7th Winter Workshop @Valencia

December 11-13, 2023

BOOK OF ABSTRACTS

Monday

Compact objects and GWs
9:50 - 10:50 Mariafelicia DeLaurentis
10:50 - 11:10 Milton Ruiz
11:10 - 11:30 Olga Mena

11:30 - 11:50 Coffee break

Quantum aspects
11:50 - 12:30 Adrià Delhom
12:30 - 12:50 Alvaro Torres Caballeros
12:50 - 13:10 Marek Liška
13:10 – 13:30 Andrés Minguez-Sanchez

13:30 - 15:30 Lunch break

Modified gravity
15:30 - 15:50 Alejandro Jiménez-Cano
15:50 - 16:10 Ángel-Jesus Murcia-Gil
16:10 – 16:30 José Perdiguero
16:30 - 16:50 Adrián Casado-Turrión

16:50 - 17:20 Coffee break

Compact objects and Gws
17.20 - 17:40 Claudio C. Lazarte Melgar
17:40 - 18:00 Marco Aurélio Abreu de Paula (ONLINE)
18:00 - 18:20 Sérgio Xavier (ONLINE)
18:20 - 18:40 Zeus moreira (ONLINE)

INTERNATIONAL FOOTBALL LEAGUE

Tuesday

Quantum aspects
9:50 - 10:50 Jorma Louko
10:50 - 11:10 Fernando Barbero
11:10 - 11:30 Sergi Nadal

11:30 - 11:50 Coffee break

Quantum aspects
11:50 - 12:30 Silvia Pla
12:30 - 12:50 Antonio Vicente-Becerril
12:50 - 13:10 Beatriz Elizaga Navascués
13:10 - 13:30 Jesús Huertas

13:30 - 15:00 Lunch break

Modified gravity ONLINE
15:00 - 15:20 Albert Petrov
15:20 - 15:40 Aneta Wojnar
15:40 - 16:00 Renan Magalhaes
16:00 - 16:20 Ángel Rincón

16:20 - 16:50 Coffee break

Compact objects ONLINE
16:50 - 17:10 Joao Luís Rosa
17:10 - 17:30 Saboura Sadat

18:30 - 20:30 SEGRE MEETING (Jardí Botànic)

FROM 20:30 FUN IN THE CENTRE OF VALENCIA

Wednesday

Modified gravity
9:50 - 10:50 Jose Beltrán-Jiménez
10:50 – 11,10 María José Guzmán
11:10 - 11:30 Andrea Donini

11:30 - 11:50 Coffee break

Modified gravity
11:50 - 12:30 Emanuele Orazi
12:30 - 12:50 Miguel Pinto
12:50 - 13:10 Tiago Gonçalves

13:10 - 15:00 Lunch break

15.00 – 15:20 Leandro Lessa (ONLINE)
15:20 - 15:40 Alana-Carolina Lima-dos-Santos (ONLINE)
15:40 - 16:00 Tiziano Schiavone (ONLINE)

16:00 - 16:30 Coffee break

Quantum aspects
16:30 - 16:50 Sebastiano Segreto
16:50 - 17:10 Gabriele Barca
17:10 - 17:30 Eleonora Giovanetti (ONLINE)
17:30 - 17:50 Giulia Maniccia (ONLINE)

17:50 – 18:00 CLOSING

Speaker: Marco Aurélio Abreu de Paula (Federal University of Pará)
marco.paula@icen.ufpa.br

Title: Shadows and gravitational lensing of electrically charged regular black holes in nonlinear electrodynamics

Abstract: Regular black holes (RBHs) are conceived as promising alternatives to the standard black holes (BHs) of General Relativity (GR) since they do not have a curvature singularity. Among the possible sources for obtaining RBHs in GR, we highlight the nonlinear electrodynamics (NED) theory. Within this theory, photons follow null geodesics of an effective geometry, which is different from the geometry of spacetime itself. In recent years, several works were dedicated to investigate the motion of photons in the effective geometry of NED-based magnetically charged RBH solutions. We study the shadows and gravitational lensing of the electrically charged RBH solution proposed by Irina Dymnikova (ID), which is a static and spherically symmetric spacetime with a NED source. We show that the shadow associated with the effective geometry can be almost 10% larger than the one

associated with the standard geometry. We obtain the so-called fine-tuned degenerate shadows, namely configurations for which the ID solution can mimic the shadow properties of the Reissner-Nordstrom BH, considering asymptotic observers. Besides that, using the backward ray-tracing technique, we calculate the gravitational lensing of the ID RBH solution. We also show that the motion of photons in the effective geometry can be interpreted as a nongeodesic curve submitted to a four-force term from the perspective of an observer in the standard geometry.

Speaker: Mariafelicia de Laurentis (INFN, U. Federico II – Napoli)

Title: Probing Black Holes Through the Eyes of the Event Horizon Telescope

Abstract: Not provided.

