3rd Karl Schwarzschild Meeting - Gravity and the Gauge/Gravity Correspondence

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Book of Abstracts
## Contents

- The Kerr-Newman black hole is an astrophysical solution ........................................ 1
- Weakness of gravity as illusion which hides true path to unification of gravity with particle physics ................................................................. 1
- Testing the Kerr black hole hypothesis using X-ray reflection spectroscopy ............. 1
- Astrophysical signatures in general black hole spacetimes: the spherically-symmetric case ................................................................. 1
- Informational theory of relativity ................................................................. 2
- A holographic stress-energy tensor near the Cauchy horizon inside a rotating black hole ................................................................. 3
- Unified and self-consistent redefinition of geodesics and emission spectrum of Schwarzschild black hole ................................................................. 3
- Mass-loss due to gravitational waves with $\Lambda > 0$ .............................................. 3
- Kerr/CFT correspondence for accelerating and magnetised extremal black holes ........ 4
- Cosmic strings with excited condensates ................................................................. 4
- Thermodynamical aspects of black holes in modified gravity ................................. 4
- Gravity’s Rainbow and Black Hole Entropy ................................................................. 5
- Local quantum effects in QED induced by evaporating black holes ......................... 5
- Generalized uncertainty principle and bounds on Lorentz violation ......................... 5
- Finite conformal quantum gravity and spacetime singularities ................................. 5
- Pre-Hawking radiation may allow for reconstruction of the mass distribution of the collapsing object ................................................................. 6
- Quasinormal modes of charged magnetic black branes and chiral magnetic transport in the dual field theory ................................................................. 6
- Signatures of extra dimensions in gravitational waves .............................................. 6
- Thermodynamics of Accelerating Black Holes ................................................................. 7
- Measurement of Hawking Radiation in the lab ................................................................. 7
- Synchrotron radiation reaction around black hole ................................................................. 7
The Kerr-Newman black hole is an astrophysical solution

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We present a systematic study of the gravitational collapse of rotating and magnetised neutron stars to charged and rotating (Kerr-Newman) black holes. In particular, we consider the collapse of magnetised and rotating neutron stars assuming that no pair-creation takes place and that the charge density in the magnetosphere is so low that the stellar exterior can be described as an electrovacuum. Under these assumptions, which are rather reasonable for a pulsar that has crossed the “death line”, we show that when the star is rotating, it acquires a net initial electrical charge, which is then trapped inside the apparent horizon of the newly formed back hole. We analyse a number of different quantities to validate that the black hole produced is indeed a Kerr-Newman one and show that, in the absence of rotation or magnetic field, the end result of the collapse is a Schwarzschild or Kerr black hole, respectively. We discuss possible association with the newly observed class of fast radio bursts.

Weakness of gravity as illusion which hides true path to unification of gravity with particle physics

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Well known weakness of Gravity in particle physics is an illusion caused by underestimation of the role of spin in gravity. Relativistic rotation is inseparable from spin, which for elementary particles is extremely high and exceeds mass on 20-22 orders (in units c = G = m = ≈ 1). Such a huge spin generates frame-dragging that distorts space much stronger than mass, and effective scale of gravitational interaction is shifted from Planck to Compton distances. We show that compatibility between gravity and quantum theory can be achieved without modifications of Einstein-Maxwell equations, by coupling to a supersymmetric Higgs model of symmetry breaking and forming a nonperturbative super-bag solution, which generates a gravity-free Compton zone necessary for consistent work of quantum theory. Super-bag is naturally upgraded to Wess-Zumino supersymmetric QED model, forming a bridge to perturbative formalism of conventional QED.

Testing the Kerr black hole hypothesis using X-ray reflection spectroscopy

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It is thought that the spacetime metric around astrophysical black holes is well approximated by the Kerr solution. However, macroscopic deviations from the Kerr background are predicted by a number of scenarios beyond Einstein’s gravity. X-ray reflection spectroscopy can be a powerful tool to probe the strong gravity region of these objects and test their actual nature. In this talk, I present the first X-ray reflection model to test the Kerr black hole hypothesis.
Astrophysical signatures in general black hole spacetimes: the spherically-symmetric case
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A binary system composed of a supermassive black hole and a pulsar orbiting around it is studied. The motivation for this study arises from the fact that pulsar timing observations have proven to be a powerful tool in identifying physical features of the orbiting companion. In this study, taking into account a general spherically-symmetric metric, we present analytic calculations of the geodesic motion, the innermost stable circular orbit, and the possible deviations with respect to the standard Schwarzschild case of General Relativity. In particular, the advance at periastron is studied with the aim of identifying corrections to General Relativity. A discussion of the motion of a pulsar very close the supermassive central black hole in our Galaxy (Sgr A*) is reported.

Informational theory of relativity
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In 1905’s Einstein historic paper, Einstein imposed the synchronization condition on the arrival times of the light exchanged between the two separated clocks a and b both sitting in one inertial frame, and by repeating the synchronization condition to every pair of the clocks in the frame we can entirely define the synchronized time coordinate. Here Einstein assume that the clock a can instantly get the time information of the light signal reflected from the clock b and vice versa. But in modern informational point of view, it is more realistic that it takes the minimal time duration $\tau$ to send one bit of time data, for $\sigma$ bits of data the time duration amounts to $\tau\sigma$ and then Einstein synchronization is modified in the informational manner. Furthermore we introduce relatively moving observers to the clocks a and b sitting in one rest frame, and find that the rest frame time duration $\tau\sigma$ is converted to the general form $u_{\mu}^\sigma(x)\tau\sigma$ which includes dilated time and relative velocity from the view point of the relatively moving observer. And Lorentz transformation is recovered in the observer coordinate where $x_{\text{obs}}^\mu := x^\mu + u_{\mu}^\sigma(x)\tau\sigma$. As an application we consider geodesic equation and red shift formula. Although the 4-dimensional effective geodesic equation remains intact, the red shift formula is modified and the informational effect accumulates.

In order to extend the special relativity to general relativity, we consider the 5-dimensional informational space-time. Under the assumption that the informational space is homogeneous, 5-dimensional infinitesimal gauge transformation can be embedded in the 5-dimensional general coordinates transformation. Then we adopt the 5-dimensional Einstein-Hilbert action with one normalization constraint condition for the vector field $u^\mu(x)$. Applying the 4+1 decomposition of Einstein-Hilbert action it is turned out that the 4-dimensional effective action becomes the slightly modified Einstein-Maxwell action with the timelike normalization constraint of $u_{\mu}^\sigma(x)$ where Maxwell-like field $A_{\mu\nu}$ is defined as the anti-symmetrized covariant derivative of $u^\mu$, that is $A_{\mu\nu} := D_{\mu}u_{\nu} - D_{\nu}u_{\mu}$. As an application to astrophysics we consider the case that the 4-dimensional space-time is spherically symmetric. Without assuming staticity of the space-time, we obtain the static exact vacuum solution with a parameter and thus Birkhoff theorem is confirmed. The solution is similar to Schwarzschild external solution at far distance but it deviates from Schwarzschild external solution near the minimum radius. We will see the deviation by the numerical plot of the $g_{tt}(r)$ and $g_{rr}(r)$ for some different values of the informational scale. Besides till the first order of the PPN expansion, our solution is coincident with Schwarzschild external solution at far distance.

