

Preface to Second Edition

The second edition of this book has improved in two main ways. Firstly, a few minor typos which plagued the first edition have been corrected. Secondly, and most notably, an extra chapter at the end has been added with detailed solutions to all exercises that appear in the main part of the text. These exercises are meant both to fill in some gaps in the main text, and also to provide the student reader with the rudimentary computational skills required in the field. The inclusion of this extra chapter of solutions should help make this second edition more complete and self-contained. It was decided to keep the overall style of the rest of the book intact, and hence the remaining chapters still serve as a brief, concise and quick introduction into the basic aspects of string theory and D-brane physics.

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These notes comprise an expanded version of the string theory lectures given by the author at the 31st and 32nd British Universities Summer Schools on Theoretical Elementary Particle Physics (BUSSTEPP) which were held, respectively, in Manchester, England in 2001 and in Glasgow, Scotland in 2002, and also at the Pacific Institute for the Mathematical Sciences *Frontiers of Mathematical Physics* Summer School on “Strings, Gravity and Cosmology” which was held in Vancouver, Canada in 2003. The schools were attended mostly by Ph.D. students in theoretical high-energy physics who had just completed their first year of graduate studies. The lectures were thereby appropriately geared for this level. No prior knowledge of string theory was assumed, but a good background in quantum field theory, introductory level particle physics and group theory was expected. An acquaintance with the basic ideas of general relativity was helpful but not absolutely essential. Some familiarity with supersymmetry was also assumed because the supersymmetry lectures preceded the string theory lectures at the schools, although the full-blown machinery and techniques of supersymmetry were not exploited to any large extent.

The main references for string theory used during the courses were the standard books on the subject [Green, Schwarz and Witten (1987); Polchinski (1998)] and the more recent review article [Johnson (2001)]. The prerequisite supersymmetry lectures can be found in [Figueroa-O’Farrill (2001)]. Further references are cited in the text, but are mostly included for historical reasons and are by no means exhaustive. Complete sets of references may be found in the various cited books and review articles.

The lectures were delivered in the morning and exercises were assigned. These problems are also included in these notes. Many of them are intended to fill in the technical gaps which due to time constraints were not covered in

the lectures. Others are intended to give the student a better grasp of some “stringy” topics. This book has expanded on many aspects of string theory that were addressed during the schools, mainly to make the presentation clearer.

There were six one-hour lectures in total. Since string theory is nowadays such a vast and extensive subject, some focus on the subject material was of course required. The lectures differ perhaps from most introductory approaches since the intent was to provide the student not only with the rudiments of perturbative string theory, but also with an introduction to the more recently discovered non-perturbative degrees of freedom known as “D-branes”, which in the past few years have revolutionalized the thinking about string theory and have brought the subject to the forefront of modern theoretical particle physics once again. This means that much of the standard introductory presentation was streamlined in order to allow for an introduction to these more current developments. The hope was that the student will have been provided with enough background to feel comfortable in starting to read current research articles, in addition to being exposed to some of the standard computational techniques in the field.

The basic perturbative material was covered in roughly the first three lectures and comprises chapters 1–4. Lecture 4 (chapter 5) then started to rapidly move towards explaining what D-branes are, and at the same time introducing some more novel stringy physics. Lectures 5 and 6 (chapters 6 and 7) then dealt with D-branes in detail, studied their dynamics, and provided a brief account of the gauge theory/string theory correspondence which has been such an active area of research over the past few years. For completeness, an extra chapter has also been added (chapter 8) which deals with the Ramond–Ramond couplings of D-branes and other novel aspects of D-brane dynamics such as the important “branes within branes” phenomenon. This final chapter is somewhat more advanced and is geared at the reader with some familiarity in differential topology and geometry.

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