

Introduction to Gauge/Gravity Duality

Johanna Erdmenger

Contents

1	Introduction	3
2	Basics	3
2.1	Conformal symmetry	3
2.2	Non-abelian gauge theories	3
2.3	Large N limit and planar diagrams	3
2.4	Anti-de Sitter spacetime	3
3	A summary of string theory statements	3
3.1	Open and closed strings	3
3.2	Strings in background fields	3
3.3	Superstring Theory: Type IIB string theory and supergravity . . .	3
3.4	D-Branes	3
3.5	Four- and Five-dimensional toy models for IIB supergravity . . .	3
4	The AdS/CFT correspondence	3
4.1	Statement of the correspondence	3
4.2	Near-horizon limit of D3 branes	3
4.3	Field-operator correspondence	3
4.4	Supergravity action as generating functional for correlation functions	3
4.5	Holographic Principle	3
5	Tests of the correspondence	3
5.1	Correlation functions	3
5.2	Conformal Anomaly	3
6	Extension to Non-conformal theories	3
6.1	Holographic renormalization group flows	3
6.2	Holographic C-Theorem	3
7	Applications I: Thermo- and Hydrodynamics	3
7.1	Quark-gluon plasma	3
7.2	Quantum field theory at finite temperature and density	3
7.3	Black Holes	3
7.4	Thermodynamics using gauge/gravity duality	3
7.5	Hydrodynamics: Kubo formula, transport coefficients	3
7.6	Shear viscosity from gauge/gravity duality	3

8	Applications II: Adding flavour degrees of freedom	3
8.1	Probe branes	3
8.2	AdS/CFT with flavour: Example of D3/D7 configuration	3
8.3	D7 branes embedded in black hole geometry	3
8.4	Chiral symmetry breaking in gauge/gravity duality	3
8.5	Outlook: Applications in Condensed Matter Physics	3

1 Introduction

2 Basics

2.1 Conformal symmetry

2.2 Non-abelian gauge theories

2.3 Large N limit and planar diagrams

2.4 Anti-de Sitter spacetime

3 A summary of string theory statements

3.1 Open and closed strings

3.2 Strings in background fields

3.3 Superstring Theory: Type IIB string theory and supergravity

3.4 D-Branes

3.5 Four- and Five-dimensional toy models for IIB supergravity

4 The AdS/CFT correspondence

4.1 Statement of the correspondence

4.2 Near-horizon limit of D3 branes

4.3 Field-operator correspondence

4.4 Supergravity action as generating functional for correlation functions

4.5 Holographic Principle

5 Tests of the correspondence

5.1 Correlation functions

5.2 Conformal Anomaly

6 Extension to Non-conformal theories

6.1 Holographic renormalization group flows