Quantum Africa 7

September 22-26 | 2025

Kenitra, Morocco

Main Goals

Foster meaningful dialogue between scientific reaserchers and industry professionals within the quantum sector.

Provide a platform for discussion and the exchange of experience between national and international stakeholders, particulary African ones, on the topic of quantum technology

Covered Topics

Bell-Like Experiment Aspects

Quantum Thermodynamics

Quantum Open Systems

Quantum Circuit

Measurements and Quantum Probabilities

Foundations, History, Pedagogy of Quantum

Mathematical Aspects of Quantum

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International Conference Quantum Africa 7th Edition
Kenitra, Morocco

First Day — Monday 22/09/2025

09:00-09:30	Welcoming	
09:30-10:00		Coffee Break
10:00-10:50	Plenary Speaker:	Jean-Marc Lévy-Leblond, Université de Nice, France Title : Enigmas of the sp^hin^x
10:50-11:20	Invited Speaker:	Arkady Fedorov, University Of Queensland, Australia Title : Superconducting no-reciprocal devices on a chip
11:20-11:50	Invited Speaker:	Ahmed Jellal, Université Chouaib Doukkali, El Jadida, Morocco Title : Transport properties of semimetals and transition metal chalcogenides
11:50-12:20	Invited Speaker:	Abdessamad Belfakir, Vanguard Center UM6 Polytechnic, Morocco Title : Directional Optimal Control of Nonadiabatic Motional Dynamics
12:30-14:00		Lunch
14:20-14:50	Invited Speaker:	Khadija El Anouz, FST El Hoceima-University Abdelmalek Essaadi, Morocco Title : Fractional Calculus Approaches to Quantum Information Theory
14:50-15:20	Invited Speaker:	Mourad Telmini, Université de Tunis, Tunisia Title : From Cold Atoms to Quantum Algorithms: Building Quantum Technology Capabilities at UTM
15:20-15:50	Invited Speaker:	Abdellah Sebbar, University of Ottawa, Canada Title : Quantum cohomology and representation theory of quantum groups
15:50-16:20		Coffee Break
16:20-16:50	Invited Speaker:	Matteo G. A. Paris, Università degli Studi di Milano, Italy Title : Multiparameter quantum estimation for quantum technology
16:50-17:10	Contributed Talk:	Felix Hartmann, University of Postdam, Germany Title : Non-Markovian phonon bath kernel in magnetization dynamics
17:10-17:40	Invited Speaker:	Fadwa El Ayachi, Faculty of Sciences, Mohammed V of Rabat, Morocco Title : Enhancing quantum support vector machines using multipartite entanglement
17:40-18:00	Contributed Talk:	Loubna El Ouaourti, Faculty of sciences Semlalia, Marrakech, Morocco Title : Bohr Hamiltonian with a Sextic Potential for Axially Symmetric Quadrupole Octupole Even–Even Nuclei

Second Day — Tuesday, 23/09/2025

09:00-09:50	Plenary Speaker:	Andreas Buchleitner, Albert-Ludwigs-Universität Freiburg, Germany Title : Inference of Interference
09:50-10:20	Invited Speaker:	Gerardo Adesso, University of Nottingham, England Title : Quantum processes as thermodynamic resources: the role of non-Markovianity
10:20-11:00		Coffee Break
11:00-11:30	Invited Speaker:	Mostafa Mansour, FS Ain Chock, Université Hassan II, Casablanca, Morocco Title : Vers une révolution énergétique quantique

11:30-12:00	Invited Speaker:	Nicolas J. Cerf, Université Libre de Bruxelles, Belgium Title : Anomalous Boson Bunching
12:30-14:00		Lunch
14:00-14:50	Plenary Speaker:	Romain Murenzi, Worcester Polytechnic Institute, USA Title : A purely Geometrical Aharonov-Bohm Effect
14:50-15:10	Contributed Talk:	Abderrahman Oularabi, FST El Hoceima, Morocco Title : Enhancing Ergotropy of Quantum Batteries through Coherence and Non-Markovianity
15:10-15:30	Contributed Talk:	Achraf Khoudiri , FST El Hoceima, Morocco Title : Quantum Information Erasure in Non-Markovian Environments : Insights from a Two-Qubit Thermal Machine
15:30-15:50	Contributed Talk:	Samanta Piano, University of Nottingham, United Kingdom Title : Quantum Theory for Surface Crack Detection
15:50-16:10	Contributed Talk:	Kaoutar El Bachiri, Faculty of Sciences, Mohammed V of Rabat, Morocco Title : Quantum Formalism in R^3 for Color Perception
16:10-16:30	Contributed Talk:	Wissal Guelfani, Vanguard Center UM6 Polytechnic, Morocco Title : Advancing quantum control for computational applications : Optimal control of molecular systems
16:30-17:00		Coffee Break
17:00-17:20	Contributed Talk:	Anas El Azizi, Vanguard Center UM6 Polytechnic, Morocco Title : Optoelectronic and thermodynamic DFT studies of a novel 2D octagonal material
17:20-17:40	Contributed Talk:	Hajar Belmahi, Faculty of Sciences, Mohammed V of Rabat, Morocco Title : Light Deflection by Rotating Regular AdS Black Holes
17:40-18:00	Contributed Talk:	Maryem Jemri, Faculty of Sciences, Mohammed V of Rabat, Morocco Title : Stability and Criticality Behaviors of Accelerating Charged AdS Black Holes in Rainbow Gravity
18:00-19:00		Poster Session

Third Day Wednesday, 24/09/2025

09:00-09:50	Plenary Speaker:	Daniel Braun, Institut für Theoretische Physik,Universität Tübingen, Germany Title : Quantum functional testing
09:50-10:20	Invited Speaker:	Thomas Konrad, University of KwaZulu-Natal, South Africa Title : Monitoring and Control of Quantum Systems
10:20-11:00		Coffee Break
11:00-11:50	Plenary Speaker:	Mahouton N. Hounkonnou, University of Abomey-Calavi, Benin Title : Nonlinear vector coherent states for an electron-phonon model in an f−deformed oscillator algebra: main properties and quantization of phase space observables
11:50-12:20	Invited Speaker:	Philippe Faist, Freie University Berlin, Germany Title : Complexity in thermodynamics from first principles
12:20-12:50	Invited Speaker:	Evaldo M. F. Curado, CBPF, Rio de Janeiro, Brazil Title : Quantum circuit complexity for linearly polarized light
12:50-13:10	Contributed Talk:	Ayoub Ouahhabi, Faculty of Sciences, Univ. Mohammed I, Oujda, Morocco Title : On Generalized Stirling Numbers of the Second Kind and Generalized Bell Numbers

13:20-14:30	Lunch
	Excursion
18:00	Presentation & Round Table
20:30	Gala Dinner

Fourth Day — Thursday, 25/09/2025

09:00-09:50	Plenary Speaker:	Yahya Tayalati, University V of Rabat & UM6 Polytechnic, Morocco Title : Probing Fundamental Physics: Light-by-Light Scattering with ATLAS, the Search for Exotic Particles with ANTARES, and New Horizons with KM3NeT
09:50-10:20	Invited Speaker:	Sanae Samsam, INFN Sezione di Milano, Italy Title : Compact Light Sources for Morocco : A strategic Step Towards the African Light Source
10:20-11:00		Coffee Break
11:00-11:30	Invited Speaker:	Laure Gouba, ICTP, Trieste, Italy Title : Role des qubits dans l'intrication quantique et la teleportation quantique
11:30-11:50	Contributed Talk:	Otman Bouladiane, Université Chouaib Doukkali, El Jadida, Morocco Title : Impact of Anisotropy on Rarita-Schwinger Energy Spectrum.
11:50-12:10	Contributed Talk:	Kamal Azaidaoui, Université Chouaib Doukkali, El Jadida, Morocco Title : Open Quantum System Approach To Graphene Transpot
12:10-12:30	Contributed Talk:	Zakariae Jellal, Faculty of Sciences, Univ. Mohammed V of Rabat, Morocco Title : Conductivity behavior in multi-Weyl semimetals.
12:30-12:50	Contributed Talk:	Saad Eddine Baddis, Faculty of Sciences, Mohammed V of Rabat, Morocco Title : Swampland Statistics for Black Holes
12:50-14:20		Lunch
14:30-15:20	Plenary Speaker:	Janet Anders, University of Postdam, Germany \ University of Exeter, U.K Title : Equilibrium states and thermalization in strong coupling thermodynamics
15:20-15:40	Contributed Talk:	Youssef Aiache, FST El Hoceima-University Abdelmalek Essaadi, Morocco Title : Non-equilibrium quantum sensing of temperature
15:40-16:00	Contributed Talk:	Chayma El Asbihani, Faculty of Sciences, Mohammed V of Rabat, Morocco Title : Security Analysis of Quantum and Semi-Quantum Key Distribution
16:00-16:30		Coffee Break
16:30-16:50	Contributed Talk:	Leila Zahhafi, African Institute for Mathematical Sciences, Rwanda Title : From QAOA to adaptive quantum optimization: Enhancing variational circuits with machine learning
16:50-17:10	Contributed Talk:	Hajar Azzouzi, Abdelmaelk Essaadi University of Tetouan, Morocco Title : Advancing Medical Image Classification through Quantum Machine Learning: The Critical Role of Data Encoding
17:10-18:00	Grand Public	Jean-Marc Lévy Leblond, Université de Nice, France Title : Mots et maux de la physique quantique Critique épistémologique et problèmes terminologiques

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Last Day **Friday, 26/09/2025**

10:00-11:30 **Panel Session**

Title : **Global and Inclusive Access to Quantum Science and Technology**

Moderator :
Dr. Philipp Kammerlander, Quantum Center, ETH Zurich, Switzerland

Panelists :
Dr. Fadwa El Ayachi, Faculty of Sciences, University of Mohammed V, Rabat, Morocco
Prof. Mohamed Ouchrif, Mohammed First University, Oujda, Morocco
Prof. Abdelouahed El Fatimy, School of Applied and Engineering Physics Director, UM6P, Morocco
Dr. Farai Mazhandu, Africa Quantum Consoritum