We also discuss the relation between Einstein-Aether theory and informational theory of relativity.
**Holography/Information/Analogue Gravity I - Board: 13 / 7**

**A holographic stress-energy tensor near the Cauchy horizon inside a rotating black hole**

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We investigate a stress-energy tensor for a CFT at strong coupling inside a small five-dimensional rotating Myers-Perry black hole with equal angular momenta by using the holographic method. As a gravitational dual, we perturbatively construct a black droplet solution by applying the “derivative expansion” method, generalizing the work of Haddad, and analytically compute the holographic stress-energy tensor for our solution. We find that the stress-energy tensor is finite at both the future and past outer (event) horizons, and that the energy density is negative just outside the event horizons due to the Hawking effect. Furthermore, we apply the holographic method to the question of quantum instability of the Cauchy horizon since, by construction, our black droplet solution also admits a Cauchy horizon inside. We analytically show that the null-null component of the holographic stress energy tensor negatively diverges at the Cauchy horizon, suggesting that a singularity appears there, in favor of strong cosmic censorship.

**Black hole theory - Board: 46 / 12**

**Unified and self-consistent redefinition of geodesics and emission spectrum of Schwarzschild black hole**

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With remedying the shortcomings of previous awkward geodesics definition in mind, we redefine the geodesics in a unified and self-consistent way. By the way, based on the brand-new definition, we proceed to investigating the emission spectrum of Schwarzschild black hole. Particle’s motion along geodesics is an intriguing process in black hole physics. Geodesic equation of particles in various black holes has been derived extensively. However, definition of geodesics for massive particles seems to be unnatural and exists some limitations. Firstly, the previous derivation of the massive particles’ geodesics was inconsistent with the variation principle of action. What’s more, according to the previous definition, quite different approaches were needed to achieve the geodesic equations of massive and massless particles, since the treatment for massive case was not applicable for describing the motion of massless particles. Besides, more awkwardly, the geodesics equation has been derived on the basis of inconsistent foundations, namely, mixing together relativistic and nonrelativistic descriptions. Motivated by an urgent need for a unified and self-consistent derivation, we focus on redefining the geodesics equations of particles in black holes.

**Black holes and astrophysics I - Board: 18 / 14**

**Mass-loss due to gravitational waves with \( \Lambda > 0 \)**

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The theoretical basis for the energy carried away by gravitational waves that an isolated gravitating system emits was first formulated by Hermann Bondi during the 1960s. Recent findings from looking at distant supernovae revealed that the rate of expansion of our universe is accelerating, which may be well-explained by sticking in a positive cosmological constant into the Einstein field equations for general relativity. By solving the Newman-Penrose equations (which are equivalent
to the Einstein field equations), we generalise this notion of Bondi mass-energy and thereby provide a firm theoretical description of how an isolated gravitating system loses energy as it radiates gravitational waves, in a universe that expands at an accelerated rate [1, 2]. This is in line with the observational front of LIGO’s first announcement in February 2016 that gravitational waves from the merger of a binary black hole system have been detected. [1] V.-L. Saw, “Mass-loss of an isolated gravitating system due to energy carried away by gravitational waves with a cosmological constant”, Physical Review D 94, 104004 (2016). [2] V.-L. Saw, “Behaviour of asymptotically electro-Λ spacetimes”, Physical Review D 95, 084038 (2017).

Plenary Session - Board: 50 / 16

Kerr/CFT correspondence for accelerating and magnetised extremal black holes

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The near horizon geometry of the rotating C-metric, describing accelerating Kerr-Newman black holes, is analysed. It is shown that, at extremality, even though not it is isomorphic to the extremal Kerr-Newman, it remains a warped and twisted product of \(\text{AdS}_2 \times \text{S}^2\). Therefore the methods of the Kerr/CFT correspondence can successfully be applied to build a CFT dual model, whose entropy reproduce, through the Cardy formula, the Beckenstein-Hawking entropy of the accelerating black hole. Further generalisation in presence of an external Melvin-like magnetic field, used to regularise the conical singularity characteristic of the C-metrics, shows that the Kerr/CFT correspondence can be applied also for extremal black holes metrics deformed by the acceleration and an external (electro)-magnetic field.

Black holes and astrophysics I - Board: 55 / 17

Cosmic strings with excited condensates

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Recent high precision cosmological and astrophysical data suggests that the knowledge of the microstructure of topological defects, that could have formed in the phase transitions in the early universe and be present in the universe to this day, is important. We have studied cosmic strings in the Abelian-Higgs (toy) model and found that these objects can have richer microstructure than previously thought. In this talk the description of this new microstructure as well as observational consequences will be discussed.

Black hole theory - Board: 45 / 18

Thermodynamical aspects of black holes in modified gravity

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In General Relativity (GR), several thermodynamical notions (the quasi-local energy, the Killing surface gravity, the Killing temperature, the entropy, etc.) can be introduced for the black holes,
but in the modified theories of gravity the black hole solutions are not expected to share the same proprieties of their Einsteinian counterparts. In particular, the definition of the analogue of the Misner-Sharp mass of GR is very problematic, since a conserved current cannot be found in the higher order differential field equations. In F(R)-modified gravity the First Law of thermodynamics may be derived from the equations of motion, evaluating independently the entropy via Wald method and the Killing-Hawking temperature via quantum mechanical methods in curved space-times. In an analogue way, in other theories of modified gravity (Gauss-Bonnet, Weyl modified gravity...) the First Law of thermodynamics can be used to infer the black hole energy. In our specific examples, the energy turns out to be proportional to the integration constant of the solutions, giving to it a physical meaning like in the Schwarzschild case. Some cases where more than one integration constants emerge from the metric will be discussed.

**Plenary Session - Board: 53 / 19**

**Gravity’s Rainbow and Black Hole Entropy**

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The ‘t Hooft brick wall is an UV cutoff introduced to keep under control divergencies which appear on the horizon of a black hole when a QFT approach is used to compute the entropy of some field. Distorting the original gravitational field by means of Gravity’s Rainbow we show that it is possible to avoid a brick wall cutoff not only for a spherically symmetric metric, but even when the metric is axisymmetric or of a Kerr-type. In this particular case, we will show that the results obtained for a comoving observer and for an inertial observer are the same.

**Black hole theory - Board: 47 / 20**

**Local quantum effects in QED induced by evaporating black holes**

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Black holes can manifest themselves in local electromagnetic phenomena. This appears to be a consequence of the formation of the event horizon. In this talk, we shall discuss several local imprints of black holes in the far-from- and near-horizon region.

