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UNIVERSIDAD AUTÓNOMA METROPOLITANA



EL COLEGIO NACIONAL

IX LEOPOLDO GARCÍA-COLÍN MEXICAN MEETING 2026

SYMPOSIUM ON GRAVITATION AND COSMOLOGY

October 5-9, 2026

El Colegio Nacional and Casa de la Primera Imprenta de América

Location	Auditorium, National College	Auditorium, National College	Auditorium, National College	College Room, 2nd Floor, House of the First Print Shop in the Americas	Auditorium, National College
9:00-9:30	Opening				
Session Chair	Roberto Olayo-Valles	Marco Maceda	Miguel Bastarrachea	Chair	John A. Franco
9:30-10:30	Marc Hillmyer	Claus Lämmerzahl	Axel Pelster	Graduate Session	Horacio Pastawski
10:30-11:00	Coffee Break				
Location	Auditorium, National College	Auditorium, National College	Auditorium, National College	College Room, 2nd Floor, House of the First Print Shop in the Americas	Auditorium, National College
11:00-11:30	Omar López	Mariano Chemicoff	Miguel Alcubierre	Graduate Session	Alberto Molgado
11:30-12:00	Hernando Quevedo	Miguel Sabido	Ana Laura García		David Vergara
12:00-12:30	Eloy Ayón-Beato	Tonatiuh Matos	Alejandro Corichi		Carlos Sopena
12:30-13:00					
13:00-13:30	Tim Eifler	Luis Ureña	Martin Bojowald		
13:30-14:00					
14:00-16:00	Lunch				
Location	Auditorium, National College	College Room, 2nd Floor, House of the First Print Shop in the Americas	College Room, 2nd Floor, House of the First Print Shop in the Americas	Visit to Templo Mayor	Auditorium, 3rd Floor, House of the First Print Shop in the Americas
16:00-16:30	Daniel Flores	Francisco Turubiates	Mariana Vargas		Memorial Session in Honor of Alfredo Macías
16:30-17:00	Flavio Pineda	Sébastien Fromenteau	Hugo Morales		
17:00-17:30	Ricardo Chávez	Guillermo Chacón	Nora Bretón		Closure
17:30-18:00	Coffee Break				
18:00-18:30		Luisa Jaime			
18:30-19:00		Daniel Martínez			

Superplenary lecture (1 hour)

1. Claus Lämmerzahl (ZARM, University of Bremen)

The use of gravitational (quantum) metrological triangles

Though general relativistic effects can be measured with very high precision, the gravitational constant - one of our most fundamental constants in physics - can be determined with very low precision only. In electrodynamics there are consistency relations between fundamental constants which are called metrological triangles. We show that such a concept of a metrological triangle can also be introduced in Einstein's General Relativity. We show that it is possible to introduce a gravitational classical metrological triangle made of gravitational permitivities and permeabilities as well as of the speed of gravity. This allows to include more existing high precision tests to the exploration of the nature of gravity. As a result it is possible to improve the determination of Solar System general relativistic effects. Beyond this classical metrological triangle it is also possible to introduce a gravitational quantum metrological triangle. This is based on gravitational analogues of the Josephson effect and the quantum Hall effect. This quantum metrological triangle gives additional insight into gravity, suggests new laboratory tests for gravity, and also may allow a new definition of the kilogram.

Plenary lectures (1 hour)

1. Eloy Ayón-Beato (CINVESTAV)

Non-Noetherian conformal Cheshire effect

The gravitational Cheshire effect refers to the possibility of turning off the gravitational field while still leaving an imprint of the nonminimal coupling of matter to gravity. This allows nontrivial solutions in flat



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spacetime for which no backreaction is possible. The effect was originally shown to manifest itself for standard nonminimal couplings, such as those allowing conventional conformally invariant scalar fields. Recently, the most general scalar field action yielding a conformally invariant second-order equation was constructed, and entails a more involved nonminimal coupling explicitly breaking the conformal invariance of the action without spoiling it in the equation. We have succeeded in fully describing the spherically symmetric stealth solutions on flat spacetime supporting the Cheshire effect within this general non-Noetherian conformal theory. The allowed configurations are divided into two branches: The first one essentially corresponds to an extension of the solutions already known for the standard Noetherian conformal theory. The second branch is only possible due to the non-Noetherian conformal contribution of the action. The complete characterization of this branch is expressed by a nonlinear first-order partial differential equation. We have found the general solution of this equation using both seemingly new and well-established mathematical tools.