12:30-14:45		Lunch
14:45-15:05	Contributed Talk:	Mohamed Ait Bahadou, FST El Hoceima, Morocco Title : Magnetic Flux Tuned Quantum Transport in Quantum Dot–Coupled Topological Nanowires
15:05-15:25	Contributed Talk:	Zakaria Bouameur, Faculty of Sciences Rabat, Univ. Mohammed V, Morocco Title : Qudits for SU(n) covariant integral quantizations
15:25-15:45	Contributed Talk:	Souhail El Khayyat, FST El Hoceima, Univ. Abdelmalek Essaadi, Morocco Title : Directional Quantum Amplification in Detuned Parametric Amplifier Arrays with Complex Linear Couplings.
15:45-16:05	Contributed Talk:	Mourad Benzahra, FS Ain Chock – University of Hassan II, Morocco Title : Quantum Machine Based on a Two-Spin-½ Heisenberg Model with Symmetric and Antisymmetric Spin-Orbit Interactions
16:05-16:25	Contributed Talk:	Hajar Assil , FST El Hoceima, Univ. Abdelmalek Essaadi, Morocco Title : Quantum Extreme Learning Machine for quantum channel discrimination
16:25-16:45	Contributed Talk:	Abderrahim Bouhouch, Faculty of Sciences,Mohammed V of Rabat, Morocco Title : Distinguishing 5D Black Hole Physics in M-theory on a Calabi-Yau Manifolds
16:45-17:15	Invited Speaker:	Jonathan Oppenheim, University College London, England **[Remote]** Title : Decoherence vs diffusion: testing the quantum nature of gravity
17:15-17:45	Invited Speaker:	Mauro Paternostro, Universita di Palmero,Italy **[Remote]** Title :
18:00	Closing	

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List of Abstracts

First Day — Monday 22/09/2025

09:00-09:30 Welcoming

09:30-10:00 Coffee Break

10:00-10:50 Plenary Speaker: Jean-Marc Lévy-Leblond, Université de Nice, France

Title : Enigmas of the sp^hin^x

Abstract :

Beyond the well-known epistemological and foundational problems of quantum theory (measurement theory, entanglement, classical limit, etc.), there are others conceptual questions which have been somewhat neglected in the past decades.

We will discuss six of these open questions, all connected with the notion of spin:

- The riddle of the position operator (or Dirac vs Wigner)
- The puzzle of the intrinsic magnetic moment
- The spin-forces connexion
- The spin-statistics connexion
- The spin-charges connexion
- Why no spin renormalization?

10:50-11:20 Invited Speaker: Arkady Fedorov, University Of Queensland, Australia

Title : Superconducting no-reciprocal devices on a chip

Abstract :

Electromagnetic wave propagation is typically reciprocal, in which scattering is invariant under the exchange of the source and the receiver. However, breaking reciprocity is essential for realising nonreciprocal devices which find applications in numerous fields, including quantum technologies based on superconducting circuits. In particular, nonreciprocal devices such as circulators and isolators route signals and isolate devices from noise, and are crucial components in cryogenic environments such as superconducting circuits.

Conventional ferrite circulators are bulky and not compatible with microfabrication or with superconducting circuits, and thus unsuitable for very-large-scale superconducting microwave networks. Given the drive to scale up superconducting quantum computers, designs for integrated microwave circulators on a chip are becoming critical.

In this talk, I will describe several approaches to building passive non-reciprocal devices on a chip using superconducting quantum circuits. First, I will consider a device that exhibits non-reciprocal transmission based on the quantum nonlinearity of superconducting qubits. I will then show our results on building an on-chip circulator based on a Josephson-junction loop, where non-reciprocity is achieved by a weak magnetic field. Finally, I will describe our recent results on building a circulator based on the effective motion of a synthetic medium.

11:20-11:50 Invited Speaker: Ahmed Jellal, Université Chouaib Doukkali, El Jadida, Morocco

Title : Transport properties of semimetals and transition metal chalcogenides

Abstract :

Semimetals and transition-metal chalcogenides (TMCs) have become focal points in quantum materials research, particularly in exfoliated forms with just a few atomic layers. Charge carriers near the Dirac points of semimetals such as graphene, Dirac semimetals, and Weyl semimetals behave as massless relativistic particles, following a linear energy–momentum relation. This unique band structure gives rise to phenomena such as Klein tunneling and the chiral anomaly—effects that were once confined to high energy accelerators, but are now accessible on a tabletop. TMC monolayers, such as MoS_2 and WSe , exhibit contrasting yet equally rich behavior. Their finite band gap separates $_2$ the conduction and valence bands, however, electrons in the K and K valleys behave like ′ massive Dirac fermions. Strong spin-orbit coupling and valley-dependent responses further open pathways to spintronics and valleytronics applications, establishing TMCs as essential components of next-generation quantum devices. In my presentation, I will introduce a new family of two-dimensional quantum materials spanning both semimetals and TMCs and examine how their exotic electronic properties evolve under tunable external forces, such as magnetic fields, laser driving, and electrostatic barriers. Through these controlled perturbations, we aim to understand the quantum dynamics that govern transport, coherence, and topological effects in these systems at the nanoscale.

11:50-12:20	Invited Speaker:	Abdessamad Belfakir, Vanguard Center UM6 Polytechnic, Morocco Title : Directional Optimal Control of Nonadiabatic Motional Dynamics Abstract : In this work, we investigate the optimal control of molecular systems undergoing transitions between coherent states characterized by complex coefficients. Using Hölder's inequality, we derive a mathematical bound relating the energy cost of control to the distance between initial and target coherent states. Our approach is applied to the H_2O molecule, focusing on the local OH bond, where we demonstrate how the required control energy depends on the separation between the states. We also examine the influence of environmental coupling by introducing a thermal bath and analysing its effect on the controllability of transitions to different final coherent states. These states are constructed as approximate eigenvectors of the Generalized Heisenberg Algebra (GHA) annihilation operator. Building on the GHA framework, we revisit Morse-type coherent states previously used for diatomic molecules, offering refined insights into quantum state control dynamics under realistic conditions.
12:30-14:00		Lunch
14:30-15:00	Invited Speaker:	Khadija El Anouz, FST El Hoceima-University Abdelmalek Essaadi, Morocco Title : Fractional Calculus Approaches to Quantum Information Theory Abstract : A fractional quantum state has created between two-qubit system by a Heisenberg XYZ model in the presence of the Dzyaloshinskii–Moriya (DM) interaction. The impact of the initial state settings and the interaction parameters on the amount of the quantum correlation is discussed. We used the concurrence and local quantum uncertainty to quantify these correlations.It is shown that, both quantifiers increase suddenly/gradually depending on the order of the fractional state, and whether the system is

ferromagnetic or anti-ferromagnetic. The fractional parameter may increase/ stabilized the memory of the generated fractional state. Small values of the DM interaction can maximize the initial quantum correlation of a partial entangled state. The possibility of using these fractional time-dependent states as quantum channels to perform quantum teleportation has examined. It is shown that, preparing the system in anti-ferromagnetic regime improves the fidelity of the teleported state. The strength of the DM interaction and the fractional's order has a clear effect on the fidelity's behavior, where they may be used as control parameters to increase the efficiency of the fractional quantum channel in the context of quantum communication.

15:00-15:30 Invited Speaker: Mourad Telmini, Université de Tunis, Tunisia

Title : From Cold Atoms to Quantum Algorithms: Building Quantum Technology Capabilities at UTM

Abstract :

The rapid advancement of quantum technologies relies on progress in two key areas: quantum sensing with cold atoms and quantum computing. This talk will overview the growing education and research initiatives in these fields at the University of Tunis El Manar. First, we will explore our work at the LSAMA laboratory on laser-cooled atoms and Bose-Einstein condensates. I will discuss our theoretical studies on coherent control, atom interferometry, and manipulation in optical lattices for applications in quantum metrology and tests of fundamental physics. Second, we will shift to quantum computing, focusing on harnessing quantum superposition and entanglement to solve classically intractable problems. I will present our recent results using the Variational Quantum Eigensolver (VQE) and Quantum Machine Learning (QML) for calculating molecular potential energy curves - a critical step toward modeling complex quantum systems. We will conclude with a perspective on our roadmap for expanding these research activities, including the development of new table-top experiments.

15:30-16:00 Invited Speaker: Abdellah Sebbar, University of Ottawa, Canada

Title : Quantum cohomology and representation theory of quantum groups

Abstract :

In this talk, we explore a deep connection between the geometry and quantum cohomology of configuration spaces and the representation theory of quantum groups. In the finite-dimensional setting, the relevant representations are Verma modules of quantum groups. In the infinite-dimensional case, we examine q analogs of Wakimoto modules arising from the bosonization of quantum affine algebras.

15:50-16:20 Coffee Break

16:20-16:50 Invited Speaker: Matteo G. A. Paris, Università degli Studi di Milano, Italy

Title : Multiparameter quantum estimation for quantum technology

Abstract :

Quantum metrology leverages quantum resources to enhance measurement precision beyond classical limits. This involves two key steps: suitably encoding the parameter of interest into a quantum system's state and designing an efficient measurement strategy to extract the encoded information. In this talk, I will first introduce the fundamentals of single-parameter quantum estimation theory, which provides the framework for optimizing these tasks and establishing ultimate quantum limits on parameter estimation. Then, I will discuss recent advances in multiparameter quantum estimation, where

correlations among parameters (sloppiness) and the non-commutativity of their respective optimal measurements (incompatibility) make the optimization highly non-trivial, yet also open new opportunities for quantum-enhanced sensing and technology.

