



IX LEOPOLDO GARCÍA-COLÍN MEXICAN MEETING
SYMPOSIUM ON QUANTUM TECHNOLOGIES

October 5-9, 2026

El Colegio Nacional and Casa de la Primera Imprenta de América

October	Monday 5	Tuesday 6	Wednesday 7	Thursday 8	Friday 9
Location	El Colegio Nacional Auditorium	El Colegio Nacional Auditorium	El Colegio Nacional Auditorium	El Colegio Nacional Room 2	El Colegio Nacional Auditorium
09:00 - 09:30	Opening			Graduate	
Chair	Roberto Olayo-V.	Marco Maceda	Miguel Bastarrachea		John A. Franco
09:30 - 10:00	Marc Hillmyer	Claus K. O. Lämmerzahl	Axel Pelster	Graduate	Horacio Pastawski
10:00 - 10:30				Graduate	
10:30 - 11:00	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE
Location	El Colegio Nacional Room 2	El Colegio Nacional Room 2	El Colegio Nacional Room 2	El Colegio Nacional Room 2	El Colegio Nacional Room 2
Chair	L. J. Fernández	T. Kottos	E. Sadurní	Chair	V. Domínguez-Rocha
11:00 - 11:30	Hans-Christoph Nägerl	Rafael A. Méndez-Sánchez	Mercedeh Khajavikhan	Graduate	Grethell G. Pérez-Sánchez
11:30 - 12:00				Graduate	
12:00 - 12:30	Roberto de J. León	Giuseppe Pirruccio	Delfino Reyes	Graduate	Ricardo Méndez
12:30 - 13:00	Eduardo Barrios	David Bermúdez	Alejandro Kunold	Graduate	José L. Pozos
13:00 - 13:30	Mauricio Torres	Thomas Stegmann	Manan Vyas	Graduate	
13:30 - 16:00	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
Location	El Colegio Nacional Room 2	El Colegio Nacional Room 2	El Colegio Nacional Room 2	El Colegio Nacional Room 2	Casa Primera Imprenta Auditorium 3rd Floor
Chair	H.-C. Nägerl	R. A. Méndez	M. Khajavikhan		M. Martínez-Mares
16:00 - 16:30	Lucas J. Fernández	Tsampikos Kottos	Emerson Sadurní	Visit to the Templo Mayor Museum	Memorial session in honor of Alfredo Macías: Octavio Pimentel and Inés García Closure
16:30 - 17:00					
17:00 - 17:30	Silvia Hidalgo	Gabriela Báez	Adrián Escobar		
17:30 - 18:00	COFFEE	COFFEE	COFFEE		
Chair	S. Hidalgo	G. Báez	A. Escobar		
18:00 - 18:30	Santiago Caballero	Luis F. Quezada	Angel M. Martínez		
18:30 - 19:00	Horacio Olivares	Fernando Ramírez	Pablo Barberis		
19:00 - 19:30	Humberto Laguna	Eduardo Serrano	Pablo Barberis		

I. SUPERPLENARY LECTURES

- Axel Pelster,
Rhineland-Palatinate Technical University of Kaiserslautern-Landau and State Research Center OPTIMAS.

On the open-dissipative nature of photon Bose-Einstein condensates

Abstract: Photon condensation was first observed in 2010 within a dye-filled microcavity at room temperature and gained interest since then. A deeper understanding is particularly needed as to whether the stationary states are equilibrium or nonequilibrium states. To this end we examine at first how the driven-dissipative nature of a photon Bose-Einstein condensate modifies the condensation process [1]. We consider a rate-equation model, which can be derived microscopically [2]. It depends on external parameters such as emission and absorption rates as well as cavity photon losses. In steady state, the photon occupation follows an open-dissipative Bose-Einstein distribution whose chemical potential is set self-consistently by the dye's ground- and excited-state populations. We show that driven-dissipative parameters strongly alter the distribution and use these results to distinguish photonic condensation from both atomic condensation and lasing. Although open-dissipative quantum fluids have extensively been studied numerically, analytical descriptions are rare. Here we show that generalizing the standard optimization method for closed condensates yields a projection optimization method, which is applicable for open-dissipative systems [3]. As an example we analyze a complex Gross-Pitaevskii equation that heuristically models a harmonically trapped photon Bose-Einstein condensate. Together with established methods from hydrodynamics, we obtain an approximate dynamical vortex solution and demonstrate how open-dissipative parameters affect both vortex size and stability. The resulting information is useful for possibly realizing vortices in photon Bose-Einstein condensates.

