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ABSTRACT BOOK

Global Conference on

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Beihang University, Beijing, China

Review on Microwave Surface Resistance of High Temperature Superconductor Yttrium Barium Copper Oxide (YBCO)

The performance of Yttrium-Barium Copper Oxide (YBCO) high-temperature superconductors in high-frequency applications is significantly affected by the microwave surface resistance (Rs). The paper delves into the basics, measuring methods and factors affecting the resistance (Rs) in YBCO, highlighting its high critical temperature (Tc) and low resistance, positioning it as a promising material. YBCO's compatibility with epitaxial growth and microstructure engineering offers opportunities to reduce grain boundary effects and improve Rs, making it advantageous for high-frequency electronics, communication systems, and MRI coils. This is due to its high critical current density (Jc) and exceptional Rs at practical temperatures.

Challenges remain in comprehending and managing Rs in YBCO, despite its favorable characteristics. Utilizing advanced fabrication methods and incorporating nanotechnology allow for customization of YBCO-based devices. Multi-scale modeling and simulation are essential for guiding experimental work and understanding YBCO's performance in high-frequency settings. This study highlights the promise of YBCO for future high-frequency technologies and stresses the importance of more research to overcome hurdles and fully exploit its capabilities, potentially transforming superconducting devices for practical use.

Osamu Hirota

Quantum ICT Research Institute, Tamagawa University

Quantum cryptology based on a new principle of quantum theory - Defence against cyber attacks on optical network

It is necessary to develop ultra-high-speed data encryption (over 100 Gbit/sec) with information theoretic security that can avoide the threat by the advances in quantum computers. Symmetric key cipher based on information-theoretic concepts was first developed by Shannon. Yuen proposed in 2000 the concept of generalized random cipher based on the basic theory of Massey et al. It can over come the defect of Shannon formula. His protocol corresponds to randomizing the ciphertext of the symmetric key cipher by means of differentiating the receiving performance of Bob with key and Eve without key according to a new principle of quantum communication theory. Its development is divided into two phases. The first phase is the study of how to implement the original protocol so called standard quantum stream cipher. The second phase is the study of how to enhance the security, it is called generalized quantum stream cipher. This talk introduces some progress on the specific method to develop from the standard type to generalized quantum stream cipher. There are two methods for generalization. Firstly we introduce a method of the additional randomization method by the product cipher form.
On the other hand, there is a method to realize a generalized quantum stream cipher without using the above randomization technique. This mechanism treats information as M-th extended code and configures a transmitted signal system of M-ary PPM based on on-off keying. It is called a coherent Pulse Position Modulation encryption (CPPM). However, the CPPM needs to expand the baseband to

avoid the time delay in encryption and decryption. In order to avoid the drawback, we proposed the FM-phase PPM scheme based on Stone-von Neumann theorem of the symplectic transformation for quantum coherent state ensemble. The detailed performance on the two types of generalization and how to work with Post Quantum Cryptography for key distribution will be explained in the presentation.

Biography:

Osamu Hirota is a Professor Emeritus at the Quantum ICT Research Institute of Tamagawa University, and Research Professor at the Research and Development Initiative of Chuo University. His research focusses on studying foundation for quantum communication theory and quantum noise analysis of quantum computers. He is the founder of the QCMC (International Conference on Quantum Communication, Measurement, and Computing). He received his Ph.D from Tokyo Institute of Technology. He has received the following prizes and award:

1. *The Takayanagi Kenjiro Research Encouragement Prize (1986)*
2. *System Science Prize of The Telecommunications Advancement Foundation (1987)*
3. *Quantum Information Science Award (2002)*
4. *The President prize of Support Center for Advanced Telecommunications Technology Research (2022).*

Xiaoyu Chen

Hangzhou City University, Hangzhou, China

Towards Genuine Entanglement Criteria of Noisy Intermediate-Scale Quantum Systems

Current quantum processors with over a hundred qubits have been developed, such as "Willow" and "Zuchongzi". The number of genuine entangled qubits reaches 51 or 60 in different systems. The measured photon number of photonic quantum computer also surpasses a hundred.

