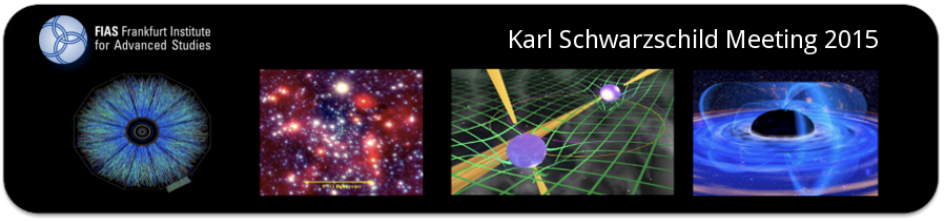
Karl Schwarzschild Meeting 2015



Report of Contributions

https://indico.cern.ch/e/ksm2015

Contribution ID: **3** Type: **not specified**

Welcome

Monday 20 July 2015 09:00 (30 minutes)

Contribution ID: **4** Type: **not specified**

Introduction to the meeting

Monday 20 July 2015 09:30 (30 minutes)

Presenter: Prof. KEMPF, Achim (PI/Waterloo)

Contribution ID: **6** Type: **not specified**

Visit of the Kleiner Feldberg Observatory

Wednesday 22 July 2015 15:00 (3 hours)

This is the *optional* excursion. We are going to the mountains with an about 15 minutes bus trip. Up there we visit an astronomical observatory.

The fee is already included in the conference fee, and it is 10€ for each accompanying person. The registration for that event was included in the registration form at indico.

Contribution ID: **8** Type: **not specified**

Closed Session - Schwarzschild Price Comittee

Thursday 23 July 2015 18:00 (1 hour)

Contribution ID: **11** Type: **not specified**

Conference summary and concluding remarks

Friday 24 July 2015 16:00 (30 minutes)

Contribution ID: **12** Type: **not specified**

Plenary discussion: ”Gravity/Information”

Friday 24 July 2015 14:00 (2 hours)

Discussion: Steve Giddings / Carlo Rovelli
Chair: Gerad ‘t Hooft

Track Classification: Keynotes

Contribution ID: **16** Type: **not specified**

AdS black holes in worldline holography

Thursday 23 July 2015 15:30 (30 minutes)

Recently, I have shown how an AdS_{d+1} description of d dimensional gauge field theories arises readily in the worldline formalism of quantum field theory. In this talk I will dicuss the role the AdS black hole plays in this worldline based approach to holography.

Author: Dr DIETRICH, Dennis D. (Goethe-Universität)

Presenter: Dr DIETRICH, Dennis D. (Goethe-Universität)

Session Classification: Senior scientist session 4

Track Classification: Seniors

Contribution ID: **17** Type: **not specified**

Extremal Rotating Black Holes in the Near-Horizon Limit: Phase Space and Symmetry Algebra

Monday 20 July 2015 14:00 (20 minutes)

We construct the classical phase space of Near-Horizon Extremal Geometries with fixed angular momenta and entropy. Each element in the phase space is a geometry with SL(2,R)×U(1)d−3 Killing isometries which has vanishing SL(2,R) and constant U(1) charges.
In four spacetime dimensions, the symmetry algebra consists of the familiar Virasoro algebra, while in d>4 dimensions the symmetry algebra, the NHEG algebra, contains infinitely many Virasoro subalgebras. The nontrivial central term of the algebra is proportional to the black hole entropy. This phase space might serve as a basis for a semiclassical description of extremal black hole microstates.

This talk is based on http://arxiv.org/abs/1506.07181 and http://arxiv.org/abs/1503.07861

Author: SERAJ, Ali (IPM, Tehran, Iran)

Presenter: SERAJ, Ali (IPM, Tehran, Iran)

Session Classification: Student plenary session 1

Track Classification: Students

Contribution ID: **18** Type: **Poster**

Particle Collision near 1+1 Dimensional Horava-Lifshitz Black Holes

The unbounded center-of-mass (CM) energy of colliding particles near horizon of a black hole emerges even in 1+1- dimensional Horava-Lifshitz gravity. The latter has imprints of renormalizable quantum gravity characteristics in accordance with simple power counting. The result obtained is valid also for a 1- dimensional Compton process between a massive/massless Hawking photon emaneting from the black hole and an in falling massless/massive particle.

Author: Prof. HALILSOY, MUSTAFA (Eastern Mediterranean University-FAMAGUSTA , NORTHERN CYPRUS)

Co-author: Mr OVGUN, ALI (Eastern Mediterranean University-FAMAGUSTA , NORTHERN CYPRUS)

Presenter: Mr OVGUN, ALI (Eastern Mediterranean University-FAMAGUSTA , NORTHERN CYPRUS)

Track Classification: Students

Contribution ID: **19** Type: **Talk**

A Modified Exponential Potential for Quintessence

Monday 20 July 2015 16:00 (20 minutes)

We examine a quintessence model with a modified exponential potential given by $V(\phi) = V_0(1 + e^{-\lambda\phi})$. We determine the evolution of the equation of state parameter, w_ϕ, and the density parameter, Ω_ϕ, as a function of the scale factor. Our model, unlike quintessence with a standard exponential potential, can produce an acceptable accelerated expansion at late times. The strongest constraints on the model come from CMB observations, rather than supernova data. The former give the limit $\lambda > 13$. This model provides a partial solution to the coincidence problem, but it does not explain why the accelerated expansion is beginning near the present day.

