MP 7: Quantum Field Theory I and Conformal Field Theory

Time: Wednesday 16:15–18:15 Location: ZHG001

Invited Talk MP 7.1 Wed 16:15 ZHG001

How the "gauge principle" derives from physical principles — •Karl-Henning Rehren — University of Göttingen

Gauge theory is a most successful paradigm to explain the interactions of the Standard Model. Yet, it remains notoriously unclear what it actually "means" in terms of physical reality, where only gauge-invariant quantities are observable.

I discuss an "autonomous" approach to explain the (same, of course) interactions of the SM without invoking gauge theory [1]. The S-matrix is computed in terms of "string-localized" free fields, which are necessary in order to reconcile interactions of quantum particles with the physical principles of Hilbert space, locality and covariance. Some of the resulting interacting quantum fields will inherit string-localization – a most desirable feature of physical relevance, e.g., in order to make the Gauß Law of QED compatible with Einstein Causality.

I will sketch how the weak interactions, QCD, and even gravitons are covered by string-localized QFT as well.

[1] K.-H. Rehren *et al*: Found. Phys. 54 (2024) 57

MP 7.2 Wed 16:45 ZHG001

Driven conformal field theory and circuit complexity — •Jani Kastikainen[1], Johanna Erdmenger[1], and Tim Schuhmann[1,2] — [1]Institute for Theoretical Physics and Astrophysics and Würzburg-Dresden Cluster of Excellence ct.qmat, Julius-Maximilians-Universität Würzburg, Am Hubland, 97074 Würzburg, Germany — [2]Department of Physics and Astronomy, Ghent University, 9000 Ghent, Belgium

Driven quantum systems exhibit a large variety of interesting and sometimes exotic phenomena. In this talk, I study driven two-dimensional conformal field theories (CFT) from spacetime and quantum information geometric points of view. I show that a large class of quantum circuits can be realized by coupling the CFT to time-dependent background fields. In particular, unitary time-evolution of the CFT in a background metric is equivalent to a quantum circuit generated by the Virasoro algebra, known as a Virasoro circuit. Similarly, turning on a source for a primary operator deforms the Virasoro circuit in a non-trivial way. Complexity of these circuits may be measured using the Fubini-Study circuit complexity whose properties I will analyze.

MP 7.3 Wed 17:05 ZHG001

Scale- without Conformal-Invariance in Gauge/Gravity Duality — •Mario Flory and Lavish Chawla — Jagiellonian University, Cracow, Poland

In Gauge/Gravity Duality, the isometries of the bulk spacetime determine the symmetries of the dual field theory. This lies at the heart of both AdS/CFT and its generalisations to non-relativistic theories for example. In this talk, we will try to construct models of bulk spacetimes that break the full conformal symmetry present in AdS space down to only scale-invariance in combination with Poincaré invariance. From the field theory point of view, there are well known no-go theorems that forbid unitary theories with such a symmetry, at least in certain dimensions. Our main interest is whether a dual no-go theorem from the bulk point of view exists. To address this question, we discuss a tension that arises between three conditions on the bulk spacetime: A local geometrical condition (Killing algebra of the bulk), a global condition (topology of the bulk) and a physical condition (null energy condition in the bulk).

MP 7.4 Wed 17:25 ZHG001

Number theoretic properties of two-dimensional conformal field theories — Hans Jockers[1], Pyry Kuusela[2], and •Maik Sarve[3] — [1]Johannes-Gutenberg Universität Mainz — [2]Johannes-Gutenberg Universität Mainz — [3]Johannes-Gutenberg Universität Mainz

Many two-dimensional conformal field theories with enhanced symmetry algebras, known as rational conformal field theories, are examples of non-trivial strongly interacting quantum field theories. These additional symmetries render the theories exactly solvable through algebraic methods. It is therefore a natural question to ask how these rational conformal field theories are distributed within the broader space of all two-dimensional conformal field theories. In this talk, I will demonstrate how number theoretic properties of rational conformal field theories can be used to formulate this distribution problem in a mathematically rigorous way and to provide novel insides.

Invited Talk MP 7.5 Wed 17:45 ZHG001

A BPS Road to Holography: Decoupling Limits and Non-Lorentzian Geometries — •Niels Obers — Niels Bohr Institute, Copenhagen, Denmark

I explore decoupling limits that lead to matrix theories on D-branes, focusing on their BPS nature and the emergence of non-Lorentzian target space geometries. In these limits, D-branes experience instantaneous gravitational forces, and when applied to curved geometries, it is shown that a single decoupling limit leads to the AdS/CFT correspondence. By applying two such limits, we generate new holographic examples, including those with non-Lorentzian bulk geometries.

We also examine the relationship between matrix theories and non-relativistic string theory, and their uplift to M-theory. Finally, we demonstrate that reversing these decoupling limits corresponds to deformations of matrix theories, connecting them to the TTbar deformation in two dimensions. These deformations provide a new perspective on the near-horizon brane geometry and lead to TTbar-like flow equations for the Dp-brane DBI action.