Program: What is new in gravity? Aug. 10-12

Schedule of the workshop

Wednesday Aug. 10 (chair: Troels Harmark)

13.30-14.15: Gerben Oling

14.45-15.30: Jay Armas

16.30-16.50: Watse Sybesma
16.55-17.15: Stefano Baiguera
short break
17.30-17.50: Emil Have
17.55-18.15: Ziqi Yan

20.00: dinner

Thursday Aug. 11 (chairs: Charlotte Kristjansen (morning)/Niels Obers (afternoon)

9.00-9.45: Jelle Hartong

10.15-11.00: Maria Rodriguez

11.30-12.15: Oscar Dias

12.30-14.00: lunch

14.00-14.45: Ricardo Monteiro

15.15-16.00: Roberto Oliveri

17.00-17.45: Gianluca Grignani

19.30: dinner

Friday Aug. 12 (chairs: Marta Orselli (morning)/Jelle Hartong (afternoon))

10.00-10.45: Valentina Giangreco Puletti

11.15-12.00: Andrea Puhm

12.30-14.00: lunch

14.00-14.45: Konstantin Zarembo

15.15-16.00: Larus Thorlacius

Speakers/Titles/Abstracts of the NBI Mini workshop: What is new in gravity ? Aug. 10-12

Gerben Oling

Title: Conformal Carroll scalar actions

Abstract: I will discuss recent approaches to Carroll geometry and its applications to field theory and gravity. Carroll symmetries appear from an ultra-local limit of Lorentz symmetries, and we can use this to systematically construct theories coupled to Carroll background geometry. Specifically, I will discuss recent work on constructing concrete scalar field theories with conformal Carroll symmetries, and their role as toy models in flat space holography.

Jay Armas

Title: A stable and causal model of magnetohydrodynamics

Abstract: Magnetohydrodynamics (MHD) is a theory with a broad range of applications, from plasma physics to heavy-ion collisions and astrophysics. In this talk, I will show how methodologies in formal hydrodynamics allows to reformulate MHD in terms of symmetry considerations. In particular, I will show that MHD can be viewed as a theory of superfluidity and highlight its usefulness as a simpler way of keeping track of dissipative effects and equilibrium configurations. Based on this formulation, I will discuss a promising model of MHD and show that for a given toy model of a relativistic plasma it cures linear stability and causality issues typically inherent to relativistic hydrodynamics.

Watse Sybesma

Title: Islands and gravity in two dimensions

Abstract: The island formula, also known as Quantum Extremal Surface prescription, provides a new perspective on old paradoxes in semi-classical gravity. Gravity in two dimensions is successful in delivering analytically tractable models of semi-classical gravity and therefore provides an arena to test and apply the island formula. I discuss some recent developments in this context that I believe are exciting.

Stefano Baiguera

Title: Non-relativistic corners of N=4 super Yang-Mills

Abstract: I consider limits of N=4 super Yang-Mills that approach BPS bounds.
These limits result in non-relativistic theories that describe the effective dynamics near the BPS bounds and upon quantization are known as Spin Matrix theories.
In this talk, I will present convenient methods to determine the interacting Hamiltonian of

these theories, proving the positivity of their spectrum.
This approach points towards a better understanding of controlled finite N effects in the AdS/CFT duality.

Emil Have

Title: Fractons on curved spacetime

Abstract: Fracton phases of matter are characterised by excitations with restricted mobility. While much of their theoretical description remains shrouded in mystery, a robust line of attack involves their spacetime symmetries and their coupling to geometric backgrounds which realise these symmetries locally. One class of fracton theories derive their mobility constraints from a conserved dipole moment. The simplest theory with a global dipole symmetry involves a complex scalar, while gauging the dipole symmetry leads to a symmetric tensor gauge field and a scalar gauge field whose dynamics are governed by "scalar charge gauge theories" that generalise Maxwell theory. The spacetime symmetries of these theories are Aristotelian (which in particular means no boost symmetry), and the curved spacetimes to which these theories couple are those which locally realise the Aristotelian symmetry algebra: so-called Aristotelian spacetimes, which are examples of non-Lorentzian geometries. I will sketch the coupling of both the scalar dipole symmetric theory and the scalar charge gauge theory to curved Aristotelian background. While the scalar theory can be coupled to arbitrary backgrounds, the scalar charge gauge theory can only be coupled to curved spacetimes if the magnetic sector is traceless, and even then the geometry must satisfy a certain condition that can be enforced with a Lagrange multiplier. If we only curve the spatial part of the background, this condition reduces to the requirement that the background has constant sectional curvature.

