V Workshop on Field theory, Gravitation and Cosmology

December 4-5, 2025

Venue: IFUAP Auditorium

Invited Talks:

- **Akin Bonillas Miranda (IF, BUAP)**
  Cotton gravity and its static spherically symmetric solution
- **Roberto Cartas Fuentevilla (IF, BUAP)**
  Elliptic functions: History and applications
- **Diana V. Castro Luna (IF, BUAP)**
  Hamiltonian analysis for perturbative λR gravity
- **Juan C. Degollado Daza (ICF, UNAM)**
  Shadow of a collapsing star in a regular spacetime
- **Alberto Escalante Hernández (IF, BUAP)**
  The Barbero-Immirzi parameter in the Pontrjagin and Euler topological invariants
- **José A. Escalante Javalera (IF, BUAP)**
  Braneworld isotropization
- **Jorge A. Hernández Caballero (FCFM, BUAP)**
  Lorentzian manifolds with spherical symmetry and gravitational collapse
- **Alfredo Herrera Aguilar (IF, BUAP)**
  From black hole to neutron star rotation curves
- **José E. Lobato Donado (FCFM, BUAP)**
  Measurement of spectral line shift in planetary spectra
- **Diego A. Martínez Valera (IF, BUAP)**
  Regular Schwarzschild-de Sitter black holes in non-local higher derivative gravity
- **Mehrab Momennia (IFM, UMSNH)**
  Accretion of dark matter into a Kerr black hole
- **Gerardo Morales Herrera (IF, BUAP)**
  Nonlinear electrodynamics and the effective metric around magnetars
- **Uriel Noriega Cornelio (FCFM, BUAP)**
  AdS black holes in two-dimensional dilaton gravity and holography
- **Ulises Nucamendi Gómez (FCFM, UMSNH)**
  Revisiting purely kinetic K-essence cosmologies
- **Israel Quiros Rodríguez (DI, UGTO)**
  Symmetry as a posible explanation of the cosmological puzzles
- **Olivier Sarbach (IFM, UMSNH)**
  Relativistic dissipative fluids with hyperbolic, causal, and stable evolution equations
- **Déborah E. Villaraos Serés (IF, BUAP)**
  Redshift of orbiting particles in SdS: A general-relativistic approach to H_0

Foto: Vía Láctea

Crédito: Adriana González Juárez.

Organizing Committee:

- Roberto Cartas Fuentevilla
- Alberto Escalante Hernández
- Adriana González Juárez
- Alfredo Herrera Aguilar

V Workshop on Field Theory, Gravitation and Cosmology

December 4-5, 2025

IF, BUAP

Program

Thursday, December 4th

Chairman: Alfredo Herrera Aguilar

9:00 Déborah Elizabeth Villaraos Serés (IF, BUAP)

Redshift of orbiting particles in SdS: A general-relativistic approach to H_0

9:30 Diego Armando Martínez Valera (IF, BUAP)

Regular Schwarzschild-de Sitter black holes in non-local higher derivative gravity

10:00 Uriel Noriega Cornelio (FCFM, BUAP)

AdS black holes in two-dimensional dilaton gravity and holography

10:30 Roberto Cartas Fuentevilla (IF, BUAP)

Elliptic functions: History and applications

11:00 Break

Chairman: Adriana González Juárez

11:20 Gerardo Morales Herrera (IF, BUAP)

Nonlinear electrodynamics and the effective metric around magnetars

11:40 Mehrab Momennia (IFM, UMSNH)

Accretion of dark matter into a Kerr black hole

12:20 José Alfredo Escalante Javalera (IF, BUAP)

Braneworld isotropization

12:40 Olivier Charles Albert Sarbach (IFM, UMSNH)

Relativistic dissipative fluids with hyperbolic, causal, and stable evolution equations

13:20 José Emmanuel Lobato Donado (FCFM, BUAP)

Measurement of spectral line shift in planetary spectra

13:40 Akin Bonillas Miranda (IF, BUAP)

Cotton gravity and its static spherically symmetric solution

_____

Friday, December 5th

Chairman: Roberto Cartas Fuentevilla

9:00 Juan Carlos Degollado (ICF, UNAM)

Shadow of a collapsing star in a regular spacetime

9:40 Alberto Escalante Hernández (IF, BUAP)

The Barbero-Immirzi parameter in the Pontrjagin and Euler topological invariants

10:20 Israel Quiros Rodríguez

Symmetry as a posible explanation of the cosmological puzzles

11:00 Break

Chairman: Alberto Escalante Hernández

11:20 Diana Vanessa Castro Luna (IF, BUAP)

Hamiltonian analysis for perturbative λR gravity

11:40 Alfredo Herrera Aguilar (IF, BUAP)

From black hole to neutron star rotation curves

12:00 Ulises Nucamendi Gómez (FCFM, UMSNH)

Revisiting purely kinetic K-essence cosmologies

12:40 Jorge Arturo Hernández Caballero (FCFM, BUAP)

Lorentzian manifolds with spherical symmetry and gravitational collapse

---

Abstracts

Déborah Elizabeth Villaraos Serés (IF, BUAP)

Redshift of orbiting particles in SdS: A general-relativistic approach to H_0

In this work, we derive the redshift expression of the photons emitted by a massive test particle circularly orbiting a Schwarzschild-de Sitter black hole, showing that the cosmic expansion is encoded in the gravitational component of the redshift. We then apply this framework to megamaser systems and use a Bayesian statistical analysis to infer black holes properties, such as mass, distance and position, as well as the Hubble constant.

