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Abstract Book

INDEX

Plenary Speakers

1 **Title: Spatial and temporal circuit cutting with hypergraphic partitioning**

WALDEMIR CAMBIUCCI, Escola Politécnica University of Sao Paulo São Paulo, Brazil

Keynote Speakers

2 **Title: Analog and qubit efficient quantum computing**

Angelakis, Dimitrios, School of ECE, TU Crete, CQT Singapore and AngelQ Quantum Computing

3 **Title: Graph Crypto-Stego system for securing Graph Data using Association Schemes**

Anuradha Sabharwal, Government College Bahadurgarh, Haryana, India

4 **Title: Relativistic Coupled-Cluster Calculations for Clock Transition Properties in Atoms and Ions**

Brajesh Kumar Mani, Indian Institute of Technology Delhi, Hauz Khas, New Delhi

5 **Title: The Road to a Prove a Quantum Computing Advantage in Future Generation Networks**

Riccardo Bassoli, Technische Universität Dresden, Dresden, Germany

6	**Title: Efficient Deep Learning Approach for Predicting Quantum Many-Body Dynamics Using Data Generated by Quantum Computers**
	Tasneem Watad, Technion, 3200003 Haifa, Israel
7	**Title: Lattice realization of non-invertible symmetry-protected topological phase**
	Zhian Jia, National University of Singapore
8	**Title: Photo physics of a Single Quantum Emitter Based on Vanadium Phthalocyanine Molecules**
	Vicente H. Alvarado, Ponticia Universidad Católica de Chile, 7820436, Santiago, Chile
9	**Title: Chitin and chitosan as source for the sustainable production of Carbon Quantum Dots**
	Fernando G. Torres, Pontificia Universidad Catolica del Peru. Av. Universitaria 1801. San Miguel
10	**Title: Bifunctional zirconium phosphate with Reigate for electrochemical detection and simultaneous removal of Heavy metal ions and Nitro compounds**
	Aaliya Qureashi, Electrochemical sensing, DFT
11	**Title: The general Bernstein function: Application to χ-fractional differential equations**
	Lakhlifa Sadek, Al-Hoceima, Abdelmalek Essaadi University, Tetouan, Morocco.

12	**Title: Implementation of CNOT gates between OAM and Polarization of Light**
	Sivarama Krishnan, Indian Institute of Technology Madras, Chennai 600036, India
13	**Title: EPR and luminescence properties of Mn2+ doped BaCO3 nanoparticles synthesized by autocombustion method**
	Brahim Abidine, National Center for Research in Materials Sciences Borj-Cedria Technopark Soliman, Tunisia
14	**Title: Candida cells devoid of the quinidine drug resistance transporter genes impact glucose transporter expression and metabolite accumulation promoting azole drug resistance**
	Hafsa Qadri, Department of Bioresources, University of Kashmir
15	**Title: Superconducting Quantum Processors: Design and Analysis for Surface Code Implementation**
	Nadia Haider, Delft University of Technology, 2628 CD, Delft, The Netherlands
16	**Title: Gauge invariance principle as a guiding star in the theory of electroweak scattering off nuclei (bound systems)**
	Oleksandr Shebeko, National Science Center" Kharkiv Institute of Physics and Technology", Kharkiv, Ukraine
17	**Title: A robust quantum image encryption algorithm based on 3D-BNM chaotic map and quantum selective scrambling operations**
	Vivek Verma, Indian Institute of Technology Roorkee, Roorkee, 247667, Uttarakhand, India

18	**Title: Enhanced Quantum Ensemble Classification Algorithm with Shallow Circuit and Parallelism Mechanism**
	Neeshu Rathi, Indian Institute of Technology Roorkee, Uttarakhand, India
19	**Title: On quantum and linear complementary dual codes from the cyclic codes over the ring**
	Bhupendra Singh, C V Raman Nagar, Bengaluru-560093, Karnataka, India
20	**Title: Non-resonant exponential Nikitin models with decay**
	Anicet Kammogne, University of Dschang, Foto, CAMEROON
21	**Title: Rydberg atom-based sensors for radio-frequency electric field measurement**
	Bao-Sen Shi, University of Science and Technology of China, Hefei 230026, China
22	**TITLE: Secrets to building a quantum team**
	Christopher Bishop, MC for The Economist's "Commercializing quantum" events
23	**Title: Hysteresis Trajectories in Quantum Rydberg Atomic Gases**
	En-Ze Li, University of Science and Technology of China, Hefei 230026, Anhui, China

24	**Title: Examining the structure functions of nucleons by introducing new ansatz and their consequences on patron distribution functions in higher approximation**
	Hossein Vaziri, Shah rood University of Technology, Shah rood P. O. Box 36155-316, Iran
25	**Title: The Impact of Russia's Invasion of Ukraine on innovation and financial technology (FinTech) and stock Market returns: Evidence from TVP-VAR**
	Ibtissam Missaoui, Tunisia Laboratory LAMIDED (University of Sousse).
26	**Title: A Categorical and Quantum Optimization Framework for Addressing Dynamic Business Challenges in Thailand as Systems of Systems**
	Jirawat Tangpanitanon, Quantum Technology Foundation, Thailand
27	**Title: Designing and Energizing the Novel BiSnO2@GQD for an In-depth Exploration of Structural, Electronic, Optical, and Excited State Electron Transfer Properties in DSSC, Adorned with Pyrelene Dye - A DFT Perspective."**
	Kaniz Fatima, University of Kashmir, Hazratbal, Srinagar, J&K, India
28	**Title: Téléportation of Twa-Qubit State Between Non-Neighboring Nodes Based on the Utilization of Multiple Cluster States Within Quantum Networks.**
	Meryem EL Kirdi, quantum state tomographie and fidélité, Denmark

29 **Title: Quasi-isentropic compressibility of noble gases, nitrogen and helium in pressure range up to 20 Tpa**

Mikhail Mochalov, Russian Federal Nuclear Center –All-Russian Research Institute of Experimental Physics Sarov, Nizhny Novgorod region, Russian Federation

30 **Title: Laser Sideband Locking Using a DDS-Based RF Signal Source**

Mingyi Zhu, School of Physical Sciences, Hefei 230026, China

31 **Title: Approximation of Mild Solutions of Delay Integro-differential Equations on Banach Spaces**

Mohammed Elghandouri, UMMISCO, IRD, Sorbonne University, Paris, France

32 **Title: Which computer will be preferred quantum or optical?**

Morteza Sasani Ghamsari, Photonics and Quantum Technologies Research school, NSTRI, Tehran, Iran

33 **Title: Lower- and higher-dimensional excitations in carbon nanotube system arrays**

Noule Simo Raïssa, University of Yaounde I, Yaounde, Cameroon

34 **Title: Quantum-Resilient Internet: Satellite-Enabled Quantum Key Distribution for Secure Global Communications**

PRAKUL SUNIL HIREMATH, DEPARTMENT OF CSE, VTU BELAGAVI

35 **Title: Harnessing Quantum Entanglement for Secure Communication Protocols**

Cristhian Calderon, Denmark.

36	**Title: Unification of integral transforms and their applications**
	Rachid El Aitouni, Chouaïb Doukkali University, P. B 20, 24000 El Jadida, Morocco
37	**Title: NONLOCAL APPROACH TO ENERGY BANDS IN PERIODIC LATTICES AND EMERGENCE OF ELECTRON MASS ENHANCEMENT**
	Rami Ahmad El-Nabulsi, Czech Republic
38	**Title: Quantum gates and quantum algorithms in a neutral atom quantum processor**
	Ravikumar Chinnarasu, National Quantum Computing Centre, Didcot, England, UK.
39	**Title: First-order quantum corrections of tunneling radiation in modified Schwarzschild-Rindler black hole**
	Riasat Ali, University of Shanghai-200444, People's Republic of China
40	**Title: The Race Towards a Global Quantum Communication Network: Competing Paradigms and Emerging Challenges**
	Rikteem Bhowmick, Head- Quantum Communications, Qulabs Software India Pvt Ltd & Quantum AI Global
41	**Title: An update on alternative therapy for Escherichia coli causing urinary tract infections; a narrative review**
	Sina Nasrollahian, Shiraz University of Medical Sciences, Shiraz, Iran

42	**Title: Sample records for instrumental analysis experiment**
	Subhash Kumar, G H Raisoni college of engineering and management,Pune,Maharashtra
43	**Title: Thin Film Diamond Nano-photonics and its quantum Application**
	Sunil Kumar Mahato, University of Hamburg, Germany.
44	**Title: Using quantum weirdness to extend the computational power of a Parity computer**
	Swati Singh, IAH, GLA University, swati121302@dei.ac.in
45	**Title: High Sensitivity, Loss-Tolerant Quantum Metrology**
	Wei Du, Beijing University of Posts and Telecommunications, Beijing 100876, China
46	**Title: A high-performance digitally controlled analog servo system for cold atom experiments**
	Xinyun Huang, School of Physical Sciences, Hefei 230026, China
47	**Title: Ab initio insight into the physical properties of Potassium based lead-free perovskite for hydrogen storage applications**
	Zia ur Rehman, Namal University, 30km Talagang Road, 42250, Mianwali, Pakistan.
48	**Title: Quantum circuits based on topological pumping in optical lattices**
	Zijie Zhu, Institute for Quantum Electronics & Quantum Center, ETH Zurich, 8093 Zurich, Switzerland

Featured Speakers

49 **Title: Fock-Space Relativistic Coupled-Cluster Study of Clock Properties in 88Pb2+**

Palki Gakkhar, Manipur University, Canchipur 795003, Manipur, India

Waldemir Cambiucci

Escola Politécnica University of Sao Paulo São Paulo, Brazil

Spatial and temporal circuit cutting with hypergraphic partitioning

Abstract

Quantum computing holds the promise of revolutionizing complex problem-solving by leveraging the principles of quantum mechanics. However, current noisy intermediate-scale quantum (NISQ) computers are constrained by limited qubit counts and high error rates, making it challenging to execute large quantum circuits with substantial depth, size, or width. To overcome these limitations and enhance scalability, two primary circuit cutting strategies have emerged: the gate-cut approach, which distributes circuit partitions across multiple processing units (spatial approach), and the qubit wire cut approach, which segments circuits into smaller parts for sequential execution (temporal approach). In this paper, we introduce a hypergraph-based methodology for quantum circuit cutting that is applicable to both spatial and temporal scenarios. By leveraging hypergraph theory and advanced partitioning heuristics, our approach aims to optimize circuit cutting by reducing communication overhead in spatial distributions and minimizing initialization costs in temporal sequences. We represent quantum circuits as high-level hypergraphs encompassing various combinations of quantum gates and compare partitioning heuristics such as Stoer-Wagner, Fiduccia- Mattheyses, and Kernighan-Lin for efficient graph and hypergraph partitioning. To evaluate the effectiveness of our method, we introduce a new metric called the coupling ratio, serving as a critical dimension in assessing circuit partitions. Our comparative analysis demonstrates that hypergraph partitioning enhances the efficiency of distributed quantum computing architectures by effectively balancing the trade-offs between communication and initialization costs. Specifically, heuristics like Fiduccia-Mattheyses exhibit greater flexibility and speed, making them an excellent choice for real- time circuit cutting processes in multi-QPU quantum machines. The results of our

research highlight hypergraph partitioning as a pivotal step in developing a new reference architecture for quantum computers within distributed computing environments, advancing the scalability and performance of quantum computations.

Biography

Waldemir Cambiucci is PhD candidate at University of São Paulo, Brazil. He is technical specialist at Microsoft, supporting discussions on digital transformation and app innovation with Microsoft customers, speaking about AI, IoT, Cloud Solutions and Quantum Solutions Architecture. With more than 25 years of experience in IT, He participated in several technology forums in Brazil and abroad. Computer Engineer and Master in Electrical Engineering from the Polytechnic School of the University of São Paulo (EPUSP). Today, he is PhD candidate at the University of São Paulo, with research in distributed quantum computing, member of the IEEE Quantum Community, and Azure Quantum Ambassador in Brazil.

