Quantum Information Session

Monday June 21st

1.30-2.00 PM Transfer of quantum correlations to populated qubits - Z. Ficek

2.05-2.35 PM Mapping current knowledge and future research opportunities in Quantum Information and Computing - J. R. López-Robles

2.40-3.10 PM ERS method and Random Media - H. Eleuch

3.15-3.45 PM Break

3.50-4.20 PM Detection of Markovian and non-Markovian dynamics in different systems - El- Allati

4.25-4.55 PM Quantum Fisher information matrix: definitions, preliminaries and applications - S. Bukbech

5.00-5.30 PM Bidirectional Teleportation using Fisher Information - C. Seida

Session Chairs: Dr. Iqbal and Dr. Metwally

Virtual Room 1F

Quantum Information Session

Tuesday June 22nd

1.30-2.00 PM	The concealment of accelerated information is possible - A. G. Abdelwahab
2.05-2.35 PM	Non-Commutativity, Superposition and Coherence - Arun K. Pati
2.40-3.10 PM	Variational Classical Quantum Algorithms for Near Term Quantum Computers - Kapil K. Sharma
3.15-3.45 PM	Break
3.50-4.20 PM	Estimating the teleported initial parameters of a single- and two-qubit systems two-qubit systems - K. El Anouz
4.25-4.55 PM	Entangled quantum refrigerator based on two anisotropic Heisenberg XY Z chain with Dzyaloshinskii-Moriya interaction - M. H. Ben Chakour
5.00-5.30 PM	Quantum steering of Tavis Cummings model - Y. Khouja

Session Chairs: Dr. Iqbal and Dr. Metwally

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Quantum Information Session

Abstracts

Dr. Zbigniew Ficek (ficekkacst@gmail.com)
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University of Zielona Gora

Transfer of quantum correlations to populated qubits

We discuss the process of transferring quantum correlations (entanglement) to uncorrelated qubits. Particular interest is paid to determine how the transfer process of quantum correlations depends on the initial population of the qubits. We show that depending on the initial population of the qubits, the transfer of the quantum correlations can be delayed even though the absorption of photons from the field is not sensitive to the initial population. In the absence of the initial population, the transfer of the quantum correlations begins immediately after the entangled _eld is turned on. In contrast, if the qubits are initially prepared in some of the excited states, the transfer is delayed by a finite time interval. A detailed discussion will be given on the dependence of the delay transfer time on the one and two photon populations, and damping rates of the qubits. The physical origin of the delayed transfer of quantum correlations is explained in terms of quantum jumps.

Dr. J. R. López-Robles (ricardolopezrobles@outlook.com)
Academic Unit of Accounting and Administration, Autonomous University of Zacatecas, Zacatecas, Mexico

Mapping current knowledge and future research opportunities in quantum Information and Computing: A scientific literature analysis from 1995 to 2020

Quantum field is evolving from theoretical research to technology development and demonstration phase to Information and Communications Technology industry, principally. Bearing in mind this evolution, the Quantum field requires research frameworks, which allow for a better understanding of the role of main quantum technologies. As a result of this evolution, there is a wide advanced technologies portfolio that seek to become the core technology, ones of the most representatives being quantum information and quantum computing. Nevertheless, quantum information and quantum computing are still in the research and development phase, so it is necessary to know and understand the roadmap being followed by all stakeholders. It will make possible to identify new research themes and determine strategies that allow accelerate the development and implementation of these technologies. In light of this, the aim of this contribution is to develop an advanced analysis that evaluates the evolution of the intellectual and cognitive structure of Quantum Technologies that supports scientific community to identify, improve and reach the research about these technologies. To do that, 3,434 publications from 1995 to 2020 related to quantum information and quantum computing were retrieved from Scopus and analyzed using advanced bibliometric techniques and technologies. Hence, the methodology and results may be useful for the scientific and academic communities, as it reflects a large-scale research of the main themes of quantum information and quantum computing, and how its intellectual and cognitive structure have evolved over time. Finally, this research is the first research framework that covers from the first publication to latest ones, discussing the researches of quantum field and summarizing the current situation.

