- **Zsolt Bernad**: *Volume ratios and detectability of entangled states in bipartite quantum systems.*

    - ...

- **Ralf Betzholz**: *Lindblad master equations for quantum systems coupled to dissipative bosonic modes.*

    - We present a general approach to obtain effective Lindblad master equations for a subsystem whose dynamicsis coupled to dissipative bosonic modes. This master equation relies on a Schrieffer-Wolff transformation tech-nique where a unitary displacement operator is determined self-consistently for the specific quantum system athand. In order to show the validity of this method we apply it to the description of optomechanical cooling of a cantilever and present a cavity-assisted ground-state preparation of an Ising chain.

- **Moisés Carrera**: *Onset of universality in the dynamical mixing of a pure state.*

    - 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 Gaussian orthogonal ensemble 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 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.

- **Alessandro Corbetta** (***ICF Colloquium***[1]): *Active flow of pedestrian crowds: from large-scale measurements to variational modeling.*

    - Pedestrians walk and choose their direction based on individual objectives and instantaneous traffic: this yields high variability in crowd dynamics, from diluted to dense regimes. Despite the unpredictability of single individuals, ensemble-level universal physical features emerge. These encompass frequent fluctuations and rare events within *solo* dynamics, mutual interactions, as well as routing choices. Reaching a quantitative understanding of these features is a major scientific challenge retaining great societal impact (e.g., in the design of civil infrastructures or crowd management measures), and sharing deep connections with the statistical physics of active matter.

      To move towards a quantitative physics-based understanding of crowd dynamics, over the previous years, we established large-scale observational experiments held in real-life settings (stations, festivals, museums), aimed at investigating statistical features of pedestrian motion. Via homemade high-fidelity tracking systems, we have collected datasets including millions of trajectories acquired with and without external influencing stimuli (i.e., crowd control measures, like signage or visual cues). In this talk, I will discuss the issue of modeling in (statistically) quantitative terms the observed dynamics, including PDFs of individual velocity, position, body rotation mutual-contact-avoidance, as well as path choice, based on Langevin-like equations and variational principles.

- **Rocío Gómez Rosas**: *Entangling operations in nonlinear two-atom Tavis-Cummings models.*

[1] Via an independent Zoom video conference (`ID 830 6128 4607`), or by YouTube.

- Entanglement between two quantum systems that are spatially separated is an important resource in order to implement quantum communication tasks. We propose the study of general operations on two qubits in order to improve the efficiency of entanglement purification. Furthermore we proposed the implementation of a quantum operation using a nonlinear Tavis Cummings model and we derive an analytical approximate solution of the time-dependent state vector in terms of material Bell states and coherent states of the field for a generalized two-atom Tavis-Cummings model with nonlinear intensity dependent matter-field interaction. Using this solution, we obtain simple expressions for the atomic concurrence and purity in order to study the entanglement in the system at specific interaction times. We show how to implement entangling atomic operations through measurement of the field.

- **Francisco González**: *Atom scattering off a vibrating surface: An example of chaotic scattering with three degrees of freedom.*

  - We study the classical chaotic scattering of a He atom off a harmonically vibrating Cu surface. The three degree of freedom (3-dof) model is studied by first considering the non-vibrating 2-dof model for different values of the energy. The set of singularities of the scattering functions shows the structure of the tangle between the stable and unstable manifolds of the fixed point at an infinite distance to the Cu surface in the Poincaré map. These invariant manifolds of the 2-dof system and their tangle can be used as a starting point for the construction of the stable and unstable manifolds and their tangle for the 3-dof coupled model. When the surface vibrates, the system has an extra closed degree of freedom and it is possible to represent the 3-dof tangle as a deformation of a stack of 2-dof tangles, where the stack parameter is the energy of the 2-dof system. Also for the 3-dof system, the resulting invariant manifolds have the correct dimension to divide the constant total energy manifold. By this construction, it is possible to understand the chaotic scattering phenomena for the 3-dof system from a geometric point of view. We explain the connection between the set of singularities of the scattering function, the Jacobian determinant of the scattering function, the relevant invariant manifolds in the scattering problem, and the cross-section, as well as their behavior when the coupling due to the surface vibration is switched on. In particular, we present in detail the relation between the changes as a function of the energy in the structure of the caustics in the cross-section and the changes in the zero level set of the Jacobian determinant of the scattering function.