Angelakis Dimitrios

School of ECE, TU Crete, CQT Singapore and AngelQ Quantum Computing

Analog and qubit efficient quantum computing

Abstract

I will start with an introduction to analog quantum simulation and computation and then briefly review our work with Google Quantum AI on the quantum simulation with superconducting qubits of the many-body localization transition. I then will discuss our recent efforts in showcasing quantum supremacy in driven many-body systems and give two examples involving spin and also Bose-Hubbard type of model. If time, I will briefly review the recent experimental verification of this work done in collaboration with the cold atom group at USTC led by JW Pan and Y. Zheng Sheng. In the second part of the talk, I will discuss some recent results in improving the performance of quantum approximate optimization algorithms for industrial applications in near term quantum computers. Our qubit efficient approach allows solving quadratic optimization problems for up to 100.000 classical variables or more, pushing the state of the art with NISQ devices by several orders of magnitude. Two real world examples will be discussed involving route and financial optimization problems, using real world data, done in collaborations with ExxonMobil and the Singapore Stock Exchange.

Biography

Dimitris G. Angelakis is a visiting Professor at the Centre for Quantum Technologies, (CQT) and a full Professor of Quantum Computing in TU Crete. His work lies in the intersection of implementations of quantum computing, near term algorithms, and quantum many-body physics. PhD at Imperial College, followed by a Cambridge JRF, at the DAMTP and the Centre for Quantum Computing. Awards he has received include the 2018 Google Quantum Innovation Award, the Valerie Myerscough Award from University of London, the Greek Ministry of Defence Scholar Prize, and UK Institute of Physics Quantum Electronics Thesis Prize. He is a member of the National AI Task Force of Cyprus, QCN Group of the EU Quantum Flagship , and of the Informatics Group of Greek National Research Council. He recently founded and advises AngelQ Quantum Computing, a Singapore based quantum software and consulting company, with operations in Singapore, EU and Canada.

Anuradha Sabharwal

Government College Bahadurgarh, Haryana, India

Graph Crypto-Stego system for securing Graph Data using Association Schemes

Abstract

Cryptography has recently become a critical area to research and advance to transmit information safely and securely among various entities, especially when the transmitted data is classified as crucial or important. This is due to the increase in the use of the internet and other novel communications technology. Many businesses now outsource sensitive data to a third party because of the rise of cloud computing and storage. Currently, the key problem is to encrypt the data such that it may be stored on an unreliable server without sacrificing the ability to use it effectively. In this study, a graph encryption scheme by using cryptography and steganography has been proposed. Data is encrypted using Association schemes over finite abelian groups and then hiding the encrypted data behind randomly chosen cover images. The efficiency of these constructions has been implemented and evaluated experimentally. Moreover, experimental results, statistical analysis, error analysis and key analysis that demonstrate the appropriateness and efficiency of the proposed technique have been provided.

Biography

Ms Anuradha Sabharwal is working as an Assistant Professor in the Department of Mathematics at Government College Bahadurgarh, Haryana. She has done Masters in Mathematics from Hindu College, University of Delhi and is pursuing doctoral studies from the Department of Mathematics, University of Delhi. Ms Sabharwal has more than 12 years of teaching experience in mathematics in many colleges of Delhi University and colleges under Higher Education Haryana, India. She is currently teaching M.Sc.(Maths) students in Government College Bahadurgarh. She has published several research papers in National and International journals. Her research interest focuses on the study and application of association schemes in cryptography.

Brajesh Kumar Mani

Indian Institute of Technology Delhi, Hauz Khas, New Delhi

Relativistic Coupled-Cluster Calculations for Clock Transition Properties in Atoms and Ions

Abstract

Atomic systems offer a plethora of fundamental and functional properties and, therefore, are of importance to several key implications. Some examples where atoms and ions can serve as important probes include, atomic clocks [1], parity and time-reversal violations [2, 3], and the search for the variations in the fundamental constants [4]. Atomic systems, however, form a many- body complex system for which the exact solution is nontrivial. This poses a serious challenge in the theoretical investigations of the properties of these systems. In this context, relativistic coupled- cluster (RCC) theory is one of the most reliable many-body theories for structure and properties calculations for atoms and ions.

In our group at IIT Delhi, we have developed RCC based theories for the properties calculations of closed-shell [5, 6], one-valence [7, 8] and two-valence [9, 10] atomic systems. These theories are implemented as sophisticated parallel FORTRAN programs [11]. The methods and codes we have developed are robust and can compute a plethora of properties, such as excitation energies, transition amplitudes and oscillator strengths, hyperfine splitting constants and energies, dipole polarizabilities, parity and time-reversal violating amplitudes, etc., in different types of atoms and ions. Our calculations also incorporate the corrections from the relativistic and QED effects to improve the accuracy to the results.

In this talk, we shall present our recent works on the clock transition properties in Al+[6, 8, 10] and Pb2+ [12]. Using our in-house code for all-particle multireference Fock-space relativistic coupled- cluster, we have computed excitation energies, allowed E1 and M1 transition amplitudes and oscillator strengths, dipole polarizability, and the lifetime of the metastable

clock state in these systems. For Al+, our computed lifetime of 20.2 s for 3s3p 3P0 clock state is in excellent agreement with experimental value 20.6 s. For Pb2+, our calculations predict a high lifetime of 9.8 x 106 s for 6s6p 3P0 clock state.

Biography

Brajesh K Mani is an Associate Professor at the Department of Physics, IIT Delhi. Before joining IIT Delhi as an Assistant Professor in December 2015, he worked as a Research Associate at Physical Research Laboratory, Ahmedabad and University of South Florida, Tampa for about five years. His doctorate is from the Physical Research Laboratory, Ahmedabad. His research area encompasses developing many-body theories and codes for atomic and condensed matter systems. Please see his webpage for more information
https://web.iitd.ac.in/~bkmani/publications.html

Riccardo Bassoli

Technische Universität Dresden, Dresden, Germany

The Road to a Prove a Quantum Computing Advantage in Future Generation Networks

Abstract

Industry and academia have been researching 6G for some years and its standardization is going to start in the next couple of years. The current architectural vision of 6G proposes a softwarized network continuum managed and orchestrated by the combination of centralized and distributed intelligence. Such a virtual network will consist of microservices and agents, collaborating in virtual chains. These virtual network entities will be places dynamically and will represent network functions, sub-functions, operations, protocols, etc. The objective of such a complex and heterogeneous system is the provisioning of global coverage, with unprecedented low-latency, resilience, reliability and trustworthiness. These requirements are necessary to host very sensitive verticals involving augmented and virtual reality, digital twins, and haptic communications such as the Tactile Internet, automated industry, remote surgery, emergency and public services, etc. Nevertheless, intrinsic trade-offs have been identified among latency, throughput, energy usage, security, and resilience that are limiting the achievement of the envisioned key performance indicators (KPIs). Moreover, these limitations are not technical but intrinsic in the ‘classical’ technologies. In order to go beyond such limitations, new different resources and technologies need to be researched. In this context, quantum technologies have been identified as the key means. In fact, they can provide new resources such as quantum coherence, entanglement, and the no-cloning theorem, which are not available with classical communication networks. This underlines the importance of realizing a unique 6G-quantum network in order to enable the achievement of the established KPIs of 6G vision. Nevertheless, how to design quantum computing and its seamless integration with 6G edge architecture for in-network computing acceleration is still an open challenge that several researchers in science and industry are trying to address. This talk highlight the foundations of identifying quantum

advantages for edge in-network computing of future 6G-quantum networks.

Biography

Riccardo Bassoli is a Juniorprofessur at the Deutsche Telekom Chair of Communication Networks and Head of the Quantum Communication Networks (QCNets) research group, at the Faculty of Electrical and Computer Engineering, at Technische Universität Dresden. He is member of the Centre for Tactile Internet with Human-in-the-loop (CeTI), Cluster of Excellence, Dresden. He is also member of the EU Quantum Internet Alliance (QIA) and the EU flagship for 6G Hexa-X II. He is principal investigator in the 6G-life research hub of Germany. He got his Ph.D. from 5G Innovation Centre at University of Surrey (UK), in 2016. He was also a Marie Curie ESR at the Instituto de Telecomunicações (Portugal) and visiting researcher at Airbus Defence and Space (France). Between 2016 and 2019, he was postdoctoral researcher at Università di Trento (Italy). He is Senior Member of the IEEE and ComSoc.

Tasneem Watad

Technion, 3200003 Haifa, Israel

Efficient Deep Learning Approach for Predicting Quantum Many-Body Dynamics Using Data Generated by Quantum Computers

Abstract

In this work, we introduce an approach that combines classical shadow tomography with deep learning to efficiently predict the dynamics of many-body quantum systems generated by some Hamiltonian. This approach involves training neural networks on quantum dynamics data computed using the classical shadow representations of a large set of time-evolved quantum states prepared on a quantum device. Specifically, the networks are trained to predict the dynamics of all k-reduced density matrices (k-RDMs). We test the performance of the neural networks in predicting the dynamics of a random transverse-field Ising model and demonstrate that the trained networks can generalize to predict the dynamics of quantum systems starting from new initial states not included in the training data.

Remarkably, they can also predict dynamics at relatively long times, even when trained primarily on dynamics samples from shorter times. This capability is particularly significant, as current and near-term quantum platforms and error mitigation techniques face challenges in performing accurate long- time Hamiltonian simulations.

Biography

Tasneem Watad is a doctoral student in the Physics Department at Technion. Her research interests lie at the intersection of Quantum Computing, Condensed Matter Physics, and Deep Learning, focusing on how quantum computers and AI can advance the study of quantum many-body systems. In addition to her doctoral research, she developed and taught a graduate-level course on quantum programming and has served as a teaching assistant in various quantum-related courses at the Technion.

Zhian Jia

National unioversity of singapore, Singapore

Lattice realization of non-invertible symmetry-protected topological phase

Abstract

Non-invertible symmetry has become a central topic in quantum field theory, quantum matter, and quantum information. Symmetry topological field theory (TFT) offers a comprehensive framework for understanding non- invertible symmetries in both gapped and gapless phases. This talk presents a lattice realization of non-invertible symmetry-protected topological phases, building on generalizations of Kitaev's quantum double models to Hopf and weak Hopf algebras, as well as extending Levin-Wen string-net models to multifusion categories. We establish an equivalence between these two broader classes of lattice models for non-chiral 2D topological phases. From the perspective of lattice gauge theory, we introduce weak Hopf gauge and charge symmetries, providing insights into the weak Hopf symmetries underpinning the multifusion string-net models. The talk will also highlight some intriguing open problems related to these generalizations.

Vicente H. Alvarado

Ponticia Universidad Católica de Chile, 7820436, Santiago, Chile

Photo physics of a Single Quantum Emitter Based on Vanadium Phthalocyanine Molecules

Abstract

Single quantum emitters are crucial for advancing quantum technologies, including quantum repeaters and quantum information processing. The ability to isolate individual molecules with stable optical properties at room temperature is key for these applications. Vanadium-oxide phthalocyanine (VOPc) molecules have emerged as promising candidates due to their long coherence times, previously measured at the ensemble level [1], a detectable EPR signal [2] and has shown to couple to microwave photons [3]. In this work [4], we study the optical properties of isolated VOPc molecules, enabling the determination of their lifetime under two different detectors, resulting in approximately 1.27 and 0.8 nanoseconds. Our findings reveal that the optical properties of the molecule remain stable under controlled laser illumination matching a pyramidal C4v symmetry and, additionally, the equipment's highly precise instrument response function (90 picosecond resolution) allowed us to observe previously unreported anomalies in the molecule’s lifetime, consisting of a series of oscillations and a plateau behavior on the aforementioned.
These results highlight the potential of single VOPc molecules to act as quantum emitters, with robust stability and measurable intrinsic properties at room temperature.