Speaker: J. Fernando Barbero G. (Insituto de Estructura de la Materia-CSIC)
fbarbero@iem.cfmac.csic.es

Title: Euclidean self-dual gravity: Ashtekar variables without gauge fixing

Abstract: I will discuss the implementation of the GNH procedure to derive the Hamiltonian formulation of Euclidean general relativity from the self-dual action. I will show how to derive the Ashtekar formulation in this framework without using the time gauge.

Speaker: Gabriele Barca (Sapienza University of Rome)
gabriele.barca@uniroma1.it

Title: Non-Singular Collapse and Perturbations with a Deformed Algebra

Abstract: We examine the impact of cut-off physics, in the form of a modified algebra, on the collapse of a spherical dust cloud. In both the Newtonian and general relativistic formulations, we find that the collapse stabilizes into an asymptotically static state above the horizon, removing the singularity. We also explore the behaviour of small perturbations, and find that within specific parameter ranges the collapse remains stable against perturbations of all scales, making the non-singular super-Schwarzschild configurations physically meaningful.

Speaker: Adrián Casado-Turrión (Universidad Complutense de Madrid)
adricasa@ucm.es

Title: Junction Conditions and their Applications in Bi-Scalar Poincaré Gauge Gravity

Abstract: The study of junction conditions is of paramount importance in the context of gravitational theories. Physically-relevant scenarios where two solutions are glued together along a boundary layer are ubiquitous; some paradigmatic examples include stars surrounded by vacuum or thin-shell wormholes. In this talk, we will introduce the junction-condition formalism in a theory-independent way, clarifying some of the subtleties arising when dealing with tensor distributions. Afterwards, we shall present the junction conditions in a paradigmatic metric-affine theory of gravity: the ghost-free subclass of quadratic Poincaré Gauge Gravity. We will show that, in this theory, the matching interface is allowed to host surface spin densities, as well as energy-momentum thin shells and double layers. We shall also discuss the relevance of our results and their practical applications in cases of physical interest.

Speaker: Adrià Delhom i Latorre (Louisiana State University)
adria.delhom@gmail.com

Title: Entanglement from superradiance in Kerr black holes and rotating fluids in the lab.

Abstract: Superradiance is a ubiquitous phenomenon in field theory. Recent results show that superradiance generates entangled radiation, even for classical input states. In this talk we will provide an overview of superradiance in full generality, pinpointing its underlying mechanisms, providing a general characterization in terms of a scattering matrix, and highligting its inherently quantum origin. We will then discuss how the entanglement of Hawking radiation is given by an interplay of the Hawking effect and superradiance. Assesing this interplay requires detailed knowledge of both effects in isolation. However, it is expected that ergoregions without a horizon develop an ergoregion instability. We propose a novel mechanism to quench this instability based on dissipative dynamics. Finally, we propose laboratory experiments to measure entanglement radiated by 1) an isolated ergoregion and 2) by a rotating black hole analogue in a dissipative quantum fluid of light.

Speaker: Andrea Donini (Instituto de Física Corpuscular (CSIC/UV))
donini@ific.uv.es

Title: A new method to measure deviations from the 1/r^2 Newton's law

Abstract: We proposed in Refs. [1,2] a new experimental setup aiming at the measurement of deviations from the Newtonian 1/r gravitational potential, by studying the orbits of a microscopical-sized "planetary system" consisting of a 10^-5 g "Planet" and a 10^-8 g "Satellite". Looking for orbit precession in this system avoids most of the electrically-induced background, that can be cast in the form of a 1/r potential, i.e. the same functional dependence from r of the Newtonian potential. Once corrections to the Newtonian potential are expressed in terms of a Yukawa-like term, alpha exp(-r/lambda), with lambda the typical length scale at which new physics set in, we have shown that using this approach we can increase the present sensitivity to deviations from the Newton's law in by an order of magnitude, testing lambda down to a few microns for alpha = O(1). We are now moving to a new phase, in which a real experiment will try to perform this measurement. I will introduce the basic ideas behind this proposal, and to sketch what we plan to realize.