16:50-17:10 Contributed Talk: Felix Hartmann, University of Postdam, Germany

Title : Non-Markovian phonon bath kernel in magnetization dynamics

Abstract :

The study of open quantum systems shows us that nature does not behave in a Markovian manner unless rather strong assumptions are applied. Although this is a fundamental principle, non-Markovian signatures have only been observed in a few experiments to date [1,2]. Using an open quantum system approach to magnetisation dynamics [3], I will show how a non-Markovian phonon bath kernel gives rise to a complex frequency spectrum in the mag netisation dynamics. Such a complex frequency spectrum has been observed experimentally in a thin Cobalt film on ultrafast timescales [4]. The obtained results show a great qualitative agreement between theory and experiment whereby all relevant parameters are determined by the experiment. In addition, I will show that this agreement of the frequency spectra between theory and experiment holds at different temperatures. This work paves the way of understanding the role of non-Markovian bath kernels on short time scales in magnetism experiments and more broadly new experiments able to explore dy namics on ultrafast timescales.

References :

[1] K. H. Madsen et al., Phys. Rev. Lett. 106 233601 (2011)

[2] J. Haase et al., Phys. Rev. Lett. 121 060401 (2018)

[3] J. Anders et al., New J. Phys. 24 033020 (2022)

[4] V. Unikandanunni et. al., Phys. Rev. Lett. 129 237201 (2022)

17:10-17:40 Invited Speaker: Fadwa El Ayachi, Faculty of Sciences, Mohammed V of Rabat, Morocco

Title : Enhancing quantum support vector machines using multipartite entanglement

Abstract :

The quantum support vector machine (QSVM) uses quantum computing to enhance machine learning tasks, offering potential speedups over classical counterparts. A critical factor influencing QSVM performance is the initialization of the quantum circuit. This paper explores the impact of initializing the circuit with various entangled states on the accuracy of QSVMs. By systematically analyzing different types of entangled states, such as GHZ states, W states, X states, and cluster states, we aim to uncover their effects on the quantum feature space and classification outcomes. Our results indicate that genuine entanglement can significantly boost the classification accuracy of QSVMs on a variety of benchmark datasets, showcasing their potential to outperform separable methods in complex problem domains. For instance, in the Fashion dataset, the entangled kernel achieved up to a 10% improvement in accuracy, while in the Penguins dataset, the |GHZ〉 4 state increased precision by 18% compared to the separable case. These findings contribute to the development of more effective quantum kernel methods and highlight the importance of initial state preparation in quantum machine learning.

17:40-18:00 Contributed Talk: Loubna El Ouaourti, Faculty of sciences Semlalia, Marrakech, Morocco

Title : Bohr Hamiltonian with a Sextic Potential for Axially Symmetric Quadrupole Octupole Even–Even Nuclei

Abstract :

We present an extended application of the analytic quadrupole octupole axially symmetric model, originally employed to study the octupole deformation and vibrations in light actinides using an infinite well potential (AQOA-IW). In this work, we extend the model's applicability to a broader range of nuclei exhibiting octupole deformation by incorporating a sextic potential (AQOA-S) instead of the Davidson potential (AQOA-D). By employing the sextic potential, phenomenologically represented as $v(\beta) = a_1\beta^2 + a_2\beta^4 + a_3\beta^6$, we solve the radial equation within the framework of a quasi-exactly solvable (QES) model. This allows us to derive analytical expressions for the energy spectra and transition rates (B(E1), B(E2), B(E3)). The energy spectra of the model are essentially governed by two critical parameters: φ_0, indicating the balance between octupole and quadrupole strain, and α, a key factor in adjusting the shape and behavior of the spectra through the sextic potential. In terms of applications, the study encompasses five isotopes, namely ^{222}– ^{226}Ra and ^{224}, ^{226}Th. Significantly, our model demonstrates remarkable agreement with the corresponding experimental data, particularly for the recently determined B(EL) transition rates of ^{224}Ra, surpassing the performance of the model that employs the Davidson potential. The stability of the octupole deformation in ^{224}Ra adds particular significance to these findings.

Second Day Tuesday, 23/09/2025

09:00-09:50 Plenary Speaker: Andreas Buchleitner, Albert-Ludwigs-Universität Freiburg, Germany

Title : Inference of Interference

Abstract :

09:50-10:20 Invited Speaker: Gerardo Adesso, University of Nottingham, England

Title : Quantum processes as thermodynamic resources: the role of non-Markovianity

Abstract :

Quantum thermodynamics studies how quantum systems and operations may be exploited as sources of work to perform useful thermodynamic tasks. In real-world conditions, the evolution of open quantum systems typically displays memory effects, resulting in a non-Markovian dynamics. The associated information backflow has been observed to provide advantage in certain thermodynamic tasks. However, a general operational connection between non-Markovianity and thermodynamics in the quantum regime has remained elusive. Here, we analyze the role of non-Markovianity in the central task of extracting work via thermal operations from general multitime quantum processes, as described by process tensors. By defining a hierarchy of four classes of extraction protocols, expressed as quantum combs, we reveal three different physical mechanisms (work investment, multitime correlations, and system-environment correlations) through which non-Markovianity increases the work distillable from the process. The advantages arising from these mechanisms are linked precisely to a quantifier of the non-Markovianity of the process. These results show in very general terms

how non-Markovianity of any given quantum process is a fundamental resource that unlocks an enhanced performance in thermodynamics.

10:20-11:00		Coffee Break
11:00-11:30	Invited Speaker:	Mostafa Mansour, FS Ain Chock, Université Hassan II, Casablanca, Morocco Title : Vers une révolution énergétique quantique Abstract : Les technologies quantiques transforment en profondeur de nombreux domaines de la science et de l'ingénierie. Le calcul quantique offre des gains exponentiels en puissance de traitement, la cryptographie quantique permet des protocoles de sécurité inédits, la simulation quantique explore des systèmes physiques inaccessibles aux méthodes classiques, et la métrologie accroît la précision des mesures fondamentales. Ces avancées reposent sur des phénomènes tels que la superposition, l'intrication et la cohérence, qui ouvrent la voie à des dispositifs aux performances inédites. Au-delà de ces applications déjà établies, un domaine émerge avec force : le stockage et la conversion de l'énergie à l'échelle quantique. Dans ce contexte, les batteries quantiques (BQ) se présentent comme une plateforme stratégique. Elles se caractérisent par trois indicateurs : la capacité, définissant l'énergie maximale stockable ; l'ergotropie, mesurant la fraction d'énergie convertible en travail ; et la puissance, liée à la vitesse de charge et de décharge. Leur optimisation dépend non seulement des propriétés individuelles des constituants, mais aussi des effets collectifs et des interactions quantiques, introduisant des mécanismes absents dans les batteries classiques. Nous étudions deux modèles complémentaires. Le premier repose sur un système dipolaire magnétique soumis à un champ de Zeeman et aux interactions Dzyaloshinsky–Moriya (DM) et Kaplan–Shekhtman–Entin-Wohlman–Aharony (KSEA). Les résultats montrent que, même sous bruit de déphasage et à température finie, l'ajustement des champs et des interactions peut compenser la dégradation des ressources quantiques et améliorer la capacité, la puissance et l'ergotropie. Le second modèle s'appuie sur deux qubits supraconducteurs couplés, en interaction avec un réservoir thermique. Il relie analytiquement cohérence quantique et performances énergétiques, et met en évidence le rôle des énergies de Josephson et de couplage dans l'optimisation du stockage et de la redistribution de l'énergie. Ces travaux confirment que le réglage précis des paramètres, des interactions et des effets de champ est essentiel pour exploiter le potentiel des batteries quantiques. Ils placent ces dispositifs émergents, aux côtés de l'informatique, de la cryptographie et de la simulation quantiques, parmi les technologies clés susceptibles de transformer durablement le paysage scientifique et technologique
11:30-12:00	Invited Speaker:	Nicolas J. Cerf, Université Libre de Bruxelles, Belgium Title : Anomalous Boson Bunching Abstract : As is well known, two indistinguishable photons impinging on a balanced beam splitter are always detected together in the same output mode as a result of a destructive suppression of coincidence events. This is the seminal Hong-Ou-Mandel effect. The complementarity principle dictates that such a quantum interference effect becomes less pronounced as soon as we are able to distinguish the photons and trace back which paths they have taken. Accordingly, if our two photons have orthogonal polarization, they behave like classical balls and are transmitted or reflected independently of each other with a probability 1/2. This trend is commonly admitted to reflect a general rule, namely that bunching must

be maximum for indistinguishable photons and gradually decline if photons are made distinguishable.

Intriguingly, by exploiting a connection between quantum optical interferometry and the theory of matrix permanents, we have challenged this rule and shown that bunching may possibly exceed this presumed limit of fully indistinguishable particles. This violation may arise when injecting partially distinguishable photons in specific interferometers and monitoring their bunching on several output modes. We exhibit an instance of such an anomalous bunching phenomenon in an optical linear interferometer involving 7 photons in 7 modes. Even more surprisingly, we show that anomalous bunching may be observed with nearly indistinguishable particles by applying a well-chosen perturbation to the state of ideal, i.e., perfectly indistinguishable, photons. Again, we exhibit an example of this highly unexpected behavior with 8 photons in a 10-mode interferometer. These counterintuitive phenomena take their roots in counterexamples that have recently been found to long-standing conjectures on matrix permanents. They deeply questions our understanding of multiparticle quantum interference in the grey zone between ideal bosons and classical particles.

12:30-14:00		Lunch
14:00-14:50	Plenary Speaker:	Romain Murenzi, Worcester Polytechnic Institute, USA Title : A purely Geometrical Aharonov-Bohm Effect
14:50-15:10	Contributed Talk:	Abderrahman Oularabi, FST El Hoceima, Morocco Title : Enhancing Ergotropy of Quantum Batteries through Coherence and Non-Markovianity Abstract : In this paper, we propose a model to examine the charging process of an open quantum battery, without using an external source, within the framework of the decoherence induced by the thermal environment. It consists of considering an open quantum battery that interacts with its environment through an auxiliary two-level quantum charger. This study focuses on a feasible charging device, where we investigate the exchange of information, work extraction and its maximum quantity, namely ergotropy from the quantum battery to its surroundings. Our results demonstrate that the ergotropy and internal energy are basically enhanced in the non-Markovian regime more than the Markovian one, including coherence and its time-derivative on the battery dynamics.
15:10-15:30	Contributed Talk:	Achraf Khoudiri , FST El Hoceima, Morocco Title : Quantum Information Erasure in Non-Markovian Environments : Insights from a Two-Qubit Thermal Machine Abstract : We investigate the validity of the Landauer principle in the context of a non-Markovian environment, employing a quantum autonomous thermal machine (QATM) comprised of two qubits attached to different Markovian thermal reservoirs, coupled to a single qubit acting as a quantum coherence reservoir (working qubit). We numerically demonstrate that the non-Markovianity, arising from correlations exchanged between the QATM and the work qubit, influences the Landauer bound. We analyze both fermionic and bosonic reservoirs and show that the QATM, operating as a single entity, interacts with the work qubit at an effective virtual temperature, leading to a violation of the conventional Landauer bound. Consequently, we derive a lower bound for the minimal energy dissipation required to erase information during the energy exchange.

