Preface

In recent years, the study of strong interaction physics within the framework of Quantum Chromodynamics (QCD) has largely been restricted to processes which involve a single hard scale (of the order of the centre-of-mass energy). There is a whole wealth of strong interaction physics which is ignored in such a study, including the connection between QCD and Regge theory, which was successfully used to describe certain aspects of the strong interactions before the advent of QCD.

The connection between QCD and Regge theory has attracted much attention in the theoretical community for many years now. Indeed the BFKL equation, which describes what we shall refer to as the perturbative Pomeron, has been known for nearly twenty years. Only recently with the arrival of the HERA and Tevatron colliders has it been possible to perform experiments in the kinematic regime relevant to the perturbative Pomeron. Structure functions at low values of Bjorken x and the observation of rapidity gaps are examples of phenomena which can be used to test the perturbative Pomeron.

The work of those many authors who have contributed to the understanding of the Pomeron in QCD is indeed very formidable. However, to our knowledge, no single self-contained compendium of such work exists. Furthermore many of the papers which have been published on this subject have not been written in a particularly pedagogical style and are therefore not easily understood by a pedestrian reader who wishes learn about the perturbative Pomeron.

In view of the high profile which the Pomeron is now receiving, this lecture note volume is designed to explain the derivation and applications of the perturbative Pomeron from first principles. It is aimed at the level of graduate students who have completed a

course in quantum field theory. Certain techniques which may not be included in such a course are briefly reviewed, often in appendices in order not to interrupt the flow of the text. It is, of course, also hoped that more senior physicists who wish to become familiar with the perturbative Pomeron will find this volume useful.

Almost all of the material in this volume is the work of other authors and only rarely have we alluded to our own modest contributions to this subject. References have been given to papers which are specifically relevant to topics covered in the text and these are by no means intended to form a complete bibliography of the vast number of papers that have been published in this field.

We begin with a review of the Pomeron in the old Regge theory, largely for the benefit of the, by now, majority of physicists who are too young to have met such material in graduate school (this includes one but not both of the authors). We then present a toy model example which introduces the reader to the techniques that are used to derive the perturbative Pomeron in QCD. One of the essential ingredients in the BFKL approach to the perturbative Pomeron is the concept of the reggeized gluon. The demonstration that the gluon does reggeize is given in Chapter 3. It is a necessarily involved demonstration. The reader who is prepared to take the result on trust may wish to skip from section 3.2 to the end of the chapter and proceed to Chapter 4, where the BFKL equation is derived. In Chapters 6 and 7 we discuss applications of the perturbative Pomeron to processes which are currently under experimental observation at the HERA and Tevatron colliders. We end the volume with a discussion of recent progress that has been made on the restoration of unitarity at very high energy.

This book has its own page on the World Wide Web at the URL "http : //h2.ph.man.ac.uk/~forshaw/book.html". The page includes a list of misprints and corrections and we would appreciate communications reporting additional errors.

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