

# Curso del Posgrado en Ciencias Físicas 2024-2

## CORRESPONDENCIA HOLOGRÁFICA

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Clases: Lunes y Miércoles 16:00-18:00 (empezando 16:10 en punto),

Salón de Seminarios de Gravitación y Altas Energías (A225)

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La correspondencia holográfica es una muy sorprendente equivalencia entre teorías cuánticas de campos (sin gravedad) y teorías de gravedad cuántica (prominentemente, teorías de cuerdas). Además de lo revolucionario que resulta desde el punto de vista conceptual el mero hecho de su existencia, esta correspondencia se ha establecido ya como una herramienta muy útil para entender el comportamiento de algunas teorías de campos en el régimen de acoplamiento fuerte, y ofrece una perspectiva novedosa sobre los aspectos problemáticos de la gravedad cuántica. Se trata de un tema extremadamente amplio (el artículo original de Maldacena, hep-th/9711200, ha recibido ya más de 19,300 citas, ¡que equivalen a un promedio de 3 por día hábil durante 26 años!), así que solo intentaremos dar un panorama de algunas de las ideas principales.

### Temario *Preliminar*

- 0. Motivación y Antecedentes:** ¿Qué es la correspondencia norma-gravedad? Teorías de Campo. Acoplamiento Débil y Fuerte. QED. QCD. Primas de QCD, N grande y MSYM. Gravedad Cuántica. Holografía.
- 1. Deducción de la Correspondencia:** Breve repaso de cuerdas, branas negras y D-branas. Deducción de AdS<sub>5</sub>/CFT<sub>4</sub> a partir de D3-branas.
- 2. Evidencias y Diccionario:** Espacio anti-de Sitter. Mapeo de coordenadas y simetrías. Conexión UV/IR. Operadores locales. Teoría de campo conforme. Funciones de correlación. Modos normalizables y no normalizables. BMN y estados cuánticos con números grandes. Quarks. Lazos de Wilson y potencial quark-antiquark. El grupo de renormalización holográfico.
- 3. AdS/CFT a Temperatura Finita:** Schwarzschild-anti de Sitter. Aplicaciones al plasma de quarks y gluones. Bekenstein-Hawking y la entropía. Schwinger-Keldysh, Kubo y la viscosidad. Correspondencia fluidos/gravedad.
- 4. Entropía de entrelazamiento.** Entropía de entrelazamiento. Entrelazamiento en teorías de campos y el truco de réplica. Fórmula de Ryu-Takayanagi. Entropía diferencial y geometría integral. Diccionario invariante bajo difeos.
- 5. Generalizaciones (si el tiempo lo permite).** MSYM en otras geometrías. Otras CFTs a partir de D3s en otros fondos, u otro tipo de branas. No-AdS/ No-CFT: Dp-branas, deformaciones. Sakai-Sugimoto(-Witten). Modelos "de abajo para arriba". Algunas aplicaciones a materia condensada. Teorías de Alto Espín.

### Información Importante

Las notas del curso (que ocasionalmente iré actualizando) están en la página

<https://nucleares.unam.mx/~alberto/apuntes/indice.html#posholografia>

Para ahorrar tiempo, el curso lo daré proyectando las notas, así que les resultará conveniente si acaso pueden tener una versión impresa o electrónica para ir haciendo anotaciones sobre ella (pues les será muy difícil tomar apuntes). Este formato tiene sus ventajas (principalmente, que podemos irnos más rápido), pero tengan presente que tiene también desventajas (principalmente, ¡que corremos el riesgo de irnos *demasiado* rápido!). Puede ser muy engañoso: a menos que en verdad hagan un esfuerzo por seguir en detalle lo que voy explicando e irme deteniendo con preguntas, van a tener la placentera ilusión de que todo es muy claro cuando expongo las ideas en la pantalla, pero no van a asimilar gran cosa. Por favor convénzanse entonces desde ahora de que el que aprendan depende principalmente no de mí sino de ustedes: **es muy recomendable que estudien el material (incluso consultando otras fuentes) por fuera de la clase, y también que me vayan frenando/retroalimentando con preguntas y comentarios.**

Para algunas partes del curso puede resultarles útil también mi artículo de revisión

[arxiv.org/abs/1611.07472](http://arxiv.org/abs/1611.07472)

(además de los libros de Nastase y Ammon & Erdmenger indicados abajo, junto con el artículo de revisión de “MAGOO” = Maldacena-Aharony-Gubser-Ooguri-Oz).