Author: Dr CHANG, Hui-Yiing (University of South Carolina Sumter)

Co-author: Dr SCHERRER, Robert (Vanderbilt University)

Presenter: Dr CHANG, Hui-Yiing (University of South Carolina Sumter)

Session Classification: Junior plenary session

Track Classification: Juniors

Contribution ID: **21** Type: **not specified**

Good properties of Schwarzschild's singularity

Monday 20 July 2015 16:20 (20 minutes)

Schwarzschild's solution is the soul of General Relativity (GR). It was found immediately after Einstein found his equation, and plays an essential role in the approximations that allow us to test GR in our solar system. Moreover, the most notable problems of GR, such as the occurrence of singularities and the information paradox, were found on the background provided by Schwarzschild's solution. The reason is that this solution has singularities, widely regarded as a big problem of GR. While the event horizon singularity can be removed by moving to non-singular coordinates, not the same is true about the r=0 singularity. However, I show that there are coordinates which make the metric finite and analytic at the singularity r=0 [1]. The metric becomes degenerate at r=0, so the singularity still exists, but it is of a type that can be described geometrically by referring to finite quantities only [2,3.4]. Also, the topology of the causal structure is shown to remain intact [5], and the singularities of this type are shown to be compatible with global hyperbolicity [1,6]. This suggests a possible solution to the black hole information paradox, in the framework of GR [7]. As a side effect, the Schwarzschild singularity belongs to a class of singularities accompanied by dimensional reduction effects, which are hoped to cure the infinities in perturbative Quantum Gravity [8].

[1] O. C. Stoica. Schwarzschild singularity is semi-regularizable. Eur. Phys. J. Plus, 127(83):1-8, 2012.
[2] O. C. Stoica. On singular semi-Riemannian manifolds. Int. J. Geom. Methods Mod. Phys., 0(0):1450041, March 2014.
[3] O. C. Stoica. Einstein equation at singularities. Cent. Eur. J. Phys, 12:123-131, 2014.
[4] O. C. Stoica. The Geometry of Black Hole Singularities. Advances in High Energy Physics, 2014:14, May 2014.
[5] O. C. Stoica. Causal structure and spacetime singularities, Preprint arXiv:1504.07110 (2015).
[6] O. C. Stoica. Spacetimes with Singularities. An. St. Univ. Ovidius Constanta, 20(2):213-238, July 2012.
[7] O. C. Stoica. The geometry of singularities and the black hole information paradox. Spacetime - Matter - Quantum Mechanics, Seventh International Workshop DICE2014, 2014.
[8] O. C. Stoica. Metric dimensional reduction at singularities with implications to quantum gravity. Ann. of Phys., 347(C):74-91, 2014.

Author: STOICA, Cristi (Horia Hulubei National Institute for Physics and Nuclear Engineering)

Presenter: STOICA, Cristi (Horia Hulubei National Institute for Physics and Nuclear Engineering)

Session Classification: Junior plenary session

Track Classification: Juniors

Contribution ID: **22** Type: **not specified**

Testing general relativity on accelerators

Monday 20 July 2015 16:40 (20 minutes)

Within the general theory of relativity, the curvature of space-time is related to the energy and momentum of the present matter and radiation. One of the more specific predictions of general relativity is the deflection of light and particle trajectories in the gravitational field of massive objects. Bending angles for electromagnetic waves and light in particular were measured with a high precision. However, the effect of gravity on relativistic massive particles was never studied experimentally. In this talk, we propose and analyse experiments devoted to that purpose. We demonstrate a high sensitivity of the laser Compton scattering at high energy accelerators to the effects of gravity. The main observable – maximal energy of the scattered photons – would experience a significant shift in the Earth's gravitational field even for a tiny deviation from the current theoretical expectations. We confirm predictions of general relativity for ultrarelativistic electrons of energy of tens of GeV at a current level of resolution and expect our work to be a starting point of further high-precision studies on current and future accelerators, such as PETRA and ILC.

Author: KALAYDZHYAN, Tigran (Stony Brook University)

Presenter: KALAYDZHYAN, Tigran (Stony Brook University)

Session Classification: Junior plenary session

Track Classification: Juniors

Contribution ID: **23** Type: **not specified**

Gravitational tests of the Generalized Uncertainty Principle

Thursday 23 July 2015 16:30 (30 minutes)

We compute the corrections to the Schwarzschild metric necessary to reproduce the Hawking temperature derived from a Generalized Uncertainty Principle (GUP), so that the GUP deformation parameter is directly linked to the deformation of the metric. Using this modified Schwarzschild metric, we compute corrections to the standard General Relativistic predictions for
the light deflection and perihelion precession, both for planets in the solar system and for binary pulsars. This analysis allows us to set bounds for the GUP deformation parameter from well-known astronomical measurements.

Author: Dr SCARDIGLI, Fabio (American University of the Middle East)

Co-author: Dr CASADIO, Roberto (University of Bologna)

Presenter: Dr SCARDIGLI, Fabio (American University of the Middle East)

Session Classification: Senior scientist session 4

Track Classification: Seniors

Contribution ID: **28** Type: **not specified**

Emergent Cosmology, Inflation and Dark Energy from SSB of Scale Invariance

Tuesday 21 July 2015 16:30 (30 minutes)

A new class of gravity-matter models defined in terms of two independent non-Riemannian volume forms (alternative generally covariant integration measure densities) on the space-time manifold are studied in some detail. These models involve an additional R2 (square of the scalar curvature) term as well as scalar matter field potentials of appropriate form so that the pertinent action is invariant under global Weyl-scale symmetry. Scale invariance is spontaneously broken upon integration of the equations of motion for the auxiliary volume-form degrees of freedom. After performing transition to the physical Einstein frame we obtain: (i) An effective potential for the scalar field with two flat regions which allows for a unified description of both early universe inflation as well as of present dark energy epoch; (ii) For a definite parameter range the model possesses a non-singular "emergent universe" solution which describes an initial phase of evolution that precedes the inflationary phase; (iii) For a reasonable choice of the parameters the present model conforms to the Planck Collaboration data.

