Monday 25 Parallel Session **A**

José Padua-Argüelles

Area-metrics and Loop Quantum Gravity

The quantum geometry arising in Loop Quantum Gravity has been known to semi-classically lead to generalizations of length-geometries. There have been several attempts to interpret these so called twisted geometries and understand their role and fate in the continuum limit of the spin foam approach to quantum gravity. In this talk I would introduce the subject and present a new perspective, namely that the twisted geometry of a 4-simplex can be understood as arising from an area-metric (in contrast to the more particular length-metric). This new lens allows one to naturally define several notions for twisted geometries that could potentially enrich our understanding of them.(https://arxiv.org/pdf/2302.11586.pdf)

Ángel Joel Sanjuan García

Revisiting the semiclassical approximation in loop quantum cosmology

Semiclassical methods in loop quantum cosmology have successfully shed light on its effective dynamics to be contrasted with the classical one. Three known routes to get the semiclassical approximation of the transition amplitude for the free particle are considered to investigate further the solvable model in loop quantum cosmology. We brief here some work in progress.

Leonardo Saúl Rubio Vázquez

On the semiclassical description of a loop quantized Schwarzschild black hole interior

On the semiclassical description of a loop quantized Schwarzschild black hole interior
An effective dynamics for the interior of a Schwarzschild black hole has been shown to yield interesting effects as opposed to its classical behavior. However, a detailed semiclassical analysis of the corresponding transition amplitude has not been given. Here we take first steps in this direction by recalling the use of the Gelfand-Yaglom construction to get the semiclassical approximation for a harmonic oscillator and its possible extension to the loop quantized black hole interior. This is work in progress.

Benjamín García Contreras

On the classical limit and flatness constraint in low dimensional quantum gravity

A flatness constraint has been noticed to afflict the spinfoam amplitude of covariant loop quantum gravity by a number of authors. The amplitude appears to be peaked on boundary data corresponding to flat instead of curved geometries. According to recent work this constraint is only apparent: the limit encoded in the refinement of a discretization, namely, where the scale of the geometry is large compared to Planck scale leads to a wrong amplitude if one forgets to consider this as an approximation only to a given accuracy. It is desirable to see the argument working in a simple low dimensional quantum gravity model and this is considered here. We recall some features of this model and sketch some steps to tackle the problem.

Monday 25 Parallel Session **B**

Vladimir Manko (H. García-Compeán and V. S. Manko)

Mass distribution in dyonic Kerr-Newman black holes

We show how the Komar mass must be calculated correctly in the Kerr-Newman black holes in the presence of a magnetic charge. The magnetic Dirac string in our approach is simply a mathematical artifact that does not take part in the description of physical properties of the dyonic black holes.

Valeriy Dvoeglazov (V. V. Dvoeglazov y A. Sierra Romero)

Soluciones de energía negativa y taquiónicas en ecuaciones de Weinberg-Tucker-Hammer para espín 1.

Se consideran cuatro ecuaciones similares a las de Weinberg en artículo [1] con el fin de construir el propagador de Feynman-Dyson para partículas de espín 1. Mientras tanto, el artículo de N. Debergh et al. considera ideas previas de la duplicación de la ecuación de Dirac, y otras formas de conjugación T y PT [2]. En este trabajo, damos bases adicionales para el desarrollo de la teoría correcta de partículas de espín alto en la Teoría Cuántica de Campos. Además, vemos que es imposible considerar la mecánica cuántica relativista de forma correcta sin energías negativas y sin las formas apropiadas de las simetrías discretas.

[1] V. V. Dvoeglazov, Rev. Mex. Fis. vol. 65, no. 6, pp. 612–617 (2019),
[2] N. Debergh, J-P. Petit y G. D'Agostini, J. Phys. Comm., vol. 2, 115012 (2018).

