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ABSTRACT BOOK

Global Summit on

Quantum Computing

MARCH 19–21

Barcelona, Spain

2026

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Mohamed Haj Yousef
UAE University, United Arab Emirates

The Dynamic Formation of Spatial Dimensions in the Inner Levels of Time

Abstract

Based on the Duality of Time hypothesis from the Single Monad Model, this work introduces and investigates a dynamically generated formulation of self-contained space-time. The resulting physical vacuum is shown to be granular and genuinely complex, governed by real and imaginary levels of time. Within this "time–time" geometry, spatial dimensions emerge dynamically through nested layers of real time, while physical evolution unfolds along the orthogonal imaginary axis. This dual-temporal framework yields a hyperbolic space-time manifold that reduces to General Relativity in the appropriate limit, while offering a deeper ontological foundation for discreteness, causality, and mass–energy relations.

From this framework, we derive the foundational principles of ``Quantum Relativity'': the constancy of the speed of light, Lorentz transformations, mass–energy equivalence, and the equivalence of inertial and gravitational mass—without assuming any background or external fields.

By reinterpreting the vacuum as a dynamically re-created medium, the theory offers a potential resolution to the cosmological constant problem and opens new insights into mass generation and quantum nonlocality. This formulation offers a mathematically rigorous and ontologically unified approach to quantum gravity, bridging quantum mechanics and general relativity through discrete temporal geometry.
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Biography

Mohamed Ali Haj Yousef received his Master from the Cambridge University in 1992 and the Ph.D. from Exeter University in 2005. He is now pursuing interdisciplinary research that integrates theoretical physics, cosmology, and Islamic metaphysics. He works as a Lecturer at the UAE University. His research topics mainly include: quantum gravity, the nature of time, ontology of space-time, dual-time geometry, foundational physics, and the metaphysical implications of the Single Monad Model. He is a full member of Sigma Xi, The Scientific Research Honor Society.

Chris Salvino

Scottsdale, Arizona, USA

Helium-3 from the Moon: How Are You Going to Cool Your Quantum Computer?

Abstract

The global supply of helium-3 is nearly gone. Less than five kilograms remain in the United States, and no process exists to synthesize or mine it at scale on Earth. Yet helium-3 is essential to two technologies that will define the century—quantum computing and nuclear fusion. The helium-3 supply chain is now one of the greatest hidden bottlenecks in science and technology.

As we all know, quantum computers rely on helium-3 to reach and maintain the ultra-cold environments required for stable qubit operation. Without helium-3, quantum systems cannot scale beyond laboratory quantities as easily or quickly as if helium-3 were available.

Workarounds are being developed, but none match the precision, cooling performance, or efficiency that helium-3 enables. Similarly, in energy, helium-3 is the only fuel capable of achieving clean, aneutronic fusion—producing power without neutron radiation, long-term waste, or greenhouse gas emissions. Fusion that relies on tritium, by contrast, produces radioactive byproducts that must be contained for decades and requires lithium mining that releases CO_2.

Lunar Helium-3 Mining (LH3M) is addressing this global shortage directly. The Moon contains an estimated one million tons of helium-3 implanted by the solar wind, representing the only viable long-term supply. LH3M holds multiple issued and pending U.S. and international patents for helium-3 detection, staged thermal extraction, gas separation, and containment technologies that are specifically engineered for lunar

extraction—not Earth-based mining adaptations. These systems are designed to operate efficiently in the Moon's vacuum, abrasive regolith, and low-concentration deposits.

Our goal is simple: to mine helium-3 from the Moon using lunar-specific techniques and return it to Earth—fueling both the quantum computing industry and the future of fusion-based green energy. This represents a commercially sustainable supply chain that could transform both energy and technology. The Moon is no longer a destination—it is the supply base for the next leap in human capability.

Prof. Dr. Artur Vladimirovich Dmitrenko

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The intensity of turbulence in the hydrogen plasma as a function of electron collision frequency

Abstract

According to the stochastic theory of turbulence based on stochastic differential equations and the equivalence of measures between deterministic and random fields made it possible for the first time to theoretically determine the distributions experimentally obtained for the electrical conductivity of a turbulent plasma when heated by a strong electric field of $1<E<1000$ V/cm. However, there is no experimental determination of the intensity of plasma turbulence under the influence of an external electric field and the electron collision frequency in the literature. At the same time, the theory allows us to fill in these data and present them, in particular, for heating hydrogen plasma. Calculations according to the theory allowed us to determine the intensity of turbulence in the hydrogen plasma as a function not only of the magnitude of the external electric field strength E, but the electron collision frequency also.

Biography

Prof. Dr. Artur Vladimirovich Dmitrenko is researcher and academician with a career spanning over four decades in the field of heat and power engineering, particularly focusing on plasma, thermo-physics and stochastic hydro-gas dynamics and plasma theory 1981-1995: a researcher at the Keldysh M.V. Center, focusing on stochastic processes in gas, liquid, and plasma. 1998: Earned the title of Doctor of Sciences, specializing in turbulent and high-temperature gas and plasma flows.1999-present: Head of the Department of Heat and Power Engineering of Transport at the Russian University of Transport.Current: Professor at the Department of Thermo-physics at the National Research Nuclear University MEPhI. 169 scientific papers, holds 2 patents, 4 monographs.

Paul Wang, Ph.D.
Morgan State University, USA

Quantum-Enhanced Machine Learning for Air Pollution Modeling

Abstract

This research applies quantum machine learning (QML) to study the air quality discrepancies. Our machine learning model ingests a dataset that covers 650,643 Baltimore residents from 44.7 million residents in 202 major cities in the US. The system was deployed to AWS cloud using the DevSecOps methodology. The process starts with code commits to the GitHub repositories aqi-quality-apis at the backend and aqi-dashboard to the frontend. Each commit triggers AWS CodePipeline, which orchestrates the entire workflow, providing a streamlined architecture.

Quantum Machine Learning (QML) represents a transformative frontier at the intersection of quantum computing and artificial intelligence, promising to revolutionize how we process and interpret data. This research leverages QML to address computational bottlenecks in environmental exposure modeling by developing methods that can process data more efficiently. The study's relevance extends across academic research, community health applications, and policy development through specific methodological advances and practical data products.

Our comprehensive technical approach involves identifying regimes where quantum feature maps theoretically outperform classical kernels, designing hybrid QML-classical integration strategies, developing efficient mapping protocols for geospatial datasets to quantum qubits, and applying advanced optimization techniques for quantum hardware execution under realistic noise conditions. We will benchmark quantum performance against classical approaches across multiple architectures,

comparing both simulated quantum results and real device execution to establish empirical criteria for when quantum methods provide measurable computational or accuracy benefits.

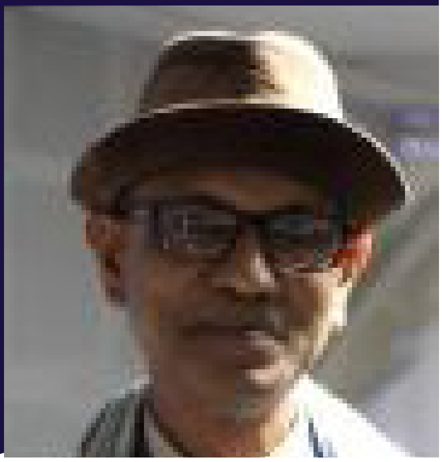
Expected outcomes include validated performance benchmarks comparing quantum and classical approaches, open-source tools enabling broader QML adoption in environmental science, and substantial preliminary results supporting future external funding applications. The developed methods could potentially transfer to other geostationary satellite applications and spatiotemporal modeling challenges beyond air quality prediction. Data products and tools will inform environmental health policy by potentially supporting more effective and targeted air pollution mitigation strategies.

