# ABSTRACTS

VI Black Holes Workshop
CMAT UMinho, Braga, Portugal
December 19 - 20, 2013

**Ballon Bayona, Alfonso**, Universidade do Porto,
**Title**: *Magnetic effect on a holographic deconfinement transition*,
**Abstract**: In this talk I will describe the effect of a magnetic field on an AdS/QCD deconfinement transition. The AdS/QCD approach can be thought as a holographic description of Quantum Chromodynamics (QCD) in the large-N limit, where N is the number of colors. I will focus on the Sakai-Sugimoto model, which describes confinement and chiral symmetry breaking and maps the deconfinement transition to a Hawking-Page transition.

**Bertolami, Orfeu**, Universidade do Porto,
**Title**: *Phase-Space Noncommutative Black Holes*,
**Abstract**: The remarkable quantum properties of phase-space noncommutative black holes are described and discussed.

**Bolejko, Krzysztof**, The University of Sydney,
**Title**: *Apparent and absolute horizons in the Szekeres models*,
**Abstract**: The apparent horizon can be defined as the outer envelope of a region in which every bundle of null geodesics is converging. A similar approach can be taken to define an absolute apparent horizon, i.e. as an envelope of a region in which every bundle of null accelerated rays (hence non-geodesics) is converging. In my talk I will describe both these horizons in relation to the Szekeres model, which is an exact, non-stationary, non-symmetrical, and inhomogeneous solution of the Einstein equations. I will discuss differences between these two horizons, which only in the limit of spherical symmetry coincide. I will show how they form in the case of anisotropic collapse of an astrophysical object.

**Brito, Richard**, Instituto Superior Técnico,
**Title**: *Massive gravitons on black hole spacetimes: Instabilities and hairy black holes*,
**Abstract**: In this talk we develop the study of massive spin-2 fluctuations around GR black holes. First, we show that the Schwarzschild geometry is linearly unstable for small tensor masses, against a spherically symmetric mode. Second, we provide solid evidence that the Kerr geometry is also generically unstable, both against the spherical mode and against long-lived superradiant modes. We end up by showing that hairy solutions exist in massive gravity and are, most likely, the generic end state of the spherically symmetric instability of the Schwarzschild black holes.

**Bronnikov, Kirill**, VNIIMS, Moscow; PFUR, Moscow,
**Title**: *Dilaton gravity, black holes and quasi-black holes*,
**Abstract**: We consider static electrically charged dust configurations in the framework of Einstein-Maxwell-dilaton gravity with the interaction $P(\chi)F^2$ where $P(\chi)$ is an arbitrary function of the dilaton $\chi$, generalizing the Majumar-Papapetrou setup. The necessity of introducing a scalar charge density is revealed. Examples of (quasi-) black hole solutions are given, including those where the energy densities of matter and the scalar field are positive.

**Cardoso, Gabriel**, Instituto Superior Técnico,
**Title**: *Indefinite theta functions and black hole partition functions*,
**Abstract**: We explore various aspects of supersymmetric black hole partition functions in four-dimensional toroidally compactified heterotic string theory. These functions suffer from divergences owing to the hyperbolic nature of the charge lattice in this theory, which prevents them from having well-defined modular transformation properties. In order to rectify this, we regularize these functions by converting the divergent series into indefinite theta functions, thereby obtaining fully regulated single-centered black hole partition functions.

**Cardoso, Vitor**, Instituto Superior Técnico,
**Title**: *Precision gravitational-wave physics*,
**Abstract**: I discuss possible systematic effects in gravitational wave detection, and how they could hamper our ability to test GR. I will focus on astrophysically "dirty" black holes.

**Costa, João L.**, ISCTE-IUL and CAMGSD,
**Title**: *Strong cosmic censorship with a cosmological constant II.*
**Abstract**: We discuss new results concerning strong cosmic censorship for the spherically symmetric Einstein-Maxwell-scalar field system with a cosmological constant.

