Workshop on Open Quantum Systems and Quantum Information

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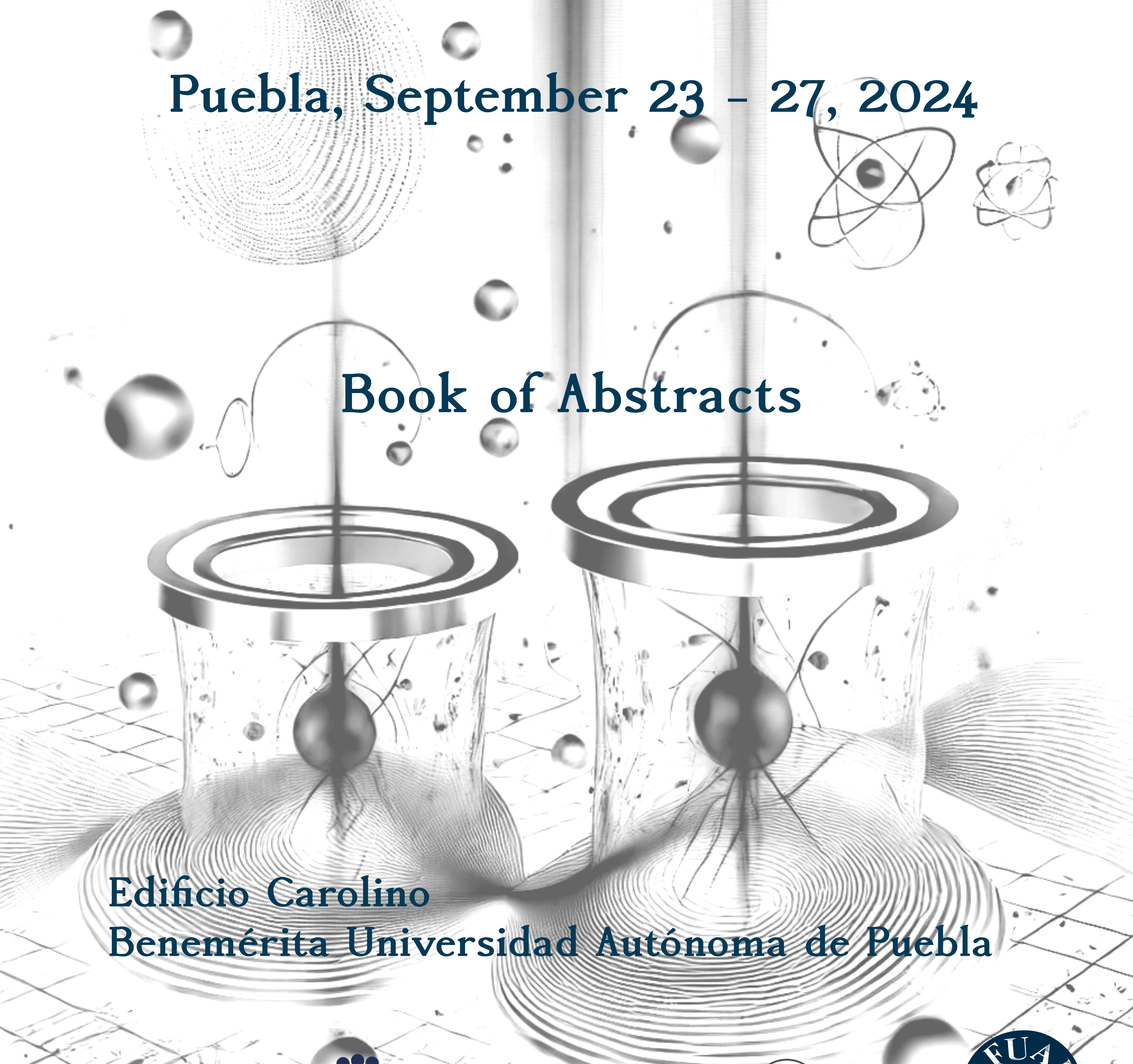

Book of Abstracts

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Contents

Talks

Decaimiento de dos átomos de dos niveles completamente excitados en electrodinámica cuántica de campos en guias de onda

Pablo Barberis
IIMAS-UNAM

Investigamos la dinámica colectiva de dos átomos, de dos niveles, distantes, acoplados a una guía de onda unidimensional, en el régimen no markoviano. Entre los resultados mas interesantes encontramos la creación espontanea de un estado entrelazado estacionario y decaimiento mas rápido que el encontrado en la superradiancia normal.