The intraurban difference analysis shows that residents of color experience higher levels of PM2.5 than white or Asian residents. This trend is reversed at the "definitely declining" grade, where PM2.5 measurements for Black residents are 0.18 ug/m3 above the Baltimore mean. Results also show that Baltimore has higher PM2.5 than national average.

The results revealed that air pollution levels have a clear association with the biased insurance estimate method. Great disparities present in NO2 level between more desirable and low-income blocks. Similar disparities exist in air pollution level between the ethnicity of residents. We recently mapped the trained model to quantum inputs to further apply QML techniques to speed up the training.

Biography

Paul Wang is a Professor and Chair of Computer Science. Paul is a LINK Fellow, Fellow of National Quantum Lab, Board Member of CyberVets and has held positions as the Endowed Chair by a $5 million endorsement, Director of Center for Security Studies with more than 3,000 cyber students, and CIO/CTO of the NBRF. Paul was directly involved in drafting the National Initiatives of Cybersecurity Education (NICE) framework. His research areas are quantum algorithms, quantum security, AI models, quantum AI, secure architecture, IoT/CPS, and video indexing. In addition to books, referred publications, conference speakers and numeral grants, Paul has four patents; three of them have been licensed to the industry. Paul Wang received his Ph.D. under Dr. Robert Ledley, the inventor of the body CT scanner. He completed postdoc studies in Quantum Computing at MIT and in AI and Data Science at the University of Cambridge.



Sunjay

Seismic Imaging centre, Geophysics, BHU, Varanasi-221005,India

Quantum Geosciences Lithosphere Subsurface Imaging

Abstract

Quantum geosciences integrate advanced quantum technologies to enable ultra-high-precision subsurface imaging of the lithosphere, offering transformative capabilities for exploration and monitoring. These emerging approaches support applications across hydrocarbon and mineral exploration, mining and coal resources, geothermal systems, natural geological hydrogen, helium-3 for nuclear fusion, aquifer and paleo-fossil water mapping, as well as archaeological site detection.Key enabling technologies include quantum sensing, quantum computing, quantum communication, quantum artificial intelligence (QAI), and quantum machine learning (QML). Specialized techniques such as quantum wavelet transforms, quantum metrology systems, quantum cryptographic networks, muography, and geoneutrino detection further enhance subsurface characterization by improving sensitivity, resolution, and signal fidelity. Quantum-enhanced sensors play a central role in geophysical data acquisition. These include superconducting quantum interference devices (SQUIDs) for gravimetry and magnetometry, atomic clocks for high-precision geodesy, quantum fiber-optic sensors, and quantum accelerometers and gyroscopes. Together, they enable unprecedented measurement accuracy in gravity, magnetic, seismic, and deformation fields.In parallel, quantum seismic imaging is emerging as a powerful framework for processing and interpreting seismic data. By leveraging quantum computing paradigms such as quantum annealing and quantum machine learning, this approach addresses the computational complexity of seismic problems, including traveltime inversion, seismic inversion, and fault detection. These methods promise higher resolution and improved accuracy compared to classical algorithms, particularly for large-scale and highly nonlinear subsurface models.Secure and efficient handling of seismic

data is supported through confidential computing and quantum-resistant encryption, ensuring data integrity and privacy during acquisition, transmission, and analysis. For wireless seismic systems, Orthogonal Frequency Division Multiplexing (OFDM) and Orthogonal Frequency Division Multiple Access (OFDMA) enable high-throughput, low-latency data transmission from dense geophone networks, overcoming the constraints of traditional cable-based deployments.Additionally, compressed sensing synergizes with quantum sensing by exploiting the sparsity of many geophysical signals. This allows accurate reconstruction from significantly fewer measurements, reducing acquisition time and data volume while preserving high dynamic range and sensitivity. As a result, quantum-enabled compressed sensing supports faster, more efficient, and more accurate subsurface imaging in challenging environments.

Biography

M.Sc (Tech) 1998 Exploration Geophysics BHU Varanasi India

PhD Thesis submitted

Seismic data processing and interpretation by wavelet transform for hydrocarbons exploration, Geophysics BHU Varanasi India

Lithosphere subsurface imaging extractive industry hydrocarbon exploration seismic imaging,Seismic data spectral decomposition by wavelet transform thin bed seismic imaging

My participation in IGCP UNESCO Projects 700 carbonate reservoir hydrocarbons exploration

South East Asia carbonate research laboratory Seacarledu.wordpress.com

My participation in IGCP UNESCO Project 432,619 Deepwater hydrocarbon exploration carbonate reservoir

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Transforming Cancer Diagnosis: Quantum AI for Global Leukemia Screening

Abstract

Early detection of Acute Lymphoblastic Leukemia (ALL) remains a critical global health challenge, particularly in resource-limited settings where advanced diagnostic tools such as flow cytometry and cytogenetics are inaccessible, contributing to the significant survival gap between high-income countries (90%) and low- and middle-income countries (25%). Classical artificial intelligence approaches, while promising, suffer from high computational complexity, large data requirements, and limited ability to detect subtle morphological variations in blood smear images. To address these limitations, we introduce a hybrid quantum-classical architecture that integrates ResNet-18 deep learning feature extraction with an 8-qubit Variational Quantum Circuit (VQC), leveraging quantum mechanical principles—superposition, entanglement, and interference—to enable exponential feature space exploration beyond classical computing capabilities. Our framework encodes 512-dimensional morphological features from peripheral blood smears into quantum states using parameterized rotation gates, achieving high-dimensional representation in Hilbert space that captures complex cellular patterns undetectable by classical methods. Rigorous validation was performed on the C-NMC 2019 benchmark dataset (N=15,114 images) and real clinical data from Ahsania Mission Cancer & General Hospital, Dhaka, Bangladesh (N=85 patients), with execution verified on IBM Quantum processors (ibm_brisbane, ibm_kyoto) via cloud platform access. The framework achieved 96.7% accuracy (95% CI: 94.2–98.4%) on benchmark data and 95.3% on hospital validation, with ROC-AUC of 0.991 and 0.979 respectively, outperforming state-of-the-art classical methods including SVM (+17.8%), Random Forest (+16.4%), and deep learning baselines.

Compared to classical ResNet-50, our model trained 1.68× faster (51.3 vs 86.2 minutes) with 266× fewer parameters (96,000 vs 25.6 million), demonstrating superior computational efficiency. Real IBM quantum hardware validation showed only 2.47% accuracy degradation (94.2% vs 96.7%), confirming NISQ-era clinical feasibility. The practical implications are transformative: with a projected screening cost of \$0.08 per patient—representing 99.5% cost reduction compared to conventional diagnostic workup (\$3,000–4,000)—the system enables deployment via standard microscopy and smartphone interfaces in frontline healthcare settings. This quantum-enhanced diagnostic framework establishes a foundation for integrating Quantum AI into cancer prevention workflows, potentially improving survival rates through timely, accessible, and affordable diagnosis in underserved populations worldwide, thereby addressing critical barriers in global health equity.

Keywords: Quantum machine learning, leukemia detection, cancer prevention, early diagnosis, health equity, hybrid quantum-classical computing, variational quantum circuits.