**Czinner, Viktor G.**, Universidade do Minho,
**Title**: *Thermodynamics of Schwarzschild black holes from the Rényi entropy formula*,
**Abstract**: Black hole thermodynamics has been actively investigated recently in a non-extensive framework. As a novel approach to the problem, in this talk I will present a model where the Bekenstein-Hawking entropy of Schwarzschild black holes is regarded as a non-extensive Tsallis entropy, and its formal logarithm, the Rényi entropy, is considered for the canonical analysis. As a result, the temperature - horizon radius relation has the same form as the one obtained from a (3+1)-dimensional black hole in anti-de Sitter space using the original Boltzmann entropy formula. In both cases the temperature has a minimum. A semi-classical estimate of the horizon radius at this minimum leads to a Bekenstein bound for the q-parameter in the Rényi entropy of micro black holes, which is surprisingly close to other q-parameter fits from very distant areas of physics, like cosmic ray spectra measurements, or power-law distribution of quarks coalescing to hadrons in high energy accelerator experiments.

**Diaz-Polo, Jacobo**, Universidade do Minho,
**Title**: *Black hole entropy in loop quantum gravity*,
**Abstract**: I will review how black holes are described within the loop quantum gravity framework and present some recent results for the computation of their entropy.

**Ferreira, Hugo**, University of Nottingham,
**Title**: *Warped AdS3 black holes: are they classically stable?*
**Abstract**: (2+1)-dimensional gravity allows us to study aspects of classical and quantum gravity in a simpler technical setting which retains much of the conceptual complexity of the standard (3+1)-dimensional gravity. However, pure Einstein gravity lacks propagating degrees of freedom in 2+1 dimensions. Topologically Massive Gravity is a deformation of GR which includes propagating degrees of freedom. Besides the famous BTZ black hole solution, this theory has a whole new class of black hole solutions – the warped AdS3 black holes – which can be viewed as deformed BTZ solutions but which, counterintuitively, are not asymptotically AdS – they are actually (almost) asymptotically flat! In this talk, I will describe the classical features of this interesting set of solutions. First, I will show that, in contrast with the BTZ solution, classical superradiance of a massive scalar field on the background of a warped AdS3 black hole is always present. Despite this fact, I then show that the black hole is classically stable to scalar perturbations, namely there are no superradiant instabilities, even if it is enclosed by a stationary mirror with Dirichlet boundary conditions. This is a surprising result in view of the similarity between the causal structure of the warped AdS3 black hole and the Kerr spacetime in 3+1 dimensions, which is classically unstable due to superradiant instabilities.

This work has been published in Phys. Rev. D 87, 124013 (2013).

**Flachi, Antonino**, Instituto Superior Técnico,
**Title**: *On gravity, black holes and confinement*,
**Abstract**: We discuss the interplay between gravity and confinement and its relevance for black hole evaporation.

**Gomes, João**, DAMTP, University of Cambridge,
**Title**: *Non-perturbative effects to the quantum entropy*,
**Abstract**: In this talk I will review recent developments in the computation of quantum corrections to the entropy of supersymmetric black holes in the context of the AdS2/CFT1 correspondence. I will show how we can use supersymmetric localisation of supergravity on AdS2 backgrounds to compute quantum corrections to the Bekenstein-Hawking's area formula. We look in particular to 1/8 BPS black holes in four dimensional $N = 8$ string theory and compare the gravity computation with the well known microscopic answer. The leading answer, given by a Bessel function of the first kind is reproduced entirely from supergravity while non-perturbative contributions given in part by number theoretic Kloosterman sums arise by considering AdS2 orbifolds. These results go well beyond the large charge approximation and may be seen as a first example where holography works exactly.

**Herdeiro, Carlos A. R.**, Universidade de Aveiro,
**Title**: *Interaction of charged scalar fields with charged black holes*,
**Abstract**: I shall discuss quasi-bound states of charged scalar fields in the background of charged black holes. In particular I shall discuss:

- How a particularly simple behaviour emerges for the imaginary part of the frequencies as a double limit is taken, in which both the scalar field and the background black hole become extremal.

- The superradiant modes that occur when the scalar field is enclosed in a cavity and show the growth rate of these superradiant modes can be much larger than in the analogous setup for rotating black holes.

- Compare the evolution of superradiant modes in the frequency and time domain.