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- Horacio Pastawski,
Instituto de Física Enrique Gaviola, Universidad Nacional de Córdoba, Academia Nacional de Ciencias, Argentina.

Non-Hermiticity, Decoherence and emergent phenomena in quantum dynamics: from molecules to living systems

Abstract: In this tutorial talk I walk through some of the main ideas that drew my own scientific pathways, much of which I shared with my wife, Patricia Rebeca Levstein. An early puzzle I confronted was the non-Hermitian Hamiltonian used to evaluate transport. Indeed non-hermiticity, much as decoherence, resulted from the interaction with infinite degrees of freedom of the environment. An early solution was de D’Amato-Pastawski model which found its grounding support on the Keldysh-Kadanoff-Baym quantum fields formalism in the form of Generalized Landauer-Büttiker Equations (GLBE) that describe a generalized density matrix that accounts for quantum dynamics and decoherent phenomena. Our own quantum dynamics experiments of spin systems lead us to recognize different emergent phenomena, such as quantum dynamical phase transitions and intrinsic irreversibility. Moreover, through the “quantum-drift model” (a particular form of stochastic Schrödinger equation) together with a quantum parallelism algorithm, one can evaluate the density matrix, polarizations and chemical yields at much more economical computational cost than the original GLBE. We will describe how these advantages, together with the basic chemistry I learnt from Patricia, allowed us to solve one of the mysteries of quantum biology: the geomagnetic detection mechanism that allows the night navigation of some birds. Didactical Reviews: Electron-Phonon interaction and electronic decoherence in molecular conductors. H. M. Pastawski, L. E. F. Foa Torres, E. Medina; Chem. Phys. **281**/2-3 pp. 257-278 (2002) Revisiting the Fermi Golden Rule: Quantum dynamical phase transition as a paradigm shift, Phys. B **398**, 278 (2007). Recent results: –Decoherent time-dependent transport beyond the Landauer-Büttiker formulation: A quantum-drift alternative to quantum jumps, L.J. Fernández-Alcázar and H.M. Pastawski, Phys. Rev. A **91**, 022117 (2015) –Universal stability of coherently diffusive 1D systems with respect to decoherence. F.S. Lozano-Negro, E. Alvarez Navarro, N.C. Chávez, F. Mattiotti, F. Borgonovi, H.M. Pastawski, G.L. Celardo, arXiv.2307.05656, Phys. Rev. A **109**, 042213 (2024) –Quantum Dynamical Phase Transition Drives Topological Sensitivity in Avian Magnetoreception. F.S. Lozano-Negro, L. Fernández-Alcázar, E. Medina and H. M. Pastawski. Ref to be announced.

II. PLENARY TALKS

- Hanns-Christoph Nägerl ,
Institute for Experimental Physics, University of Innsbruck, Innsbruck, Austria.

Cold atoms: A wonderful platform for quantum physics

Abstract: Since the formation of atomic Bose-Einstein condensates (BEC) a bit more than 30 years ago, systems of cold atoms have developed into a versatile playground for the investigation into quantum many-body physics, with the promise to shed light onto dynamical processes in the spirit of quantum simulation efforts. With exquisite parameter control and a broad range of detection methods, a multitude of phenomena, ranging from

superfluidity and quantum phase transitions to supersolidity and quantum transport, can be probed with high precision. I will give a short introduction to the field of cold atoms and its techniques, and then turn to a selected set of experiments from my group that address various dynamical quantum many-body phenomena such as dynamical localization in 1D [1] and, surprisingly, also in 3D [2], anyonization of bosons [3], fractional Fermi seas [4], Bethe strings [5] and dissipationless flow beyond the Landau paradigm [6].

References:

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- [2] Interaction-enabled metal-insulator phase transition in a driven quantum gas, C. Cantillano et al., preprint at arxiv.org/abs/2605.22449(2026).
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- [4] Realization of fractional Fermi seas, Yi Zeng et al, preprint at [arXiv:2602.17657](https://arxiv.org/abs/2602.17657) (2026).
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- Rafael A. Méndez-Sánchez,
Instituto de Ciencias Físicas, Universidad Nacional Autónoma de México, Mexico.