**Plenary Session - Board: 54 / 21**

**Generalized uncertainty principle and bounds on Lorentz violation**

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We compute the Hawking temperature of a black hole in two different ways. The first way involves the deformation parameter $\beta$ of the Generalized Uncertainty Principle, and therefore we get a deformed Hawking temperature containing the parameter $\beta$. The second way involves a deformed Schwarzschild metric containing the Lorentz violating terms $\tilde{s}^{\mu\nu}$ proposed by A.Kostelecky in the gravity sector. The comparison between the two different techniques yields a relation between $\beta$ and $\tilde{s}^{\mu\nu}$, and allows us to transfer bounds from $\beta$ to $\tilde{s}^{\mu\nu}$. 
Black hole theory - Board: 38 / 23

Finite conformal quantum gravity and spacetime singularities

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We prove that a class of finite quantum gravitational theories is actually a range of anomaly-free conformally invariant quantum theories in the spontaneously broken phase of the Weyl symmetry. At classical level we show how the Weyl conformal invariance is likely able to tame all the spacetime singularities that plague not only Einstein gravity, but also local and weakly non-local higher derivative theories. This latter statement is rigorously proved by a singularity theorem that applies to a large class of weakly non-local theories. Following the seminal paper by Narlikar and Kembhavi, we provide an explicit construction of singularity-free black hole exact solutions.

Plenary Session - Board: 51 / 24

Pre-Hawking radiation may allow for reconstruction of the mass distribution of the collapsing object

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Hawking radiation explicitly depends only on the black hole’s total mass, charge and angular momentum. It is therefore generally believed that one cannot reconstruct the information about the initial mass distribution of an object that made the black hole. However, instead of looking at radiation from a static black hole, we can study the whole time-dependent process of the gravitational collapse, and pre-Hawking radiation which is excited because of the time-dependent metric. We compare radiation emitted by a single collapsing shell with that emitted by two concentric shells of the equivalent total mass. We calculate the gravitational trajectory and the momentum energy tensor. We show that the flux of energy emitted during the collapse by a single shell is significantly different from the flux emitted by two concentric shells of the equivalent total mass. When the static black hole is formed, the fluxes become indistinguishable. This implies that an observer studying the flux of particles from a collapsing object could in principle reconstruct information not only about the total mass of the collapsing object, but also about the mass distribution.

Holography/Information/Analogue Gravity I - Board: 10 / 25

Quasinormal modes of charged magnetic black branes and chiral magnetic transport in the dual field theory

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I will review the charged magnetic black brane solutions in Einstein-Maxwell-Chern-Simons (EMCS) theory. The holographic dual of this setup on the field theory side is a particular charged plasma subjected to the external magnetic field in the presence of a chiral anomaly. The calculation of quasinormal modes (QNMs) of the black branes in EMCS theory will be presented. QNMs are holographically dual to the poles of field theory correlation functions. Using hydrodynamics as an effective field theory close to equilibrium, I will verify the location of the lowest lying QNMs. Finally, I will discuss the computation of the field theory transport coefficients from this setup.
**Signatures of extra dimensions in gravitational waves**

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Considering gravitational waves propagating on the most general 4+N-dimensional space-time, we investigate the effects due to the N extra dimensions on the four-dimensional waves. All wave equations are derived in general and discussed. On Minkowski4 times an arbitrary Ricci-flat compact manifold, we find: a massless wave with an additional polarization, the breathing mode, and extra waves with high frequencies fixed by Kaluza-Klein masses. We discuss whether these two effects could be observed. Based on 1704.07392.

**Thermodynamics of Accelerating Black Holes**

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An accelerating black hole can be described by an exact solution in GR in which the black hole is accelerated by a conical deficit, or cosmic string, emerging from one pole. Although this is not an isolated system, nonetheless I show how its thermodynamics can be properly defined, giving a Smarr relation and First Law, including variations of the conical deficit. This extends the regime of validity of black hole thermodynamics to non-static configurations, as well as introducing new a thermodynamic parameter - the thermodynamic length, associated with varying tension.

**Measurement of Hawking Radiation in the lab**

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Hawking’s result that black holes radiate is one of the most mysterious results in physics in the past 50 years. 40 years later we still do not understand the process or its implications. About 35 years ago I notices that the same effect is present in fluids with trans-sonic flows, which opened the way to doing laboratory experiments to investigate the physics of the process. I will discuss the Hawking process, and the problems in its derivation, the analog models and the experiments which have and are being done to measure the effect in a variety of fluids and of waves in those fluids.

**Synchrotron radiation reaction around black hole**

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Synchrotron radiation emitted by a charged particle leads to appearance of the back-reaction force which can affect the motion of particle significantly. For the motion around black hole it raises a question of location and stability of circular orbits which play important role in astrophysical phenomena occurring in the vicinity of black holes. I will present our recent results on the
study of the problem of charged particles undergoing radiation reaction force in combined field of Schwarzschild black hole and external asymptotically uniform magnetic field. Equations of motion in general contain runaway solutions which can be avoided by reduction of order procedure. We test the dynamical equations numerically and find explicit trajectories of charged particles in two, ultrarelativistic and weakly relativistic limits. I will demonstrate that in case when the Lorentz force acting on a ultrarelativistic charged particle directed towards the black hole, a particle spirals down to the horizon, while in opposite case a charged particle decays its oscillations ending up at the stable circular orbit. In weakly relativistic limit I will describe a new interesting effect of the widening of orbits in time outward from black hole, although the process is relatively slow. I will also discuss the possible astrophysical relevance of presented results.

Holography/Information/ Analogue Gravity II - Board: 32 / 32

Generalized Entropy and the Quantum Focussing Conjecture

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The study of black holes has revealed a deep and general connection between quantum information and spacetime geometry. Its origin must lie in a quantum theory of gravity, so it offers a valuable hint in our search for a unified theory. Precise formulations of this relation recently led to new insights in Quantum Field Theory, some of which have been rigorously proven. An important example is the first universal lower bound on the local energy density.

Plenary Session - Board: 52 / 33

Kerr black holes with synchronized bosonic hair

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Over the last three years it has been found that a new class of asymptotically flat black hole solutions exists in General Relativity – namely Kerr black holes with scalar hair and Proca hair. These solutions possess a simple matter contents that obey the energy conditions, are regular on and outside the event horizon and bifurcate from the vacuum Kerr solution. In this talk I will review the general mechanism that allows such black holes to exist, how they circumvent well known no-hair theorems and some of their phenomenology which can be considerably distinct from that of Kerr.

Key references:

- Carlos Herdeiro, Eugen Radu, Helgi Runarsson, Kerr black holes with Proca hair Class.Quant.Grav. 33 (2016) no.15, 154001

Holography/Information/Analogue Gravity I - Board: 5 / 35

Time evolution of entanglement for holographic steady state formation
Within gauge/gravity duality, we consider the local quench-like time evolution obtained by joining two 1+1-dimensional heat baths at different temperatures at time t=0. A steady state forms and expands in space. For the 2+1-dimensional gravity dual, we holographically calculate the entanglement entropy and also the mutual information for different entangling regions. For general temperatures, we find that the entanglement entropy increase rate satisfies the same bound as in the “entanglement tsunami” setups. For small temperatures of the two baths, we derive an analytical formula for the time dependence of the entanglement entropy. This replaces the entanglement tsunami-like behaviour seen for high temperatures. Finally, we check that strong subadditivity holds in this time-dependent system, as well as further more general entanglement inequalities for five or more regions recently derived for the static case.