**Lemos, José Sande**, CENTRA, Instituto Superior Técnico,
**Title**: *Entropy of extremal black holes from the entropy of matter shells: a solution to the debate*,
**Abstract**: Black hole entropy $S$ is one of the most fascinating issues in contemporary physics, as one does not yet know what are the degrees of freedom at the fundamental microlevel. In addition, there are two mutually inconsistent results for extremal black holes. There is the usual $S = A/4$ value, where A is the horizon radius, obtained from string theory, and there is the prescription $S = 0$ obtained from the fact that for extremal black holes the period of the Euclidean time is not fixed in a classical calculation of the action. In order to better understand this problem, we exploit a framework set up by Martinez and use a thermodynamic approach for an electrically charged thin shell. We then take the shell radius into its horizon limit. This limit is called a quasi-black hole. We show that

(i) for a non-extremal shell the horizon limit yields $S = A/4$, and

(ii) for an extremal shell the horizon limit gives an entropy which is a function of the horizon radius alone, but the precise functional form depends on how we set the initial shell.

This formalism clearly shows that non-extremal and extremal black holes are different objects.

**Lopes, Francisco João**, Instituto Superior Técnico,
**Title**: *Buchdahl limit for stars with a Schwarzschild interior and a small electrical charge: Analytical approach based on Misner's method to solve the TOV equation*,
**Abstract**: Schwarzschild's interior solution (1916) for a star with constant energy density, can be neatly found from the Tolman-Oppenheimer-Volkoff (TOV) equation as first presented by Misner (Brandeis School 1969). From it one can deduce at once the Buchdahl limit (PR 1959). This is the minimum radius R a star with a given fixed mass M can have. It is a model-independent bound and it is achieved when the central pressure goes to infinity. For perfect fluids the limit is R/M = 9/4, which is stronger than the bound R/M = 2 for excluding trapped surfaces.

By adding a small charge Q to the interior Schwarzschild solution, and matching it to a Reissner-Nordstrom exterior, one can study analytically, by

an approximation method valid to the corresponding Buchdahl limit. We find that the limit in this case is in accord with Andreasson's results (CMP 2009) for thin charged shells and the numerical results of Arbanil, Lemos, Zanchin (PRD 2013).

**Luz, Paulo**, Instituto Superior Técnico,
**Title**: *Black holes and wormholes in nonrelativistic theories of gravitation*,
**Abstract**: When many alternative theories to general relativity are being suggested, and the gravitational field is being theoretically and experimentally put to test, it is interesting to try an alternative to Newton's gravitation through an unexpected but simple modification of it. The idea is to have Newtonian gravitation, not in flat space, as we are used to, but in curved spaced. This intriguing possibility has been suggested by Abramowicz (2012). Noting that Newtonian gravitation in curved space, and the corresponding Newtonian dynamics in a circle distinguishes three radii, namely, the geodesic radius (which gives the distance from the center to its perimeter), the circumferential radius (which is given by the perimeter divided by $2\pi$), and the curvature radius (which is Frenet's radius of curvature of a curve, in this case a circle), he calculated the perihelion advance formula for a planet in an elliptical orbit in the gravitational field of a star in spherical space in curved Newtonian gravitation.

One can further consider solutions with matter, in which case Poisson's equation for Newtonian gravitation in curved space has to be used. Moreover, an equation that connects the curvature to the matter, i.e, connects the Ricci scalar with the density, can be sought for, giving an enhanced Newtonian theory of gravitation as proposed by Abramowicz, Ellis, Horak, and Wielgus (2013).

Now this enhanced Newtonian gravitation can have wormhole solutions. We present here a Newtonian wormhole in the enhanced Newtonian gravitation in curved space. We also comment on black hole solutions.

**Mas Solé, Javier**, Universidad de Santiago de Compostela,
**Title**: *Holographic Entanglement Entropy on Time Dependent Backgrounds*,
**Abstract**: The evolution of entanglement after a quench is a subject of much interest. Holographically it has been addressed in a number of papers where the time dependent background is a collapsing metric of the Vaydia type. Going beyond that case needs numerical methods and demanding computation. I will review the state of the art and report on work in progress in our group.

