

# Preface

This book describes “real-world” applications of the AdS/CFT duality for beginning graduate students in particle physics and for researchers in the other fields.

The AdS/CFT duality is a powerful tool for analyzing strongly coupled gauge theories using classical gravitational theories. The duality originated from string theory, so it has been actively investigated in particle physics. In recent years, however, the duality has been discussed beyond theoretical particle physics. In fact, the original AdS/CFT paper by Maldacena has been cited in all physics arXivs. This is because the duality is becoming a powerful tool to analyze the “real world.” For example, it turns out that one prediction of AdS/CFT is indeed close to the experimental results of the real quark–gluon plasma. Since then, the duality has been applied to various fields of physics; examples are QCD, nuclear physics, nonequilibrium physics, and condensed matter physics.

In order to carry out such researches, one has to know many materials such as string theory, general relativity, nuclear physics, nonequilibrium physics, and condensed matter physics. The aim of this book is to provide these background materials as well as some key applications of the AdS/CFT duality in a single volume. The emphasis throughout the book is on a pedagogical and intuitive approach focusing on the underlying physical concepts. Yet it also includes step-by-step computations for important results which are useful for beginners. Most of them are contained in the appendices.

Following conventions of many textbooks, I often do not refer to original research papers and refer only to the other textbooks and reviews that may be more useful to readers. Also, the choice of references reflects my knowledge, and I apologize in advance for possible omissions.

Initially, this project was begun for a book that was published in Japanese (Saiensu-sha Co., Ltd, 2012), and this is the “translated” one. But I used this opportunity to improve many explanations and to add more materials to the Japanese edition. So, this book is the “second edition” in this sense.

I would like to thank many people who helped me with this book. This book is based on review talks at various conferences and on courses I taught at various

graduate schools (Tohoku University, Ochanomizu University, Graduate University of Advanced Studies, and Rikkyo University). I thank the organizers and the participants of the conferences and the courses. I also like to thank Elena Cáceres, Koji Hashimoto, Tetsuo Hatsuda, Gary Horowitz, and Joe Polchinski for encouraging me to write this English edition. I also thank Tetsufumi Hirano, Akihiro Ishibashi, and Takeshi Morita for useful comments and discussion. I especially would like to thank Takashi Okamura who clarified my understanding of the subjects in this book through collaboration for many years. He also gave many suggestions for improvement. I thank my editor Hisako Niko at Springer Japan and the staff of the Lecture Notes in Physics. Of course, the responsibility for any remaining mistake is solely mine. I will be happy to receive comments on this book. Please send them to [makoto.natsuume@icloud.com](mailto:makoto.natsuume@icloud.com).

An updated list of corrections will be posted on my website. The tentative address is <http://research.kek.jp/people/natsuume/ads-real-world.html>. Even if the address changes in future, you can probably easily search the website because my family name is rather rare.

I hope that this book will help readers to explore new applications of the AdS/CFT duality.

AdS/CFT Duality User Guide

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