Latin American Workshop on Gravity and Holography

Program

	Mon. 4th	Tue. 5th	Wed. 6th	Thu. 7th	Fri. 8th
08:00 - 09:00	Registration				
09:00 - 09:30	**Güijosa** Overview				
09:30 - 10:15	**Andrade**	**Andrade**	**Vieira**	**Galante/ Pedraza**	**Galante/ Pedraza**
10:15 - 11:00	**Andrade**	**Andrade**	**Vieira**	**Galante/ Pedraza**	**Galante/ Pedraza**
11:00 - 11:30	Coffee break	Coffee break	Coffee break	Coffee break	Coffee break
11:30 - 12:15	**Pando Zayas**	**Grandi**	**Kruczenski**	**Agon Quintero**	**Garcia Hernandez**
12:15 - 13:00	**de Novaes Santos**	**Cisterna Roa**	**Faraggi**	**Pedraza**	**Virrueta**
13:00 - 14:30	Lunch	Lunch	Lunch 13:00 - 14:00	Lunch	Lunch
			IFT Colloquium 14:00 - 15:15 **Pando Zayas**		
14:30 - 15:15	**Cuadros Melgar**	**Miskovic**	Coffee break 15:15 - 15:45	**Caceres**	**Araya Quezada**
15:15 - 16:00	**Valdivia**	**Nastase**	**Correa** 15:45 - 16:30	**Güijosa**	**Corral**
16:00 - 16:30	Coffee break	Coffee break	**Silva** 16:30 - 17:15	Coffee break	Coffee break
16:30 - 17:15	**Oliva**	**Poster session**	**Vescovi** 17:15 - 18:00	**Hartmann**	**Final discussion**
		Social dinner			

Overview talks

Tomas Andrade (University of Barcelona)
Applications of AdS/CFT

I will give a brief overview of the field of applied AdS/CFT. The main goal of my talks is to provide the students with an introduction to a number of topics and methodologies relevant to the current research in this field. We will focus on the gravitational side of the duality: in essence, we will study different type of problems in General Relativity and how can they be interpreted in terms of a field theory dual via the holographic dictionary.

Damian Galante + Juan Pedraza (University of Amsterdam)
HEE

We will be giving introductory lectures to Holographic Entanglement Entropy.

Alberto Güijosa (UNAM)
The Latin American Hologravi Bestiary

This workshop is bringing together Latin American researchers who work on holography and gravity. We also have the hope of establishing ourselves as a permanent network. To start to develop a sense of community, a useful first step is to better identify who we are. This talk will present a brief overview of the people and institutions involved.

Pedro Vieira (Perimeter Institute & ICTP-SAIFR)
The S-matrix Bootstrap

Research talks

Cesar Agon Quintero (Stony Brook University)
Subsystem complexity and Holography

In this talk I will describe the holographic computation of subsystem complexity for a one sided region of an eternal static neutral and charged black holes in arbitrary dimensions. The holographic computations are done using the proposals known as "complexity=action" and "complexity=volume. Then, I will describe some proposals of circuit complexity for mixed states. Using tensor networks ideas I will show some qualitative match between some of these proposals and the results from the "complexity=action" computation.

Ignacio Araya Quezada (Universidad Andrés Bello)
Renormalization of Entanglement Entropy from topological terms

We present the topological scheme for renormalizing Entanglement Entropy for holographic (odd-dimensional) CFTs in the context of the AdS/CFT correspondence. The procedure consists in adding the Chern form as a boundary term to the area functional of the Ryu-Takayanagi minimal surface. The renormalized Entanglement Entropy thus obtained can be rewritten in terms of the Euler characteristic and the AdS curvature of the minimal surface. This prescription considers the use of the Replica Trick to express the renormalized Entanglement Entropy in terms of the renormalized gravitational action evaluated on the conically-singular replica manifold extended to the bulk. This renormalized action is obtained in turn by adding the Chern form as the counterterm at the boundary of the 2n-dimensional asymptotically AdS bulk manifold. We explicitly show that, up to next-to-leading order in the holographic radial coordinate, the addition of this boundary term cancels the divergent part of the Entanglement

Entropy. We discuss possible applications of the method for studying CFT parameters like central charges.