2. Tim Eifler (The University of Arizona)

Cosmology with the Roman Space Telescope

The Nancy Grace Roman Space Telescope launched successfully on August 30 and is well on its way to L2. After commissioning, it will provide an unprecedented amount of cosmological information to the community world-wide. This talk will review the state of the art of cosmological measurements from the Dark Energy Survey and the Dark Energy Spectroscopic Instrument before detailing the Roman Space Telescope's capabilities to measure geometry and structure growth in the Universe. I will outline Roman's main cosmological science cases and discuss systematic effects that pose challenges to extract the cosmological information.

3. Tonatiuh Matos (CINVESTAV)

CMaDE Inflation

We live immersed in a Gravitational Wave Background (GWB) that spans all frequencies. With this in mind, we developed a model covering the period from inflation to the present day—capable of explaining the earliest moments and the accelerated expansion of our universe—that is at least as effective as the standard model at reproducing the observed universe. In this talk, we present the model, explain how it connects the inflationary epoch to the present day, and compare the observed universe with that model.

4. Luis Ureña (University of Guanajuato)

Ultralight axions in dark energy and dark matter models

In the first part of this talk, we present constraints on axion quintessence dark energy using the latest cosmological observations. Focusing on the physical parameters of the model, we find a preferred axion mass of $\log_{10}(m_a/\text{eV}) \simeq -32.6$ and a decay constant of $\log_{10}(f_a/\text{MPI}) \simeq 0.1$. We perform a Bayesian model comparison with the standard cosmological constant scenario and show that axion quintessence provides a competitive description of current data. For the second part, we present the possibility to consider the same axion model for dark matter, but now for an axion mass of the order of $\log_{10}(m_a/\text{eV}) \simeq -22$. We will discuss the predictions of the model for the formation of galaxies and their distribution, and what constraints we can obtain for the axion mass from present observations. We will close with general conclusions and future possibilities for the models.

5. Alejandro Corichi (Centro de Ciencias Matemáticas, UNAM)

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6. Martin Bojowald (Pennsylvania State University)

Tidal effects and quantum operations

7. Carlos F. Sopuerta (Institute of Space Sciences)

Solitonic echoes: Hidden symmetries behind Black Hole resonances

Shallow-water waves are governed by the Korteweg-de Vries (KdV) equation, a very special equation first proposed to describe how perturbations propagate along a fluid surface, directly tied to the surface gravity. What makes the KdV equation truly remarkable is that it turns out to be completely integrable, and that it also appears in entirely different physical settings, such as plasma physics, nonlinear optics, and condensed-matter systems.

At the other end of the physical spectrum sit black holes (BHs), one of the wildest predictions of Einstein's General Relativity. A central theme in BH physics is understanding the physical phenomena that take place around them, such as scattering processes and the excitation of quasinormal modes. To that end, BH perturbation theory was developed as the natural framework to study these processes. Remarkably, the dynamics of these perturbations reduce to a set of master variables obeying Schrödinger-type equations, whose solutions carry the full physical information about the system.

In this talk, I will show that these master equations, even though they describe fully generic gravitational dynamics, hide an infinite family of symmetries. A distinguished subset of them turns out to be tied to the flow generated by the KdV equation and its associated integrable hierarchy. This structure leads to balance laws that let us compute BH scattering probabilities directly from these symmetries and their conserved quantities.

Finally, I will discuss the mathematical and physical implications of this unexpected connection between integrable systems, in particular the KdV hierarchy, and BH physics, along with a few directions for future work.

