MP 11: AdS/CFT: Complexity

Time: Wednesday 14:15–15:35 Location: H-HS I

MP 11.1 Wed 14:15 H-HS I

Complexity for Quantum Fields: Subregions, Mixed States and Purifications — •Hugo Antonio Camargo Montero — Albert Einstein Institute, Potsdam, Germany

In this talk we explore the notion of complexity in quantum field theories. We first apply the notion of circuit complexity to a quantum quench through a critical point in 1+1 dimensions. We apply this setup to a Gaussian state with two degrees of freedom, where we quantify the complexity of purification associated with a subregion, and show that complexity is capable of probing features to which the entanglement entropy is insensitive. We find that the complexity of subregions is subadditive, and comment on potential implications for holography. We also discuss upcoming work regarding the study of complexity of purification for mixed Gaussian states with a large number of degrees of freedom. In the second part of the talk, we enter the recent discussion involving the two definitions of complexity in field theories, namely circuit complexity and path integral complexity. We focus on two-dimensional conformal field theories (CFTs) where we provide a measure for the circuit complexity associated to the unnormalized thermal density matrix $\rho = \exp(-\beta H)$. We show that the Liouville action, which is the path integral complexity measure for ρ, is an approximation to a genuine circuit complexity measure.

MP 11.2 Wed 14:35 H-HS I

Virasoro complexity and circuits as geodesic motion in infinite dimensions — •Mario Flory[1] and Michał P. Heller[2] — [1]Institute of Physics, Jagiellonian University, 30-348 Kraków, Poland — [2]Albert Einstein Institute, 14476 Potsdam, Germany

We utilize the Fubini-Study metric in order to define a notion of distance and hence circuit complexity on the Virasoro group. The resulting problem is mathematically equivalent to geodesic motion in infinite dimensions, with integro-differential equations of motion. We discuss the properties of these equations and of their solutions.

MP 11.3 Wed 14:55 H-HS I

Realizing Computational Complexity in Conformal Field Theory with Kac-Moody Symmetry — Johanna Erdmenger, Marius Gerbershagen, and •Anna-Lena Weigel — Institute for Theoretical Physics and Astrophysics, Julius-Maximilians-Universität Würzburg, 97074 Würzburg, Germany

An important question for the AdS/CFT correspondence is how the bulk geometry is encoded in the boundary field theory. A useful quantity proposed in this context is computational complexity. This is a concept adapted from quantum information that counts the minimum number of simple steps, gates, necessary to perform a calculation. While there exist concrete proposals for complexity in the AdS gravity theory, it remains an open question how to define it in a CFT. To make progress in this direction, a recent proposal suggests to restrict the allowed set of gates to symmetry transformations. This was employed to compute complexity for conformal transformations in 2d CFTs [1]. We generalize this approach to Kac-Moody symmetries and show that the complexity is equal to actions defined on coadjoint orbits of the according symmetry group. In this way, we calculate the complexity for several examples of CFTs [2]. The coadjoint orbit actions also arise from 3d gravity theory. We comment on connections between these gravity actions and complexity.

[1] P. Caputa, J. Magan. "Quantum Computation as Gravity". In: Phys. Rev. Lett. 122 (2019), p. 231302. arXiv:1807.04422 [hep-th].

[2] J. Erdmenger, M. Gerbershagen, A. Weigel, to appear.

MP 11.4 Wed 15:15 H-HS I

Holographic complexity with TT deformation — •Souvik Banerjee, Johanna Erdmenger, and Emma Loos — Julius-Maximilians-University Würzburg, Würzburg, Germany

TT deformed CFTs are dual to semiclassical gravity in AdS spacetime with a finite radial cutoff. Complexity of boundary CFT operators, on the other hand, has an intimate connection to radial depth in the bulk. The duality between TT deformed CFTs and gravitational physics at a cut off AdS spacetime will therefore be an ideal playground to test holographic proposals for complexity. This also helps in understanding quantitatively and explicitly, the renormalization group flow in the bulk and thereby explaining the emergence of AdS spacetime in the tensor network like cMERA.