The QATM's information engine properties and impact on the work qubit are characterized by monitoring coherence and population dynamics, revealing oscillating populations and nonmonotonic coherence decay.

15:30-15:50 Contributed Talk: Samanta Piano, University of Nottingham, United Kingdom

Title : Quantum Theory for Surface Crack Detection

Abstract :

Surface crack detection represents a critical challenge in surface metrology, particularly in the manufacture of safety critical components where reliability is paramount. Industries such as aerospace and automotive engineering rely heavily on precise crack detection, since components are routinely exposed to high levels of stress and fatigue. Traditionally, surface variations and cracks are measured using tactile profilometry. This method employs a fine stylus that traces the material's surface, with its vertical displacements recorded to reconstruct the profile. While widely used, tactile profilometry suffers from key drawbacks: it is slow, requires physical contact, and may risk damaging delicate surfaces. These limitations motivate the search for alternative, non contact approaches. Optical surface metrology offers a promising alternative by exploiting light for surface measurement. Techniques such as interferometry and confocal microscopy can generate high resolution three dimensional reconstructions rapidly and without contact. However, their accuracy is fundamentally constrained by optical diffraction, as described by the Rayleigh criterion, which limits the resolution achievable with direct intensity imaging. Although long considered insurmountable, this limit has recently been challenged by advanced approaches that leverage richer information contained in the quantum properties of light. Building on these insights, we reframe the task of surface crack detection as a problem of statistical hypothesis testing between quantum states corresponding to different image configurations. By employing Chernoff information as a performance metric, we benchmark conventional measurement strategies against the ultimate quantum limit given by the quantum Chernoff bound. Our results demonstrate that spatial mode demultiplexing, a novel measurement technique, significantly outperforms direct imaging and approaches the quantum limit for resolving cracks smaller than the diffraction scale. While further investigation is required, these findings highlight the potential of advanced optical metrology to deliver faster, non invasive, and more precise defect detection. Beyond manufacturing, such quantum enhanced measurement strategies may also enable breakthroughs in diverse fields, from exoplanet imaging in astronomy to quality control in semiconductor fabrication.

15:50-16:10 Contributed Talk: Kaoutar El Bachiri, Faculty of Sciences, Mohammed V of Rabat, Morocco

Title : Quantum Formalism in R^3 for Color Perception

Abstract :

This work explores the use of quantum formalism to model color perception beyond classical approaches. By representing colors as quantum states in a three-dimensional Hilbert space associated with SO(3), we capture both coherence and uncertainty in perception. Quantum information tools such as entropy, fidelity, and quantum distances are applied to characterize the distinguishability and information content of colors, opening perspectives for applications in vision science, quantum-inspired technologies, and medical imaging.

16:10-16:30 Contributed Talk: Wissal Guelfani, Vanguard Center UM6 Polytechnic, Morocco

Title : Advancing quantum control for computational applications : Optimal control of molecular systems

Abstract :

Controlling quantum phenomena has long been a primary goal of research in quantum physics and chemistry. The main objective of quantum control theory is to establish a solid theoretical foundation and develop systematic methods for the active manipulation of quantum systems. Our work focuses on the theoretical formulation and numerical implementation of quantum optimal control strategies. We employ algorithms such as gradient-based methods, the Krotov algorithm, and other iterative schemes to design control fields capable of steering quantum states with high precision. As a demonstration, we apply quantum optimal control techniques to the Morse potential, a realistic model that describes vibrational motion in diatomic molecules.

16:30-17:00		Coffee Break

17:00-17:20 Contributed Talk: Anas El Azizi, Vanguard Center UM6 Polytechnic, Morocco

Title : Optoelectronic and thermodynamic DFT studies of a novel 2D octagonal material

Abstract :

Inspired by our recent investigations in connection with Lie Algebras, we engineer a novel 2D material with an octagonal structure offering a geometry going beyond known configurations. To approach such a novel 2D material, we use the density functional theory formalism to unveil data on the associated carbon behaviors. Employing numerical techniques by help of the Quantum Espresso code via the Generalized Gradient Approximations, we examine certain physical properties including the optoelectronic and thermodynamic ones. Among others, we find that the proposed 2D material exhibits metallic and thermal behaviors with potential applications. Concretely, we compute and discuss the dielectric function, the absorption spectra, the refractive index, and the reflectivity. Then, we discuss certain thermodynamic quantities. We show that the proposed geometry could be exploited in 2D material activities to reveal extra physical characteristics for photovoltaic and thermoelectric potential applications.

17:20-17:40 Contributed Talk: Hajar Belmahi, Faculty of Sciences, Mohammed V of Rabat, Morocco

Title : Light Deflection by Rotating Regular AdS Black Holes

Abstract :

Using the Gauss–Bonnet theorem, we analyze light deflection by rotating regular black holes with a cosmological constant. Within optical geometry, we examine Hayward and Bardeen solutions, highlighting the cosmological constant’s impact on the deflection angle. We identify additional correction terms that extend previous results and compare our findings with Kerr spacetime. The analysis shows that non-linear electrodynamic charges alter spacetime geometry, leading to a reduced deflection angle in cosmological black holes.

17:40-18:00 Contributed Talk: Maryem Jemri, Faculty of Sciences, Mohammed V of Rabat, Morocco

Title : Stability and Criticality Behaviors of Accelerating Charged AdS Black Holes in Rainbow Gravity

Abstract :

In this work, we investigate the thermodynamical properties of accelerated charged Anti-de Sitter black holes in the context of rainbow gravity. Concretely, we compute the corresponding quantities needed to study the thermal stability and the critical behaviors including the phase transitions. Linking the acceleration parameter A and the horizon radius

r_h via a constant parameter a, we discuss the P−V criticality behaviors by calculating the critical pressure P_c, the critical temperature T_c, and the critical specific volume v_c in terms of a and the rainbow gravity parameter ε. As a result, we find that the ratio $\frac{P_c v_c}{T_c}$ is a universal number with respect to the charge. In the small limits of the external black hole parameters, we recover the Van der Waals fluid behaviors. After that, we examine the Joule-Thomson expansion effects for such black holes. We observe that the similarities and the differences with Van der Waals fluids depend on the region parameters.

18:00-19:00	Poster Session

Third Day — Wednesday, 24/09/2025

09:00-09:50 Plenary Speaker: Daniel Braun, Institut für Theoretische Physik,Universität Tübingen, Germany

Title : Quantum functional testing

Abstract :

Quantum Functional Testing With increasing complexity of quantum-information-processing devices, testing their functionality becomes a pressing and difficult problem. "Quantum Functional Testing" refers to the decision problem of accepting or rejecting a quantum device based on specifications provided by the producer and limited experimental evidence. The decision should be reached as quickly as possible, yet with as high confidence as possible. The task is therefore fundamentally different from quantum tomography, where one seeks as complete characterization of a quantum state or a quantum channel as possible. Here we review and propose several tools and principles for quantum functional testing, ranging from the formalism of truncated moment sequences, over statistics of the lengths of measurement sequences, to coherent enhancement of deterministic errors, automated experimental design for maximum information gain with non-greedy Bayesian parameter estimation, and finally pattern-based functional testing of quantum memories.

09:50-10:20 Invited Speaker: Thomas Konrad, University of KwaZulu-Natal, South Africa

Title : Monitoring and Control of Quantum Systems

Abstract :

In this presentation we discuss the possibility to monitor and control individual quantum systems such as ions and photons by means of measurements, which transfer possibilities in the quantum realm to facts in the classical world. Is it possible to design a quantum system that navigates towards a target, circumventing obstructions, without such an interface to the classical world? I attempt to give an answer to this question.

10:20-11:00	Coffee Break

11:00-11:50 Plenary Speaker: Mahouton N. Hounkonnou, University of Abomey-Calavi, Benin

Title : Nonlinear vector coherent states for an electron-phonon model in an f−deformed oscillator algebra: main properties and quantization of phase space observables

Abstract :

In this talk, we provide a construction of a dual pair of nonlinear coherent states (NCS) for an f−deformed oscillator algebra in electron-phonon dynamics. We discuss the existence and properties of reproducing ker

nel in the NCS Hilbert space, as well as the probability density and its dynamics in the basis of constructed coherent states. We present a Glauber-Sudarshan P−representation of the density matrix and address rel evant issues related to the reproducing kernel properties. Furthermore, we perform a NCS quantization of classical phase space observables, and illustrate it on q-deformed coherent states. Finally, we give some associated quantum optical properties.

11:50-12:20 Invited Speaker: Philippe Faist, Freie University Berlin, Germany

Title : Complexity in thermodynamics from first principles

Abstract :

I will present techniques based on the resource theory of thermodynamics and quantum information theory to quantify operational physical properties of many-body systems which might be undergoing complex dynamics. In particular, I will discuss how the resource-theoretic picture can accommodate the concept of complexity. Quantum circuit complexity measures the difficulty of realizing a quantum process, such as preparing a state or implementing a unitary. I will consider the prototypical task of information erasure, or Landauer erasure, where an n-qubit memory is reset to the all-zero state. In this setting, I'll show that the trade-off between the thermodynamic work and computational complexity required for erasure is determined by the complexity entropy, which quantifies the entropy a system appears to have to an observer of limited computational power. In a second part of my talk, I will introduce maximum-entropy methods for quantum channels and I will discuss their use as a toolbox to learn and model complex quantum dynamics.

