# Black Hole Information in Holography and String Theory



# Report of Contributions

Contribution ID: **1**　　　　　　　　　　　　　　　　Type: **not specified**

# Welcome Address

*Saturday 8 February 2025 09:15 (15 minutes)*

Speaker: Sudhir K. Vempati
Chair CHEP

Contribution ID: **2**                                                        Type: **not specified**

# Quantising JT Gravity and It's Extensions (Sandip Trivedi)

*Saturday 8 February 2025 09:30 (45 minutes)*

Speaker: Sandip Trivedi

Abstract: We will discuss the canonical quantisation of Jackiw - Teitleboim Gravity, and similar models, in 2 dimensions.

Contribution ID: **3**                                        Type: **not specified**

# Black Holes and Higher Derivative Gravity (Nilay Kundu)

*Saturday 8 February 2025 10:15 (45 minutes)*

Speaker: Nilay Kundu

Contribution ID: **4** Type: **not specified**

# Coffee Break

*Saturday 8 February 2025 11:00 (30 minutes)*

Contribution ID: **5**                                               Type: **not specified**

# Index for Black Holes in N=2 Supergravity (Amitabh Virmani)

*Saturday 8 February 2025 11:30 (45 minutes)*

Speaker : Amitabh Virmani

Abstract:
We compute the supersymmetric index of half BPS black holes in N=2 supergravity with higher curvature corrections and show that the result agrees with the degeneracy of supersymmetric extremal black holes carrying the same charges.

Contribution ID: **6** Type: **not specified**

# The Black hole IR triangle (Nava Gaddam)

*Saturday 8 February 2025 12:15 (45 minutes)*

Speaker: Nava Gaddam

Abstract:

I will argue that there is an emergent infrared triangle near the horizon of a black hole, analogous to the one in flat space. In scalar QED in a Schwarzschild background, I will show that the Ward identities corresponding to near-horizon asymptotic symmetries match exactly with a new emergent leading soft photon theorem that can be derived in an effective field theory near the horizon. Finally, the soft factor is related to a near-horizon memory effect via a Fourier transform. I will argue that the story generalises to gravitational perturbations. I will conclude with speculations on the impact of these soft modes on the validity of effective field theory in quantum gravity.

Contribution ID: **7**                                          Type: **not specified**

# Lunch Break

*Saturday 8 February 2025 13:00 (1h 30m)*

Contribution ID: **8**                                        Type: **not specified**

# Wigner negativity, Random matrices and Gravity (Onkar Parikar)

*Saturday 8 February 2025 14:30 (45 minutes)*

Speaker: Onkar Parikar

Abstract:

For any state in a D-dimensional Hilbert space with a choice of an ordered basis, one can define a discrete version of the Wigner function —a quasi-probability distribution which represents the state on a discrete phase space. The Wigner function can, in general, take on negative values, and the amount of negativity in the Wigner function of a state can be interpreted as a measure of the "non-classicality" of the state from several points of view. In this talk, we will study the growth of Wigner negativity for a generic initial state under time evolution with chaotic Hamiltonians. We first give a perturbative argument to show that a certain special choice of basis – called the Krylov basis – minimizes the early time growth of Wigner negativity in the large D limit. Using tools from random matrix theory, we then show that for a generic choice of basis, the Wigner negativity becomes exponentially large in an O(1) amount of time evolution. On the other hand, in the Krylov basis, the negativity grows gradually (i.e., as a power law) for an exponential amount of time, before saturating close to its maximum value. We take this as evidence that the Krylov basis is ideally suited for a dual, semi-classical effective description of chaotic quantum dynamics at large D. We propose that this effective description is akin to the dual gravitational description in the AdS/CFT correspondence.

Contribution ID: **9**                                                                 Type: **not specified**

# TBA(Debjyoti Sarkar)

*Saturday 8 February 2025 15:15 (45 minutes)*

Speaker : Debjyoti Sarkar

Contribution ID: **10** Type: **not specified**

# Coffee Break

*Saturday 8 February 2025 16:00 (30 minutes)*

Contribution ID: **11**                                    Type: **not specified**

# Black(ish) Holes (Arnab Kundu)

*Saturday 8 February 2025 16:30 (45 minutes)*

Speaker: Arnab Kundu

Abstract: In this talk, we will review some recent progress on
understanding how an ad hoc Dirichlet boundary that is placed in front of
an event-horizon can capture certain quantum chaotic features of the black
hole one-loop determinant sector. We will further discuss how quasi-normal
modes are encoded within the corresponding normal modes. We will also
comment on how this emergence of quasi-normal modes is connected to a
notion of "weak" and a "strong" thermalization, as well as associated
thermal features.

Contribution ID: **12**                                                        Type: **not specified**

# Topics in von Neumann algebras and semiclassical gravity (Suneeta Varadarajan)

*Sunday 9 February 2025 09:30 (45 minutes)*

Speaker : Suneeta Varadarajan

Abstract: The generalized second law (GSL) in semiclassical gravity was proposed in order that the second law of thermodynamics be valid near black holes. We first discuss a proof of the GSL using crossed product constructions in von Neumann algebras. Next we discuss a recent idea by Gesteau and Liu to describe stringy horizons holographically in a purely von Neumann (boundary) algebraic language . We describe its connection to causal structure in higher curvature gravity.