**Supersymmetry and singularity in dynamical M-brane background**

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The supersymmetry arises in certain theories of fermions coupled to gauge fields and gravity in a spacetime of 11 dimensions. The dynamical brane background has mainly been studied for the class of purely bosonic solutions only, but recent developments involving time-dependent brane solution have made it clear that one can get more information by asking what happens on supersymmetric systems. In this talk, we present an exact supersymmetric solution of dynamical M-brane background in the 11-dimensional supergravity and discuss the geometric features near the singularity and the black hole horizon.

**Quasinormal modes and instability of Einstein-Gauss-Bonnet-AdS black holes and branes**

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We shall show that the gravitational quasinormal spectrum of Einstein-Gauss-Bonnet-AdS black holes consists from the two essentially different types of modes: perturbative and non-perturbative in the Gauss-Bonnet coupling $\alpha$. The sound and hydrodynamic modes of the perturbative branch can be expressed as linear corrections in $\alpha$ to the damping rates of their Schwarzschild-AdS limits: $w \approx \Re \left( w_{SAdS} \right) - \Im \left( w_{SAdS} \right) \left( 1 - \alpha \cdot \left( (D + 1)(D - 4)/2R^2 \right) i \right)$, where $R$ is the AdS radius. The non-perturbative branch of modes consists of purely imaginary modes, whose damping rates unboundedly increase when $\alpha$ goes to zero. At the same time, when the Gauss-Bonnet coupling $\alpha$ (or used in holography $l_{GB}$) is not small enough, then the black holes and branes suffer from the instability, so that the holographic interpretation of perturbation of such black holes becomes questionable, as, for example, the claimed viscosity bound violation in the higher derivative gravity. For example, D=5 black brane is unstable at $|l_{GB}| > 1/8$ and has anomalously large relaxation time even at smaller $|l_{GB}|$ when approaching the threshold of instability.
Horizon quantum mechanics of rotating black holes

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The horizon quantum mechanics is an approach that was previously introduced in order to analyze the gravitational radius of spherically symmetric systems and compute the probability that a given quantum state is a black hole. In this work, we first extend the formalism to general space-times with asymptotic (ADM) mass and angular momentum. We then apply the extended horizon quantum mechanics to a harmonic model of rotating corpuscular black holes. We find that simple configurations of this model naturally suppress the appearance of the inner horizon and seem to disfavor extremal (macroscopic) geometries.

The Schwarzschild solution

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The Schwarzschild solution has confused us for over a hundred years and it has forced us to sharpen our views on space and time. It has led to a sharper understanding of Einstein’s theory. Experimentally, it is explaining several astrophysical observations. Its quantum aspects have been a source of theoretical paradoxes that are forcing us to understand better the relation between spacetime geometry and quantum mechanics.

Panel discussion: String theory

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Comments on the string theory approach to quantum gravity and its relation to the rest of physics.

Quantization of quasi-Poisson spaces and the Turaev-Viro model

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Quantum systems with quasitriangular Hopf algebra symmetry, such as the Turaev-Viro model, can be considered as quantizations of phase spaces with Poisson Lie group symmetry. The model ‘phase space’ for 3D gravity with a positive cosmological constant is the double SU(2)xSU(2), which is not a proper phase space but a quasi-Poisson space and does not have a classical r-matrix.
The Turaev-Viro model, however, is defined in terms of certain representations of a Hopf algebra at \( q \) root of unity. Following work by G. Mack and V. Schomerus we will argue that it is more consistent with our classical setting to consider the Turaev-Viro model in terms of a quasi-Hopf algebra. Within this setting we can construct certain geometric operators probing the quantum geometry and a Hamiltonian constraint whose kernel gives rise to the Turaev-Viro amplitudes.

**Holography/Information/Analogue Gravity I - Board: 7 / 47**

**Holographic bulk reconstruction beyond (super)gravity**

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We outline a holographic recipe to reconstruct \( \alpha' \) corrections to AdS (quantum) gravity from an underlying CFT in the strictly planar limit (\( N \to \infty \)). Assuming that the boundary CFT can be solved in principle to all orders of the \( 't \) Hooft coupling \( \lambda \), for scalar primary operators, the \( \lambda^{-1} \) expansion of the conformal dimensions can be mapped to higher curvature corrections of the dual bulk scalar field action. Furthermore, for the metric perturbations in the bulk, the AdS/CFT operator-field isomorphism forces these corrections to be of the Lovelock type. We demonstrate this by reconstructing the coefficient of the leading Lovelock correction, aka the Gauss-Bonnet term in a bulk AdS gravity action using the expression of stress-tensor two-point function up to sub-leading order in \( \lambda^{-1} \).

**Black holes and astrophysics II - Board: 48 / 49**

**Observing the Signature of Dynamical Space-Time**

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The detection of gravitational waves from binary black holes constitutes a major scientific discovery, as it permits a new kind of observation of the cosmos, quite different from electromagnetic and particle observations. In this talk I will review the theoretical groundwork that allowed us to identify and interpret the gravitational-wave signals, and discuss how those new astronomical messengers can unveil the properties of the most extreme astrophysical objects in the universe, and inform us about the theory of gravity in the highly dynamical space-time regime.

**Holography/Information/Analogue Gravity I - Board: 4 / 50**

**Strong energy condition and complexity growth bound in holography**

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1) Computational complexity and its growth rate bound; 2) Holographic complexity/action conjecture for a thermofield double state; 3) Strong energy condition and complexity growth bound in holography.
Testing general relativity with X-ray reflection spectroscopy of MCG-06-30-15

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The spacetime geometry around astrophysical black holes is thought to be well approximated by the Kerr metric, but deviations from standard predictions are possible in a number of scenarios beyond Einstein’s gravity and in the presence of exotic matter. In this talk, I present the constraints on possible deviations from the Kerr solution using X-ray reflection spectroscopy from the analysis of real data. I use the relativistic X-ray reflection code RELXILL modified to a generic stationary, axisymmetric and asymptotically flat black hole metric. I analyze XMM-Newton, NuSTAR and SUZAKU observations of the AGN in MCG-06-30-15 and constrain the Johannsen deformation parameter $\alpha_{13}$.

Cosmic Censorship in Quantum Einstein Gravity

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The quantum gravity modification of the Kuroda-Papapetrou model induced by the running of the Newton’s constant at high energy in Quantum Einstein Gravity are discussed. It is argued that although the antiscreening character of the gravitational interaction favours the formation of a naked singularity, quantum gravity effects turn the classical singularity into a “whimper” singularity which remains naked for a finite amount of advanced time.