Diego Armando Martínez Valera (IF, BUAP)

Regular Schwarzschild-de Sitter black holes in non-local higher derivative gravity

In this talk, we analyze the conditions under which we can construct a spacetime regular at r=0 from a conformal mapping of the singular spacetime of Schwarzschild-de Sitter, within the framework of a non-local higher-derivative theory of gravity. To achieve this goal, the cosmological constant must arise as an integration constant, and we find that it is related to the theory's coupling constants. Then, we study the regularity of the curvature invariants, as well as the geodesic completeness of conformal and non-conformal coupled particles. Furthermore, we investigate the link between the results of this work and a recent study on singularities in non-local higher derivative theories of gravity.

Uriel Noriega Cornelio (FCFM, BUAP)

AdS black holes in two-dimensional dilaton gravity and holography

In this talk, we present two novel analytic anti-de Sitter (AdS) black hole solutions in a two-dimensional dilaton gravity theory with two scalar fields nonminimally coupled to gravity. Our solutions contain two arbitrary integration constants in the blackening factor f(r), allowing for an extremal configuration. We explore the causal structure of these solutions. We establish a consistent thermodynamics, verified by the first law. Finally, we perform a holographic analysis of the effective theory living at the boundary of one of our black hole solutions. This theory is characterized by a Schwarzian action supplemented by a black hole mass term determined by the two integration constants in f(r). We also examine the holographic implications of the boundary counter-term.

Roberto Cartas Fuentevilla (IF, BUAP)

Elliptic functions: History and applications

Gerardo Morales Herrera (IF, BUAP)

Nonlinear electrodynamics and the effective metric around magnetars

A modification of the spacetime around a magnetar as perceived by light is presented as a result of nonlinear electrodynamics (NLED) effects arising in the vicinity of an intense magnetic field.

Mehrab Momennia (IFM, UMSNH)

Accretion of dark matter into a Kerr black hole

In this talk, we model the dark matter-black hole interaction with the help of the accretion of a Vlasov gas into a rotating Kerr black hole. We provide analytic relations for the energy, mass, and angular momentum accretion rates in the slow-rotation approximation and compare the results with numerical values. These formulas are used to derive characteristic time scales of the black hole mass growth and the associated spin-down in two different scenarios: assuming that the ambient energy density is either constant or decreases on a cosmological scale.

José Alfredo Escalante Javalera (IF, BUAP)

Braneworld isotropization

Based on evidence from the Cosmic Microwave Background, the Universe appears to be homogeneous and isotropic on a large scale. In Friedmann's cosmological models, these properties are included in the metric ansatz. In this work, in the braneworld scenario, a 5D bulk with a phantom scalar field and cosmological constant is used to provide a mechanism that isotropizes a Universe with anisotropic initial conditions.

Olivier Charles Albert Sarbach (IFM, UMSNH)

Relativistic dissipative fluids with hyperbolic, causal, and stable evolution equations

The first part of the talk reviews the phenomenological (macroscopic) description of first-order dissipative fluid theories, including the old theories by Eckart and Landau-Lifshitz. Until recently, it was thought that first-order theories generally suffer from stability problems. However, a new formulationhyperbolicity literature as Bemfica-Disconzi-Noronha-Kovton (BDNK) theory has shown that it is possible to obtain a description in terms of strongly hyperbolic evolution equations with causal propagation for which global equilibrium configurations are stable.
In the second part of the talk I will present a new first-order theory similar in spirit to BDNK. However, unlike BDNK, our theory is based on the choice of a fixed frame which is similar to Eckart's, except that the temperature is determined by fixing the trace of the stress-energy tensor. As will be shown, our theory is hyperbolic and causal provided that a single inequality holds. It is also shown that for low wave numbers, the expected damped modes in the shear, acoustic, and heat diffusion channels are recovered. Stability of global equilibria with respect to all wave numbers is also analyzed and I will show that the conditions for hyperbolicity, causality and stability are satisfied for a simple gas of hard spheres or disks.
Work in collaboration with J. Félix Salazar and Ana Laura Garcia-Perciante, arXiv:2412.03712, arXiv:2412.03713

José Emmanuel Lobato Donado (FCFM, BUAP)

Measurement of spectral line shift in planetary spectra

This work presents a methodology that employs the PyRAF software package to reduce and calibrate spectral data from the planets Mercury and Venus. The aim is to determine the redshifts and blueshifts of the spectral lines observed in their respective spectra.