12:20-12:50 Invited Speaker: Evaldo M. F. Curado, CBPF, Rio de Janeiro, Brazil

Title : Quantum circuit complexity for linearly polarized light

Abstract :

We investigate a measure of quantum circuit complexity applicable to open quantum systems. To demonstrate our approach, we examine a model in which the projective Hilbert space of states is represented by orientations in the Euclidean plane. Specifically, we analyze the dynamics of mixed quantum states as they interact with a sequence of quantum gates designed to optimally steer the state from a reference state toward a target state, minimizing deviations from the intended trajectory. Our framework involves the study of sequences of real 2×2 density matrices. This formalism finds a physical realization in Stokes density matrices, which describe the linear polarization of a quasi-monochromatic light beam, while the gates are modeled as quantum polarizers—each also represented by real 2×2 density matrices. The interaction between a polarizer and linearly polarized light is rigorously described within this quantum-mechanical framework. Between successive gate operations, the evolution of the light's density matrix follows a dynamics analogous to a Gorini-Kossakowski-Lindblad-Sudarshan (GKLS) process. Notably, when an upper bound is imposed on the tolerance (or precision) of the gate sequence, we find that the number of gates required scales according to a power law. This scaling provides an upper bound of the complexity.

12:50-13:10 Contributed Talk: Ayoub Ouahhabi, Faculty of Sciences, Univ. Mohammed I, Oujda, Morocco

Title : On Generalized Stirling Numbers of the Second Kind and Generalized Bell Numbers

Abstract :

In quantum field theory, normal ordering problem is crucial in quantifying classical Hamiltonians, it resolves ordering ambiguities, avoids vacuum divergences, and simplifies mean values Calculations in coherent states. The process of writing the normal ordering form of an arbitrary function of creation and annihilation operators $F(a, a^{\dagger})$ is generally a nontrivial challenge. The universal method provided by the Wick theorem [1] is unfortunately limited and can not give explicit solutions for problems involving more complicated operators as polynomials or functions expresses as infinite series. An alternative method, based on combinatorics and generating functions particularly on the use of the Bell and Stirling numbers, has been introduced in a seminal paper of J. Katriel [2] to overcome this technical problem and so the normal ordering problem for general quantum operator functions can be solved. Since then, This approach has been widely followed to investigate the normal ordered form of many useful functions $F(a, a^{\dagger})$, and also extended to the q-deformed versions of the Heisenberg algebra. In this presentation we extend this method to the generalized Heisenberg algebra introduced by Curado and Rego-Monteiro in [3] which is characterized by a characteristic function generating the energy spectrum of the corresponding quantum system. We show that the corresponding generalized Stirling numbers of the second kind are operator functions of the Hamiltonian satisfying a generalized recurrence relation to which we give the general solution. Then, we introduce the generalization of Bell polynomials and associated numbers, and looking for the normal ordering form of operators functions. In this framework, it is possible to go beyond the quantum harmonic oscillator or its q-deformed versions which appear as particular cases associated with specific characteristic functions. In this regard, we provide explicit generalized Stirling numbers of the second kind and generalized Bell numbers associated with the quantum infinite square well potential and investigate the normal ordering problem based on its corresponding generalized Heisenberg algebra. these results are published in [4] and [5].

References :

[1] Gian-Carlo Wick, "The evaluation of the collision matrix". Physical review 80.2 (1950), 268.

[2] J Katriel, "Combinatorial aspects of boson algebra". Lett. Nuovo Cimento 10.13 (1974), 565–567.

[3] EMF Curado, MA Rego-Monteiro, "Multi-parametric deformed Heisenberg algebras: a route to complexity". Journal of Physics A: Mathematical and General 34.15 (2001), 3253.

[4] A Ouahhabi, EH Tahri, "On generalized normal ordering and generalized Stirling operators".Physics Letters A 525 (2024), 129917.

[5] A. Ouahhabi, E. H. Tahri, "On generalized Bell numbers and normal ordering problem". International Journal of Geometric Methods in Modern Physics (2025). Manuscript ID: 00845R1.

13:20-14:30	Lunch
	Excursion
18:00	Presentation & Round Table
20:30	Gala Dinner

Fourth Day Thursday, 25/09/2025

International Conference Quantum Africa 7th Edition
Kenitra, Morocco

09:00-09:50 Plenary Speaker: Yahya Tayalati, University V of Rabat & UM6 Polytechnic, Morocco

Title : Probing Fundamental Physics: Light-by-Light Scattering with ATLAS, the Search for Exotic Particles with ANTARES, and New Horizons with KM3NeT.

Abstract :

Light-by-light scattering, a rare quantum electrodynamics process, has recently been observed with the ATLAS detector at the Large Hadron Collider, providing a powerful test of the Standard Model and a window onto possible new physics. In parallel, the ANTARES neutrino telescope has explored the deep sea to search for exotic particles such as magnetic monopoles and nuclearites, pushing the boundaries of multimessenger astrophysics.

Building on this legacy, KM3NeT, a next-generation neutrino observatory, is currently under construction and has been taking data in partial detector configuration for several years now. It not only promises unprecedented sensitivity to cosmic neutrino sources and searches for beyond-Standard-Model phenomena but has already achieved a remarkable milestone with the detection of an ultra-high-energy neutrino event, a breakthrough that opens a new observational window. In this talk, I will present recent highlights from ATLAS and ANTARES and discuss the exciting new perspectives opened by KM3NeT in the quest to uncover new physics.

09:50-10:20 Invited Speaker: Sanae Samsam, INFN Sezione di Milano, Italy

Title : Compact Light Sources for Morocco : A strategic Step Towards the African Light Source

Abstract :

Accelerator physics drives advances in medicine, industry, cultural heritage, and fundamental research, yet Africa remains underrepresented in this field. Compact Light Sources (CLS) based on Inverse Compton Scattering go back to the roots of quantum physics, as they exploit the quantum nature of light, which was experimentally proven by Arthur Compton 100 years ago, to generate advanced beams of X-ray and gamma-ray photons. With moderate investment (≈ $10 M), CLS can be hosted on a university campus, providing monochromatic, high-brightness X-rays (5–300keV) for applications in medical imaging, biophysics, and materials science, with future upgrades to 500MeV electron beams. Drawing on European examples such as Italy's STAR infrastructure, this talk proposes establishing a CLS in Morocco through national initiatives and international partnerships, including Piano Mattei. Such a facility would catalyze innovation, retain scientific talent, and integrate Morocco into a Pan-African and Euro-Mediterranean research network, in line with the African Strategy for Fundamental and Applied Physics (ASFAP). We will also highlight how CLS based on ICS can probe new regimes of quantum electrodynamics, following recent studies on full inverse Compton scattering.

10:20-11:00 Coffee Break

11:00-11:30 Invited Speaker: Laure Gouba, ICTP, Trieste, Italy

Title : Rôle des qubits dans l'intrication quantique et la téléportation quantique.

Abstract :

Le qubit est une manifestation de l'intrication quantique et un élément clé du processus de téléportation quantique. Dans cet expose nous

examinons le rôle des qubits dans l'intrication quantique et la téléportation quantique.

11:30-11:50 Contributed Talk: Otman Bouladiane, Université Chouaib Doukkali, El Jadida, Morocco

Title : Impact of Anisotropy on Rarita-Schwinger Energy Spectrum.

Abstract :

In this study, we investigate the dispersion relations of Rarita-Schwinger semimetals, a novel class of topological materials characterized by spin-($^3/_2$) quasiparticles. We focus on two specific cases: (v=0), where the Hamiltonian exhibits full rotational symmetry, and (v#0), where a small anisotropy is introduced as a perturbation. Our analysis shows that in the isotropic case (v=0) the energy spectrum remains rotationally invariant. However, when (v#0), the rotational symmetry is reduced to the cubic rotational group (O). These findings highlight the significant impact of anisotropy on the electronic band structure and topological properties of these materials, paving the way for further exploration in the engineering of exotic quantum phases.

11:50-12:10 Contributed Talk: Kamal Azaidaoui, Université Chouaib Doukkali, El Jadida, Morocco

Title : Open Quantum System Approach To Graphene Transpot

Abstract :

We Used an open quantum systems framework to study transport phenomena in graphene, where charge carriers behave as massless Dirac fermions due to the material's linear energy dispersion near the Dirac points. This property makes graphene an exceptional platform for exploring relativistic-like effects in condensed matter systems. Our approach is based on the Lindblad master equation, which governs the time evolution of the system's density matrix while incorporating both coherent quantum dynamics and environmental decoherence. As a consistency check, we first analyze the closed-system limit in which no dissipation is present and successfully reproduce known results from the standard Schrödinger framework. This validation confirms the reliability of the open-system formalism and establishes a solid basis for further investigation. We then explore how environmental interactions affect chiral tunneling in graphene, particularly focusing on the suppression of Klein tunneling, a hallmark of relativistic quantum transport that allows for perfect transmission through potential barriers.

12:10-12:30 Contributed Talk: Zakariae Jellal, Faculty of Sciences, Univ. Mohammed V of Rabat, Morocco

Title : Conductivity behavior in multi-Weyl semimetals.

Abstract:

Multi-Weyl semimetals are an emerging class of topological materials in which Weyl points have Chern charges greater than unity. This characteristic results in anisotropic and nonlinear energy dispersion, which profoundly alters the density of states and electronic transport properties. In this study, we analyze the longitudinal and transverse conductivity in these systems, highlighting the impact of topological effects, disorder, and spectral anisotropy. The approach is based on Kubo's formalism, which allows us to rigorously capture the linear responses to electric and magnetic fields. We show that the anisotropic structure induces non-trivial scaling laws for conductivity, depending on temperature, carrier density, and current direction. Furthermore, the chiral anomaly, a topological signature of Weyl systems, plays an essential role in the magnetotransport response, particularly under longitudinal magnetic fields. These results highlight the unconventional transport behavior of multi-Weyl semimetals and underscore

their potential for applications in spintronics, quantum sensors, and emerging topological technologies.