Ziqi Yan

Title: Quantum Critical Membranes and Gravity

Abstract: I will review the challenges of quantizing supermembranes and the proposal of quantum critical membrane as a candidate high-energy completion. Quantum critical membranes are described by a renormalizable worldvolume theory exhibiting anisotropy in the worldvolume space and time. I will discuss the quantization of a three-dimensional Lifshitz sigma model associated with the matter sector of quantum critical supermembranes and the bimetric nature of the target-space geometry. I will also comment on how to couple such sigma models to dynamical worldvolume quantum (super)gravity.

Jelle Hartong

Title: The Case for Non-Lorentzian Strings

Abstract: Non-Lorentzian strings are strings that move in a target space-time that has a non-Lorentzian metric structure defined on it. Some of these strings are described by worldsheet CFTs and some are described by non-Lorentzian 2D sigma models. Most of these types of strings have so far been obtained as limits of ordinary string theory but their notion and definition can be given independently of ordinary string theory and it is expected that there exists a whole landscape of different non-Lorentzian string theories. In this talk I will mainly focus on closed bosonic strings that can be obtained as non-relativistic approximations of standard closed bosonic strings. In particular I will discuss the 1/c expansion of relativistic strings and the equivalence with the Gomis-Ooguri string at the next-to-leading order in 1/c. I will conclude with a brief overview of a few other non-Lorentzian strings and discuss open problems/questions such as: is there a holographic duality possible in such a non-Lorentzian setup and does there exist a well-defined regime of non-relativistic quantum gravity whose UV completion is a string theory?

Maria Rodriguez

Title: What is new in black hole jets?

Abstract: One of the leading mechanisms powering relativistic black hole jets is the Blandford–Znajek (BZ) process. Inspired by its success we constructed energy extracting models for black holes in five space-time dimensions. In this talk an overview will be given of recently discovered set of solutions to the force-free electrodynamic equations representing plasma-magnetospheres for slowly rotating Myers-Perry black holes. Comparisons of the main features of the five-dimensional BZ models with lower four-dimensional counterparts will also be discussed.

Oscar Dias

Title: New phases of N=4 SYM at finite chemical potential

Abstract: We do a systematic search of supergravity solutions that, via the AdS5/CFT4 correspondence, are dual to thermal states in N=4 SYM at finite chemical potential. These solutions dominate the microcanonical ensemble and are required to ultimately reproduce the microscopic entropy of AdS black holes. Using a mix of analytical and numerical methods, we construct and study static charged hairy solitonic and black hole solutions with global AdS5 asymptotics. They are constructed in two distinct consistent truncations of five dimensional gauged supergravity (and can thus be uplifted to asymptotically AdS5 x S5 solutions of type IIB supergravity). In the ``single charge'' truncation which consists of one charged scalar field, hairy black holes exist above a critical charge and merge with the known Cvetic-Lu-Pope (CLP) black holes along a curve determined by the onset of superradiance in the latter family. The lowest mass hairy black hole is a singular zero

entropy soliton. In the ``two charge'' truncation which consists of a two equal charged scalar fields, hairy black holes exist for all charges and merge with the known CLP black holes along their superradiant onset curve. The lowest mass hairy black hole is a smooth supersymmetric zero entropy soliton. Together with the known phases of the truncation with three equal charges, our findings permit a good understanding of the full phase space of SYM thermal states with three arbitrary chemical potentials.

Ricardo Monteiro

Title: Gravity as a double copy of gauge theory

Abstract: Relations expressing gravity as a "double copy" of gauge theory appeared first in string theory, and have been used to compute scattering amplitudes in theories of gravity, with applications to both theory and phenomenology. I will discuss how the double copy extends to a class of solutions to the equations of motion, including our best known black hole spacetimes, and how this story connects to the original story for scattering amplitudes.