Contribution ID: **13**                                              Type: **not specified**

# TBA (Gautam Mandal)

*Sunday 9 February 2025 10:15 (45 minutes)*

Speaker: Gautam mandal

Contribution ID: **14**                                          Type: **not specified**

# Coffee Break

*Sunday 9 February 2025 11:00 (30 minutes)*

Contribution ID: **15**

Type: **not specified**

# Supersymmetric deformations of $AdS_3 \times S^3$ and hair modes (Yogesh Srivastava)

*Sunday 9 February 2025 11:30 (45 minutes)*

Speaker: Yogesh Srivastava

Abstract: The 4D-5D connection allows us to view the near-horizon geometry as part of a 4D Black Hole or a 5D Black Hole. The discrepancy between the entropy/index in the two cases is resolved by introducing hair modes which live outside the horizon. After a review, we discuss the construction and analysis of modes in Poincare AdS_3 ×Sˆ3 which connect to hair modes in the full Black Hole spacetime. We do the same for global $AdS_3 X S^3$. We compare and contrast these near-horizon modes with analogous "hair" modes in other approaches.

Contribution ID: **16**
Type: **not specified**

# Statistical chaos in excited string scattering (Diptarka Das)

*Sunday 9 February 2025 12:15 (45 minutes)*

Speaker: Diptarka Das

Abstract : We review recent amplitude results in tree level bosonic string theory that involve highly excited string states. We show how random matrix correlations are present in these scattering amplitudes. We conclude by highlighting certain semiclassical and asymptotic features of these amplitudes which lend support to the Horowitz-Polchinski-Susskind black hole correspondence.

Contribution ID: **17** Type: **not specified**

# Lunch Break

*Sunday 9 February 2025 13:00 (1h 30m)*

Contribution ID: **18**            Type: **not specified**

# Quantum fields on maximal slices (Anurag Kaushal )

*Sunday 9 February 2025 14:30 (45 minutes)*

Speaker: Anurag Kaushal

Abstract: We study the semi-classical dynamics of a scalar field in the background of a black hole in an asymptotically AdS (AAdS) spacetime, in the framework of the Hamiltonian formulation of General Relativity. The small diffeomorphism (gauge) symmetries generated by the Hamiltonian and momentum constraints are completely fixed by the maximal slicing and spatial harmonic/Dirac gauge conditions after which the residual phase space degrees of freedom are gauge invariant. While many of our results are valid for AAdS$_{d+1}$ spacetimes, we mainly discuss the $d = 2$ case of the static BTZ solution. We present the explicit solution for the smooth maximal slicing of the fully extended BTZ solution where the spatial slices cut across the horizons, asymptote to the usual Schwarzschild slices, do not include the past and future singularities, and for which the lapse remains non-zero at the bifurcate point. We also derive unique large diffeomorphisms that asymptote to time translations on both boundaries in the maximal slicing gauge.

We present the solution of the scalar field wave equation in this gauge in terms of its boundary values which correspond to boundary CFT operators by the AdS/CFT dictionary. We explicitly construct the finite, time-dependent Hamiltonian in terms of a discrete set of mode functions of the scalar field that are smooth and differentiable across the horizons of the fully extended BTZ black hole. These modes mix the boundary operators from the two sides and are appropriate linear combinations of the Hartle-Hawking-Unruh modes. This Hamiltonian is an operator in the product of the two CFTs associated to the two boundaries and describes the time evolution of CFT operators. Our results are valid for evolution times smaller than the scrambling time during which the fully extended BTZ solution continues to be a valid saddle point of the quantum gravity path integral.

Contribution ID: **19**                                                        Type: **not specified**

# Holographic observers for time band algebras
# (Suvrat Raju)

*Sunday 9 February 2025 15:15 (45 minutes)*

Speaker: Suvrat Raju

Abstract: We study the algebra of observables in a time band on the boundary of anti-de Sitter space in a theory of quantum gravity. Strictly speaking this algebra does not have a commutant because products of operators within the time band gives rise to operators outside the time band. We show that in a state where the bulk contains a macroscopic observer, it is possible to design a coarse-grained version of this algebra with a non-trivial commutant, a resolution limited by the observer's characteristics. This algebra acts on a little Hilbert space that describes excitations above the observer's state and time-translated versions of this state. Our construction requires a choice of dressing that determines how elements of the algebra transforms under the Hamiltonian. At leading order in gravitational perturbation theory, and with a specific choice of dressing, our construction reduces to the modular crossed-product described previously in the literature.

Contribution ID: **20** Type: **not specified**

# Coffee Break

*Sunday 9 February 2025 16:00 (30 minutes)*

Contribution ID: **21**

Type: **not specified**

# Black Holes and Higher Derivative Gravity (Nilay Kundu)

Speaker: Nilay Kundu

Contribution ID: **22**                                               Type: **not specified**

# Thank you Ceremony

*Sunday 9 February 2025 16:30 (15 minutes)*