Author: Prof. GUENDELMAN, Eduardo (Ben Gurion University)

Presenter: Prof. GUENDELMAN, Eduardo (Ben Gurion University)

Session Classification: Senior scientist session 1

Track Classification: Seniors

Contribution ID: **29** Type: **not specified**

Analog Duality

Tuesday 21 July 2015 16:00 (30 minutes)

I will discuss a new duality between strongly coupled and weakly coupled condensed matter systems. It can be obtained by combining the gauge-gravity duality with analog gravity. In my talk I will explain how one arrives at the new duality, what it can be good for, and what questions this finding raises.

Author: HOSSENFELDER, Sabine (Nordita)

Presenter: HOSSENFELDER, Sabine (Nordita)

Session Classification: Senior scientist session 2

Track Classification: Seniors

Contribution ID: **30** Type: **not specified**

Black holes and causal structure with Lorentz violations

Monday 20 July 2015 14:20 (20 minutes)

When Lorentz symmetry is broken, defining the concept of Black Hole becomes highly non-trivial. In this talk I wish to discuss the problems related to such definition and introduce a way to define the causal structure and horizons for a manifold with a preferred foliation.

Authors: Dr BHATTACHARYYA, Jishnu (University of Nottingham); Mr COLOMBO, Mattia (University of Nottingham); Dr SOTIRIOU, Thomas (University of Nottingham)

Presenter: Mr COLOMBO, Mattia (University of Nottingham)

Session Classification: Student plenary session 1

Track Classification: Students

Contribution ID: **31** Type: **not specified**

Three-dimensional gravity with a conformally coupled scalar field: Chern-Simons-like formulation and black hole thermodynamics

Monday 20 July 2015 14:40 (20 minutes)

We present a Chern-Simons-like description of three-dimensional gravity with negative cosmological constant, where the matter source is a conformally coupled real scalar field. This description is based on a first-order action that provides a set of field equations equivalent to that derived from the usual second-order action. The system admits a rotating hairy black hole solution, which is accordingly expressed in terms of the first-order fields. The mass, angular momentum and entropy are obtained from the Chern-Simons-like Euclidean action in the grand canonical ensemble. Regularity conditions at the horizon are provided when the holonomies along the thermal cycle are computed. This procedure establishes the relations between the integration constants that characterizes the hairy black hole and the fixed chemical potentials.

Author: Ms CÁRDENAS, Marcela (Universidad de Concepción, Centro de Estudios Científicos)

Co-authors: Dr MARTINEZ, Cristián (Centro de Estudios Científicos); Mr FUENTEALBA, Oscar (Universidad de Concepción, Centro de Estudios Científicos)

Presenter: Ms CÁRDENAS, Marcela (Universidad de Concepción, Centro de Estudios Científicos)

Session Classification: Student plenary session 1

Track Classification: Students

Contribution ID: **32** Type: **not specified**

A quantum cosmic censorship

Tuesday 21 July 2015 16:00 (30 minutes)

We propose to investigate the Cosmic Censorship Conjecture in the quantum domain by means of the horizon wave-function (HWF) formalism applied to a spherically symmetric Gaussian state. When the charge-to-mass ratio q<1, the formalism allows for a straightforward quantum mechanical description of both inner and outer horizons. For q>1, where the classical theory predicts a naked singularity, one can still obtain a normalisable HWF below a critical value qˆ2˜2, with a non-vanishing probability of being a black hole instead. However, the HWF is not normalisable above qˆ2˜2, and the uncertainty in the location of the horizon blows up there, signalling that such states are indeed not well-defined and most likely very unstable.

Author: CASADIO, Roberto (Alma Mater Bologna University)

Co-author: Dr MICU, Octavian (Institute of Space Science)

Presenter: CASADIO, Roberto (Alma Mater Bologna University)

Session Classification: Senior scientist session 1

Track Classification: Seniors

Contribution ID: **34** Type: **not specified**

Clocks exploring the gravitational interaction

Thursday 23 July 2015 14:00 (1 hour)

Presenter: Prof. LÄMMERZAHL, Claus (ZARM/Bremen)

Session Classification: Keynote Speaker plenary session 1

Track Classification: Keynotes

Contribution ID: **38** Type: **not specified**

Quantum black holes as the link between microphysics and macrophysics

Wednesday 22 July 2015 09:00 (1 hour)

Black holes span 60 decades of mass - from the Planck scale (10^{-5}g) to the cosmological scale ($10^{22} M_{\rm Sun}$) - and probe many domains of physics (quantum gravity, high-energy physics, gravitational physics, astrophysics and cosmology). Quantum black holes, here regarded as the ones for which quantum evaporation is important (i.e. those hotter than the CMB temperature), span the lower 30 decades of mass and provide a profound link between micro and macro physics. The link is most striking at the Planck scale itself and this raises the question of what happens to relativity theory as one approaches the Planck scale from above and to quantum theory as one approaches it from below. This may also suggest some connection between sub-Planckian black holes and elementary particles.

Presenter: Prof. CARR, Bernard (QMU, London)

Session Classification: Keynote Speaker plenary session 2

Track Classification: Keynotes

Contribution ID: **41** Type: **not specified**

Flat space holography

Wednesday 22 July 2015 14:00 (1 hour)

If the holographic principle is a true aspect of Nature it must work beyond AdS/CFT. In this talk I address a particular aspect of the question how general holography is by considering flat space holography. I report recent progress, in particular the calculation of stress tensor correlators in three-dimensional gravity, microstate counting and holographic entanglement entropy, all of which match beautifully the corresponding results in the dual Galilean conformal field theory.

Presenter: Prof. GRUMILLER, Daniel (TU Vienna)

Session Classification: Keynote Speaker plenary session 3

Track Classification: Keynotes

Contribution ID: **42** Type: **not specified**

Conformal Bootstrap, Universality and Gravitational Scattering

Thursday 23 July 2015 09:30 (1 hour)

Presenter: Prof. VERLINDE, Herman (Princeton)

Session Classification: Keynote Speaker plenary session 4

Track Classification: Keynotes

Contribution ID: **43** Type: **not specified**

Beyond Schwarzschild: Quantum implications for black holes

Thursday 23 July 2015 11:00 (1 hour)

If nature respects quantum-mechanical principles, this implies significant modification to our semi-classical picture of black holes. The ongoing project to image the black hole at the center of our galaxy offers a possible opportunity to probe such departures from this picture initiated by Schwarzschild.

