Black holes and strongly coupled thermal dynamics: June 2-6, 2025

Events for:
Monday, June 2nd - Friday, June 6th

Monday, June 2nd

9:00am **Workshop: Breakfast - SCGP Cafe**

Title: Breakfast

10:00am **Workshop: Thomas Hartman - SCGP 102**

Speaker: Thomas Hartman

Title: Replica manifolds, pole skipping, and the butterfly effect

Abstract: In holographic theories, the butterfly velocity can be defined two different ways, using out-of-time-order correlators (OTOCs) or entanglement wedge reconstruction. There are many calculations showing that the two velocities are equal, including higher curvature corrections, but there was no explanation for this apparent coincidence. I will show that it follows from a deeper relationship between replica manifolds, shockwaves, and the pole skipping mode in the thermal 2-point function.

10:45am **Workshop: Coffee Break - SCGP Cafe**

Title: Coffee Break

11:15am **Workshop: Kristan Jensen - SCGP 102**

Speaker: Kristan Jensen

Title: Wormholes and random matrix statistics in pure 3d supergravity

Abstract: I will discuss the torus times interval wormhole amplitude of simple models of pure gravity in three dimensions, including pure minimal supergravity, and the connection between this amplitude and random matrix statistics in a putative ensemble of dual (S)CFTs. These wormholes reproduce the expected level statistics in CFT only when all bulk symmetries are gauged, including CRT and fermion number when it exists.

12:00pm **Workshop: Lunch - SCGP Cafe**

Title: Lunch

2:00pm **Workshop: Benjamin Withers - SCGP 102**

Speaker: Benjamin Withers

Title: Quasinormal mode orthogonality in AdS

Abstract: Quasinormal modes of black holes in AdS are eigenfunctions of a non-normal Hamiltonian, arising from the dissipative nature of the horizon. As such they are not orthogonal to each other in a standard sense due to a lack of an associated spectral theorem. I will discuss some physical consequences of this and show how it is still possible to construct an orthogonality relation among them.

2:45pm **Workshop: Roberto Emparan - SCGP 102**

Speaker: Roberto Emparan

Title: Probing the Quantum Regime of Near-Extremal Black Holes

Abstract: Can large, controllable quantum fluctuations of spacetime geometry be observed? We investigate how to probe the quantum throat of a near-extremal black hole, where the dynamics are governed by the Schwarzian theory. To this end, we study the scattering of a low- frequency wave of a massless scalar field off the black hole and compute the resulting absorption cross-section, uncovering distinctive quantum effects. In the semiclassical regime, we recover the universal result that the cross-section equals the horizon area. However, in the regime where quantum fluctuations dominate, we find that the absorption cross-section exceeds the semiclassical prediction, since quantum fluctuations greatly enhance transitions between black hole states. Therefore, a measurement showing an enhanced absorption cross-section serves as a clear signature of the large quantum fluctuations in the geometry. The absorption of other waves also reveals characteristic features in the quantum regime.

3:30pm **Workshop: Tea Time - SCGP Cafe**

Title: Tea Time

4:00pm **Workshop: Netta Engelhardt - SCGP 102**

Speaker: Netta Engelhardt

Title: Further Evidence Against a Semiclassical Baby Universe

Abstract: A number of recent arguments have suggested that baby universes in quantum gravity have a one-dimensional Hilbert space. I will provide a new argument, based on work with E. Gesteau, in favor of this conclusion. The argument makes use of a standard asymptotically AdS spacetime dual to a thermal state below the Hawking-Page transition. In particular, there is a low-energy, low-complexity causal wedge operator whose expectation value in the dual CFT is only consistent with a one-dimensional Hilbert space for baby universes. I will discuss upcoming work with E. Gesteau and D. Harlow, in which we find that incorporating observers changes the expectation value of this operator appropriately.