Dibujos amigables para la introducción del curso pueden encontrarse (en PowerPoint o pdf) en mi minicurso más reciente (DGFM-SMF)

[www.nucleares.unam.mx/~alberto/platicas/entrelazagravedaddgfm.ppt](http://www.nucleares.unam.mx/~alberto/platicas/entrelazagravedaddgfm.ppt)

[www.nucleares.unam.mx/~alberto/platicas/entrelazagravedaddgfm.pdf](http://www.nucleares.unam.mx/~alberto/platicas/entrelazagravedaddgfm.pdf)

y para el resto del curso, en el minicurso un poco anterior (MexiCOPAS)

[www.nucleares.unam.mx/~alberto/platicas/emc2017.ppt](http://www.nucleares.unam.mx/~alberto/platicas/emc2017.ppt)

[www.nucleares.unam.mx/~alberto/platicas/emc2017.pdf](http://www.nucleares.unam.mx/~alberto/platicas/emc2017.pdf)

Una versión relámpago de parte del material del curso a nivel de licenciatura está en <http://www.nucleares.unam.mx/~alberto/apuntes/indice.html#miniholografia>

### **Pre-requisitos para el curso:**

Trataré de que el curso sea autocontenido, en la medida de lo posible. Todas y todos los oyentes son por supuesto bienvenidos; pero para aprovechar mejor el curso, es altamente deseable que conozcan ya las ideas básicas de teoría cuántica de campos y relatividad general.

Si requieren ayuda en esos temas, pueden consultar, por ejemplo,

M. E. Peskin y D. V. Schroeder, *An Introduction to Quantum Field Theory*, Addison-Wesley (1995).

B. F. Schutz, *A First Course in General Relativity*, Cambridge University Press (1994).

En ocasiones resultaría útil también (aunque NO será indispensable) cierta familiaridad con algunas ideas básicas de cuerdas, al nivel de, p.ej.,

K. Becker, M. Becker y J. H. Schwarz, *String Theory and M Theory*, Cambridge University Press (2007).

J. Polchinski, *String Theory*, Cambridge University Press (1998), vols. I y II.

## Bibliografía

Para una lista extensa (¡que falta actualizar!) de artículos de revisión sobre distintos temas de cuerdas, ir a

<http://www.nucleares.unam.mx/~alberto/physics/stringrev.html>

<http://www.stringwiki.org/>

### Libros sobre la Correspondencia

H. Nastase, *Introduction to the AdS/CFT Correspondence*, Cambridge University Press (2015).

J. Erdmenger y M. Ammon, *Gauge/Gravity Duality*, Cambridge University Press (2015).

E. Papantonopoulos, ed., *From Gravity to Thermal Gauge Theories: The AdS/CFT Correspondence*, Lecture Notes on Physics vol. 828, Springer (2011).

M. Natsuume, *AdS/CFT Duality User Guide*, Lecture Notes in Physics vol. 903, Springer (2015).

J. Casalderrey-Solana, H. Liu, D. Mateos, K. Rajagopal y U. Wiedemann, *Gauge/String Duality, Hot QCD and Heavy Ion Collisions*, Cambridge University Press (2014).

J. Zaanen, Y. Liu, Y.-W. Sun, K. Schalm, *Holographic Duality in Condensed Matter Physics*, Cambridge University Press (2016).