1) Donini, Marimón, Eur.Phys.J.C 76 (2016) 12, 696; arXiv:1609.05654
2) Baeza-Ballesteros, Donini, Nadal-Gisbert, Eur.Phys.J.C 82 (2022) 2, 154; arXiv:2106.08611

Speaker: Beatriz Elizaga Navascués (Louisiana State University (LSU))
bnavascues@lsu.edu

Title: Entanglement harvesting by localised relativistic detectors

Abstract: Entanglement is generally expected to be unavoidable in QFT. For instance, the vacuum state (and any state of bounded energy) of a free field in Minkowski spacetime contains entanglement between any two spatially separated regions. Considerable theoretical effort has been put into designing ways of extracting entanglement from the QFT vacuum using “particle detectors”, leading to

entanglement harvesting protocols. While the widespread use of non-relativistic detectors is conceptually simple and useful in practice, it can lead to some artificial results (e.g. introducing superluminal signaling). It is therefore important to test the robustness of the predictions made so far by entanglement harvesting protocols using relativistic, local particle detectors. These, however, come with the caveat of introducing unavoidable noise due to the mixedness of their states when restricted to localized regions (precisely as a consequence of their own QFT entanglement structure). Our aim is thus to provide a theoretical framework allowing for concrete calculations that show how feasible it is to extract entanglement from the vacuum state of a real scalar field in Minkowski spacetime which is weakly and linearly coupled to other two fields of the same type, to be treated as detectors. This talk aims to introduce the subject and the strategy we follow in a pedagogical way.

Speaker: Eleonora Giovannetti (CPT Marseille)
ele.giovannetti@gmail.com

Title: Quasi-isotropic Bounce à la Vilenkin in the Bianchi IX model

Abstract: We study the implementation of Polymer Quantum Mechanics (PQM) to a system decomposed into a quasi-classical background and a small quantum subsystem, according to the original Vilenkin proposal. We develop the whole formalism in the momentum representation that is the only viable in the continuum limit of the polymer paradigm and we generalize the fundamental equations of the original Vilenkin analysis in the considered context. Then, we provide a Minisuperspace application of the theory, first considering a Bianchi I cosmology and then extending the analysis to a Bianchi IX model in the limit of small anisotropies. In both these cases, the quasi-classical background is identified with an isotropic bouncing Universe whereas the small quantum subsystem contains the anisotropic degrees of freedom. When the Big Bounce scenario is considered, we obtain that in the Bianchi I model the anisotropies standard deviation is regular at t=0 but still increases indefinitely, whereas in the presence of the harmonic Bianchi IX potential such same quantity is bounded and oscillate around a constant value. As a consequence, we demonstrate that the picture of a semiclassical isotropic Bounce can be extended to more general cosmological settings if the spatial curvature becomes relevant when the anisotropic degrees of freedom are still small quantum variables.

Speaker: Tiago Gonçalves (IA-ULisboa)
tbgoncalves@ciencias.ulisboa.pt

Title: When will gravity be revolutionised?

Abstract: I may summarize some ideas and results of this year's work of my PhD on modified gravity. Particularly, about the study of linear perturbations to compute cosmological observables in a model of f(Q) gravity. These modifications of gravity based on non-metricity are reviving interest, as they remained the least explored ones until now. However, I would also like to share my doubts and disappointments about my current exploration of modified gravity (if mere extensions to GR can help us), and spark some discussion on whether we need substantial alternatives beyond these theories of gravity or dark matter and dark

energy models to make significant progress in our physical understanding, and to ask what these could be. In this, I would like to share one playful idea of a different way of thinking about mass, going all the way from the tiniest particles to the largest black holes. Could I challenge us to go beyond modified of gravities, and instead turn GR on its head and create Revolutionised Gravities (RG)? Or, perhaps more realistically, make a call for help for my PhD?

Speaker: Jesús Huertas (IFT Madrid)
j.huertas@csic.es

Title: Aspects of dynamical cobordism in AdS/CFT

Abstract: The cobordism conjecture implies that consistent theories of Quantum Gravity must admit the introduction of boundaries. We study the dynamical realization of the cobordism conjecture in type IIB in AdS5 × S5. We show that these configurations are, from the 5d perspective, dynamical cobordism solutions which start from an asymptotic AdS5 vacuum and evolve until they hit an end of the world (ETW) brane with AdS4 worldvolume. The latter displays localization of gravity, and provide a completion of the Karch-Randall (KR) AdS branes.

Speaker: Alejandro Jiménez Cano (Institute of Physics, University of Tartu)
alejandro.jimenez.cano@ut.ee

Title: Pathologies in f(Q) cosmology

Abstract: In this talk we will discuss the inevitability of certain types of unstable degrees of freedom in spatially flat cosmological backgrounds in f(Q). We will also argue that these problems are expected to appear in other backgrounds, as well as in other theories within the symmetric teleparallel framework

Speaker: Claudio Cesar Lazarte Melgar (University of Valencia)
claudio.lazarte@uv.es

Title: ell-Proca stars

Abstract: Initially applied to the case of a complex scalar field, in this talk I will present the extension of applicability of such a multi-field generalization with the angular momentum of bosonic stars to the case of a massive vector field, obtaining new configurations that generalize the known Proca stars and source a static and spherically symmetric spacetime. Parametrized by a fixed angular momentum number ell, these new compact objects, which we call ell-Proca stars have matter content formed by an odd number of 2ell+1 of complex Proca fields with the same mass, time-frequency, radial profile, and angular momentum number. After probing the self-consistency of the evolution and constraint equations of our proposal, I will present our first numerical results: the initial data for the first few values of ell and some preliminary 3-dimensional evolution simulations.