Coupled-Resonator Phononic Molecules: A Platform for Exploring Topological Phase Transitions

Abstract: An artificial phononic molecule is an elastic structure consisting of resonators coupled by finite phononic crystals. When a normal-mode frequency of a resonator falls within the bandgap of the phononic crystals, the associated wave amplitudes become trapped in the resonators and decay evanescently through the couplers. This effect mimics the quantum mechanical orbitals of atoms and molecules; thus, the artificial phononic molecule satisfies a tight-binding model similar to that of condensed matter physics. In this talk, we provide an overview of the phenomena appearing in these artificial molecules. A twofold topological transition, induced by the ratio between third- and first-nearest-neighbor hoppings, is revealed in artificial cis-polyacetylene. For an artificial phononic transpolyacetylene, the Su-Schrieffer-Heeger chain is obtained with its well-known topological phase transition. Adding second-nearest-neighbor hoppings and using two different site energies, a kappadeformed Dirac equation is emulated. Finally, a dual energy-differentiated topological phase transition, observed in red phosphorus, is presented.

- Mercedeh Khajavikhan,
Department of Electrical and Computer Engineering, University of Southern California,

USA.

From Symmetry to Entropy: New Design Principles for Next-Generation Photonic Devices

Abstract: Modern photonics has achieved remarkable control over light by isolating modes and suppressing complexity. Yet emerging demands for higher power, greater functionality, and increased information capacity are driving optical systems into multimode and nonlinear regimes, where conventional design strategies become insufficient. In this talk, I will describe how ideas originating in fundamental physics can provide new principles for controlling such systems. I will first show how engineered symmetries –and their deliberate breaking– in non-Hermitian and topological photonic structures enable mode selection, robust laser operation, and asymmetric transport. I will then turn to optical thermodynamics, where many interacting modes collectively acquire macroscopic quantities such as temperature and entropy. Recent experiments have revealed negative-temperature states, irreversible optical cooling, self-organization into coherent states, and universal routing in conservative systems. Together, these results suggest a transition from controlling light mode by mode to engineering its collective behavior, opening new opportunities for coherent sources, power redistribution, beam combining, and next-generation photonic devices.

- Grethell G. Pérez-Sánchez,
Universidad Autónoma Metropolitana, Unidad Azcapotzalco, Mexico.

Optical Fiber Gratings and Applications

Abstract: Optical Fiber Gratings are photonic microstructures characterized by a periodic modulation of the core's refractive index. Their basic structure consists of a spatially modified photosensitive core protected by a cladding layer. Various types of fiber gratings exist based on their modulation pattern: Fiber Bragg Gratings (FBGs) reflect a specific wavelength of light while transmitting all others; Chirped Fiber Bragg Gratings (CFBGs) feature a variable grating period along the fiber, making them ideal for chromatic dispersion compensation; Long-Period Gratings (LPGs) couple light from the core to the cladding, facilitating refractometric and biomedical measurements; and Tilted Fiber Bragg Gratings (TFBGs) tilt optical coupling to interact via evanescent fields for chemical sensing. In telecommunications, these structures are essential for channel filtering in DWDM systems and for laser stabilization. In sensing applications, they excel in structural health monitoring (SHM) networks embedded in bridges, aircraft, train tracks, and wind turbine blades. Furthermore, their complete electromagnetic immunity and thermal resistance enable reliable deployment in harsh environments.

- Lucas J. Fernández-Alcázar,
Universidad Nacional del Nordeste, Argentina.

Beam Thermalization in multimoded nonlinear photonic networks and (classical) many-body localization

Abstract: Multimode nonlinear photonic systems provide a rich setting for exploring emergent many-body dynamics and collective phenomena far from the behavior of individual optical modes. In this talk, I will discuss several complementary theoretical approaches developed to describe these systems across different regimes. Starting from optical thermodynamics in the weakly nonlinear limit, I will examine how statistical-mechanical concepts can be used to characterize thermal states and phase transitions in multimode photonic networks. I will then move beyond this regime to address stronger nonlinearities and finite-size systems, including photonic oligomers. The role of kinetic descriptions in predicting relaxation toward equilibrium will also be discussed, together with the impact of disorder on multimode thermalization. Finally, I will present a transport-based perspective aimed at connecting modal dynamics with the propagation and redistribution of optical power. These approaches provide complementary tools for understanding and controlling complex nonlinear light dynamics in multimode settings and the associated relaxation toward equilibrium.

- Tsampikos Kottos,
Department of Physics, Wesleyan, USA.

Programming wave transport from within: In-situ adjoint optimization in complex scattering media

Abstract: Controlling waves in complex media is a grand challenge with implications for wireless communications, sensing, imaging, energy delivery, and wave-based computing. Yet the most promising platforms –multiple-scattering, nonlinear, and wave-chaotic systems– are also the hardest to model and optimize. I will present an in-situ adjoint-optimization framework that turns this apparent limitation into an advantage: the physical system itself performs part of the computation needed for its own design. By combining forward and adjoint wave excitations, the method identifies local perturbations that steer transport toward a desired functionality with exceptional time and energy efficiency. In highly reverberant environments, waves repeatedly interrogate the same perturbations, so small local changes can produce large programmable effects. I will discuss microwave and RF experiments demonstrating targeted channel emission, coherent perfect absorption, and wave camouflage. I will also outline opportunities in indoor wireless control, adaptive imaging, power-electronic networks, and optical or RF neural computing.