### Artículos de Revisión sobre Generalidades de la Correspondencia:

O. Aharony, S. S. Gubser, J. Maldacena, H. Ooguri, Y. Oz, “Large N Field Theories, String Theory and Gravity,” hep-th/9905111

H. Nastase, “Introduction to AdS-CFT”, arXiv:0712.0689

E. D’Hoker, D. Z. Freedman, “Supersymmetric Gauge Theories and the AdS/CFT Correspondence,” hep-th/0201253

J. Polchinski, “Introduction to Gauge/Gravity Duality,” arXiv:1010.6134

G. Horowitz, J. Polchinski, “Gauge/Gravity Duality,” gr-qc/0602037

V. Hubeny, “The AdS/CFT Correspondence”, arXiv:1501.00007

R. Sundrum, “From Fixed Points to the Fifth Dimension,” arXiv:1106.4501

J. McGreevy, “Holographic Duality with a view toward Many-Body Physics,” arXiv:0909.0518

J. Kaplan, “Lectures on AdS/CFT from the Bottom Up,” <http://sites.krieger.jhu.edu/jared-kaplan/files/2016/05/AdSCFTCourseNotesCurrentPublic.pdf>

J. Penedones, “TASI Lectures on AdS/CFT,” arXiv:1608.04948

Marcus K. Benna, I. R. Klebanov, “Gauge-String Dualities and Some Applications,” arXiv:0803.1315

I. R. Klebanov, “QCD and String Theory,” hep-ph/0509087

I. R. Klebanov, “TASI Lectures: Introduction to the AdS/CFT Correspondence,” TASI ’99, hep-th/0009139

I. R. Klebanov, “From Threebranes to Large N Gauge Theories,” hep-th/9901018

J. M. Maldacena, “The Gauge/Gravity Duality,” arxiv:1106.6073

J. M. Maldacena, “TASI 2003 Lectures on AdS/CFT,” hep-th/0309246

J. L. Petersen, “Introduction to Maldacena Conjecture on AdS/CFT,” hep-th/9902131

P. Di Vecchia, A. Liccardo, R. Marotta, F. Pezzella, “On the Gauge/Gravity Correspondence and the Open/Closed String Duality,” hep-th/0503156

P. Di Vecchia, “Large N Gauge Theories and AdS/CFT Correspondence,” hep-th/9908148  
P. Di Vecchia, “An Introduction to AdS/CFT Correspondence,” hep-th/9903007  
M. Bertolini, “Four Lectures on the Gauge/Gravity Correspondence,” hep-th/0303160  
S. Randjbar-Daemi, “Aspects of the Gauge Theory – Gravity Correspondence,” hep-th/0004204  
M. R. Douglas, S. Randjbar-Daemi, “Two Lectures on the AdS/CFT Correspondence,” hep-th/9902022  
E. Álvarez, J. Conde, L. Hernández, “Rudiments of Holography,” hep-th/0205075  
J. H. Schwarz, “Recent Progress in AdS/CFT,” arXiv:0907.4972  
R. Peschanski, “Introduction to String Theory and Gauge/Gravity Duality for Students in QCD and QGP Phenomenology,” arXiv:0804.3210  
V. Schomerus, “Strings for Quantumchromodynamics,” arXiv:0706.1209  
A. M. Polyakov, “From Quarks to Strings,” arXiv:0812.0183  
S. S. Gubser, “Dynamics of D-brane Black Holes,” Ph.D. thesis, hep-th/9908004  
S. Kovacs, “N=4 Supersymmetric Yang-Mills Theory and the AdS/SCFT Correspondence,” Ph.D. thesis, hep-th/9908171  
J. de Boer, L. Maoz, A. Naqvi, “Some Aspects of the AdS/CFT Correspondence,” hep-th/0407212  
K. Furuuchi, “Lectures on AdS-CFT at Weak ‘t Hooft Coupling at Finite Temperature,” hep-th/0608181  
J. Penedones, “High Energy Scattering in the AdS/CFT Correspondence,” Ph.D. thesis, arXiv:0712.0802  
A. V. Ryzhov, “Operators in the d=4, N=4 SYM and the AdS/CFT Correspondence,” Ph.D. thesis, hep-th/0307169