Speaker: Leandro Lessa (Universidade Federal do Ceará)
leandrolessa@fisica.ufc.br

Title: Braneworlds in cubic gravity

Abstract: We explore the effects of high-derivative gravity, incorporating up to cubic curvature terms in braneworld scenarios. Our investigation reveals that by assuming a 5D warped spacetime, we can construct a theory with up to cubic

interaction that shares the spectrum with General Relativity and features equations of motion up to second order. The development of a first-order formalism for this theory allows the derivation of thick brane solutions. Furthermore, we analyze the linear stability of the brane system under tensor perturbations, establishing their stability.

Speaker: Alana Carolina Lima dos Santos (Universidade Federal do Ceará)
alanasantos@fisica.ufc.br

Title: Regular Black Holes in D = 2+1 with f(R) Gravity

Abstract: Despite the experimental success of General Relativity in the scales it has been tested, there are still some inconsistencies, such as explaining the acceleration of the universe and singularities. f(R) gravity emerged to provide corrections to the Ricci scalar that lead to new equations of motion that could explaining this acceleration. On the other hand, Regular Black Holes, supported by non-linear electrodynamics, have well-defined curvature scalars but often violate energy conditions. Trying to combine both approaches, in this work, we investigate how to obtain regular solutions in (2+1) dimensions considering f(R) gravity and non-linear electrodynamics. Subsequently, we find that non-linear electrodynamics models that guarantee regular solutions in General Relativity do not produce regular solutions in an f(R) theory. Finally, when considering a regular geometry, no longer provided by non-linear electrodynamics, we observe that energy conditions are violated depending on the choice of parameters.

Speaker: Marek Liška (Charles university, Prague)
liska.mk@seznam.cz

Title: Thermodynamics as a tool for (quantum) gravitational dynamics

Abstract: Thermodynamics of local causal horizons has been shown to encode the information necessary to reconstruct the equations governing gravitational equations. In my talk, I outline how this observation can be used to improve our understanding of (quantum) gravity. In particular, I focus on the low energy quantum gravitational effects. These arise from the leading order quantum correction to Bekenstein entropy which is logarithmic in the horizon area. Additionally, I discuss how the (semi)classical thermodynamics allows us to address some problems related to the value of the cosmological constant.

Speaker: Renan Magalhães (Federal University of Pará)
rbmagalhaes22@hotmail.com

Title: Echoes from bounded universes

Abstract: We construct a general class of modified Ellis wormholes, where one asymptotic Minkowski region is replaced by a bounded 2-sphere core, characterized by asymptotic finite areal radius. We pursue an in-depth analysis of the resulting geometry, outlining that geodesic completeness is guaranteed also when the radial function asymptotically shrinks to zero. Then, we study the evolution of scalar perturbations, bringing out how these geometric configurations can in principle affect the time-domain profiles of quasinormal modes, pointing out the distinctive features with respect to other black holes or wormholes geometries.

Speaker: Giulia Maniccia (Sapienza University of Rome, INFN Roma1)
giulia.maniccia@uniroma1.it

Title: Gauging graviton fluctuations in the WKB approach

Abstract: We will show how to construct the proper low-energy limit of QFT in curved spacetime from a canonically quantized gravity-matter system, discussing four emerging points of previous literature. To address them, we will consider the gravitational sector as composed of a classical background (vacuum Bianchi I universe) and quantum fluctuations on top (gravitons), the latter regarded as “slow” quantum components in a Born-Oppenheimer approximation. The matter component, expressed via a scalar field, will instead have a “fast” quantum character. Via a WKB expansion of the full system, the matter dynamics will recover a functional Schrödinger form after averaging over quantum gravitational effects, thanks to a gauge condition imposed on the gravitons’ wave functional, which is equivalent to the gravitational Wheeler-DeWitt constraint implemented a priori in previous approaches.

Speaker: Olga Mena(IFIC/CSIC-UV), omena@ific.uv.es

Title: Interacting dark energy

Abstract: We shall review the landscape of dark energy models, focusing on non-minimal cosmologies which exhibit a coupling among the dark sectors of the theory, that is, an energy flow among dark energy and dark matter. Such a very appealing possibility may alleviate the current mismatch in the observations of the Hubble constant. It could also play a non-negligible role in the recent results of the JWST.