Presenter: Prof. GIDDINGS, Steven (UC Santa Barbara)

Session Classification: Keynote Speaker plenary session 4

Track Classification: Keynotes

Contribution ID: **46** Type: **not specified**

What if Spacetime is Bandlimited at the Planck scale?

Friday 24 July 2015 10:00 (1 hour)

Presenter: Prof. KEMPF, Achim (PI/Waterloo)

Session Classification: Keynote Speaker plenary session 5

Track Classification: Keynotes

Contribution ID: **48** Type: **not specified**

Black holes sourced by a massless scalar

Tuesday 21 July 2015 17:00 (30 minutes)

We construct asymptotically flat black hole solutions of Einstein-scalar gravity sourced by a non-trivial scalar field with $1/r$ asymptotic behavior. Near the singularity the black hole behaves as the Janis-Newmann-Winicour-Wyman solution. The hairy black hole
solutions allow for consistent thermodynamical description. At large mass they have the same thermodynamical behavior of the Schwarzschild black hole, whereas for small masses they differ substantially from the latter.

Author: CADONI, Mariano (University of cagliari)

Presenter: CADONI, Mariano (University of cagliari)

Session Classification: Senior scientist session 1

Track Classification: Seniors

Contribution ID: **49** Type: **not specified**

Size scaling of self gravitating polymers and strings

Thursday 23 July 2015 17:00 (30 minutes)

We study a statistical ensemble of a single polymer with self gravitational interaction. This is a model of a gravitating string — the precursor of a black hole. We analyze averaged sizes by mean field approximations with an effective Hamiltonian a la Edwards with Newtonian potential as well as a contact repulsive interaction. We find that there exists a certain scaling region where the attractive and the repulsive forces balance out. The repulsive interaction pushes the critical gravitational coupling to a larger value, at which the size of a polymer becomes comparable to its Schwarzschild radius, and as a result the size of the corresponding black hole increases considerably.

Author: KAWAMOTO, Shoichi (Chung Yuan Christian University)

Co-author: Prof. MATSUO, Toshihiro (National Institute of Technology, Anan College)

Presenter: KAWAMOTO, Shoichi (Chung Yuan Christian University)

Session Classification: Senior scientist session 4

Track Classification: Seniors

Contribution ID: **50** Type: **not specified**

Thermal Corpuscular Black Holes

Monday 20 July 2015 15:00 (20 minutes)

We study a corpuscular model of evaporating black holes consisting of a large number N of self-confined bosons. The single-particle spectrum contains a discrete ground state of energy m (corresponding to toy gravitons forming a black hole), and a gapless continuous spectrum (to accommodate for Hawking radiation with energy $\omega > m$).
In particular, we consider each constituent in a superposition of the ground state and a Planckian distribution at the expected Hawking temperature in the continuum. We first find that, assuming the leading order effect of the internal scatterings is only to give rise to the Hawking radiation, the corresponding N-particle state can be collectively described by a single-particle wave-function given by a superposition of a total ground state with energy $M = N\,m$ and a Planckian distribution for $E > M$ at the same Hawking temperature.
From this collective state, we compute the partition function and obtain an entropy which reproduces the usual area law with a logarithmic correction precisely related with the Hawking component. By means of the horizon wave-function for the system, we finally show the backreaction of modes with $\omega > m$ reduces the Hawking flux.
Both corrections to the entropy and to the Hawking flux suggest the evaporation properly stops for vanishing mass, if the black hole is in this particular quantum state.

Author: GIUGNO, Andrea (University of Bologna)

Presenter: GIUGNO, Andrea (University of Bologna)

Session Classification: Student plenary session 1

Track Classification: Students

Contribution ID: **51** Type: **not specified**

Quantum-gravity phenomenology with primordial black holes

Thursday 23 July 2015 15:00 (20 minutes)

Quantum gravity may allow black holes to tunnel into white holes. If so, the lifetime of a black hole would be shorter than the one given by Hawking evaporation, solving the information paradox. More interestingly, this could open to a new window for quantum-gravity phenomenology, in connection with the existence of primordial black holes. I discuss in particular the power of the associated explosion and the possibility to observe an astrophysical signal in the radio and in the gamma wavelengths.

Author: VIDOTTO, Francesca (Radboud University Nijmegen)

Co-authors: BARRAU, Aurelien (LPSC Laboratoire de Physique Subatomique et de Cosmologie (LPSC)); Prof. ROVELLI, Carlo (Aix-Marseille University)

Presenter: VIDOTTO, Francesca (Radboud University Nijmegen)

Session Classification: Junior plenary session

Track Classification: Juniors

Contribution ID: **52** Type: **Talk**

Black hole entropy in the presence of Chern-Simons term and holography

Monday 20 July 2015 17:00 (20 minutes)

In this presentation, I will revisit the Noether charge formulation of black hole entropy in the presence of gravitational Chern-Simons terms in higher dimensions. I will provide a manifestly covariant formulation of the differential Noether charge and prove the (generalized version of) black hole entropy formula for gravitational Chern-Simons terms proposed by Tachikawa. In the context of gauge/gravity duality, gravitational theory with Chern-Simons term on AdS black hole background is dual to CFT at finite temperature with quantum anomalies, which is actively and systematically investigated in the hydrodynamic limit recently. I will explain the role of our formulation in this holographic setup.