### **Artículos de Revisión sobre Entropía de Entrelazamiento y Gravedad**

T. Takayanagi, “Entanglement Entropy from a Holographic Viewpoint,” arXiv:1204.2450  
M. Rangamani, T. Takayanagi, “Holographic Entanglement Entropy,” arXiv:1609.01287  
M. Van Raamsdonk, “Lectures on Gravity and Entanglement,” arXiv:1609.00026  
D. Harlow, “Jerusalem Lectures on Black Holes and Quantum Information,” arXiv:1409.1231  
T. Nishioka, S. Ryu, T. Takayanagi, “Holographic Entanglement Entropy: An Overview,” arXiv:0905.0932  
H. Casini, M. Huerta, “Entanglement Entropy in Free Quantum Field Theory,” arXiv:0905.2562  
P. Calabrese, J. Cardy, “Entanglement Entropy and Conformal Field Theory,” arXiv:0909.4013

### **Artículos de Revisión sobre Lazos de Wilson**

G. W. Semenoff, K. Zarembo, “Wilson Loops in SYM Theory: from Weak to Strong Coupling,” hep-th/0202156  
J. Sonnenschein, “What does the String/Gauge Correspondence teach us about Wilson Loops?,” hep-th/0003032

### **Artículos de Revisión sobre Renormalización Holográfica**

K. Skenderis, “Lecture Notes on Holographic Renormalization,” hep-th/0209067

K. Skenderis, I. Papadimitriou, “AdS/CFT Correspondence and Geometry,” hep-th/0404176

M. Fukuma, S. Matsuura, T. Sakai, “Holographic Renormalization Group,” hep-th/0212314

J. de Boer, “The Holographic Renormalization Group,” hep-th/0101026

### **Artículos de revisión sobre la Correspondencia Fluidos/Gravedad**

V. E. Hubeny, S. Minwalla, M. Rangamani, “The Fluid/Gravity Correspondence,” arXiv:1107.5780

V. E. Hubeny, “The Fluid/Gravity Correspondence: a new perspective on the Membrane Paradigm,” arXiv:1011.4948

M. Rangamani, “Gravity & Hydrodynamics: Lectures on the Fluid-Gravity Correspondence,” arXiv:0905.4342

N. Ambrosetti, J. Charbonneau, S. Weinfurter, “The Fluid/gravity Correspondence: Lecture Notes from the 2008 Summer School on Particles, Fields and Strings,” lectures by V. E. Hubeny, arXiv:0810.2631

### **Artículos de Revisión sobre Aplicaciones a Física Tipo QCD**

J. Casalderrey, D. Mateos, H. Liu, K. Rajagopal, U. A. Wiedemann, “Gauge/String Duality, Hot QCD and Heavy Ion Collisions,” arXiv:1101.0618

S. S. Gubser, A. Karch, “From Gauge-String Duality to Strong Interactions: a Pedestrian’s Guide,” arXiv:0901.0935

D. Mateos, “String Theory and Quantum Chromodynamics,” arXiv:0709.1523

D. Mateos, “Gauge/String Duality applied to Heavy Ion Collisions: Limitations, Insights and Prospects,” arXiv:1106.3295

V. Hubeny, M. Rangamani, “A Holographic View on Physics Out of Equilibrium,” arXiv:1006.3675

O. DeWolfe, S. S. Gubser, C. Rosen, D. Teaney, “Heavy Ions and String Theory,” arXiv:1304.7794

S. S. Gubser, “The Gauge-String Duality and Heavy Ion Collisions,” arXiv:1103.3636

S. S. Gubser, “TASI Lectures: Collisions in anti-de Sitter Space, Conformal Symmetry, and Holographic Superconductors,” arXiv:1012.5312

A. Karch, “Recent Progress in Applying Gauge/Gravity Duality to Quark-Gluon Plasma Physics,” arXiv:1108.4014

S. Cremonini, “The Shear Viscosity to Entropy Ratio: A Status Report,” arXiv:1108.0677

D. T. Son, A. Starinets, “Viscosity, Black Holes, and Quantum Field Theory,” arXiv:0704.0240

A. Rebhan, “The Witten-Sakai-Sugimoto Model: A Brief Review and some Recent Results,” arXiv:1410.8858

N. Banerjee, S. Dutta, “Holographic Hydrodynamics: Models and Methods,” arXiv:1112.5345

A. Starinets, “Transport Coefficients of Strongly Coupled Gauge Theories: Insights from String Theory,” nucl-th/0511073

M. Natsuume, “String Theory Implications on Causal Hydrodynamics,” arXiv:0807.1394

A. O’Bannon, “Holographic Thermodynamics and Transport of Flavor Fields,” Ph.D. thesis, arXiv:0808.1115

T. Springer, “Hydrodynamics of Strongly Coupled Non-Conformal Fluids from Gauge/Gravity Duality,” arXiv:0908.1587

F. Bigazzi, A. L. Cotrone, J. Mas, d. Mayerson, J. Tarrio, “Holographic Duals of Quark Gluon Plasmas with Unquenched Flavors,” arXiv:1110.1744