Andrés Crespo Hernández

Deformed Phase-Space in Supersymmetric Kantowski-Sachs Model

We study some consequences of a wave packet resulting from the solution in a type of Wheeler-DeWitt equation in the Kantowski-Sachs superspace including supersymmetry with and without noncommutativity. These first results show a change in the most probable states of the Universe, clearly differentiating one case from the other. On the other hand, the semiclassical equations of movement were obtained using the Wentzel–Kramers–Brillouin (WKB) method, with this it was calculated the volume expansion, the shear and the characteristic volume. As a result of our analysis, we show that the supersymmetric non-commutative proposal can significantly modify the evolution of the universe.

Omar Gallegos Santiago

On Self-adjointness in Loop Quantum Cosmology

This work generalizes the effect of curvature on an isotropic and homogeneous model in loop quantum cosmology, which includes both the Euclidean and Lorentzian terms in a universe with curvature. From the quantum description, it is possible to build an effective model for which we explore the path integral method. The effective model is consistent to the first order with the effective models built through the expectation value of the quantum Hamiltonian operator using Gaussian quantum states, as shown in the papers that have studied effective models that use the value expectation method. From this effective model obtained we study the asymptotic limit of the modified Friedmann equations, where we note that the big bang is replaced by a quantum bounce.

Tuesday 26 Parallel Session **A**

Luis Ureña-López

Ultralight boson fields and large scale structure in the universe

Ultralight boson fields, also known as fuzzy dark matter or wave dark matter, are one of the most studied alternative dark matter models in cosmology in the recent years. In this talk, we discuss the general properties of the model and their connection to the formation of structure in the universe, at the linear and semi-linear regimes. Conversely, we also present the constraints that can be obtained for the model from observations of the large scale structure, specially for the mass of the boson particles and their self-interaction. We close with general comments on the future viability of the model as a dark matter model.

Johnatan Osvaldo Román Herrera

Scalar Field Dark Matter with a quartic self-interaction potential

For a few years now, alternative dark matter models named ultra-light Scalar Field Dark Matter (ulSFDM) have been studied in detail , and here we propose a potential with a quartic self-interaction to be endowed to the ulSFDM. To solve the new dynamics for both background and linear density perturbations, we transform the Klein-Gordon equation into a suitable dynamical system under a spherical change of variables. Numerical methods must then be used to solve them in a specially amended version of the Boltzman code CLASS. Some preliminary results are shown and the physical impact of ulSFDM on large scale structure is discussed.

Francisco S. Guzmán Murillo

Stationary solutions of the Schrödinger-Poisson-Euler system and their stability

We present the construction of stationary boson-fermion spherically symmetric configurations governed by Newtonian gravity. Bosons are described in the Gross-Pitaevskii regime and fermions are assumed to obey Euler equations for an inviscid fluid with polytropic equation of state. The two components are coupled through the gravitational potential. The families of solutions are parametrized by the central value of the wave function describing the bosons and the central density of the fluid. We explore the stability of the solutions using numerical evolutions that solve the time dependent Schrödinger-Euler-Poisson system, using the truncation error of the numerical methods as the perturbation. We find that all configurations are stable as long as the polytropic equation of state (EoS) is enforced during the evolution. When the configurations are evolved using the ideal gas EoS they all are unstable that decay into a sort of twin solutions that approach a nearly stationary configuration. We expect these solutions and their evolution serve to test numerical codes that are currently being used in the study of Fuzzy Dark Matter plus baryons.

Iván Álvarez Rios

Is the core-halo scaling relation in FDM fundamental?

The core-halo scaling relation within the FDM model has received considerable attention, because it links the initial properties of a clump of FDM and the resulting corified halo. In our work we present a gauge transformation that leaves the GPP system invariant in a periodic domain, but not the core-halo scaling relation, which indicates that the core-halo scaling does not seem to be fundamental but gauge dependent. Nevertheless, when Dirichlet boundary conditions are imposed to the gravitational potential, the gauge transformation changes the GPP system and in such case the core-halo relation is fundamental.

