Preface

He reached a much higher plane of creativity when he blacked out everything but *a*, *an* and *the*. That erected more dynamic intralinear tensions.

J. Heller, *Catch-22*

This textbook is based on lecture courses originally given at:

(1) Autonoma University of Madrid, Winter Semester of 1993;
(2) Leipzig University, Winter Semester of 1995;
(3) Moscow Physical and Technical Institute, Spring Semester of 1995;

and then repeated with some modifications at several Universities, Schools of Physics, etc.

My intention in these courses was to introduce graduate students to selected nonperturbative methods of contemporary gauge theory. The term "nonperturbative" means literally "beyond the scope of perturbation theory". Therefore, it is assumed that the reader is familiar with quantum mechanics as well as with the standard methods of perturbative expansion in quantum field theory and, in particular, with the theory of renormalization.

Another purpose was to make the courses useful for more experienced researchers (including those working in condensed-matter theory), as a survey of ideas, terminology and methods, which have been developed in Gauge Theory since the beginning of the 1970s. For this reason, these notes do not go into great detail, and so some subjects are only touched upon briefly. Correspondingly, the subjects which are usually covered by modern courses in string theory, such as two-dimensional conformal field theories, are not examined. It is assumed that such a course will follow this one.

The main body of the book deals with lattice gauge theories, large-N methods, and reduced models. These three parts are preceded by Part 1, which is devoted to the method of path integrals. The path-integral approach is loosely used in quantum field theory and statistical mechanics. In Part 1, I shall pay most attention to aspects of the path integrals, which are then used in the next three parts.

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At the beginning of each part, I try to stay as close to the original papers, where the methods were first proposed, as possible. The list of these papers includes:

1. FEYNMAN R.P. 'An operator calculus having applications in quantum electrodynamics'. *Phys. Rev.* **84** (1951) 108.
2. WILSON K.G. 'Confinement of quarks'. *Phys. Rev.* **D10** (1974) 2445.
3. 'T HOOFT G. 'A planar diagram theory for strong interactions'. *Nucl. Phys.* **B72** (1974) 461.
4. EGUCHI T. AND KAWAI H. 'Reduction of dynamical degrees of freedom in the large-N gauge theory'. *Phys. Rev. Lett.* **48** (1982) 1063.

The lectures were followed by seminars where some more involved problems were solved on a blackboard. They are inserted in the text as problems, which may be omitted at first reading. Some more information is also added as remarks after the main text. Both of them contain some relevant references.

The references, which are collected at the end of each part of the book, are usually given only to either a first paper (or papers) in a series or those containing a pedagogic presentation of the material. With the modern electronic database at `http://www.slac.stanford.edu/spires/hep` (SLAC), a list of subsequent papers can, in most cases, be retrieved by downloading citations of the first paper.

The selection of the material for this book is, as usual, personal and dictated by the author's research activity in the area of quantum field theory over the last almost 30 years. In fact, many important developments, in particular, in supersymmetric gauge theories are not included.

I would like to thank my students for their attention, patience, and questions. I am grateful to Martin Gürtler for his help in preparing the lecture notes. I am also indebted to my colleagues – too numerous to be listed personally – for their invaluable comments, suggestions, and encouragement.

Y.M.