The 27th Nordic Network Meeting on "Strings, Fields and Branes"

Thursday, 24 March 2011 - Saturday, 26 March 2011

Niels Bohr International Academy

Scientific Programme

<**font color="992233">Pedagogical Lectures**

Scattering Amplitudes at Strong Coupling

by Luis F. Alday (Oxford, Math)

In these lectures we will describe recent developments regarding the computation of scattering amplitudes of planar maximally super-symmetric Yang-Mills at strong coupling.

After a brief introduction to the perturbative results, we show how to use the AdS/CFT duality in order to compute such amplitudes at strong coupling. The problem boils down to the computation of (the area of) certain minimal surfaces. Quite remarkably, the integrability of the classical equations of motion can be used in order to compute the area of such minimal surfaces. We will show how this works in detail.

Time permitting, we will mention briefly an idea that allows to obtain results (in certain kinematic limits) to all values of the coupling.

Recommended reading:

[1] L. F. Alday and R. Roiban, "Scattering Amplitudes, Wilson Loops and the String/Gauge Theory Correspondence", Phys. Rept. 468 (2008) 153, [arXiv:0807.1889 [hep-th]].

[2] J. M. Henn, "Duality between Wilson loops and gluon amplitudes", Fortsch. Phys. 57 (2009) 729, [arXiv:0903.0522 [hep-th]].

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

[4] L.F. Alday, J. Maldacena, A. Sever and P. Vieira, "Y-system for Scattering Amplitudes", J. Phys. A 43 (2010) 485401, [arXiv:1002.2459 [hep-th]].

Supergravity Black Holes and Attractors

by Gianguido Dall'Agata (Padova)

In these lectures we will discuss extremal black hole configurations in supergravity and string theory.
We will especially focus on the attractor mechanism, both for supersymmetric as well as non-supersymmetric configurations, and on the first order formalism that is used to construct these solutions.

The attractor mechanism plays a central role in our attempts to give a microscopic interpretation of black hole entropy, because it implies that the horizon area does not depend on the asymptotic value of the scalar fields, but only on the (quantized) charges of the black hole,
The first order formalism, on the other hand, identifies a unique function that gives the ADM mass of the black hole as well as the horizon area and the gradient flow equations describing the evolution of the scalar fields from infinity to the horizon.

We will also see how to relate the 4-dimensional black hole configurations to the 10- and 11-dimensional configurations of wrapped membranes and how to use duality transformations to map different configurations to each other, hence reducing the number of independent configurations for which one has to provide a microscopic interpretation.

Some (classic) references could be:

S.Ferrara, R.Kallosh, A.Strominger, "N=2 extremal black holes"
Phys.Rev. D52 (1995) 5412-5416. [hep-th/9508072].

F.Denef, "Supergravity flows and D-brane stability",
JHEP 0008 (2000) 050. [hep-th/0005049].

L.Andrianopoli, R.D'Auria, S.Ferrara, M. Trigiante, "Extremal black holes in
supergravity", Lect. Notes Phys. 737 (2008) 661-727. [<a href="http://arxiv.org/abs/hep-th/0611345"

hep-th/0611345].

A.Ceresole, G.Dall'Agata, "Flow Equations for Non-BPS Extremal Black Holes", JHEP 0703, 110 (2007). [hep-th/0702088].

UPDATE (June 2011): A writeup of these lectures has now appeared in arXiv:1106.2611.

Gauge-gravity Duality and Transport in Strongly Interacting Quantum Systems

by Andrei Starinets (Oxford, Physics)

In these lectures, we describe some of the gauge-gravity duality methods used to study strongly coupled finite temperature/density quantum field theories in the near-equilibrium regime. We show how the hydrodynamic behavior of a field theory is reflected in the low-momentum limit of correlation functions computed through a real-time AdS/CFT prescription. We also show how transport properties of the field theory are encoded in the spectrum of the low-lying quasinormal modes of the dual gravitational background. A number of applications to qualitative understanding of RHIC/LHC heavy ion collisions physics will be mentioned.

References include reviews on the gauge-string duality at finite temperature [1,2] as well as general reviews on the AdS/CFT correspondence [3-5].

J.Casalderrey-Solana, H.Liu, D.Mateos, K.Rajagopal, U.A.Wiedemann, "Gauge/String Duality, Hot QCD and Heavy Ion Collisions", [arXiv:1101.0618 [hep-th]].

D.T.Son, A.O.Starinets, "Viscosity, Black Holes, and Quantum Field Theory", Ann. Rev. Nucl. Part.Sci. 57, 95-118 (2007). [arXiv:0704.0240 [hep-th]].

O.Aharony, S.S.Gubser, J.M.Maldacena, H.Ooguri, Y.Oz, "Large N field theories, string theory and gravity", Phys. Rept. 323, 183-386 (2000). [hep-th/9905111].

I.R.Klebanov, "TASI lectures: Introduction to the AdS / CFT correspondence", [hep-th/0009139].

E.D'Hoker, D.Z.Freedman, "Supersymmetric gauge theories and the AdS / CFT correspondence", [hep-th/0201253].