C. Núñez, A. Paredes, A. V. Ramallo, “Unquenched Flavor in the Gauge/Gravity Correspondence,” arXiv:1002.1088

M. Kaminski, “Holographic Quark Gluon Plasma with Flavor,” arXiv:0808.1114

D. Arean, “Holographic Flavor in the Gauge/Gravity Duality,” Ph.D. thesis, arXiv:0906.5183

V. G. Filev, “Aspects of the Holographic Study of Flavor Dynamics,” Ph.D. thesis, arXiv:0809.4701

Y. V. Kovchegov, “AdS/CFT applications to Relativistic Heavy Ion Collisions: a Brief Review,” arXiv:1112.5403

E. Shuryak, “Toward the AdS/CFT Dual of the “Little Bang”,” arXiv:1112.2573

E. Iancu, “Partons and Jets in a Strongly-Coupled Plasma from AdS/CFT,” arXiv:0812.0500

M. Chernicoff, J. Antonio García, A. Güijosa, J. F. Pedraza, “Holographic Lessons for Quark Dynamics,” arXiv:1111.0872

R. C. Myers, S. E. Vázquez, “Quark Soup al Dente: Applied Superstring Theory,” arXiv:0804.2423

J. D. Edelstein, C. A. Salgado, “Jet Quenching in Heavy Ion Collisions from AdS/CFT,” arXiv:0805.4515

J. Erdmenger, N. Evans, I. Kirsch, E. Threlfall, “Mesons in Gauge/Gravity Duals- A Review,” arXiv:0711.4467

K. Peeters, M. Zamaklar, “The String/gauge theory correspondence in QCD,” arXiv:0708.1502

S. S. Gubser, S. Pufu, Rocha, A. Yarom, “Energy Loss in a Strongly Coupled Thermal Medium and the Gauge-String Duality,” arXiv:0902.4041

J. D. Edelstein, J. Shock, D. Zoakos, “The AdS/CFT Correspondence and Non-perturbative QCD,” arXiv:0901.2534

R. A. Janik, “The Dynamics of Quark-Gluon Plasma and AdS/CFT,” arXiv:1003.3291

M. P. Heller, R. A. Janik, R. Peschanski, “Hydrodynamic Flow of the quark-Gluon Plasma and Gauge/Gravity Correspondence,” arXiv:0811.3113