Computer-assisted design of entanglement purification protocols

Zsolt Bernad
Forschungszentrum Jülich

A method to optimize recurrence entanglement purification protocols is presented. The approach is based on a numerical search in the whole set of SU(4) matrices with a quasi-Newton algorithm. Our method evaluates average concurrences and is applied to the convex set of all two-qubit states. The resulting optimized protocols turn out to surpass former proposals by not wasting too many entangled states.

Quantum beats and their stationary and time-resolved spectra

Héctor Manuel Castro Beltrán
CIICAP-UAEM

Quantum beats are a hallmark of quantum interference and a basic tool in spectroscopy. They can be realized, for example, by interfering the two π (m=m') transitions in a two-level system with angular momentum structure J=1/2 - J'=1/2 and an applied magnetic field to break the level degeneracy. Preparing the atom in an initial superposition of both upper states, which is the case of spontaneous emission, the quantum beats are seen as a modulated decay of the total excited state population. On the other hand, by driving the atom with a monochromatic laser and preparing the atom in an initial superposition of both lower states, the case of resonance fluorescence, we find quantum beats in observables such as the emitted intensity and two-time correlations. If the laser and Zeeman fields are strong, the beats have well-defined mean and modulation frequencies. The spontaneous emission spectrum should acknowledge its transient nature, so we use the Eberly-Woódkiewicz (EW) time-dependent spectrum: it rises as a singlet and, after a time of the order of the filter filling time, it becomes a doublet and then fades. That is because there is only one photon to emit. For resonance fluorescence, the steady state (Wiener-Khinchin) spectrum has a Mollow-like spectrum with close doublets product of quantum beats. However, for an appropriate filter's bandwidth, signatures of these beats can be observed in the evolution of its EW spectrum.

Tunable Perfect Absorption of Microwave Radiation via Dielectric Slabs in Irregular Arrangements

John Alexander Franco
USLP

This study introduces a novel passive approach for achieving tunable perfect absorption of microwave radiation, employing non-Hermitian physics to manipulate electromagnetic waves without conductive elements. We can completely absorb electromagnetic energy by utilizing common dielectric slabs in irregular configurations within a rectangular waveguide, efficiently converting it into heat while minimizing conductive losses. This method contrasts with traditional metamaterials that rely on conductive components to absorb energy. Employing the transfer matrix method and Sequential Quadratic Programming for optimization, our research identifies specific non-uniform placements of FR4 slabs that maximize absorption within targeted

microwave bands. Experimental validation, executed in a standard WR90 waveguide connected to a vector network analyzer, confirms the theoretical and finite element simulation results, underscoring the effectiveness of our passive strategy. This work advances our understanding of non-Hermitian systems in electromagnetic wave control and offers significant potential for applications in reducing electromagnetic pollution and enhancing secure communications.

Waveguide QED with left-handed transmission line metamaterials: Localization properties and non-Markovian Dynamics

Carlos Gonzalez-Gutierrez
ICF, UNAM

Waveguide quantum electrodynamics has become an important experimental platform for demonstrating collective quantum effects, observing non-Markovian behavior, and simulating few and many-body quantum systems. Here we explore the use of left-handed transmission lines as waveguides interacting with a single qubit. We show the existence of bound states outside the continuum and present a complete study of the dynamics in the single-excitation sector. We show that the intrinsic memory of the transmission line gives rise to non-Markovian oscillations of the qubit population.

Normal quantum channels as error models for quantum devices

Thomas Gorin
UDG

Until today and in the near future only noisy intermediate-scale quantum (NISQ) machines will be available, where either error mitigation is more relevant than full quantum error correction or one will work right from the start with processes which are only partially coherent. In either case, sufficiently precise error and decoherence models are important. Cross talk errors, i.e. two- or more qubit errors are dominant in today's quantum information processing. Such errors have first been modeled by simple correlated Pauli channels, and more recently by Lindblad master equations. Both methods only allow to compute the resulting effective quantum channel, but fail to describe higher order averages – necessary to estimate statistical uncertainties of experimental finite sample averages. Here, we present an error model which is defined

in terms of a diffusive random walk in the group manifold of unitary operations. On the one hand, this induces a unital quantum channel, which we will call ‘normal’. On the other hand, it defines a unital quantum process, generated by a Lindblad master equation. Importantly, the harmonic analysis on the group allows to calculate the resulting quantum channel as well as higher order moments of this process. In this talk I will show examples which highlight the difference between classical and quantum cross talk, as well as the fact that different models can yield the same quantum channel, but different statistical uncertainties for experimental finite sample averages. Reference: Alejandro Contreras Reynoso and Thomas Gorin, JPA 57 (2024) 225301