Biography

Vicente Alvarado finished is BSc in Physics in 2023 at Pontificia Universidad Católica de Chile and currently he is finishing is MSc degree in Physics in the same institution. His main field of research is quantum optics, focusing on quantum sensing, applications of color centers in solid state spin defects and molecular qubits for quantum technologies

Fernando G. Torres

Pontificia Universidad Catolica del Peru. Av. Universitaria 1801. San Miguel

Chitin and chitosan as source for the sustainable production of Carbon Quantum Dots

Abstract

There is a growing interest in replacing commercial industrial materials with novel, bioresource-derived materials that have a reduced environmental impact. For instance, in the field of electronics, commercial materials often contain heavy metals such as arsenic, chromium, cadmium, copper, and mercury. The disposal of e-waste is challenging and is not always conducted properly, leading to significant impacts on human health and the environment.

Quantum dots (QDs) are among the most promising semiconductor nanocrystals and are rapidly gaining importance in the development of electronic devices due to their exceptional photophysical properties. They are used as active components in a wide range of applications, including light-emitting diodes (LEDs), quantum dot-based displays, photovoltaic cells, photoconductors, and photodetectors, among others.

This work explores the use of chitin and chitosan as raw materials for the synthesis of carbon quantum dots. A green chemistry approach was employed via a hydrothermal process. The synthesized QDs were characterized using Dynamic Light Scattering (DLS), Atomic Force Microscopy (AFM), and Fluorescence Spectroscopy (FS). The results demonstrate that chitin and chitosan can serve as viable bioprecursors for the synthesis of carbon quantum dots, with particle sizes ranging from 5 to 10 nm. These QDs exhibit blue light emission when excited with UV light at a wavelength of 365 nm.

Biography

Prof. Fernando G. Torres obtained his Ph.D. degree in Polymer Engineering at the University of Manchester, UK. He is a full professor at the Department of Mechanical Engineering, Pontifical Catholic University of Peru, and Head of the Laboratory of Polymers and Bionanomaterials. He has coauthored book chapters, conference papers, and over 100 journal papers. His research interests are focused on the structure-property relationships in bio- and nanomaterials and the development of new functional bionanocomposites for energy applications.

Aaliya Qureashi

Electrochemical sensing, DFT

Bifunctional zirconium phosphate with Reigate for electrochemical detection and simultaneous removal of Heavy metal ions and Nitro compounds

Abstract

Electrochemical sensing is emerging as a method of choice for sensing and monitoring of contaminants in water. Various sensing platforms have been designed for sensing heavy metal ions and organic pollutants in water bodies. Herein, we report a novel electrochemical platform that can be used for the detection of both heavy metal ions and nitro-based organic contaminants in waterbodies. The electrochemical sensor uses a modified electrode based on Fe3S4 impregnated zirconium phosphate (ZrP) nanoparticles synthesized by a simple ultrasonication method. The ZrP@Fe_3S_4 nanoparticles have been thoroughly characterized by PXRD, XPS, TEM, SEM-EDX, and zeta potential studies. The material exhibits excellent electrochemical performance for the detection of Pb^{2+}, Hg^{2+}, nitrophenol, nitroaniline, and picric acid with a low limit of detection ca. 0.93, 0.70, 0.98, 1.10, 1.53 ppm, respectively. Since ZrP@Fe_3S_4 nanoparticles are magnetically recyclable, their adsorption capacity and recyclability has been thoroughly investigated for the uptake of Pb^{2+} and Hg^{2+} ions from contaminated water. We observed that the adsorption of Pb2+ and Hg^{2+} ions on ZrP@Fe3S4 is best described by Langmuir isotherm and pseudo-second-order kinetic model, with adsorption capacity of 219.44 and 118.4 mg/g, respectively. Similarly, the removal efficiency of ZrP@ Fe_3S_4 was found to be 91, 57.6, 31.3 % for nitrophenol, nitroaniline and picric acid respectively. Furthermore, the theoretical calculations using density functional theory (DFT) were carried out to find the adsorption energy, affinity and point of adsorption which are in line with the experimental results. DFT calculations further suggest that the incorporation of Fe_3S_4 on ZrP improves the surface charge density and facile electron transfer between electrode and analyte.

We have shown real-time analysis of tomato juice and dal water as a proof of concept, and the synthesized composite exhibits good recovery and promising results for metal ion and nitroaromatics sensing, respectively. ZrP@Fe_3S_4 demonstrated excellent cycling and long-term stability without noticeable degradation for one week.

Lakhlifa Sadek

Al-Hoceima, Abdelmalek Essaadi University, Tetouan, Morocco

The general Bernstein function: Application to χ-fractional differential equations

Abstract

In this paper, we present the general Bernstein functions for the first time. The properties of generalized Bernstein basis functions are given and demonstrated. The classical Bernstein polynomial bases are merely a subset of the general Bernstein functions. Based on the new Bernstein base functions and the collocation method, we present a numerical method for solving linear and nonlinear χ-fractional differential equations (χ-FDEs) with variable coefficients. The fractional derivative used in this work is the χ-Caputo fractional derivative sense (χ-CFD). Combining the Bernstein functions basis and the collocation methods yields the approximation solution of nonlinear differential equations. These base functions can be used to solve many problems in applied mathematics, including calculus of variations, differential equations, optimal control, and integral equations. Furthermore, the convergence of the method is rigorously justified and supported by numerical experiments.

Biography

Lakhlifa Sadek received master's and Ph.D. degrees in applied mathematics from the Faculty of Science, Chouaib Doukkali University, El Jadida, Morocco, in 2018 and 2022, respectively. In 2023 he held the position of Associate Professor with the Department of Mathematics, Faculty of Sciences and Technology, Al-Hoceima, Abdelmalek Essaadi University, Tetouan, Morocco. His research interests include differential equations, differential matrix equations, numerical methods, Krylov subspace methods, special functions, mathematical modeling, fractional calculus, numerical linear algebra, and control theory.

Dr. Sivarama Krishnan

Indian Institute of Technology Madras, Chennai 600036, India

Implementation of CNOT gates between OAM and Polarization of Light

Abstract

As quantum information can be encoded in multiple degrees of freedom (DoF) of single photons, these can be exploited for efficient quantum information processing. Using OAM to encode qubits is advantageous as it constitutes an infinite dimensional Hilbert space, characterized by the topological charge $\infty < \ell < \infty$. The resultant infinite orthonormal states have been exploited for numerous applications in quantum communication and quantum information, such as multiplexing and demultiplexing states and implementing the Deutsch algorithm. Implementing CNOT gates between OAM and polarization involves cumbersome interferometric setups that are not readily scalable. However, restricting our two-qubit space to the subspace spanned by $l = \pm 1$ and horizontal and vertical polarization presents a platform to implement CNOT gates with polarization as the control qubit. By employing birefringence and total internal reflection, one can introduce a conditional flip of the OAM topological charge, thereby implementing a CNOT gate. Here, we present the design and the demonstration of a birefringent monolithic CNOT gate, dubbed the polarization selective dove prism (PSDP). We also detail a protocol whereby the PSDP can be applied to realize quantum random walks.

Biography

Dr. Sivarama Krishnan completed his PhD at the Max Planck Institute for Nuclear Physics in 2012. He is currently an associate professor in the Department of Physics at IIT Madras. His research interests include femto- and sub-femtosecond dynamics of nanoscale atomic systems, quantum optics and quantum computing, nanoscale superfluid systems, EUV physics with synchrotrons and table-top laser sources.

Brahim Abidine

National Center for Research in Materials Sciences Borja-Cedria Technopark Soliman, Tunisia

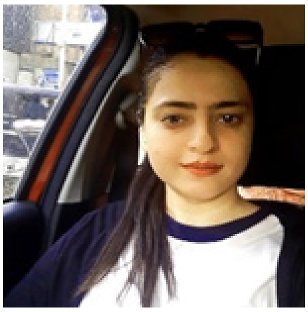
EPR and luminescence properties of Mn^{2+} doped $BaCO_3$ nanoparticles synthesized by autocombustion method

Abstract

Undoped and Mn^{2+} doped $BaCO_3$, were synthesized using the auto combustion method. The powders obtained by auto combustion were characterized using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy, scanning electron microscopy (SEM), electron paramagnetic resonance (EPR), and photoluminescence (PL). The orthorhombic phase is obtained just after auto combustion without additional heat treatment. The Crystallite size changes from (64.1 to 70.5 nm) to (41.7 to 44.9 nm) for undoped to Mn^{2+} doped $BaCO_3$. The FTIR and Raman spectra show the characteristic vibration modes of BaCO3. Morphological analysis shows that the synthesized powders consist of spherical and agglomerated particles. The EPR measurements show for doped sample the appearance of the characteristic broad signal of Mn^{2+} ions, in addition to the narrow response of $BaCO_3$ with g = 2.0025, which shows the incorporation of Mn^{2+} ions in the matrix. The estimated optical deviation values, obtained by extrapolating the linear portion of the curve for the undoped and Mn^{2+} doped $BaCO_3$ samples, are 3.22 eV and 3.28 eV, respectively. Photoluminescence showed that the sample had intense yellow emission at 567 nm (4T1 → 6A1) when excited at a wavelength of 366 nm. The typical CCT value of Mn^{2+} doped BaCO3 was estimated to be around 4070 K. The CIE coordinates of the sample are (x=0.421, y=0.556) with a purity of 94%, which makes it a potential candidate for laser emission.

Biography

obtained my PhD at the age of 26 from the University of Gabès with highest honors. I have published three articles in reputable journals. I am currently working on perovskite materials for electrochemical, photocatalytic, photovoltaic and optical applications.



Hafsa Qadri

Department of Bioresources, University of Kashmir

Candida cells devoid of the quinidine drug resistance transporter genes impact glucose transporter expression and metabolite accumulation promoting azole drug resistance

Abstract

This study highlights the role of QDR (quinidine drug resistance) transporters, a subset of Major Facilitator Superfamily (MFS) exporters, in conferring pathogenicity and virulence to Candida albicans. Transcriptome analysis of QDR knockout (QDRKO) strains versus wild-type (WT) strains reveals differential expression of key virulence-associated genes, including those involved in chitin and β-glucan synthesis, mannosyl transferases, vacuolar ion transporters, acid phosphatase, and sugar transporters (HGT8 and HGT9). Although some phenotypic assays showed no significant differences in growth under various stresses, QDRKO strains exhibited elevated expression of HGT genes, particularly under glucose limitation, leading to increased intracellular glucose accumulation. Interestingly, QDRKO strains demonstrated enhanced resistance to azole drugs, particularly under low glucose conditions, suggesting that deleting QDR genes alters cellular pathways associated with glucose and glycerol accumulation, potentially enabling cells to maintain pathogenicity/virulence in the absence of QDR MFS transporters. Moreover, the absence of QDR123 genes in Candida albicans leads to enhanced hyphae formation and cytotoxicity in co-cultures with HEK293 and MDA-MB-231 mammalian cell lines, particularly evident under low glucose conditions, highlighting the pivotal role of QDR genes in Candida pathogenicity and virulence. These findings underscore the complex interplay between glucose levels, QDR genes, and Candida pathogenicity, offering insights into adaptive responses and compensatory mechanisms employed by Candida cells in diverse host environments.

Biography

Dr. Hafsa is a dedicated Senior Research Fellow with a Ph.D. in Bioresources and specialization in Clinical Microbiology. They excel in investigating drug resistance mechanisms in human fungal pathogens, specifically Candida species, using advanced molecular and microbiological techniques. Their research focuses on analysisng drug resistance mechanisms, identifying antifungal targets, evaluating antifungal properties, and contributing to impactful publications. Dr. Hafsa has authored numerous papers in their field of expertise and has been recognized with awards including the Best Scholar Award and ICMR-SRF, reflecting their commitment to advancing knowledge in their field.