- Emerson Sadurní,
Instituto de Física, Benemérita Universidad Autónoma de Puebla, Mexico.

The WKB centennial and its influence on modern Quantum Analogies

Abstract: More than one hundred years ago, the semiclassical limit of the Schrödinger equation, and thereby the geometric limit of physical optics, were formulated with the well-known scale analysis of differential equations. The smoothness of potentials or scatterers compared to the size of incident wavelengths are the usual working hypothesis in this textbook formalism. However, less elegantly, the sewing method of Airy functions around turning points is introduced as a patch to avoid divergences. In this talk, we shall approach the elimination of amplitude divergences already at **zero order** by employing a new meromorphic function akin to the Riccati solution of the Schrödinger equation. With this, regular wavefunctions and corrected Bohr-Sommerfeld energies can be found. Some applications shall be mentioned.

III. SHORT TALKS

- Roberto De J. León-Montiel,
Instituto de Ciencias Nucleares, Universidad Nacional Autónoma de México, Mexico.

Rapid photon bunching characterization via photon-number-resolved detection

Abstract: Photon-statistics characterization underpins quantum imaging and sensing but is hindered by slow, data-intensive correlation estimators. We demonstrate neural-network-based learned inference for ultrafast, source-agnostic estimation of second-order coherence from photon-number-resolved measurements. The method achieves equal or better precision with three orders-of-magnitude faster processing, enabling real-time diagnostics in few-photon regimes.

- José Eduardo Barrios Vargas,
Facultad de Química, Universidad Nacional Autónoma de México, Mexico.

Defect-induced topological pumping in a non-Hermitian chain

Abstract: Non-Hermitian physics has emerged as a powerful framework for exploring phenomena that have no direct counterpart in conventional Hermitian quantum systems, including complex spectra, exceptional structures, unconventional localization, and modified topological transport. In this work, we investigate adiabatic charge pumping in a non-Hermitian Rice-Mele model with periodically modulated hopping amplitudes and complex on-site energies. We explore different trajectories in the complex parameter space to assess how non-Hermiticity modifies topological pumping. We find that pumping is preserved only in the Hermitian limit, while a localized defect can restore pumping for a non-Hermitian protocol. These results highlight the unconventional role of non-Hermiticity and defects in controlling topological transport.

- Mauricio Torres,
Instituto de Física, Benemérita Universidad Autónoma de Puebla, Mexico.

Quantum Information Protocols with Perfect Revivals of Rabi Oscillations

Abstract: Entanglement between distant quantum systems is a crucial resource for quantum communication, yet environmental noise continuously degrades these vital correlations. In this talk, we exploit cavity-QED systems exhibiting perfect revivals of Rabi oscillations to engineer non-unitary entangling operations. We show that these processes enable efficient entanglement purification protocols for generic two-qubit state outperforming traditional recurrence schemes. Furthermore, we expand this non-unitary framework to broader quantum state engineering protocols, showing its direct application in generating hybrid atom-cavity and ion-motion entanglement, as well as preparing non-Gaussian cubic phase states.

- Silvia Hidalgo Tobón,
Departamento de Física, Universidade Autónoma Metropolitana, Unidad Iztapalapa, Mexico.

Quantum Spin Dynamics in Magnetic Fields: From Theory to Clinical Imaging

Abstract: The evolution of modern medical physics is intrinsically linked to our ability to translate the most fundamental principles of quantum mechanics into high-precision, non-invasive diagnostic tools. This talk presents a review of the quantum dynamics of nuclear spins subjected to external magnetic fields, establishing the mathematical and physical bridge connecting fundamental time-evolution equations with image acquisition in daily clinical practice.