Bloqueo de Fotones y su Rompimiento en el Limite de Pocos Cuerpos

Ricardo Gutiérrez Jáuregui
IFUNAM

Comportamientos emergentes en sistemas de muchos cuerpos siguen leyes universales que se vuelven aparentes en transiciones de orden-desorden. Estas transiciones tienen una larga historia en óptica cuántica que se remonta a la descripción del láser y—-aunque comúnmente se han explorado en el límite de muchos cuerpos—recientes avances experimentales permiten su extensión a sistemas de uno o pocos cuerpos. En este trabajo exploramos el límite de pocos cuerpos usando el modelo de Tavis-Cummings forzado y amortiguado como guía. Este modelo describe una colección de átomos acoplada a un modo de una cavidad forzada. El modelo presenta estados vestidos colectivos cuyas energías colapsan al aumentar la intensidad del forzamiento, dando asi una primera señal de una transición de fase en el sistema. Este colapso se da por etapas debido a las correlaciones interatómicas, mostrando asi un cambio fundamental respecto a resultados anteriores basados en campo medio. Mostramos el efecto de estas correlaciones sobre la luz de salida. Nuestro trabajo ejemplifica la importancia del límite de pocos cuerpos en la óptica cuántica, donde las correlaciones interatómicas pueden ser medidas con alta precisión, y su capacidad de unir los mundos microscópicos y macroscópicos.

Onset of universality in the dynamical mixing of a pure state

Angel M. Martinez-Argüello
IFUAP

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.

Non-Hermitian Hamiltonians in Optics: Make Your Own

Héctor Moya
INAOE

I show that the Markovian dynamics of two coupled harmonic oscillators can be analyzed using a Schrödinger equation and an effective non-Hermitian Hamiltonian. This is achieved by a non-unitary transformation involving superoperators that allows the Lindblad master equation to be rewritten in terms of a von Neumann-like equation with an effective non-Hermitian Hamiltonian.

Quantum Nonlinear Optics Mediated by Rydberg Atoms

Asaf Paris
IFUNAM

Exciting atoms in dilute cold gases to highly excited Rydberg states introduces an amplification mechanism where single photons can significantly impact the optical properties of surrounding atoms. By leveraging this phenomenon, a large ensemble of individual atoms can be transformed into a collective system that behaves like a single two-level emitter, exhibiting enhanced coupling to the optical driving field. This approach allows for strong, coherent interactions at the few-photon level, even in free space. In this talk, we present tools that exploit this principle to manipulate light at the few-photon level. Additionally, we will discuss the ongoing development of an experiment in Mexico City aimed at placing a cloud of cold atoms inside a low-finesse cavity to further explore the light-matter interaction through the collective atomic response.

Pauli component erasing quantum channels

Carlos Pineda
IFUNAM

Decoherence of quantum systems is described by quantum channels. However, a complete understanding of such channels, specially in the multi- particle setting, is still an ongoing difficult task. We propose the family of quantum maps that preserve or completely erase the components of a multi-qubit system in the basis of Pauli strings, which we call Pauli component erasing (PCE) maps. For the corresponding channels, it is shown that the preserved components can be interpreted as a finite vector subspace, from which we derive several properties and complete the characterization. Moreover, we show that the obtained family of channels form a semigroup and derive its generators. We use this simple structure to determine physical implementations and connect the obtained family of channels with Markovian processes.

Spectroscopy and critical quantum thermometry in the ultrastrong coupling regime

Ricardo Roman Ancheyta
CFATA-UNAM

We present an exact analytical solution of the anisotropic Hopfield model, and we use it to investigate in detail the spectral and thermometric response of two ultrastrongly coupled quantum systems. Interestingly, we show that depending on the initial state of the coupled system, the vacuum Rabi splitting manifests significant asymmetries that may be considered spectral signatures of the counterintuitive decoupling effect. Using the coupled system as a thermometer for quantum thermodynamics applications, we obtain the ultimate bounds on the estimation of temperature that remain valid in the ultrastrong coupling regime. We also show how the Eberly-Wódkiewicz physical spectrum can be used to describe the spectral response of interacting defects in amorphous materials and nonlinear quantum fields.

