to this book. First of all, I am especially indebted to Andrei O. Barvinsky, Vladislav R. Khalilov, Grigori M. Vereshkov and Grigori A. Vilkovisky who inspired my interest in quantum field theory and quantum gravity and from whom I learned most of the material of this book. I also have learned a great deal from the pioneering works of V.A. Fock, J. Schwinger and B.S. De Witt, as well as from more recent papers of T. Branson, S.M. Christensen, J.S. Dowker, M.J. Duff, E.S. Fradkin, S. Fulling, P.B. Gilkey, S. Hawking, H. Osborn, T. Osborn, L. Parker and A. Tseytlin among others. It was also a great pleasure to collaborate with Andrei Barvinsky, Thomas Branson, Giampiero Esposito and Rainer Schimming.

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