**Minamitsuji, Masato**, Instituto Superior Técnico,
**Title**: *Solutions in the scalar-tensor theory with nonminimal derivative coupling*,
**Abstract**: We present black hole type solutions in the scalar-tensor theory with nonminimal derivative coupling to the Einstein tensor. The effects of the nonminimal derivative coupling appear in the large scales, while the solutions approach those in the Einstein gravity in the small scales.

**Natário, José**, Instituto Superior Técnico,
**Title**: *Strong cosmic censorship with a cosmological constant I.*
**Abstract**: We discuss the existing results on strong cosmic censorship for spherically symmetric scalar fields, and how the inclusion of a positive cosmological constant may change the mass inflation picture.

**Okawa, Hirotada**, Instituto Superior Técnico,
**Title**: *Collapse of self-interacting fundamental fields in asymptotic spacetimes*,
**Abstract**: It was recently pointed out that anti-de Sitter(AdS) spacetime is unstable against gravitational collapse. The pertubation in AdS does not simply decay away and can be reflected by AdS boundary to nonlinearly interact with one another. Confinement would play an important role in the nonlinear, turbulent instability. On the other hand, massive fundamental fields can also provide low-frequency confinement. We revisit an old problem on collapse of massive fields and will show the collapse after successive reflections by the potential wall.

**Penedones, João**, Universidade do Porto,
**Title**: *Black holes and Matrix Quantum Mechanics*,
**Abstract**: In this talk, I will quickly review the duality between supersymmetric matrix quantum mechanics and 11 dimensional supergravity, that follows from the decoupling limit of D0-branes. I will then discuss the thermodynamics of the system at finite temperature and under a massive deformation. In particular, I shall explain how to construct the black hole geometry that describes the deconfined phase of the plane-wave matrix model.

**Quinta, Gonçalo M.**, Instituto Superior Técnico,
**Title**: *Thermodynamics and entropy of shells in 2+1 dimensional AdS spacetimes and the BTZ black hole limit*,
**Abstract**:We study the thermodynamics of 3-dimensional thin matter shells in the context of general relativity. We start with the calculation of the necessary pressure and energy of the thin shell in order for it to be static which allows the calculation of the entropy as well as a thermodynamic stability analysis. We then take the shells to their gravitational radius, where it is shown that they possess the entropy of BTZ black holes.

**Rocha, Jorge**, Instituto Superior Técnico,
**Title**: *Holographic collisions in confining theories*,
**Abstract**: High energy collisions in non-abelian gauge theories is currently a subject of great interest. In heavy ion collisions performed at RHIC and LHC the formation of a quark-gluon plasma is observed. The physics involved is presumably described by Quantum Chromodynamics (QCD), a non-conformal field theory that exhibits confinement. Although the dual of QCD is not known, the analogous process in gauge theories with a gravity dual can be described via the collision of two objects that form a black hole in an asymptotically AdS spacetime. This is a challenging problem that requires solving Einstein's equations in a dynamical setting. Nevertheless, various aspects of collision processes in con-

formal field theories have been explored recently by employing the AdS/CFT correspondence.

I will describe a first step towards extending this program to gravitational duals of confining gauge theories. We consider a linearized approach in which two point particles traveling in an AdS-soliton background suddenly collide to form an object at rest. Our results include some universal features that are expected also for non-linear collisions. The importance of phenomenological cutoffs to regularize the emission spectrum will also be addressed.

**Rosa, João**, University of Aveiro,
**Title**: *Superradiant instabilities in warped geometries*,
**Abstract**: We study the development of superradiant instabilities for rotating black strings in warped extra-dimensions, focusing on 5-dimensional Randall-Sundrum scenarios with either a compact or infinite extra-dimension. We consider, in particular, the spectrum of Kaluza-Klein bound states in the simplest rotating black string geometry and show that it approaches a continuum in the decompactification limit, rendering the black string unstable for any mass and spin. We then discuss the potential implications of this result in view of other known instabilities and properties of these solutions.

**Rubiera-Garcia, Diego**, Universidade Federal da Paraíba,
**Title**: *Semiclassical Palatini geons*,
**Abstract**: We present a explicit realization of Wheeler's geon concept introduced in 1955. These geons arise in an extension of General Relativity containing (Planck-supressed) quadratic terms and formulated within a first-order (Palatini) formalism. We describe how the Reissner-Nordström geometry is deformed by non-perturbative effects close to the central-point singularity, which is generically replaced by a wormhole. We consider the dynamical process by which such geons may be generated, and discuss their potential applications as dark matter candidates and objects at particle accelerators.