Certification of continuous variable entanglement and steering by using phase space methods

Laura Rosales
CIO

Entanglement and Einstein-Podolsky Rosen steering are two nonlocal quantum correlations that cannot be explained by a classical theory. They are also important resources for possible technological applications in both quantum information and quantum technologies. However, in some quantum information protocols it is also important to either certify if there is entanglement or steering, and also how to quantify it. On the other hand, there are different theoretical methods that can be used to certify these non-local quantum correlations. In this talk we will show how phase space methods, which has been widely used in quantum optics, can be used to certify both bipartite and tripartite quantum entanglement (steering). We well consider two different systems, where entanglement (steering) is generated by a non-linear process and then, by considering different entanglement (steering) criteria, we will show the regimes where bipartite as well as tripartite entanglement is certified.

Improving entanglement purification with generalized quantum measurements

Juan Mauricio Torres
IFUAP

Entanglement between distant quantum systems is a crucial resource for quantum communication. However, this property can be compromised by external factors and must be restored using efficient entanglement purification protocols. In this talk, we introduce entanglement purification protocols that utilize two-qubit non-unitary operations derived from generalized quantum measurements. By applying these protocols to various classes of two-qubit states, including random density matrices, we show that they outperform traditional recurrence purification schemes.

Universal distribution functions in the dynamics of interacting quantum systems

E. Jonathan Torres-Herrera
IFUAP

We investigate the long-time probability distribution function of observables where time evolution is governed by Hamiltonians modeling clean and disordered one-dimensional chains of many interacting and non-interacting spin-$1/2$ particles. Specifically, we focus on the survival probability and the spectral form factor. Our analysis is further enriched by studying few-body observables like the spin autocorrelation and connected spin-spin correlation functions, which are of particular relevance in experiments with quantum simulators. We demonstrate that the distribution function exhibits a universal shape provided the Central Limit Theorem holds. Notably, the survival probability and spectral form factor follow an exponential distribution, while the distribution is Gaussian for the observables. Additionally, we discuss the implications for the so-called many-body localization. Our approach requires only a single sample and small system sizes, offering significant advantages, specially for disordered systems.

A nonstationary electromagnetic cavity field with uniformly mirror motion and its photonic realization

Alejandro Urzua Pineda
ICF, UNAM

En 1994, C.K. Law presentó un Hamiltoniano efectivo para la interacción optomecánica en función de la dinámica de la frontera móvil que encierra a un campo electromagnético de N-modos en un medio dieléctrico no dispersivo. Recientemente, junto con colaboradores[1], se ha efectuado un análisis de este Hamiltoniano cuando la frontera experimenta movimiento a tasa de cambio espacial constante. Usando métodos algebraicos de transformaciones, es posible obtener la solución exacta bajo condiciones adecuadas de unitariedad. Se muestra, que debido a que los operadores involucrados en la ley dinámica pertenecen como generadores al álgebra simpléctica Sp(4, R), es posible entender este sistema como fotónico, en el cual la tasa de cambio representa un parámetro adecuado de acoplamiento entre elementos ópticos. Para $N = 2$ modos, se muestra la evolución del número promedio de fotones en cada modo, además de propiedades estadísticas dadas por el parámetro de Mandel, y la entropía lineal; además, la función de Wigner es usada para observar en el espacio-fase la generación de estados comprimidos.

Self-averaging: from isolated to open quantum systems

Isaías Vallejo-Fabila
University of Connecticut

The content of this talk is based on our latest published paper, Ref. [1]. In this paper we perform the self averaging analysis for the survival probability. The presence of self-averaging is important because it implies that the number of samples used in experiments and in numerical analysis can be decreased as the system size increases. We investigate how the dynamical fluctuations of many-body quantum systems out of equilibrium can be mitigated when they are opened to a dephasing environment. We consider the survival probability (spectral form factor with a filter) evolving under different kinds of random matrices and under a spin-1/2 model with weak and strong disorder. In isolated many-body quantum systems, the survival probability is non-self-averaging at any timescale, that is, the relative variance of its fluctuations does not decrease with system size. By opening the system, we find that the fluctuations are always reduced, but self-averaging can only be ensured away from critical points.