Elena Caceres (University of Texas at Austin)
Rotating Traversable Wormholes
An interaction that couples the two boundaries of an eternal BTZ black hole produces a violation of the average null energy condition and makes the wormhole traversable. I will present work that extends this scenario to rotating black holes. We study the effect of rotation in the size of the wormhole and the amount of information transferred.

Adolfo Cisterna Roa (Universidad Central de Chile)
Axionic black branes with conformal coupling
We find neutral and charged black branes solutions with axion fields in the context of a conformally coupled gravitational theory in four dimensions. These solutions describe AdS black branes supported by axion fields that break translational invariance at the boundary, providing for momentum dissipation. The conformally coupled scalar field is regular inside and outside the event horizon and there is no need of any self-interaction, obtaining in this way solutions without fine-tuned parameters. We analyze the thermodynamics of our solutions considering the effects of the axion charges and it is shown that axionic and electric charges must be related such that the conformal scalar field does not contribute to the mass. We compute the holographic DC conductivity and we show how it is affected by the inclusion of the conformal scalar field, which provides a temperature independent behavior. We include a non-linear axionic contribution given by a k-essence term that modifies the DC conductivity providing for more general behaviors. Finally, we endorse our solutions with rotation showing that angular momentum is sustained by the axion charges.

Cristóbal Corral (UNAM)
Unimodular Einstein--Cartan gravity: Dynamics and conservation laws
Unimodular gravity is an interesting approach to address the cosmological constant problem, since the vacuum energy density of quantum fields does not gravitate in this framework, and the cosmological constant appears as an integration constant. These features arise as a consequence of considering a constrained volume element 4-form, that breaks the diffeomorphisms invariance down to volume preserving diffeomorphisms. In this work, the first-order formulation of unimodular gravity is presented by considering the spin density of matter fields as source of spacetime torsion. Even though the most general matter Lagrangian allowed by the symmetries is considered, dynamical restrictions arise on their functional dependence. The field equations are obtained and the conservation laws associated with the symmetries are derived. It is found that, analogous to torsion-free unimodular gravity, the field equation for the vierbein is traceless, nevertheless, torsion is algebraically related to the spin density as in standard Einstein--Cartan theory. The particular example of massless Dirac spinors is studied, and comparisons with standard Einstein--Cartan theory are shown.

Diego Correa (Universidad Nacional La Plata)
Wilson loop correlators
The AdS/CFT correspondence is a strong/weak coupling duality and the realization of precision tests requires the computation of observables exactly in the coupling constant dependence. In this context, the exact resummation of ladder diagrams contribution to the expectation values of Wilson loops and their correlators is an interesting problem to consider. In particular they enable explicit verifications of the AdS/CFT correspondence by identifying cases and regimes in which the full perturbative expansion is dominated by ladder diagrams.

Bertha Cuadros Melgar (USP - Lorena)
Stability of galileon black holes under spinorial perturbations
In this work we consider the interaction of gravity with matter fields with galilean invariance and their corresponding black hole solution. Quasinormal modes of spinorial perturbations were computed using different methods. For massless spinors we show that black holes are dynamically stable even in cases

where the potential has a small negative region. This is possible because the ground state always has an energy larger than well's depth.

Fábio de Novaes Santos (IIP - Natal)

Non-Relativistic Boundary Conditions of AdS3 Gravity and Microstate Counting

We present a new hierarchy of boundary conditions of AdS3 gravity with non- relativistic dynamical exponent z. The boundary dynamics is integrable and has an infinite number of conserved charges. The charges are simultaneously diagonalized in terms of CFT states with closed-form eigenvalues. We write the partition function for these eigenstates in the semiclassical limit and obtain the entropy from microcanonical counting. This result depends on the dynamical exponent z and matches a generalized Cardy formula with Lifshitz modular invariance.