Using the Bloch equation formalism and a quantum description of the Nuclear Magnetic Resonance phenomenon, the behavior of intrinsic proton magnetic moments, such as those in hydrogen nuclei, is analyzed under the combined interaction of high-strength static magnetic fields (like 3 Tesla systems) and specific dynamic magnetic fields, such as radiofrequency pulses and magnetic field gradients. The discussion addresses how subtle variations in longitudinal T1 and transverse T2 relaxation times, governed by quantum fluctuations in the tissue environment, are transformed into a spectral frequency map. This map generates the spatial contrast that enables tissue characterization in both pediatric and adult patients, leveraging the high water content of body tissues. Finally, the critical role of the clinical medical physicist in optimizing these quantum principles is emphasized. The talk explores how precise modeling of Larmor precession and quality control of magnetic field homogeneity are essential for mitigating artifacts, implementing advanced imaging sequences, such as Diffusion Tensor Imaging (DTI) and magnetic susceptibility imaging, and ensuring maximum patient safety during the clinical use of magnetic fields.

- Santiago F. Caballero-Benitez,
Instituto de Física, Universidad Nacional Autónoma de México, Mexico.

Quantum Correlations and Entanglement in Generalized Dicke-Ising Models

Abstract: Quantum systems inside high-Q cavities offer an excellent testbed for the control of emergent symmetries induced by light and their interplay with quantum matter [1]. Recently several developments in cavity experiments with neutral atoms and other quantum objects such as ions motivate the study of their quantum correlated properties and their entanglement to tailor and control the behavior of the system. Using the enhanced coupling between light and interacting matter we explore the properties of emergent superradiant modes using our newly developed Light-Matter DMRG algorithm [2] with strongly interacting spin chains [3]. We explore a experimentally viable generalization of the transverse Ising chain coupled to the cavity light where it is possible to induce multimode structures tailored by the light pumped into the system. We find a plethora of scenarios can be explored with clear and accesible measurable signatures. This allows to study the physics of emergent orders and strong quantum correlations with quantum spins where the local and long range coupling can be efficiently simulated. We find that quantum spin nematic states [4,5] with long range order and magnon pairs[6] emerge as the transitions to superradiant phases take place. Notably, we show the cavity field allows the optimization of entanglement between spins for different light induced modes[7,8] which can be used for quantum state engineering of quantum correlated states. Our methods can be used to model other hybrid quantum systems efficiently. This work is partially supported by the grants UNAM-DGAPA-PAPIIT: IN118823, UNAM-DGPA- PAPIIT: IG101826, UNAM-CIC: Apoyo a Laboratorios Nacionales 2025, CONAHCYT/ SECIHITI:LNC-2023-51, as well as by grants from NVIDIA and utilized NVIDIA RTX 6000 Ada.

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- Horacio Olivares Pilón,
Departamento de Física, Universidad Autónoma Metropolitana, Unidad Iztapalapa, Mexico.

Periodic Trajectories in Molecular Physics: The H_3^+ Molecule

Abstract: A molecule is a many-body quantum system consisting of electrons and nuclei. The well-established Born-Oppenheimer approximation enables the separation of electronic and nuclear motions, with the eigenvalues of the electronic Hamiltonian defining the corresponding potential energy surfaces. Within this quantum-mechanical framework, the rotational-vibrational spectrum of a molecule is obtained by solving the nuclear Schrödinger equation, using one of these electronic potential energy surfaces as the potential. In the classical picture, instead, we can study the dynamics in terms of trajectories. In this talk, we present a study of closed periodic trajectories in the H_3^+ molecule. We will explore the rich variety of trajectories that arise and show how their properties give rise to a phenomenon of energy quantization.

- Humberto Laguna Galindo,
Departamento de Química, Universidade Autónoma Metropolitana, Unidad Iztapalapa, Mexico.

Correlations in quantum channels in position, momentum and phase-space in superpositions of quantum harmonic oscillators

Abstract: We analyze the impact of dephasing and decoherence channels in finite superpositions of harmonic-oscillator states, in position, momentum and phase-space, using tools from information theory, such as Shannon entropy and mutual information. The impact of both channels is analyzed in different distributions.

- Giuseppe Pirruccio,
Instituto de Física, Universidad Nacional Autónoma de México, Mexico.

Macroscopic coherence and vorticity in a room-temperature polariton condensate confined in a self-assembled perovskite microcavity

Abstract: Metal-halide perovskites have emerged as a promising platform for room-temperature exciton-polariton condensation due to their strong light-matter coupling, large exciton binding energies, and scalable fabrication. Here, we investigate self-assembled $CsPbBr_3$ whispering-gallery-mode microcavities, which combine strong lateral photon confinement with optical gain while intrinsically exhibiting a disordered energy landscape. This provides a distinctive regime in which confinement, gain, and disorder are naturally intertwined. In addition to the nonlinear threshold, spectral narrowing and interaction-induced blueshift characteristic of driven-dissipative condensation, we report interferometric

measurements that directly reveal extended spatial coherence and fork-shaped phase dislocations associated with quantized vortices. Our results show that structural disorder can actively reshape the effective cavity potential, producing real-space fragmentation and stabilizing topological excitations. This establishes self-assembled, lithography-free microcavities as a platform for exploring coherent and topological phenomena in room-temperature polariton condensates.