12:30-12:50 Contributed Talk: Saad Eddine Baddis, Faculty of Sciences, Mohammed V of Rabat, Morocco

Title : Swampland Statistics for Black Holes

Abstract :

In this work, we approach certain black hole issues, including remnants, by providing a statistical description based on the weak gravity conjecture in the swampland program. Inspired by the Pauli exclusion principle in the context of the Fermi sphere, we derive an inequality which can be exploited to verify the instability manifestation of the black holes via a characteristic function. For several species, we show that this function is in accord with the weak gravity swampland conjecture. Then, we deal with the cutoff issue as an interval estimation problem by putting a lower bound on the black hole mass scale matching with certain results reported in the literature. Using the developed formalism for the proposed instability scenarios, we provide a suppression mechanism to the remnant production rate. Furthermore, we reconsider the stability study of the Reissner–Nordström black holes. Among others, we show that the proposed instabilities prohibit naked singularity behaviors.

12:50-14:20 Lunch

14:30-15:20 Plenary Speaker: Janet Anders, University of Postdam, Germany \ University of Exeter, U.K

Title : Equilibrium states and thermalization in strong coupling thermodynamics

Abstract :

The interaction of nanoscale and quantum systems with their environment can be relatively strong, and alter the equilibrium state. For open quantum systems, explicit expressions of these so-called mean force (MF) equilibrium states have been missing. In this talk I will report on useful analytic expressions of these states, valid for a general quantum system in contact with a bosonic bath [1]. The results are illustrated with the well-known spin-boson model, for which we provide the first classification of coupling regimes, from weak to ultrastrong, and for both the quantum and classical setting [2].
Moreover, by numerically solving an extended spin-boson model, which includes non- commuting system-bath couplings (3D bath), we identify significant spin-bath entangle- ment in comparison to the standard 1D bath situation [3]. Finally, I will briefly comment on the differences of open system thermalization and thermalization in closed quantum many-body systems [4]. For the example of a double quantum dot (DQD) coupled to a fermionic lead, I will clarify in what sense the local DQD can do both, thermalize and not thermalize.

References:

[1] J.D Cresser, J. Anders, Weak and Ultrastrong Coupling Limits of the Quantum Mean Force Gibbs State, Phys. Rev. Lett 127 (2021) 250601.
[2] F. Cerisola, M. Berritta, S. Scali, S.A.R. Horsley, J.D Cresser, J. Anders, Quantum–classical correspondence in spin–boson equilibrium states at arbitrary coupling, New J. of Phys. 26 (2024) 053032.
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[4] A. Purkayastha, G. Guarnieri, J. Anders, M. Merkli, On the difference between thermalization in open and isolated quantum systems: a case study, arxiv (2024) 2409.11932.

15:20-15:40 Contributed Talk: Youssef Aiache, FST El Hoceima-University Abdelmalek Essaadi, Morocco

Title : Non-equilibrium quantum sensing of temperature

Abstract :

Quantum probes, such as single- and two-qubit systems, offer a powerful method for accurately measuring the temperature of a bosonic bath. This work explores how the precision of temperature estimation can be improved through the use of quantum Fisher information and the quantum signal-to-noise ratio. A key result is that introducing an ancilla qubit, which mediates the interaction between the probe and the thermal environment, enhances the thermometric sensitivity by encoding temperature information into the coherence of the probe. We further investigate the use of two interacting qubits, either entangled or separated initially, as quantum probes in various environmental configurations.

15:40-16:00 Contributed Talk: Chayma El Asbihani, Faculty of Sciences, Mohammed V of Rabat, Morocco

Title : Security Analysis of Quantum and Semi-Quantum Key Distribution

Abstract :

In today's digital world, encryption forms the backbone of secure communication. Classical encryption methods, however, depend on mathematical complexity and are vulnerable to attacks by quantum computers. Quantum key distribution (QKD) offers a fundamentally secure alternative by harnessing the principles of quantum mechanics. This presentation explores both fully quantum and semi-quantum key distribution protocols, focusing on BB84 and BKM07, and examines their resilience against eavesdropping and noise. We evaluate error rates, key generation efficiency, and security thresholds to determine how much "quantumness" is necessary to maintain secure communication. Through a combination of simulation and theoretical analysis, this work highlights the practical trade-offs between implementation constraints and security guarantees in quantum cryptography.

16:00-16:30 Coffee Break

16:30-16:50 Contributed Talk: Leila Zahhafi, African Institute for Mathematical Sciences, Rwanda

Title : From QAOA to adaptive quantum optimization: Enhancing variational circuits with machine learning

Abstract :

This work presents advancements in the Quantum Approximate Optimization Algorithm (QAOA), a leading candidate for solving combinatorial optimization problems on near-term quantum devices. Standard QAOA is limited by shallow circuit depths, barren plateaus, and fixed mixer Hamiltonians that may not capture problem-specific structure. To overcome these constraints, we introduce adaptive variants such as LH-QAOA with entangling mixers, QDD for continuous variables, and ADAPT-QAOA, which builds circuits dynamically using a pool of mixeroperators. We further enhance ADAPT-QAOA using machine learning techniques. By modeling mixer selection as a sequential decision-making task, we apply reinforcement learning (RL) to guide the construction of efficient variational circuits. Simulations show that this hybrid quantum classical framework significantly improves performance by adaptively tailoring the circuit to the optimization landscape. These results support the development of scalable and intelligent quantum optimization strategies and contribute to QA7's goal of advancing quantum technologies through interdisciplinary collaboration. The

approach is especially relevant for applications in logistics, scheduling, and quantum-enhanced modeling in Africa and beyond.

16:50-17:10 Contributed Talk: Hajar Azzouzi, Abdelmaelk Essaadi University of Tetouan, Morocco

Title : Advancing Medical Image Classification through Quantum Machine Learning: The Critical Role of Data Encoding

Abstract :

We explore the integration of medical image data into quantum machine learning frameworks, with a strong emphasis on the importance of data encoding. Encoding functions as the essential bridge between high-dimensional classical medical images and quantum computational models, facilitating the conversion of pixel or feature data into quantum states. Our research underscores how the selection and design of encoding methods influence the efficiency, scalability, and performance of quantum-enhanced neural networks for medical image classification. The results offer methodological insights and experimental validation, highlighting encoding as a central element in advancing quantum computing applications for medical imaging, and paving the way for more efficient and scalable quantum machine learning solutions in healthcare.

17:10-18:00 **Grand Public**

Jean-Marc Lévy Leblond
Université de Nice, France

Mots et maux de la physique quantique

Critique épistémologique et problèmes terminologiques

Abstract :

Selon l'un des dogmes traditionnels de la physique quantique, avancé et défendu avec insistance par Bohr, tout énoncé se référant au monde quantique devrait en fin de compte être formulé dans le langage de la physique classique, de façon à faire sens pour notre expérience commune (macroscopique). Si cette exigence a pu avoir un effet libérateur et fécond sur l'émergence de la théorie quantique, elle ne saurait être plus longtemps acceptée sans critique. Plus d'un demi-siècle de "pratique quantique", à la fois expérimentale et théorique, a conduit à une nouvelle perception du domaine quantique et à de véritables intuitions quant aux comportements propres à ses objets. Mais cet approfondissement de notre compréhension est sérieusement inhibé par le manque d'une terminologie adéquate et spécifique.

On peut d'ailleurs constater la différence entre la faible productivité terminologique de la physique (quantique surtout, mais pas seulement) au vingtième siècle, et la féconde inventivité de celle du dix-neuvième, grande productrice de vocabulaire. Bien qu'apparemment fondée en principe sur la position de la prétendue "école de Copenhague", cette négligence trouve sa source dans les transformations modernes de la pratique scientifique (spécialisation et séparation des tâches). Il s'agit en vérité d'une véritable irresponsabilité linguistique, qui continue à exercer des effets dévastateurs sur la maîtrise conceptuelle de la physique quantique, tant chez les philosophes que chez les physiciens eux-mêmes — sans parler des profanes.

Il n'en est que plus nécessaire et urgent, si l'on veut réconcilier la vision quantique du monde avec la culture contemporaine, de développer une activité terminologique délibérée, à la fois critique et inventive. Quelques propositions en ce sens seront faites.

International Conference Quantum Africa 7th Edition
Kenitra, Morocco

Last Day **Friday, 26/09/2025**

10:00-11:30 **Panel Session**

Title : **Global and Inclusive Access to Quantum Science and Technology**

Abstract :

As part of our commitment to democratizing quantum computing as an emerging technology, the Open Quantum Institute is convening a session on inclusive access to quantum science and technology. The panel session will explore how international partnerships, education initiatives, and science diplomacy can ensure that all countries benefit from and contribute to the quantum revolution.
This session will also highlight a major upcoming initiative: an OQI-supported quantum hackathon planned for 2026 at Université Mohammed V in Rabat, focused on SDG-aligned use cases.

Moderator :

Dr. Philipp Kammerlander, Quantum Center, ETH Zurich, Switzerland

Panelists :

Dr. Fadwa El Ayachi, Faculty of Sciences, University of Mohammed V, Rabat, Morocco

Prof. Mohamed Ouchrif, Mohammed First University, Oujda, Morocco

Prof. Abdelouahed El Fatimy, School of Applied and Engineering Physics Director, UM6P, Morocco

Dr. Farai Mazhandu, Africa Quantum Consoritum

Schedule

10:00-10:10 Philipp Kammerlander presentation

The Open Quantum Institute (in short: OQI) was born at GESDA, is supported by UBS, and is hosted at CERN. During the introductory presentation to the panel I will tell the story of OQI and GESDA, explain what we aim to do and how we aim to achieve this.

10:10-10:13 Panelists enter the stage/ short intro panelists

10:13-10-17 Dr. Fadwa El Ayachi, Faculty of Sciences, University of Mohammed V, Rabat, Morocco

From the perspective of a young academic in the field, how is the world doing on global and inclusive access to quantum science and technology?

10:17-10:21 Prof. Abdelouahed El Fatimy, School of Applied and Engineering Physics Director, UM6P

What are the main challenges in global and equitable access to quantum technologies ?