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2. *Cameroon College of Technology, University of Buea, Cameroon*
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Skyrmions, Anyons, and the Quest for Robust Topological Qubits: Towards Scalable Quantum Computing

Abstract

This work explores the potential of skyrmions and anyons, both topological entities, as building blocks for robust and scalable topological qubits in quantum computing. It focuses on the use of skyrmions, nanoscale magnetic structures, for stable qubit implementation and anyons for topological quantum computation, specifically for braiding operations. The study emphasizes the need for robust qubits to overcome decoherence challenges in existing technologies and envisions a future with fault-tolerant quantum computation through topological approaches. The research delves into the theoretical underpinnings of using skyrmions and anyons to create and manipulate topological qubits, ultimately contributing to the development of a practical and scalable quantum computer.

Vladimir V. Egorov

National Research Center "Kurchatov Institute"

Nanophysics as an Innovation Discovery

Abstract

In quantum mechanics (QM) the theory of quantum transitions works only in atomic physics and in the adiabatic approximation (AA) in molecular and chemical physics. To restore the functionality of QM in molecular and chemical physics beyond AA, Egorov is forced to introduce the so-called dozy chaos (DC) into QM. DC is introduced by replacing the infinitesimal imaginary additive in the energy denominator of the total Green's function of the system with a finite value. As a result, the transition between quantum states taken in AA becomes continuous, and QM itself becomes quantum-classical mechanics (QCM). In the case of strong DC, QCM leads to the same results as QM. In the case of weak DC, a regular component in the transient state dynamics appears against the background of chaos. The coherent interaction of the regular component in the electron charge motion and the regular component in the reorganization motion of the nuclei in the environment leads to the so-called Egorov resonance (ER). The same chaos can be strong for small molecules (standard optical spectroscopy) and weak for large molecules (photochemistry and nanophotonics). Therefore, ER is also called nano-resonance. ER explains the nature of the well-known narrow and intense optical J-band of J-aggregates of polymethine dyes, discovered by Jelley and Scheibe in 1936. The first explanation of the nature of the J-band was given by Franck and Teller in 1938 based on the Frenkel exciton concept. This article discusses in detail the evolution of theoretical ideas about the nature of the J-band over almost a century of history and provides a deeply reasoned criticism of them. On the basis of QCM it is explained a large number of experimental data on the shape of optical bands in polymethine dyes and their aggregates. The nature of the physical source of life, possible alternative life forms and the idea of living materials

are discussed [1].

Keywords: Planck quantum transitions; Egorov quantum-classical transitions; Egorov nano-resonance; shape of optical bands; optical J-band of J-aggregates.

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ACKNOWLEDGMENT

This work was performed within the State assignment of NRC “Kurchatov Institute”.

Biography

Prof Dr Vladimir Valentinovich Egorov has his expertise in theoretical molecular and chemical physics. Education: National Research Nuclear University MEPhI, Faculty of Theoretical and Experimental Physics (1966 – 1972), Moscow, USSR. He has completed his PhD from Theoretical Department of Institute of Chemical Physics, USSR Academy of Sciences (1981), and he has completed his Dr Phys&Math Sci degree from Institute of Physical Chemistry, Russian Academy of Sciences (2004). He is leading researcher at NRC “Kurchatov Institute”, Moscow, Russia. Prof Egorov is working on the development of a fundamentally new physical theory - quantum-classical mechanics and their applications in physics, chemistry, biology and biomedicine.

Inki Kim
Department of Biophysics, Institute of Quantum Biophysics, Sungkuynkwan University, Republic of Korea

Metasurface-enhanced quantum biosensors for neuroscience research

Abstract

Nowadays, the emergence of technologies for precision health and early disease diagnosis benefits from inexpensive and sensitive devices that can provide abundant information about molecule composition and their structural arrangements, cell secretome and morphology, and the presence of viruses in biological samples. Optical metasurfaces have proven to be a promising solution for advanced biosensing assay and bioimaging settings thanks to their engineerable properties of light manipulation via designing unit cell structures. On the other hand, new fields of quantum life sciences and spatial omics driven by precise manipulation of incident light properties show clear benefits of empowered diagnostics and remote therapeutics. However, the metasurface functionalities in those fields remain largely unexplored. In this talk, I will introduce metasurface-assisted continuous cell monitoring, molecular diagnostics and 3D biomedical imaging technologies. First, I will report metasurfaces-driven hyperspectral imaging via multiplexed plasmon resonance energy transfer (PRET) to probe biological light-matter interactions, which can detect quantum biological electron transfer (QBET). Second, I will introduce a dielectric metalens device of submicrometer thickness for integrating single molecule on-chip sensors for point-of-care testing and quantum coherence energy transfer. An application of single-molecular extracellular vesicle sensing will be presented for Parkison disease biomarker tracking. Third, I will present a fast metaphotonic PCR device composed of a metamaterial perfect absorber that can rapidly go through thermocycling steps using a single infrared LED for quantitative studies of quantum enzymology. Last, I will present label-free 3D photoacoustic imaging with multifuntional metalens for real-time monitoring of live

brain organoid and its drug screening applicaitons.

Biography

Inki Kim is an Assistant Professor in the Department of Biophysics, Institute of Quantum Biophysics (IQB) at Sungkyunkwan University (SKKU). He received his Ph.D. degree in Mechanical Engineering at Pohang University of Science and Technology (POSTECH), and B.S. degree in Mechanical Engineering at Ulsan National Institute of Science and Technology (UNIST). He has published 80+ peer-reviewed journal articles including 1 Nature Nanotechnology, 3 Nature Communications, 3 Science Advances, 3 Advanced Materials, 3 Light: Science and Applications, 1 Materials Today. Also, I am the recipient of several notable honors and awards such as Global Ph.D. Fellowship (2016), SPIE Optics and Photonics Scholarship (2020), Ministry of Education Minister's Commendation (2021), Chang Kun-Soo Memorial Award (Best Dissertation in POSTECH) (2021), OSA Robert S. Hilbert Memorial Student Grant (2021), and Young Optical Scientist Award from Optical Society of Korea (2024). The total citation is over 5,200 and h-index is 41.

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From Atoms to Qubits: Foundations, Devices, and Challenges in Quantum Electronics

Abstract

The emergence of quantum electronics represents a pivotal transition from atomic-scale physics to engineered quantum information systems. This review explores the path “from the atom to the qubit,” highlighting how the principles of quantum mechanics—such as superposition, entanglement, and quantum coherence—are exploited to design physical qubits across various platforms. We focus on recent advancements in solid-state quantum devices, with particular emphasis on superconducting qubits [1], silicon spin qubits [2], and scalable trapped-ion architectures [3].

In addition to foundational theory, this paper examines key challenges such as qubit decoherence, gate fidelity, error correction, and cryogenic integration [4][5]. Emerging directions are discussed, including hybrid quantum systems, cryo-CMOS electronics [6], and topological approaches aiming to increase robustness against noise [7]. Recent experimental breakthroughs in qubit connectivity and 2D quantum chip integration further reflect how atomic-level control is now a cornerstone of quantum processor development [8].

By bridging fundamental quantum theory with the technological efforts of nanoelectronics and quantum engineering, this review aims to provide physicists and electronic engineers with an integrated perspective on the trajectory of quantum hardware innovation.

Keywords:
Quantum electronics, qubits, superconducting circuits, spin qubits, cryo-CMOS, decoherence, hybrid systems, quantum hardware.

