

Flat Holography on Workshop Talk Schedule

Events for:
Monday, April 4th - Friday, April 8th

Monday, April 4th

9:30am **Eric Bergshoeff - SCGP 102**

Title: Applied Newton-Cartan Geometry

Abstract: Recently, non-relativistic geometry and gravity, also known as Newton-Cartan geometry and gravity, have found interesting applications both in non-AdS holography as well as in condensed matter physics. In this talk I discuss a few properties of Newton-Cartan geometry with a special emphasis on the peculiarities that occur in the case of three space-time dimensions.

10:30am **Coffee Break - SCGP Cafe**

11:00am **Ricardo Troncoso - SCGP 102**

Title: Soft hairy black holes and a new kind of asymptotics in 3D

Abstract: It is shown that General Relativity in 3D admits stationary black holes that are not necessarily spherically symmetric and do not fulfill the Brown-Henneaux boundary conditions. A new set of boundary conditions that accommodates them is proposed, which possesses a surprisingly simple asymptotic symmetry algebra consisting of two independent affine $u(1)$ currents. The associated global charges give a specific example of "soft hair" on the horizon, in the sense of Hawking, Perry and Strominger. We show that soft hair does not contribute to the Bekenstein-Hawking entropy of this kind of "black flowers". The Virasoro generators turn out to be composite operators of the $u(1)$ currents, which we interpret in the spirit of black hole complementarity. A remarkable feature of our boundary conditions is that they are singled out by requiring that the whole spectrum is compatible with regularity at the horizon, regardless the value of the global charges like mass or angular momentum. Finally, we address the flat limit and the generalization to soft hairy cosmological horizons.

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

2:30pm **Andy Strominger - SCGP 102**

Title: Area, Entanglement Entropy and Supertranslations at Null Infinity

3:30pm **Tea Time**

4:00pm **Tom Banks - SCGP 102**

Title: Holographic Space Time and the Degrees of Freedom of Quantum Gravity

Abstract: The Wheeler DeWitt equation implies that gravity is a holographic theory: the degrees of freedom in a bounded region live on its boundary. The covariant entropy principle quantifies this, and can be thought of as a definition of area in terms of the dimension of a Hilbert space. The principle implies that the algebra of operators in a diamond is a subalgebra of the algebra on the conformal boundary. I'll argue that the algebra on the conformal boundary of Minkowski space consists of currents carrying helicity and internal quantum numbers on and through the momentum light-cone dual to the conformal boundary. The Hilbert space is constrained by insisting that the currents concentrated at zero momentum vanish in annuli surrounding jets of particles. This constraint is made quantitative by a cutoff on the algebra in finite causal diamonds: states of particle jets are constrained states of the degrees of freedom saturating the covariant entropy bound. An infinite set of Hamiltonians define a scattering theory for these degrees of freedom, all of which have an emergent energy conservation law, and describe scattering localized in finite causal diamonds. When the diamonds containing interaction vertices are small in Planck units, the interactions are described by time ordered Feynman diagrams, while if they are large, meta-stable states with the qualitative properties of black holes are formed. The criterion separating the two types of process scales according to the rule, "a black hole is formed when the energy in a causal diamond has a Schwarzschild radius of order the size of the diamond". Rotation invariance around a given timelike geodesic is built into the formalism, while spatial translation invariance and Lorentz boost invariance are imposed by insisting on consistency of the descriptions along different trajectories. We have not yet found a Hamiltonian which obeys the constraints between trajectories with non-zero relative velocity.

Tuesday, April 5th

9:30am **Alejandra Castro - SCGP 102**

Title: Higher Spin Black Holes

10:30am **Coffee Break - SCGP Cafe**

11:00am **Marc Henneaux - SCGP 102**

Title: Asymptotically flat spaces in D spacetime dimensions: a review of the Hamiltonian approach

Abstract: A review of the Hamiltonian analysis of asymptotically flat spaces will be provided in $D=4$ and $D>4$ dimensions. Inclusion of the electromagnetic field will be discussed. Parity conditions, and how angle-dependent translations and gauge transformations are handled in this context, will be analyzed. The starting point of this talk is the seminal work by Regge and Teitelboim, which will be explained.

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

1:45pm **Steve Giddings - SCGP 102**

Title: Flat Holography from Large-R AdS/CFT?

2:45pm **Alexander Zhiboedov - SCGP 102**

Title: The S-matrix Bootstrap and the Leading Regge Trajectory

3:45pm **Tea Time**

4:15pm **SCGP Weekly Talk By Andy Strominger - SCGP 103**

Speaker: Andy Strominger

Title: The Black Hole Information Paradox, Revisited

Abstract: Recent investigations have uncovered an infinite number of conserved quantities in essentially all theories with gravity or electromagnetism. We will give a review of these developments and their implications for the black hole information paradox.

