Module title			Abbreviation
Introduction to Gauge/Gravity Duality			11-GGD-Int-201-m01
Module coordinator		**Module offered by**	
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
8	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

1. Elements of quantum field theory:
- Quantisation of the free field
- Interactions
- Renormalisation Group
- Gauge Fields
- Conformal Symmetry
- Large N expansion
- Supersymmetry

2. Elements of gravity
- Manifolds, coordinate covariance and metric
- Riemann curvature
- Maximally symmetric spacetimes
- Black holes

3. Elements of string theory
- Open and closed strings
- Strings in background fields
- Type IIB String Theory
- D-Branes

4. The AdS/CFT correspondence
- Statement of the correspondence
- Near-horizon limit of D3-Branes
- Field-operator correspondence
- Tests of the correspondence: Correlation functions
- Tests of the correspondence: Conformal anomaly
- Holographic principle

5. Extensions to non-conformal theories
- Holographic renormalisation group
- Holographic C-Theorem

6. Applications I: Thermo- and hydrodynamics
- Quantum field theory at finite temperature
- Black holes
- Holographic linear response formalism
- Transport coefficients: Shear viscosity and conductivities

7. Applications II: Condensed matter physics
- Finite charge density and Reissner-Nordström black holes
- Quantum critical behaviour
- Holographic fermions

- Holographic superconductors
- Entanglement entropy

8. Applications III: Particle physics
- Gravity dual of confinement
- Gravity dual of chiral symmetry breaking
- Quark-gluon plasma

Intended learning outcomes

Thorough understanding of the foundations of gauge/gravity duality and the ability to carry out basic tests. Working knowledge of essential applications. Knowledge of quantum mechanics and classical electrodynamics is a prerequisite for this course. Knowledge of quantum field theory and general relativity will be useful, however is not a prerequisite.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + R (2)
Module taught in: English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes).
If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Language of assessment: English
Assessment offered: In the semester in which the course is offered and in the subsequent semester

Allocation of places

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Additional information

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Referred to in LPO I (examination regulations for teaching-degree programmes)

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Module appears in

Master's degree (1 major) Physics International (2020)