Einstein-Maxwell-Chern-Simons Black Holes

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In this talk black holes in 5-dimensional Einstein-Maxwell-Chern-Simons (EMCS) theory and their intriguing properties are discussed. For the special case of the CS coupling constant $\lambda = \lambda_{SG}$, as obtained from supergravity, a closed form solution is known for the rotating black holes. Beyond this supergravity value, the EMCS black hole solutions can e.g. exhibit nonuniqueness and form sequences of radially excited solutions. In the presence of a negative cosmological constant the black holes can possess an extra-parameter corresponding to a magnetic flux in addition to the mass, electric charge and angular momenta. This latter family of black holes possesses also a solitonic limit. Finally, a new class of squashed EMCS black hole solutions is discussed.

Causal nature and dynamics of trapping horizons in black hole collapse

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In calculations of gravitational collapse to form black holes, trapping horizons (foliated by marginally trapped surfaces) make their first appearance either within the collapsing matter or where it joins on to a vacuum exterior. Those which then move outwards with respect to the matter have been proposed for use in defining black holes, replacing the global concept of an “event horizon” which has some serious drawbacks for practical applications. We here present results from a study of the properties of both outgoing and ingoing trapping horizons, assuming strict spherical symmetry throughout. We have investigated their causal nature (i.e. whether they are spacelike, timelike or null), following two different approaches, one using a geometrical quantity related to expansions of null geodesic congruences, and the other using the horizon velocity measured with respect to the collapsing matter. The models treated are simplified, but do include pressure effects in a meaningful way and we analyze how the horizon evolution depends on the initial conditions of energy density and pressure of the collapse.

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We derive the generic part of the gauge theory of gravity, based merely on the action principle and on the general principle of relativity. We apply the canonical transformation framework to formulate geometrodynamics as a gauge theory. The starting point is constituted by the general De Donder-Weyl Hamiltonian of a system of scalar and vector fields, which is supposed to be form-invariant under (global) Lorentz transformations. Following the reasoning of gauge theories, the corresponding locally form-invariant system is worked out by means of canonical transformations. The canonical transformation approach ensures by construction that the form of the action functional is maintained. We thus encounter amended Hamiltonian systems which are form-invariant under arbitrary space-time transformations. This amended system complies with the general principle of relativity and describes both, the dynamics of the given physical system’s fields and their coupling to those quantities which describe the dynamics of the space-time
geometry. In this way, it is unambiguously determined how spin-0 and spin-1 fields couple to the dynamics of space-time.

A term that describes the dynamics of the “free” gauge fields must finally be added to the amended Hamiltonian, as common to all gauge theories, to allow for a dynamic space-time geometry. It accounts for the remaining indefiniteness of any gauge theory of gravity and must be chosen “by hand” on the basis of physical reasoning. We show that the Hamiltonian of the gauge theory of gravity must be at least quadratic in the conjugate momenta of the gauge fields - this is beyond the Einstein-Hilbert theory of General Relativity. Interestingly, in the case of scalar fields, we recover the energy-momentum tensor as the only source term of gravitation. In contrast, matter fields with higher spins produce further source terms.

Black holes and astrophysics I - Board: 20 / 68

The Event Horizon Scale Structure of SAGITTARIUS A* at a Resolution of 3 Schwarzschild Radii

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We report results from Very Long Baseline Interferometry observations of the supermassive black hole at the Galactic center (Sgr A) at 1.3 mm (230 GHz) with the Event Horizon Telescope in 2013. The observations were made with stations at four sites, including CARMA, SMT, Hawaii (JCMT and SMA), and APEX. The addition of the APEX telescope greatly improves the baseline coverage of the array, providing a spatial resolution of ~2.5 Schwarzschild radii on Sgr A. With the improved array performance, the event horizon scale structure of Sgr A* has been spatially resolved and is more complex than previously modeled. We describe the brightness distribution of the source in terms of multiple-Gaussian and crescent-like models and discuss our results in the context of disk-dominated and jet-dominated accretion flow models. Near-future VLBI observations with better uv-coverage and sensitivity should allow more detailed imaging and thus testing general relativity and accretion physics in the vicinity of the supermassive black hole.

Poster Session & Coffee Break - Board: 107 / 69

New Transport Effects in Chiral Materials

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Anomalies are important effects in quantum field theories with chiral fermions which lead to the breaking of classically preserved symmetries due to quantum renormalization effects. For gauge symmetries such as the ones underlying the standard model of particle physics requiring the absence of such anomalies, i.e. the preservation of the gauge symmetry also on the quantum level, puts strong constraints on the allowed chiral particle content (e.g. quarks and neutrinos). For global symmetries, on the other hand, anomaly effects do not need to cancel but rather lead to new interesting transport phenomena in the presence of external fields. These phenomena are of particular importance for recently discovered chiral materials, so called Dirac and Weyl semimetals, in which the electrons behave like the chiral particles known from the standard model of particle physics, and we are far from a complete classification of all possible effects and their physical understanding. In fact, one such effect, the Chiral Magnetic Effect, has already been measured in such materials in the form of a universal negative magnetoresistance. In my talk I will give an introduction into chirality and anomaly induced effects in physics, and present a new effect in asymmetric semimetals, Weyl semimetals with an intrinsically Parity breaking dispersion relation. Based on https://arxiv.org/abs/1610.08986
Corrections to holographic entanglement plateau from CFT

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For the holographic entanglement entropy of a large enough subregion in a finite volume, the Araki-Lieb inequality is saturated, which is called the holographic entanglement plateau. The correction to holographic entanglement plateau is just a mutual information in the bulk gravity. We investigate the holographic entanglement plateau in AdS\(^3\)/CFT\(^2\) correspondence and calculate the mutual information in a large central charge two-dimensional CFT. We consider both the cases of high temperature and low temperature and find corrections to the holographic entanglement plateau.

Holography/Information/Analogue Gravity I - Board: 8 / 73

AdS/CFT far from Equilibrium in a Vaidya Setup

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The so-called gauge/gravity duality provides a link between gravitational and quantum physics, more specifically between quantities in an asymptotic Anti-de Sitter spacetime and its dual conformal field theory on the boundary. The duality can be used to obtain observables in a strongly coupled system by addressing the analogous problem in the associated weakly curved gravitational theory. This correspondence turned out to be a successful means to calculate transport coefficients of (non-)conformal field theories, which for example lead to a prediction of the low shear viscosity over entropy density ratio which was later supported by heavy ion collisions. In order to study far-from-equilibrium properties on the field theory side, we work with a generalized time-dependent Vaidya background on the gravity side: A black brane which grows due to the collapse of infalling null matter in the presence of electromagnetic fields. We investigate the time dependence of metric perturbations in order to find the reaction to shear of the dual plasma. This can find application e.g. in the description of heavy ion collisions.

