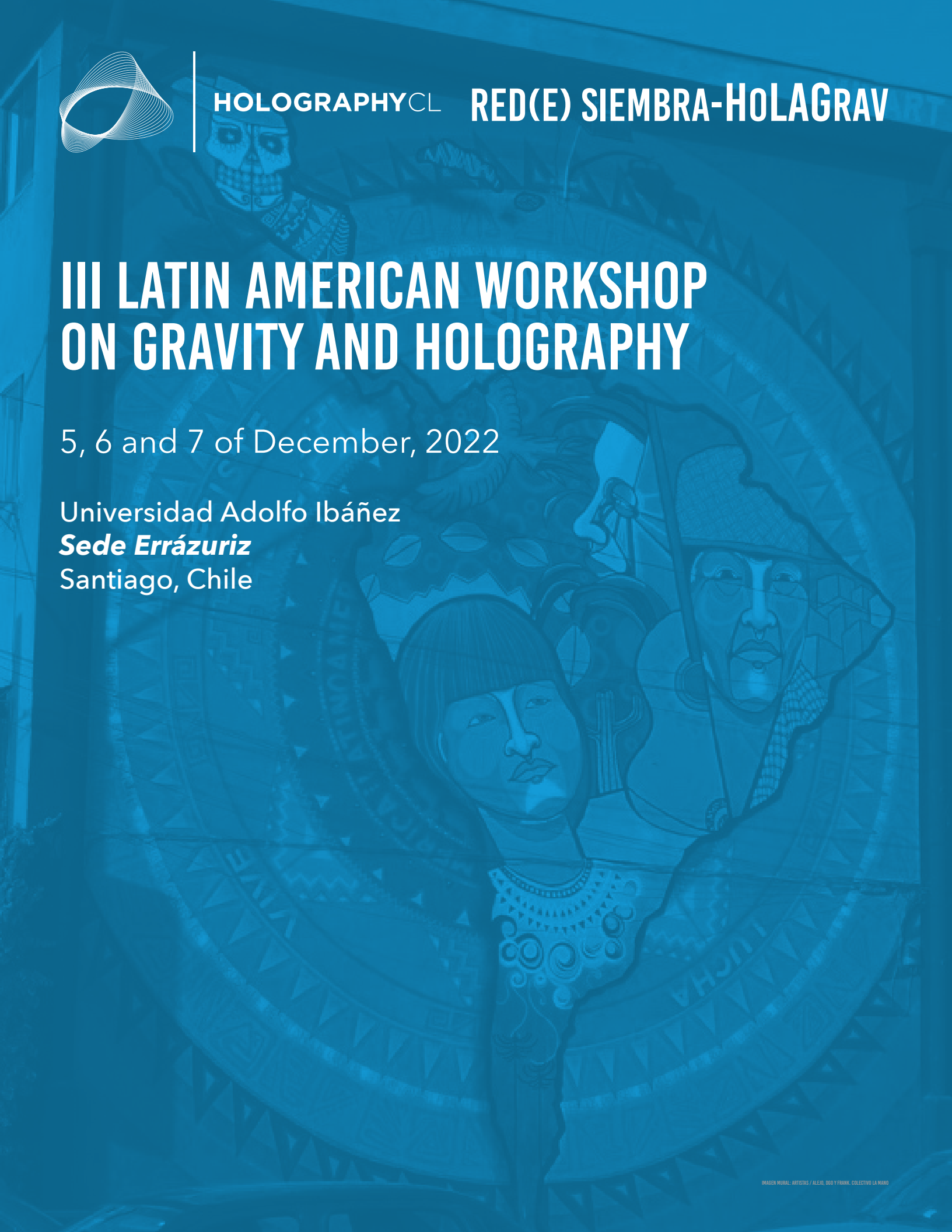
HOLOGRAPHYCL

RED(E) SIEMBRA-HOLAGRAV

III LATIN AMERICAN WORKSHOP ON GRAVITY AND HOLOGRAPHY

5, 6 and 7 of December, 2022

Universidad Adolfo Ibáñez
Sede Errázuriz
Santiago, Chile



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BOOK OF ABSTRACTS

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Holography and its Applications to High Energy Physics, Quantum Gravity and Condensed Matter Systems