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Tadese Desta

Department of Physics, College of Natural Science, Aksum University, Aksum, Ethiopia

Coexistence of Superconductivity and Spin Density Wave (SDW) in Ferropnictide Ba1−xKxFe$_2$As$_2$

Abstract

This work focuses on the theoretical investigation of the coexistence of superconductivity and spin density wave (SDW) in ferropnictide Ba1–xKxFe2As2. By developing a model Hamiltonian for the system and by using quantum field theory Green's function formalism, we have obtained mathematical expressions for superconducting transition temperature (TC), spin density wave transition temperature (Tsdw), superconductivity order parameter (ΔSc), and spin density wave order parameter (Δsdw). By employing the experimental and theoretical values of the parameters in the obtained expressions, phase diagrams of superconducting transition temperature (TC) versus superconducting order parameter (ΔSc) and spin density wave transition temperature (Tsdw), versus spin density wave order parameter (Δsdw) have been plotted. By combining the two phase diagrams, we have demonstrated the possible coexistence of superconductivity and spin density wave (SDW) in ferropnictide Ba1–xKxFe2As2.
Keywords:- Superconductivity; Spin density wave (SDW); Coexistence; Green function; Pnictides; Ba1–xKxFe2As2.

Hamid Reza Ebrahimi
Islamic Azad University of Iran (IAU)

A Performance Comparison of Q# and Qiskit Quantum Programming Languages Running the Shor's Algorithm

Abstract

In this paper, I provide a comprehensive performance comparison of two popular quantum programming languages, i.e., Qiskit from IBM and Q# from Microsoft in the special case of Shor's Algorithm.
The related codes would be run on their respected software quantum simulators.
I consider two key factors for adopting a programming language: performance and developer-friendliness, but my main focus is on comparing execution time of Shor's quantum algorithm. The main challenge is to provide fair conditions for comparing the implemented algorithms.
The results of this research may help newcomers to the quantum programming world in choosing one of them (although there are many more quantum programming languages to choose from).

Biography

Hamid Reza Ebrahimi is a member of faculty of IAU since 2011 and has finished his MSc in Computer Engineering-Artificial Intelligence from Tehran Polytechnic and his BSc in Computer Engineering-Hardware Design from Shiraz University as a top student.

He has been active in some corporations in the field of e-commerce and has a deep interest in math and quantum computing. He has some experience in teaching IMO and IOI. He has also written a book named: "Mobile development tools" to be published by IAU very soon.

Milos Milovanović

Mathematical Institute of the Serbian Academy of Sciences and Arts

Mathematical Metrology and Information Processing

Abstract

The author argues that classical states might be represented by uniform distributions which satisfy uncertainty principle as well, due to the infinite deviation. For that aim, the quantum mechanics is expanded to involve classical in a non-trivial manner. The position operator in quantum mechanics corresponds to linear time in classical one and the momentum has corresponded to classical velocity. In that regard, the mass is eliminated and quantum dynamics has reduced to classical kinematics. In order to involve classical dynamics, one requires statistical mechanics of quantum ensembles wherein canonical coordinates are represented by superoperators. A generalization to relativistic mechanics is indicated, as well as the measurement problem which has resolved due to existence of an intrinsic time superoperator acting upon densities.

The measurement is regarded to be a stochastic process corresponding to the time series of binary digits. Due to that, classical and quantum information is unified in a procedure which takes place temporally step by step. The time continuum emerging in that manner comes to be a skeletal category of mathematical physics. The inference provides a consistent realization of metrology which is considered mathematically notwithstanding any dependence on physical conceptions. It contributes to the definition of information and foundation of mathematics upon a measurement process.

Biography

Miloš Milovanović is a research associate professor at Mathematical Instititute of the Serbian Academy od Sciences and Arts. He investigates mathematical physics of complex systems from the viewpoint of statistical signal processing. The current paper is inspired by Rogerius Boscovicius and Teoria philosophiae naturalis.

Johanna Angulo
Universidad Europea de Madrid

From Qubits to Care: Quantum-Inspired Tensor Networks for Few-Shot Clinical Forecasting

Abstract

Healthcare runs on time-series—vitals, labs, admissions, ICU occupancy—but labeled data and site-specific retraining are scarce. This talk presents a quantum-inspired approach to few-shot clinical forecasting that marries time-series foundation models with tensor-network representations drawn from quantum many-body physics.

We frame forecasting as in-context adaptation: at inference, the model conditions on a small set of clinically analogous sequences to make a patient- or operations-level prediction. An agentic retrieval module selects those analogs on the fly. The quantum-inspired twist is twofold:

- Tensor-network embeddings (e.g., matrix-product states / tensor trains) compress long, noisy sequences into structured representations that are robust to drift and missingness—improving which examples are retrieved without heavy feature engineering.

- TN-parameterized adapters act as lightweight, parameter-efficient bridges that specialize a foundation forecaster with far fewer trainable weights than conventional fine-tuning, preserving portability and governance.

The result is a practical path to data-efficient, uncertainty-aware, and explainable forecasting in high-stakes settings. The same inductive biases that make TNs powerful for quantum systems help us (i) capture long-range temporal dependencies, (ii)

attribute predictions to specific retrieved trajectories, and (iii) expose compact factors that clinicians can interrogate.

Preliminary results on de-identified, publicly available clinical time-series indicate that quantum-inspired components enhance retrieval robustness, improve forecast quality, and reduce adaptation cost versus naïve baselines—while keeping the system transparent enough for clinical review.

Biography

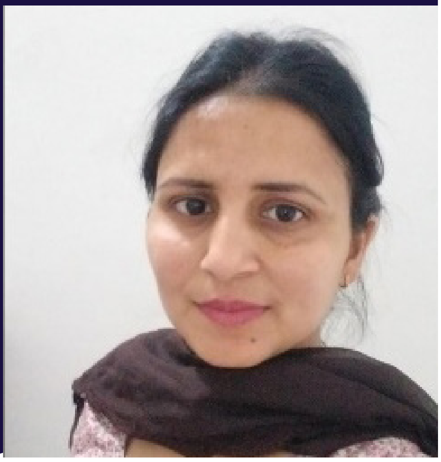
PhD Candidate in Intelligent Systems for Health and AI Engineer focused on bringing quantum-inspired algorithms to Health AI. My current work applies tensor-network factorization (MPS/TT) and low-rank structure to (i) few-shot clinical forecasting with retrieval-augmented time-series foundation models and (ii) an uncertainty-aware, LLM-enhanced multi-agent framework for drug repurposing in rare diseases.

I develop explainable, uncertainty-aware systems using quantum-inspired tensor networks (MPS/TT), deployed on classical hardware.

Earlier, I built multilingual biomedical NLP and medical imaging systems.

I hold two M.Sc. degrees in AI (UAX in progress; Universidad Europea with three "Matrículas de Honor").

My goal is practical impact: data-efficient models that clinicians can interrogate and that can transition to clinical validation without sacrificing transparency.



Dr. Tarnveer Kaur

Assistant Professor, Department of Basic & Applied Chemistry, Sri Guru Granth Sahib World University, Fatehgarh Sahib, Punjab 140 406, India

Molecular interactions and FTIR studies of L-serine in aqueous 1-butyl-3-methylimidazolium bromide solutions

Abstract

Ionic liquids (ILs) gained more interest in recent years due to their wide applications in the field of chemical synthesis as well as in technology development such as solubilize protein, increase the protein activity, refolding for biocatalysis and also preserve the enzyme's stability [1-2]. In this context, researchers are trying to develop the ionic liquids, which are of biological origin so that they can be used safely and can have applications in the field of medicine and protein chemistry [3]. In view of above, densities, of L-serine in water and in aqueous 1-butyl-3-methylimidazolium bromide, solutions of various molalities, m = (0.1-1.0) mol•kg-1 over the temperature range T = (288.15-318.15) K and at atmospheric pressure have been determined using vibrating-tube digital density meter (DMA 4500M, Anton Paar, Austria). FTIR spectra for the mixture solutions of amino acids and aqueous have been recorded using a Perkin-Elmer IR instrument with a diamond ATR (attenuated total reflectance) crystal (MODEL SPECTRUM TWO) at room temperature i.e. 308.15 K. The density data have been used to calculate the apparent molar volume, , partial molar volume, and partial molar volumes of transfer, . The values of L-serine in aqueous solutions are higher than those in water and thus exhibit positive , which are indicative of strong interactions between L-serine and . The volumetric interaction parameters, and and hydration numbers, have also been calculated to discuss in context of hydration of L-serine. Conclusions drawn from FTIR study are in line to the results obtained from volumetric study.