Tuesday 26 Parallel Session **B**

Juan Barranco Monarca

Polytropic dark matter

We propose that dark matter is a perfect fluid with a poly tropic equation of state. Relevant constraints on the polyropic index and the compressibility of the polytrope by fitting the variation of the Hubble constant with the SNe Pantheon sample combined with the observed rotational velocity of low surface brightness galaxies as well as dispersion velocity of local Dwarf Galaxies. Particular cases of polytropes include a degenerate gas of fermions or a strongly interacting bosonic gas. Thus, we prove that our analysis will give relevant constraints on the mass of possible ultra light massive candidates of dark matter, either they are a boson or a fermion.

Jorge H. Mastache de los Santos

Spectral Distortions in the Cosmic Microwave Background: Insights from QCD Dark Matter

The cosmic microwave background (CMB) offers an unexploited avenue to probe the early Universe, particularly through spectral distortions. We study a dark matter (DM) particle model characterized by a confinement scale (ac) in a radiation-dominated epoch, analog to QCD. This model presents a scenario where, alongside a neutral and stable CDM particle, a transient DM particle emerges and subsequently decays. Our methodology centers on forecasting the mu-type and y-type SDs, integrating constraints from COBE constraints and projecting bounds for upcoming CMB spectral distortions surveys like PIXIE. Results put constraints on the confinement scale and the lifespan of the DM particle. We also approach the SD as a useful tool to constrain non-standard energy deposition phenomena in the early Universe, such as for decaying-DM, primordial black holes, and gravitational waves.

Nandan Roy

Tracker behaviour of quintom dark energy model and Hubble tension

In this study, we examine the quintom dark energy model through a dynamical system analysis and constrain its cosmological parameters using state-of-the-art cosmological observations. The system of equations has been transformed into an autonomous system using appropriate variable transformations, enabling the investigation of tracker solutions for the model. The observations indicate that during later stages, the phantom field is expected to dominate the dark energy sector and also exhibit tracking behavior with the background. We also provide an update on the current status of the Hubble tension within the quintom model. Although not completely resolved, it can be reduced to 2.6σ. Additionally, a Bayesian model comparison with ΛCDM has been conducted, suggesting a moderate preference for the quintom model.

Eric Santiago Escobar Aguilar

On the physics of the Gravitational Wave Background

The universe lives on a Gravitational Wave Background (GWB). This GWB is extra energy that is not contained in Einstein's equations, and a new model was developed to explain the accelerating expansion of the universe where a GWB was incorporated into Einstein's equations. In this talk, we study this new paradigm: due to GWB, quantum particles cannot follow geodesics, but rather stochastic trajectories. A stochastic term is added to the trajectories of quantum particles and derive the corresponding field equations of a quantum particle. We arrive at the Klein-Gordon equation in curved spacetime and from it we obtain a generalized Schrödinger equation. This leads to the following relevant result: the Schrödinger equation can be a direct consequence of the fact that the universe lives on a GWB.

Thursday 28 Parallel Session **A**

Claudia Moreno González

The next challenges for the detection of Gravitational Waves

The search for Gravitational Waves from Einstein's theory was successful thanks to the emission of these waves through the coalescence of binary black hole systems. Now, the LIGO collaboration searches for gravitational signals with new astrophysical objects, such as supernovae. I will talk about the new challenges and alternative ideas involved in detecting these signals, since they are not deterministic and are expected to occur in our galaxy once every 100 years.