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UNIVERSIDAD ADOLFO IBÁÑEZ

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Agencia Nacional de Investigación y Desarrollo

Ministerio de Ciencia, Tecnología, Conocimiento e Innovación

Gobierno de Chile

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INTRODUCTION

The Latin American Workshop on Gravity and Holography (LAWGH) is a biennial event organized by the Siembra-HoLAGrav network since 2018. The main purpose of this network is to promote a sense community among physicists from Latin American countries working in Holography and related topics. We aim to fuel scientific collaborations, support emerging research groups and contribute to the training of future Latin American researchers. In this sense, LAWGH plays a crucial role by allowing us to interact directly with leading members of the international community, keep up with the state of the art and showcase our own contributions to the field.

This year's edition of LAWGH is marked by the 25th anniversary of Juan Maldacena's groundbreaking work on AdS/CFT, and we want to celebrate accordingly. As preparation for the Workshop we will host the Latin American Workshop on Gravity and Holography, directed at students of all levels.

For more information please visit holography.cl/lawgh

PROGRAM

	Monday	Tuesday	Wednesday
8:30 – 8:45	Registration		
8:45 – 9:00	Opening		
9:00 – 9:30	Juan Maldacena (Zoom)	**Diego Trancanelli (Zoom)**	**Tomás Andrade**
9:30 – 10:00		**Diego Correa**	**Giorgos Anastasiou**
10:00 – 10:30	**Horatiu Nastase**	**Alan Ríos Fukelman**	**Marcela Cárdenas**
10:30 – 11:00	COFFEE BREAK	COFFEE BREAK	COFFEE BREAK
11:00 – 11:30	**Daniel Ávila**	**Francisco Rojas**	**Ignacio Salazar Landea**
11:30 – 12:00	**Pedro Jorge Martínez**	**Carlos Rubio**	**Olivera Miskovic**
12:00 – 12:15	**Raúl Arias**	**Kristiansen Lara**	**Andrés Argandoña**
12:15 – 12:30		**Luciano Montecchio**	**Joaquín Liniado**
12:30 – 14:30	LUNCH BREAK	LUNCH BREAK	LUNCH BREAK
14:30 – 14:45	**Juan Laurnagaray**	**Ernesto Bianchi**	**Adolfo Holguín**
14:45 – 15:00	**Gabriel Palau**	**Robinson Mancilla**	**Ricardo Stuardo**
15:00 – 15:30	**Ignacio Reyes**	**Nicolás Grandi**	**Adolfo Guarino**
15:30 – 16:00	**Mariana Carrillo González**	**Rodrigo Soto Garrido**	**Cristóbal Corral**
16:00 – 17:00	GONG SHOW	Discussion	Coffee + Discussion
17:00 – 18:00	Coffee + Poster Session		

Keynote

Juan Maldacena
Institute for Advanced Studies

$T\bar{T}$ DEFORMATIONS AND THE PP WAVE CORRESPONDENCE

Horatiu Nastase
Universidade Estadual Paulista

$T\bar{T}$ deformations were defined for 2-dimensional theories and preserve integrability. In holography, one can define either the deformations of the boundary condition or, for "single-trace deformations", the deformation of an AdS3 bulk theory. I describe proposals to extend the latter to Penrose limits of AdS5 vs. N=4 SYM and define the SYM deformation, and deformations of the pp wave limit, in both gravity and for the corresponding spin chain.