Comparing to the fast experimental developments of noisy intermediate-scale quantum systems, the theoretical entanglement detection methods are left behind, they are either inefficient or cumbersome. The aim of this study was therefore to systematically identify and present validated genuine entanglement detecting criteria for noisy intermediate-scale quantum systems. For continuous variable systems, with the matched entanglement witness methods, we proposed a serial of matrix criteria for the genuine entanglement of multipartite systems. We illustrate the applications of the criteria in detecting genuine entanglement of randomly generated covariance matrices of three and four mode systems. We also demonstrate the applications of the criteria to noisy continuous variable GHZ states of over 200 modes in photon loss environment. The genuine entangled states can be explicitly demonstrated. For discrete variable systems, we show the necessary and sufficient conditions of various separabilities for three and four qubit GHZ and W mixed states or GHZ and Dicke mixed states in white noise environment, the robusteness of these states. For any n qubit GHZ state in white noise environment, we also present the necessary and sufficient condition of k-separability when k is larger than a half of n.

Biography:

Professor Xiaoyu Chen received his BS and MS at 1984 and 1987 from Nankai University in physics and PhD at 2003 from Zhejiang University in information and electronic engineering. He is with the school of information and electrical engineering, Hangzhou city university. He has published in excess of one hundred papers in quantum information. His recent research interests are on entanglement detection and quantification, especially for large scale continuous variable quantum systems.

Wensheng Bian

Institute of Chemistry, Chinese Academy of Sciences, China

Search for potential candidates for ultracold molecules and construction of molecular qubits

Ultracold molecules have attracted considerable interest due to their potential applications in various fields, including quantum computing, quantum information storage, and precision measurement. Among these, the realization of quantum computing will lead to revolutionary advances in computing power. Current quantum computers primarily rely on qubits based on photons or superconducting electrons. On the other hand, molecular qubits represent a new direction that offers unique advantages, such as efficient quantum gates implemented through dipole manipulation. Research on preparing ultracold molecules via laser-cooling techniques to construct molecular qubits is of great significance. The present work employs high-precision quantum mechanical methods to conduct systematic and comprehensive theoretical research on the electronic excited-state properties and laser cooling of molecules. The feasibility of laser cooling of a series of molecules was systematically evaluated based on Di Rosa's three established criteria as well as the fourth criterion proposed in our recent work, that there should be no electronic-state crossing between the upper electronic state and other states, or the crossing points must reside at a sufficiently high energy position. Our work demonstrates the important role that excited-state crossings play in molecular laser cooling, and we presents viable three-laser cooling schemes for several systems. For example, our scheme for SH was able to scatter 9.30×103 photons, which were sufficient for cooling SH into ultracold temperatures. In addition, we found that the law of “crossing point shifting down” found in our recent work remains valid for the group VIA hydrides. Our current study will provide an important theoretical basis for the experimental preparation of ultracold molecules. Furthermore, I will present a new method for establishing laser cooling schemes capable of achieving ultracold temperatures based on non-adiabatic effects. Based upon our findings, we further explore potential molecular systems suitable for the construction of molecular qubits.

Biography:

Dr. Wensheng Bian, now is a professor of Physical Chemistry, group leader of Non-Adiabatic Dynamics and Theoretical Chemistry Research Group, at Institute of Chemistry, Chinese Academy of Sciences (ICCAS). He got his Doctor's degree (Ph.D.) in 1994 in physical chemistry. He became a full professor in 1999 at Shandong University. He worked at University of Stuttgart as Humboldt Research Fellow from 1996 to 1998, and worked at Institute of Molecular Science (Japan) as JSPS fellow from 2000 to 2002. In 2003, he was selected to “Hundred Talents Project of Chinese

Academy of Sciences” and since then has been a full Professor at ICCAS. He was the director of the State Key Laboratory of Molecular Reaction Dynamics (Beijing Branch) of ICCAS from 2004 to 2014. Dr. Wensheng Bian has published more than 100 research papers including those in top academic journals such as Science, Nature Commun., PNAS and Sci.Adv.

Irena Kostova

Department of Chemistry, Faculty of Pharmacy, Medical University, 2 Dunav St., Sofia 1000, BULGARIA

Theoretical and spectral studies of biologically active metal coordination compounds

There is a growing demand for the discovery of new metal-based compounds exhibiting enhanced biological activity compared to their precursors. The cytotoxicity and oxidative behavior of metal ions play a crucial role in determining their medicinal potential. As part of our ongoing research on the synthesis, characterization, and pharmacological evaluation of metal coordination compounds with biologically relevant organic molecules, it has been observed that variations in ligands, metal centers, and reaction conditions significantly influence the selectivity and activity of the resulting products.

