QUARKS, BARYONS AND CHIRAL SYMMETRY

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Preface

When the editor of the World Scientific offered us an opportunity to expand our previous review article on the chiral bag model [Hosaka and Toki 1996] into the form of a book, we thought that the topic was rather specific and wondered if it worth doing. However, while we were collecting series of works, we realized that the chiral bag model seems to contain many interesting physics which are quite common in various physical systems. Furthermore, the physics of baryons is now regarded as one of exciting subjects, where many new developments are being made both in theories and experiments.

We know that a number of excellent articles have already appeared dealing with topics related to baryon physics. They are the ones, for instance, by Kokkedee [1969], by Close [1979], by Thomas [1984], by Bhaduri [1988], and by Donoghue, Golowich and Holstine [1992]. While thinking about the structure of our book we have noticed that many of our colleagues, including ourselves often ask naive but very important questions related mostly to chiral symmetry. For instance; Why the axial-vector coupling constant of the nucleon is so close to unity? Why the chiral field can be expressed in the matrix form of U ? What is the chiral partner of the nucleon? It is not difficult to see that these questions confuse us.

Therefore, we thought that we would like to produce a volume which will help answer such questions. Also we would like to write one useful, not only to graduate course students, but also to ourselves. In order to accommodate these requirements, we have decided to discuss materials exclusively related to baryon physics from quarks and chiral symmetry. But, for selected topics, we have tried to describe all the details starting from very fundamental

issues.

Readers should have knowledge of quantum mechanics, and some basics of the field theory and the many-body problem. We do not assume that the readers have achieved complete understanding of the latter advanced subjects. But they should have some experiences with standard textbook materials.

For the discussion of baryon structure, the group theoretical method is particularly important. The reason is that many features of the strong interaction physics result from symmetries such as isospin, flavor and chiral symmetries. Another issue is the semiclassical nature of strongly and non-linearly interacting systems of quarks and pions. These two issues form the main body of this volume. The first four chapters describe introductory and elementary topics, while the latter chapters are rather devoted to applications. But, whenever a new topic is introduced the discussion starts with necessary fundamentals. We have also included problems in the end of the chapters, where readers can learn the derivations, details and related topics not sufficiently discussed in the text.

In this book we decided not to discuss the dynamics of color confinement explicitly. This is also a very exciting subject in hadron physics and a lot of new progress has been achieved lately. Still the concept of confinement is not so simple. Also, we did not discuss related subjects such as dynamical symmetry breaking, chiral anomaly, chiral perturbation theories and etc.

In editing this book, we were helped by Miho Takayama in many ways. Especially, we thank her for creating tables for quark model wave functions, baryon mass plots and baryon tables in chapters 3 and 8. We would like also to express our thanks to Veljko Dmitrasinovic who read through the manuscript and gave us useful suggestions. AH would like to thank the colleagues from Numazu College of Technology, where he worked out most of his part. Finally, we can not forget acknowledging all of our colleagues whom we list in the bibliography. Without their help this book would not have appeared.

January 2001

Numazu
Osaka

Atsushi Hosaka
Hiroshi Toki

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