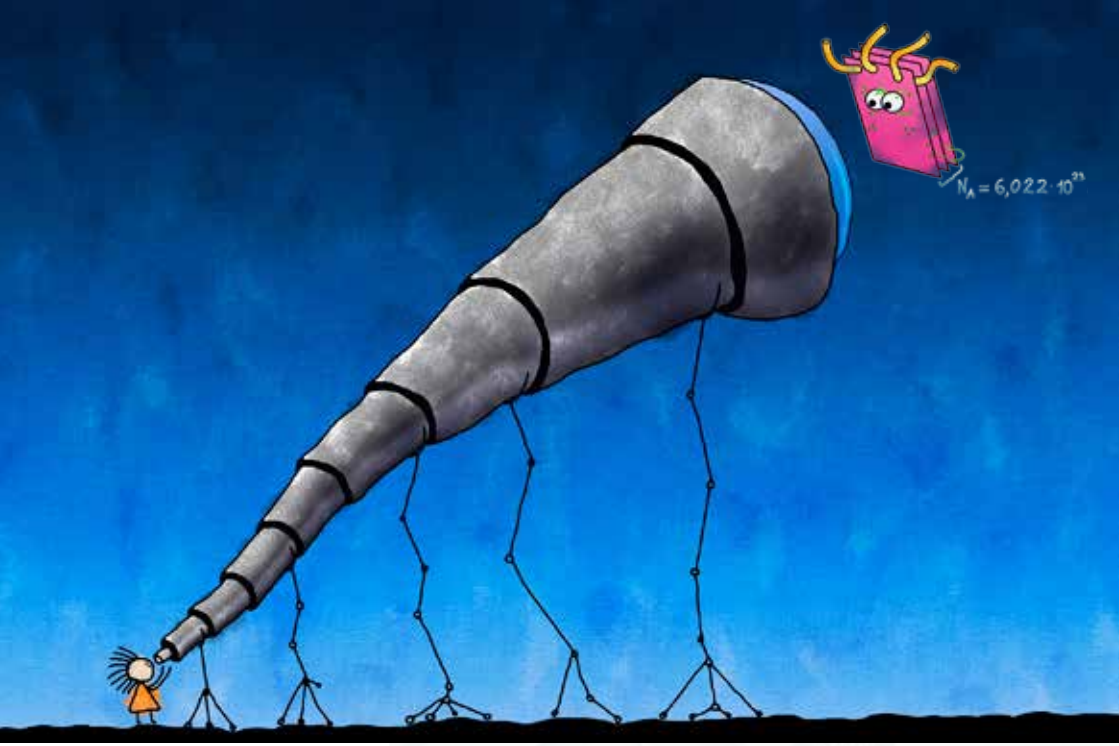

X AVOGADRO MEETING

On Strings, Supergravity and Gauge Theories

17-19 DECEMBER 2014

Scuola Normale Superiore
Sala Stemmi - Palazzo della Carovana
Piazza dei Cavalieri, 7
56126 Pisa - Italy

ORGANIZERS

Dario Francia - local organizer
Scuola Normale Superiore and INFN

Marco Caldarelli
Southampton University

Michele Cirafici
Lisbon University

Valentina Forini
Humboldt-Universität zu Berlin

Erik Tonni
SISSA and INFN

Roberto Valandro
Trieste U., ICTP and INFN

TOPICS AND SPEAKERS:

ENTANGLEMENT AND HOLOGRAPHY
G. Policastro (ENS Paris), **E. Tonni** (SISSA and INFN)

HIGHER SPINS AND STRINGS
A. Campoleoni (ULB), **M. Taronna** (AEI Potsdam)

CONFORMAL BOOTSTRAP
A. Bissi (Oxford U.), **A. Vichi** (CERN)

COSMOLOGY IN THE PLANCK/BICEP ERA
F. Finelli (INAF-IASF), **A. Orlando** (Rome U. Sapienza)

RESURGENCE: A BRIDGE BETWEEN PERTURBATIVE AND NON PERTURBATIVE PHYSICS
D. Dorigoni (Cambridge U.)

Per informazioni:
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INFN Istituto Nazionale di Fisica Nucleare

ICTP The Abdus Salam International Centre for Theoretical Physics 50th Anniversary

The Avogadro Meetings started in 2005 as an occasion for young Italian theorists, active in String Theory and related subjects, to gather and share their ideas and results in an informal atmosphere. The meeting took its name after the University of Piemonte Orientale that hosted its first three editions.

It is usually scheduled in December, just before the beginning of the Christmas holidays, so as to simplify the participation of Italian Ph.D. students or postdocs working abroad, who can take the occasion of their travel back to Italy for Christmas and meet their young colleagues to exchange ideas and news on their activity.