Short talks (30 minutes)

1. Omar López Cruz (INAOE)

Star Formation under the Magnifying Glass in a Galaxy at $z \sim 3$

The combination of telescopes and galaxy clusters functioning as gravitational lenses is referred to as Natural Telescopes. This approach enables detailed examination of the dynamics and morphology of distant galaxies that would otherwise remain unobservable. In this talk, we present new observations of the Bullet Cluster obtained with the James Webb Space Telescope (JWST). The resulting data refine the Bullet Cluster lensing map and resolve, at sub-kiloparsec resolution, the giant molecular clouds in the highly magnified submillimeter galaxy behind the Bullet Cluster, known as the Cosmic Seagull at redshift $z = 2.7768 \pm 0.0002$. We trace the evolution of observational capabilities, from the initial discovery of the Cosmic Seagull with single-dish telescopes to later advances with space telescopes and submillimeter arrays.

2. Hernando Quevedo (ICN, UNAM)

Entropy and time

Using the formalism of geometrothermodynamics, we show that in the space of equilibrium states of any thermodynamic system, entropy can be used as time parameter similar to the proper time. The laws of thermodynamics are satisfied along the curves parametrized by the entropy and, in particular, the second law determines the arrow of time.



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3. Daniel Andrés Flores Alfonso (UAM-Azcapotzalco)

Connecting superconductors and the Gödel universe

In this talk, we draw connections between the magnetic fields inside superconductors and Gödel's renowned solution to the Einstein field equations. In order to establish this we adapt a theorem on contact topology and hydrodynamics, adjusting it for Lorentzian signature. Our results link systems with translational symmetry by their complementary three-dimensional cross sections taking advantage of underlying geometrical structures.

4. Flavio Pineda (UAM-Iztapalapa)

Large primordial non-Gaussianities from transient turns in multifield inflation

We investigate the generation of primordial non-Gaussianities in multifield inflation, focusing on the effects of transient turning trajectories in the hyperbolic field space manifold. We compute the full bispectrum without relying on slow-roll or local approximations and follow the complete superhorizon evolution of curvature and isocurvature perturbations. We show that transient turns efficiently transfer isocurvature fluctuations into the adiabatic sector, generating sizeable local non-Gaussianities.

5. Ricardo Chávez Murillo (UAM-Iztapalapa)

From the Local Universe to Cosmic Dawn: Charting Cosmic Expansion with H II Galaxies

The expansion history of the Universe is now constrained by several powerful cosmological probes, yet independent distance indicators remain essential for testing possible systematic effects and extensions to the standard cosmological model. H II galaxies and giant extragalactic H II regions provide such an alternative through the correlation between their Balmer-line luminosity and ionised-gas velocity dispersion, the $L(H\beta)$ - σ relation.

In this talk, I will present our latest extension of the H II-galaxy Hubble diagram, spanning the remarkable interval from the nearby Universe to $z \sim 14$. By combining local systems with primary distance measurements, ground-based observations, JWST/NIRSpec spectroscopy, and, at the highest redshifts, complementary ALMA and JWST/MIRI measurements, we construct a homogenised sample of 243 objects and trace the Hubble flow well beyond the epoch of reionization.

A central result is that the L - σ relation shows no significant evidence for evolution across this enormous redshift baseline: systems within tens of Mpc and galaxies observed during cosmic dawn are consistent with the same relation. We use this standardisation to constrain flat and non-flat Λ CDM, w CDM and evolving-dark-energy models, while explicitly accounting for observational systematics and the increasing importance of gravitational lensing at high redshift.

6. Mariano Chernicoff (Facultad de Ciencias, UNAM)

Logarithmic corrections to the entropy of near-extremal black holes in Einstein-Gauss-Bonnet

We compute the one-loop contribution to the semiclassical partition function of near-extremal, asymptotically AdS black holes in five-dimensional Einstein-Gauss-Bonnet gravity. The analysis is based on the spectrum of a generalized Lichnerowicz operator governing linearized perturbations on the near-horizon geometry of the extremal solution, including its deformation by the Gauss-Bonnet coupling α . In the canonical ensemble, the low-temperature behavior of the one-loop partition function leads to logarithmic corrections to the entropy of the form $\text{Log}(T/T_0)$, where the scale T_0 depends on both the fluctuation sector and the Gauss-Bonnet coupling.