- David Bermúdez Rosales,
Centro de Investigación y Estudios Avanzados, Unidad Zacatenco,
Instituto Politécnico Nacional, Mexico.

Backreaction of stimulated Hawking radiation in an optical analogue

Abstract: Hawking radiation, the emission of quantum particles at the event horizon of a black hole, connects gravity with quantum mechanics and thermodynamics; the Bekenstein-Hawking entropy has been the benchmark for potential quantum theories of gravity. But Hawking radiation has never been observed in astronomy, only in laboratory analogues and the chances of ever observing it in space are astronomically small. The energy of Hawking radiation must come from the gravitational field around the black hole, but how field quanta generate Hawking quanta has been unknown. Here we report on experimental and theoretical evidence for the process that generates Hawking radiation in a fibre-optical analogue of the event horizon. There, as in gravity, it has been believed that Hawking radiation comes from a complicated, cascaded process; here we have found a simple, direct process and measured its backreaction on the field. Our findings suggest an equally direct process for other laboratory analogues and perhaps also for gravitational fields, shedding light on how black holes might radiate.

- Thomas W. Stegmann,
Instituto de Ciencias Físicas, Universidad Nacional Autónoma de México, Mexico.

Edge-State Transport in Graphene-Based Materials

Abstract: Motivated by recent transport experiments on bilayer graphene with a gap, opened either by twisting the layers [1] or by applying an interlayer gate potential bias [2], we show edge-state conduction within the band gap. We find that certain edge terminations — typically combinations of zigzag, armchair, and bearded edges — support conducting edge states that can give rise to non-local resistance. Band-structure calculations confirm the existence of these states, whose edge localization can be switched by tuning the electron energy. Importantly, their presence depends sensitively on the microscopic edge termination and does not arise from a topological bulk-boundary correspondence [3,4]. In the second part of the talk, we address graphene with Kekulé-O modifications and show that grain

boundaries of the Kekulé pattern separates the system into topologically distinct regions and induces a ballistic domain-wall state. The state is independent of the orientation of the grain boundary with respect to the graphene lattice and permits guiding the current on any given path through the system [5]. Together, these results highlight how edge and domain-wall states in graphene-based materials can provide versatile mechanisms for controlling electronic transport through structural engineering.

References:

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- Ma. Gabriela Báez Juárez,
Departamento de Ciencias Básicas, Universidad Autónoma Metropolitana, Unidad Azcapotzalco, Mexico.

Vibration Control: Classical and Quantum Wave Analogies

Abstract: Using elastic waves traveling through strategically designed, structured systems, the behavior of electrons under the influence of certain potentials is reproduced. Thus, it is possible to emulate some wave phenomena characteristic of quantum systems, using structured systems for vibration control. The design principle of these elastic structures originates from introducing small deformations or defects into an originally periodic elastic structure as a function of a relevant geometric parameter. Numerical and experimental results have allowed the reproduction of the trapping of a vibration packet, as well as some elastic tight-binding models that mimic crystals or atomic molecules. These elastic structures, designed for the control of mechanical waves, are a class of new smart materials.

- Luis F. Quezada Mata,
Universidad Autónoma de San Luis Potosí, Mexico.

Quantum Games in Quantum Networks: From Secure Communications to Strategic Decision-Making

Abstract: Quantum game theory extends classical strategic interactions by incorporating quantum states, unitary strategies, measurements, and entanglement. Beyond studying how quantum resources modify the equilibria and payoffs of familiar games, these ideas can provide useful frameworks for problems in quantum information and quantum networks. In this talk, I will present examples ranging from quantum key-distribution protocols inspired by the Monty Hall game, to multi-party extensions designed for quantum-network settings. I will also discuss recent results on the quantum Prisoners' Dilemma, where entanglement enables deviations from classical rational-choice principles. Together, these works illustrate how quantum game theory can serve as a framework for both communication protocols and strategic behavior in quantum networks.

- Fernando Ramírez,

Abstract:

- Eduardo Serrano Ensástiga,
Universidad Autónoma Metropolitana, Unidad Iztapalapa, Mexico.