- **Carlos González Gutiérrez**: *Ultrastrong waveguide-QED with giant quantum emitters.*

  - The coupling of a single quantum emitter to a continuum of electromagnetic modes is an important problem since the birth of quantum theory. In most scenarios emitters (atoms) are described as point-like particles of negligible size compared with the wavelength of the electromagnetic radiation. This justifies the standard dipole approximation widely employed in quantum optics. In recent years, however, experiments with artificial emitters have led to a reconsideration of atoms as point-like matter, giving rise to new engineered quantum systems with non-local interactions exhibiting non-Markovian properties. In this talk, we will discuss the extension of such systems to the non-perturbative light-matter regime. We will discuss the low energy physics at equilibrium and out-of-equilibrium employing variational polaron methods.

- **Thomas Gorin**: *Linear PT-symmetric Hamiltonians and their dynamics on the Bloch sphere.*

  - ...

- **Peter Hess**: *The role of the Pauli Principle in Nuclear Models.*

- Group theory is a quite powerful tool to construct a basis for a model, or to develop a first idea about the structure of a complicated system. Unfortunately, occasionally the group theory is taken too seriously, i.e., more than a tool, without a relation to the physics involved, creating quite successful models. The talk discussed two main areas: The nuclear structure model, i.e., geometric model versus the Interacting Boson Model, and recently developed alpha-cluster models. We show that the omission of the obviously important implementation of the Pauli exclusion principle can nevertheless lead to successful, though flawed, theories. The talk starts quite general from a system of n degrees of freedom and how a model can be constructed, without further relying of physics. Then the examples will be discussed and compared. The present contribution is meant as a warning on overestimating the role of group theory.

- **Felix Izrailev**: *Thermalization in isolated quantum systems of interacting particles.*

  - ...

- **Christof Jung**: *An example of a horseshoe in a 4-dimensional Poincare map*

  - The chaotic invariant set of a 3-dof Hamiltonian system is presented. Its central parts are two NHIMs and their stable and unstable manifolds. The mapping of the internal structure of the NHIMs into the homoclinic/heteroclinic intersection surfaces is shown. The construction of the 4-dimensional horseshoe of the full 3-dof system over the 2-dimensional horseshoe of the horizontal subsystem is explained.

- **Mario Kieburg**: *Computing Entanglement Entropy with Random Matrix Theory.*

  - The eigenstate thermalisation hypothesis is one of the most important problems in modern quantum information theory to be understood. It happens that eigenstates of chaotic quantum systems look in a generic subsystem as if they were thermalised. This means that their entropy is almost completely maximal. For generic pure states in an Hilbert space this leads to the famous Page curve which says that in the thermodynamical limit of large system and subsystem size the entanglement entropy is maximal. This result can be deduced with random matrix theory as the corresponding physical ensemble is a Haar-distributed co-set. Very recently, we carried over this idea to subclasses of pure states. One of these classes are the Gaussian fermionic states. The corresponding matrices are known as embedded random matrix ensembles implying that the matrix size grows exponentially with the degrees of freedom of the system. Also generic states of this kind can be dealt with exactly, and we have found that the entanglement entropy is not maximal anymore though the curve seems to follow a universal result as numerical simulations of spin systems show. I will report on these new developments.

- **Ulrich Kuhl**: *Microwave studies of the three chiral ensembles in chains of coupled dielectric resonators.*

  - After an introduction of the three standard RMT ensembles and their corresponding microwave realizations, I present a microwave setup allowing to realize the three chiral random matrix ensembles. As the experiment allows only to measure small systems, where the corresponding matrix is tridiagonal we derive analytic descriptions for the density of states and their correlation for small matrices and compare them to the experimental findings. Even though, due to the finite system size, the results are not universal still the experiment shows the universal behavior in the vicinity of zero energy.

- **Ivan Kukuljan**: *Entanglement in quantum field theory.*

  - Entanglement is the crucial property that distinguishes quantum from classical systems. It is also the key resource for quantum technologies ranging from quantum computation to quantum communication. In the talk, I'll give a very short introduction into entanglement. I'll then give a short introduction into entanglement in quantum field theory (QFT). Finally, I'll present our recent work where we have developed a new method to compute entanglement in QFT.