Nadia Haider

Delft University of Technology, 2628 CD, Delft, The Netherlands

Superconducting Quantum Processors: Design and Analysis for Surface Code Implementation

Abstract

Electronic design automation (EDA) plays a key role in advancing the field of various qubits by streamlining and optimizing the design process. In the realm of quantum applications, the reliance on microwave signals and systems spans a broad spectrum. The importance of proper electromagnetic analysis and microwave design is evident in the pursuit of groundbreaking advancements in quantum computing, particularly for large-scale, fault-tolerant quantum information processing units. This is impacting quantum processing chip design processes, particularly for superconducting and spin-based systems.

The complex nature of quantum circuits, particularly those based on superconducting technology, demands sophisticated EDA tools to handle complex qubit geometries and sophisticated quantum effects. Employing advanced simulation tools, engineers and researchers model the complex interactions of electromagnetic fields within the superconducting circuits to predict and understand the qubit's and resonator's behaviour. These simulations take into account various factors, such as the geometry of qubits and Josephson junctions, the impact of fabrication tolerance, and the coupling between qubits and their surrounding environment. The primary challenges in designing a large-scale quantum processor include developing a scalable chip architecture, ensuring proper signal routing, maintaining acceptable levels of cross-talk and unwanted couplings, and suppressing cavity modes, among other considerations.
Superconducting qubits harness the fundamental principles of superconductivity to achieve quantum information processing [1]. Utilizing superconducting materials that exhibit zero electrical resistance, these qubits are implemented as Josephson junctions—tiny devices capable of carrying a supercurrent. The two quantum states, $|0\rangle$ and $|1\rangle$, correspond to the

direction of the supercurrent in the Josephson junction. Through controlled manipulation of these quantum states via microwave pulses, superconducting qubits enable the creation of quantum gates, forming the building blocks for quantum computations. The inherent controllability of superconducting qubits make them promising candidates for the realization of practical quantum processors.

From the perspective of microwave engineering, the superconducting qubits, such as transmon [2] and fluxonium [3], are systems of coupled nonlinear LC resonators. By leveraging EM simulation techniques, researchers can predict in advance various performance matrices of such superconducting qubits under different conditions, identify potential sources of decoherence, and optimize the design parameters for enhanced quantum performance. This iterative simulation process is instrumental in fine-tuning the geometrical and material aspects of the qubit, aiding in the development of more robust and efficient quantum processors. In addition to designing and optimizing superconducting chips, electrostatic simulation tools are often used to predict the presence of any unwanted cavity modes that can affect the overall performance of the system.

Researchers often adapt existing EDA tools, such as HFSS [4], CST [5] and COMSOL [6], or use a combination of tools to meet the specific challenges posed by superconducting qubit designs. In addition, specific tools have been developed by quantum industries and research institutions dedicated to quantum circuit simulation, including Qiskit Metal [7]. In the design of superconducting quantum processors, a common practice involves employing a hybrid simulation approach that combines finite element and circuit simulations. This approach has proven to be a valuable tool for investigating the next generation of chips with numerous qubits. In these simulations, researchers utilize a complex and detailed finite element model for the qubit and a simplified circuit model for the transmission lines as depicted in Fig. 1. This strategy is particularly beneficial when analysing large circuits, as the resource-intensive finite element EM simulation of the qubits can be computed in advance. Subsequently, by seamlessly integrating these simulation results into a circuit simulator, much like assembling Lego blocks, researchers can effectively analyse the overall chip performance [8-9].

For quantum devices based on spin technologies, it has also become essential to have a proper understanding of the microwave performance as the number of qubits in these devices is also rapidly increasing. It is now become critical to have a proper understanding of the sources of microwave losses, DC and microwave cross-talks. Various research groups within academia and industries are exploring where the simulation works will make a difference by analysing the microwave and electromagnetic performance of current spin-based quantum chips, understand the sources of cross-talk and identify critical components to improve chip performance. Currently, there are design tools like QTCAD [10] that also facilitate electrostatic analysis. Looking ahead, we anticipate the emergence of an expanded array of tools for diverse technologies employed in Quantum Processing Units (QPUs).

Biography

Nadia Haider is an Assistant Professor at Delft University of Technology and a reseach group leader at QuTech. Her scientific interests and research work focuses on superconducting qubit design, cryogenic microwave circuit design and simulation for quantum processors and quantum sensors, antenna and passive RF design, and numerical electromagnetic analysis. Nadia received her M.Sc. (Cum Laude) and Ph.D. degrees in electrical engineering from the Delft University of Technology in 2010 and 2015, respectively. In 2015, she joined Netherlands Organization for Applied Scientific Research (TNO) and QuTech (a collaboration between TU Delft and TNO) where she has been the lead applied electromagnetic scientist. In 2023, Nadia joined Delft University of Technology.

Oleksandr Shebeko

National Science Center" Kharkiv Institute of Physics and Technology", Kharkiv, Ukraine

Gauge invariance principle as a guiding star in the theory of electroweak scattering off nuclei (bound systems)

Abstract

We are trying to resume our previous studies of electromagnetic interactions with the simplest nucleon systems, started in the 90's [1-5]. As before, we have focused upon constructing the many- particle contributions to the electromagnetic current density operator. From the outset special attention is paid to ensuring the requirements of the gauge independence principle being relied upon the Fock-Weyl criterion. Its formulation and consequences can be found in Ref. [6].

Our consideration is a field-theoretical one based on a corpuscular picture by Fridrichs, in which one uses the notion of particle creation and destruction with transitions between separate subspaces of the Fock space and other delicate problems in relativistic quantum field theory (see, e.g., Appendix B in [2]). In practical calculations, we are addressing the instant form of relativistic dynamics, where merely the total Hamiltonian H and the boost generator B embody the operators that stem from the interactions between particles included.

Instead of a standard approach, we use the clothed-particle representation with all the particles on their mass shells that allows us to get rid of some uncertainties inherent in the preceding theory with bound systems.

We will note that along with the one-clothed-particle states by Greenberg and Schweber [7] in quantum field theory there are other one-particle states which are the H eigenvectors as well. In the article [8] there was presented the equivalence theorem that connects the definitions of the S- matrix within the in(out) formalism by Lehmann, Symanzik and Zimmermann and the clothed- particle representation approach.

Biography

Graduated from the Physics Department of Kharkiv State University in December 1960. From 1961 to 1994 worked in the Division for Theoretical Physics of the Department of Nuclear Physics & Accelerator Facilities at Kharkiv Institute of Physics & Technology. From 1995 to the fall of 1998 he had the last position at the Bogoliubov Laboratory of Theoretical Physics of the Joint Institute for Nuclear Research (Dubna, Russia) where worked by contract. At present, Leading Researcher at the Institute for Theoretical Physics of the National Research Centre “Kharkiv Institute of Physics & Technology”.
Member of the Ukrainian Physical Society and referee at a few physical journals.
Author of over 200 scientific publications, including reviews, lectures and talks. At present, concerned with bridging the field-theoretical description of hadronic systems and the approach conventional for nuclear physics via a clothing procedure in quantum field theory.

Vivek Verma

Indian Institute of Technology Roorkee, Roorkee, 247667, Uttarakhand, India

A robust quantum image encryption algorithm based on 3D-BNM chaotic map and quantum selective scrambling operations

Abstract

The advent of quantum computers could enable the resolution of complex computational problems that conventional cryptographic protocols find challenging. As a result, the formidable computing capabilities of quantum computers may render all present-day cryptographic schemes that rely on computational complexity ineffectual. Inspired by these possibilities, in this research, we have developed a quantum image encryption algorithm using a 3D chaotic map and controlled qubit-level scrambling operations. The newly proposed 3D-BNM chaotic map effectively reduces the degradation of chaotic dynamics resulting from the finite word length effect. It facilitates the generation of highly unpredictable random sequences and enhances chaotic performance. The system's efficacy is additionally enhanced by the inclusion of a SHA-256 hash function. Our algorithm commences by encoding a square grayscale image into the Novel Enhanced Quantum Image (NEQR) format. To disrupt and reduce the pixel correlation, we apply a 2-dimensional nonuniform generalized Arnold transformation (GQAT) for initial scrambling. Subsequently, the algorithm leverages chaotic sequences derived from our proposed chaotic map to perform chaotic diffusion using quantum XOR operations, effectively obfuscating the grayscale information of the scrambled image. To further augment randomness and reduce the correlation among the pixels in the resulting cipher image, the image undergoes two bit-level scrambling procedures: bit-level swap operations and quantum cyclic XOR-shift operations by using qubit level based selective scrambling. The encryption algorithm capitalizes on the computational efficiency of fundamental quantum gates, such as the Controlled-NOT gate, modular adder (ADDER-Modulo 2^n) and the SWAP gate. Both

theoretical and numerical simulation analyses affirm that our algorithm holds significant promise for image encryption applications on quantum computers, offering a substantial advancement in the field of quantum cryptography.

Biography

Vivek Verma received M.Sc. degree in mathematics and computing from the IIT Dhanbad, in 2019 and, he is pursuing his PhD in Mathematics department from IIT Roorkee. His research interests include Information security and quantum information processing.

Neeshu Rathi

Indian Institute of Technology Roorkee, Uttarakhand, India

Enhanced Quantum Ensemble Classification Algorithm with Shallow Circuit and Parallelism Mechanism

Abstract

We present a Quantum Ensemble Learning (QEL) algorithm with an optimized strategy for improving classification accuracy. By leveraging the inherent parallelism of quantum computing, the proposed approach enhances the performance of machine learning classifiers. Specifically, it employs a bagging strategy using three quantum registers—data, control, and test—to generate modified training set samples in a superposition state. The ensemble estimates for each test data point are computed through state preparation, superposition-based sampling, quantum interference learning, and measurement. Unlike classical methods, our technique adds classifiers to the time complexity additively rather than multiplicatively, benefiting from quantum parallelism. We validated the performance of the algorithm on several benchmark datasets using the IBM Qiskit environment.

Simulation results indicate that the QEL framework, with integrated Quantum Support Vector Machine (QSVM) and quantum feature extraction, demonstrates superior accuracy and efficiency.

Biography

Neeshu Rathi received M.Sc. degree in Mathematics from Kurukshetra University Kurukshetra, in 2017 and, she is pursuing her PhD in Mathematics department from IIT Roorkee. Her research interests include Quantum Machine Learning Algorithms.

Bhupendra Singh

C V Raman Nagar, Bengaluru-560093, Karnataka, India

On quantum and linear complementary dual codes from the cyclic codes over the ring

Abstract

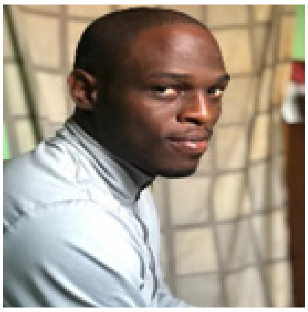
In this talk I will introduce cyclic codes over the ring $S = F_q [u, v, w]/u^3 - u, v^2 - v, w^2 - w, uv, vu, uw, wu, vw - wv\rangle$ for an odd prime P and a positive integer r, let $q = P^r$ and finding of new and better quantum and linear complementary dual (LCD) codes from them. The Gray map on S and the structural properties of cyclic codes over S will be discussed. The construction of new quantum codes from the gray image of cyclic codes over S will be presented. The investigation of LCD codes over S and some optimal and best-known linear codes from the gray image of cyclic LCD codes over S will be talked.

Biography

Bhupendra Singh is working as senior scientist at CAIR, DRDO, Bengaluru, India and having 19 years of research experience. He has published 03 book chapters and 27 research articles in journals and conferences. He is also editor of 2 books. He has several patents and copyright in the area of cyber security.

His areas of research include, design and analysis of symmetric key cryptographic primitives, design and analysis quantum-safe symmetric and asymmetric key cryptographic algorithms and construction of quantum error correcting codes.