Tuesday, June 3rd

9:00am **Workshop: Breakfast - SCGP Cafe**

Title: Breakfast

10:00am **Workshop: Daniel Harlow - SCGP 102**

Speaker: Daniel Harlow

Title: Quantum mechanics and observers for quantum gravity in a closed universe

Abstract: I will discuss recent work trying to make sense of the idea that the Hilbert space of quantum gravity in a closed universe is one dimensional. This apparently crazy statement seems to be a consequence of ideas which lead to reasonable results in the context of black holes, and I will propose that a careful treatment of the observer doing experiments in a closed universe leads to a theory with the emergence of a nontrivial semiclassical spacetime in the closed universe.

10:45am **Workshop: Coffee Break - SCGP Cafe**

Title: Coffee Break

11:15am **Workshop: Adam Levine - SCGP 102**

Speaker: Adam Levine

Title: The black hole singularity in 2D dilaton gravity

Abstract: I will review some classical and quantum aspects of the spacelike black hole singularity in 2D dilaton gravity with an exponential dilaton potential, largely following arXiv:2402.10162.

12:00pm **- SCGP Lobby**

Title: Group Photo

12:00pm **Workshop: Lunch - SCGP Cafe**

Title: Lunch

2:00pm **Workshop: Jerome Gauntlett - SCGP 102**

Speaker: Jerome Gauntlett

Title: Computing with supergravity the easy way

Abstract: Important BPS quantities, including the black hole entropy and the on-shell action, can be computed for supersymmetric solutions of supergravity without ever solving the Einstein equations or the Killing spinor equations. Instead one exploits the fact that the solutions generically have a Killing vector and a set of equivariantly closed forms. This allows one to compute just by inputting some topologically information and utilising the Atiyah-Bott-Berligne-Verne localisation theorem. We explain the formalism and illustrate with some examples.

2:45pm **Workshop: Mukund Rangamani - SCGP 102**

Speaker: Mukund Rangamani

Title: Holographic thermal correlators and quasinormal modes from semiclassical Virasoro blocks

Abstract: I will describe how 2d CFT techniques help in determining real-time thermal correlation functions in holographic CFTs in four dimensions. The expressions for the holographic correlators in fact, closely resemble the well known results for 2d thermal CFTs. This structural similarity stems from the locality of fusion transformation for Virasoro blocks. I will also discuss the application of our results to understand specific physical properties of QNMs, including their near-extremal and asymptotic limits.

3:30pm **Workshop: Tea Time - SCGP Cafe**

Title: Tea Time

4:00pm **Workshop: Gustavo Turiaci - SCGP 102**

Speaker: Gustavo Turiaci

Title: Quantum Effects in Extremal Black Holes and in Cosmology

Abstract: Quantum gravity effects become increasingly significant as we approach the black hole extremal limit. This has been mostly studied in a low-temperature expansion exploiting an effective 2d description near the horizon. I will outline how to reproduce these results from a higher-dimension perspective at finite temperature. Next, I will describe a problem in cosmology on universes with S1 x S2 spatial slices that is resolved by similar quantum corrections. Finally I will comment on the connection to the pair production rate of black holes in inflating spacetimes.

Wednesday, June 4th

9:00am **Workshop: Breakfast - SCGP Cafe**

Title: Breakfast

10:00am **Workshop: Sean Hartnoll - SCGP 102**

Speaker: Sean Hartnoll

Title: The conformal primon gas at the end of time

Abstract: It is believed, following the work of BKL 50 years ago, that the classical dynamics of general relativity greatly simplifies close to singularities such as those inside black holes. Each point in space evolves separately, with dynamics that is equivalent to the motion of a particle bouncing within the fundamental domain of the modular group. I will explain how the emergent conformal and modular symmetries in this regime suggest possible dual formulations of the physics. The mathematical language that pertains is that of L-functions. These share key properties of the Riemann zeta function, including nontrivial zeros and a representation in terms of prime numbers. I will describe the physical consequences of these facts.