Author: Dr AZEYANAGI, Tatsuo (Ecole Normale Superieure)

Presenter: Dr AZEYANAGI, Tatsuo (Ecole Normale Superieure)

Session Classification: Junior plenary session

Track Classification: Juniors

Contribution ID: **53** Type: **not specified**

Supermassive Black Holes, Black Hole Pairs & the Event Horizon Telescope

Thursday 23 July 2015 15:30 (30 minutes)

Highest resolution Event Horizon Telescope (EHT) observations will probably soon tell us more about the supermassive black hole at the Galactic Centre (Sgr A*) and the cores of active galactic nuclei (AGN).
It might also help to clarify the long-standing question whether the central massive objects in AGN are instead close pairs of black holes. Mergers of supermassive black hole pairs would provide the strongest gravitational wave signals.
I will present examples of how we identify potential close binary black hole candidates based on the combined analysis of high resolution radio interferometric (VLBI) observations and multi-wavelength data. I will also provide an outlook on the scientific prospects with regard to future EHT-observations of these AGN.

Author: BRITZEN, Silke (MPIfR)

Presenter: BRITZEN, Silke (MPIfR)

Session Classification: Senior scientist session 3

Track Classification: Seniors

Contribution ID: **55** Type: **not specified**

Einstein-Charged Scalar Field Theory: Black Hole Solutions and Their Stability.

Tuesday 21 July 2015 14:00 (20 minutes)

A charged scalar field can be used to extract energy from a charged black hole via superradiant scattering. A mirror-like or AdS boundary could lead the system to an instability. This is because the scalar fields are trapped outside the black hole and repeatedly amplified, there-fore ultimately the back-reaction on the black hole background will become non-negligible.
A charged scalar field on the Reissner-Nordström background with a mirror has been shown to possess a superradiant instability [1]. However the possible end-point of this superradiant instability remains unknown. In this talk, I will consider a fully coupled system consisting of gravity, an electric field and a charged scalar field with a mirror. By solving the field equations, numerical solutions representing charged hairy black holes are obtained. Then I will comment on the stability of these solutions. More details of this work are to appear in
Ref. [2].

References

[1] Juan Carlos Degollado, Carlos A. R. Herdeiro, and Helgi Freyr R ´unarsson. Rapid growth of superradiant instabilities for charged black holes in a cavity. Phys.Rev., D88:063003, 2013.

[2] Sam Dolan, Supakchai Ponglertsakul, and Elizabeth Winstanley. Article in preparation.

Author: PONGLERTSAKUL, Supakchai

Co-authors: Prof. WINSTANLEY, Elizabeth (Consortium for Fundamental Physics, School of Mathematics and Statistics, University of Sheffield); Dr DOLAN, Sam (Consortium for Fundamental Physics, School of Mathematics and Statistics, University of Sheffield)

Presenter: PONGLERTSAKUL, Supakchai

Session Classification: Student plenary session 2

Track Classification: Students

Contribution ID: **56** Type: **not specified**

The nature of trapping horizons in collapses forming black holes

Thursday 23 July 2015 16:00 (30 minutes)

In the context of gravitational collapse to form a black hole, one sees the appearance of inner and outer trapping horizons (foliated by marginally trapped surfaces), as was already noted in numerical calculations in the 1960s. This phenomenology has acquired new interest in connection with discussions of the Hayward unified first law of black hole dynamics. We have investigated the nature of the inner and outer horizons (ie whether they are spacelike, timelike or null), making contact with the Misner-Sharp formalism used in calculations for collapse of spherically symmetric fluid configurations to form black holes. By means of numerical simulations, we have followed the $R = 2M$ condition dynamically during the gravitational collapse, and have found that the nature of these trapping horizons is given by a very simple expression depending on the equation of state. Whether they are spacelike or timelike plays an important role in in classical depletion and quantum evaporation of black holes because only timelike or null horizons allow particles to pass through. We have observed different behaviours for the cases of stellar collapse and primordial black hole formation within an expanding Universe, resulting from the different nature of the matter involved. In this talk we will present results from our investigations.

Author: Dr MUSCO, Ilia (CNRS, Observatorire de Paris, LUTH (Meudon))

Co-authors: Dr HELOU, Alexis (APC, Université Paris Diderot, CNRS, CEA, Observatoire de Paris); Prof. MILLER, John (Department of Physics (Astrophysics) University of Oxford (UK), S.I.S.S.A. Trieste (Italy)); Prof. BINÉTRUY, Pierre (APC, Université Paris Diderot, CNRS, CEA, Observatoire de Paris)

Presenter: Dr MUSCO, Ilia (CNRS, Observatorire de Paris, LUTH (Meudon))

Session Classification: Senior scientist session 4

Track Classification: Seniors

Contribution ID: **57** Type: **Talk**

Singularities, horizons, firewalls and local conformal symmetry

Thursday 23 July 2015 19:30 (1 hour)

We rephrase the einstein-Hilbert theory of gravity by focusing on local conformal symmetry as an exact, but spontaneously broken symmetry of nature. We then put a constraint on the theory by imposing regularity of the action as the dilaton field variable tends to 0, which is a constraint on the small distance behaviour. This appears to turn a black hole into a regular, topologically trivial soliton without singularities, horizons of firewalls, but many questions remain.

Author: 'T HOOFT, Gerardus (Utrecht University)

Presenter: 'T HOOFT, Gerardus (Utrecht University)

Session Classification: Schwarzschild Memorial lecture

Track Classification: Keynotes

Contribution ID: **58** Type: **not specified**

Axially symmetric black hole solutions in f(R) gravity

Thursday 23 July 2015 16:30 (30 minutes)

Axially symmetric solutions for f(R)-gravity can be derived starting from exact spherically symmetric solutions achieved by Noether symmetries. The method takes advantage of a complex coordinate transformation previously developed by Newman and Janis in general relativity. An example is worked out to show the general validity of the approach. The physical properties of the solution are also considered.