**Shock, Jonathan**, University of Cape Town,
**Title**: *The open string membrane paradigm with external electromagnetic fields*,
**Abstract**: We study the effective geometry felt by the fluctuations of open strings living on the worldvolume of probe D-branes in the presence of background electromagnetic fields. This is captured by an effective action consisting of a Maxwell term and a topological term, with the role of the metric played by the open string metric. Studying generalized Eddington-Finkelstein coordinates for stationary but non-static manifolds, we consider an open string membrane paradigm to obtain a generic formula for the DC transport coefficients, including the effect of external electromagnetic fields present on the worldvolume of the probe branes. We show that the previously studied singular shell, present when a critical electric field strength is turned on, behaves as a horizon for the open string degrees of freedom. The results of this analysis can be used to define a membrane paradigm for a very general class of spacetimes with non-diagonal metrics.

**Tavakoli, Yaser**, Universidade da Beira Interior,
**Title**: *Quantum gravity inspired homogeneous dust collapse*,
**Abstract**: The evolution of the gravitational system is described by Einstein's field equation which can be solved for a general spherically symmetric spacetime in vacuum without the assumption of staticity. According to Birkhoff's theorem in general relativity, all spherically symmetric solutions of Einstein's equations in vacuum must be static and asymptotically flat (in the absence of cosmological constant). It shows that the Schwarzschild solution remains the only solution of this more general system of equations, that is, all spherically symmetric spacetimes, with vanishing Ricci tensor, are static. Several attempts have been done in order to establish a Birkhoff-like theorem in quantum gravity. In this talk, we study whether or not loop quantum gravity will share such property of Einstein's gravity, investigating if the exterior vacuum solutions in gravitational collapse with LQG are static.

**Vitagliano, Vincenzo**, Instituto Superior Técnico,
**Title**: *Horizon thermodynamics and spacetime mappings*,
**Abstract**: When black holes are dynamical, event horizons are replaced by apparent and trapping horizons. Conformal and Kerr-Schild transformations are widely used in relation with dynamical black holes and we study the behaviour under such transformations of quantities related to the thermodynamics of these horizons. The transformation properties are not those expected on the basis of naive arguments.

**Willison, Steven**, Instituto Superior Técnico,
**Title**: *Gravitational Physics from the embedding point of view*,
**Abstract**: The formulation of GR in terms of embedding space variables in 10 or more dimensions is reconsidered. We argue that questions of local existence and uniqueness are not as straightforward, and questions of global existence and uniqueness not as hopeless, as one may expect.

**Zaslavskii, Oleg**, Kharkov V. N. Karazin University,
**Title**: *Ultra-high energy collisions near black holes: new developments*,
**Abstract**: We suggest brief review of the effect of acceleration of particles by rotating and charged black holes to unbound energies in the centre of mass frame. Simple and general explanations of the effect are given:

(i) the kinematic one based on the behaviour of relative velocity of colliding particles near the horizon,

(ii) the geometric one, based on properties of particles' four-velocities with respect to a local light cone near the horizon.

The similar effect near the inner black hole horizon is also discussed and the role of the bifurcation point is revealed. We also consider which energies can be detected by an observer at infinity. The possible role of gravitational radiation is discussed.

**Zilhão, Miguel**, Rochester Institute of Technology,
**Title**: *Warped dynamical grids for accreting binary black holes*,
**Abstract**: We present a warped gridding scheme adapted to simulate gas dynamics in binary black hole spacetimes. The grid concentrates grid points in the vicinity of each black hole to resolve the smaller scale structures there, and rarefies grid points away from the binary to keep the overall problem size to a practical level. Though general, this construction is intended to be used in circumbinary accretion disk numerical evolutions. In this talk we will introduce the field of general relativistic magnetohydrodynamics (GRMHD), motivate and show the construction of our warped gridding scheme and show preliminary results of its usefulness in evolving a circumbinary disk surrounding an equal-mass non-spinning black hole binary.