In the present study, novel biologically active metal complexes were synthesized, and their structures were elucidated using theoretical, analytical, and spectroscopic techniques. Particular attention was given to understanding the effects of the metal type, its oxidation state, and the metal–ligand binding mode on the complexes' therapeutic and thermodynamic properties. Detailed spectral analyses of the ligands and their metal complexes, based on both theoretical (DFT) calculations and experimental data (FT-IR, FT-Raman, ^{1}H NMR, and ^{13}C NMR), confirmed the proposed metal–ligand coordination modes. Characteristic marker bands corresponding to specific functional groups were identified, providing a useful spectral database for future trace analysis of similar metal complexes.

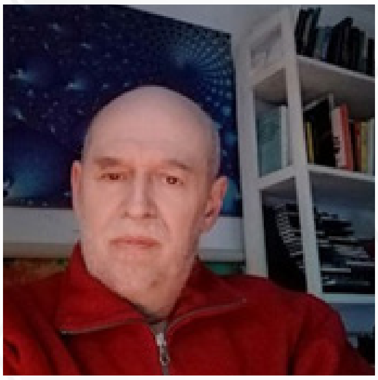
Overall, the results confirmed that DFT approximations represent a reliable approach for predicting the electronic and structural properties, metal–ligand interactions, intra- and intermolecular hydrogen bonding, and vibrational frequencies of the investigated ligands and their complexes. Biological evaluations further demonstrated that the synthesized metal complexes exhibit notable oxidative and cytotoxic activities, with pharmacological effects consistently more pronounced than those of the corresponding free ligands.

Acknowledgments: The administrative support received by the European Union-NextGenerationEU, through the National Recovery and Resilience Plan of the Republic of Bulgaria, project No. BG-RRP-2.004-0004-C01 is greatly acknowledged.

Biography:

Prof. Kostova is one of the World's Top 1% of scientists according to Stanford University's ranking of scientists with the greatest contribution to the development of modern science. She graduated from Mendeleev University with the highest grade. Defended her PhD and DSc theses at MU-Sofia where she is currently a full professor. Author of hundreds of publications with high impact factor, several textbooks and monographs with thousands of citations. Lecturer at renowned European universities. Member of organizing committees of over 40 international conferences. Editor of 9 prestigious international scientific journals, a member of the Editorial Boards of over 25 international journals and a reviewer for high-ranking journals. She has created and maintains collaborations with a number of European universities in joint research projects and programs.

https://www.researchgate.net/profile/Irena_Kostova2
https://www.scopus.com/authid/detail.uri?authorId=7004126316
https://scholar.google.com/citations?user=PPateJQAAAAJ&hl=en
https://orcid.org/0000-0001-6290-7327



Marius-F. Danca

STAR-UBB, Babes Bolyai University of Cluj-Napoa, Romania

Attractors decomposition in a class of nonlinear dynamical systems

Most autonomous chaotic systems such as the Lorenz system, Chen system, etc., can be modeled by the following Initial Value Problem (IVP):

$\dot{x}(t) = f_p(x(t)),\ x(0) = x_0,\ t \in I = [0, \infty),\ x_0 \in R^n$, (1) 0 0

$f_p : R_n \rightarrow R_n,\ p \in R,\ f_p(x) = {}^{p}Bx = g(x)$, (2)

f_p depends linearly on the bifurcation parameter g is a continuous nonlinear function and B is an n×n real constant matrix. In [1,2], it is proved analytically and verified numerically that by using the periodic time-varying Parameter Switching (PS) algorithm, any attractor of a system modeled by the IVP (1)–(2) can be numerically approximated and, also, expressed as a convex combination of a set of attractors of the considered system. The algorithm is time-varying, periodically switching the parameter *N* within a chosen set of *N* parameters, PN = { p_1, p_2 ,..., pN }, according to some rules, while the IVP is integrated with a convergent scheme for ordinary differential equations. Under the usual uniqueness assumption of the solutions of the IVP, to each switched parameter pi $\in P_N$ corresponds a unique attractor A . Via the PS algorithm, any attractor can be approximated by the i PS algorithm [1-5]. This property is useful, for example, to "force" the considered system to evolve along some desired attractor corresponding to a parameter p* , A when, by some objective
*