Dr. Singh was the Panelist of VAIBHAV-2020 in Quantum Technology Vertical organized by PMO. His team won the second prize in International Quantum Science and technology hackathon 2022 organized by office of principal scientific advisor, Government of India.



Anicet Kammogne

University of Dschang, Foto, CAMEROON

Non-resonant exponential Nikitin models with decay

Abstract

We analyzed the dissipative time-dependent Schrödinger equation in the frame of the decaying two-state problem with decay rates $\Gamma 1,2$. We illustrated our vision through the exponential Nikitin model with decay, where the detuning is represented by two parts: the time-dependent exponential part and the static part characterized by the real part and the imaginary part. We studied two cases of the Rabi frequency: in the first case, the Rabi frequency is constant and we denoted this model by EXP1, in the second case the Rabi frequency is a time-dependent exponential function, and this model is denoted by EXP2. Due to its multiple applications, the description of the Nikitin model is extended to the limiting case in the short and rapid time approximation, these variations make possible the assimilation of the Nikitin model to the Rabi and Landau–Zener model in the short time variation, while in the rapid time approximation, this model corresponds only to the Rabi model. The analytical description of the Nikitin model is in perfect agreement with the numerical results. Exact analytical and numerical solutions to dissipative Schrödinger equations with exponential Nikitin models are obtained for all possible initial moments instead of $t0 = -\infty$ and $t0 = 0$ with the help of the confluent hypergeometric functions..

Biography

finished his PhD at 25 years old years from Andhra University and postdoctoral investigations from Stanford University School of Medicine. He is the chief of XXXX, a head Bio-Soft administration association. He has Published in excess of 25 papers in rumored diaries and has been filling in as a publication board individual from notoriety.

Bao-Sen Shi

University of Science and Technology of China, Hefei 230026, China

Rydberg atom-based sensors for radio-frequency electric field measurement

Abstract

Rydberg atoms are very sensitive to external fields, making them a promising platform for field detection. Recently Rydberg atoms have been utilized to measure the electric field of radio frequency, showing some potential advantages surpassing conventional methods. In this talk, I will mainly report the new results of Rydberg atomic-based radio-frequency electric field sensing achieved in our group, including many-body enhanced metrology for microwave electric fields in a non-equilibrium Rydberg atomic gas, deep learning enhanced Rydberg multi-frequency microwave recognition, the measurement of a Megahertz radio-frequency electric field, and the demonstration a Rydberg microwave-frequency-comb spectrometer via multiple-microwave field dressing, etc. The reported results are hopeful for developing Rydberg atomic-based sensors for metrology applications linking to the International System of Units.

Biography

Dr. Bao-Sen Shi is a professor of physics in University of Science and Technology of China (USTC). During the past years, he has been focusing on the experimental realization of quantum memories based on atomic ensembles, constructing the quantum interface through nonlinear frequency conversion. Besides, he also does many jobs on preparation of a high-quality entangled pair source with a nonlinear crystal or an atomic system, and works on the topic of nonlinear optics with structured light and integrated nonlinear optics. He is the author or co-author of over 150 peer-reviewed SCI papers in Nat. Photon. /Phys, Nat. Commun., Sci. Adv., Light, Phys. Rev. Lett. /X, Optica, etc. He is an editorial member of journals J. Phys. B and Photonics, an associate editor of journal Frontiers in Quantum Science and Technology. His current interests include experimental quantum information, quantum optics, nonlinear optics and integrated optics

Christopher Bishop

MC for The Economist's "Commercializing quantum" events

Secrets to building a quantum team

Abstract

The Global Quantum Computing Market Size was estimated at USD 10.13 Billion in 2022 and is expected to surpass around USD 125 Billion by 2030. It is poised to grow at a projected CAGR of 36.89% from 2023 to 2030. Total quantum investments have increased from USD 59 Million in 2012 to an estimated USD 2.7 Billion in 2022.

In the next decade, quantum information science (QIS) discoveries will transform businesses, including energy storage, chemical engineering, drug discovery, financial services, materials science, communications, and more.

The quantum workforce needs to include talented people across various roles and functions to drive broader adoption and ultimately deliver business benefit. There are opportunities for people with skills in management consulting, PR and communications, investment strategies, operations, project management, legal, regulatory, and policy issues as well as education.

Participants will learn the ten steps to assembling a quantum workforce. Leveraging the transformational power of quantum information science will drive business models, ultimately providing competitive advantage regardless of vertical or geography.

KEYNOTE OBJECTIVES:

- Provide strategic guidance on how to stay ahead and leverage this emerging technology
- Identify specific opportunities to take advantage of quantum to drive a business model regardless of vertical or industry go-to-market portfolio
- Guidance on connecting with the broader quantum community
- Pointers to resources, including thought leaders and organizations leading the latest developments in the quantum industry.

En-Ze Li

University of Science and Technology of China, Hefei 230026, Anhui, China

Hysteresis Trajectories in Quantum Rydberg Atomic Gases

Abstract

The interplay between strong long-range interactions and the coherent driving contribute to the formation of complex patterns, symmetry, and novel phases of matter in many-body systems. However, long-range interactions may induce an additional dissipation channel, resulting in non-Hermitian many-body dynamics and the emergence of exceptional points in spectrum. In this talk, we will introduce our resent experimental observation of interaction-induced exceptional points in cold Rydberg atomic gases, revealing the breaking of charge-conjugation parity symmetry. By measuring the transmission spectrum under increasing and decreasing probe intensity, the interaction-induced hysteresis trajectories are observed, which give rise to non-Hermitian dynamics. We record the area enclosed by hysteresis loops and investigate the dynamics of hysteresis loops. The reported exceptional points and hysteresis trajectories in cold Rydberg atomic gases provide valuable insights into the underlying non-Hermitian physics in many-body systems, allowing us to study the interplay between long-range interactions and non-Hermiticity.

Biography

En-Ze finished his PhD at 2025 from Key Laboratory of Quantum Information from University of Science and Technology of China of Physics. He is currently conducting a postdoctoral research project at the School of Physics, University of Science and Technology of China. He is currently focusing on quantum many-body physics and non-Hermitian physics, both of which are explored within the framework of atomic systems.

Hossein Vaziri

Shah rood University of Technology, Shah rood P. O. Box 36155-316, Iran

Examining the structure functions of nucleons by introducing new ansatz and their consequences on patron distribution functions in higher approximation

Abstract

By introducing ansatz and using a PDF at the N^3 LO approximation in this paper, we have studied the structure of the nucleons in generalized patron distributions. For this purpose, the form factors and the electric radius of nucleons, as well as the quark's form factors, are calculated in this paper. These calculations give important new information about the nucleons and the distribution of patrons within them. The results are analyzed, and to validate them, the abstract emphasizes the importance of comparing the results with existing research and experimental data. By varying the free appropriate parameters of the new ansatz, the study seeks to optimize the model, ensure its suitability for accurately describing the nucleon's internal structure, and provide valuable insights about the distribution of patrons.

Ibtissam Missaoui

Tunisia Laboratory LAMIDED (University of Sousse)

The Impact of Russia’s Invasion of Ukraine on innovation and financial technology (FinTech) and stock Market returns: Evidence from TVP-VAR

Abstract

The impact of Russia's invasion of Ukraine on innovation and financial technology (FinTech) and stock market returns has become a topic of increasing interest in recent years. This study examines the interconnectedness among FinTech, technological innovation, and African stock returns using the Time-Varying Parameter Vector Autoregressive (TVP-VAR) model. Specifically, we analyze how events such as the COVID-19 pandemic and the Russia-Ukraine conflicts have affected these variables.

Our findings reveal a strong connection among FinTech, technological innovation, and African stock market returns, particularly during times of uncertainty like the COVID-19 pandemic and the Russia-Ukraine conflict. We identify the key contributors and creators of shocks in these areas and show that volatility spillovers are dynamic, changing from contributors to creators of volatility and vice versa during different crisis periods. Interestingly, during the Russia-Ukraine conflict, exchanges such as the Tunisia Stock Exchange (TUN), Nigeria Stock Exchange (NAG), and the Financial Technology Index (KBW-NFT) shifted from being net recipients to net transmitters of volatility.

This research provides valuable insights for investors, industry leaders, and policymakers looking to develop effective diversification strategies for their investments. By understanding the dynamics of these interconnected variables, stakeholders can better navigate the impact of geopolitical events on financial markets and innovation in the FinTech sector.

Jirawat Tangpanitanon

Quantum Technology Foundation (Thailand) [QTFT], Bangkok, Thailand

A Categorical and Quantum Optimization Framework for Addressing Dynamic Business Challenges in Thailand as Systems of Systems

Abstract

In this talk, I will discuss our efforts at QTFT towards building a system-of-systems framework, called SOR, to optimize complex enterprise network as systems of systems. The SOR framework is structured into three layers. The first layer formalizes customer's data structure using Category Theory. The second layer utilizes operads and principle of causality to define systems of systems. The third layer focuses on optimization with the emphasis on quantum clustering. I will discuss one of our SOR use cases involving route optimization for over 5,000 convenience stores in Bangkok that leverages IBM's 127 qubit systems in a production setting and involves actual users. Other use cases in energy management, production planing, and air traffic management will be briefly discussed.

Biography

I'm a CEO and co-founder of Quantum Technology Foundation (Thailand) [QTFT] as well as a research fellow at Thailand Center of Excellence in Physics. Based in Bangkok, I work with leading STEM talents and corporates in Thailand to bring advanced optimization solutions to life using digital and quantum technologies.

During my PhD, I worked on quantum simulation at Center for Quantum Technologies, National University of Singapore. I was granted with Google's Quantum Innovations award in 2018 for the development of a spectroscopy technique used to characterize Google's quantum computer. The work was published in Science

At QTFT, I have been working with our corporate partners to deliver optimization solutions in various areas including Air Traffic Management, Financial Asset Management, Logistics Optimization, Virtual Power Plant, and Production Planning.

Kaniz Fatima

University of Kashmir, Hazratbal, Srinagar, J&K, India

Designing and Energizing the Novel $BiSnO_2$@GQD for an In-depth Exploration of Structural, Electronic, Optical, and Excited State Electron Transfer Properties in DSSC, Adorned with Pyrelene Dye - A DFT Perspective

Abstract

In order to improve the photo-response of a dye-sensitized solar cell, theoretical modelling of various systems using density functional theory (DFT) is presented in this study. Using B3LYP and 6-311G level of theory and DFT as included in Gaussian 09 level of programming, the dye, dye-TiO_2)9, and ($BiSnO_2$)-Dye-(TiO_2)9 were optimised. In contrast to dyes and dye-TiO_2 systems, the HOMO-LUMO energy gaps are less for ($BiSnO_2$)-Dye-(TiO_2)9 multi-junction systems. When compared to Dye-TiO_2 systems, it was shown that the absorption peaks for ($BiSnO_2$)-Dye-(TiO_2)9 multi-junction systems were primarily red-shifted, indicating an improvement in the dye sensitizer's absorption behavior due to its interaction with the $BiSnO_2$@GO framework. The findings suggest that the dye sensitizer and the $BiSnO_2$@GO may have co-sensitized the TiO_2, which is predicted to boost the solar device's efficiency.