HOLOGRAPHIC REMEMORIZATION

Daniel Ávila
Universidad Nacional Autónoma de México

It is well known in holography that the reduced density matrix associated with a subregion of the boundary theory is dual to a corresponding subregion in the bulk, known as the entanglement wedge. However, while the reduced density matrix suffices to compute any correlator defined in the associated subregion, the holographic computation via the GKPW or BDHM prescriptions requires bulk information that lies beyond the entanglement wedge. It was recently shown that this tension is resolved by noting that the reduced state is only completely determined when the entanglement wedge is supplemented with a specific infrared boundary action. The latter can be computed using a variant of Wilsonian renormalization, a procedure that was named holographic rememorization, and which can also be applied to more general bulk regions. In this talk, I will show the basic features of holographic rememorization by tackling the specific example of a free scalar field propagating on a two-sided black hole geometry.

MUTUAL INFORMATION OF GENERALIZED FREE FIELDS

Pedro Jorge Martínez
Centro Atómico Bariloche

In this talk we will study some properties of generalized free fields (GFF) from the point of view of information measures. I will first highlight some properties of GFFs regarding non-equivalent ways of assigning operators to a spacetime region. In very simple examples one can see that different valid algebra choices lead to different results for entropy measures. There is no contradiction: different algebra choices also lead to different physical systems that are allowed to yield different entropy results. Armed with this intuition, we will explore the mutual information (MI) of holographic GFFs defined as the boundary theory of free fields in AdS. We pick two results from arXiv:2210.00013 we find particularly interesting and (will try to) present them in a pedagogical way.

COMMENTS ON CAPACITY OF ENTANGLEMENT

Raúl Arias
Universidad Nacional de La Plata

I will review and comment on some new results about the capacity of entanglement, like the existence of accidental c-functions and the behavior after a quantum quench. Although the talk will be mostly in the framework of QFTs I will contact on the way with some known results in holography and also mention some open problems in AdS/CFT.

RÉNYI ENTROPIES OF THE MASSLESS DIRAC FIELD ON THE TORUS

Juan Laurnagaray
Universidad de Buenos Aires

We compute the Rényi entropies of the massless Dirac field on the Euclidean torus (the Lorentzian cylinder at non-zero temperature) for arbitrary spatial regions. We do it by the resolvent method, i.e., we express the entropies in terms of the resolvent of a certain operator and then use the explicit form of that resolvent, which was obtained recently. Our results are different in appearance from those already existing in the literature (obtained via the replica trick), but they agree perfectly, as we show numerically for non-integer order and analytically for integer order. We also compute the Rényi mutual information, and find that, for appropriate choices of the parameters, it is non-positive and non-monotonic. This behavior is expected, but it cannot be seen with the simplest known Rényi entropies in quantum field theory because they are proportional to the entanglement entropy.

RELATIVE ENTROPY OF AN INTERVAL FOR A MASSLESS BOSON AT FINITE TEMPERATURE

Gabriel Palau
niversidad de Buenos Aires

We compute Araki's relative entropy associated to a bounded interval I=(a,b) between a thermal state and a coherent excitation of itself in the bosonic U(1)-current model, namely the (derivative of the) chiral boson. For this purpose we briefly review some recent results on the entropy of standard subspaces and on the relative entropy of non-pure states such as thermal states. In particular, recently Bostelmann, Cadamuro and Del Vecchio have obtained the relative entropy at finite temperature for the unbounded interval $(-\infty,t)$, using previous results of Borchers and Yngvason, mainly a unitary dilation that provides the modular evolution in the negative half-line. Here we find a unitary rotation in order to make use of the full PSL(2,R) symmetries and obtain the modular group, modular Hamiltonian and the relative entropy S of a bounded interval at finite temperature. Such relative entropy entails both a Bekenstein-like bound and a QNEC-like bound, but violates $S''\geq 0$. Finally, we extend the results to the free massless boson in 1+1 dimensions with analogous bounds.