Laura Olivia Villegas Olvera

Gravitational wave from core-collapse supernovae

Core Collapse Supernova Explosions (CCSN) are the explosions of massive stars (above 8 Msol) that play an important role in the evolution of the universe. According to the study of stellar evolution, a star spends most of its life in main sequence, during this stage it is in hydrostatic equilibrium. As the nuclear reactions transform the elements that compose it, until obtaining an iron nucleus, the balance is broken and that is when the process of collapse of the nucleus begins. Then, in the nucleus of the star a supersonic fall of the outer material is generated, while in the center a proto-neutron star (PNS) is formed that generates a shock wave outwards. Upon impact against the incoming material, it forms a rebound of material that is what gives the impulse to the explosion. The CCSN releases a large amount of energy through electromagnetic radiation, the generation of neutrinos, kinetic energy and in the form of gravitational waves. This paper summarizes the physical processes related to the CCSN. In addition, the importance of the differential rotation of the progenitor nucleus and its correlation with the morphology of gravitational waves is analyzed, which is quite simple and can be written as an increase in amplitude prior to the rebound of the nucleus, a large peak during rebound and a post-rebound phase where the remaining PNS energy is hydrodynamically dissipated.

Javier M. Antelis

Multi-channel convolutional neural network for the detection of gravitational wave bursts from core-collapse supernovae

Gravitational waves (GW) from core-collapse supernovae (CCSN) is a vivid research field. It is expected to observe these astrophysical signals in the upcoming LIGO-VIRGO-KAGRA observing runs. This will open new scientific opportunities for the gravitational and multi-messenger astronomy. The detection of such GW consists of deciding whether a signal is present or absent in the detectors observed data. Machine Learning and Deep Learning models offer novel opportunities to tackle this problem. In this talks we will present a new deep neural network model designed to discriminate between noise and GW from CCSN embedded in noise. The fundamental idea is to consider the data of each detector each combination of detectors as independent input channel and to integrate the output of those to estimate the probability of a GW present in the observed data. The advantage of this model is the ability to automatically provide detection results even when data from a detector is not available. We will show the technical detail of the architecture and a systematic experimental methodology performed to validate the model in the detection of GW signal embedded in real noise.

Ricardo Escobedo Alcaraz

Post-Newtonian Gravitational Waves with cosmological constant Λ from the Einstein-Hilbert theory

We study the Post-Newtonian approach implemented to the Einstein-Hilbert action adding the cosmological constant at 1PN order. The smallness positive value of the cosmological constant is considered to derive the Lagrangian of a two body compact system at the center of mass frame at 1PN order. The phase $\phi(t)$ is calculated from the balance equation and the two polarization h_{+} and $h_{\times}$ are also calculated. The changes due to Λ are observed at very low frequencies and we can observe that it plays the role of "stretch" the spacetime implying that both amplitues become smaller.

Rafael Hernández Jiménez

Geometrical scalar back-reaction effects in inflation

Starting with the Lagrangian formulation of General Relativity, we will conduct an investigation into the production of spacetime waves, due to a geometric boundary term of a closed extended manifold, within the tensor and scalar sectors. This scheme will be studied in an inflationary universe. We explore two distinct scenarios: Cold Inflation and Warm Inflation. The scalar modes $Z_{k}^{\mathbb{R}}$ and $Z_{k}^{\mathbb{I}}$ oscillate within the horizon, and they become constant at (or right after) horizon crossing $k\simeq aH$ and they remain so when radiation starts to dominate. The larger k/k_{0} the Z_{k}'s amplitudes increase too. In general we can notice that radiation reduces the size of the Z_{k}'s amplitudes, hence yielding smaller signals of such modes. The tensor sector shows an irregular journey due to their abruptly growth just as they cross the horizon. This upshot hinders any probable observational hint or signal. However, we expect this novel mechanism of spacetime waves production brings new cosmological sources, for which no astrophysical source has been identified.

Thursday 28 Parallel Session **B**

Francisco Xavier Linares Cedeño

Gauge fixing in cosmological models of Unimodular Gravity

In this talk the gravitational theory known as Unimodular Gravity is reviewed. In particular, a cosmological model is built and compared with the standard LCDM model. Once the dynamics of a homogeneous and isotropic universe is analyzed, cosmological perturbations are studied. These, unlike what has been reported in the literature so far, do present distinctions typical of the theory due to the unimodular constraint. The fluctuations of dark matter density obtained in this theory are compared with the case of General Relativity, and possible implications for large-scale structure formation are discussed.