10:21-10:25 Prof. Mohamed Ouchrif, Mohammed First University, Oujda, Morocco

- How important are national programs as well as international initiatives and collaborations to enhance inclusivity in quantum science and technology?
- You are invited to comment on past and existing collaborations with CERN and their impact.

10:25-10:29 Dr. Farai Mazhandu, Africa Quantum Consoritum

As the founder of Quantum Africa Consortium, what brings a pan-African initiative to the table that national initiatives cannot provide ?

10:29:10:35 Open discussion

- Time for responses to other panelists' inputs
- Highlight Moroccan and African initiatives, focus on educational activities in the field
- What would you like to see in this respect in Morocco ? On the African continent ? In the world ?

10:35-10:45

Focus on OQI-supported quantum hackathon with SDG-focused hackathon challenges / use cases of quantum computing questions directed to Fadwa El Ayachi and Abdelouahed El Fatimy as co-organizers, inputs and views from Mohamed Ouchrif and Farai Mazhandu, open discussion In the remainder of the panel we will be focusing on an important educational event happening next year at Université Mohammed V in Rabat: an OQI-supported quantum

hackathon with SDG-focused hackathon challenges / use cases of quantum computing.

- What was the motivation behind applying for this
- Who is this hackathon aimed at ? what will the participants be asked to do ?
- Who will benefit from this event and how ? local ecosystem, students, universities,…
- What are you expecting the students/participants to take away from it ?
- Why do you think such initiatives are important for advancing global and inclusive to this groundbreaking technology (quantum computing) ?

10:45-10:50

Outlook, vision, “dreaming” each panelist gets the opportunity to share their view on:

- What is their dream/vision for the next 5 year ?
- What would they want to see happen in the next 5 years in terms of global collaboration, access, inclusivity ?
- What can be done as a community (feel free to formulate a call to action for the participants of the conference)

10:50-11:00	Q&A, opening the discussion to the audience
12:30-14:45	Lunch

14:45-15:05 Contributed Talk: Mohamed Ait Bahadou, FST El Hoceima, Morocco

Title : Magnetic Flux Tuned Quantum Transport in Quantum Dot–Coupled Topological Nanowires

Abstract :

We investigate the quantum transport properties of two topological nanowires coupled via a quantum dot, focusing on the influence of magnetic flux. At zero temperature, the linear conductance exhibits a 4π periodicity when the Majorana coupling $\varepsilon_M = 0$ and $\varphi_1 = \varphi_2 = (2n+1)\pi$. This periodicity shifts from 2π to 4π when $\varepsilon_M \neq 0$, reflecting the effect of hybridization between Majorana bound states (MBSs). In addition, at zero bias, the differential conductance reaches $\frac{e^2}{2h}$ for unhybridized MBSs ($\varepsilon_M = 0$) at $\varphi_1 = \varphi_2 = \pi$ providing a clear signature of MBS presence. In contrast, for hybridized states ($\varepsilon_M \neq 0$), the conductance increases to $\frac{e^2}{h}$. Additionally, the linear conductance is independent of electron-phonon interactions when $\varphi_1 = 0$ and $\varepsilon_M = 0$, highlighting the robustness of Majorana-induced transport features. These results demonstrate the tunability of quantum transport via magnetic flux and provide a clear platform for detecting and manipulating Majorana modes in quantum dot–coupled topological nanowires, with potential applications in topological quantum computing.

15:05-15:25 Contributed Talk: Zakaria Bouameur, Faculty of Sciences Rabat, Univ. Mohammed V, Morocco

Title : Qudits for SU(n) covariant integral quantizations

Abstract :

This work explores the use of qudits within SU(n) covariant integral quantization, emphasizing the interplay between symmetry, geometry,

and coherent state methods. We begin by revisiting the description of quantum states through density matrices in projective Hilbert space $\mathbb{C}^n$. The coset decomposition $SU(n)\backslash T^{n-1}$ is employed to achieve an angular parametrization adapted to the construction of coherent states. On this basis, we introduce the set of n orthogonal families of Perelomov SU(n) coherent states, which provide the foundation for a quantization procedure covariant under SU(n).

15:25-15:45 Contributed Talk: Souhail El Khayyat, FST El Hoceima, Univ. Abdelmalek Essaadi, Morocco

Title : Directional Quantum Amplification in Detuned Parametric Amplifier Arrays with Complex Linear Couplings.

Abstract :

Parametric amplification has become an indispensable tool for quantum technologies, enabling the amplification of ultra-weak signals with near-quantum-limited noise. In superconducting circuits, Josephson Parametric Amplifiers (JPAs) and Josephson Traveling-Wave Parametric Amplifiers (JTWPAs) provide essential performance for homodyne detection of quantum fields, quantum sensing, and qubit readout. However, conventional designs face persistent challenges, including the trade-off between gain and bandwidth, limited dynamic range due to unwanted saturation effects, and the need for bulky isolators to protect the quantum source from noise.

This work investigates parametric amplification from two complementary perspectives. First, we develop a normalized theoretical framework for the single JPA, mapping amplifier performance as functions of dimensionless parameters. This approach identifies optimal operating points capable of achieving more than 20 dB of gain over broad bandwidths while preserving near-quantum-limited performance. Second, we extend the analysis to coupled-JPA arrays; by introducing a phase-gradient pump and controlled detuning, we achieve directional and broadband amplification. Unlike previous proposals, this architecture only requires local nonlinearities and thus alleviates experimental conditions for its realization, while retaining its performance and robustness to disorder.

The results demonstrate that it is possible to combine high gain, flat and wide bandwidth, strong directionality, and robustness within a unified framework of parametric amplification. These findings provide a pathway toward scalable, isolator-free, quantum-limited amplifiers, with implications for superconducting quantum processors, hybrid quantum systems, and quantum sensing platforms.

15:45-16:05 Contributed Talk: Mourad Benzahra, FS Ain Chock – University of Hassan II, Morocco

Title : Quantum Machine Based on a Two-Spin-½ Heisenberg Model with Symmetric and Antisymmetric Spin-Orbit Interactions

Abstract :

The interplay between quantum entanglement and quantum machines represents a vibrant area of research in quantum thermodynamics. Current studies investigate how entanglement within the working medium of a quantum machine can influence its performance.
In this work, we examine a two-qubit Heisenberg XXZ spin-½ system incorporating Kaplan-Shekhtman-Entin-Wohlman-Aharony (KSEA) and Dzyaloshinskii–Moriya (DM) spin-orbit interactions as the operational physical medium for a quantum machine, which in the present setup functions as a quantum refrigerator. We provide explicit formulations for key thermodynamic quantities of the refrigerator as functions of the magnetic field (B) and the coupling strengths of the spin-orbit interactions. Furthermore, the relationship between entanglement and

thermodynamic behavior is analyzed using concurrence as a quantitative measure of thermal entanglement. Our results highlight the critical role of fine-tuning the amplitudes of both DM and KSEA interactions in enhancing the refrigerator's performance. Notably, the findings indicate that entanglement between the qubits is not essential for improving the efficiency of the quantum refrigerator.

16:05-16:25 Contributed Talk: Hajar Assil , FST El Hoceima, Univ. Abdelmalek Essaadi, Morocco

Title : Quantum Extreme Learning Machine for quantum channel discrimination

Abstract :

Quantum Extreme Learning Machines (QELMs) provide an efficient framework for quantum machine learning, where a fixed reservoir maps input dynamics into a high-dimensional feature space and only a linear readout is trained. We apply this approach to quantum channel discrimination, aiming to classify whether a channel behaves in a more Markovian or non-Markovian manner. Using a collision model to generate system dynamics and a five-qubit reservoir for processing, we consider two tasks: parameter estimation and channel discrimination. In both cases, we show that incorporating memory, by extending the feature vectors with outputs from previous steps, enhances accuracy and robustness. These results highlight the potential of memory-augmented QELMs as lightweight tools for analyzing open quantum dynamics.

16:25-16:45 Contributed Talk: Abderrahim Bouhouch, Faculty of Sciences,Mohammed V of Rabat, Morocco

Title : Distinguishing 5D Black Hole Physics in M-theory on a Calabi-Yau Manifolds.

Abstract :

Combining complete intersections in projective spaces and toric geometry techniques with $\mathcal{N}=2$ supergravity formalisms, we study 5D black branes in the M-theory compactification on a two, three and four parameters Calabi-Yau threefold. First, we investigate 5D BPS and non-BPS black holes that are derived by wrapping $M2$-branes on non-holomorphic 2-cycles in such a Calabi-Yau manifold. Concretely, we provide the allowed electric charge regions of BPS and non-BPS black hole states that are obtained by surrounding $M2$-branes over appropriate 2-cycles. Then, we approach the black hole thermodynamic behavior by computing the entropy and the temperature. By evaluating the recombination factor, we examine the stability of such non-BPS black holes in relation to the predicted conditions of the WeakGravity Conjecture (WGC). Precisely, we find stable and unstable solutions depending on the allowedelectric charge regions. After that, we study 5D black strings by wrapping $M5$-branes on non-holomorphicdual 4-cycles in the proposed complete intersections and toric Calabi-Yau manifolds by focusing on the stability behaviors. In the allowed regions of the moduli space of the non-BPS stringy solutions, we find stable and unstable states depending on the magnetic charge values. Finally, we present a general approach to distinguish the stability behavior of all non-BPS black objects in M-theory compactified on Complete Intersection Calabi–Yau threefold models, in terms of Kahler parameters determined by hodge numbers $h^{1,1} = 2, 3, 4$.

16:45-17:15 Invited Speaker: Jonathan Oppenheim, University College London, England **[Remote]**

Title : Decoherence vs diffusion: testing the quantum nature of gravity

Abstract :

We consider two interacting systems when one is treated classically while the other remains quantum. The most general form of such dynamics can be derived and has implications for the foundations of quantum theory, and to the problem of understanding gravity when spacetime is treated as fundamentally or effectively classically. If any system is treated as fundamentally classical, the dynamics necessarily results in apparent decoherence of quantum systems, and a breakdown in predictability in classical phase space. We prove that a trade-off between the rate of decoherence and the degree of diffusion induced in the classical system is a general feature of all classical-quantum dynamics. Applying the trade-off to general relativity enables us to experimentally test the nature of spacetime. Bounds on decoherence rates arising from interferometry experiments, combined with precision acceleration measurements, squeezes the theory from both sides and can be used to rule out theories in which spacetime is described classically.