Biography

Kaniz Fatima is an accomplished scholar in the field of chemistry, with a strong academic background and a focus on cutting-edge research. She graduated from Jammu University, where she laid the foundation for her scientific career. Building on this, she pursued and completed her Master of Science in Chemistry from Garhwal University, further honing her skills and deepening her knowledge. Currently, she is engaged in her doctoral studies at Kashmir University, where her research is centered on the innovative and impactful field of Metal-oxide decorated graphene in solar energy applications. Her work uniquely combines computational studies with experimental approaches, aiming to advance the understanding and utilization of graphene in enhancing solar energy technologies. Kaniz's dedication to both theoretical and practical aspects of her research highlights her comprehensive approach and potential to contribute significantly to sustainable energy solutions

Meryem EL Kirdi

quantum state tomographie and fidélité, Denmark

Téléportation of Twa-Qubit State Between Non-Neighboring Nodes Based on the Utilization of Multiple Cluster States Within Quantum Networks

Abstract

The transmission of quantum states over extended distances is constrained by photon lisses, Rolling out direct amplification Akin to class cal télécommunications due to the non-coping théorème. Overbooking This challenge in volves implémentions quantum répéter protocoles That levurage étranglement swapping to cérate long-distance étranglement from shorter distances. A Novell multi-hop quantum téléportation schème, landing concepts from quantum répéteurs and téléportation, Is Under exploration. It amis to Transfer arbitrer two-qubit states between two distant parties, Even in the absence of a direct quantum Channel. Intermédiate notes, connecte via a four-qubit entage cluster state as quantum channels, are introduced based on a more général routing Protocol. Bell mesurément are Independent conducted by the source Node (Alice) and all intermédiate notes, with simultanés transmission of mesurément résulte, significantly reducing time consomptions. Datamining the quantum state from Bell mea surement résulte requiers onlay the destination Node (Bob) for a simple unitary transformation. More over, This Protocol holds promise for implémentation on the IBM Quantum Expérience platform once the réquisit quantum circuits are désigne. This overview en compasses both the théorétique and expérimental statuts of the propose schème, with expérimental bindings incorporâtes into quantum state tomographie to verify the accuracy of the transmitted quantum state.

Mikhail Mochalov

Russian Federal Nuclear Center –All-Russian Research Institute of Experimental Physics Sarov, Nizhny Novgorod region, Russian Federation

Quasi-isentropic compressibility of noble gases, nitrogen and helium in pressure range up to 20 TPa

Abstract

The authors present experimental data on quasi-isentropic compressibility of strongly nonideal plasma of noble gases, nitrogen and helium obtained in RFNC – VNIIEF in the density range of 7.5 – 21 g/cm3 and the pressure range of 720 – 20000 GPa. The investigated density range is record for today. In laboratory experiments with helium the authors achieved parameters (density of 14 g/cm3 and pressure of ? 20000 GPa), which are typical for values in the central areas of such giant planets of the Solar System as Jupiter or Saturn.

In tests the devices of cylindrical and spherical geometries were used. They were transforming shock-wave compression into quasi-isentropic compression at significant reduction of thermal heating and longer holding a substance in compressed state. The tests were performed at RFNC – VNIIEF X-ray radiography facility consisting of betatrons with the limiting energy of ? 60 MeV. They are used in the multipulse regime of generation of slowing-down radiation with multichannel optical-electrical system for recording X-ray images. Values of density of compressed plasma were determined using the measured value of the shell radius at time of its "stopping". Pressure of compressed plasma was obtained basing on gasdynamic calculations, which took account for actual characteristics of experimental facilities.

Mingyi Zhu

School of Physical Sciences, Hefei 230026, China

Laser Sideband Locking Using a DDS-Based RF Signal Source

Abstract

Laser frequency stabilization is critical for applications in quantum optics, cold atom experiments, and optical communication systems. This paper presents a laser sideband locking method based on a radio frequency (RF) signal source utilizing a Direct Digital Synthesizer (DDS) and a Field-Programmable Gate Array (FPGA). The system generates phase-modulated RF signals using DDS and FPGA to drive an electro-optic modulator (EOM), producing optical sidebands. By extracting the error signal and employing a PID controller, the sidebands are locked to a high-finesse optical reference cavity. This approach achieves both frequency shifting and locking with a single EOM, enabling a maximum frequency shift of up to 1.4 GHz. Compared to traditional methods, this technique offers significant advantages, including a simplified signal generation scheme, reduced optical components, continuous phase tuning, high dynamic range, and adaptability to rapidly changing environments. Potential applications include cold atom trapping, quantum computing, and optical clock systems. Future work will focus on reducing phase noise and miniaturizing the system for portable applications.

Biography

I studied in the Department of Modern Physics, University of Science and Technology of China during the period of 2012.8-2016.6 and graduated with a bachelor of science degree at 2016.6. Since 2016, I have been pursuing a Ph.D. degree in the Department of Modern Physics at University of Science and Technology of China. Throughout my Ph.D. studies at USTC, I have been primarily involved in research related to strontium atomic optical lattice clocks, with one paper currently in the process of being published.

Mohammed Elghandouri

UMMISCO, IRD, Sorbonne University, Paris, France

Approximation of Mild Solutions of Delay Integro-differential Equations on Banach Spaces

Abstract

The aim of this work is to study an approximation of the mild solution of a delay semi-linear integro-differential equation with an initial history condition φ. Using the theory of resolvent operators as given by R. Grimmer (1982), we can ensure an explicit form for the mild solution uφ of our considered equation. The approximation takes into account the mild solutions (u^{φ}) of the related family of integro-differential equations with Piecewise Constant Arguments. Our main result is to show that (u^{φ}) converges to uφ as σ goes to zero uniformly on compact and unbounded intervals. For the error function, we obtain explicit exponential decay estimates by using the stability of the resolvent operator and Halanay's Inequality. We also show that the approximation is stable and that the solution of the delayed integro-differential equation and its associated difference equation produced via the Piecewise Constant Arguments (DEPCA) method are asymptotically stable. Some examples are given to illustrate our basic results.

Biography

Ph.D. in a joint doctoral program between Cadi Ayyad University of Marrakech (Morocco) and Sorbonne University of Paris (France), specializing in applied mathematics and computer science through the International Doctoral Program: Modelling of Complex Systems (PDI-MSC). My research interests include Controllability of dynamic systems, Evolution Equations, Integrodifferential Equations, Optimal Control, Epidemiological Systems, Mathematical and Computer Modelling.

Morteza Sasani Ghamsari

Photonics and Quantum Technologies Research school, NSTRI, Tehran, Iran

Which computer will be preferred quantum or optical?

Abstract

In the race among modern technologies for rapid computation and solving complex problems, it seems that quantum computing appears to offer a solution. As a result, in recent years, significant efforts have been made to develop quantum computers capable of performing calculations that would take a considerable amount of time using classical computers. One of the primary challenges in advancing quantum technology is keeping qubits stable in their required states long enough to carry out computations. Qubits are highly sensitive to environmental changes. Quantum coherence is a key property for qubits, and their quality is often measured by coherence time, which indicates how long a qubit can retain information. Various factors can lead to qubit instability and decoherence, with the main cause being interaction with the surrounding environment. Common environmental influences include temperature fluctuations, stray particles, and electromagnetic fields. On the other hand, optical computers, operate similarly to electric ones, but they use light instead of electricity. This allows a single wire to carry multiple signals of different colors simultaneously, whereas electric wires transmit one bit at a time. Over the past decade, there has been growing interest in optical computing platforms due to their potential to enable rapid, large-scale parallel processing with minimal power consumption. Optical computers are expected to be millions of times faster than current computers and could even pave the way for quantum computing at room temperature. However, the question remains as to which type of quantum or optical computer will emerge as the winner in this competition. In my presentation, I will cover this topic and emphasize my prediction.

Biography

Dr. Morteza Sasani Ghamsari is a senior researcher in the Photonics and Quantum Technologies Research School of the Iranian Nuclear Science and Technology Research Institute. His research focused on photonic materials, including metamaterials, quantum dots, and plasmonic nanomaterials, that can be used in a wide range of nanophotonics applications. His recent interests also lie in quantum materials, including single photon sources including boron nitride and sic, diamond quantum dots, rare earth complexes, thin superconductor films optical modulators (ITO, Si_3N4, AlN, TiO_2, $LiNbO_3$), and 2D materials such as graphene, and WSe_2. He edited five books, authored five chapter books, and over 135 articles in scientific journals as well as in conference proceedings

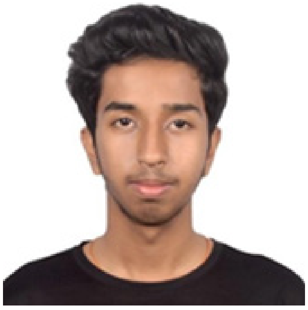
Noule Simo Raïssa

University of Yaounde I, PO. Box 812, Yaounde, Cameroon

Lower- and higher-dimensional excitations in carbon nanotube system arrays

Abstract

Carbon nanotubes are one- or two-dimensional nanostructures comprised exclusively of carbon, exhibiting exceptional physical properties and including high mechanical strength, signifi-can't electrical and thermal conductivity, for innovative applications in fields such as electronics, optics, mechanics, and energy. We aim to demonstrating the existence of multiple nonlinear solutions characterizing the dynamics of carbon nanotubes. Also, we determine how the nonlinear properties of these systems influence their dynamic behavior and identify the underlying mechanisms responsible for such miscellaneous solutions. Our methodology involves deriving the evolution equation governing the carbon nanotube dynamics from Maxwell's equations and the Boltzmann kinetic equation. We then apply the Weiss-Tabor-Carnevale approach to study deeply the integrability of the system. To alleviate the mathematical complexity of the analysis, we thoroughly examine the Kruskal simplification formalism verifying that the system satisfies the Painlevé test and exhibits additional integrable properties such as the Backlund transform-motion and the Hirota's bilinearization. We demonstrate that the (2+1)-dimensional system supports a broad spectrum of nonlinear solutions, including geometrically defined excitations, singular excitations, and various waveguide excitations among others. We show that the above solutions exhibit characteristic nonlinear properties, such as localization and dispersion, highlighting the system's intricate dynamics and its potential for sustaining diverse nonlinear wave behaviors. We arrive to the conclusion that the existence of the previous miscellaneous excitations offer new insights into their properties and applications in electronics and optics. We also address that further investigation needs more regards to uncover the underlying mechanisms driving the previous phenomenon while unlocking the full potential of the material.



Prakul Sunil Hiremath

Department Of Cse, Vtu Belagavi

Quantum-Resilient Internet: Satellite-Enabled Quantum Key Distribution for Secure Global Communications

Abstract

As advancements in quantum computing challenge traditional cryptographic methods, the urgency for a quantum-resilient internet has never been more pressing. This paper explores the integration of satellite-enabled Quantum Key Distribution (QKD) as a foundational technology for secure global communications. QKD offers theoretically unbreakable encryption by leveraging quantum mechanics, creating secure communication channels resistant to both classical and quantum-based attacks. By deploying QKD through satellite networks, this approach aims to overcome the limitations of ground-based fiber optic systems, such as signal attenuation over long distances, allowing for secure data transfer on a global scale.

Our work delves into the practical challenges and solutions in implementing satellite-based QKD, focusing on the development of robust protocols for key generation, distribution, and management. We analyze the critical aspects of system design, such as photon transmission stability, atmospheric interference mitigation, and satellite network architecture, which are essential for sustaining reliable quantum communication channels over vast distances. Additionally, we examine the scalability of this technology and its potential integration with existing infrastructure, offering a roadmap for transitioning from isolated QKD systems to a comprehensive quantum-secure global network.

This research underscores the transformative potential of satellite-based QKD to redefine internet security in a quantum era, highlighting its application across government, defense, and commercial sectors where data confidentiality is paramount. By addressing both technical and operational challenges, this study aims to contribute to the growing body of work focused on achieving a resilient, scalable, and quantum-secure internet, paving the way for a future-proofed digital infrastructure.

Biography

Prakul Sunil Hiremath is an undergraduate student pursuing a Bachelor of Technology in Computer Science Engineering at VTU Belagavi. He is actively engaged in research, focusing on innovative applications of nanotechnology and sustainable energy solutions. His projects include the "BioLoop," which aims to enhance carbon capture and biofuel production, as well as advancements.