10:45am **Workshop: Coffee Break - SCGP Cafe**

Title: Coffee Break

11:15am **Workshop: Simon Caron-Huot - SCGP 102**

Speaker: Simon Caron-Huot

Title: Imaging behind the horizon

Abstract: Does the interior geometry of a black hole answer well-defined questions about its exterior? We generalize known relations involving two-point correlators to spectral density tails and to four-point correlators. The latter enable direct measurements of the past lightcone of various interior points. Details about the interior tunnel to the exterior at the cost of a Boltzmann suppression exp(-1/(2Tx)), where x is the desired spatial resolution. We comment on the relation (or lack thereof) between such exterior measurements and the experience of infalling observers.

12:00pm **Workshop: Lunch - SCGP Cafe**

Title: Lunch

2:00pm **Workshop: Vladimir Rosenhaus - SCGP 102**

Speaker: Vladimir Rosenhaus

Title: Renormalization Group in far-from-equilibrium states

Abstract: We study renormalization group flows in far-from-equilibrium states. The study is made tractable by focusing on states that are spatially homogeneous, time-independent, and scale invariant. Such states, in which mode k has occupation number $n_k = k^{-\gamma}$, are well-known in nonlinear physics (going under the name of wave turbulence). RG flow in such states is qualitatively different than in the vacuum -- a positive γ decreases the dimension of an operator, turning marginal interactions into relevant interactions. We compute one loop beta functions. Depending on the sign of the beta function, backreaction may either cause a minor shift of the state in the IR, or completely change the nature of the state. Focusing on nearly marginal interactions, we construct an analog of the epsilon expansion and IR fixed points, with epsilon now set by the scaling of the interaction rather than the spacetime dimension. In the language of RG flow, critical balance scaling -- having applications in fields as varied as astrophysics and ocean waves -- corresponds to the state dynamically adjusting itself along the RG flow until the interaction becomes marginal.

3:30pm **Workshop: Tea Time - SCGP Cafe**

Title: Tea Time

6:00pm **Workshop: Banquet Dinner - SCGP Cafe**

Title: Banquet Dinner

Thursday, June 5th

9:00am **Workshop: Breakfast - SCGP Cafe**

Title: Breakfast

10:00am **Workshop: Johanna Erdmenger - SCGP 102**

Speaker: Johanna Erdmenger

Title: Non-locality induces isometry and factorisation in holography

Abstract: In holography, two manifestations of the black hole information paradox are given by the non-isometric nature of the bulk-boundary map and by the factorisation puzzle. By considering time-shifted microstates of the eternal black hole, we demonstrate that both these puzzles may be simultaneously resolved by taking into account non-local quantum corrections that correspond to wormholes arising from state averaging. This is achieved by showing, using a resolvent technique, that the resulting Hilbert space for an eternal black hole in Anti-de Sitter space is finite-dimensional with a discrete energy spectrum. The latter gives rise to a transition to a type I von Neumann algebra. Based on 2411.09616.

10:45am **Workshop: Coffee Break - SCGP Cafe**

Title: Coffee Break

11:15am **Workshop: Jan de Boer - SCGP 102**

Speaker: Jan de Boer

Title: The statistics of 3d gravity

Abstract: I will summarize the statistical interpretation of the gravitational path integral, and describe some recent work applying these ideas to pure 3d gravity with a negative cosmological constant.

12:00pm **Workshop: Lunch - SCGP Cafe**

Title: Lunch

2:00pm **Workshop: Natalia Pinzani Fokeeva - SCGP 102**

Speaker: Natalia Pinzani Fokeeva

Title: New horizon symmetries, hydrodynamics, and chaos

Abstract: A local reparameterization symmetry is required to write fluid dynamics from a modern, effective field theory point of view. Curiously, black hole horizons possess the same redundancy. In this talk, I will show how asymptotic symmetries of horizons can be interpreted as symmetries of a dual hydrodynamic theory in the context of holography. In addition, I will show how the horizon structure leads to additional symmetries responsible for the dual theory's chaotic behavior.