[1] I. Vallejo-Fabila, A. Kumar Das, D. A. Zarate-Herrada, A. S. Matsoukas-Roubeas, E. J. Torres-Herrera, and L. F. Santos, Reducing dynamical fluctuations and enforcing self-averaging by opening many-body quantum systems, Phys. Rev. B 110, 075138 (2024).

Short-Talks

Heat transport and rectification via quantum statistical and coherence asymmetries

Karen Palafox
CFATA-UNAM

Recent experiments at the nanoscales confirm that thermal rectifiers, the thermal equivalent of electrical diodes, can operate in the quantum regime. We present a thorough investigation of the effect of different particle exchange statistics, coherence, and collective interactions on the quantum heat transport of rectifiers with two-terminal junctions. Using a collision model approach to describe the open system dynamics, we obtain a general expression of the nonlinear heat flow that fundamentally deviates from the Landauer formula whenever quantum statistical or coherence asymmetries are present in the bath particles. Building on this, we show that heat rectification is possible even with symmetric medium-bath couplings if the two baths differ in quantum statistics or coherence. Furthermore, the associated thermal conductance vanishes exponentially at low temperatures as in the Coulomb-blockade effect. However, at high temperatures it acquires a power-law behavior depending on the quantum statistics. Our results can be significant for heat management in hybrid open quantum systems or solid-state thermal circuits.

Espectro, eigenestados y propiedades de transporte en sistemas PT-simétricos sencillos

Francisco Torres Arvizu
ICF, UNAM

En 1997 Carl Bender y Stefan Boettcher demostraron que los hamiltonianos no hermitianos que obedecen la simetría de paridad-tiempo (PT) pueden presentar un espectro real. A partir de este hecho, la simetría PT se ha establecido como un campo de la física que ha generado un especial interés por los muchos fenómenos físicos relacionados con ella. Sin embargo, uno de los aspectos menos explorados de estos sistemas son sus propiedades de transporte, siendo las pocas referencias a este tema limitadas a modelos tipo tight-binding y en menor medida a pozos de potencial, donde se ha reportado que el transporte de la densidad de probabilidad en la fase PT-simétrica es eficiente, mientras que la ruptura en la simetría PT hace que el sistema exhiba acumulación o pérdida de probabilidad. En este trabajo obtenemos y caracterizamos el espectro y los estados estacionarios de sistemas tipo pozo de potencial PT-simétrico y analizamos sus flujos de densidad de probabilidad y densidad de energía.

Motional states of a trapped ion as ancillary states for the cubic phase gate

Christian Ventura-Velazquez
IFUAP

We study the motional states of a trapped ion with characteristics suitable for their use as ancillary states for the cubic phase gate, which is necessary for universal quantum computation. We use the variance of a non-linear quadrature and the Wigner function to characterize those states. We found a new way to obtain acceptable ancillary quantum states in this model without using an additional cubic potential.

Lindblad equations for hybrid systems with strong internal coupling

Artemisa Villalobos
IFUAP

The Lindblad master equation, derived from first principles under Markovian assumptions, provides a framework for describing the time evolution of quantum systems under dissipative and decoherence processes. The open quantum systems are essential for understanding how the environment affects the system of interest. In this work, we apply the Lindblad master equation to study two two-level atoms and extend this focus to the Jaynes-Cummings model. Using a microscopic derivation, we present a dressed-state master equation formulated with Lindblad operators obtained from the eigensystem. We obtain that the eigensystem of the Liouville operator governing the master equation is constructed from the eigenvalues and eigenstates of a non-Hermitian effective Hamiltonian, formulated as a normal matrix. We provide a closed-form solution to the eigenvalue and eigenvector problem and emphasize the importance of a rigorous formulation of the master equation, as it is crucial for accurately predicting the behaviour of quantum systems in realistic scenarios, especially those involving strong internal coupling.

Generalized survival probability

David Abraham Zarate Herrada
IFUAP

The survival probability measures the probability that a non-equilibrium system is in some initial state at a given time. Motivated by the generalized entropies used to analyze non-ergodic states, we introduce a generalized version of the survival probability (SPq(t)) as well as a generalized local density of states (LDOSq). Using the one-dimensional spin-1/2 model with disorder, a typical model in the study of many-body localization, we compare the results for the LDOSq and the SPq(t) in the chaotic regime and far from it. We also compare results for the spin model with random matrices from the Gaussian orthogonal ensemble (GOE). We explore the behavior of the generalized quantities and investigate specific characteristics of these such as the power-law decay exponent of SPq(t) and the standard deviation of LDOSq. In the latter case, we propose an analytical expression for the entire evolution of the generalized survival probability for the case of GOE matrices.