Dr. Cristhian Calderon

Denmark

Harnessing Quantum Entanglement for Secure Communication Protocols

Abstract

Quantum entanglement, a phenomenon where particles become correlated in such a way that the state of one particle instantaneously affects the state of another, regardless of the distance between them, has long been a fundamental concept in quantum mechanics. In recent years, harnessing this phenomenon has emerged as a promising avenue for developing secure communication pro- tocols. This abstract explores the utilization of entanglement-based quantum key distribution (QKD) protocols for ensuring the security of communication channels. We delve into the principles behind QKD, including the generation, transmission, and measurement of entangled particles, as well as the underlying quantum principles that make such protocols inherently secure. Additionally, we discuss the current challenges and ongoing research efforts in implementing QKD systems in real-world scenarios, including issues related to scalability, practical- ity, and compatibility with existing communication infrastructure. Finally, we highlight the potential impact of quantum entanglement-based communication protocols on cybersecurity and data privacy, paving the way for a new era of secure and quantum-resistant communication networks.

Rachid El Aitouni

Chouaïb Doukkali University, P. B 20, 24000 El Jadida, Morocco

Unification of integral transforms and their applications

Abstract

An integral transform, called BA-transform, is introduced in this work, which yields a known number of transforms by changing variables.We prove that Laplace, Sumudu, Natural, Elzaki, Aboodh, Tarig, Srivastava, Kamal, Laplace-Carson, Mohaned, Shehu and Sawi transforms are particular cases of our new generalized integral transform, which is similar to Srivastava transform. We establish for our transform few fundamental properties, connections with these well-known integral transforms in literature, and some test examples with their graphic illustrations in application section. Also, the double new integral transform and some of its fundamental properties are investigated. Some results and relationships between our simple and double integral transforms are established.

Biography

I obtained my PhD in theoretical physics at the age of 37. I have been a college-level teacher of physics and chemistry for 16 years. I have five publications in graphene physics and one publication in mathematics. I am a versatile researcher, with a strong inclination towards theory and mathematics.

Rami Ahmad El-Nabulsi

Czech Republic

Nonlocal Approach To Energy Bands In Periodic Lattices And Emergence Of Electron Mass Enhancement

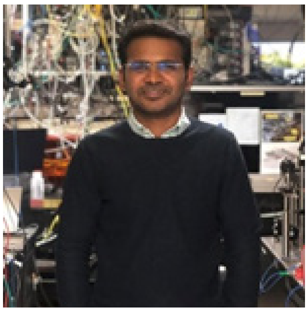
Abstract

Two of the most intriguing concepts of quantum theory are the "Heisenberg's uncertainty relation" and the "spooky action at a distance" or "nonlocal correlations of measurements (in space or in time)" as introduced by Einstein. The uncertainty principle which represents the cornerstone of quantum mechanics states since it introduces the concept of indeterminacy in atomic theory. It is considered a fundamental intrinsic limitation in the explanation of the atomic world. This principle proves that, for a quantum system, there exist certain observable properties such that physical information of one unavoidably implies uncertainty about the other. Quantum mechanics is known to permit a number of nonlocal correlations between spatially separated particles known as entanglement. Nonlocality which is explained merely non-classically through quantum entanglement represents a delicate topic and is still not well understood. Nonlocality which is the most fascinating and hardly understood phenomenon of the quantum theory is in general manifested when measurements (in space or in time) on two or additional isolated quantum mechanical systems are achieved. As a result, physical effects can be correlated technically to some extent defying any local classical explanation and for that reason quantum mechanics is nonlocal. It was argued that an association between Heisenberg's uncertainty principle (HUP) and nonlocality holds for merely all physical systems and moreover a link between the "Einstein's spooky action at a distance" concept and HUP exits. We discuss a nonlocal quantum effects in crystals from a new standpoint. Our approach will be based on the concept of nonlocal-in-time kinetic energy where higher derivative corrections occur merely in terms multiplied by a small perturbative nonlocal

time parameter. These higher-order derivative theories are characterized by the presence of an infinite number of the higher-order temporal derivatives and they don’t disagree with the formalism of quantum theory. One well-known example is the Abraham-Lorentz theory which describes the equation of motion for charged particles taking into account radiative effects. A nonlocal Schrödinger operator is emerged which will be the basic operator for treatment of nonlocal quantum mechanics in a period lattice such as crystals and analysis of energy bands in periodic lattices. We consider the electron dynamics in the periodic potential and construct a nonlocal approach to the weak binding case in three dimensions. A number of features are revealed. In particular, we demonstrate an effective mass enhancement for electrons of around for typical solids, where is a real free parameter. The electron at the bottom of the lowest energy band in a period crystal has less inertia than a free electron in a vacuum in contrast to the standard result.

Biography

Rami Ahmad El-Nabulsi holds a PhD in Particle Physics, Mathematical Physics and Modelling from Provence University (currently Aix-Marseille University), France and a diploma of advanced studies in Plasma Physics and Radiation Astrophysics from the same institution. He worked with different worldwide research departments in UK, South Korea, China, Greece, Thailand, India, etc. and he is currently affiliated to Chiang Mai University and the University of South Bohemia. He is the author of more than 380 peer-reviewed papers in peer-refereed reputed journals and a reviewer for more than 200 scientific journals. He has been selected as the World's Top 2% Scientists 2021 and 2022 (by Stanford University). His research ranges from applied mathematics to theoretical physics.



Dr. Ravikumar Chinnarasu

National Quantum Computing Centre, Didcot, England, UK

Quantum gates and quantum algorithms in a neutral atom quantum processor

Abstract

In recent years neutral atoms has grown as promising platform to realize useful quantum computers. This presentation aims to provide my recent works on realizing the necessary ingredients for quantum computing with neutral atoms. To name a few mid-circuit measurements in a single species atomic processor, improving two qubit gate fidelities and executing variational quantum algorithms on a neutral atom quantum processor will be discussed.

Biography

Dr. Ravikumar Chinnarasu finished his PhD from National Tsing Hua University, Taiwan. During his doctoral studies he was working on generating and manipulating entangled photons using cold atomic ensembles. And he did his postdoctoral investigations from University of Wisconsin-Madison, USA during 2021-2024. In his post-doctoral tenure, he was working on multiple aspects of neutral atom quantum computing and networking. Currently starting 2025, he is working as a senior AMO Physicist at NQCC, England, UK with long term focus on building tweezer array based neutral atom quantum computers.

Riasat Ali

University of Shanghai-200444, People's Republic of China

First-order quantum corrections of tunneling radiation in modified Schwarzschild-Rindler black hole

Abstract

In this work, we study the first order corrections of Hawking temperature and entropy for modified Schwarzschild-Rindler black hole. To do so, we use the modified Lagrangian equation for vector particles in the background of the quantum correction parameter δ. We examine the graphical interpretation of the corrected Hawking temperature with respect to the horizon under the effects of the correction parameter in order to verify the gravitational effects on the geometry of the modified Schwarschild-Rindler black hole. We perform a graphic analysis of the modified Schwarschild Rindler black hole's physical state as a function of the mass and Rindler acceleration under the effects of the correction parameter. Moreover, we derive the corrected entropy and study the effects of mass and Rindler acceleration parameter on entropy under different variations of correction parameter.

Rikteem Bhowmick

Head- Quantum Communications, Qulabs Software India Pvt Ltd & Quantum AI Global

The Race Towards a Global Quantum Communication Network: Competing Paradigms and Emerging Challenges

Abstract

The quest to establish a secure, country-wide quantum communication network is intensifying, with various approaches vying for dominance. In this presentation, we explore the diverse strategies being pursued, including the implementation of weak Quantum Key Distribution (QKD) in metropolitan networks with plans for broader scaling, the integration of Post Quantum Cryptography (PQC) within existing classical infrastructures, and the innovative use of satellite-aided networks in conjunction with fiber-based telecom systems. We will also discuss the candidates for scaling terrestrial QKD networks and try to find a balance between "trust" and "physics", highlighting the competitive dynamics and technological breakthroughs that are shaping the future of global secure communications. Join us as we delve into these cutting-edge developments and discuss the implications for the future of internet security.

Biography

Graduating as a physicist with the Institute Medal from IIT Hyderabad, India, I have embarked on a collaborative journey at the forefront of quantum communications, cybersecurity, and quantum computing, bridging industry and academia. Leading dedicated teams, I have pioneered novel technologies in Post Quantum Cryptography (PQC), Quantum Key Distribution (QKD), and developed essential quantum building blocks for the future quantum internet. My contributions include authoring research and patents in quantum memory, QKD, quantum networks, and simulations, all aimed at transitioning cutting-edge research into practical use-cases. Currently, with Qulabs and Quantum AI Global, I drive strategic projects in defence, telecommunications, and financial institutions. My passion lies in designing and innovating across quantum-enabled technologies, continually pushing the boundaries of what is possible in this transformative field.

Sina Nasrollahian

Shiraz University of Medical Sciences, Shiraz, Iran

An update on alternative therapy for Escherichia coli causing urinary tract infections; a narrative review

Abstract

Urinary tract infections (UTIs) are the most common type of nosocomial infection and severe health issues because of the difficulties and frequent recurrence. Today, alternative methods such as sonodynamic therapy (SDT), photodynamic therapy (PDT) and herbal materials use for treating infections like UTI in many countries. We conducted searches of the biomedical databases (Google Scholar, Scopus, PubMed, and Web of sciences) to identify related studies from 2008 to 2023. SDT aims to use ultrasound to activate a sonosensitizer, which causes a biological effect by raising reactive oxygen species (ROS). When bacteria are exposed to ROS, several important effects occur: oxidative damage, DNA damage, protein dysfunction etc. SDT with herbal medicine significantly reduced the number of colony-forming units and bactericidal activity for Klebsiella pneumonia and E. coli. PDT is a promising treatment for cancer and microbial infections, combining a photosensitiser, light and tissue molecular oxygen. It involves a photosensitizer, light source, and oxygen, with variations affecting microbial binding and bactericidal activity. Factors affecting antibacterial properties include plant type, growing conditions, harvesting, and processing. This review highlights the recent advancements in sonodynamic, photodynamic, herbal, and bio-material-based approaches in the treatment of E. coli infections. These alternative therapies offer exciting prospects for addressing UTIs, especially in cases where traditional antibiotic treatments may be less effective. Further research and clinical studies are warranted to fully explore the potential of these innovative treatment modalities in combating UTIs and improving patient outcomes.

International Experts Summit on Quantum Technologies

March 14-16, 2025 | Singapore

QuantumTech -2025

Subhash Kumar

G H Raisoni college of engineering and management, Pune, Maharashtra

Sample records for instrumental analysis experiment

Abstract

This Paper presents a comprehensive performance analysis of a heat pump air conditioning system for both heating and cooling applications. The study aims to evaluate the system's efficiency, energy consumption, and overall performance under varying operating conditions. The investigation utilizes a combination of experimental measurements. The analysis begins with an overview of the heat pump air conditioning system, including its components and working principles. The experimental setup involves monitoring key parameters such as ambient temperature, refrigerant flow rate, compressor power consumption, and indoor/outdoor temperature differentials. These measurements are collected during various operating scenarios, considering both heating and cooling modes. The performance analysis of the heat pump air conditioning system presented in this report serves as a valuable resource for HVAC engineers, researchers, and policymakers. The insights gained from this study contribute to the ongoing efforts to improve the design and operation of heat pump systems for heating and cooling applications, fostering sustainability and energy conservation in the built environment..

Biography

i am in Assistant Professor in Mechanical engineering Department and Deputy COE in G H Raisoni college of engineering and management,Pune. I have total 14 years of teaching and adminstration experience . i have published 12 international research paper and 10 national and international conference paper.

