11th Vienna Central European Seminar on Particle Physics and Quantum Field Theory

CONFERENCE SCHEDULE

DAY 1 - FRIDAY, NOVEMBER 27
The talks will take place in the Ernst-Mach lecture hall.

08:30-09:15: Registration (at the conference site)
09:15-09:30: Conference opening
09:30-10:15: Tadashi Takayanagi, "Information metric and holography"
10:15-11:00: Esperanza Lopez, "Holographic out of equilibrium dynamics"
11:00-11:30: *COFFEE BREAK*
11:30-12:15: Martin Ammon: “Phase diagram of 4D field theories with chiral anomaly from holography”
12:15-12:45: Ayan Mukhopadhyay, "Reconstructing holography as RG flow and applications"
12:45-14:30: *LUNCH BREAK*
14:30-15:15: Stephane Detournay, "Asymptotic symmetries and two-dimensional field theories"
15:15-15:38: Christian Ecker, "Holographic entanglement entropy in heavy ion collisions"
15:38-16:00: Max Riegler, "Flat space holography and entanglement entropy in 2+1 dimensions"
16:00-16:30: *COFFEE BREAK*
16:30-17:00: Neven Bilic, "Randall-Sundrum vs. holographic cosmology"
17:00-17:45: Jan de Boer: “Entanglement Holography”
TECHNICAL BREAK
18:15-19:15: PUBLIC TALK: Soo-Jong Rey, "Memorable events in fields, gravity and strings"
19:30-? : *DINNER in Melker Keller*

DAY 2 - SATURDAY, NOVEMBER 28
The talks will take place in the Christian-Doppler lecture hall.

09:30-10:15: Markus Aspelmeyer, "Quantum tests of (quantum) gravity"
10:15-11:00: Caslav Brukner, "Indefinite causal order in quantum mechanics"
11:00-11:30: *COFFEE BREAK*
11:30-11:52: Helena Kolesova, "Gravity induced corrections to proton lifetime estimates"
11:52-12:15 Steven Bass, "Vacuum energy and the cosmological constant"
12:15-12:45: Harold Steinacker, "Quantum geometry from matrix models"
12:45-14:30: *LUNCH BREAK*
14:30-15:15: Kyriakos Papadodimas:” Quantum Mechanics and the Black Hole Horizon”
15:15-16:00: Andrea Puhm: “Quantum Tunneling & Black Hole Horizons”
16:00-16:30: *COFFEE BREAK*
16:30-16:52: Iva Lovrekovic, "One loop partition function in conformal gravity"
16:52-17:15 Wout Merbis, "Stress tensor correlation function from flat-space holography"
17:15-18:00: Soo-Jong Rey, "Higher spins over the rainbow"
18:00-? Poster session and *FAREWELL RECEPTION*

IN THE TIME ALLOCATED FOR EACH TALK 5 MIN DISCUSSION IS ASSUMED TO BE INCLUDED!

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VIENNA PARTICLE PHYSICS

ABSTRACTS OF ALL TALKS

Invited speakers:

TADASHI TAKAYANAGI "Information Metric and Holography"

ESPERANZA LOPEZ "Holographic out of equilibrium dynamics"

I will review the modeling of the out of equilibrium dynamics of isolated quantum systems in terms of processes of gravitational collapse in an asymptotically AdS space. I will show how this setup naturally reproduces know results for the evolution of the entanglement pattern towards equilibration. Under certain circumstances, finite size systems can undergo a series of dephasing and rephasing cycles in which the initial state that triggers the evolution is periodically reconstructed, called revivals. Depending on the initial conditions, a shell of matter in AdS might undergo a series of implosions and expansions giving rise to oscillations in the geometry. After exploring the phenomenology of both phenomena, I will propose that such oscillating geometries are dual to quantum revivals.

MARTIN AMMON "Phase diagram of 4D field theories with chiral anomaly from holography"

STEPHANE DETOURNAY "Asymptotic Symmetries and Two-Dimensional Field Theories"

The concept of asymptotic symmetries has played a significant role in the discovery and subsequent developments of gauge/gravity (or holographic) dualities. Examples include the analysis of Brown-Henneaux on asymptotic symmetries of AdS_3 spaces, pointing at the existence of a two-dimensional Conformal Field Theory dual to quantum gravity in AdS_3, or more recently the Kerr/CFT correspondence.
After briefly reviewing the points mentioned above, I will discuss new holographic scenarios emerging by following the same philosophy. I will describe the asymptotic symmetries of certain classes of non-asymptotically AdS spaces (e.g. flat spaces and toy models for extreme Kerr black holes) and analyze the implications for their potential field theory duals. In particular, I will show that the corresponding field theories admit Cardy-like regimes allowing to derive universal formulas for their degeneracy of states, which exactly reproduce the Bekenstein-Hawking entropy of the corresponding gravitational solutions - much like the BTZ black hole entropy can be reproduced by a Cardy formula.