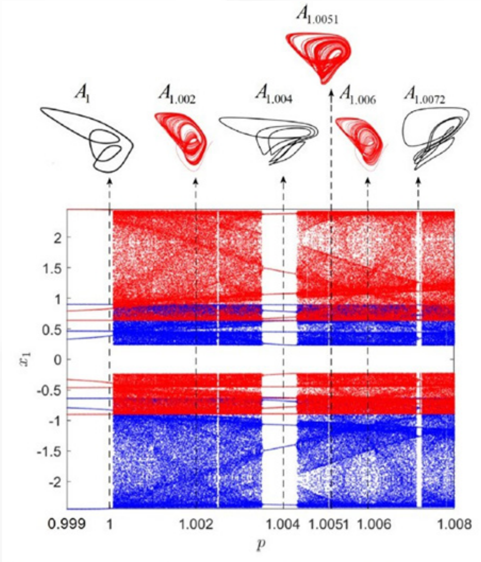


Fig. 1 . Bifurcation of the HNN system for $p \in [0.999, 1.008]$ of the component x_1, after transients are removed. Several chosen parameters with their corresponding attractors are indicated.

reasons, p* it cannot be set (accessed). Then, by choosing PN with a well defined switching rule, the PS algorithm allows you to approximate the attractor A * . Moreover, it is proved that any attractor can be decomposed as a convex set combination of a set of other attractors [3]. Consider the Hopfield Neural Network

$$\begin{aligned}
\dot{x}_1 &= -px_1 + 2\tanh x_1 - 1.2\tanh x_2,\\
\dot{x}_2 &= -x_2 + 1.9995\tanh x_1 + 1.71\tanh x_2 + 1.15\tanh x_3,\\
\dot{x}_3 &= -x_3 - 4.75\tanh x_1 + 1.1\tanh x_3,
\end{aligned}$$

whereas, the elements (1)–(2) are

$$B = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad g(x) = W \begin{pmatrix} \tanh x_1 \\ \tanh x_2 \\ \tanh x_3 \end{pmatrix}$$

From the bifurcation diagram in Fig.1, consider attractor $A_{1.004}$. This attractor can be expressed as the following (not unique) convex combination of attractors A1 , $A_{1.0016}$, $A_{1.003}$, $A_{1.0074}$ and $A_{1.008}$:

$$A_{1.004} = \frac{1}{2} \square A_{1} \oplus \frac{1}{4} \square A_{1.0016} \oplus \frac{1}{4} \square A_{1.003} \oplus \frac{1}{4} \square A_{1.0074} \oplus \frac{1}{8} \square A_{1.008},$$

the operations □ and ⊕ being defined in [4], and the coefficients multiplying the attractors are defined via the weigths $\square_N$. This way of decomposing can be applied to all systems modeled by the IVP (1)-(2).

1. Marius-F., Danca, Convergence of a parameter switching algorithm for a class of nonlinear continuous systems and a generalization of Parrondo's paradox. Commun Nonlinear Sci Numer Simul 2013;18(3):500–10.
2. Mao Yu, Tang Wallace KS, Marius-F., Danca, An averaging model for chaotic system with periodic time-varying parameter, Appl Math Comput 2010;217(1):355–62.
3. Marius-F, Danca , Michal, Feckan, Nikolay, Kuznetsov, Guanrong, Chen, Attractor as a convex combination of a set of attractors. Commun Nonlinear Sci Numer Simul 2021;96:105721.
4. Marius-F., Danca, Guanrong, Chen, Approximation and decomposition of attractors of a Hopfield neural network system, Chaos, Solitons and Fractals 186 (2024) 115213.

Biography:

Graduated from Babes Bolyai University of Cluj-Napoca, Romania, Faculty of Mathematics and Computer Science, and Technical University of Cluj-Napoca, Romania, Faculty of Electronics, Telecommunications and Information Technology. Obtained the PhD in Engineering, Faculty of Automation and Computer Science, Technical University of Cluj-Napoca, Department of Automation. He also obtained a PhD in Mathematics at the Faculty of Mathematics and Computer Science, Babes-Bolyai University. He has 100+ WOS papers with 1,700 + WOS citations, WOS IF 23, in top 2% of scientists in the Scopus Database 2019, 2020, 2021 and 2023.

Fields of interest/specialization: nonlinear science: continuous/discontinuous chaotic dynamical systems of integer/fractional order, hidden attractors, scientific computation.

