PHYS-739

Conformal Field theory and Gravity

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Cursus	Sem.	Type
Physics		Obl.

Language of teaching	English
Credits	4
Session	
Exam	Multiple
Workload	120h
Hours	**56**
Courses	28
Exercises	28
Number of positions	**30**

Frequency

Every year

Remark

Every year / Next time: Fall 2018

Summary

This course is an introduction to the non-perturbative bootstrap approach to Conformal Field Theory and to the Gauge/Gravity duality, emphasizing the fruitful interplay between these two ideas.

Content

1. Scaling and Renormalization - quick review of phase transitions, critical exponents, block spin transformations, scaling variables and operators, renormalization group flows.
2. Conformal field theory - Conformal transformations, conformal algebra, local operators (primaries and descendants), correlation functions, stress tensor, Weyl invariance, conformal Ward identities, Radial quantization (state-operator map), unitarity bounds, operator product expansion, conformal blocks (Casimir equation), conformal bootstrap, conformal anomaly, embedding space formalism, large N factorization.
3. Anti-de Sitter spacetime - Geometry, particle dynamics, free fields in AdS, interacting fields in AdS.
4. The AdS/CFT correspondence - quantum gravity as CFT, semi-classical limit and the large N expansion, the role of String Theory, black holes and thermodynamics, universal long range forces, entanglement entropy.

Keywords

gauge/gravity duality
conformal bootstrap

Learning Prerequisites

Required courses

Quantum Field Theory, General Relativity

Recommended courses

Advanced Quantum Field Theory
Gauge Theories and the Standard Model

Learning Outcomes

By the end of the course, the student must be able to:

- Formulate the bootstrap conditions on the CFT data.
- Use the gauge/gravity duality to describe QFT phenomena.
- Apply CFT methods to explain properties of continuous phase transitions.

Transversal skills

- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Continue to work through difficulties or initial failure to find optimal solutions.
- Make an oral presentation.
- Demonstrate the capacity for critical thinking
- Write a scientific or technical report.

Teaching methods

Black board lectures and problem solving sessions.

Expected student activities

Attendance of lectures and problem solving sessions. Critical study of the material.

Assessment methods

Oral exam.
Small project including presentation and short written report.

Resources

Bibliography

Slava Rychkov, lectures notes on CFT, http://arxiv.org/abs/1601.05000
David Simmos-Duffin, lecture notes on CFT, http://arxiv.org/abs/1602.07982
Joao Penedones, lecture notes on AdS/CFT, https://arxiv.org/abs/1608.04948