Mini-Courses

Gleason's theorem with an outlook towards the Eilers-Horst theorem

Zsolt Bernád
Forschungszentrum Jülich

Spin-boson model in superconducting quantum cirtcits

Carlos Gonzalez-Gutierrez
ICF, UNAM

Posters

Manifestations of resonant poles on various scattering functions for potential scattering

Nelson Barrales Gonzalez
IFUAP

We analyzed the time delay , average dwell time, cross-section, effective path, and trapping probability for a one-dimensional, one-channel square well. The maxima of these quantities were compared with the poles of the S-matrix. We found patterns for the first and second resonances, with the pattern for the first resonances being $k_\omega \approx k_{T_I} < k_{\sigma_\phi} < \kappa \approx k_\tau < k < k_{T_D} < |K| \approx k_P$, and for the second resonances $k_\omega \approx k_{T_I} < k_{\sigma_\phi} \approx \kappa < k_\tau < k < k_{T_I} < |K| \approx k_P$. With the knowledge of the boundary conditions, we perform a one-level approximation in the R-matrix to obtain analytical expressions for the dispersion functions and for the S-poles. The one-level approximation agrees well with the patterns found numerically and with the values of the real and imaginary parts of the S-poles.

Sensibilidad del entrelazamiento a perturbaciones de sistemas cuánticos de muchos cuerpos

Francisco Correa Alvarado
IFUAP

Estudiamos la entropía de entrelazamiento haciendo uso de un sistema de L partículas con espín 1/2 acomodada cada una en cada uno de los sitios de una cadena unidimensional, sujetas a una sola perturbación en la dirección z a la mitad de la cadena. En particular se estudia como la entropía de entrelazamiento de los estados propios de energía se comporta conforme se varía la magnitud de la perturbación. Nuestro estudio también incluye la estadística de niveles energéticos, así como la estructura de estados propios del sistema. Nuestros resultados numéricos muestran que el enfoque basado en la entropía de entrelazamiento bipartita es equivalente al enfoque de caos cuántico basado en el análisis de la estadística espectral y la estructura de estados propios de energía[1]. Específicamente conforme la perturbación se incrementa a partir del cero, el sistema transita de un punto integrable a una fase caótica con valores propios de energía correlacionados[2] estados propios extendidos cercanamente como aquellos de matrices aleatorias del así llamado ensamble guassiano ortogonal[3] y entropía de entrelazamiento similar a la de estados puros aleatorios[4] Para este modelo una pequeña perturbación a la mitad de la cadena nos permite transicionar de un régimen integrable a uno caótico, esta transición modifica la extensión de los estados propios del Hamiltoniano, se observa que el promedio de la razón de participación aumenta junto con el valor de la perturbación al pasar del sistema integrable al caótico, finalmente podemos ver el grado de entrelazamiento de los estados propios del Hamitloniano también es dependiente del valor de la perturbación, se observa que la distribución de estos cambia conforme a esta, finalmente el valor promedio aumenta al pasar de un régimen al otro de igual forma que con la razón de participación.

[1] E. J. Torres-Herrera and L.F. Santos J. Karp, M. Távora. Realistic many-body quantum systems vs. full random matrices: Static and dynamical properties. Entropy, 18 (10):359, 2016.

[2] L. F. Santos, F. Pérez-Bernal, and E. J. Torres-Herrera. Speck of chaos. Phys. Rev. Res., 2(4):043034, 2020.

[3] N. Ullah. Invariance hypothesis and higher correlations of Hamiltonian matrix elements. Nucl. Phys., 58:65–71, 1964. URL https://doi.org/10.1016/0029-5582(64) 90522-X.

[4] L. Vidmar and M. Rigol. Entanglement entropy of eigenstates of quantum chaotic Hamiltonians. Phys. Rev. Lett., 119(22):220603, 2017.

Static Properties of the Aubry-André Model with PT Symmetry

Steven Galván
IFUAP

El interés por la simetría PT y por sistemas que ostentan este tipo de simetría ha ido en aumento en los últimos años, en el presente trabajo mostramos algunos resultados obtenidos al analizar ciertas propiedades estáticas del modelo unidimensional de Aubry-André con simetría PT: la estructura de los estados propios, el espectro de energía, la transición metal-aislante del sistema, étc...; Haciendo uso de herramientas de la teoría de matrices aleatorias entre otras.