In order to stress the pedagogical aims of the meeting, preference is given to extended presentations on general themes rather than to conventional seminars on specific works, possibly organised and illustrated by more than one speaker and followed by a long discussion session.

Consistently with the original spirit of the event the invited speakers are Italian; however, participation is open to anybody and non-Italians are welcome to join. For this reason the seminars are anyway presented in English.

Past editions:

2005 Alessandria

2006 Alessandria

2007 Alessandria

2008 Sissa, Trieste

2009 Sissa, Trieste

2010 GGI, Firenze

2011 GGI, Firenze

2012 SNS, Pisa

2013 SISSA, Trieste

Wednesday, December 17 - Sala Stemmi

8.45 - 9.00 Opening

9.00 - 11.00

Giuseppe Policastro (ENS Paris)
Erik Tonni (SISSA and INFN)

Entanglement and holography

Abstract and references

Abstract

We will review the basic ideas underlying the computations of the entanglement entropy and the Renyi entropies in conformal field theories and of their holographic counterparts. The topics that will be covered are

- path integral representation of the reduced density matrix
- replica trick for the entanglement entropy
- twist fields and Riemann surfaces for the Renyi entropies
- reduced density matrix for a sphere in higher dimensional CFT
- Ryu-Takayanagi formula for the holographic entanglement entropy
- covariant generalizations of the RT prescription to time-dependent situations
- connection to black hole entropy via the "generalized gravitational entropy"

Additional topics:

- strong subadditivity
- holographic Renyi entropies

References

reviews:

– http://arxiv.org/abs/1204.2450

– http://arxiv.org/abs/0905.4013

CFT:

– http://arxiv.org/abs/hep-th/9403108

– http://arxiv.org/abs/hep-th/0405152

– http://arxiv.org/abs/1102.0440

Holography:

– http://arxiv.org/abs/hep-th/0605073

– http://arxiv.org/abs/0704.3719

– http://arxiv.org/abs/arXiv:0705.0016

– http://arxiv.org/abs/1110.1084

– http://arxiv.org/abs/1304.4926

11.00 - 11.30 Coffee break

11.30 - 12.30 Discussion session

12:30 - 14:30 Lunch break

14.30 - 16.30

Andrea Campoleoni (Université Libre de Bruxelles)
Massimo Taronna (AEI Potsdam)

Higher-spins and strings

Abstract and references

Abstract

We give an introduction to Vasiliev equations aimed at deciphering some recent results on the relations between higher-spin gauge theories and string theory. After reviewing the main ingredients of the unfolded formulation we take advantage of it in a holographic context, emphasizing the bulk-to-bulk duality between Vasiliev theories and the ABJM model. We conclude by providing a brief overview of the current status of higher spin holography.

References

- S. Giombi and X. Yin, ``The Higher Spin/Vector Model Duality,'' J. Phys. A46 (2013) 214003
  http://arxiv.org/abs/arXiv:1208.4036
- M.A. Vasiliev, ``Holography, Unfolding and Higher-Spin Theory,'' J. Phys. A46 (2013) 214013.
  http://arxiv.org/abs/arXiv:1203.5554
- C.M. Chang, S. Minwalla, T. Sharma and X. Yin, ``ABJ Triality: from Higher Spin Fields to Strings,'' J. Phys. A46 (2013) 214009
  http://arxiv.org/abs/arXiv:1207.4485
- M.R. Gaberdiel and R. Gopakumar, ``Higher Spins & Strings,'' JHEP 1411 (2014) 044
  http://arxiv.org/abs/arXiv:1406.6103

16.30 - 17.00 Coffee break

17.00 - 18.00 Discussion session

Thursday, December 18 - Sala Stemmi

9.00 - 11.00

Agnese Bissi (Oxford University)
Alessandro Vichi (CERN)

Conformal bootstrap

Abstract and references

Abstract

The conformal bootstrap is a program that aims to exploit general properties of a Conformal Field Theories (CFT), such as unitarity, operator product expansion (OPE) and crossing symmetry to solve completely the theory. Despite the idea goes back to the '70, only recent progresses in the conformal block decomposition and numerical techniques have led to quantitative results.