Akin Bonillas Miranda (IF, BUAP)

Cotton gravity and its static spherically symmetric solution

Cotton gravity is presented as an alternative theory to General Relativity capable of explaining galactic rotation curves without invoking dark matter. Starting from the discrepancy that arises when standard gravitational predictions fail to match the observed velocities of stars in galaxies, an action based on the Weyl tensor is introduced, whose field equations are expressed in terms of the Cotton tensor and allow for a static, spherically symmetric solution with a new parameter, γ, which modifies the gravitational potential at galactic scales. When this solution is applied to 84 galaxies from the SPARC catalogue, the theoretical predictions closely match the observational data. These results suggest that the apparent need for dark matter may be reinterpreted as an additional manifestation of spacetime curvature, positioning Cotton gravity as a viable alternative in the study of galactic dynamics.

Juan Carlos Degollado (ICF, UNAM)

Shadow of a collapsing star in a regular spacetime

In this talk I will revisit the dynamical formation of the shadow of a collapsing star in a Hayward regular spacetime in terms of an observer far away from the center. We determine the angular size of the shadow as a function of time and found that the formation of the shadow is a finite process, and its size is affected by the Hayward spacetime parameters. We consider several scenarios, from the Schwarzschild limit to an extreme Hayward black hole.

Alberto Escalante Hernández (IF, BUAP)

The Barbero-Immirzi parameter in the Pontrjagin and Euler topological invariants

In this talk I will revisit the dynamical formation of the shadow of a collapsing star in a Hayward regular spacetime in terms of an observer far away from the center. We determine the angular size of the shadow as a function of time and found that the formation of the shadow is a finite process, and its size is affected by the Hayward spacetime parameters. We consider several scenarios, from the Schwarzschild limit to an extreme Hayward black hole.

Israel Quiros Rodríguez

Symmetry as a posible explanation of the cosmological puzzles

The possibility that a symmetry could explain some of the current cosmological enigmas, such as dark energy, dark matter, and Hubble tension, among others, is discussed. The case of Weyl symmetry is considered. According to most of the literature, this should be a broken symmetry in nature due to the existence of different energy scales. Another argument that invalidates it is the well-known result that only matter fields with a zero energy-momentum tensor trace can couple to Weyl symmetric gravitation. Recent results, as well as strong arguments, allow us to overcome these invalidating elements and consider Weyl symmetry as a symmetry present in nature, which could explain the current stage of accelerated expansion of the Universe, as well as the rotation curves of galaxies, without resorting to dark matter.

Diana Vanessa Castro Luna (IF, BUAP)

Hamiltonian analysis for perturbative λR gravity

The λR model is a perturbative modification of General Relativity in which the kinetic term is deformed by the parameter λ through the generalized DeWitt metric. This deformation may alter the constraint structure of the theory. In this work, we perform a perturbative expansion around flat spacetime and apply the Dirac formalism to identify the full set of constraints and determine the number of physical degrees of freedom. We explicitly analyze the cases $\lambda \neq 1/3$ and $\lambda = 1/3$, showing that both lead to two propagating degrees of freedom, consistently with General Relativity. Additionally, we implement the Hamilton–Jacobi formalism to study the dynamical consistency of the constraint structure through integrability conditions. Our results confirm the kinematical consistency of the λR model in the linearized approximation and provide an alternative framework for analyzing gravitational theories with modified gauge symmetries.

Alfredo Herrera Aguilar (IF, BUAP)

From black hole to neutron star rotation curves

In this talk we apply a General Relativistic (GR) method previously implemented to determine the central black hole parameters -mass, distance and recessional velocity- of a sample of active galactic nuclei (AGNs), to neutron stars. This GR method makes use of astrophysical observables: the frequency shifted photons emitted from the orbiting particles and their orbital positions on the sky. We express the neutron star radius in terms of the aforementioned observables and discuss about its impact on the corresponding equations of state.

Ulises Nucamendi Gómez (FCFM, UMSNH)

Revisiting purely kinetic K-essence cosmologies

In this talk, we perform a study of dynamical systems for a set of pure K-essence cosmological models (without a scalar field potential) combined with the analysis of their constraints coming from the avoidance of the ghost, Laplacian and sound velocity instabilities due to cosmological perturbations. Altogether it gives us the constraints for the model parameters.

Jorge Arturo Hernández Caballero (FCFM, BUAP)

Lorentzian manifolds with spherical symmetry and gravitational collapse: The Misner-Sharp formalism

This talk explores the Misner-Sharp formalism as a key framework for modeling gravitational collapse in spherically symmetric Lorentzian manifolds. We will discuss how this formalism bridges abstract geometric structures with the dynamical evolution of self-gravitating systems, translating theoretical constraints into physical insights regarding the collapse process.