Alberto Faraggi (Universidad Andrés Bello)

Functional Determinants in AdS_2

The study of one-loops corrections in AdS/CFT requires the calculation of functional determinants and the appearance of asymptotically AdS_2 geometries is ubiquitous. In this talk I will review a recent method to compute the zeta-function of circularly-symmetric operators in AdS_2, with the application to the 1/4-BPS Wilson loop in N=4 SYM as the main example.

Edel Efraín García Hernández (UNAM)

Matter contributions to holographic entanglement entropy

The Ryu-Takayanagi formula to obtain the entanglement entropy works only if the gravity theory is the Einstein theory, so if we change the theory we can find other contributions to the HEE. If the theory is minimally coupled with some matter term, it can be proved that there are no new contributions to the HEE functional coming from this terms. In this work we consider different gravity theories, and we couple them non-minimally to a scalar field. Then we use the Dong-Camps prescription to obtain the generalized gravitational entropy, and we show that there are non-trivial contributions coming from these non-minimal couplings.

Nicolas Grandi (Universidad Nacional La Plata)

Fermions at finite doping in AdS/CMT

I will give a brief overview on how to generalize the model recently proposed by Kiritsis and Li for the holographic superconductor, that introduces a doping axes and results in a phase diagram which shares many features with that proposed for the Hight Tc materials. I will explain how fermions can be introduced in such model, and describe some of the features of the resulting metallic phases. Moreover, I will also comment on how to include a magnetic field axes in the phase diagram.

Alberto Güijosa (UNAM)

Living on the Wedge: Rindler Reconstruction and Entanglement of Purification

In the holographic correspondence, subregion duality posits that knowledge of the mixed state of a finite spacelike region of the boundary theory allows full reconstruction of a specific region of the bulk, known as the entanglement wedge. In this talk, specializing for simplicity to AdS_3, we examine whether curves within an entanglement wedge can be reconstructed via hole-ography. A challenge is encountered already in the Poincaré wedge, but we show that it can be overcome by using a variant of hole-ography involving 'null alignment'. We then find that in a Rindler wedge, generic curves are not fully reconstructible with entanglement entropies in the corresponding boundary region, even after using null alignment. This limitation is an analog of the familiar phenomenon of entanglement shadows, which we call 'entanglement shade'. We overcome it by showing that the information about the nonreconstructible curve segments is encoded in a slight generalization of the concept of entanglement of purification, whose holographic dual has been discussed very recently. We introduce the notion of 'differential purification', and demonstrate that, in combination with differential entropy, it enables the complete reconstruction of all spacelike curves within an arbitrary entanglement wedge in any 3-dimensional bulk geometry..

Betti Hartmann (USP - Sao Carlos)

Strings with excited condensates

In this talk, a novel type of string solution in the U(1) x U(1) Witten model will be discussed. These solutions are Abelian-Higgs strings with a conserved current along the symmetry axis that - as will be discussed in this talk - can be excited. This implies that for a certain range of parameters of the model there exists a finite (and countable) number of string solutions that differ in the number of nodes of the condensate function associated to the unbroken U(1) symmetry. While these solutions can be macroscopically stable, our results indicate that they are microscopically unstable and would hence decay to the fundamental solution without nodes. Since the space-time curvature close to the string is influenced by these excitations, we would expect networks of strings not only to emit high energy particles, but also gravitational waves.

Martin Kruczenski (Purdue U.)

S-matrix bootstrap applied to the 2d bosonic O(N) model

Recently a new approach to quantum field theory, called the S-matrix bootstrap, was proposed where the old idea of computing the S-matrix in terms of its analytic and symmetry properties was complemented with the new idea of minimizing certain functional on the space of allowed S-matrices. In this talk I am going to show how this approach applies to the integrable 2d bosonic O(N) model. Although such model has already been solved long ago, studying it with the new method provides interesting insights on the S-matrix bootstrap approach.

Olivera Miskovic (PUC Valparaiso)

Phase transitions of extremal black holes

We study static, charged extremal black holes in 4D gravity non-linearly coupled to a scalar field. We show that the system can exhibit a phase transition due to electric charge variations only in presence of a cosmological constant and if the scalar is massive. A near-critical analysis reveals that, on one side of the critical point, the hairy black hole has larger entropy than the non-hairy one, thus giving rise to a zero temperature phase transition. Our results are analytical and based on the second law of thermodynamics.