Holography/Information/Analogue Gravity I - Board: 49 / 75

Shear viscosity of QFTs dual to Gauss-Bonnet black holes

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Gauss-Bonnet (GB) gravity is an interesting playground for investigating thermodynamical and holographic properties of black holes. We discuss the computation of the shear viscosity to entropy ratio in the dual QFT, both for GB black branes and GB black holes. In particular, we will show that in the black hole case, the behaviour of the shear viscosity keeps information about
the complicate thermodynamical phase portrait of the system (phase transitions, meta-stabilities, Van der Waals-like behaviour)

**Holography/Information/Analogue Gravity I - Board: 3 / 76**

**Holographic Entanglement Density**

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We will study the way in which the entanglement entropy of a holographic quantum system becomes the thermodynamic entropy, at finite temperature, as we vary the size of the entangling region. For this purpose, we will concentrate on the holographic entanglement entropy using the Ryu – Takayanagi prescription. We will study the holographic entanglement per unit volume, to understand how the Infrared degrees of freedom can affect the way in which the entanglement entropy becomes extensive. In particular, we will show that the holographic entanglement density will become over – extensive and develop a peak, for intermediate scales.

**Holography/Information/Analogue Gravity I - Board: 9 / 78**

**Hysteresis in QFTs Dual to Spherical Black Holes**

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Usually, one uses holographic dualities to learn about transport coefficients in the hydrodynamic limit of strongly coupled QFTs by investigating bulk gravity configurations. However, it is still possible to change the paradigm, i.e. to use transport properties of the dual quantum field theory to infer about the behaviour of bulk gravity solutions. Following this perspective, in this talk I will show, using the AdS/CFT framework, that transport coefficients computed in a quantum field theory can lead to a better understanding of black hole physics. In particular, I will focus on the shear viscosity and its relationship with thermodynamics of charged black holes. Interestingly enough, I will show that the shear viscosity to entropy density ratio in the hydrodynamic limit of the QFT dual to charged black holes exhibits a temperature-dependent hysteresis, reflecting the rich phase structure, in particular metastabilities and Wan der Waals-like behaviour of charged black holes.

**Holography/Information/Analogue Gravity I - Board: 1 / 79**

**Gauge/gravity duality: Introduction and application to magnetic impurities**

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I will begin by introducing the main concepts of gauge/gravity duality. In the second half of the talk, I will present recent applications of a particular gauge/gravity model to magnetic impurities coupled to a strongly correlated electron gas. This corresponds to a holographic version of the Kondo model for and SU(N) spin coupled to strongly correlated electrons. I will describe the
main features of this model, which describes the RG flow from a UV to an IR fixed point, at
which screening takes place. The model bears some similarities with low-energy QCD. The RG
flow considered is generated by a double-trace operator. The backreaction may be included for a
calculation of the impurity entropy, which matches with field-theory results. I will also present
results for quantum quenches and the two-point functions in this model. The two-point functions
display Fano resonances, a particular type of asymmetry in the spectral function which reflect
the scattering between ambient modes and defect modes with broken conformal symmetry.

Holography/Information/ Analogue Gravity II - Board: 31 / 80

From Emergent Gravity to Dark Energy and Dark Matter.
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The observed deviations from the laws of gravity of Newton and Einstein in galaxies and clusters
can logically speaking be either due to the presence of unseen dark matter particles or due to
a change in the way gravity works in these situations. Until recently there was little reason to
doubt that general relativity correctly describes gravity in all circumstances. In the past few
year insights from black hole physics and string theory have lead to a new theoretical framework
in which the gravitational laws are derived from the quantum entanglement of the microscopic
information that is underlying space-time. An essential ingredient in the derivation is of the
Einstein equations is that the vacuum entanglement obeys an area law, a condition that is known
to hold in Anti-de Sitter space due to the work of Ryu and Takayanagi. We will argue that in
de Sitter space due to the positive dark energy, that the microscopic entanglement entropy also
contains also a volume law contribution in addition to the area law. This volume law contribution
is related to the thermal properties of de Sitter space and leads to a total entropy that precisely
matches the Bekenstein-Hawking formula for the cosmological horizon. We study the effect of
this extra contribution on the emergent laws of gravity, and argue that it leads to a modification
compared to Einstein gravity. We provide evidence for the fact that this modification explains
the observed phenomena in galaxies and clusters currently attributed to dark matter.

Holography/Information/Analogue Gravity I - Board: 11 / 81

Linearized perturbations of a Holographic Non-Relativistic
Hořava Gravity Black Brane
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It has been conjectured that a certain non-relativistic conformal field theory on the boundary
is dual to Hořava Gravity in the bulk with 3 spatial + 1 time dimensions. With a Hořava
theory in the bulk one can obtain a Newton-Cartan geometry which shares the same symmetries
as the Schrodinger group with \( z=2 \). In this particular presentation, we will study transport
effects through a calculation of the poles of retarded correlators of various conserved currents,
such as the momentum current. For this purpose, we explore perturbations on a black brane
in Hořava Gravity and numerically solve their equations of motion with the shooting method.
We simultaneously require a Dirichlet boundary condition at the AdS-boundary and an in-going
mode condition at the sound horizon for spin-2 gravitons. For a given momentum, there exists a
set of quasinormal modes that will satisfy these boundary conditions.

Black hole theory - Board: 41 / 82

Aharonov-Bohm protection of black hole’s baryon/skyrmion
hair
Prof. DVALI, Gia¹ ; Mr. GUSSMANN, Alexander²
The baryon/skyrmion correspondence implies that the baryon number is encoded into a topological surface integral. Under certain conditions that we clarify, this surface integral can be measured by an asymptotic observer in form of an Aharonov–Bohm phase-shift in an experiment in which the skyrmion passes through a loop of a probe string. In such a setup the baryon/skyrmion number is respected by black holes, despite the fact that it produces no long-range classical field. If initially swallowed by a black hole, the baryon number resurfaces in form of a classical skyrmion hair, after the black hole evaporates below a certain critical size. The presentation is based on the article “Aharonov–Bohm protection of black hole’s baryon/skyrmion hair” by G. Dvali and A. Gussmann (Phys. Lett. B768, 2017). If time permits, also new related results are presented.
Probability for Primordial Black Holes in (1+1)-Dimensions

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We investigate the probability for spontaneous creation of neutral primordial black holes inside a very early and lower dimensional universe. Based on the Hartle-Hawking no-boundary proposal, we construct two possible gravitational instantons, one for the background and one for the black hole inside the background, and we measure the creation rate of primordial black holes.

Quantum corpuscular corrections to the Newtonian potential

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We study an effective quantum description of the static gravitational potential for spherically symmetric systems up to the first post-Newtonian order. We start by building a Lagrangian for the gravitational potential coupled to a static current from the weak field expansion of the Einstein-Hilbert action. We show that our construction leads indeed to the correct post-Newtonian expressions, by considering, as an example, a few classical solutions of the resulting field equation. Furthermore, we demonstrate that one can reproduce the classical Newtonian results very accurately by using a coherent quantum state and modifications to include the first post-Newtonian corrections are considered. The results establish a connection between the corpuscular model of black holes and post-Newtonian physics, and lay the foundations for further analysis of these effective models of quantum gravity.

