Black Holes and Holography

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Rong-Gen Cai , Institute of Theoretical Physics, Chinese Academy of Sciences

Title: TBA

Abstract: TBA

Bartek Czech, Institute for Advanced Study, Tsinghua University

Title: How to glue a spacetime from entanglement wedges

Abstract: If a holographic bulk spacetime is built out of quantum entanglement in the boundary theory, how do we understand the bulk connection? To inspect the entanglement structure of a boundary state, we dissect it into components and look at their quantum correlations. Each boundary component reconstructs a region of the bulk called entanglement wedge. The entanglement wedge (and its corresponding component subregion of the boundary) has an internal symmetry called modular flow, which has two properties that will be useful for our purposes. First, modular flow is a gauge symmetry because it relates to one another different ways of presenting the same physical system–the entanglement wedge. Second, modular flow is a generalization of choosing the phase of a pure quantum state in a Hilbert space. When we glue together two overlapping entanglement wedges to build a larger spacetime, we must specify how to map the observables in the first wedge (presented in some modular frame–in some gauge) to observables in the second wedge (also presented in some gauge). Thus, gluing together two component subregions of the boundary–as well as two entanglement wedges–requires a connection that relates their respective modular frames. This connection is analogous to specifying the phase of a quantum state that evolves under a time-dependent Hamiltonian, that is the Berry phase. I argue that the modular Berry connection is the boundary origin of the usual, geometric connection in the bulk. I will sketch some subtleties in the formal construction of the modular Berry connection, give examples and list key questions for the future.

Stephane Detournay, Universite Libre de Bruxelles

Title: AdS-free black objects

Abstract: Most known black holes in 3 dimensional space-times have an entropy that can be accounted for by Cardy-type counting formulas. In almost all of these cases, the match can be traced back to the presence of an (A)dS factor either in the asymptotic or the near-horizon regions. In this talk I will focus on space-times devoid of this property and discuss some of their geometric and thermodynamic properties.

Finn Larsen, University of Michigan

Title: TBA

Abstract: TBA

Matthias Gaberdiel, ETH Zurich

Title: The worldsheet dual of the symmetric orbifold CFT

Abstract: Superstring theory on $\mathrm{AdS}_3 \times \mathrm{S}^3 \times \mathrm{T}^4$ with the smallest amount of NS-NS flux ($k = 1$) is shown to be dual to the spacetime CFT given by the large N limit of the free symmetric product orbifold $\mathrm{Sym}_N(\mathrm{T}^4)$. To define the worldsheet theory at $k = 1$, we employ the hybrid formalism in which the $\mathrm{AdS}_3 \times \mathrm{S}^3$ part is described by the $psu(1, 1|2)_1$ WZW model (which is well defined). Unlike the case for $k \geq 2$, it turns out that the string spectrum at $k = 1$ does not exhibit the long string continuum, and perfectly matches with the large N limit of the symmetric product. We also demonstrate that the fusion rules of the symmetric orbifold are reproduced from the worldsheet perspective. Our proposal therefore affords a tractable worldsheet description of a tensionless limit in string theory, for which the dual CFT is also explicitly known.

Ping Gao, Harvard University

Title: Regenesis and quantum traversable wormholes

Abstract: Recent gravity discussions of a traversable wormhole indicate that in holographic systems signals generated by a source could reappear long after they have dissipated, with the need of only performing some simple operations.

In this talk I will argue the phenomenon, to which I refer as "regenesis", is universal in general quantum chaotic many-body systems, and elucidate its underlying physics. The essential elements behind the phenomenon are: (i) scrambling which in a chaotic system makes out-of-time-ordered correlation functions (OTOCs) vanish at large times; (ii) the entanglement structure of the state of the system. The latter aspect also implies that the regenesis phenomenon requires fine tuning of the initial state. Compared to other manifestations of quantum chaos such as the initial growth of OTOCs which deals with early times, and a random matrix-type energy spectrum which reflects very large time behavior, regenesis concerns with intermediate times, of order the scrambling time of a system.

In this talk I will illustrate this phenomenon in detail in general two-dimensional conformal field theories in the large central charge limit, and highlight some interesting features including a resonant enhancement of regenesis signals near the scrambling time and their oscillations in coupling. Finally, I will discuss gravity implications of the phenomenon for systems with a gravity dual, arguing that there exist regimes for which traversability of a wormhole is quantum in nature, i.e. cannot be associated with a semi-classical spacetime causal structure.

Sebastian De Haro, University of Amsterdam

Title: Noether's Theorem and Gauge-Gravity Duality

Abstract: 100 years ago, Emmy Noether published two theorems relating symmetries and physical quantities, which continue to be a source of inspiration for symmetry arguments

in physics, and for the interpretation of symmetry in philosophy.