Session Chairs: Dr. Iqbal and Dr. Metwally

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Quantum Information Session

Abstracts

Dr. H. ELeuch (hichemeleuch@yahoo.fr)
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ERS method and Random Media

Exact solutions of the Schrödinger equations are limited to a list of a few known potentials, as a matter of fact, many techniques were developed to derive approximate solutions of the Schrödinger equation, such as WKB and ERS methods, to overcome this limitation.
The first part of my talk is dedicated to reviewing our ERS (Eleuch- Rostovtsev-Scully) method. This technique generates analytical solutions for general potentials beyond the adiabatic approximation of 1D, 2D, and 3D stationary Schrödinger equations.
Its application, to the propagation of waves in random media described by the Schrödinger-like equation, will be the subject of the second part of this talk. Analytical results were limited to low disorder, where perturbative approaches are used to disordered potentials. We have shown that the localization behavior of the standard disordered wave equation can be determined for all disorder strengths correlation lengths by using the ERS solution.

Dr. A. El-Allati (abdou.allati@gmail.com)
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Detection of Markovian and non-Markovian dynamics in different systems

The Markovianity/non-Markovianity of two different systems are presented by means of the quantum speed limit time and quantum Fisher information. The first and second systems consist of a single qubit interacts with a non-detuning Lorentzian cavity and with a thermal reservoir, respectively. For the first system the driving time is an important parameter that control on the Markovianity/non-Markovianity behavior. For the second model, it proves that non-Markovianity dynamic may increase the speed and the sensitivity of the open system.

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Abstracts

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Quantum Fisher information matrix: definitions, preliminaries and applications

Quantum Fisher information matrix is a fundamental concept in quantum metrology by reason of its huge importance in multiparameter quantum estimation theory. Its wide connections to other features of quantum mechanics such as entanglement, coherence, quantum thermodynamics and quantum phase transitions, require to obtain analytical simple expressions for it. We outline the properties of this quantity and two calculation techniques of it: the first which, in principal, rely on the diagonalization of the density matrix, and the second, unlike previously does not require diagonalization of the density matrix, but it make use of the concept of vectorisation of matrices. Moreover, as an application of quantum Fisher information matrix, we discuss the quantum multiparameter Cramer{Rao bound, a lower bound on the uncertainty of estimators of the parameters, and its attainability condition.

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ESMAR, Mohammed V University, Faculty of Sciences, Rabat, Morocco

Bidirectional Teleportation using Fisher Information

In this contribution, we reformulated the bidirectional teleportation protocol suggested in [1], by means of Bloch vectors as well as the local operations are represented by using Pauli operators. Analytical and numerical calculations for the teleported state and Fisher information are introduced. It is shown that both quantities depend on the initial state settings of the teleported qubits and their triggers. The Fidelities and the Fisher information of the bidirectionally teleported states are maximized when the qubit and its trigger are polarized in the same direction. The minimum values are predicted if both initial qubits have di_erent polarization or non-zero phase. The maximum values of the Fidelity and the quantum Fisher information are the same, but they are predicted at different polarization angles. We display that the multi-parameter form is much better than the single parameter form, where it satis_es the bounds of classical, entangled systems and the uncertainty principle.

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Abstracts

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Department of Basic Science, Faculty of Computers and Informatics, Suez Canal University, Ismailia, Egypt

The concealment of accelerated information is possible

The possibility of masking an accelerated two-qubit system by using a minimum number of qubits is discussed. It is shown that the information may be masked in either entangled local states or product non-local separable states. We examine that each partition of these states satisfies the masking conditions. Due to the presence of nonlocal separable partition, one may consider that it is a type of quantum data hiding scheme. The local/non-local information encoded in the masked entangled state is robust against the decoherence of the acceleration process. The possibility of estimating the acceleration parameter via the entangled/separable masked state increases as the initial entanglement value increases. The efficiency of the masking process is examined by quantifying the fidelity of the accelerated state and its subsystems. It is shown that the fidelity of the masked state is maximum at small initial acceleration, while the minimum fidelity is more than 96%.