Nicolae A. Enaki

Quantum Optics and Kinetic Processes Lab, Institute of Applied Physics of Moldova,Moldova State University, Academiei Str. 5, Chisinau, MD 2028, Republic of Moldova

Cooperative description of multiple step scattering emission for the description of intrinsic quantum correlations

The principal attention is given to the development of coherent aspects of multiple scattering induced emissions in which this coherent state is realized among the photon groups generated in the nonlinear conversion interaction by emitters (atoms, molecules, biomolecules, etc.). The master equations and the moments of this equation are proposed in order to describe the quantum aspects of this type of emission. Using the coherent representation of multiple photon conversion, the quantum aspects of correlations of photons between adjacent and nonadjacent modes are proposed for transferring of information in the process of quantum communication. This type of light generation supports the idea of coherent correlation between the new portion of energies that appear in the description of correlated bi-modal fields [see Refs [1-3])]. In induced multiple Raman processes was introduced the quasi particles with energy of each such a quanta is equal to the difference between energies of two photons from adjacent modes of cavity. The coherent states of cooperative lasing in multiple lasing is introduced, taking into consideration the correlations between the generated photons. The correlation functions and possible teleportation/transmission of quantum information from one mode to other is described. The master equations and the moments of this equation is proposed in order to describe the quantum aspects of this type of emission [1-3]. The bimodal collective photon operators are introduced describing the emission or absorption acts of the fixed portion of energy from the cavity. A key impact of the study focuses on the statistical properties of the bimodal field and their detection possibilities are proposed for the description of the time evolution of quantum correlations between the field components of Raman conversion and two-photon emission [4].

The last idea can be applied in microbiology [5,6], where a selective dis-activation of some molecular structures (for example, of viruses) in the tissue may become possible in induced Raman excitation. In such situations, appears a necessity for a good description of both the amplitude and phase of this new type of radiation formed from bimodal correlated photons. Another application of multiple scattering coherence may be used in photon recycling inside solar cells. Here the photon absorption is accompanied by the excitation of the charge carrier and reemitted another photon with lower energy, which in the next step participates in the same cycle of reabsorption and generation of a new carrier in semiconductors like perovskites.

Biography:

From 1981 to 1985 he becomes a post-graduate student of the radio-physics department, Physics Faculty of Lomonosov State University from Moscow. Here he was focused on the subject of PhD dissertation "Quantum Statistics of superradiance in an extended system of radiators". After that N Enachi continues the studies of the quantum statistical properties of radiation in "Single- and two-photon cooperative processes in optics" (Dr. Hab Dis., 1993). In posrtdoc as a Principal Researcher of Institute of Atomic Physics, Theoretical Physics Lab. Magurele, Bucharest Romania (1995-1998) he extended the area of interests in the cooperative phenomena of condensed matter and quantum nucleons. Scientific advisor of Quantum Optics and Kinetic Process Lab in Institute of Applied Physics, Chishinau, R. Moldova. As a professor in physics, his lessons are reflected in the monograph "Nonlinear Cooperative effects in open quantum systems: entanglement and second-order coherence", published in Nova Science Publishers, NY, USA, 2015, 325 pp, which of course reflects his research Interests.

Vladimir G. Chigrinov

Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kongu

Photoaligned Azodye Nanolayers: Basic Technology for New Liquid Crystal Devices

Photoalignment and photopatterning has been proposed and studied for a long time [1]. Light is responsible for the delivery of energy as well as phase and polarization information to materials systems. It was shown that photoalignment liquid crystals by azodye nanolayers could provide high quality alignment of molecules in a liquid crystal (LC) cell. Over the past years, a lot of improvements and variations of the photoalignment and photopatterning technology has been made for photonics applications. In particular, the application of this technology to active optical elements in optical signal processing and communications is currently a hot topic in photonics research [2]. Sensors of external electric field, pressure and water and air velocity based on liquid crystal photonics devices can be very helpful for the indicators of the climate change.

We will demonstrate a physical model of photoalignment and photopatterning based on rotational diffusion in solid azodye nanolayers. We will also highlight the new applications of photoalignment and photopatterning in display and photonics such as: (i) fast high resolution LC display devices, such as field sequential color ferroelectric LCD; (ii) LC sensors; (iii) LC lenses; (iv) LC E-paper devices, including electrically and optically rewritable LC E-paper; (v) photo induced semiconductor quantum rods alignment for new LC display applications; (vi)100% polarizers based on photoalignment; (vii) LC smart windows based on photopatterned diffraction structures; (vii) LC antenna elements with a voltage controllable frequency.

Acknowledgements

1. V.G. Chigrinov, V.M. Kozenkov and H.S. Kwok, Photoalignment of liquid crystalline materials, Wiley, 2008.
2. V.G. Chigrinov, Liquid Crystal Photonics, Nova Science Publishers, 2015..