Speaker: Andrés Mínguez Sánchez (Instituto de Estructura de la Materia - CSIC)
andres.minguez@iem.cfmac.csic.es

Title: Extended phase space quantization of a black hole interior model in loop quantum cosmology

Abstract: Considerable attention has been paid to the study of the quantum geometry of nonrotating black holes within the framework of loop quantum cosmology. This interest has been reinvigorated since the introduction of a novel effective model by Ashtekar, Olmedo, and Singh. Despite recent advances in its foundation, there are certain questions about its quantization that still remain open. Here we complete this quantization taking as starting point an extended phase space formalism suggested by several authors, including the proposers of the model. Adopting a prescription that has proven successful in loop quantum cosmology, we construct an operator representation of the Hamiltonian constraint. By searching for solutions to this constraint operator in a sufficiently large set of dual states, we show that it can be solved for a continuous range of the black hole mass. This fact seems in favor of a conventional classical limit (at least for large masses) and contrasts with recent works that advocate a discrete spectrum. We present an algorithm that determines the solutions in closed form. To build the corresponding physical Hilbert space and conclude the quantization, we carry out an asymptotic analysis of those solutions, which allows us to introduce a suitable inner product on them.

Speaker: Zeus Moreira (UFPA), zeussalesm@gmail.com

Title: Quasinormal mode spectrum of a Schwarzschild black hole with loop quantum corrections

Abstract: We analyze the quasinormal modes (QNMs) of a recently obtained solution of a Schwarzschild black hole (BH) with corrections motivated by Loop Quantum Gravity (LQG). This spacetime is regular everywhere and presents the global structure of a black bounce, whose radius depends on a LQG parameter. We focus on the investigation of massless scalar field perturbations over the spacetime. We compute the QNMs with the Wentzel-Kramers-Brillouin (WKB) approximation as well as the continued fraction method. The QNM frequency orbits, for $l=0$ and $n>0$, where l and n are the multipole and overtone numbers, respectively, are self-intersecting, spiraling curves in the complex plane. These orbits accumulate to a fixed complex value corresponding to the QNMs of the extremal case. We obtain that, for small values of the LQG parameter, the overall damping decreases as we increase the LQG parameter. Moreover, the spectrum of the quantum corrected black hole exhibits an oscillatory pattern, which might imply in the existence of QNMs with vanishing real part. This pattern suggests that the limit $n\rightarrow\infty$ for the real part of the QNMs is not well defined, which differs from Schwarzschild's case. We also analyze the time-domain profiles for the scalar perturbations, showing that the LQG correction does not alter the Schwarzschild power-law tail. We compute the fundamental mode from the time profile by means of the Prony method, obtaining excellent agreement with the two previously mentioned methods.

Speaker: Ángel Jesús Murcia Gil (INFN, Sezione di Padova)
angelmurcia20@gmail.com

Title: Cosmological higher-curvature gravities

Abstract: We examine higher-curvature gravities whose FLRW configurations are specified by equations of motion which are of second order in derivatives, just like in Einstein gravity. We name these theories Cosmological Gravities and initiate a systematic exploration in dimensions $D \geq 3$. First, we derive an instance of Cosmological Gravity to all curvature orders and dimensions $D \geq 3$. Second, we study Cosmological Gravities admitting non-hairy generalizations of the Schwarzschild solution characterized by a single function whose equation of motion is, at most, of second order in derivatives. We present explicit instances of such theories for all curvature orders and dimensions $D \geq 4$. Finally, we investigate the equations of motion for cosmological perturbations in the context of generic Cosmological Gravities. Remarkably, we find that the linearized equations of motion for scalar cosmological perturbations in any Cosmological Gravity in $D \geq 3$ contain no more than two time derivatives. We explicitly corroborate this aspect by presenting the equations for the scalar perturbations in some four-dimensional Cosmological Gravities up to fifth order in the curvature.

Speaker: Sergi Nadal Gisbert (UV - CSIC)
sergi.nadal@uv.es

Title: Quantifying entanglement in QFT and Harvesting entanglement with particle detectors.

Abstract: In this presentation, I will introduce an operational method for extracting degrees of freedom from a quantum field theory and quantifying entanglement between them for Gaussian states. Additionally, I will delve into the entanglement structure of quantum field theory that lies behind the harvesting protocol with particle detectors.

Speaker: Emanuele Orazi (UFRN), orazi.emanuele@gmail.com

Title: Symmetry enhancement in metric-affine theories

Abstract: We provide strong arguments implying a symmetry-enhancement of gravity theories when the metric-affine framework is used. Consequences of this symmetry are explored leading to the introduction of massive gauge fields that could solve some puzzles of the standard cosmological model.

Speaker: José Perdiguero (UV - CSIC)
joperga@alumni.uv.es

Title: Some results on purely affine gravity.