- **Pablo López Vázquez**: *Solutions to linear dissipative quantum systems.*
  - We use the characteristic function of the Wigner function (its double Fourier transform) to give solutions to any generic open quantum linear systems (systems whose Hamiltonian is at most quadratic). The solution is carried out in terms of the application of the transition matrix of the dynamical evolution in the Fourier space. We address two cases: the time-independent coefficients for which we give the solutions for several dissipative models of the quantum harmonic oscillator and the one-dimensional free particle. In the latter, we also derive a heuristic model for a pure damped motion with suppression of diffusion. For the time-dependent coefficient problem, we give some particular cases that are integrable. We additionally explore the solutions of the system when the diffusion processes of the dissipative model lie beyond the weak coupling limit.
- **Parisa Majari**: *Photonic realization of the κ-deformed Dirac equation.*
  - We show an implementation of a κ-deformed Dirac equation in tight-binding arrays of photonic waveguides. This is done with a special configuration of couplings extending to second-nearest neighbors. Geometric manipulations can control these evanescent couplings. A careful study of wave packet propagation is presented, including the effects of deformation parameters on Zitterbewegung or trembling motion. In this way, we demonstrate how to emulate the effects of a flat noncommutative spacetime—i.e., κ-Minkowski spacetime—in simple experimental setups.
- **Bryan Manjarrez**: *Vanishing-dispersion mechanical metamaterial in 1D.*
  - ...
- **Ángel Martínez Argüello**: *Microwave graph analogs for the voltage drop in three-terminal devices with orthogonal, unitary, and symplectic symmetry.*
  - Transmission measurements through three-port microwave graphs are performed, in analogy to three-terminal voltage drop devices with orthogonal, unitary, and symplectic symmetry. The terminal used as a probe is symmetrically located between two chaotic subgraphs, and each graph is connected to one port, the input and the output, respectively. The analysis of the experimental data clearly exhibits the weak localization and antilocalization phenomena. We find a good agreement with theoretical predictions, provided that the effects of dissipation and imperfect coupling to the ports are taken into account.
- **Rafael Méndez**: *Emulation of benzene and borazine pi-orbitals using elasticity*
  - ...
- **Bruno Taketani**: *Co-designing quantum accelerators for high-performance computing*
  - ...
- **Mauricio Torres**: *Lindblad master equations without gain in the weak and strong coupling regime.*

- Lindblad master equations have been quite successful in the theory of open quantum systems. The dynamical equation includes a unitary part representing the properties of a central system, and a dissipative part that accounts for the unavoidable losses to an environment. For central systems composed of weakly coupled subsystems, a valid approach describes the dissipation without taking into account the interaction between the subsystems. This approach is no longer valid in the strong coupling regime, where a careful derivation of the master equation reveals the presence of combined decay mechanisms. In this talk, the solution to the eigenvalue problem of certain Lindblad master equations without any source of gain will be presented. In particular, it will be shown that some of these equations, although more complicated at first sight, present a simpler solution in the strong coupling regime.

- **Jonathan Torres Herrera**: *Signatures of thermalization and chaos in the dynamics of isolated interacting quantum systems.*
  - ...

- **Isaías Vallejo**: *Analysis of the Aurich-Steiner conjecture in one-dimensional interacting quantum systems.*
  - A way to detect chaotic behavior in the time evolution of a given quantum system with chaotic classical limit was proposed by R. Aurich and F. Steiner in 1999. Specifically, in the context of two- and three-dimensional quantum billiards, it was conjectured that given an extended initial state, the distribution in time of the survival amplitude follows an universal Rayleigh shape when the classical counterpart of the quantum system is chaotic, otherwise the distribution is simply non-universal. This approach is relevant for theoretical and experimental studies since a single sample is needed for the analysis; furthermore, it could be useful in finding chaotic signatures in experiments with trapped ions or cold atoms that routinely study dynamics and do not have access to the energy spectrum. Here we explore this conjecture for one-dimensional quantum many-body systems with no classical analog. In particular, by studying the late time values of the so-called survival probability (squared survival amplitude) and spectral form factor we show that their distributions are universal whenever the Central Limit Theorem holds at the level of the energy spectrum and initial state components. In addition, observables of experimental interest as the spin-spin autocorrelation function and the connected spin-spin correlation function have a Gaussian distribution when the Central Limit Theorem holds[2].

- **Manan Vyas**: *Eigenvector structure in many-body quantum systems: Conditional q-normal form.*
  - ...

- **Marko Žnidarič**: *Non-Hermitian phantoms in random circuits.*
  - A study of random quantum circuits and their avearge dynamics reveals that the relaxation rate is not necessarily given by the gap of the relevant transfer matrix. Due to non-Hermiticity a many-body explosion of expansion coefficients can happen, resulting in the rate that is either faster, or, even more interestingly, slower than predicted by the largest eigenvalue. This new phenomenon leading to a multistage thermalization of entanglement and OTOC is identified in a number of different random circuits.

[2] Authors: I. Vallejo-Fabila and E. J. Torres-Herrera