U. Gürsoy, E. Kiritsis, L. Mazzanti, G. Michalogiorgakis, F. Nitti, “Improved Holographic QCD,” arXiv:1006.5461

U. Gürsoy, “Deconfinement and Thermodynamics in 5D Holographic Models of QCD,” arXiv:0904.2750

T. Brasoveanu, D. Kharzeev, M. Martínez, “In Search of the QCD-Gravity Correspondence,” arXiv:0901.1903

T. Schäfer, D. Teaney, “Nearly Perfect Fluidity: From cold Atomic Gases to Hot Quark Gluon Plasmas,” arXiv:0904.3107

A. Tedder, “Holographic Descriptions of QCD,” Ph.D. thesis, arXiv:0805.0984

### **Artículos de Revisión sobre Aplicaciones a Materia Condensada (y Física Atómica)**

N. Iqbal, H. Liu, M. Mezei, “Lectures on Holographic non-Fermi Liquids and Quantum Phase Transitions,” arXiv:11103814

G. Horowitz, “Introduction to Holographic Superconductors,” arXiv:1002.1722

C. P. Herzog, "Lectures on Holographic Superfluidity and Superconductivity," arXiv:0904.1975  
S. A. Hartnoll, "Horizons, holography and condensed matter," arXiv:1106.4324  
S. A. Hartnoll, "Quantum Critical Dynamics from Black Holes," arXiv:0909.3553  
S. A. Hartnoll, "Lectures on Holographic Methods for Condensed Matter Physics," arXiv:0903.3246  
S. Sachdev, "What can Gauge-Gravity Duality teach us about Condensed Matter Physics?," arXiv:1108.1197  
S. Sachdev, "Condensed Matter and AdS/CFT," arXiv:1002.2947  
M. Kaminski, "Flavor Superconductivity & Superfluidity," arXiv:1002.4886  
S. S. Gubser, "TASI Lectures: Collisions in anti-de Sitter Space, Conformal Symmetry, and Holographic Superconductors," arXiv:1012.5312  
T. Schäfer, D. Teaney, "Nearly Perfect Fluidity: From cold Atomic Gases to Hot Quark Gluon Plasmas," arXiv:0904.3107  
J. McGreevy, "Holographic Duality with a view toward Many-Body Physics," arXiv:0909.0518  
S.-S. Lee, "Lectures on Emergence of Supersymmetry, Gauge Theory and String in Condensed Matter Systems," arXiv: 1009.5127

#### **Artículos de Revisión sobre otros ejemplos de AdS/CFT y no-AdS/no-CFT**

O. Aharony, "The non-AdS/non-CFT Correspondence, or Three Different Paths to QCD," hep-th/0212193  
J. Edelstein, R. Portugues, "Gauge/String Duality in Confining Theories," hep-th/0602021  
J. Edelstein, "Large N Dualities from Wrapped D-branes," hep-th/0211204  
M. J. Strassler, "The Duality Cascade," hep-th/0505153  
M. Spradlin, A. Strominger, A. Volovich, "Les Houches Lectures on de Sitter Space," hep-th/0110007  
V. Balasubramanian, "Accelerating Universes and String Theory," hep-th/0404075  
I. Bredberg, C. Keeler, V. Lysov, A. Strominger, "Cargese Lectures on the Kerr/CFT Correspondence", arXiv:1103.2355  
I. R. Klebanov, G. Torri, "M2-branes and AdS/CFT," arXiv:0909.1580  
A. Rebhan, "The Witten-Sakai-Sugimoto Model: A Brief Review and some Recent Results," arXiv:1410.8858  
M. Mariño, "Lectures on Localization and Matrix Models in Supersymmetric Chern-Simons-matter Theories," arXiv:1104.0783  
K. D. Kennaway, "Brane Tilings," arXiv:0706.1660  
M Yamazaki, "Brane Tilings and Their Applications," arXiv:0803.4474  
C. P. Herzog, I. R. Klebanov, P. Ouyang, "D-branes on the Conifold and N=1 Gauge/Gravity Dualities," hep-th/0205100  
R. Gwyn, A. Knauf, "Conifolds and Geometric Transitions," hep-th/0703289  
F. Bigazzi, A. L. Cotrone, M. Petrini, A. Zaffaroni, "Supergravity duals of supersymmetric four-dimensional gauge theories," hep-th/0303191  
D. Rodríguez-Gómez, "Holographic Flavor in Theories with Eight Supercharges," arXiv:0710.4471  
M. Mariño, "Enumerative Geometry and Knot Invariants," hep-th/0210145  
D. Auckly, S. Koshkin, "Introduction to the Gopakumar, Vafa large N Duality," math.GT/0701568

- I. Swanson, “A Review of Integrable Deformations in AdS/CFT,” arXiv:0705.2844  
M. Mia, “From String Theory to Large N QCD,” Ph.D. thesis, arXiv:1012.2881  
E. Imeroni, “The Gauge/String Correspondence Towards Realistic Gauge Theories,” Ph.D. thesis, hep-th/0312070  
F. Canoura Fernández, “D-branes in Supersymmetric Backgrounds,” Ph.D. thesis, arXiv:0804.4878  
I. Kirsch, “Generalizations of the AdS/CFT Correspondence,” Ph.D. thesis, hep-th/0406274