OJ287: Deciphering the Rosetta stone of Active Black Holes

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OJ287 is the best candidate galaxy for hosting a supermassive binary black hole (SMBBH) at very close separation. Periodicities in the historical optical light-cuve (1890-now) have been modeled successfully within an SMBBH scenario. At a redshift of z=0.306 and with a mass of more than $10^{10} M_{\odot}$, OJ287 is one of the few Active Galactic Nuclei (AGN) which promises to allow observations on event horizon scales. OJ287 has thus been observed with the Event Horizon Telescope (EHT) project in April this year.

We studied this source in 118 Very Long Baseline Array (VLBA) observations covering the time between Apr. 1995 and Jan 2017. Our results allow us to solve some long-standing questions with regard to explaining the variability of active black hole jets, and the launching of jets from the vicinity of black holes. In addition, we question the necessity to invoke a binary black hole to explain the observations in OJ287. We will present and discuss our most recent results.

Quasinormal Modes of a Scalar-Tensor-Vector-Gravity (STVG) MODified-Gravity (MOG) Black Hole using the Asymptotic Iteration Method (AIM)

Mr. MANFREDI CONSOLE, Luciano¹; Prof. MUREIKA, Jonas¹; Dr. MOFFAT, John²

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The Quasi Normal Modes (QNMs) for gravitational and electromagnetic perturbations are calculated in a Scalar-Tensor-Vector (Modified Gravity) spacetime, which was initially proposed to obtain correct dynamics of galaxies and galaxy clusters without the need for dark matter. It is found that for increasing model parameter $\alpha$, both the real and imaginary parts of the QNMs decrease compared to those in standard Schwarzschild solution. These results can be identified in the ringdown phase of massive compact object mergers, and are thus timely in light of the recent gravitational wave detections by LIGO.

Quantum Completeness of Schwarzschild Black Holes

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The singularity theorem by Hawking and Penrose qualifies Schwarzschild black-holes as geodesic incomplete space-times. Albeit this is a mathematically rigorous statement, it requires an operational framework that allows to probe the space-like singularity via a measurement process. Any such framework necessarily has to be based on quantum theory, and consequently the notion of dynamical completeness has to be adapted to situations where the only adequate description is in terms of quantum fields in dynamical space-times. It is shown that Schwarzschild black-holes, albeit classically incomplete, are quantum complete when probed by self-interacting quantum fields in the ground state and in excited states. The measure for populating quantum fields on hypersurfaces in the vicinity of the blackhole singularity goes to zero towards the singularity.

Towards Imaging the Event Horizon in the Galactic Center

Prof. FALCKE, Heino¹
Towards Imaging the Event Horizon in the Galactic Center

Heino Falcke, Radboud University Nijmegen

Gravity is successfully described by Einstein’s theory of general relativity, governing the structure of our entire universe. Yet gravity remains the least understood of all forces in nature, e.g., resisting unification with quantum physics. One of the most fundamental predictions of general relativity are black holes. Their defining feature is the event horizon, the surface that even light cannot escape and where time and space exchange their nature. So, does general relativity really hold in its most extreme limit? Do BHs exist or are alternatives needed? Gravitational waves are now probing the merger of two black holes, providing some tests of GR. Another approach would be to directly image the event horizon of black holes. The best place to do this is in the center of our own Milky Way. Here a massive and compact radio source, Sgr A*, provides by far the best case for a supermassive black hole. Very long baseline radio observations are now probing the smallest scales of this source, making it soon possible to image the shadow of the event horizon of a black hole for the very first time. Moreover, with the help of advanced numerical general relativistic magneto-hydrodynamic simulations emission and appearance of the source can be successfully modeled almost from first principles. The comparison of detailed simulations, VLBI images as well as measurements of the gravitational potential with stars and perhaps also pulsars, makes the Galactic center a promising laboratory for probing black hole astrophysics and general relativity.

Poster Session & Coffee Break - Board: 109 / 94

Quadratic gravity in first order formalism

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We consider the most general action for gravity which is quadratic in curvature. In this case first order and second order formalisms are not equivalent. This framework is a good candidate for a unitary and renormalizable theory of the gravitational field; in particular, there are no propagators falling down faster than $1/p^2$. Calculations are somewhat involved when all monomials are considered, but we have intended to laid down the general case. The interaction between external sources is analyzed; this interaction is conveyed mainly by the three-index connection field. The theory as it stands, is in the conformal invariant phase; only when Weyl invariance is broken through the coupling to matter can an Einstein-Hilbert term (and its corresponding Planck mass scale) be generated by quantum corrections.

Poster Session & Coffee Break - Board: 110 / 95

Stellar winds effect in Bondi-Hoyle accretion around Schwarzschild black hole

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The Bondi-Hoyle accretion around a black hole is a possible result from kicked black hole in the interstellar medium moving with supersonic velocities, accreting mass from the medium. The interesting morphology is obtained when the accretion process reach to near steady state, the shock cone formation in the downstream part of the fluid and in some cases the flip-flop instabilities of this shock cone. In this talk I will present the hydrodynamics simulation of the Bondi-Hoyle accretion around a Schwarzschild black hole using the CAFE code, and discuss bout the effects on morphology and the accretion rates of the presence of stellar winds by using a toy model, i.e., including static, rigid and spherical objects in the numerical domain.
Universality in Chaos of Particle and String Motions near Black Hole Horizon

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Motion of a particle near a black hole horizon is shown to possess a universal Lyapunov exponent of a chaos provided by its surface gravity. To probe the horizon, we apply an external force to the particle so that it does not fall into the horizon. There appears an unstable maximum of the total potential for the particle motion where the evaluated maximal Lyapunov exponent is found to be independent of the external forces and the particle mass. The Lyapunov exponent is universally given by the surface gravity of the black hole. Unless there are other sources of a chaos, the Lyapunov exponent is subject to an inequality $\lambda \leq \frac{2\pi T_{BH}}{\hbar}$, which is identical to the bound recently discovered by Maldacena, Shenker and Stanford. We also show that the same upper bound applies to the chaotic motion of a string in AdS spacetime, which is holographically dual to the quark-anti quark pair and the flux tube of gluons between them.