INTERPOLATING WILSON LOOPS AND ENRICHED RG FLOWS

Diego Trancanelli
UniMORE/INFN

We study new 1/24 BPS circular Wilson loops in ABJ(M) theory, which are defined in terms of several parameters that continuously interpolate between previously known 1/6 BPS loops (both bosonic and fermionic) and the 1/2 BPS fermionic loop. We compute the expectation value of these operators up to second order in perturbation theory using a one-dimensional effective field theory approach. We find non-trivial beta-functions for the parameters, which are marginally relevant deformations triggering RG flows from a UV fixed point represented by the 1/6 BPS bosonic loop to a IR fixed point represented by the 1/2 BPS fermionic loop. These flows can take place along two different trajectories described by the two 1/6 BPS fermionic loops of the theory or along runaway directions described by the new 1/24 BPS loop. Along all flows at least one supercharge of the theory is preserved, so that we refer to them as enriched RG flows. We also establish a g-theorem, relating the expectation values of the Wilson loops corresponding to the UV and IR fixed points of the flows, and discuss the one-dimensional defect SCFT living on the Wilson loop contour.

INTERPOLATING BOUNDARY CONDITIONS IN ADS_2 AS DEFECT CFT_1 DEFORMATIONS

Diego Correa
Universidad Nacional de La Plata

The holographic dual description of line operators in a CFT_d is given in terms of AdS_2 world-sheets inside AdSd+1. The fact that we have an AdS2 might seem to indicate that the line defect behaves as a CFT_1. However, as we shall discuss in various examples, the conformal symmetry in the line eventually depends on the boundary conditions imposed for the fields in AdS_2.

QFT OF COMPACT STARS

Ignacio Reyes
University of Amsterdam

We explore the behavior of QFT in the spacetime of very compact stars. The trapping of modes around the inner light ring at the classical level leads, in the quantum theory, to a vacuum renormalized stress tensor that diverges in the Buchdahl limit and violates energy conditions. Thus, some well known classical theorems forbidding compact objects in GR might need revision at the quantum level.

MASSIVE GRAVITONS FROM THE DOUBLE COPY

Mariana Carrillo González
Imperial College London

The double copy is a relation that allows us to write gravitational phenomena as the "square " of the analog Yang-Mills phenomena. This simplifies involved gravitational calculations and gives an insight into hidden symmetries of gravity. Given the possibility of having a massive graviton that can explain the acceleration of the Universe, it is interesting to understand whether this relationship extends to this case. In my talk I will introduce the BCJ double copy and the color-kinematics duality, and I will explain how to start generalizing this to massive gravitons. I will focus on the 3-dimensional case of topologically massive gravity and will give examples of different realizations of the topologically massive double copy.

COMMENTS ON BPS OBSERVABLES AND MATRIX MODELS

Alan Ríos Fukelman
King's College London

In this talk I will review some recent developments in the study of Matrix Models in the large N limit and the characterization of the perturbative regime of a general class of such models. I will then review how these results allow us to obtain exact results for BPS observables in certain N=2 Super Conformal Field Theories, and discuss the implications for the 2 and 3 point functions of Chiral Primary Operators of arbitrary scaling dimensions in these theories.

CELESTIAL HOLOGRAPHY

Francisco Rojas
Universidad Adolfo Ibáñez

In a theory of quantum gravity, scattering amplitudes are one of the few physical observables one can define in asymptotically flat spacetime. Since amplitudes correspond to correlations between |in> and |out> states defined at the boundary of Minkowski space, it is natural to search for a holographic description of the bulk physics in terms of boundary degrees of freedom only. Exploiting the fact that SL(2,C) Lorentz transformations act as the global conformal group on the celestial sphere at infinity, bulk scattering processes can be recast as correlations functions of a (yet to be discovered) Celestial Conformal Field Theory (CCFT) living at the boundary of flat spacetime. These novel objects have also been given the name of Celestial Amplitudes. In this talk we will introduce this new and fast-developing subject and show some of its most recent results, both for field theory and string theory amplitudes. We will also see how the universality of the quantum mechanical structure of gravity and gauge theories in the deep infrared may shed light on the central properties this unknown CFT must possess.