Extreme quantum spin states for metrology: characterization and engineering

Abstract: In this talk, we present several complementary advances in the characterization and engineering of extreme quantum spin states that are useful for metrological tasks. First, we explain the notion of anticonherent states and why they are useful for measuring rotations. Then, we discuss the discrepancies that arise when this notion is generalized to mixed states and propose a way to circumvent this problem by defining both a total and a quantum measure of anticonherence [1]. In particular, we find that the mixed states maximizing this new measure are the best states for estimating infinitesimal rotations about any axis –referred to as optimal quantum roto-sensors [2]. Surprisingly, they perform as well as their pure-state counterparts. Finally, we explain a protocol for generating these states via symmetry-based dissipative engineering [3].

References:

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- Delfino Reyes Contreras,
Facultad de Ciencias, Universidade Autónoma del Estado de México, Mexico.

Carbon quantum materials: the case of carbon nanodots

Abstract: Carbon quantum materials have become a rapidly expanding research field due to their unique size-dependent optical and electronic properties, which position them as promising platforms for emerging quantum and photonic technologies. In particular, carbon nanodots (CNDs) exhibit remarkable photoluminescence (PL), quantum confinement effects, tunable emission, high photostability, and low toxicity, making them attractive candidates for applications ranging from quantum sensing and bioimaging to optoelectronic and nanophotonic devices. This talk presents recent advances in the synthesis and optical characterization of carbon nanodots produced through pulsed laser ablation and fragmentation of waste-derived biocarbon obtained from agroindustrial residues. By combining sustainable carbonization processes with laser-based nanomanufacturing, it is possible to generate ultrasmall carbon quantum structures whose optical response is strongly governed by surface chemistry, defect states, and the intrinsic composition of the precursor biomass. Particular emphasis will be placed on the excitation-dependent photoluminescence response of these laser-generated carbon nanodots, including wavelength shifts, broadband visible emission, and the role of oxygen-containing functional groups and surface defects in the radiative recombination mechanisms. The relationship between biomass precursor composition, biocarbon microstructure, and the resulting PL behaviour of carbon nanodots will be discussed from both experimental and physicochemical perspectives. Results reveal that the optical response can be modulated through intelligent selection of waste-derived precursors, enabling the engineering of carbon quantum materials with tailored emission properties. These findings provide new insights into the interplay between disorder, surface states, and quantum confinement effects in carbon-based nanostructures. Beyond their fundamental interest, laser-synthesized carbon nanodots from waste-biocarbon represent a sustainable pathway toward the development of low-cost quantum photonic materials within the framework of circular economy. The talk will also address prospective applications of these materials in quantum technologies, including optical sensing, photonic interfaces, bio-optoelectronic systems, and light-matter interaction platforms.

- Alejandro Kunold Bello,
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How to Train Your Transmon: Neural Networks for Quantum Gate Engineering

Abstract: The realization of fault-tolerant quantum computers relies on the ability to implement quantum gates with high fidelity while minimizing leakage to non-computational states. In this talk, I will present a machine-learning approach to the quantum control of

superconducting transmon qubits based on the numerical solution of the Lindblad equation in Liouville space. Our approach begins by solving the open-system dynamics of a multi-level transmon driven by microwave pulses with different amplitude and phase modulations. These simulations generate large training and testing datasets that are used to train a convolutional neural network capable of learning the mapping between pulse parameters and the resulting quantum evolution. Remarkably, the trained network not only reproduces the numerical solutions of the Lindblad equation with high accuracy, but also identifies pulse profiles that naturally suppress leakage into higher excited states. In particular, the network independently discovers phase modulations with an approximately quadratic time dependence, closely related to pulse-shaping strategies known to reduce leakage in weakly anharmonic systems. Using the trained model, we demonstrate the efficient synthesis of arbitrary single-qubit operations spanning the entire $SU(2)$ group. Finally, I will present preliminary results extending the method to two-qubit systems, where the neural network is used to engineer microwave pulses implementing high-fidelity CNOT gates. These results illustrate how artificial intelligence can accelerate quantum control design while providing physically meaningful pulse solutions for superconducting quantum processors.

- Manan Vyas,
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Structure of Interacting Many-Body Quantum Spectra

Abstract: How do interacting quantum particles organize their energy levels and wave functions when the interaction is complex? Embedded random matrix models offer a realistic model, with random few-body interactions embedded in many-particle Hilbert space. Using extensive numerical calculations, we show that q -normal distributions and its variants capture the eigenvalue and eigenvector structure of these systems. We discuss how a single parameter q tracks transitions in various structures, and what this reveals about chaos and localization in many-body quantum systems.

- Adrián Escobar Ruiz,
Departamento de Física, Universidade Autónoma Metropolitana, Unidad Iztapalapa, Mexico.