Author: Prof. DE LAURENTIS, Mariafelicia (Tomsk State Pedagogical University)

Presenter: Prof. DE LAURENTIS, Mariafelicia (Tomsk State Pedagogical University)

Session Classification: Senior scientist session 3

Track Classification: Seniors

Contribution ID: **59** Type: **Talk**

On the importance of gravitational collapse in astrophysics

Monday 20 July 2015 10:00 (1 hour)

Gravitational collapse to a rotating black hole is a common and recurrent feature of the dynamics of compact stars. I will discuss several examples of this process and the implications they have in potentially explaining some of the most dramatic and puzzling processes in astrophysics.

Author: Prof. REZZOLLA, Luciano (ITP, Goethe University Frankfurt)

Presenter: Prof. REZZOLLA, Luciano (ITP, Goethe University Frankfurt)

Session Classification: Keynote Speaker plenary session 1

Track Classification: Keynotes

Contribution ID: **60** Type: **Talk**

Super-Entropic Black Holes

Thursday 23 July 2015 12:00 (1 hour)

Black Hole Chemistry is a new perspective on black hole thermodynamics, one that indicates that once vacuum energy is taken into account, black holes behave more like chemical systems. As a consequence mass becomes chemical enthalpy, the notion of a thermodynamic volume appears, and black holes exhibit a broad range of chemical phenomena, including liquid/gas phase transitions similar to a Van der Waals fluid, triple points similar to that of water, and re-entrant phase transitions that appear in gels. One conjecture to follow from this program is that the entropy of an AdS black hole is bounded above by a function of its thermodynamic volume via a relation known as the Reverse Isoperimetric Inequality. Here I construct a new new class of rotating AdS black holes that provide counterexamples to this conjecture. They are formed by taking a new ultraspinning limit to the Kerr-AdS class of black holes, yielding objects whose event horizons are non-compact but have finite area. The structure of the spacetime is qualitatively changed since it is no longer possible to return to a frame that does not rotate at infinity. I shall present both the construction of these "super-entropic"black holes and their implications for black hole thermodynamics.

Author: MANN, Robert (University of Waterloo)

Presenter: MANN, Robert (University of Waterloo)

Session Classification: Keynote Speaker plenary session 4

Track Classification: Keynotes

Contribution ID: **61** Type: **Talk**

Black holes have no hair: what about neutron stars?

Tuesday 21 July 2015 10:00 (1 hour)

It is known that black holes have no hair, which means that they are fully described by only three parameters: mass, spin and charge. Conversely, a neutron star may have a very rich multipole structure, and all information about this structure is supposed to be radiated away during the gravitational collapse. However, the transition from a fully hairy star to a bald black hole may not be so sharp.

In recent years some relations among the moment of inertia, the quadrupole moment and the tidal deformability of neutron stars have been shown to exist, which are approximately independent of the equation of state. We will discuss the origin of these relations, which considerably reduce the number of parameters characterizing a neutron star, their range of validity, and provide examples of how they could be used.

Author: FERRARI, Valeria (Sapienza Rome)

Presenter: FERRARI, Valeria (Sapienza Rome)

Session Classification: Keynote Speaker plenary session 1

Track Classification: Keynotes

Contribution ID: **62** Type: **Talk**

Black hole evaporation in a cosmological context

Wednesday 22 July 2015 10:00 (1 hour)

Black hole evaporation calculations are usually carried out in a static asymptotically flat context. However real black holes are imbedded in an expanding universe filled with Cosmic Background radiation. This talk will discuss the relevant horizons and causal limits in this context, and make the case that black hole evaporation cannot take place until very late stages in the expansion of the universe, if at all.

Author: Prof. ELLIS, George (Cape Town)

Presenter: Prof. ELLIS, George (Cape Town)

Session Classification: Keynote Speaker plenary session 2

Track Classification: Keynotes

Contribution ID: **64** Type: **not specified**

Flat space higher spin gravity with chemical potentials

Monday 20 July 2015 17:20 (20 minutes)

Working in three dimensions, we introduce flat space spin-3 gravity in the presence of chemical potentials and discuss some applications to flat space cosmology solutions, their entropy, free energy and flat space orbifold singularity resolution. Our results include flat space Einstein gravity with chemical potentials as special case. We discover novel types of phase transitions between flat space cosmologies with spin-3 hair and show that the branch that continuously connects to spin-2 gravity becomes thermodynamically unstable for sufficiently large temperature or spin-3 chemical potential.

Author: GARY, Mirah (Institute for Theoretical Physics, TU Wien)

Co-authors: GRUMILLER, Daniel (MIT); ROSSEEL, Jan (University of Torino); Mr RIEGLER, Max (Institute for Theoretical Physics, TU Wien)

Presenter: GARY, Mirah (Institute for Theoretical Physics, TU Wien)

Session Classification: Junior plenary session

Track Classification: Juniors

Contribution ID: **65** Type: **Talk**

A surprising extension of the Schwarzschild metric

Wednesday 22 July 2015 11:30 (1 hour)

I describe an extension of the Schwarzschild metric that describes matter collapsing into a black hole and then bouncing out of a white hole. The metric is locally, but not globally, isomorphic to the Kruskal extension, and has a compact internal region where a violation of the Einstein equations mimics quantum effects. The metric may describe an actual black hole explosion.

Author: Prof. ROVELLI, Carlo (Marseille University)

Presenter: Prof. ROVELLI, Carlo (Marseille University)

Session Classification: Keynote Speaker plenary session 3

Track Classification: Keynotes

Contribution ID: **67** Type: **not specified**

Self Sustained Traversable Wormholes in Distorted Gravity

Thursday 23 July 2015 16:00 (30 minutes)

We consider the effects of Distorted Gravity on the traversability of the wormholes. In particular, we consider configurations which are sustained by their own gravitational quantum fluctuations. The Ultra-Violet divergences appearing to one loop are taken under control with the help of a Noncommutative geometry representation and Gravity's Rainbow. In this context, it will be shown that for every framework, the self-sustained equation will produce a Wheeler wormhole, namely a wormhole of Planckian size. This means that, from the point of view of traversability, the wormhole will be traversable in principle, but not in practice. To this purpose, in the context of Gravity's Rainbow we have considered different proposals of rainbow's functions to see if the smallness of the wormhole is dependent on the chosen form of the rainbow's function. Unfortunately, we discover that this is not the case and we suggest that the self-sustained equation can be improved to see if the wormhole radius can be enlarged or not. Some consequences on topology change are discussed.