JAN DE BOER "Entanglement Holography"

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.

MARKUS ASPELMEYER "Quantum tests of (quantum) gravity"

CASLAV BRUKNER, "Indefinite causal order in quantum mechanics"

KYRIAKOS PAPADODIMAS "Quantum Mechanics and the Black Hole Horizon"

ANDREA PUHM "Quantum Tunneling & Black Hole Horizons"

A massive star undergoing gravitational collapse must inevitably evolve into a black hole. Yet to resolve the information paradox, it has been argued, that quantum gravity effects must destroy the classical black hole horizon and have to replace it by a firewall or horizon-scale structure. This claim is rather bold but is supported in string theory whose very ingredients - (anti) branes, topology and fluxes - can be used to build horizon-scale structure. An outstanding question about dynamics is to understand how a collapsing star can evolve into this structure. To address this I will study quantum tunneling into explicit black hole microstate geometries and discuss how this process may be fast enough to avoid the formation of a horizon.

SOO-JONG REY "Higher Spins Over the Rainbow"

Interacting theory of massive and massless higher spin fields in (anti-)de Sitter space is not presently available. In this talk, I present a new idea to this issue. I start with interacting massless higher spin theory in higher-dimensional anti-de Sitter space. I then perform Kaluza-Klein compactification to lower-dimensional (anti-)de Sitter space, obtaining an interacting theory of massless and massive higher spin fields. This compactification involves internal space with nonempty boundary. Therefore, the latter theory is classified by all possible boundary conditions for higher spin fields. I show that there are 2s+1 many boundary conditions for spin-s field, of which only two lead to unitary theory. All other boundary conditions lead to non-unitary theories involving partially massless or negative mass-squared higher spin spectra of varying depths. Upon analytic continuation to de Sitter space, however, these theories become unitary and admit sensible physical interpretations. We systematically classify all these theories from the classification of the boundary conditions.

Contributed talks:

AYAN MUKHOPADHYAY "Reconstructing holography as RG flow and applications"
Reconstructing holography as a RG flow could lead us to a new approach towards constructive field theories at strong coupling, where we cannot use the traditional methodology of diagrammatic perturbation series. We will take first steps in this direction by generalizing Wilsonian RG via three simple principles, and showing how it leads to the traditional AdS/CFT results using classical gravity in one higher dimension. We will focus on the hydrodynamic limit for an explicit construction. We will also present some possibilities of using this approach to generalize the holographic correspondence by including weakly interacting degrees of freedom.

CHRISTIAN ECKER "Holographic Entanglement Entropy in Heavy Ion Collisions"
Entanglement entropy, a measure for entanglement in quantum systems, attracts a lot of attention in seemingly unrelated branches of physics like quantum information, condensed matter and conformal field theories. While computing entanglement entropy in quantum field theories turns out to be notoriously hard, the holographic principle maps the problem to the much easier task of finding minimal (hyper)surfaces in a higher dimensional gravity theory. In this talk I will present our recent numerical relativity computations of entanglement entropy using a system of colliding gravitational shock waves as holographic toy model for the early stage of heavy ion collisions.

MAX RIEGLER "Flat Space Holography and Entanglement Entropy in 2+1 Dimensions"
In order to gain a better understanding of the general nature of the holographic principle it is of interest to establish new kinds of holographic correspondences. One particularly interesting example of such a new correspondence is flat space holography in 2+1 dimensions. In this talk I will give a short introduction on flat space holography and then elaborate on a specific aspect of this correspondence namely on how to calculate entanglement entropy holographically in this setup (the talk will be based on the work hep-th/1410.4089).

NEVEN BILIC: "Randall-Sundrum vs holographic cosmology"
We consider a model of a holographic braneworld universe in which a cosmological fluid occupies a 3+1 dimensional brane located at the boundary of the asymptotic AdS_5 bulk. We combine the AdS/CFT correspondence and the second Randall-Sundrum (RSII) model to establish a relationship between the RSII braneworld cosmology and the boundary metric induced by the time dependent bulk geometry. In the framework of the FRW cosmology some physically interesting scenarios will be discussed involving the RSII and holographic braneworlds.

HELENA KOLESOVA "Gravity induced corrections to proton lifetime estimates"
As the main experimental prediction, the proton lifetime was computed for different grand unification models. However, since the unification scale is typically rather close to the Planck scale, the corresponding higher dimensional operators may change the result considerably. We study such operators affecting either the position of the unification scale or the flavor structure of the theory, and try to find the cases where one can obtain results robust with respect to these "gravity smearing" effects.

STEVEN BASS "Vacuum energy and the cosmological constant"
The accelerating expansion of the Universe points to a small positive value for the cosmological constant or vacuum energy density. We discuss recent ideas that the cosmological constant plus LHC results might hint at critical phenomena near the Planck scale.