Horatio Nastase (IFT-UNESP)

Probing non-Abelian T-duals of holographic theories through AdS/CFT and pp wave limits

Non-Abelian T-duality acts on 3 directions transforming under the group SU(2). We can consider acting on such directions in the compact spaces of gravity duals, and thus learning about what the T-duality does on the CFTs. We examine cases with an AdS factor, RG flow between AdS factors, and duals to nonrelativistic theories, and learn about the dual CFTs. We also consider Penrose limits of T-duals (abelian and nonabelian) of the usual AdS_5xS^5 case, as a way to simplify the probing of the dual theory and learn about field theory operators and other properties.

Julio Oliva (Universidad de Concepción)

Black strings in higher curvature gravity

We present different aspects of the construction and perturbative stability of black strings in higher curvature gravity. We also present some new recent results on the existence of analytic black strings and black brane solutions supported by p-form fields in General Relativity and Lovelock theories.

Leopoldo A. Pando Zayas (University of Michigan)

Microstate Counting of AdS_4 Black Hole Entropy

I will describe how within eleven dimensional supergravity one can compute the logarithmic correction to the Bekenstein-Hawking entropy of certain magnetically charged asymptotically AdS_4 black holes with arbitrary horizon topology. The result perfectly agrees with the dual field theory computation of the topologically twisted index of ABJM theory.

Juan Pedraza (University of Amsterdam)

Chaotic strings in AdS/CFT

Holographic theories with classical gravity duals are maximally chaotic. It is interesting to ask weather this property is true only for leading large N correlators or if it can show up elsewhere. In this talk I will explain the simplest setup to tackle this question: a Brownian particle dual to a probe open string in an AdS black hole. We find that the four-point out-of-time-order correlator that diagnoses chaos initially grows at an exponential rate that saturates chaos bound, i.e. with a Lyapunov exponent $\lambda=2\pi/\beta$. Our result shows that, at least in certain cases, maximal chaos can be attained in the probe sector without the explicit need of gravitational degrees of freedom.

Guillermo Silva (Universidad Nacional La Plata)

Wilson Loops and precision tests

We discuss the status of Wilson loops in the AdS/CFT correspondence and their precision tests.

Omar Valdivia (Universidad Arturo Prat)

Nonminimal couplings, gravitational waves, and torsion in Horndeski's theory

The Horndeski Lagrangian brings together all possible interactions between gravity and a scalar field that yield second-order field equations in four-dimensional spacetime. As originally proposed, it only addresses phenomenology without torsion, which is a non-Riemannian feature of geometry. Since torsion can potentially affect interesting phenomena such as gravitational waves and early Universe inflation, in this paper we allow torsion to exist and propagate within the Horndeski framework. To achieve this goal, we cast the Horndeski Lagrangian in Cartan's first-order formalism, and introduce wave operators designed to act covariantly on p-form fields that carry Lorentz indices. We find that nonminimal couplings and second-order derivatives of the scalar field in the Lagrangian are indeed generic sources of torsion. Metric perturbations couple to the background torsion and new torsional modes appear. These may be detected via gravitational waves but not through Yang-Mills gauge bosons.

Edoardo Vescovi (University of São Paulo)

Deformations of the circular Wilson loop and spectral independence

We study "wavy" deformations of the circular Wilson loop in N=4 SYM and of the dual minimal surface in hyperbolic space H_3 through AdS/CFT. Recent formalism introduced by Kruczenski shows that the expectation value at strong coupling is invariant under spectral deformations of the Wilson loop contour. We complete a previous analysis by Dekel and prove that the symmetry breaks down at weak coupling in an unexpected mild way: the quartic order in the deformation parameter is invariant under spectral deformations up to 2 loops, whereas higher powers are not. We comment on further work to understand the unknown symmetry that is responsible for this behavior.