Biography:

Professor Vladimir G. Chigrinov is Professor of Hong Kong University of Science and Technology since 1999. He is an Expert in Flat Panel Technology in Russia, recognized by the World Technology Evaluation Centre, 1994, and SID Fellow since 2008. He is an author of 6 books, 31 reviews and book chapters, about 333 journal papers, more than 718 Conference presentations, and 121 patents and patent applications including 50 US patents in the field of liquid crystals since 1974. He got Excellent Research Award of HKUST School of Engineering in 2012. He obtained Gold Medal and The Best Award in the Invention & Innovation Awards 2014 held at the, which was hosted in Kuala Lumpur, Malaysia, on 20-22 Feb 2014. He is a Member of EU Academy of Sciences (EUAS) since July 2017. He got A Slottow Owaki Prize of SID in 2018 https://ece.hkust.edu.hk/news/prof-vladimir-chigrinov-wins-2018-slottow-owaki-prize

Since 2018 until 2020 he works as Professor in the School of Physics and Optoelectronics Engineering in Foshan University, Foshan, China. 2020-2024 Vice President of Fellow of Institute of Data Science and Artificial Intelligence (IDSAI) Since 2021 distinguished Fellow of Institute of Data Science and Artificial Intelligence.

He is IETI Fellow (https://www.ieti.net/pro/memberdetail.aspx?ID=539) since 2019.

Vinod Kumar Verma

Sant Longowal Institute of Engineering and Technology, deemed to be University, Longowal, India

Quantum Computing: Emerging Technologies, Breakthroughs, Synergetic Reviews, Opinions and Advancements

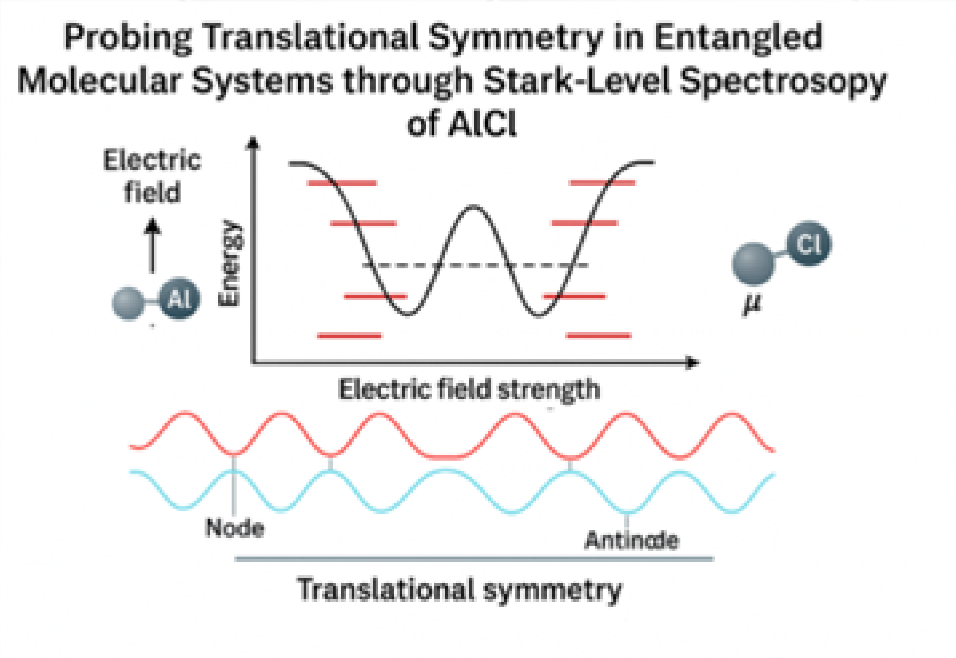
Quantum Computing is an emerging research field and has potential to affect all computing applications worldwide. This can include the daily-life activities of the common man from simple applications to complex and intricate appliances used in military and healthcare systems etc. The role and utility of Quantum allied applications and products can dramatically change the different sectors and industries. The recent efforts in the direction of Quantum computing research have attracted challenges like security, authenticity, accuracy etc. for the associated products and solutions. Some recent efforts in the direction of Quantum computing focuses on least relative pose estimation for planer scenarios, noise resilient quantum neural networks, dynamic threshold based key allocation in quantum secure networks predictive time series analysis for a supercomputing quantum computer to predict the error patterns, privacy preservation with the post-quantum blockchain based systems for the knowledge enhancement and improvements. In terms of the software, a new control and management architecture has been proposed for software defined networks with quantum key distribution networks, a new initiative for learning and task based trainable systems for electrical appliances and electronic converters like analog to digital converters etc. In autonomous driving, quantum computing can assist with the efficient post-processing networks for semantic segmentation enhancement. For the transformers domain, the load monitoring and efficient prediction can be made by the quantum computing assisted systems. In the image processing domain, pre-constitution of the pattern of the images with the different dimensions including 3D pertaining to the single image can be benefited with quantum computing. Further in the image compression field, the utility of Quantum computing can be easily integrated with the artificial intelligence for the efficient and effective neural network models for extracting better image analysis for medical applications. For the varieties of application, using convolutional neural networks can be enhanced with the use of Quantum computing and results in the enhanced Quantum enabled neural networks solutions for the allied applications. Overall, the observations reveal the significance and impact of the Internet of things-based application and products in our life from technological advancement and automation perspectives.