The Janus Cosmological Model

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When one tries to introduce negative masses in RG the subsequent interaction laws, as shown by Bondi in 1957, makes the things unmanageable, due to the runaway effect and the obvious instability of negative mass clusters. Shifting to a bimetric description of the universe, where the second metric refers to negative mass and negative energy particles, involved to the the positive mass metric through a system of two coupled field equations, the interaction laws drastically change. Negative masses mutually attract, while opposite sign masses repel each other. This brings a new insight on cosmology, with many benefits. In particular an exact solution is derived, which provides the acceleration of the expansion, as a consequence of the presence of a dominating negative mass in the universe. Negative mass replaces both dark matter and black energy. Negative mass implies a negative energy content. Dynamical groups theory provides the nature of such negative content whose particles are nothing but a copy of ordinary ones with negative mass and negative energy. Emitting negative energy photons, negative mass is basically invisible to us. As negative mass forms the major part of the universe, it rules the gravitational instability, after discoupling, and gives the positive matter a lacunar structure, anchored around invisible negative mass clusters, the Great Repeller being one of them. Related papers
J.P.Petit, G.D’Agostini Cosmological Bimetric model with interacting positive and negative masses and two different speeds of light, in agreement with the observed acceleration of the Universe. Modern Physics Letters A, Vol.29 34, 2014 Nov 10th

Nonconformal generalization of fluid/gravity correspondence and the chiral vortical effect

Author(s): Dr. WU, Chao¹
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Poster Session & Coffee Break - Board: 112 / 100

Nonconformal generalization of fluid/gravity correspondence and the chiral vortical effect
The boundary derivative expansion (BDE) formalism of the fluid/gravity correspondence developed by Bhattacharyya, Hubeny, Minwalla and Rangamani is a beautiful and powerful method to extract the transport properties of strongly coupled relativistic fluid. It has been applied to various kinds of asymptotic AdS black holes and almost all of these studies are in the conformal regime. In this talk, I would like to show how we generalize the BDE formalism in the nonconformal compactified black D4-brane background and apply it to the Chiral Vortical Effect of RHIC physics.

**Poster Session & Coffee Break / 101**

**Shocks in the relativistic transonic accretion with low angular momentum.**

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We perform 2D relativistic hydrodynamical simulations of accretion flows with low angular momentum, filling the gap between spherically symmetric Bondi accretion and disc-like accretion flows. Scenarios with different directional distributions of angular momentum of falling matter and varying values of key parameters such as spin of central black hole, energy and angular momentum of matter are considered. In some of the scenarios the shock front is formed. We identify ranges of parameters for which the shock after formation moves towards or outwards the central black hole or the long lasting oscillating shock is observed. The frequencies of oscillations of shock positions which can cause flaring in mass accretion rate are extracted. The results are scalable with mass of central black hole and can be compared to the quasi-periodic oscillations of selected microquasars (such as GRS 1915+105, XTE J1550-564 or IGR J17091-3624), as well as to the supermassive black holes in the centers of weakly active galaxies, such as Sgr A*.

**Holography/Information/Analogue Gravity I - Board: 2 / 106**

**How general is holography? Flat space limit and soft hairs in higher spin gravity.**

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How general is holography? Does the holographic principle work beyond the renowned AdS/CFT duality? And what does it teach us for quantum gravity in asymptotically flat spacetimes? In this talk I will focus on recent progress within three-dimensional higher spin gravity concerning the flat space limit and the soft hair proposal therein. In particular, I present a new set of boundary conditions for higher spin gravity, inspired by a recent “soft Heisenberg hair”-proposal for General Relativity. The asymptotic symmetry algebra consists of set of affine $u(1)$ current algebras. Its associated canonical charges generate higher spin soft hair. The generators of the three-dimensional higher spin version of the Bondi-Metzner-Sachs algebra arise from composite operators of the affine $u(1)$ currents through a twisted Sugawara-like construction.

**Black holes and astrophysics I - Board: 24 / 107**

**Noncommutative Black Holes at the LHC.**

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The boundary derivative expansion (BDE) formalism of the fluid/gravity correspondence developed by Bhattacharyya, Hubeny, Minwalla and Rangamani is a beautiful and powerful method to extract the transport properties of strongly coupled relativistic fluid. It has been applied to various kinds of asymptotic AdS black holes and almost all of these studies are in the conformal regime. In this talk, I would like to show how we generalize the BDE formalism in the nonconformal compactified black D4-brane background and apply it to the Chiral Vortical Effect of RHIC physics.
Based on the latest public results, 13 TeV data from the Large Hadron Collider at CERN has not indicated any evidence of hitherto tested models of quantum black holes and semiclassical black holes. Such models have predicted signatures of particles with high transverse momenta. Noncommutative black holes remain an untested model of TeV-scale gravity that offers the starkly different signature of particles with relatively low transverse momenta. Considerations for a search for noncommutative black holes using the ATLAS detector will be presented.

Compton Schwarzschild duality in higher dimensions. Is TeV quantum gravity possible?

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With three spatial dimensions, the Compton wavelength ($\lambda_C \sim M^{-1}$) and Schwarzschild radius ($R_S \sim M^{-1}$) are dual under the transformation $M \rightarrow M^2/M_P$, where $M_P$ is the Planck mass. This suggests a fundamental link between elementary particles in the $M < M_P$ regime and black holes in the $M > M_P$ regime. With $n$ extra spatial dimensions, compactified on some scale $R_E$, one expects $R_S \sim M^{1/(1+n)}$ for $R < R_E$. However, the effective Compton wavelength depends on the form of the $(3+n)$-dimensional wave-function. If this is spherically symmetric, one still has $R_C \sim M^{-1}$, so the Compton-Schwarzschild duality is broken and the effective Planck mass is reduced. This allows the possibility of TeV quantum gravity and black hole production at the LHC. However, if the wave function is pancaked in the extra dimensions, $R_C \sim M^{-1/(1+n)}$ and the duality is preserved. In this case, the Planck mass is unchanged, so TeV quantum gravity is precluded and black holes cannot be generated at LHC. Nevertheless, the extra dimensions could still have consequences for the detectability of black hole evaporations and the enhancement of pair-production at accelerators on scales below $R_E$.

GRMHD simulations in alternative theories of gravity

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Future mm and sub-mm very long baseline interferometry will provide the first images of the shadow cast by the candidate supermassive black hole in our galactic center, Sgr A*. If the observations are sufficiently accurate, they will not only provide convincing evidence for the existence of an event horizon, but they could also indicate if deviations exist from the predictions of general relativity. Rezzolla and Zhidenko (2014) have proposed a new parametric framework to describe the most generic spherically symmetric black hole geometry through a finite number of adjustable quantities. Here, as a first test, using this new parametric framework we have performed 2D general-relativistic MHD simulations of magnetized torus of a non-rotating dilaton
black hole using the newly developed BHAC code. Initially we consider a magnetized torus with constant angular momentum with a weak single poloidal magnetic field loop inside the torus. The simulations show a behaviour that is qualitatively very similar to those for a Schwarzschild black hole, but also some quantitative differences in terms of the mass-accretion rates and of the appearance of the shadow.

Black holes and astrophysics I - Board: 14 / 110

A new vista on black holes: probing astrophysical space-times with the Event Horizon Telescope

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This past April, the full Event Horizon Telescope (EHT), a global millimeter-wavelength interferometer capable of resolve the horizons of nearby supermassive black holes, observed for the first time. This EHT promises to transform our understanding of black hole astrophysics and provide a window onto the structure of spacetime itself around astrophysical black holes. I will describe what we already know from a set of precursor experiments with a smaller array, and discuss some of the opportunities presented by the full EHT in the future.