Julio Virrueta (Stony Brook University)

Entanglement Dynamic in the Scaling Limit

It was proposed recently (Jonay, Huse, Nahum, 2018) that the leading coarse-grained behavior of the entanglement entropy dynamics can be studied as a membrane theory, with the dynamics determined by a surface tension function. This model was recently formulated in the language of AdS/CFT (Mezei, 2018). In this talk I'll present some recent work on the membrane model which considers higher derivatives corrections to the bulk gravity theory and possible generalizations to the case of inhomogeneous quenches.

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List of Abstracts

POSTERS

Confinement of quarks and gluons in a tachyon matter

Adamu Issifu (UFPB, Brazil)

We investigate the confi nement of fermions in tachyon matter using gauge theory in color dielectric medium (G(\phi)). We investigate the net confining potential resulting from the quarks and gluons in the tachyon matter. We show that pair-production (hadronization) is impossible if all quark flavors are heavy. We study the relationship between tachyon condensation and QCD-monopole condensation and its association with con nement. We also investigate the behavior of the QCD string tension obtained from the net con fining potential. String theory and field theory duality will be applied in our investigation. We approximate non-Abelian QCD using an Abelian QED theory.

Exploring the boundary behavior in AdS/CFT correspondence

Breno Almeida da Silveira Dultra Chrispim (UERJ, Brazil)

The basic idea of the AdS/CFT is a correspondence between two theories: one gravitacional, defined in a asymptotic AdS space-time, and another CFT, living in it's boundary. Any physical state can be (in theory) described in one or another. This relations is called holographic map and, more precisely, is the way any operator in one theory can be mapped to an operator on the other theory. The complet map is still a mystery but some clues can be obtained from understanding how the correspondence treats theories that have dualitys. The electric-magnetic SL(2,Z) duality (defined by the combination of T- and S- dualitys) is especially interesting because it is boundary-sensible. If the bulk action is invariant under SL(2,Z) the corresponding boundary action is not. Using the realizations of Haro and Peng Gao's paper “Electric-magnetic Duality and Deformations of Three-Dimensional CFT's” it is possible to realize some relations between the different theories and boundary conditions. This work is part of an ongoing paper that intends to explore the relations between SL(2,Z) in arbitrary dimension and AdS/CFT correspondence.

Fully resonant scalars on asymptotically AdS wormholes

Constanza Quijada Barrera (Universidad de Concepción, Chile)

It is known that Einstein-Gauss-Bonnet theory admits exact and analytic wormhole solutions which are asymptotically AdS in both asymptotic region [Phys.Rev. D75 (2007) 024002]. On this spacetime an exact expression for the spectrum of a massive scalar field was found analytically [JHEP 0808 (2008) 081]. In the present work we show that remarkably, for a probe scalar field non-minimally coupled one can obtain a fully resonant (equispaced) spectrum by imposing Dirichlet boundary conditions at both asymptotic regions. This is reminiscent of what happens in pure AdS, and we therefore study the perturbative non-linear dynamics of a scalar by introducing a cubic selfinteraction. Our results indicate that there is energy transfer between the normal modes in a turbulent manner that resembles what occurs in AdS, which leads us to conjecture the non-perturbative instability of these asymptotically AdS wormholes.

SL(2,Z) duality and massive deformations in AdS4/CFT3

Duive Maria van Egmond (UERJ, Brazil)

In this work we study SL(2,Z) duality of the Maxwell theory. It will be shown that this duality is generated by two dualities called S- and T-duality. We are specifically interested in SL(2,Z) transformations at the conformal boundary of AdS4. At this boundary, according to the principles of AdS/CFT, there is a correspondence between quantities from the classical Maxwell theory and quantities of the conformal field theory (CFT) living at the boundary. We show that whereas the bulk action is invariant under SL(2,Z), the boundary action is not. However, with the choice of massive self-dual boundary conditions we find SL(2,Z) invariance established at the boundary. These massive self-dual boundary conditions, which break conformal invariance at the boundary, turn out to be related to topologically massive theories in three dimensions. In particular, for these solutions we can find the duality between the Maxwell-Chern-Simons (MCS) and self-dual (SD) theory at the boundary of AdS4. Thus, topologically massive theories in three dimensions are connected to SL(2,Z) duality in the bulk. This connection could be used to understand better both the AdS4/CFT3 duality and the three-dimensional MCS/SD duality.