In the first lecture we will review the main features of CFTs, introduce the conformal bootstrap idea and present a few applications. Topics covered in the first part include:

- review of conformal symmetry in D dimensions and its representations
- Operator product expansion
- structure of two, three and four point functions
- crossing symmetry constraints
- conformal bootstrap and numerical algorithms
- the Ising model in D<4 dimension

The second part extends the discussion to SuperConformal Field Theories (SCFT's), outlining the main differences from the non-supersymmetric case and presenting a few applications. The second lecture will cover:

- N=1 and N=4 Super conformal algebra
- protected operators
- super conformal blocks
- future directions

References

CFT Review:

- S. Ferrara, R. Gatto and A. F. Grillo, "Conformal algebra in space-time and operator product expansion", Springer Tracts Mod. Phys. 67, 1 (1973).
- I. T. Todorov, M. C. Mintchev and V. B. Petkova, "Conformal Invariance In Quantum Field Theory", Pisa, Italy: Sc. Norm. Sup. (1978)
- E. S. Fradkin and M. Y. Palchik, "Conformal quantum field theory in D-dimensions," Dordrecht, Netherlands: Kluwer (1996)
- P. Di Francesco, P. Mathieu and D. Senechal, "Conformal Field Theory", New York, USA: Springer (1997)

Conformal blocks:

- F. A. Dolan and H. Osborn, "Conformal partial waves and the operator product expansion", Nucl. Phys. B 678, 491 (2004) [arXiv:hep-th/0309180]
- F. A. Dolan and H. Osborn, "Superconformal symmetry, correlation functions and the operator product expansion", Nucl. Phys. B 629, 3-73 (2002) [arXiv:hep-th/0112251]
- F. A. Dolan and H. Osborn, "Conformal partial waves Further Mathematical Results", Nucl. Phys. B 678, 491 (2004) [arXiv:1108.6194]

Conformal bootstrap:

- R. Rattazzi, V. S. Rychkov, E. Tonni, and A. Vichi, "Bounding scalar operator dimensions in 4D CFT", JHEP 12 (2008) 031, arXiv:0807.0004
- D. Poland, D. Simmons-Duffin, and A. Vichi, "Carving Out the Space of 4D CFTs", JHEP 1205 (2012) 110, arXiv:1109.5176
- S. El-Showk, M. F. Paulos, D. Poland, S. Rychkov, D. Simmons-Duffin, and A. Vichi, "Solving the 3D Ising Model with the Conformal Bootstrap", Phys.Rev. D86 (2012) 025022, arXiv:1203.6064

Super Conformal bootstrap:

- D. Poland and D. Simmons-Duffin, "Bounds on 4D Conformal and SuperconformalField Theories", JHEP 1105 (2011) 017, arXiv:1009.2087
- C. Beem, L. Rastelli, B. C. van Rees, "The N=4 Superconformal bootstrap", Phys. Rev. Lett. 111 (2013) 071601, arXv:1304.1803
- L. F. Alday and A. Bissi, "Generalized boostrap equations for N=4 SCFT", arXv:1404.5864
- M. Nirschl, H. Osborn, "Superconformal Ward identities and their solution", Nucl. Phys. B711 (2005) 409-479, [arXiv:0407060]
- F.A. Dolan, H. Osborn , "Conformal partial wave expansions for N=4 chiral four point functions", Annals Phys. 321 (2006) 581-626, [arXiv:0412335]

11.00 - 11.30 Coffee break

11.30 - 12.30 Discussion session

12:30 - 14:30 Lunch break

14.30 - 16.30

Fabio Finelli (INAF-IASF Bologna and INFN)
Angiola Orlando (Rome U. Sapienza)

Cosmology in the Planck/Bicep era

16.30 - 17.00 Coffee break

17.00 - 18.00 Discussion session

20.00 Social dinner

Friday, December 19 - Aula Bianchi:

9.00 - 11.00

Daniele Dorigoni (Cambridge Univeristy)

Resurgence: a bridge between perturbative and non perturbative physics

Abstract and references

Abstract

Resurgence provides a systematic unification of semiclassical analysis for the perturbative and non-perturbative sectors. It can be applied to resolve fundamental problems in quantum theories with degenerate minima. Expansions about different saddle points are quantitatively related to one another in a precise manner. I will illustrate the general framework by discussing various examples, from the double-well potential in QM, to asymptotically free QFTs such as the CP^N and the principal chiral model and Yang-Mills, where this resurgent approach yields a new semiclassical interpretation of IR renormalons.

References

- Aniceto and Schiappa, ``Nonperturbative Ambiguities and the Reality of Resurgent Transseries''
  http://arxiv.org/abs/1308.1115
- Dunne and Unsal, ``Uniform WKB, Multi-instantons, and Resurgent Trans-Series''
- http://arxiv.org/abs/1401.5202
  Cherman, Dorigoni and Unsal, `Decoding perturbation theory using resurgence: Stokes phenomena, new saddle points and Lefschetz thimbles''
  http://arxiv.org/abs/1403.1277
- Dorigoni, ``An Introduction to Resurgence, Trans-Series and Alien Calculus''
  http://arxiv.org/abs/1411.3585

11.00 - 11.30 Coffee break

11.30 - 12.30 Discussion session

12:30 - 12:45 Closure and Christmas greetings

http://webtheory.sns.it/avogadro2014/

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