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7. Miguel Sabido (Universidad de Guanajuato)

Entropic cosmology, late time acceleration and the quantum bounce

We present a unified entropic framework linking the early quantum bounce in Loop Quantum Cosmology (LQC) with late-time dark energy acceleration. By introducing a fundamental minimal area A_0 and a composite modified entropy functional (SQ+SBH+SDE), we derive the modified Friedmann equations. We show that in the ultraviolet limit ($A \sim A_0$), a critical density naturally generates the quantum bounce. In the infrared limit ($A \gg A_0$), the late-time dynamics yields an accelerating scale factor. Thus, this model offers a compelling thermodynamic origin for both cosmic regimes.

8. Francisco Javier Turribiates Saldívar (ESFM-IPN)

Wigner function in quantum cosmology: a phase space description

This talk discusses the use of the Wigner function in quantum cosmology. The application of the Weyl-Wigner-Moyal formalism to cosmological models in minisuperspace is described. In particular, the quantization procedure is applied to the case of flat minisuperspaces. Some examples of cosmological models such as de Sitter and Kantowski-Sachs are analyzed using this approach.

9. Sebastien Fromenteau (Instituto de Ciencias Físicas, UNAM)

Machine Learning the Universe: From Galaxies to Cosmology

Modern cosmology aims to extract information about the origin, composition, and evolution of the Universe from increasingly large and precise observational datasets. Traditionally, this process relies on compressing the data into summary statistics and comparing them with theoretical models within a Bayesian inference framework. However, the growing complexity of these datasets, the nonlinear evolution of cosmic structures, and the challenging connection between the underlying matter distribution and the galaxies we observe pose new difficulties for this standard approach.

In this talk, we will present, from a pedagogical perspective, how Machine Learning can help address these challenges. We will first explore its use in accelerating traditional calculations through emulators and related methods, before introducing a more fundamental shift in the way cosmological inference can be performed: Simulation-Based Inference and Field-Level Inference. Finally, we will discuss some perspectives on how these tools may transform the way we extract and model the information encoded in the Universe.

10. Guillermo Chacón (UAM-Cuajimalpa)

Relativistic Equilibrium Distribution in Rapidity Space

We reformulate the relativistic Boltzmann kinetic equation using rapidity as the fundamental dynamical variable. Owing to its Lorentz-invariant character and additive transformation law under boosts, rapidity provides a natural framework for relativistic kinetic theory. The associated equilibrium distribution is derived, its statistical and physical properties are examined. Its behavior is with the standard Jüttner distribution, emphasizing potential applications in relativistic statistical mechanics.

11. Luisa Jaime (Facultad de Ciencias, UNAM)

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12. Daniel Martínez Carbajal (TESOEM)

Born-Infeld boson stars

We study the Einstein-Klein-Gordon system minimally coupled to non-linear Born-Infeld electrodynamics for a static, spherically symmetric complex scalar field. The resulting asymptotically flat solutions generalise the classical charged boson stars of Maxwell theory. By analysing the solution space as a function of the Born-Infeld parameter b and the scalar charge q , we show that for a given b , static configurations only exist up to a critical charge q_{crit} , which increases as b decreases. Furthermore, Born-Infeld boson stars exhibit lower total mass and reduced compactness compared to their Maxwell counterparts across all finite values of b .

13. Miguel Alcubierre (ICN, UNAM)

Electrically charged bosonic stars

In this talk I will discuss some recent results related to the study of electrically charged bosonic stars. Such objects are self gravitating systems in general relativity formed by massive complex bosonic charged fields, such as the Klein-Gordon and Proca fields. I will consider the particular case of spherical symmetry, and discuss the properties of stationary configurations, as well as their stability against perturbations.