Sunil Kumar Mahato

University of Hamburg, Germany

Thin Film Diamond Nano-photonics and its quantum Application

Abstract

Exploiting quantum effects of light matter entanglement has been limited to a small number of qubits and has only been performed in tabletop experimental setups consisting of a large number of macroscopic components Diamond is a potential candidate for the realization of quantum information technology because it encompasses optically active color centers with long-lived spin coherence and material properties that permits for the efficient use of photons and phonons as quantum information carriers. It has a large bandgap, allowing for optical transitions in defect centers. Also, diamond naturally has low number of nuclear background spins (98.9% in natural diamond is spin 0), realizing a magnetic vacuum.

Swati Singh

IAH, GLA University, India

Using quantum weirdness to extend the computational power of a Parity computer

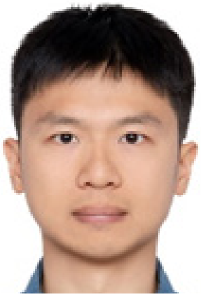
Abstract

In this paper, the author implemented measurement-based quantum computing (MBQC) on IBM Quantum Experience and verified the formalism of 'Anders and Browne'. IBM Quantum Experience is an online utility provided to us by IBM experts. In layman's terms, Anders and Browne provided us with a possible method for implementing a NAND gate using a parity computer. This is important because a parity computer can utilize peculiar features of quantum theory, such as entanglement and superposition, to perform calculations and ultimately create a quantum computer. However, a parity computer can only execute CNOT, NOT, and XOR gates. Furthermore, it is not a universal computer. Therefore, the author describes how to construct a NAND gate using a parity computer. In this paper, following a similar approach, author also elucidated how to construct a NOR gate for implementation on a parity computer. The author will delve into Bell's inequalities, which provide compelling evidence against the EPR paradox. Bell designed a thought experiment that could demonstrate the dominance of quantum mechanics in our world. Moreover, it demonstrates that hidden variable theories are unnecessary to complete quantum theory. The author applied Bell's inequalities to real-life situations, such as gambling. One such game is detailed in, where the author observed that by using CHSH inequality, the probability of winning is 75%. The author may enhance the odds of winning by employing another set of inequalities known as Cirelson's inequality, which increases our chances of winning to 85.3%. However, an obvious question arises: Can a player achieve a winning probability of 100%? In principle, the answer is yes. There exists a theoretical concept called a PR box that yields a winning probability of 100%. This insight prompted us to seek an intermediate solution between 85.3% and 100%. Subsequently, the

author reverts to the classical world and investigate if there is an improvement in the 75% probability of the game described in a paper. To our surprise, the author could find that by altering our thought experiment or game, the author can potentially attain a probability of 80%.

Biography

Dr. Swati Singh holds impressive academic qualifications and has made notable contributions to the field of Physics. Here's a summary of her achievements.



Wei Du

Beijing University of Posts and Telecommunications, Beijing 100876, China

High Sensitivity, Loss-Tolerant Quantum Metrology

Abstract

The advent of lasers, as highly coherent light sources, revolutionized precision measurement techniques, exemplified by the Laser Interferometer Gravitational-Wave Observatory (LIGO). The sensitivity of interferometer phase measurements is limited by the standard quantum limit (SQL) due to photon statistical fluctuations. To surpass the SQL in laser interferometry, "squeezed light" was proposed for LIGO to reduce noise and enhance the detection sensitivity of weak phase signals from gravitational waves. However, quantum squeezing is fragile and easily disrupted by decoherence from environmental losses, hindering quantum enhancement. Addressing this bottleneck, we systematically developed techniques for quantum manipulation of light and atoms, and the correlative detection of light-atom quantum interactions, leading to the successful creation of a noiseless quantum amplifier. By applying the "noiseless amplification" principle of quantum amplifiers, we constructed a quantum-correlated interferometer that breaks through the SQL of conventional interferometers. By integrating a linear laser interferometer with a nonlinear quantum amplifier, the new technique allows phase-sensitive operations using photons from the linear interferometer, followed by extraction and amplification of the phase signal using quantum correlations of the amplifier, while keeping noise unamplified, thus achieving signal amplification, noise suppression, and loss tolerance. Unlike "squeezed light," this method maintains quantum enhancement even with significant photon loss, such as in inefficient detectors or highly lossy interferometer paths.

Biography

Wei Du obtains B.S. in Physics from Sichuan University in 2014, underwent joint training at the Institute of Photonic Sciences (ICFO), Spain, from 2018 to 2019, and received a Ph.D. in Physics from East China Normal University in 2020. Since 2021, he has been a postdoctoral researcher at Shanghai Jiao Tong University in the School of Physics and Astronomy and was selected for the Morning Star Postdoctoral Incentive Program. He focus on the research in quantum optics, quantum sensing, and precision measurements. He has published in excess of 10 papers in journals such as Phys. Rev. Lett, Phys. Rev. Applied Appl. Phys. Lett, with work on quantum interferometers recognized as one of the Top Ten Advances in Chinese Optics for 2022.

Xinyun Huang

School of Physical Sciences, Hefei 230026, China

A high-performance digitally controlled analog servo system for cold atom experiments

Abstract

High-performance servo systems play a crucial role in Pound-Drever-Hall (PDH) locking for ultra-stable lasers. Meanwhile, the timing sequence of cold atom experiments demands greater functionality and flexibility. To address this, we have developed a digital control high-performance analog servo based on Field Programmable Gate Arrays (FPGA). This system combines the low noise and high bandwidth characteristics of traditional analog servo systems with the advanced capabilities of FPGAs, featuring an input noise of 4.9 μV. The FPGA-implemented automatic locking feature enables the PDH control loop to maintain its lock for prolonged periods in unattended environments. Additionally, the dynamic hold functionality permits real-time synchronization with the timing of atomic experiments.

We also conduct a detailed analysis of the digital noise introduced by the FPGA within the analog channel and propose a method to mitigate its impact by disabling the FPGA clock..

Biography

I graduated with a bachelor's degree from the School of Physics at Dalian University of Technology in 2017 and subsequently began pursuing my Ph.D. at the Department of Modern Physics, University of Science and Technology of China (USTC). During my undergraduate studies, I participated in theoretical research on open quantum systems and published a paper in Physical Review E (PRE). Throughout my Ph.D. studies at USTC, I have been primarily involved in research related to strontium atomic optical lattice clocks, with two papers currently in the process of being published.

Zia ur Rehman

Namal University, 30km Talagang Road, 42250, Mianwali, Pakistan

Ab initio insight into the physical properties of Potassium based lead-free perovskite for hydrogen storage applications

Abstract

Perovskite hydrides are emerging as promising candidates for efficient hydrogen storage along, with their unique properties in renewable energy systems. This study explores the structural, electronic, mechanical, population analysis, lattice dynamical and hydrogen storage properties of Potassium based single hydrides using density function theory (DFT). The energy volume curves play a crucial role in optimizing the lattice parameters of the simulated crystal structures $KZrH_3$ yielding values of 3.875 Å, respectively. Stability of hydrides is confirmed by Phonon dispersion curves, as evidenced by the fulfillment of the Born criteria for their elastic constants C_{ij}, Pugh ratio and Poisson ratio and were also computed. The metallic nature of studied hydrides is disclosed by investigation of the electronic band structure. The predicted volumetric hydrogen storage capacities of $KZrH_3$ are 83.15 respectively. Furthermore, the analysis of the electronic and thermodynamic properties of $KZrH_3$ hydrides reveals their capacity to function as effective conductors of both electrical and thermal energy. Our results suggest that $KZrH_3$ hydrides are promising candidates for hydrogen storage applications.

Biography

I am currently an Assistant Professor of Physics at Namal University, Mianwali, Pakistan. I completed my PhD in Applied Physics in 2018 from Universiti Teknologi PETRONAS, Malaysia, and previously served as a lecturer for six years at the Federal Urdu University, Islamabad. With over 12 years of experience, I have published 30 research papers with an impact factor of 90+ and 306+ citations, alongside six conference publications. My research interests include Density Functional Theory, Material Science, Nanomaterials, CVD, heterogeneous catalysis, and more. I have co-chaired sessions and delivered invited talks at international conferences. Additionally, I am a reviewer for several journals and have earned awards such as a Gold Medal at ITEX Malaysia 2017. Since 2019, I have held various leadership roles at Namal, contributing to academic committees and student education management.

Zijie Zhu

Institute for Quantum Electronics & Quantum Center, ETH Zurich, 8093 Zurich, Switzerland

Quantum circuits based on topological pumping in optical lattices

Abstract

Gate operations composed in quantum circuits form the basis of digital quantum simulation and quantum processing. While two-qubit gates generally operate between nearest neighbours, many circuits require non-local connectivity, necessitating some form of quantum information transport, such as the repeated application of swap gates or qubit shuttling. Preserving motional coherence during such transport remains a key challenge to improve gate fidelity and qubit connectivity, as well as to connect local fermionic modes. Here we combine tunable gate operations between fermionic potassium-40 atoms – based on exchange interaction – with their bi-directional transport via topological Thouless pumping in an optical lattice. We demonstrate high-fidelity transport of atomic singlet pairs over large distances with a 1/e–decay constant exceeding 200 lattice sites. We spatially and coherently split a large number of randomly distributed fermionic spin singlet pairs and show gate operations between atoms encountering each other during transport, including an all-swap circuit that allows atoms to cross without seeing each other. As a direct signature of entanglement between fermions separated over large distances, we observe multi-frequency singlet-triplet oscillations. Our topological pumpingapproach to transport quantum information is generally applicable to long living atomic and molecular states, and specifically overcomes lifetime limitations inherent to transport using state-dependent optical lattices. Our work opens up new avenues towards universal quantum computation with exchange-only interactions, fermionic quantum circuits in optical lattices, as well as atom interferometry.

Biography

Zijie Zhu completed his Bachelor's degree at Peking University and earned his Master's and PhD at ETH Zurich. He is major interests lie in quantum simulation and computation based on ultracold atoms in optical lattice system. As the leading authors, he has published papers in Science and Nature Physics, and co-authored articles in journals such as Physical Review Letters, Physical Review Research, and Physical Review X.

Palki Gakkhar

Manipur University, Canchipur 795003, Manipur, India

Fock-Space Relativistic Coupled-Cluster Study of Clock Properties in $88Pb^{2+}$

Abstract

Atomic clocks are the most precise timekeeping device and uses atomic transition frequency as a time measurement parameter. Atomic clocks are used in several fundamental and technological implications where accuracy in time is indispensable. To mention some important implications where atomic clocks are required, satellite navigation systems, communication networks, scientific research, quantum computers, and to measure the variations in the fundamental constants. The atomic clock which is currently in use for Universal Coordinated Time is NIST-F1 Cesium atomic clock [1], which is based on the microwave frequency of the electromagnetic radiation. The accuracy of Cs clock is of the order of 10-16. However, the atomic clocks with better accuracies and stabilities are needed to probe the above-mentioned applications more accurately. In this context, 88Pb2+ can be a potential candidate for developing a new and improved time and frequency standards. The systematic errors in Pb2+ are reported to be very small [2], due to its zero nuclear spin, heavier mass, and zero total angular momentum of the clock state, which makes the clock transition (6s2 1S0 – 6s6p 3P0) more immune to the environmental perturbations.

In this work, we have carried out a theoretical study of the clock transition-related properties, such as excitation energies, electric and magnetic dipole transition amplitudes, and the lifetime of the clock state (3P0) using Fock-space relativistic coupled-cluster theory [3, 4]. To improve the accuracy of our results further, we have also incorporated the contributions from relativistic effects and QED corrections. Our calculated results are in good agreement with available other theory and experimental data. Our calculations predict a long lifetime of 9.8×10^{6} s for the clock state.

Biography

Palki Gakkhar is currently pursuing a PhD in the Department of Physics at the Indian Institute of Technology Delhi. Her research focuses on exploring various atomic clock candidates and studying

their transition-related properties. By providing critical theoretical insights, her work supports experimental advancements in precision timekeeping. With three research publications till date, she is dedicated to the field of atomic physics and contributing toward the development of next- generation atomic clocks.