Roberto Oliveri

Title: Metric reconstruction from celestial multipoles

Abstract: Multipole moments are important quantities to characterize spacetimes.
In General Relativity, the most general vacuum solution with no incoming radiation is parametrized by two sets of infinite multipole moments. In this talk I will show that non-radiative regions of spacetimes are completely characterized by a set of conserved celestial charges that consist of the Geroch-Hansen multipole moments, the generalized BMS charges and additional celestial multipoles accounting for subleading memory effects. Transitions among non-radiative regions, induced by radiative processes, are therefore labelled by celestial charges, which are identified in terms of canonical multipole moments of the linearized gravitational field. The dictionary between celestial charges and canonical multipole moments allows to holographically reconstruct the metric in de Donder or Bondi gauge outside of sources.

Gianluca Grignani

Title: Tidal deformation of a binary system induced by a Kerr black hole

Abstract: Thanks to the next generation of gravitational wave detectors, LISA and ET, that will explore the mHz to 10Hz band, it will be possible to observe signals from extreme mass ratio inspirals (EMRIs) of massive black holes and stars/stellar-mass black holes mergers. If the EMRI system is not isolated and it is influenced by another astrophysical object such as a supermassive black hole, the orbital dynamics and the GW radiation are modified by the gravitational interaction between the binary and the external object. We study the effect of tidal deformations induced by a supermassive Kerr black hole on the dynamics of a binary

system with an extreme mass ratio and we derive how the physical quantities, associated to the innermost stable circular orbit **(**ISCO), shift due to tidal effects.

Valentina Puletti

Title: Precision holography for 5D Super Yang-Mills

Abstract: With the advent of AdS/CFT and localisation, supersymmetric extensions of Wilson loop (WL) operators came to the forefront as tools to advance our understanding of holography itself. In this talk, I will focus on a circular Wilson loop in maximally supersymmetric Yang-Mills theory (MSYM) living on a 5-sphere. This operator preserves 1/2 of the supercharges of the theory and its vacuum expectation value (vev) is known in the planar limit and at any value of the ’t Hooft coupling via supersymmetric localisation.

The holographic dual to MSYM on a five-sphere is geometrically realised by a stack of N D4-branes with spherical worldvolume in ten dimensions. In particular, the vev of the circular WL is holographically dual to the partition function of a fundamental string in this background. I will illustrate the main steps in the computations of the string partition, with an emphasis on the next-to-leading order corrections in the large ’t Hooft coupling expansion, and on the role of the non-constant dilaton in this background.

Andrea Puhm

Title: Celestial holography on Kerr-Schild backgrounds

Abstract: The four-dimensional flat space S-matrix takes the form of a two-dimensional correlation function on the celestial sphere when changing from an asymptotic energy-momentum to a boost basis. This motivates the conjecture that quantum gravity in asymptotically flat spacetimes is dual to a co-dimension two celestial CFT. In this talk we test this celestial holography proposal for non-trivial asymptotically flat backgrounds of Kerr-Schild type which include the Coulomb field of a static and spinning charge, the Schwarzschild and Kerr geometry as well as electromagnetic and gravitational shockwaves.

Konstantin Zarembo

Ttitle: Exact predictions for orbifolds of AdS/CFT

Abstract: The orbifolds of AdS/CFT have an extra parameter, the theta angle of the vanishing cycle. Localization techniques give concrete predictions for the dual quiver gauge theory, potentially testable in string theory.

Larus Thorlacius

Title: Holographic black hole evolution

Abstract: We revisit the black hole information problem in the context of the AdS/CFT correspondence. The formation and evaporation of small AdS black holes is governed by unitary time evolution in the dual gauge theory but how does this translate to the gravitational theory? We argue that the eigenstate thermalisation hypothesis can explain the validity of semiclassical gravity for local bulk observables. Small AdS black holes correspond to states with finite energy width in the holographic dual, and observables that are smooth functions on the classical phase space will self-average over a large number of energy eigenstates, exponential in the Bekenstein-Hawking entropy, giving expectation values that are consistent with semiclassical gravity up to small corrections. On the other hand, the semiclassical bulk description breaks down at leading order for transition amplitudes which probe the unitary evolution of the theory.