Biography:

Dr. Vinod Kumar Verma is an Assistant Professor in the Department of Computer Science and Engineering at Sant Longowal Institute of Engineering and Technology, Longowal, Punjab, India. Dr. Verma holds Teaching and Research Experience at International Level and visited UK, USA, Japan, Italy, Australia, France, and Greece. Dr Verma worked with University of Surrey, England and visited the University of West Attica, Athens, Greece under ERASMUS+ and collaboration with University of Nottingham, Malaysia.Dr Verma has published many research papers in the International Journals of IEEE, Springer, Elsevier, Taylor and Francis. Dr. Verma is also serving as Editorial Board Member / Reviewer for many International Journals like IEEE Sensor Journal, USA, IEEE Transactions on Neural Networks and Learning Systems, USA, ELSEVIER Computer Networks, Dr Verma has served many international conferences in different capacities at UK (2012), USA (2014,2024), JAPAN (2015), ITALY (2016), AUSTRALIA (2017), FRANCE (2018).

Kisalaya Chakrabarti and Mrs. Rajrupa Metia
Haldia Institute of Technology, India-721657

Translational Symmetry in Stark-Level Spectroscopy: Probing Quantum Entanglement through AlCl Molecules



At the crossroads of precision spectroscopy and quantum symmetry theory lies an unexplored frontier, where the electric dipole moment of polar molecules emerges not simply as a fixed property but as a dynamic portal into the hidden symmetries of quantum space. Investigating AlCl molecules through high-resolution Stark-level spectroscopy reveals a rich spectral fingerprint containing signatures of rotational coherence, field-induced splitting, and vibrational transitions [1] . Viewed through the framework of Kisalaya Chakrabarti's concept of translational symmetry of intermediate nodes and antinodes, these Stark-modulated patterns acquire a deeper significance beyond classical interpretation. The molecular wavefunctions, shaped by the applied electric field, form standing-wave-like distributions whose node–antinode arrangements may mirror the topology of quantum entanglement described by Chakrabarti. By orchestrating entangled ensembles of AlCl molecules under carefully tuned fields, it may be possible to generate translationally invariant coherence across spatially distributed nodes, offering an experimental analogue of non-local quantum symmetry. This synthesis of molecular-scale measurement and entanglement geometry opens a pathway to a new paradigm in which molecules become quantum probes for revealing, testing, and ultimately manipulating the fundamental laws of symmetry [2].

Fig. 1. Stark-Level Spectroscopy of AlCl Molecules: Translational Symmetry and Dipole Moment Representation

In Fig.1. aluminum (Al) and chlorine (Cl) were shown in separate positions to illustrate two different conceptual aspects rather than the actual bond geometry of the AlCl molecule. The Al atom was placed near the electric field arrow to emphasize the interaction of the molecule with the applied field, while the Cl atom was positioned next to the dipole moment symbol (μ) to highlight the molecule's polarity and the direction of its dipole moment. This arrangement was intended for conceptual clarity in explaining the Stark effect and translational symmetry, not for chemical structural accuracy. For a more realistic representation, Al and Cl should appear together as a bonded molecule (Al–Cl) with the dipole arrow drawn along the bond, pointing from Al to Cl, and the electric field arrow positioned to indicate the direction of the applied field, while retaining the rest of the diagram showing Stark-level changes and translational symmetry.

References:

1. Townes, C. H.; Schawlow, A. L. Microwave Spectroscopy; McGraw-Hill: New York, Toronto, London, 1955.
2. Chakrabarti, K. (2023). Translational Symmetry of Intermediate Nodes and Antinodes of Entangled Particles. In Quantum Entanglement in High Energy Physics. IntechOpen. https://doi.org/10.5772/intechopen.1002292. .