Modelo de Holstein-Cummings para una molécula en una cavidad

Ana Fernanda Hernández Bravo
IFUAP

Se describe el modelo de una molécula restringida a dos estados electrónicos y un modo fonónico atrapada en una cavidad que interactúa con un modo óptico del campo de radiación mediante el hamiltoniano de Holstain-Tavis-Cummings. A través de un desplazamiento del modo vibracional, se observa una estructura similar a la conocida en el modelo de Rabi y utilizando una aproximación de onda rotante, es posible reducir el modelo a una colección de modelos de Jaynes-Cummings fuera de resonancia llegando a un modelo efectivo válido bajo el régimen de acoplamiento fuerte, de esta manera logramos proponer una solución analítica aproximada, que nos permite emplear algunos resultados conocidos para el modelo de Jaynes Cummings.

Time series approach to the metal-insulator transition in the Aubry-André model

Miriam Jiménez Valdez
IFUAP

We characterize the metal-insulator transition in the one-dimensional Aubry André model (with and without interactions) by using the squared module of the Fourier transform of spacings between adjacent energy levels, that is through so-called power spectrum. We also study some properties of the system in the chaotic regime and localized regime.

Blinking resonance fluorescence and quantum jump trajectories

Kevin Martínez Franco
CIICAP-UAEM

Blinking resonance fluorescence is the interesting effect of the random temporal interruption of the fluorescence in a strong transition by passage to a metastable state. It has various uses in optics, such as monitoring weak transitions for atomic clocks and fluorescence microscopy. It also spurred investigations on the problem of measurement in quantum mechanics. One case is the nature of quantum jumps. This was a prime detonator of the use of quantum trajectories or Monte-Carlo wave-function methods. We study theoretically the resonance fluorescence of a three-level atom using quantum jump trajectories, which simulate photocount measurements, obtaining statistical information of the emitted field, such as the length of the bright and dark periods and their probability distributions, and consequences of the slow decay scale on the spectrum, following the experiment by Bühner and Tamm [Phys. Rev. A 61, 061801 (2000)] on a 171Yb ion in a Paul trap. KVM thanks CONAHCYT for a scholarship.

Quantum thermal machine as a rectifier

Moroni Santiago García
INAOE

Heat can flow through a bridge consisting of two interacting qubits that connect a hot and a cold reservoir. This system represents the simplest autonomous quantum thermal machine, consuming incoherent resources and delivering quantum entanglement. Our study demonstrates that such a machine, and its generalization to hybrid quantum structures, can also operate as a thermal rectifier, displaying asymmetric heat conduction. In the strong coupling regime, the machine exhibits an asymmetric Rabi-type splitting in the thermal conductance, resulting in increased heat transport and higher values of thermal rectification. Interestingly, in the weak coupling regime, heat rectification is independent of the length of the qubit chain.

The trapped ion model as a tool to generate ancillary states with cubicity.

Christian Ventura-Velazquez
IFUAP

We present an analytical study of the time evolution of the quantum states of a trapped ion. Then, we find conditions to obtain ancillary states with a good performance measured with the variance of a non-linear quadrature. Numerically, we compare the results obtained with the full model and the approximated solution.

Lindblad master equation for two two-level atoms with strong internal coupling

Artemisa Villalobos
IFUAP

The study of open quantum systems is crucial for understanding the effects of the environment on a quantum system of interest. The Lindblad master equation provides the most general description for open Markovian systems and is able to describe the time evolution under dissipative and decoherence effects induced by the environment. In this work we consider two strongly interacting two-level atoms coupled to an environment of harmonic oscillators. Using a microscopic derivation, a dressed-state master equation is presented to describe the dynamics of the system. This equation is written in terms of Lindblad operators obtained from the eigenstates of the central system. The eigensystem of the Liouville operator, which determines the master equation, is constructed from the eigenvalues and eigenstates of a non-Hermitian effective Hamiltonian, which in this construction turns out to be a normal matrix. We present a closed solution to the eigenvalue and eigenvector problem of the master equation and compare our results with the phenomenological model found in the literature. We also discuss possible generalisations of this problem to other models, such as the Jaynes-Cummings model. Finally, we emphasise the importance of applying a rigorous formulation of the master equation, which is crucial for predicting the behaviour of quantum systems in more realistic contexts, in particular those that exhibit strong internal coupling.

Author Index