Biography

Dr. Tarnveer Kaur is an Assistant Professor of Chemistry at Sri Guru Granth Sahib World University, specializing in Physical Chemistry. She earned her Ph.D. and M.Phil. from Punjabi University, Patiala, focusing on thermodynamic studies of protein model compounds in aqueous ionic liquids. With over a decade of teaching and research experience, she has published 7 international journal articles and multiple book chapters with reputed publishers. Dr. Kaur has presented her work at national and international conferences, serves as a reviewer and editor, and holds lifetime fellowship of The Indian Thermodynamic Society. Her research interests span green chemistry, ionic liquids, and advanced materials.

George Mallis
Independent Researcher, Patras, Greece

Noesis 3D: Emergent Spacetime and the Hetero-Auto Symmetry of Consciousness

Abstract

This paper presents Noesis 3D, a comprehensive theoretical framework designed to address the "Hard Problem" of consciousness and the "Observer Problem" of quantum mechanics. We posit that the Primordial Quantum Field (PQF) is ontologically identical to the substrate of consciousness. We introduce the Emergent Spacetime Participatory Model (ESPM), postulating the existence of a Qualia Field (Ξ), whose fundamental excitations correspond to topological defects (Spin Network Knots) in the geometry of spacetime.

Crucially, we propose a "No-Time" ontology where linear time is not fundamental but emergent, modeled as a thermodynamic artifact of local information actualization (Recycled Potentiality). We construct a minimal extension to the Standard Model via a Participatory Lagrangian containing a dynamical agent source term $J(x)$. The theory is formulated as a coherent Effective Field Theory (EFT) featuring a non-minimal ΞR gravitational coupling.

We propose the Hetero-Auto Symmetry Principle, a fundamental duality linking the internal topology of the observer (Neural Connectome) to the external geometry of spacetime (Einstein Curvature). We provide a rigorous derivation of the Thermo-Informational Bridging Law based on Landauer's Principle and propose concrete, falsifiable predictions:

1. Measurable deviations in the Modified Casimir Effect ($F \propto 1 + \eta g_p^2 P \tau$).
2. A novel Cognitive Aharonov-Bohm phase shift.
3. Consciousness-Induced Entanglement Asymmetry, specifically predicting a

divergence between Awake and Deep Sleep states.

4. Connectome-Curvature Resonance, where neural coherence amplifies in specific geometric topologies.

This framework offers a direct pathway to experimentally verify the interaction between cognitive activity and quantum vacuum dynamics, ultimately framing consciousness as a topological invariant of the spacetime manifold.

Biography

George Mallis is an Independent Researcher based in Patras, Greece, specializing in the intersection of Quantum Foundations, General Relativity, and Consciousness Studies. His primary research focus is the development of mathematically rigorous Effective Field Theories (EFT) that formalize the "Hard Problem" of consciousness. He is the author of the "Noesis 3D" framework, which proposes a participatory mechanism for the emergence of spacetime and time itself. His work aims to bridge the gap between abstract philosophy and experimental physics by deriving falsifiable predictions, such as the Modified Casimir Effect and Entanglement Asymmetry, for next-generation quantum metrology. He has recently submitted his definitive monograph on the subject to Foundations of Physics.

Sharanjeet Dhawan

Department of Mathematics & Statistics, CCSHAU COA Bawal, Haryana

Quantum Algorithms for efficient Solution of Multidimensional Partial Differential Equations

Abstract

Quantum computing provides a promising avenue for tackling the curse of dimensionality that plagues classical solvers for multidimensional partial differential equations (PDEs). This work presents a quantum–enhanced framework for linear multidimensional PDEs that couples high-dimensional spatial discretization with quantum algorithms for the resulting large-scale linear systems. The method maps the discretized multidimensional domain to quantum states and employs a suitable quantum linear solver to approximate the solution with favorable scaling in dimension and grid size under appropriate sparsity and conditioning assumptions. Performance is assessed on prototypical multidimensional Poisson and diffusion problems, examining accuracy, complexity, and resource requirements relative to classical iterative schemes. Numerical experiments and complexity estimates indicate potential quantum advantages in high-dimensional regimes, while highlighting hardware constraints and precision issues that currently limit practical deployment and motivate further algorithmic refinements.

Biography

Dr. Sharanjeet Dhawan is an Assistant Professor of Mathematics at CCSHAU, Haryana, India and a Core Committee Member in Mathematical Sciences at the Indian National Young Academy of Sciences (INYAS), India. Her research bridges theory and practice, developing and solving mathematical models for real-world problems *published in high-impact journals.*

Beyond her research, Dr. Dhawan is a passionate advocate for equitable science. Through hands-on workshops in remote regions, she brings practical STEM education to rural youth. A strong advocate for gender inclusion in science, Dr. Dhawan is an active member of the Organization for Women in Science for the Developing World (OWSD) and a founding member of the Women in STEM Network. Her work systematically connects researchers with rural schools and focuses on empowering women and youth through accessible education and leadership opportunities in STEM.

Ahmad Salmanogli

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[2]*Iranian Quantum Technologies Research Center (IQTEC), Tehran, Iran*

Quantum Chip Co-Design for Simultaneous Entanglement Preservation and High-Fidelity Operation: Architecture and Hamiltonian Engineering with QGHNN

Abstract

This work introduces a superconducting quantum-chip architecture specifically designed to simultaneously preserve entanglement and quantum-state separation fidelity—two figures of merit that are often in competition in scalable quantum hardware. In conventional superconducting circuits, enhancing qubit–qubit coupling strengthens entanglement but typically leads to increased crosstalk, dephasing, and degradation of readout fidelity. To address this trade-off, we propose a hybrid qubit architecture consisting of interior and exterior transmon groups coupled via a flux-tunable qubit and a distributed resonator network. The interior qubits, together with the tunable qubit, form a controllable entanglement core, while the exterior qubits operate deep in the dispersive regime to enable high-fidelity readout. The degree of entanglement is dynamically regulated by tuning the coupling between the central flux-tunable qubit and the interior qubits. The complete system Hamiltonian incorporates all relevant direct, mediated, and exchange interactions among the interior and exterior qubits, as well as the interface resonator modes. By numerically solving the full Hamiltonian in combination with the Lindblad master equation, we analyze the system dynamics, spectroscopic response, and quantum-state separation fidelity. The results demonstrate that the proposed architecture sustains strong entanglement within an engineered avoided-crossing region while maintaining separation fidelity as high as 0.995 under realistic noise conditions. These findings indicate that entanglement and readout fidelity can be co-optimized within a single reconfigurable

superconducting platform, providing a viable route toward scalable, high-performance quantum processors. Furthermore, by expressing the Hamiltonian in a Pauli-operator representation, we derive a gate-level equivalent circuit compatible with AI-driven quantum graph Hamiltonian neural network (QGHNN) optimization. This framework enables physically interpretable parameter updates that can be directly translated into device-level design modifications. The results offer clear visual evidence that the QGHNN-guided optimization effectively reshapes the device Hamiltonian, achieving quantum-state separation fidelities approaching 0.998 or higher.