Wednesday, April 6th

9:30am **Herman Verlinde - SCGP 102**

Title: Entropy, back-reaction and bulk reconstruction

Abstract: In this talk I combine the first law of entanglement thermodynamics and the kinematic space formalism to derive a soft-graviton theorem for bulk correlation functions in AdS₃/CFT₂. The result supports the proposed identification of bulk operators with cross cap boundary states. I present some further checks of this proposal, and comment on how gravitational back-reaction and scattering are encoded in the CFT.

10:30am **Coffee Break - SCGP Cafe**

11:00am **Raphael Bousso - SCGP 102**

Title: Geometry and Quantum Information: New Conjectures and Theorems

Abstract: There is a growing web of conjectures that relate quantum information to the area of surfaces. A particularly powerful example is the Quantum Focussing Conjecture. This conjecture remains nontrivial as either G or \hbar vanish. This has led to novel statements purely within quantum field theory, or in classical GR, which can be proven directly. I will describe a new Area Theorem in GR, the Quantum Null Energy Condition in QFT, and a bound on the vacuum subtracted entropy of a region in QFT, all of which have recently been formulated and proven.

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

2:15pm **Jan de Boer - SCGP 102**

Title: Entanglement Holography

Abstract: I will discuss how entanglement entropy, and generalizations thereof, give rise to local propagating and interacting degrees of freedom in an auxiliary de Sitter spacetime, and discuss possible implications of this statement.

3:15pm **Tea Time**

3:45pm **Anastasia Volovich - SCGP 102**

Title: Landau Singularities and Cluster Structure in Scattering Amplitudes

5:00pm **Workshop Reception - SCGP Cafe**

Thursday, April 7th

9:30am **David Skinner - SCGP 102**

Title: Perturbative Amplitudes at Null Infinity

10:30am **Coffee Break - SCGP Cafe**

11:00am **Eanna Flanagan - SCGP 102**

Title: Properties of asymptotic BMS charges

Abstract: We discuss three different aspects of asymptotic BMS charges: (i) We describe operational procedures for how some of the charges can be measured from local measurements of the spacetime geometry by asymptotic observers, for the special case of stationary regions and transitions between stationary regions. (ii) We compute charges associated with the extended BMS algebra of Barnich and Troessaert and describe how they are related to the two types of gravitational wave memory, ordinary memory and null memory. (iii) We estimate the net fluctuations in the BMS charges produced by Hawking radiation from an evaporating black hole, over the lifetime of the black hole. These fluctuations make the usual arguments for the information loss paradox less sharp, but are insufficient to resolve the paradox.

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

2:30pm **Niels Obers - SCGP 102**

Title: Non-relativistic geometry in non-AdS holographic dualities

Abstract: After a brief introduction to Newton-Cartan (NC) geometry and its torsional version, I will show how torsional Newton-Cartan (TNC) geometry appears as a boundary geometry in the context of holography for bulk Lifshitz spacetimes. The coupling of field theories to TNC geometry will be discussed and I will show how dynamical NC geometry leads to a covariant formulation of the known versions of Horava-Lifshitz gravity. The latter may also be used as bulk theories in a holographic context, which will be illustrated via a novel formulation of 3D Horava-Lifshitz gravity, providing a new way to implement a non-relativistic gravity/field theory correspondence. Given the isomorphism between theories with Carrollian (ultra-relativistic) and massless Galilean (non-relativistic) symmetries in 1+1 dimensions, I will also outline a connection with flat space holography in three bulk dimensions, which features Carrollian geometry on the boundary. If time permits, I will briefly discuss Galilean electrodynamics as an example of a massless Galilean theory.

3:30pm **Tea Time**

Friday, April 8th

9:30am **Thomas Hartman - SCGP 102**

Title: Black Hole Collapse in the $1/c$ Expansion

10:30am **Coffee Break - SCGP Cafe**

11:00am **Hong Liu - SCGP 102**

Title: Effective field theory for dissipative fluids

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

2:00pm **Robert Penna - SCGP 102**

Title: BMS invariance and the membrane paradigm

Abstract: According to the black hole membrane paradigm, null infinity (in asymptotically flat spacetime) and black hole event horizons behave like fluid membranes. The fluid dynamics of the membrane is governed by an infinite set of symmetries and conservation laws. We relate this infinite set of symmetries and conserved charges to the BMS group. This relationship sheds light on the physical interpretation of BMS conservation laws, generalizes the BMS conservation laws to arbitrary subregions of arbitrary null surfaces, and gives a new perspective on the superrotation subgroup of the BMS group.

3:30pm **Tea Time**