A CONNECTION BETWEEN SHADOW AMPLITUDES AND SCATTERING AMPLITUDES?

Carlos Rubio
Universidad Adolfo Ibáñez

In this talk, I will give a brief introduction to celestial holography. This program establishes a duality between scattering amplitudes in Minkowski space and correlation functions on a 2D CFT defined on the celestial sphere at the boundary of flat spacetime. These correlators have been given the name of "celestial amplitudes". After introducing the subject, I will present an alternative conformal basis for celestial amplitudes. This basis is known as "shadow celestial amplitudes". For massless QED theory, when applying the shadow transformation to an n-point function to the soft/hard factorization theorem, a saddle point approximation dominates the shadow transform as one removes the IR regulator. The saddle-point equation imposes a novel condition we interpret as a new kind of Cachazo-He-Yuan "scattering equations". These equations relate the charges of the particles to their positions in the celestial sphere, and are invariant under SL(2,C) transformations. Finally, I will present possible generalizations of these new relations to the nonabelian case.

NONLINEAR INTEGRABLE HIERARCHIES AND THE BOUNDARY DYNAMICS OF GENERAL RELATIVITY ON ADS$_3$

Kristiansen Lara
Universidad de Santiago de Chile

It is shown that the Ablowitz-Kaup-Newell-Segur (AKNS) integrable hierarchy can be obtained as the dynamical equations of three-dimensional general relativity with a negative cosmological constant. This geometrization of the AKNS system is possible through the construction of novel boundary conditions for the gravitational field. These are invariant under an asymptotic symmetry group characterized by an infinite set of AKNS commuting conserved charges. Gravitational configurations are studied by means of SL(2,R) conjugacy classes. Conical singularities and black hole solutions are included in the boundary conditions.

INFINITE-DIMENSIONAL SYMMETRIES IN THE NEAR-HORIZON LIMIT

Luciano Montecchio
Universidad de Buenos Aires

It was shown that an infinite set of asymptotic symmetries emerge in the vicinity of black hole horizons. Similarly to the BMS group at the null infinity, the generators of these symmetries spawn an infinite-dimensional algebra that exhibits super-translations and super-rotations in the near horizon limit. The addition of gauge fields results in a further enhancement of the asymptotic symmetries; I will discuss both the Abelian and non-Abelian case.

ADS/CFT AT LOOP ORDER

Ernesto Bianchi
University of Southampton

We develop a systematic renormalization procedure for QFT in anti-de Sitter spacetime. UV infinities are regulated using a geodesic point-splitting method, which respects AdS isometries, while IR infinities are regulated by cutting off the radial direction (as in holographic renormalization). The renormalized theory is defined by introducing Z factors for all parameters in the Lagrangian and the boundary conditions of bulk fields (sources of dual operators), and a boundary counterterm action, Sct, such that the limit of removing the UV and IR regulators exists. The results are in general scheme dependent (mirroring the analogous result in flat space) and require renormalization conditions. These may be provided by the dual CFT (or by string theory in AdS). Our analysis amounts also to a first principles derivation of the Feynman rules regarding Witten diagrams. The presence and treatment of IR divergences is essential for correctly accounting for anomalous dimen- sions of dual operators. We apply the method to scalar $\Phi 4$ theory and obtain the renormalized 2-point function of the dual operator to 2-loops, and the renormalized 4-point function to 1-loop order, for operators of any dimension Δ and bulk spacetime dimension up to d+1=7.

ASPECTS OF THERMAL ONE-POINT FUNCTIONS AND RESPONSE FUNCTIONS IN AdS BLACK HOLES

Robinson Mancilla
University of California, Santa Barbara

We revisit the problem of analytically computing the one point functions for scalar fields in planar AdS black holes, which are sourced by the Weyl squared tensor. We analyze the problem in terms of power series expansions using the Frobenius method that allows us to clarify the pole structure of the final answer in terms of operator mixing. We also study the first order corrections to the one point function of the global AdS black hole at large mass, where we perturb in terms that correspond to the curvature of the horizon.