Author: Prof. GARATTINI, REMO (University of Bergamo)

Presenter: Prof. GARATTINI, REMO (University of Bergamo)

Session Classification: Senior scientist session 3

Track Classification: Seniors

Contribution ID: **68** Type: **Poster**

Quantum chaos inside black holes

Tuesday 21 July 2015 14:40 (20 minutes)

We show how a system of $N >> 1$ horizonless conic singularities, with average opening angle at the horizon $\langle\Theta\rangle = 2\pi$, can effectively approximate the geometry and the entropy of a semiclassical black hole. We test what happen to in-going informations in such a system, with a simple gedanken experiment: we consider a plane wave function in-going in this system of N conic singularities. The initial quantum wave will subsequently scatter on N conic singularities, and the resultant dynamics will be a quantum chaotic one. This system is nothing but a quantum Sinai billiard. As a consequence, information is "practically" lost in this system. Our approach also seems motivated by fuzzballs' physics, where BPS microstates and conical defects are typically considered.

Author: ADDAZI, Andrea (INFN)

Presenter: ADDAZI, Andrea (INFN)

Session Classification: Student plenary session 2

Track Classification: Students

Contribution ID: **69** Type: **Talk**

Evidence for black hole compositeness: Physics of black hole information processing.

Tuesday 21 July 2015 11:30 (1 hour)

We discuss physics of black hole information storage and processing in a quantum portrait according to which black hole is a loose bound-state of many soft gravitons at the quantum critical point, with characteristic Liapunov exponent responsible for the quantum instability and information scrambling. This picture sheds light at the microscopic origin of black hole entropy and also shows that black holes can consistently carr a detectable hair under global symmetry charges, such as baryon number. We discuss some evidence and possible observational consequences of this picture.

Author: DVALI, Georgi (LMU, Arnold Sommerfeld Center)

Presenter: DVALI, Georgi (LMU, Arnold Sommerfeld Center)

Session Classification: Keynote Speaker plenary session 2

Track Classification: Keynotes

Contribution ID: **70** Type: **Talk**

A menagerie of hairy black holes

Friday 24 July 2015 11:30 (1 hour)

According to the no-hair conjecture, equilibrium black holes are simple objects, completely determined by global charges which can be measured at infinity. This is the case in Einstein-Maxwell theory due to beautiful uniqueness theorems. However, the no-hair conjecture is not true in general, and there is now a plethora of matter models possessing hairy black hole solutions. In this talk we focus on one such matter model: Einstein-Yang-Mills (EYM) theory, and restrict our attention to four-dimensional, static, non-rotating black holes for simplicity. We outline some of the menagerie of EYM solutions in both asymptotically flat and asymptotically anti-de Sitter space. We attempt to make sense of this black hole zoo in terms of Bizon's modified no-hair conjecture.

Author: WINSTANLEY, Elizabeth (The University of Sheffield)

Presenter: WINSTANLEY, Elizabeth (The University of Sheffield)

Session Classification: Keynote Speaker plenary session 4

Track Classification: Keynotes

Contribution ID: **71** Type: **not specified**

Lovelock Black Hole Thermodynamics

Tuesday 21 July 2015 14:20 (20 minutes)

I will talk about the effects of higher curvature corrections from Lovelock gravity on the phase structure of asymptotically AdS black holes, treating the cosmological constant as a thermodynamic pressure.

Authors: FRASSINO, Antonia Micol; KUBIZNAK, David (Perimeter Institute); Mr SIMOVIC, Fil (Department of Physics and Astronomy, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada); MANN, Robert (University of Waterloo)

Presenter: FRASSINO, Antonia Micol

Session Classification: Student plenary session 2

Track Classification: Students

Contribution ID: **72** Type: **Talk**

Ultra-relativistic Collisions and Black Hole Formation

Tuesday 21 July 2015 09:00 (1 hour)

I will review what been learnt in recent years about the ultra-relativistic collision problem in classical general relativity. This area has connections to super-Planck scale particle collisions and the interaction of gravitational shock waves, and addresses questions pertinent to cosmic censorship, black hole formation and the hoop conjecture. I will also discuss some open questions and problems for future research.

Author: PRETORIUS, Frans

Presenter: PRETORIUS, Frans

Session Classification: Keynote Speaker plenary session 1

Track Classification: Keynotes

Contribution ID: **73** Type: **not specified**

Black Hole Entropy From Multisymplectic Geometry

Tuesday 21 July 2015 15:00 (20 minutes)

I will discuss multisymplectic geometry and its application to finite spacetime regions. This allows one to perform a 3+1 decomposition where the spatial slice need not be a Cauchy surface. I show how this can lead to a modification of the symplectic structure, Hamilton's principle function, and momentum maps (conserved charges). Such modifications are in the form of boundary terms which can arise from non-trivial boundary conditions at the edge of the spatial slice. I show how this can be applied to evolution in the presence of a black hole and how we can reproduce Wald's derivation of the first law of black hole thermodynamics using the modified conserved charges.

Author: KUR, Eugene (University of California, Berkeley)

Presenter: KUR, Eugene (University of California, Berkeley)

Session Classification: Student plenary session 2

Track Classification: Students

Contribution ID: **75** Type: **not specified**

Generalized Uncertainty Principle in extradimensions

Tuesday 21 July 2015 15:20 (20 minutes)

I will talk about the extension of general uncertainty principle (GUP) inspired black holes to the scenario of large spatial extradimensions (ADD).