Asymptotically AdS black holes in scalar-tensor gravity

Felipe de Carvalho Ceregatti de Console (USP-IFSC,Brazil)

In recent years, Horndeski scalar-tensor gravity models have gained interest. These are models in which a non-minimal coupling between the curvature invariants of the space-time and a real scalar field exist. These models possess a shift symmetry of the scalar field which leads to a locally conserved Noether current. We are investigating black hole solutions in these theories including a negative cosmological constant. The solution are -to linear order in the scalar-tensor coupling - asymptotically Anti-de Sitter.

Effective holographic models for QCD: glueball spectrum and trace anomaly

Luis Alex Huahuachampi Mamani (Universidade Estadual de Santa Cruz, Brazil)

We investigate effective holographic models for QCD arising from five dimensional Dilaton-Gravity. The models are characterized by a dilaton with a mass term in the UV, dual to a CFT deformation by a relevant operator, and quadratic in the IR. The UV constraint leads to the explicit breaking of conformal symmetry whereas the IR constraint guarantees linear confinement. We propose semi-analytic interpolations between the UV and the IR and obtain a spectrum for scalar and tensor glueballs consistent with lattice QCD data. We use the glueball spectrum as a physical constraint to find the evolution of the model parameters as the mass term goes to zero. Finally, we reproduce the universal result for the trace anomaly of deformed CFTs and propose a dictionary between this result and the QCD trace anomaly. A nontrivial consequence of this dictionary is the emergence of a β function similar to the two-loop perturbative QCD result.

Eigenstate thermalization in the Sachdev-Ye-Kitaev model

Manuel Vidal Vielma Blanco (University of Geneva, Switzerland)

The eigenstate thermalization hypothesis (ETH) explains how closed unitary quantum systems can exhibit thermal behavior in pure states. In this work we examine a recently proposed microscopic model of a black hole in AdS2, the so-called Sachdev-Ye-Kitaev (SYK) model. We show that this model satisfies the eigenstate thermalization hypothesis by solving the system in exact diagonalization. Using these results we also study the behavior, in eigenstates, of various measures of thermalization and scrambling of information. We establish that two-point functions in finite-energy eigenstates approximate closely their thermal counterparts and that information is scrambled in individual eigenstates. We study both the eigenstates of a single random realization of the model, as well as the model obtained after averaging of the random disordered couplings. We use our results to comment on the implications for thermal states of a putative dual theory, i.e. the AdS2 black hole.

Isoperimetric surfaces and area-angular momentum inequality in a rotating black hole in New Massive Gravity

Mario Francisco Llerena Oña (Escuela Politecnica Nacional/Observatorio de Quito, Ecuador)

We study the existence and stability of isoperimetric surfaces in a family of rotating black holes in New Massive Gravity. We show that the stability of such surfaces is determined by the sign of the hair parameter. We use the isoperimetric surfaces to find a geometric inequality between the area and the angular momentum of the black hole, conjecturing geometric inequalities for more general black holes.

SL(2,Z) duality of p-forms in holography

Matheus Moreira de Assis Paganelly (UERJ, Brazil)

We extend the SL(2,Z) duality, of which electromagnetism is part, to p-forms in D=2(p+1) dimensions. We provide a holographic mapping in AdS/CFT that leaves the bulk invariant, but provides a boundary term that coincides with SL(2,Z) duality in CFT.

Alan Pavan (UNIFEI, Brazil)

Renormalizability of N=1 Super Yang-Mills theory in landau gauge with Stueckelberg-like field

Ozorio Bezerra Holanda Neto (UERJ, Brazil)

We construct a vector gauge invariant transverse field configuration, consisting of the well-known superfield vector and of a Stueckelberg-like chiral superfield. The renormalizability of the Super Yang-Mills action in the Landau gauge is analyzed in the presence of a gauge invariant mass term, with a power series in the superfield vector. Unlike the original Stueckelberg action, the resulting action turns out to be renormalizable to all orders.

Segundo Parra Milián (IFT-UNESP)