2:45pm **Workshop: Ping Gao - SCGP 102**

Speaker: Ping Gao

Title: A unified effective field theory for non-maximal quantum chaos in general dimensions

Abstract: In this talk, I will introduce a construction of an EFT for non-maximal quantum chaos in general dimensions. Unlike the maximal chaos, we require a pair of complex scalars as the effective fields for the dynamics of non-maximal chaos. For a pair of few-body operators, it has a vertex expansion almost locally coupled to the effective fields in an appropriate way. Any four-point function of two pairs of few-body operators is dominated by the exchange of the effective fields in the chaotic regime. We impose shift symmetries to both the vertex expansion and the effective action to guarantee the exponential growth of OTOC and the non-exponential growth of TOC. Including higher-order exchanges of effective fields leads to an exponentiation formula similar to the stringy scattering near an AdS black hole horizon. To illustrate that our EFT is universal, we successfully construct the effective fields from three essentially different microscopic theories: conformal Regge theory, SYK model, and SYK chain. We find that they all share the same essential structures and are described by our EFT in a unified way. If time permits, I will briefly discuss a few applications of the EFT.

3:30pm **Workshop: Tea Time - SCGP Cafe**

Title: Tea Time

4:00pm **Workshop: Nejc Ceplak - SCGP 102**

Speaker: Nejc Ceplak

Title: Black Hole Singularity from OPE

Abstract: Black hole singularities leave distinct imprints on holographic correlators, traceable to bouncing geodesics: null geodesics that begin on one boundary of an eternal AdS black hole, reflect off the singularity, and reach the opposite boundary. Using the Operator ProductExpansion (OPE), I will show that singularities in the stress-tensor sector of the holographic correlator occur precisely at positions predicted by these geodesics, establishing a direct connection between black hole singularities and the analytic structure of holographic correlators. I will also discuss how complexified geodesics—crucial for capturing the full correlator—correspond to contributions from double-trace operators in the CFT. If time permits, I will outline ongoing extensions to charged black holes, whose richer causal structure offers new insights into these holographic signatures.

Friday, June 6th

9:00am **Workshop: Breakfast - SCGP Cafe**

Title: Breakfast

10:00am **Workshop: Erik Verlinde - SCGP 102**

Speaker: Erik Verlinde

Title: span>An Algebraic Approach to Black Hole Evaporation and Complexit

Abstract: We study the black hole information process in the G to zero limit near the Page time in terms of the emergent type III von Neumann algebra. We start by reviewing the theory of algebra inclusions and introduce the concepts of conditional expectations and the Jones-Kosaki index. We argue that the black hole evaporation process involves algebra inclusions of algebras that allow for conditional expectations with finite index. We express the difference in the von Neumann entropy during the evaporation process in terms of these quantities and explain the origin of the Page curve. We also describe the notions of entanglement Islands, computational complexity and non-isometric codes in terms of the emergent type III algebra.

10:45am **Workshop: Coffee Break - SCGP Cafe**

Title: Coffee Break

11:15am **Workshop: Silviu Pufu - SCGP 102**

Speaker: Silviu Pufu

Title: Higher-derivative corrections to supergravity from bootstrap and localization

Abstract: I will review what one can learn about higher-derivative corrections in string theory and M-theory from combining analytical and/or numerical bootstrap techniques with exact results from supersymmetric localization. The bootstrap study will focus on maximally supersymmetric theories in 3 and 4 dimensions, with input from integrated correlators that can be computed exactly in ABJM theory and N = 4 super-Yang-Mills theory, respectively.

12:00pm **Workshop: Lunch - SCGP Cafe**

Title: Lunch

3:30pm **Workshop: Tea Time - SCGP Cafe**

Title: Tea Time