HOLOGRAPHIC NEUTRON STARS AND HOLOGRAPHIC METALS

Nicolás Grandi
Universidad Nacional de La Plata

WI will review recent results on the holographic description of metals in the context of holographic neutron stars at finite temperature. I will explain how the lessons learned from this theoretical model can be applied to the physics of the strange metallic phase of High Tc materials.

FLAT BANDS AND HOLOGRAPHY

Rodrigo Soto Garrido
Pontificia Universidad Católica de Chile

Flat bands in condensed matter physics, such as twisted bilayer graphene, have been the focus of intense research in the last years. Since interaction effects govern the structure of the phase diagram, it is necessary to go beyond perturbation theory to study those systems. In this talk, we show that a strongly interacting system featuring flat bands can be engineered using the holographic duality.

SIMULATIONS OF BLACK HOLE BINARIES AND THEIR GRAVITATIONAL WAVES

Tomás Andrade
Universitat de Barcelona

Our recently acquired ability to detect gravitational waves has expanded our senses and our possibilities of inquiring about the Universe. As a new era of gravitational wave detections rapidly unfolds, the importance of having accurate models for their signals becomes increasingly important. In this context, we will discuss numerical simulations of black hole binaries. In particular, we will focus on how they are made, what they help us achieve, and what are the current challenges in this research area.

ENERGY FUNCTIONALS FROM CONFORMAL GRAVITY

Giorgos Anastasiou
Universidad Arturo Prat

Recent works have shown that bulk conformal invariance dictates the counterterms that render the Einstein-AdS action finite. In this talk, we extend this new prescription, dubbed conformal renormalization, in the context of codimension-2 area functionals for AAdS spacetimes. In particular, we provide a new derivation of the Hawking mass and Willmore energy functionals, that arise as particular cases of L_{Σ}, which is the conical contributions of the Conformal Gravity action when evaluated in a manifold with a conical defect. Since L_{Σ} inherits conformal invariance from the parent action, the results suggest that conformal renormalization can be extended to codimension-2 hypersurfaces.

INTEGRABLE SYSTEMS AND THE ASYMPTOTIC DYNAMICS OF GRAVITY IN 3D

Marcela Cárdenas
Universidad de Santiago

It is shown that the asymptotic dynamics of three-dimensional general relativity with a negative cosmological constant can be described by the Ablowitz-Kaup-Newell-Segur (AKNS) integrable hierarchy. The AKNS integrable system includes the notable equations of Sine-Gordon, Korteweg-de Vries, Non-linear Schrödinger, among others. The existence of this novel boundary conditions for the gravitational field is possible by constructing field-dependent asymptotic Killing vectors. They lead to an asymptotic symmetry group characterized by an infinite set of AKNS commuting conserved charges.

HAIRY BLACK HOLES IN 5D

Ignacio Salazar Landea
Universidad Nacional de La Plata

We investigate solutions of the Einstein-Gauss-Bonnet gravity corresponding to a charged black-hole with scalar hair. Outside the black hole the solutions are asymptotically flat. Behind the event horizon, we find a variety of dynamical epochs, with the particular important feature that the Cauchy horizon is not present. This makes the violation of the no-hair theorem a possible tool to understand how the strong cosmic censorship conjecture works.

STABILITY OF BLACK HOLES AT THE ZERO TEMPERATURE

Olivera Miskovic
Pontificia Universidad Católica de Valparaíso

We will compute the entropy of extremal black holes and discuss the conditions of spontaneous formation of scalar condensates near its horizon. This phenomenon occurs at some critical black hole mass, in space-times with non-vanishing cosmological constant and strongly interacting massive scalar fields. Our analysis is analytical, generic and based on the laws of thermodynamics.