Abstract: TBA

Speaker: Albert Petrov (UFPB (Universidade Federal da Paraiba))
petrov@fisica.ufpb.br

Title: Braneworlds in bumblebee gravity

Abstract: We investigate thick-brane solutions within the five-dimensional bumblebee gravity in the presence of a real scalar field. Specifically, we implement the Lorentz symmetry breaking scenario within this context and obtain brane-like structures. Since the contribution of the bumblebee field is expected to be weak, we solve the field equations in the small-parameter regime. In this situation, we develop a first-order framework to describe the brane. The results show that the function which drives the bumblebee field may engender a lumplike structure whose shape depends on the parameters. On one hand, the effect of the non-minimal coupling between the bumblebee field and gravity shifts the field from the vacuum expectation value. On the other hand, the aether parameter is responsible for modifying the solution inside the brane.

Speaker: Miguel Pinto (University of Lisbon)
mapinto@fc.ul.pt

Title: Non-minimal geometry-matter couplings and their implications

Abstract: Although General Relativity remains an impressive description of gravitational phenomena, it is currently suffering from some conceptual issues such as explaining an accelerating expansion without a dark component or lack of uniqueness. These problems could be a hint that new gravitational physics is needed. One possible avenue is to assume that at large scales a more general action describes gravity, which is the core idea behind Modified Gravity Theories (MTGs). In this talk, I first provide a concise overview of a particularly interesting class of MTGs: non-minimal geometry-matter coupling theories. Subsequently, I emphasize two works I have been involved in on this line of research: the pursuit of

regular black hole solutions in 2+1-dimensional f(R,T) gravity and the construction of a novel generalized non-minimal geometry-matter coupling theory in the Palatini formalism. Finally, I offer my perspective on a recent paper (arXiv:2311.12925), which claims that this class of theories is not relevant to cosmology

Speaker: Silvia Pla Garcia (King's College London)
silvia.pla_garcia@kcl.ac.uk

Title: Can quantum tunnelling induce a cosmic bounce?

Abstract: If we imagine rewinding the universe to early times, the scale factor shrinks and the existence of a finite spatial volume may play a role in quantum tunnelling effects in a closed universe. In this talk, I will present a novel mechanism to induce a cosmological bounce that is purely generated by quantum fluctuations without the need for exotic matter or modified gravity. The quantum-induced bounce emerges when we allow a scalar field to tunnel between two degenerate minima. I will also explain how the picture can change in the presence of anisotropies, identifying a criterium for a successful bounce in terms of the size of the closed universe and the properties of the quantum field.

Speaker: Ángel Rincón (Universidad de Alicante)
angel.rincon@ua.es

Title: Quasinormal modes and shadow in Einstein Maxwell power-Yang-Mills black hole

Abstract: We investigate the quasinormal modes of an Einstein-Maxwell power-Yang-Mills black hole in four dimensions, considering a specific value of the power parameter $p = 1/2$. This case represents a black hole with both Abelian and Non-Abelian charges and is asymptotically non-flat. We begin by deriving the effective potential for a neutral massless particle using the aforementioned black hole solution. Subsequently, employing the sixth-order WKB approximation
method, we calculate the (scalar) quasinormal modes. Our numerical analysis indicates that these modes are stable within the considered parameter range. This result is also confirmed using the eikonal approximation. Furthermore, we calculate the shadow radius for this class of black hole and derive constraints on the electric and Yang-Mills charges ($Q, Q_{\rm YM}$) by using imaging observational data for Sgr A*, provided by the Event Horizon Telescope Collaboration. We observe that as the electric charge Q increases, the allowed range shifts towards negative values of $Q_{\rm YM}$. For instance, for the maximum value $Q\approx 1.1$ obtained, the allowed range becomes $-0.171 \lesssim Q_{\rm YM} \lesssim -0.087$ consistent with KECK and VLTI data, while still retaining a non-vanishing horizon.

Speaker: João Luís Rosa (University of Gdansk)
joaoluis92@gmail.com

Title: Fluids and fundamental fields as supermassive objects

Abstract: Recent astrophysical observations by the GRAVITY collaboration and the EHT have suggested the existence of black-hole-like objects in the universe. However, black-hole spacetimes are problematic from a mathematical and physical point of view. To overcome this limitation, several alternative compact

objects have been proposed, including perfect fluid stars, bosonic stars, Proca stars, fermionic stars, and wormholes. In this talk, we explore the validity of these alternatives by simulating the observational properties of accretion disks and isotropically emitting sources orbiting a central exotic compact object. Specifically, we investigate whether these alternative objects can replicate the observational properties of black-hole spacetimes, namely if they could cast a shadow and how their astrometric properties, e.g. the magnitude and centroid of the observation, compare with the black-hole scenario.