14. Ana Laura García Perciante (UAM-Cuajimalpa)

Dissipation in Relativistic Fluids: General First-Order Constitutive Equations

General first-order theories of relativistic dissipative fluids have been shown to be physically sound. However, their extension to multicomponent charged fluids has not yet been established, despite their importance in astrophysics, cosmology, and high energy physics. We develop a general first-order formalism for a relativistic dissipative fluid composed of an arbitrary number of species in the presence of a weak background electromagnetic field, in the spirit of the BDNK framework. Throughout this work, the electromagnetic force acting on each species is assumed to be of the same order as the gradients of thermodynamic state variables and is therefore treated as a first-order driving force for dissipation within the gradient expansion. We derive the entropy production and formulate the constitutive relations in terms of first-order frame-invariant quantities. We further establish the conditions under which the transport coefficients satisfy Onsager's reciprocal relations and the second law of thermodynamics. Finally, we construct a complete, closed set of evolution equations for a binary mixture within a family of frames in which hyperbolicity, causality, and stability have already been established for the single-component fluid.

15. Mariana Vargas Magaña (IF, UNAM)

The Universe through three years of DESI: What have we learned, and what comes next?

With three years of data, DESI is providing an increasingly precise view of the late-time Universe. In this talk, I will review what we have learned from DESI so far, from BAO to the latest full-shape results, and discuss the cosmological picture emerging from these measurements. I will then look ahead to the next steps: extracting more information from large-scale structure, going beyond standard two-point analyses, and discussing what we may learn from the next stages of DESI.



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16. Hugo A. Morales Técotl (UAM-Iztapalapa)

Polymeric propagators via path integrals of particles and gravitational models

Taking as a motivation the loop quantization of gravity we briefly recall in this talk how this approach can be adapted to the case of a particle in a lattice to get the corresponding propagator. This then is extended to a spatially homogeneous and isotropic cosmological Friedmann-Lemaître-Robertson Walker (FLRW) as well as an spherically symmetric gravitational model. While in the first two cases an analytical form can be obtained, we will focus on the semiclassical approximation description for the three kinds of systems within this. Some recent results and problematic findings are touched upon.

17. Nora Bretón (CINVESTAV)

Ultracompact Anisotropic Stars and Gravastars in General Relativity

We study static, spherically symmetric ultracompact objects with anisotropic stress. Assuming homogeneous density and a covariant anisotropic EOS we construct a mostly analytical model admitting configurations beyond the Buchdahl limit and with compactness arbitrarily close to the black hole value. The solutions exhibit two regimes separated by a critical curve in the parameter space of compactness and anisotropy, associated with the divergence of the central pressure: regular anisotropic configurations with positive central pressure, and singular configurations with negative central pressure for arbitrary anisotropy. In the latter case, a thick shell removes the pressure divergence, yielding regular ultracompact gravastar configurations.

18. Alberto Molgado (UASLP)

Phase space quantization of anisotropic cosmologies

We introduce an explicit construction of the non-diagonal and diagonal Wigner distributions for the homogeneous but anisotropic Taub and Kantowski-Sachs cosmological models within the framework of phase space deformation quantization. Conventional canonical quantization of these models via the Wheeler-DeWitt equation is inherently plagued by factor ordering ambiguities. To circumvent these issues, we employ the totally symmetric Weyl quantization map and the Moyal star product. By means of a canonical separation of the Hamiltonian constraint, we are able to resolve the formal convergence problems typically associated with the star product. Furthermore, to establish a rigorous connection with conventional quantum cosmology, we calculate the standard wave functions directly from the diagonal Wigner distributions, recovering the exact physical states in terms of modified Bessel functions in both cases

19. David Vergara (ICN, UNAM)

N-bein formalism for degenerate states in the parameter space of quantum geometry

In this talk, we extend the geometric framework of the N-bein formalism—an orthonormal frame analog in the Cartan formalism that acts as the "square root" of the quantum geometric tensor (QGT)—to quantum systems with degenerate spectra. We define a non-Abelian two-state QGT to identify possible transitions between degenerate states after two consecutive parameter variations. Additionally, using the Wilczek-Zee connection, we introduce a torsion-like tensor as the covariant derivative of the N-bein. This torsion captures the noncommutativity of successive parameter variations and coincides with the antisymmetric part of the two-state QGT. We also present a geometrical formulation using differential forms and discuss the physical implications of the newly defined tensors. Furthermore, we construct several gauge-invariant observables from the N-bein and its derivatives to highlight the utility of the new tensors.