Geometry at fixed energy: nodal curves and information in degenerate quantum oscillator states

Abstract: What information about a quantum state is invisible to its energy? In a degenerate system, states with exactly the same energy can possess strikingly different spatial structures. We examine this freedom in the two-dimensional isotropic quantum harmonic oscillator. For real superpositions within a fixed energy shell, the zeros of the wavefunction

form algebraic nodal curves. Moving through the shell deforms these curves and can change their topology –through rotations, reconnections, or rearrangements of their large-distance branches– without changing the energy. These transitions are organized by finite singularities and degeneracies of the asymptotic nodal structure. This geometry also leaves a signature in the quantum probability distribution. Nodal-domain entropy measures how probability is redistributed among connected nodal regions, Cartesian mutual information captures correlations between spatial coordinates, and the position-momentum entropic sum probes global delocalization. The low-lying oscillator shells reveal a progression from rotating nodal lines to conic transitions and cubic branch rearrangements. We conclude by discussing possible realizations in Hermite-Gaussian structured light and trapped motional states, where nodal geometry can provide an experimentally accessible fingerprint of state preparation and energy-preserving quantum control.

- Angel M. Martínez-Argüello,
Instituto de Física, Benemérita Universidad Autónoma de Puebla, Mexico.

Onset of universality in the dynamical mixing of a pure state

Abstract: We study the time dynamics of random density matrices generated by evolving the same pure state using a Gaussian orthogonal ensemble (GOE) of Hamiltonians. We show that the spectral statistics of the resulting mixed state is well described by random matrix theory (RMT) and undergoes a crossover from the GOE to the Gaussian unitary ensemble (GUE) for short and large times respectively. Using a semi-analytical treatment relying on a power series of the density matrix as a function of time, we find that the crossover occurs in a characteristic time that scales as the inverse of the Hilbert space dimension. The RMT results are contrasted with a paradigmatic model of many-body localization in the chaotic regime, where the GUE statistics is reached at large times, while for short times the statistics strongly depends on the peculiarity of the considered subspace.

- Pablo Barberis Blostein,
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Delayed Non-Markovian Waveguide QED: Spontaneous Dark-State Generation and Quantum Memory

Abstract: We investigate the collective dynamics of two-level atoms and Lambda-type three-level atoms coupled to a one-dimensional waveguide in the non-Markovian regime. We study the emergence of superradiant decay and stationary entanglement in the two-level system, and investigate how finite propagation delays affect quantum memories based on Electromagnetically Induced Transparency (EIT) in the three-level system. By explicitly

accounting for the finite propagation time of light between the atoms, our model captures the resulting non-Markovian dynamics and provides a framework for studying delay-induced effects in collective quantum phenomena and quantum memory protocols.

- Ricardo Méndez Frago,
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Optical atoms as simulators of confined quantum systems

Abstract: This talk begins with a 21st-century reinterpretation of the Millikan experiment used to measure the electron's charge and its quantization. The setup employs a micrometer-sized oil droplet levitating between parallel plates subject to a potential difference. A low-intensity radioactive source emitting electrons is used; when these electrons collide with the droplet, it undergoes discrete jumps in charge proportional to integer multiples of the electron's charge. Subsequently, inspired by this experiment, we capture the scintillation of a levitating water droplet that evaporates under laser action, ultimately producing a spectrum analogous to that of an atom. This scintillation occurs because light entering the water droplet reflects repeatedly off the inner surface, circulating within. When the circumference is a multiple of the wavelength, the droplet acts as an optical resonance cavity, causing it to glow more brightly. As the droplet evaporates and shrinks, the resulting resonances exhibit a profile resembling Fano resonances –phenomena first discovered in atoms. The research demonstrates that light scattering by these droplets is equivalent to scattering by an atom, effectively turning the water droplet into a variable-sized.

- José Luis Hernández Pozos,
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Paul trap to a generalized elliptical trap at the turn of one parameter

Abstract: In this work, a generalized potential for the electrodynamic (Paul) trap is described. By changing such parameter, the geometry varies from a traditional quadrupole trap to configurations such as rectangular, elliptical or some intermediate figure. How the first stability region of such trap changes with respect to the traditional Paul trap is described. As ions trapped in Paul traps are also used as physical realizations for frequency standards or quantum computers, a better understanding of how nonlinearities of the trapping potential affect the trajectories of trapped ions and, in turn, how this may affect the dynamics of trapped ions is worth to study. We find that with this generalized potential, under certain circumstances chaotic behavior can be found for a single trapped ion.