Jesus Antonio Astorga Moreno

f(R) gravity for a FLRW Universe in a deformed phase space

Modify gravity theories have received huge attention in the last decade. In this work, we find the Wheeler-DeWitt (WDW) equation in the Quantum Cosmology (QC) scenario for a Friedmann-Lemaitre-Robertson-Walker (FLRW) model using the deformed phase space in f(R) gravity. In addition to the already stated, we consider a function f(R) who provides the Lambda-Cold Dark Matter(Lambda CDM) model as an immediate consideration.

Flor de María Lozano Rodríguez

Resolution test for modified gravity models

We study the reliability of the MG-PICOLA code through resolution tests, where we vary the numerical parameters in the cosmological simulations. We do the analysis with three modified gravity models: Hu-Sawicki $f(R)$, nDGP (the normal branch of the Dvali, Gabadadze, and Porrati model), and the Symmetron. For the DGP model we compare our results with those of the MG-GLAM code. We found that MG-PICOLA simulations are suitable for the rapid exploration of MG models, since it achieves reliable results on moderately large values of numerical parameters, but with short execution times. We use these results to search for differences between the mass power spectrum of the MG models and that of the standard gravity GR.

Juan Carlos Del Águila Rodríguez

Probing the local geometry around a singularity in a five-dimensional space-time

In this talk the geometry of the neighborhood of a curvature singularity is presented in the context of Kaluza-Klein theory, which is a five-dimensional description of space-time. In such a theory, electromagnetism is naturally incorporated into the space-time geometry through the addition of a fifth dimension that is assumed to be compactified and periodic. The studied singularity corresponds to that of an axially symmetric wormhole coupled to electromagnetism and a dilatonic scalar field. Among the particular features of this wormhole, the most relevant is that, against common intuition, its unbounded curvature does not neccesarily imply geodesic incompleteness. The five-dimensional analysis done here allows us to provide a possible explanation for this peculiar property.

Maribel Hernández Márquez

Constraining Agegraphic Dark Energy scenarios in DGP braneworld cosmologies with gravitational waves standard sirens

Gravitational waves provides a new way to test gravity at large scales and since they can travel through extra spatial dimensions we can use it to constrain the number of extra dimensions of a cosmological model. On the other hand, ADE and NADE models have been studied in the framework of DGP cosmology as a possible explanation to the nature of dark energy. So, in this work we constrain the parameters of these models using gravitational waves standard sirens and considering an interaction between dark energy and dark matter.

Posters

Fabián Hernández Gutiérrez

Constraints to fermionic dark matter

Using observations of galactic rotational curves we constraint the free parameters of a model of dark matter made of a gas of degenerate fermions.

Edgar Iván Preciado Govea

Fermion Fields On Curved Spacetimes

Analizaremos la produccion gravitacional de partículas de campos de spin 1/2 en espacio-tiempo curvos. Particularmente aplicados al periodo inflacionario.

Néstor Andrés Montiel Hernández

Lower bound of dark matter self-interaction from rotation curves.

We find a lower bound of the dark matter cross section by fitting the rotational velocity of low surface brightness (LSB) galaxies with a model for the dark matter halo using a barotropic equation of state and a Navarro-Frenk-White (NFW) density profile.

Ignacio Abraham Sarmiento Alvarado

ONE DIMENSIONAL SUBSPACES OF EXACT SOLUTIONS OF THE n-DIMENSIONAL EINSTEIN FIELD EQUATIONS IN VACUUM: SL(n, R)

The problem of finding solutions to Einstein field equations in a vacuum reduces to solving a chiral equation $ (\alpha g_{ , \bar{z} } g^{-1}) _{, z} + (\alpha g_{, z} g^{-1}) _{, \bar{z} } = 0 $ with $ g \in SL (n, \mathbb{R}) $ and another differential equation. In this work the ansätze $ g = g (\xi) $, where $ \xi $ satisfies Laplace equation, is made.