HAROLD STEINACKER "Quantum geometry from matrix models"
The quantum (or non-commutative) geometry arising from Yang-Mills matrix models is illustrated by several examples, including self-intersecting branes and covariant 4-dimensional spaces. The dynamics of this geometry and its possible relevance to particle physics and gravity is discussed.

IVA LOVREKOVIC "One loop partition function in conformal gravity"
Partition functions are functions that describe the statistical properties of a system in thermodynamic equilibrium and depend on thermodynamical variables. The Euclidean parti- tions function are then compared to partition functions for CFT that are con- jectured to be dual to corresponding gravity theory. This has been done for quantum gravity in AdS_3 which is dual to 2 dimensional CFT, and it was shown to work well and shed further light on the properties of dual CFT. We generalize the above calculation and calculate such partition function for the conformal gravity in AdS_4 which is dual to 3 dimensional CFT.

WOUT MERBIS "Stress tensor correlation functions from flat-space holography"
One of the most remarkable advances in our understanding of quantum gravity has been the development of the AdS/CFT correspondence, which provides a concrete realization of the holographic principle. But many believe that holography is more general than AdS/CFT and could be extended to gravity theories with different asymptotic behavior. In this talk I will highlight some recent advances in flat-space holography. In particular, I will focus on the relation between pure Einstein gravity in three dimensions and a two dimensional quantum field theory with so-called Galilean conformal symmetry. We'll discuss how we can compute all boundary stress-tensor n-point correlation functions recursively in both the bulk and boundary and hence provide a non-trivial check for a 3D/2D flat space holographic correspondence.

POSTER Description:

ANAMARIJA KIRIN "Non-minimally coupled scalar field in teleparallel gravity: boson stars"
The self-gravitating configurations of the scalar field - boson stars - are constructed by introducing the nonminimal coupling of the scalar field to the torsion scalar within the framework of teleparallel gravity. Coupling of the field nonminimally to the torsion scalar destroys the Lorentz invariance of the theory in the sense that the resulting equations of motion depend on the choice of a tetrad. After finding a tetrad which leads to a self--consistent set of equations, for the assumed static spherically symmetric spacetime, boson stars are constructed. An interesting property of the configurations obtained with sufficiently large field-to-torsion coupling constant is the outwardly increasing energy density, followed by an abrupt drop towards the usual asymptotic tail. Extending the model with the U(1) gauge field, it is found that the combined effect of the charge and coupling of the field to torsion leads to a significant increase of the maximal mass and the particle number that can be supported against gravity.

FLAMINIA GIACOMINI "Infinite-dimensional quantum systems on indefinite causal structures"
Standard quantum mechanics assumes that events are embedded in a global causal structure such that, for every pair of events, the causal order between the two events is always fixed. The process matrix framework keeps the local validity of standard quantum mechanics while relaxing the assumption on the global causal structure. This allows to describe situations in which the order of events is not fixed, but is rather subject to quantum uncertainty. Moreover, it is possible to derive multipartite correlations which lie outside the usual causally ordered framework. So far, the formalism has been developed only for finite-dimensional systems and its direct extension to infinite dimensions leads to singularities. We show how the framework can be extended to infinite-dimensional Hilbert spaces, and we provide an example of a causally non-separable process -the quantum switch - in infinite dimensions. The correlation arising from this process exhibits interference which is due to superposition of processes in which A is before B and B is before A.

ESTEBAN CASTRO RUIZ "Entanglement of quantum clocks through gravity"
In general relativity, the picture of spacetime assigns an ideal clock to each spacetime point. Being ideal, gravitational effects due to these clocks are ignored and the flow of time according to one clock is not affected by the presence of surrounding clocks. However, if time is defined operationally, as a pointer position of a physical clock that obeys the laws of quantum mechanics and general relativity, such a picture is at most a convenient fiction. We show that the mass-energy equivalence implies gravitational interaction between the clocks, while the superposition of energy eigenstates leads to a non-fixed metric background. Based only on the assumption that both quantum mechanics and general relativity are valid in this situation, we show that the clocks necessarily get entangled through time dilation effect, which eventually leads to a loss of coherence of a single clock. Hence, the time as measured by a single clock is not well-defined. However, the general relativistic notion of time is recovered in the classical limit of clocks.

KONSTANTIN MERZ "On the leading energy correction for the statistical model of the atom using phase space localization techniques"

THOMAS GAJDOSIK "Restricting the Higgs sector by radiative neutrino masses"
Inclusion of a second Higgs doublet allows the radiative mass generation in the neutrino sector, even when we include only a single gauge singlet fermion for the seesaw mechanism. We present the
tight constraints on the Higgs sector from the requirement that our model reproduces the measured experimental mass differences in the neutrino sector.