After reviewing some of the consequences of Noether's theorem in general relativity, in particular the existence of various energy-momentum pseudo-tensors, I will review the definition of the holographic stress-energy tensor in gauge-gravity dualities, in connection with those ambiguities.

Peng-xiang Hao, Peking University

Title: TBA

Abstract: TBA

Ling-Yan Hung, Fudan University

Title: TBA

Abstract: TBA

Joonho Kim, Korea Institute for Advanced Study

Title: TBA

Abstract: TBA

Wei Li, Institute of Theoretical Physics, Chinese Academy of Sciences

Title: How to glue plane partitions to construct new VOAs/affine Yangians.

Abstract: There exists a useful triangle connecting W symmetry, affine Yangian, and plane partition representations. Further, this triangle can serve as the building block for new VOA's and affine Yangians. I will explain the gluing procedure in this construction.

Hai Lin, Tsinghua University

Title: TBA

Abstract: TBA

Jiang Long, Asia Pacific Center for Theoretical Physics

Title: Spin and Higher Multipole Corrections to IMRIs

Abstract: We present analytic results of gravitational waveforms from Intermediate mass ratio inspirals (IMRIs) around near extremal Kerr black holes by including spin and higher multipole corrections in the framework of Mathisson-Papapetrou-Dixon formalism. The observational frequency and critical angular momentum are modified by the spin and higher multipole effects. We also show that there is an enhancement factor for the waveform when the angular momentum becomes critical.

Jianxin Lu, The Interdisciplinary Center for Theoretical Study, USTC

Title: On the open string pair production enhancement

Abstract: In this talk, I will first explain that there is no open string pair production for an isolated Dp brane in Type II superstring theories even if a worldvolume electric flux is applied. Further I will explain that this pair production can indeed occur for a system of two Dp branes, placed parallel at a separation, with each carrying a different electric flux. I will then move to discuss the enhancement of this pair production by adding a different magnetic flux on each Dp in a certain way and explain the largest enhancement occurs for $p = 3$ for the same applied electric and magnetic fluxes. I will address from different angles the underlying physical reason for this enhancement.

Ioannis Papadimitriou, Korea Institute for Advanced Study

Title: TBA

Abstract: TBA

Huajia Wang, University of California Santa Barbara

Title: TBA

Abstract: TBA

Yi Wang, Hong Kong University

Title: Inflation as a Cosmological Collider

Abstract: The conventional way to study high energy particle physics is to build particle colliders. In fact, the nature has already built a ?collider? running at unprecedentedly high energy (up to 10^13 GeV): During cosmic inflation, high energy particles (up to the Hubble scale of inflation) are produced and interacts with each other. The relics of the interaction are imprinted in the density fluctuations of our current universe in a unique and model-independent way. By measuring the correlations of these density fluctuations, the particle spectrum and interactions at the energy scale of inflation can be reconstructed. This is known as the cosmological collider physics. In this talk, the cosmological collider physics, and the corresponding signature for the Standard Model are reviewed. We also discuss how the expansion history of the primordial universe can be measured by the same process.

Jie-qiang Wu, MIT

Title: Covariant phase space with boundaries

Abstract: TBA

Jianfei Xu, Shing-Tung Yau Center and School of Mathematics, Southeast University

Title: Structure constants from modularity in warped CFT

Abstract: Warped Conformal Field Theory (WCFT) is a two dimensional quantum field theory described by a chiral Virasoro and U(1) Kac-Moody algebra. We derive the average value of heavy-heavy-light three-point coefficient for WCFT and find its dual picture in a bulk AdS3 with Compere-Song-Strominger boundary conditions. The WCFT calculation amounts to the calculation of a one-point function on torus, whose high temperature limit can be approximated by using modular covariance of WCFT, similar to the derivation of Cardy formula. Using the holographic dictionary for AdS3/WCFT, the bulk process is a tadpole diagram, with a massive spinning particle propagates from the infinity to horizon, and splits into particle and antiparticle which annihilate after going around the horizon. Under the WKB approximation, the bulk process can be calculated by the on-shell worldline action of massive spinning particles, which successfully reproduces the average value of the heavy-heavy-light three-point coefficient for the WCFT up to some normalization factors. Our result indicates that the black hole geometries in asymptotically AdS3 spacetimes can emerge upon course graining over microstates in WCFTs.

Zhenbin Yang, Princeton University

Title: A black hole as a particle

Abstract: We study the quantum effects of Near-Extremal black holes near their horizons. The gravitational dynamics in such backgrounds are closely connected to a particle in 2 with constant electric field. We use this picture to solve the theory exactly. We will give a formula to calculate all correlation functions with quantum gravity backreactions as well as the exact Wheeler-DeWitt wavefunction. Using the WdW wavefunction, we investigate the complexity growth in quantum gravity.