Authors: MUREIKA, Jonas (Loyala Marymount University); KNIPFER, Marco (Frankfurt Institute for Advanced Studies); ISI, Maximiliano (Caltech); NICOLINI, Piero (Frankfurt Institute for Advanced Studies); KÖPPEL, Sven (Frankfurt Institute for Advanced Sciences)

Presenter: KÖPPEL, Sven (Frankfurt Institute for Advanced Sciences)

Session Classification: Student plenary session 2

Track Classification: Students

Contribution ID: **76** Type: **not specified**

General Relativity from a Canonical Transformation Formalism

Thursday 23 July 2015 17:00 (30 minutes)

Any physical theory that follows from an *action principle* should be *invariant in its form* under mappings of the reference frame in order to comply with the *general principle of relativity*. The required form-invariance of the action principle implies that the mapping must constitute a particular *extended canonical transformation*.

In the realm of the covariant Hamiltonian formulation of field theory, the term "extended" implies that not only the *fields* but also the *space-time geometry* is subject to transformation.
A *canonical* transformation maintains the general form of the action principle by simultaneously defining the appropriate transformation rules for the fields, the conjugate momentum fields, and the transformation rule for the Hamiltonian.
Provided that the given system of fields exhibits a particular *global* symmetry, the associated extended canonical transformation reveals exactly the particular amended Hamiltonian that is form-invariant under the corresponding *local* symmetry.

This will be worked out for a Hamiltonian system of scalar and vector fields that is presupposed to be form-invariant under space-time transformations $x^\mu \mapsto X^\mu$ with $\partial X^\mu / \partial x^\nu = \mathrm{const.}$, hence under *global* space-time transformations such as the Poincarè transformation. The corresponding amended system that is form-invariant under *local* space-time transformations $\partial X^\mu / \partial x^\nu \neq \mathrm{const.}$ then describes the coupling of the fields to the space-time geometry and thus yields the dynamics of space-time that is associated with the given physical system.

Authors: VASAK, David (FIAS); STOECKER, Horst (GSI); STRUCKMEIER, Jürgen (GSI)

Presenter: STRUCKMEIER, Jürgen (GSI)

Session Classification: Senior scientist session 3

Track Classification: Seniors

Contribution ID: **77** Type: **Talk**

The LHC is a GlueBall factory - probing a novel form of pure gauge matter from the early universe to cosmic rays

Monday 20 July 2015 11:30 (1 hour)

Pure SU_c Lattice Gauge Theory, LGT, predicts a strong first order phase transition from a deconfined glue plasma to a confined GlueBall fluid, at a critical temperature of T_c=270 MeV.

QCD-transport calculations show that such pure gauge matter can be created for a fleeting moment in high multiplicity pp, pA and AA collisions at the LHC at CERN and at RHiC at BNL. Pure gauge matter is also predicted to be formed in Air Showers of UHE Cosmic Rays - this novel phase of matter may also have existed briefly during the big bang. Experimental observables which pin down the properties of this new form of pure gauge matter are discussed.

Authors: Prof. STÖCKER, Horst (FIAS & GSI); Dr ZHOU, Kai (ITP, Goethe-University Frankfurt am Main)

Presenter: Prof. STÖCKER, Horst (FIAS & GSI)

Track Classification: Seniors

Contribution ID: **78** Type: **Talk**

Bounds on the un-particle sector from Casimir effect experiments

Tuesday 21 July 2015 16:30 (30 minutes)

We present the un-Casimir effect, namely the study of the Casimir energy in the presence of an unparticle component in addition to the electromagnetic field contribution.
The distinctive feature of the un-Casimir effect is a fractalisation of metallic plates. This result emerges through a new dependence of the Casimir energy on the plate separation that scales with a continuous power controlled by the unparticle dimension.
As long as the perfect conductor approximation is valid, we find bounds on the unparticle scale that are independent of the effective coupling constant between the scale invariant sector and ordinary matter. We find regions of the parameter space such that for plates distances around 5 microns and larger the un-Casimir bound wins over the other bounds.

Author: PANELLA, Orlando (INFN)

Co-authors: FRASSINO, Antonia Micol; NICOLINI, Piero

Presenter: PANELLA, Orlando (INFN)

Session Classification: Senior scientist session 2

Track Classification: Seniors

Contribution ID: **79** Type: **Talk**

Laboratory analogues of black hole evaporation and its partner particles

Friday 24 July 2015 09:00 (1 hour)

Many quantum radiation phenomena such as black hole evaporation (Hawking effect) are far removed from experimental access.
Therefore, analogies between these fundamental phenomena and laboratory physics can help to understand both sides better – from a theoretical as well as from an experimental point of view.
This talk will start with a brief introduction into black hole evaporation with special emphasis on the issue of the partner particles of Hawking radiation. As such quantum radiation phenomena can be described as (squeezing) processes where particles are created in pairs, one can ask the following question: given a mode (e.g., wave-packet) corresponding to a created particle (e.g., as part of Hawking radiation), what is its partner, i.e., the other particle of the pair?
After a general derivation of this partner mode, examples such as moving mirror radiation and black hole evaporation will be discussed, together with speculations about possible implications for the black hole information puzzle.
After an introduction into the laboratory analogues of black hole evaporation, the second part of the talk will be devoted to the question of what can be learned from them about the origin and the robustness of Hawking radiation and its partner particles.

Author: Prof. SCHÜTZHOLD, Ralf (Uni Duisburg-Essen)

Presenter: Prof. SCHÜTZHOLD, Ralf (Uni Duisburg-Essen)

Session Classification: Keynote Speaker plenary session 5

Track Classification: Keynotes

Contribution ID: **80** Type: **not specified**

Integration and Path-Integration by Differentiation

Thursday 23 July 2015 17:30 (30 minutes)

Presenter: KEMPF, Achim (PI/Waterloo)