Speaker: Milton Ruiz (University of Valencia)
milton.ruiz@uv.es

Title: Neutron Star Binary Mergers as Multimessenger Sources

Abstract: One outstanding problem in current astrophysics is the determination of the equation of state of matter at supranuclear densities like the ones present in neutron stars. In this talk I will describe general relativistic magnetohydrodynamic numerical simulations of neutron star binaries that undergo delay collapse and eventually launch magnetically-driven jets. Using these simulations along with current gravitational wave and electromagnetic
observations we will impose tight constraints on the maximum mass of a nonrotating neutron star.

Speaker: Saboura Sadat (University of Szczecin),
saboura.zamani@phd.usz.edu.pl

Title: Gravitational lensing from clusters of galaxies to test Disformal Couplings Theories

Abstract: In this study, we investigate the potential existence of a non-minimal coupling between dark matter and gravity using a compilation of galaxy clusters. We focus on the disformal scenario of a non-minimal model with an associated length L. Within the Newtonian approximation, this model introduces a modification to the Poisson equation, characterized by a term proportional to $L^2 \nabla^2 \rho$, where ρ represents the density of the DM field. We have tested the model by examining strong and weak gravitational lensing data available for a selection of 19 high-mass galaxy clusters observed by the CLASH survey. In this talk, we will show the main results of this analysis.

Speaker: Tiziano Schiavone (Institute of Astrophysics and Space Sciences, Lisbon), tschiavone@fc.ul.pt

Title: An effective Hubble constant in f(R) modified gravity

Abstract: The measurement of the Hubble constant $H0$ has been one of the most challenging effort of modern cosmology. To match incompatible measurements of $H0$ obtained from various probes located at different redshifts, we analyse the $f(R)$ gravity in the Jordan frame. In this formalism, it is possible to account for an effective redshift dependence of $H0$, according to recent data analysis of the supernovae Ia Pantheon sample. The apparent variation of $H0$ is related to the dynamics of a non-minimally coupled scalar field, as it emerges in the Jordan

frame of the $f(R)$ gravity, due to the rescaling of the Einstein constant given by the $f(R)$ scalar mode. We infer the form of the scalar field potential to ensure the decay of $H0$ with the redshift. We face the question both from an analytical and purely numerical point of view, following the same technical paradigm.
[This talk is based on arXiv:2211.16737]

Speaker: Sebastiano Segreto (University of Rome "La Sapienza")
sebastiano.segreto@uniroma1.it

Title: n-dimensional non-commutative GUP quantization and application to Bianchi I cosmology

Abstract: We analyse a n-dimensional Generalized Uncertainty Principle (GUP) quantization framework, characterized by a non-commutative nature of the configurational variables. In order to recover information about localization on the whole configuration space, we use the only state of the theory which exhibits maximal localization simultaneously in every direction to construct a satisfactory quasi-position representation, by virtue of a suitable translational operator. The resultant quantum framework is then applied to model the dynamics of the Bianchi I cosmology. The corresponding Wheeler-DeWitt equation is reduced to Schrodinger dynamics for the two anisotropy degrees of freedom, using a WKB representation for the volume-like variable of the Universe, in accordance with the Vilenkin scenario. The main result of our cosmological implementation of the constructed quantum theory demonstrates how the dynamics of a wave packet peaked at some point in the configuration space represented in the quasi-position variables, favours as the most probable configuration exactly the initial one for a relatively long time, if compared with the ordinary quantum theory. This preference persists because, as the packet spreads, its peak - remarkably - remains located where initially placed.

Speaker: Álvaro Torres Caballeros (Instituto de la Estructura de la Materia, CSIC)
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Title: Uniqueness of the Fock quantization of a massless scalar field in Kantowski-Sachs

Abstract: In this talk, I discuss a criterion to guarantee the uniqueness of the Fock quantization of a massless free scalar field in a Kantowski-Sachs background. In general spacetimes, the infinite ambiguity of choosing a set of annihilation and creation operators leads to non-equivalent Fock representations, a fact that is due to the unavailability of a privileged vacuum state in the theory. In the case of a Kantowski-Sachs spacetime, we show that the problem can be overcome by imposing invariance under the background's spatial symmetries and requiring a quantum dynamics that admits a unitary implementation. This result may find applications in the quantization of matter fields and perturbations in the interior of nonrotating black hole spacetimes.

Speaker: Antonio Vicente-Becerril (IEM-CSIC)
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Title: Primordial Power Spectrum in modified gravity: from thermodynamics of spacetime to LQC

Abstract: In this talk, I present a derivation of the Primordial Power Spectrum

(PPS) from a phenomenological model of quantum gravity based on the thermodynamics of spacetime which coincides with the PPS in the dressed metric prescription in Loop Quantum Cosmology (LQC). Starting from general gravitational equations of motion which encode low-energy quantum gravity effects, we found the dynamics of the system by assuming a homogenous and isotropic universe with a free scalar field content. These dynamics coincides with the dynamics in the Dressed metric prescription in LQC when a free parameter is fixed. Then, I present the perturbations of this cosmological model where an approximative time-dependent effective mass should be imposed to obtain the perturbations and the vacuum choice and its oscillatory impact in the PPS. Lastly, I also discuss here the main distinctions in the PPS between the hybrid and dressed metric prescriptions in LQC.