Biography

Ahmad Salmanogli received his B.S. and M.Sc. degrees in Electrical Engineering from Tabriz University and his Ph.D. in Electrical and Electronics Engineering from Hacettepe University in 2021. He has held academic and industrial positions in Iran and Turkey, with a particular focus on senior-level RF and microwave circuit design as well as RF/CMOS integrated circuit development and chip design for more than eight years. He is currently an Assistant Professor in the Department of Electrical and Electronics Engineering at Ankara Yıldırım Beyazıt University, Türkiye. His research interests span quantum-AI circuit design, quantum RF and microwave circuit design, circuit quantum electrodynamics (cQED), quantum optics, quantum radar, and cryogenic low-noise amplifiers and RF circuits for quantum computing applications. He has authored over 80 publications in peer-reviewed journals and conferences.

Simea Sharlice Krieger
EnBW AG, DHBW Heilbronn

A QUBO Approach for Residential Energy Scheduling using QAOA

Abstract

The integration of dynamic energy pricing, electric vehicles (EVs), and heat pumps in residential areas creates new challenges for local energy coordination and decentralized grid management. This study investigates the feasibility of applying quantum optimization techniques to such energy scheduling problems by formulating a Quadratic Unconstrained Binary Optimization (QUBO) model and executing it on real quantum hardware. The objective was to assess whether current quantum devices can represent and process realistic optimization structures within residential energy management.

A QUBO model was developed to represent the binary control logic of bidirectional EV charging and heat pump operation while maintaining local power balance through adapted penalty factors. Since current quantum hardware imposes limitations on qubit count and circuit depth, the problem was abstracted and simplified to preserve the structural characteristics and constraint interactions of a realistic district energy management system, while remaining executable on available hardware. Three solvers were implemented for comparison: an exact classical reference, the Quantum Approximate Optimization Algorithm (QAOA), and a Linear-Ramp QAOA (LR-QAOA) variant designed for smoother convergence through gradual parameter evolution. Both quantum algorithms were executed on the IBM Quantum System One located in Pittsburgh, enabling direct evaluation under real hardware conditions.

Results show that both QAOA and LR-QAOA produced feasible binary solutions

consistent with the modeled operational constraints. The LR-QAOA variant achieved a better objective value than the standard QAOA, indicating improved parameter stability and convergence behavior.

The study confirms that QUBO-based formulations can be successfully mapped to present-day quantum hardware and executed with acceptable fidelity for small-scale test cases. While constrained by current technological boundaries, the results validate the conceptual feasibility of using quantum devices for structured energy optimization problems. This work contributes to the growing body of applied research bridging classical and quantum optimization and provides empirical insights into how quantum algorithms perform in constrained, domain-specific contexts such as residential energy management. Future research will extend this framework toward scalable hybrid optimization approaches and uncertainty-aware formulations to increase scalability and practical relevance.

Biography

Simea Sharlice Krieger is currently pursuing her Bachelor's degree in Information Systems at the Baden-Wuerttemberg Cooperative State University (DHBW) Heilbronn, Germany as part of a cooperative education program with EnBW AG.

Rishi Kumar Tiwari

Government Model science College, Rewa-486001, Madhya Pradesh,
India

Bianchi Type I Cosmological Model with Special form of q in *f(R, T)* Gravity

Abstract

This study examines the anisotropic Bianchi type-I cosmological model in the framework of $f(R, T)$ gravity. A particular form for $f(R,T) = R + 2f(T)$ have been discussed. The Einstein field equations are solved by assuming a special law of time varying deceleration parameter $q=-1-\frac{\alpha}{H}$, 0<n<1 (α is constant). We find that the universe expand exponentially for this amphibian physical and geometrical parameter have discussed.

Keywords: modified gravity, deceleration parameter, cosmological red-shift, state-finder parameter

Hiba Aouahchi

Al Akhawayn University (School of Science and Engineering)

Quantum-Enhanced Association Rule Mining (QARM) for Optimizing Antibiotic Usage

Abstract

The global rise of antimicrobial resistance (AMR) has become one of the most pressing challenges in modern healthcare, largely driven by the misuse and over-prescription of antibiotics. To address this issue, the ability to rapidly identify patterns linking antibiotic usage and resistance is crucial. Traditional association rule mining (ARM) algorithms such as Apriori and FP-Growth have proven effective in discovering such correlations, but their computational complexity limits scalability when applied to large, high-dimensional medical datasets.

This research proposes a Quantum-Enhanced Association Rule Mining (QARM) approach leveraging Grover's search algorithm to accelerate the discovery of frequent itemsets and optimize antibiotic prescription analysis. By encoding antibiotic-prescription data into quantum states, Grover's algorithm amplifies the probability amplitudes of frequent patterns, achieving a theoretical $O(\sqrt{N})$ search complexity compared to the $O(N)$ of classical algorithms. The proposed system integrates both classical and quantum workflows, establishing a direct performance comparison across runtime, scalability, and rule quality metrics.

The project utilizes a predefined clinical dataset previously applied in classical machine learning studies on antibiotic optimization. The quantum implementation was developed using IBM Quantum Lab and Qiskit, incorporating custom-designed oracles and diffusion operators for pattern marking and amplitude amplification. Initial simulations on small datasets (5×3 transactions) demonstrate correct identification

of frequent antibiotic combinations, confirming the algorithm's validity. Measurement histograms show amplified probability distributions for the most frequent items (M1, M3), aligning with the expected outcomes of Grover's amplitude amplification process.

Preliminary results indicate that the quantum approach reduces the number of iterations required for pattern discovery while maintaining interpretability of rules comparable to classical methods. Ongoing work focuses on scaling the system to larger datasets, integrating quantum counting for frequency estimation, and exploring hybrid classical–quantum approaches for improved efficiency.

This study highlights the potential of quantum computing to revolutionize healthcare data analytics by providing faster and more efficient methods for uncovering complex prescription–resistance relationships. The QARM model contributes to the advancement of quantum-assisted decision support systems, promoting better antibiotic stewardship and reinforcing the role of quantum technologies in solving critical real-world challenges.

Biography

I am a senior Computer Science student at Al Akhawayn University in Ifrane (AUI), specializing in Artificial Intelligence and Data Science. My current research focuses on quantum computing applications in medical data mining, specifically applying Grover's algorithm to optimize antibiotic prescription analysis. Guided by Professor Fouad Mohammed Abbou, I am conducting my capstone project titled Quantum-Enhanced Association Rule Mining (QARM), which explores the intersection of quantum algorithms and healthcare decision-support systems. I have previously worked on projects involving deep learning, video super-resolution, and AI-driven chatbot systems. I am passionate about leveraging emerging technologies to create innovative, data-driven solutions to global challenges. My goal is to pursue graduate studies in quantum-assisted artificial intelligence, contributing to the development of scalable and ethical AI for healthcare applications..