17:15-17:45	Invited Speaker:	Mauro Paternostro, Universita di Palmero,Italy Title : Abstract :	**[Remote]**
18:00	Closing		

18:00-19:00 Poster Session

Alae addin bezzaz *(Faculty of Sciences and Techniques Al-Hoceima)* :
Title :Quantum Discord Under the Influence of LOCC Maps
Abstract: We discuss quantum correlations beyond entanglement through quantum discord, focusing on its behavior under Local Operations and Classical Communication (LOCC). As quantum correlations become more and more popular, quantum discord presents itself as a very intuitive and easy to understand measure. In our poster, we provide the theoretical foundations of discord, from entropy to correlation hierarchies. The purpose of the research is to verify, through numerical simulations, what the impact of LOCC maps is on quantum discord and by extension: quantum correlation.
Our work implements numerical simulations of quantum discord across multiple quantum systems, including Werner states, Zurek & Ollivier's two-qubit system, and various other classical and quantum states. These simulations provide numerical verification of theoretical predictions and extend them to other quantum states. The central contribution is our investigation of how some separable Completely Positive Trace Preserving maps can increase, decrease, and preserve quantum discord. Our findings boost our confidence in the validity of the claims found in the literature regarding quantum discord and its relationship with LOCC.

Khalil loukhssami *(Faculty of sciences Rabat , team ESMaR) :*
Charging Efficiency and Correlation Effects in Double Quantum Dot Quantum Batteries.
Abstract : Quantum batteries (QBs) have been proposed as devices that take advantage of quantum resources, such as coherence and entanglement, to improve charge performance. This work presents a theoretical study of a quantum battery model based on two coupled double quantum dots (TDQDs) implemented on the AlGaAs/GaAs platform. Ergotropy and power are used as key indicators to analyze the influence of system parameters on energy performance. Results show that increasing the energy offset enhances ergotropy and power while reducing quantum coherence, whereas stronger tunneling couplings lead to a non-monotonic variation in ergotropy correlated with entanglement. These findings confirm the potential of quantum dots for efficient energy storage and emphasize that coherence alone is insufficient, with other quantum correlations being essential for optimal performance.

Sara chafik *(Faculty of sciences Rabat , team ESMaR) :*
Title: Shape transition and coexistence in 66Se studied with phenomenological and microscopic models.
Abstract: We present a theoretical investigation of nuclear shape coexistence and transition dynamics in the neutron-deficient nucleus 66Se using two complementary quantum nuclear models. This study aims to better understand the evolution of nuclear shapes in exotic systems where shell structure and collective dynamics interplay significantly.
The first approach involves Covariant Density Functional Theory (CDFT) with the Density- Dependent Meson-Exchange (DD-ME2) interaction to compute the potential energy surfaces in the deformation plane. This microscopic method provides a self-consistent and relativistic description of nuclear structure, capturing the subtle effects of spin-orbit coupling and shape evolution. Our results indicate a γ-soft behavior with an oblate global minimum and suggest the presence of shape coexistence.

To complement this, we employ the Bohr–Mottelson collective model with a sextic oscillator potential, which enables the description of collective excitations and dynamical shape transitions between spherical and γ-unstable configurations. This phenomenological model successfully reproduces the experimental energy spectrum of 66Se, including the low-lying 02+ state at 1226 keV, a key signature of shape coexistence.
The analysis of probability density distributions for quadrupole deformation confirms the presence of distinct nuclear shapes without significant mixing between configurations, revealing a dynamic shape transition mechanism along the yrast band. Additionally, electromagnetic transition rates are calculated and discussed in the context of collective behavior and structural dynamics. This work demonstrates the power of combining quantum microscopic and collective models to understand complex nuclear phenomena such as shape coexistence and dynamic phase transitions. It contributes to the broader effort of modeling quantum systems with rich structural diversity and could inspire further exploration in nuclear and quantum many-body physics.

Khadija El Hawary*(Faculty of sciences Rabat , team ESMaR) :*
Title : Navigating the phase diagram of quantum many-body systems in phase space.
Abstract: We demonstrate the unique capabilities of the Wigner function, particularly in its positive and negative parts, for exploring the phase diagram of the spin−(1 2 −1 2) and spin−(1 2 −1) Ising-Heisenberg chains. We highlight the advantages and limitations of the phase space approach in comparison with the entanglement concurrence in detecting phase boundaries. We establish that the equal angle slice approximation in the phase space is an effective method for capturing the essential features of the phase diagram, but falls short in accurately assessing the negativity of the Wigner function for the homogeneous spin−(1 2 −1 2) Ising-Heisenberg chain. In contrast, we find for the inhomogeneous spin−(1 2 −1) chain that an integral over the entire phase space is necessary to accurately capture the phase diagram of the system. This distinction underscores the sensitivity of phase space methods to the homogeneity of the quantum system under consideration.

El Bir Oumayma *(Faculty of sciences Rabat , team ESMaR) :*
Title : Mirrors-light-atoms entanglement in ring optomechanical cavity.
Abstract : The realization of an atom-optomechanical system where an atomic ensemble is confined in a ring optomechanical cavity consisting of a fixed mirror and two movable ones. An analysis of the dynamics and the linearization of the equations allows us to derive the multimode covariance matrix. Under realistic experimental conditions, we numerically simulate the steady-state bipartite and tripartite continuous variable entanglement using the logarithmic negativity and analyze the shared entanglement in the multimode system. The introduction of the atomic medium is responsible for a more expansive plateau of entanglement indicating its robustness against temperature-induced decoherence effects.

Chaouki Salhi *(PhD student, Laboratory of R&D in Engineering Sciences Abdelmalek Essaâdi University – FST Al Hoceima)*
Title :Quantum NLP: Global Trends and Applications in Arabic Handwriting Recognition
Abstract : This poster presents a dual-focus research contribution combining a technological landscape review of Quantum Natural Language Processing (QNLP) and its concrete application to Arabic Handwritten Text Recognition (AHTR). The first part of the work focuses on a comprehensive and up-to-date survey of QNLP advances across global, African, and Moroccan contexts. We highlight current research trends, tools, and emerging architectures such as quantum-enhanced Transformers, QBERT, SENN, QGANs, and Hilbert space embeddings. Emphasis is placed on how quantum computational principles—superposition, entanglement, and tensor-based semantic modeling—are being integrated into NLP systems.
In the second part, we explore the relevance of these innovations in addressing the challenges of Arabic handwriting recognition. The Arabic script presents unique complexities including cursive structure, multiple calligraphic styles, ligatures, and diacritic variability. We review and compare classical approaches (CNN, RNN, Transformers), quantum-inspired techniques (QSVM, QCWE, DisCoCat), and hybrid architectures (CICWE-QNN, Quantum-enhanced Transformers). Special attention is given to the robustness of these models in noisy, low- resource, and historical manuscript scenarios.
The methodology is based on a systematic literature review, comparative analysis of existing models, and synthesis of strengths, limitations, and future directions. Key findings highlight that hybrid quantum-classical models offer significant potential in low-data environments, while quantum NLP holds promise for broader semantic understanding and contextual modeling in Arabic script analysis. This poster aims to bridge theoretical advances in QNLP with practical, high-impact applications in language digitization and heritage preservation. It also advocates for more investment, training, and research collaboration in quantum computing across Africa, particularly for Arabic and morphologically rich languages.

Ziyad IMARA *(Faculty of Sciences and Techniques Al-HoceimaAbdelmalek Essaadi University- Tetouan)*
Title :Squeezed Magnons-Induced Nonreciprocal Entanglement in a Magnomechanical Cavity
Abstract: Magnomechanical cavities offer a new frontier in quantum electrodynamics that give rise to several significant theoretical and experimental results. In this paper, we propose a novel theoretical mechanism for achieving a nonreciprocal macroscopic entanglement between magnons, photons, and phonons, based on the use of an alternative squeezed magnons method. Indeed, in contrast to conventional approaches, we show how precise control of the amplitude and phase of the squeezed mode allows to obtain a tunable nonreciprocity of entanglement. The magnons resulting from the collective motion of the spin in a macroscopic ferrimagnet become coupled to the microwave photons via magnetic dipole interaction and to the phonons via magnetostrictive interaction. Moreover, we establish that the proposed scheme achieves ideal nonreciprocity, which can be optimized by cavity–magnon coupling and bath temperature control. Finally, by using parameters that are experimentally feasible with current technologies, this work provides new perspectives for hybrid magnon-based quantum technologies.

Fouad Elhani *(Faculty of Sciences and Techniques Al-HoceimaAbdelmalek Essaadi University- Tetouan)*
Title : Quantum battery in the Heisenberg spin chain models with Dzyaloshinskii-Moriya interaction.
Abstract *:* In this study, we consider the characteristics of QBs for the Heisenberg spin chain models in the absence and presence of Dzyaloshinskii-Moriya (DM) interaction. Our results show that the DM interaction can enhance the ergotropy and power of QBs, which shows the collective charging can outperform parallel charging regarding QB's performance. Besides, it turns out that first-order coherence is a crucial quantum resource during charging.

Ayoub Lemou *(Laboratory of R&D in Engineering Sciences, Faculty of Sciences and Techniques of Al-Hoceima, Abdelmalek Essaâdi University, Morocco.)*
Title: Quantum speed limit time and thermodynamics .
Abstract:We explore the relationship between the Quantum Speed Limit (QSL) and quantum thermodynamics in an open qubit subject to amplitude damping dynamics. By connecting QSL to physically measurable quantities — energy fluctuations, entropy production rate, and dynamical activity — we show that the initial state preparation and the system–environment coupling strongly determine the evolution speed. These results provide insights for optimizing quantum control, metrology, and the energy efficiency of quantum technologies.