CFT CORRELATORS FROM SHAPE DEFORMATIONS IN CUBIC CURVATURE GRAVITY

Andrés Argandoña
Universidad Nacional Autónoma de México

We find a covariant expression for the universal part of the holographic entanglement entropy which is valid for CFTs dual to generic higher curvature gravities in up to five bulk dimensions. We use this functional to compute universal coefficients of stress-tensor correlators in three-dimensional CFTs dual to Cubic Curvature Gravity. Using gauge/gravity duality, we work out an expression for the entanglement entropy of deformed entangling regions and read the coefficients from the power expansion of the entropy in the deformation parameter. In particular, we obtain the t4 coefficient of the 3-point function and exhibit a difference between the results obtained using the entanglement entropy functional for minimal and non-minimal splittings. We compare the obtained expressions for t4 derived considering both splittings with results obtained through other holographic methods which are splitting-independent. We find agreement with the result obtained from the non-minimal splitting, whereas the result derived from the minimal splitting is inconsistent and it is therefore ruled out.

4D CHERN-SIMONS AND 2D INTEGRABLE FIELD THEORIES

Joaquín Liniado
Swansea University

In this talk we will discuss the correspondence between 4d Chern-Simons theory and 2d Integrable Field Theories. The aim is to introduce the main ideas and address some of the far reaching applications in the study of integrable structures.

SADDLING GIANTS (WITH STRINGS)

Ricardo Stuardo
Swansea University

We study an infinite family of Massive Type IIA backgrounds that holographically describe the twisted compactification of N=(1,0) six-dimensional SCFTs to four dimensions. The analysis of the branes involved suggests a four dimensional linear quiver QFT, that deconstructs the theory in six dimensions. For the case in which the system reaches a strongly coupled fixed point, we calculate some observables that we compare with holographic results. Two quantities measuring the number of degrees of freedom for the flow across dimensions are studied.

TYPE IIB S-FOLDS: DEFORMATIONS, STABILITY AND HOLOGRAPHY

Adolfo Guarino
Universidad de Oviedo

In this talk I will discuss recent progress towards understanding geometric and holographic aspects of type IIB S-fold solutions of the form $AdS_4 \times S^1 \times S^5$. Using an effective 4D description of the S-folds, I will focus on the existence of flat directions in the 4D scalar potential which are expected to describe (non-)supersymmetric marginal deformations of the dual S-fold CFT's.

HIGHER-CURVATURE GENERALIZATION OF EGUCHI-HANSON SPACES

Cristóbal Corral
Universidad Arturo Prat

In this talk, a higher-dimensional generalization of the Eguchi-Hanson gravitational instanton in the presence of higher-curvature deformations of general relativity is presented. These spaces are solutions to Einstein gravity supplemented with the dimensional extension of the quadratic Chern-Gauss-Bonnet invariant in arbitrary even dimension $D=2m\geq4$, and they are constructed out of non-trivial fibrations over $(2m-2)$-dimensional Kähler-Einstein manifolds. Different aspects of these solutions are analyzed; among them, the regularization of the on-shell Euclidean action by means of the addition of topological invariants. We also consider higher-curvature corrections to the gravity action that are cubic in the Riemann tensor and explicitly construct Eguchi-Hanson type solutions for such.

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III LATIN AMERICAN WORKSHOP ON GRAVITY AND HOLOGRAPHY

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IMAGEN MURAL: ARTISTAS / ALEJO, DOS Y FRANK, COLECTIVO LA MANO

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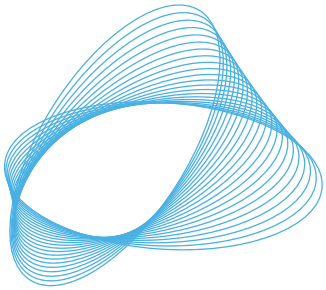

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