Sakshi

Indira Gandhi Delhi Technical University for Women Delhi, India

Photon-Number Splitting (PNS) Attacks in Weak Coherent Pulse QKD: Simulation and Countermeasures

Abstract

For a start, Quantum Key Distribution offers security not depending on any fundamental assumption. However, actual realizations choose to use weak coherent pulses as photon sources, rather than the ideal single-photon state, which bears security weaknesses due to the emission of sporadic multi-photon states. These states can be used in Photon-Number Splitting (PNS) attacks, where the attacker intercepts and buffers photons of multi-photon pulses and forwards the rest, enabling partial recovery of the key without inducing detectable perturbations. This article presents a simulation-based approach to analyze PNS attacks with realistic channel conditions like losses, detector imperfections, and finite key lengths. The research also examines the performance of decoy-state countermeasures, that use variable-intensity pulses to statistically reveal eavesdropping and Simulation results confirm the dominant character of PNS on raw key rates for the no-countermeasure scenario and ensure optimal decoy-state schemes restore security by cutting single-photon contributions. Results establish that although WCP QKD is vulnerable to PNS attacks in theory, strict adoption of decoy-state protocols aided with monitoring and finite-key analysis can provide immunity against an adversary. The paper emphasizes the need for simulation-based, implementation-dependent security analysis in direction towards well-designed practical quantum cryptographic systems.

Keywords: Quantum Key Distribution, Photon-Number Splitting, Weak Coherent Pulses, Decoy-State Protocol,Quantum Cryptography, Security Simulation.

Ishwari Patil

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CryptexQ - A Quantum-Resilient End-to-End Encrypted Messaging Framework

Abstract

A secure communication system called CryptexQ was created to address the growing threat of quantum attacks on current encryption methods. To develop a hybrid, quantum-proof secure communication system for the future, this project combines the BB84 protocol and Quantum Key Distribution with the standard encryption method AES. A simulated Quantum Key Distribution technique will generate the shared secret keys needed for communication between parties; it will also detect any eavesdroppers. Using the encryption method AES-256 GCM, these keys will further encrypt the messages sent through the communication system. Additionally, the system chooses PQC implementation using Kyber512. This system explains in detail how quantum cryptography and standard encryption work together. It also shows how this approach could completely change the current communication system while keeping it secure.

Keywords—Quantum Key Distribution, BB84 Protocol, Post-Quantum Cryptography, AES Encryption, Quantum Communication, Quantum Security.

I. INTRODUCTION

Quantum computing is moving forward fast. This is making the ways of keeping things secret like RSA and ECC not as good as they used to be. These old ways use hard math problems. With new ways of solving problems like the one made by Shor, quantum computers can solve them easily. Quantum computing is advancing quickly. It is making traditional cryptography methods, like RSA and ECC seem less reliable. This means that a lot of the codes we use now will not be safe when quantum computers are fully developed. So people are trying to find ways to keep things secret that can

keep up with quantum technology. Quantum computing and quantum technology are changing the way we think about codes and security systems that can keep pace with them.
This is where Quantum Key Distribution or QKD comes into play. Quantum Key Distribution does not use the math techniques. Quantum Key Distribution uses the principles of quantum physics to exchange encryption keys. An important property about Quantum Key Distribution is that if someone tries to listen in the Quantum Key Distribution key changes in a way that you can notice right away. You can be sure that your Quantum Key Distribution key is secure it has not been. It is not a fake key. However, Quantum Key Distribution, by itself does not work well for big networks. To work properly for everyone, it needs help from a reliable way to encrypt things like symmetric encryption. This symmetric encryption has to be good and work quickly so that it can do its job.

This is where CryptexQ steps in. It bridges that gap by combining QKD's secure key generation with AES, a trusted symmetric encryption standard. The system runs a BB84 protocol simulation to generate session keys, which are then used in AES-256 GCM to encrypt messages both quickly and securely. This combined approach allows for real-time data exchange while protecting against current cyber threats and any challenges posed by future quantum computers. The aim is straightforward: create quantum-proof messaging that is practical, scalable, and user-friendly.

Timothy Heightman

ICFO - The Institute of Photonic Sciences (ICFO)

A Composable Phase-Space Framework for Quantum Machine Learning

Abstract

Quantum machine learning (QML) seeks to exploit the intrinsic properties of quantum mechanical systems, including superposition, coherence, and quantum entanglement for classical data processing. However, due to the exponential growth of the Hilbert space, QML faces practical limits in classical simulations with the state-vector representation of quantum systems. On the other hand, phase-space methods offer an alternative by encoding quantum states as quasi-probability functions. Building on prior work in qubit phase-space and the Stratonovich-Weyl (SW) correspondence, we construct a closed, composable dynamical formalism for one- and many-qubit systems in phase-space. This formalism replaces the operator algebra of the Pauli group with function dynamics on symplectic manifolds, and recasts the curse of dimensionality in terms of harmonic support on a domain that scales linearly with the number of qubits. It opens a new route for QML based on variational modelling over phase-space.

Biography

Timothy Heightman is a PhD student in the Quantum Information Theory Group of Prof. Acin at ICFO. Arriving in the group three years ago with a Dean's list award from Imperial College London (Bsc and MSc, graduating top 5), his work focuses on mathematical foundations of quantum

machine learning and its interface with contemporary techniques in the AI sector. He *is a lecturer in University of Barcelona, delivering an MSc course "Machine Learning Quantum and Classical", and is currently engaged with Springer to write a book on recent advancements in this topic. Other problems of interest for him are deep learning methods in process tomography, and neural differential equations.*

Hong-Xu Huang

School of Instrumentation and Optoelectronic Engineering, Beihang University, Beijing 100191, China

Ultra-high-speed LED array for three-dimensional profilometry with projector defocusing

Abstract

Phase-shifting fringe projection profilometry, which involves projecting sinusoidal fringes onto objects and decoding the distorted fringes, is widely used in industrial inspection, face recognition, biological microscopy, and other fields. Typically, to enhance measurement speed, binary defocusing projection techniques are employed in fringe projection profilometry—where binary fringe patterns are optically defocused to approximate sinusoidal fringes. Although displaying binary patterns enables DMD-based projectors to significantly increase projection speed, they are still constrained by the fundamental speed limits imposed by DMD hardware and display mechanisms, making it challenging to achieve both high speed and high precision in 3D measurements. This paper presents a self-developed high-speed LED array device with a refresh rate of up to 25 MHz, surpassing DMD by three orders of magnitude. Experimental results demonstrate that our high-speed LED array can achieve a measurement speed of up to 1 MHz while maintaining a measurement accuracy of 20 µm.

Biography

Hong-Xu Huang was born in China, in 1995. He received the B.E. degree in electronic science and technology from Zhengzhou University, Zhengzhou, China, in 2017. He is currently working toward a Ph.D. degree in optical engineering in Beihang University, Beijing, China. His research interests include high-speed circuit design, 3D measurement, and computational ghost imaging.

Jurabek Abdiev

Xinjiang Technical Institute of Physics and Chemistry, Chinese Academy of Sciences, China

Quantum Algorithms for Efficient Error Correction in Noisy Intermediate-Scale Quantum Devices

Abstract

Quantum computing is racing toward useful applications at a breakneck speed, but noise and error in today's Noisy Intermediate-Scale Quantum (NISQ) hardware are the single biggest roadblock to robust computation. Here, we promote new hybrid quantum-classical algorithms to achieve maximum error correction fidelity with minimal wasted computation in these noisy hardware. By combining machine learning-based noise profiling with adaptive quantum error correction codes, our scheme learns real-time error correction schemes and self-dynamically adjusts to system error environments. Large-scale simulations show long coherence times and reduced gate error rates for superconducting and trapped-ion qubit hardware platforms. The strategy scales to deployable applications in future quantum hardware, from theoretical error correction architectures to practice-altering applications. This work removes the biggest pitfall to scalable quantum computing, opening the door to fault-tolerant quantum algorithms and achieving quantum advantage in near-term devices.