### **Artículos de Revisión sobre BMN, Cadenas de Espín, Amplitudes de Dispersión e Integrabilidad**

- Beisert et al., “Review of AdS/CFT Integrability: an Overview,” arXiv:1012.3982  
J. A. Minahan, “Review of AdS/CFT Integrability, Chapter I.1: Spin Chains in N=4 SYM,” arXiv:1012.3983  
C. Sieg, “Review of AdS/CFT Integrability, Chapter I.2: The Spectrum from Perturbative Gauge Theory,” arXiv:1012.3984  
A. Rej, “Review of AdS/CFT Integrability, Chapter I.3: Long-range Spin Chains,” arXiv:1012.3985  
A. Tseytlin, “Review of AdS/CFT Integrability, Chapter II.1: Classical AdS<sub>5</sub> x S<sup>5</sup> String Solutions,” arXiv:1012.3986  
T. McLoughlin, “Review of AdS/CFT Integrability, Chapter II.2: Quantum Strings in AdS<sub>5</sub> x S<sup>5</sup>,” arXiv:1012.3987  
M. Magro, “Review of AdS/CFT Integrability, Chapter II.3: Sigma Model, Gauge Fixing,” arXiv:1012.3988  
S. Schäfer-Nameki, “Review of AdS/CFT Integrability, Chapter II.4: The Spectral Curve,” arXiv:1012.3989  
M. Staudacher, “Review of AdS/CFT Integrability, Chapter III.1: Bethe Ansätze and the R-Matrix Formalism,” arXiv:1012.3990  
C. Ahn and R. I. Nepomechie, “Review of AdS/CFT Integrability, Chapter III.2: Exact World-sheet S-matrix,” arXiv:1012.3991  
P. Vieira, D. Volin, “Review of AdS/CFT Integrability, Chapter III.3: The Dressing Factor,” arXiv:1012.3992  
L. Freyhult, “Review of AdS/CFT Integrability, Chapter III.4: Twist States and the Cusp Anomalous Dimension,” arXiv:1012.3993  
R. Janik, “Review of AdS/CFT Integrability, Chapter III.5: Lüscher Corrections,” arXiv:102.3994  
Z. Bajnok, “Review of AdS/CFT Integrability, Chapter III.6: Thermodynamic Bethe Ansatz,” arXiv:1012.3995  
V. Kazakov, N. Gromov, “Review of AdS/CFT Integrability, chapter III.7: Hirota Dynamics for Quantum Integrability,” arXiv:1012.3996  
C. Kristjansen, “Review of AdS/CFT Integrability, Chapter IV.1: Aspects of Non-Planarity,” arXiv:1012.3997  
K. Zoubos, “Review of AdS/CFT Integrability, Chapter IV.2: Deformations, Orbifolds and Open Boundaries,” arXiv:102.3998  
T. Klose, “Review of AdS/CFT Integrability, Chapter IV.3: N=6 Chern-simons and Strings on AdS<sub>4</sub> x CP<sup>3</sup>,” arXiv:102.3999  
G. Korchemsky, “Review of AdS/CFT Integrability, Chapter IV.4: Integrability in QCD and N<4 SYM,” arXiv:1012.4000



R. Roiban, "Review of AdS/CFT Integrability, Chapter V.1: Scattering Amplitudes- a Brief Introduction," arXiv:1012.4001

J. M. Drummond, "Review of AdS/CFT Integrability, Chapter V.2: Dual Superconformal Symmetry," arXiv:1012.4002

L.F. Alday, "Review of AdS/CFT Integrability, Chapter V.3: Scattering Amplitudes at Strong Coupling," arXiv:1012.4003

N. Beisert, "Review of AdS/CFT Integrability, Chapter VI.1: Superconformal Algebra," arXiv:1012.4004

A. Torrielli, "Review of AdS/CFT Integrability, Chapter VI.2: Yangian Algebra," arXiv:1012.4005

L. Mazzucato, "Superstrings in AdS," arXiv:1104.2604

D. Serban, "Integrability and the AdS/CFT Correspondence," arXiv:1003.4214

L. Ferro, "Yangian Symmetry in N=4 Super Yang-Mills," arXiv:1107.1776

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