Speaker: Aneta Wojnar (Complutense University of Madrid)
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Title: Earthquakes as probing tools for modified and quantum gravity

Abstract: We introduce a novel approach to assess (quantum) gravity theories by leveraging seismic data from Earth. Through stringent constraints applied to Earth's moment of inertia and mass, we establish a robust framework that confines gravitational model parameters with a precision of 2σ. Additionally, we delve into potential strategies to further refine this methodology, with the ultimate goal of imposing even more stringent limitations on gravity theories.

Speaker: Sérgio Xavier (Universidade Federal do Pará)
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Title: Multiple light rings and dark matter halos: Investigating the shadows of supermassive black holes.

Abstract: It is unlikely that black holes (BHs) are completely isolated objects in the universe, since the known astrophysical scenarios where most of BHs live are rich environments. In particular, there is strong evidence that supermassive black holes source active galactic nuclei. On these galactic stages, another character plays an important role: dark matter. There is a large amount of evidence that dark matter surrounds most galaxies in a halo extending beyond the luminous part of the galaxy. We investigate the shadow of an exact black hole solution of Einstein's equations recently proposed by Cardoso et al., to describe a supermassive black hole immersed in a dark matter halo. We analyze and discuss the light rings and the gravitational lensing of this spacetime comparing them with an isolated Schwarzschild black hole. Using backward ray-tracing techniques, we study the shadows cast by such black hole when illuminated by a celestial sphere that emits radiation isotropically. We find that when the dark matter distribution concentrates near the event horizon of the black hole, multiple light rings emerge. In this high compactness regime, the shadows and gravitational lensing are significantly different from the Schwarzschild one. We also use the M87* and SgrA* shadow data, obtained by the Event Horizon Telescope collaboration, to constrain the parameters of the dark matter halo.
Authors: S. V. M. C. B. Xavier, H. C. D. Lima Junior, L. C. B. Crispino

Speaker: María José Guzmán
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Title: The 3+1 formalism in the teleparallel framework

Abstract: We will review the main progress and obstacles in the development of the 3+1 formalism of teleparallel theories of gravity, with particular attention to the metric teleparallel and symmetric teleparallel equivalents of general relativity. Since this issue permeates their nonlinear extensions, we will also discuss why it is important and what are the repercussions of this knowledge in the Hamiltonian formulations and degrees of freedom controversies of f(T) and f(Q) gravity.

Speaker: Jose Beltrán-Jímenez (Universidad de Salamanca)
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Title: Electrically K-mouflaged dark matter and the secret supersymmetry of haloes.

Abstract: I will discuss a cosmological scenario where dark matter is provided with a dark electric charge whose features a screening mechanism so that all the effects only appear at low redshift when dark matter is sufficiently clustered. Within these models, it is natural to have a universe described by a Lemaitre model instead of a FLRW. Instead of solving the full relativistic equations, I will consider a Newtonian approach that is sufficient for a matter dominated universe with, possibly, a cosmological constant. In this scenario, it is possible to explain the Hubble tension in terms of the dark electric repulsion between dark matter halos. After reviewing some phenomenological consequences, I will proceed to analysing the deformability of dark matter haloes due to the dark electromagnetic interaction. The Born-Infeld electromagnetism stands out and shows the strongest resilience so that all odd multipoles above the dipole have vanishing polarisability and all even multipoles have vanishing magnetic susceptibility. For this theory, it is possible to describe the perturbations in terms of two sets of ladder operators that permit to introduce a hierarchy of conserved charges. The results show an intriguing resemblance with the vanishing of the Love numbers of black holes and the existing ladder structures, although with some important differences. A remarkable relation with super-symmetric quantum mechanical systems will be explained. Finally, I will discuss an equivalence to a DBI scalar field theory for which similar results arise.

Speaker: Jorma Louko (U. Nottingham), Jorma.Louko@nottingham.ac.uk

Title: Thermality of circular motion, in spacetime and in the laboratory

Abstract: The celebrated Unruh effect states that observers in uniform linear acceleration experience Minkowski vacuum in relativistic quantum field theory as a thermal state, in a temperature proportional to the proper acceleration. Observers in uniform circular acceleration experience a similar effect, with a more subtle notion of an effective temperature, but, crucially, with better prospects of experimental verification, especially so in condensed matter analogue spacetime systems that are realisable in the laboratory. This talk reviews the theoretical distinctions between linear and circular acceleration and the recent experimental proposals to observe the circular motion Unruh effect in the laboratory. The talk is based on 2007.09523, 2007.07160 and 2302.12023.