Biography

Jurabek Abdiev, PhD candidate in the Laboratory of Environmental Science and Technology, Xinjiang Technical Institute of Physics and Chemistry (XTIPC-CAS), Chinese Academy of Sciences. Jurabek's research fields of interest are in materials science and engineering, basalt fiber composite structures, and their applications in advanced composites and semiconductor devices. Jurabek published over 25 SCI/E *journal articles, with an overall h-index of 7 and over 96 citation numbers. Jurabek Abdiev is also involved in international cooperation and work posters/presentations at science conferences. Jurabek's research focus is on the design, synthesis, and characterization of advanced composite structures and the environmental and technologically applicable ones. Jurabek's achievement is in his foundational work in sustainable material research and continued efforts to kindle applied work in materials science at the environmental technology interface.*

Meliani Kawther

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Effect of Pressure on X_2CrSb (X = Mn, Co, Cu) Heusler Alloys: Insights for Spintronic and Thermoelectric Applications

Abstract

In this study, the structural, electronic, elastic, and magnetic properties of the full Heusler alloys X_2CrSb (X = Mn, Co, Cu) were systematically investigated using density functional theory (DFT) within the plane-wave pseudopotential method and the generalized gradient approximation (GGA) for exchange–correlation effects. A pressure-induced phase transition from the XA to the $L2_1$ structure is predicted for Mn_2CrSb at 8.933 GPa. This compound exhibits a half-metallic character at ambient pressure, transitioning into a magnetic metal phase at 17.5 GPa. Co_2CrSb maintains a half-metallic behavior under expansion and shows nearly half-metallic features under compression above 1 GPa. The calculated total magnetic moments are 5.0 µB for Mn_2CrSb, 1.0 µB for Co_2CrSb, and 3.4 µB for Cu_2CrSb. In all cases, magnetism is predominantly carried by Cr atoms, except in the XA-phase of Mn_2CrSb, where Mn atoms are the main contributors. Density of states (DOS) analysis reveals weak spin polarization in Cu_2CrSb, while Co_2CrSb and Mn_2CrSb show enhanced spin polarization under expansion. However, spin polarization in Mn_2CrSb diminishes under compression, vanishing completely at 29.4 GPa. These findings highlight the tunability of magnetic and electronic properties in X_2CrSb compounds under pressure, offering promising insights for spintronic and thermoelectric applications.

Biography

Kawther Meliani is a Ph.D. candidate in Material Physics at Yahia Fares University of Médéa, Algeria. She holds a Master's degree in Material Physics and a teaching diploma in Physics. Her research focuses on the theoretical and experimental investigation of Heusler alloys and related compounds, particularly their magnetic and thermoelectric properties. She has authored several peer-reviewed articles in international journals such as Physica B and the Brazilian Journal of Physics. Meliani has presented her work at numerous national and international conferences and participated in a research training program at the University of Girona, Spain. She is skilled in both computational tools (Quantum ESPRESSO, WIEN2k, CASTEP) and experimental techniques (XRD, SEM, EDX). In addition to her research, she serves as a physics teacher and is committed to advancing material science for technological innovation.

Qishen Liang

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Integrated Scalable Hybrid Spatial-spectral Switch Based on Bandpass Ring-assisted Asymmetric Mach-Zehnder Interferometer

Abstract

Silicon-based photonic devices for quantum networks offer a promising pathway to enhance scalability and reduce device costs in communication system construction, driving research on integrated quantum networks and the development of photonic quantum communication and quantum computing. The integrated wavelength-selective switch is a critical component for wavelength-division multiplexing (WDM) quantum networks and quantum key distribution applications. However, current optical switches (typically based on arrayed waveguide gratings or microring resonators) suffer from limitations, such as poor reconfigurability and temperature sensitivity, which complicate their control systems.

To address these challenges, we propose an integrated hybrid spatial-spectral switch based on the 2×2 asymmetric ring-assisted Mach-Zehnder interferometer (RAMZI). The RAMZI, composed of an asymmetric Mach-Zehnder interferometer with microrings on its arms, provides a box-shaped spectral response. The proposed switch leverages the RAMZI's capability to separately route multi-wavelength photons, enabling flexible configuration of scalable multi-wavelength channels without using additional wavelength-division (de)multiplexers. Furthermore, this scheme reduces the minimum number of switch units required for traditional N spatial-port and M-wavelength routing from $MN(2\log_2 N - 1)/2$ to $N(M\log_2 N - 1)/2$, significantly enhancing the scalability of on-chip optical quantum networks.

To demonstrate the performance of our integrated hybrid spatial-spectral switch,

we fabricated a dual-wavelength, 4-port optical switch on a silicon-on-insulator (SOI) platform. The compact device, with a footprint of 0.4 mm^2, comprises just six 2×2 RAMZI switch elements to route 8 light paths without blocking. Spectral characterization demonstrates that the chip achieves a 3-dB channel bandwidth > 1.5 nm and maintains relatively high passband flatness across all switch configurations, with an average 1-dB bandwidth of 1.27 nm. This work presents a novel approach for integrated WDM quantum networks, offering enhanced spectral utilization and port scalability compared to conventional solutions, and demonstrates significant potential for large-scale quantum communication systems.

Biography

Qishen Liang is a Ph.D. candidate in the College of Information Science and Electronic Engineering, Zhejiang University, China. His research focuses on silicon photonic integrated devices for optical interconnects and wavelength-division-multiplexed optical switching arrays, with recent extensions into integrated quantum optical communication systems. He developed an efficient calibration algorithm for high-order Ring-Assisted Mach-Zehnder Interferometers (presented at the Optical Fiber Communication Conference and Exhibition 2025).

Yusuf Asam
Zhejiang Sci-Tech University, China

A dual-path feature learning neural network for enhancing image classification in marine biology

Abstract

In marine life, images classification is an important task for environmental monitoring and marine resource management; it has significant implications for real-time monitoring, tracking endangered species, and ensuring the effectiveness of conservation efforts. However, the accurate classification is difficult due to challenges like light distortion, poor visibility, and limited annotated data. To improve classification accuracy, we introduced a dual-path feature fusion neural network architecture inspired by squeeze and excitation operations. Our model employs a dual-path approach for feature extraction: the first path utilizes Xception model by initially freezing to keep weights and fine-tune for new datasets. The second path used a custom CNN that implements multiple convolutions, pooling, and Squeeze-and-Excitation operations to abstract complementary features. The outputs of both paths are concatenated as feature vector. The classification stage involves fully connected layers with activation functions and regularization, applying dropout to prevent overfitting, and culminating in a softmax layer for final classification. Experiments conducted on the LifeCLEF2015 and Fish4Knowledge datasets demonstrate competitive results, with accuracies of 99.57% and 99.39%, respectively, and more than 99% overall recall, precision, and F1 score. The model generalized well with other general datasets and achieved high accuracy. Different visualization techniques are used to validate the effectiveness of our approach. Although the model shows promising results, challenges remain, including the need for high-quality labeled data and the model's performance in extremely low visibility conditions. The future research could focus on enhancing data augmentation and domain adaptation strategies. Additionally, tuning the hyperparameters proved to be quite challenging

Biography

Computer vision researcher, with deep learning application in different fields. Passionate about leveraging advanced algorithms to solve complex challenges across diverse environments and enhance computer vision applications. Proven track record in research, project management, and teaching, with a strong foundation in AI, machine learning, and data science. Finished his Master degree at in Computer Science and Technology from Zhejiang Sci-Tech University, China. Currently PhD student at Nanjing university of information science and technology, China.

Thank You