Dr. Arun K. Pati (akpati@hri.res.in)
Quantum Information and Computation (QIC) Group
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Non-Commutativity, Superposition and Coherence

Non-commutativity between two or more observables give rise to quantum superposition-a fundamental feature of quantum mechanics. Quantum superposition then leads to coherence which is a useful resource in quantum information. We establish an inequality involving the quantum coherence of quantum state and a non-commutativity of two arbitrary observables. The relation provides a direct method of obtaining an estimate of the quantum coherence of an arbitrary quantum state, without resorting to quantum state tomography. Further, we will discuss the relation between coherence and disturbance in quantum measurement. Under a complete measurement, the system undergoes ecoherence and loses its coherence. If there is no disturbance, the state retains all of its coherence. It is therefore natural to ask if there is trade-off between disturbance caused to a state and its coherence. We will prove a coherence disturbance trade-off relation using the relative entropy of coherence. For bipartite states we will prove a trade-off relation between the quantum coherence, entanglement and disturbance.

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Quantum Information Session

Abstracts

Dr. Kapil K. Sharma (iitbkapil@gmail.com)

Variational Classical Quantum Algorithms for Near Term Quantum Computers.

The aim of the talk is to introduce the landmark quantum algorithms while focusing on the progress in optimization techniques which are especially suitable for Near Term Quantum Computers (ie. NISQ devices). In recent years, there is a rapid advancement in developing quantum algorithms for varieties of NP problems encountered in many scientific domains. Hence, it is of our great interest to highlight some of the quantum-algorithms developed to solve the NP problems, despite the fact that the class category P vs. NP has been a debatable topic over the decades. In continuation of this discussion, we also cover the quantum adiabatic computation with D'Wave quantum computer, its drawback and significance. Towards the end of the talk, we touch upon recently developed variational classical-quantum hybrid approach for NISQ devices and discuss the potential use of quantum chemistry in variational framework.

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Estimating the teleported initial parameters of a single- and two-qubit systems

A single atomic field state is used as a quantum channel to teleport a state of two-qubit system. The possibility of estimating the teleported initial state parameters is discussed by means of quantum Fisher information. It is shown that by controlling the initial atomic Field parameters, one may freeze the quantum Fisher information of the teleported parameters. Mean while, the teleported state keeps its local information. The sizes of the frozen areas depend on the initial state settings and the atomic field parameters. We show that the estimation degree of teleporting a single qubit is larger than that depicted for two-qubit system. Moreover, the estimation degree
increases in the resonance case. It is shown that the maximum bounds of the quantum Fisher information are reached periodically. The phenomena of the sudden changes of quantum Fisher information are displayed at larger values of detuning parameters and the number of photons inside the cavity.

Quantum Information Session

Abstracts

Dr. M. H. Ben Chakour (achousnii@gmail.com)
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Entangled quantum refrigerator based on two anisotropic Heisenberg XY Z chain with Dzyaloshinskii-Moriya interaction

Inspired by the pioneering works of Scovil and Schultz-DuBois who developed the first realization of a quantum heat engine and the quantum equivalence of the Carnot cycle [1, 2, 3] many researchers have been working on the construction and improvement of cyclic quantum machines with different working substances such as Entangled spin chain systems. On the other hand, the DM interaction introduced by Dzyaloshinskii and later developed by Moriya [4, 5] proved to be of major importance for the effects of entanglement dynamics in a spin-chain system, in particular the Heisenberg spin chain. It is considered over time as a basic element of quantum phenomena and is increasingly used for modeling and studying quantum processes such as quantum teleportation and quantum key distribution. Here we present an intricate quantum refrigerator based on the quantum thermal machine model introduced by Zhang et al.[6] consisting of two anisotropic spin-1/2 Heisenberg XYZ systems in external magnetic fields with Dzyaloshinski-Moriya (DM) interaction as working substance. We focus on the behavior of the heat quantities exchanged between the system and its environment, the work done, and the efficiency of the system as a function of the DM interaction, the homogeneous magnetic field, and the entanglement.

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Quantum steering of Tavis Cummings model

In this work we aim to investigate quantum steering correlation with different types of witnesses, with taking in consideration intrinsic decoherence of our considered model, as well in other environment of open quantum systems. Furthermore, we check our system evolution in Markovian and Non-Markovian dynamics respectively.