Biography:

Kisalaya Chakrabarti *has 24 years of teaching and research experience in the field of Electronics and Communication Engineering. His research domain covers different areas of Optical Communications. He has obtained Doctoral from University of Tsukuba, Japan and two Postdoctoral certificates from Utsunomiya University and National Institute for Material Science also from Japan. He has administrative experiences as Chair Professor in the department of Electronics and Communication Engineering at Bengal Institute of Technology and Management (Santiniketan), where he has also worked as Dean (R&D) for few months. He rendered his duties as Principal at Secom Engineering College situated at Sankrail, Howrah and Pailan College of Management and Technology (PCMT), Kolkata for around two years. The title of his PhD thesis was "An Investigation of Photonic Crystals and Time-Reversed Scattering using Nonstandard FDTD". Presently he is working as a Professor in the Department of Electronics and Communication Engineering at Haldia Institute of Technology, ICARE Complex, HIT Campus, Haldia, Purba Medinipur, India.*

He is the Senior Member of IEEE and he is the Life Fellow of Optical Society of India since 2005. He was the recipient of prestigious MONBUKAGAKUSHO (MEXT) Scholarship for his Doctoral Program at University of Tsukuba from the Japanese Government.

Mrs. Rajrupa Metia *received her B.Tech. in Information Technology in 2008 from Bankura Unnayani Institute of Technology , Bankura , India & M.Tech . in CSE in 2011 in the field of Image Processing from Haldia Institute of Technology, Haldia , India. She has a rich teaching experience of more than 11 years in the domain of Artificial Intelligence & Machine Learning. She is currently working an Assistant Professor in Computer Science & Engineering at Haldia Institute of Technology, Haldia, India.*

Bao-Sen Shi

Department of Optics and Optical Engineering
University of Science and Technology of China, Hefei 230026, China

High-Capacity Quantum Networks Based on Photon's Orbital Angular Momentum

Optical information processing based on high-dimensional encoding has become a research hot topic in the fields of classical and quantum communication due to its advantages of large channel capacity and high confidentiality. The orbital angular momentum (OAM) of photons is infinite dimensional, and it can be used to construct encoding spaces of arbitrary dimension. At the same time, its generation and detection are relatively simple. Therefore, using photons carrying OAM as information carriers is one of best choices for building up high-dimensional quantum networks. The construction of quantum networks must solve some key technologies such as the preparation of non-classical quantum states, storage and manipulation of quantum states, as well as transfer of quantum information between different physical systems, etc. In this report, I will combine the research works of others and focus on reporting a serial of progresses on the key technologies mentioned before achieved in our group, based on photon's OAM encoding in recent years, as well as the existed problems to be solved along the building up high-capacity quantum networks based on OAM.

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./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.

Burdyuzha, V. V

Russia

Obtaining the baryon asymmetry with high accuracy

The super-symmetric period of the early Universe evolution (10-38-10-30) sec when quarks were in a free state is considered. Quarks with an electric charge q = -2/3 at input in scattering reactions on bosons could creating our baryon world. These scattering reactions forbidden in the Standard model had a competitor from quarks with an electric charge q = 2/3 at input, which could creating an anti-baryon world. Similar reactions with the same gauge (B-L) took place with quarks q=2/3, q=1/3 and q= -2/3, q= -1/3 at input. Two chains of reactions formed in the Universe began an explosive multiplication realizing the geometric progression in each chain. One from reactions was dead-end (marker). It has clogged the reverse chain much more than the direct to the end of super symmetric period and then it faded. The stirring of quarks in these scattering reactions brought the correct composition of protons and the baryon asymmetry. Also there were twice as many electrons as positrons. Scattering bosons could be deuterons and α-particles. The exact value of the observed baryon asymmetry was obtained at the end of 17th step of the geometric progression at E~1012 GeV.

Chen Ge
Institute of Physics Chinese Academy of Sciences

Interface-engineered non-volatile visible-blind photodetector for in-sensor computing

Ultraviolet (UV) detection is extensively used in a variety of applications. However, the storage and processing of information after detection require multiple components, resulting in increased energy consumption and data transmission latency. In this paper, a reconfigurable UV photodetector based on $CeO_2/SrTiO_3$ heterostructures is demonstrated with in-sensor computing capabilities achieved through interface engineering. We show that the non-volatile storage capability of the device could be significantly improved by the introduction of an oxygen reservoir. A photodetector array operated as a single-layer neural network was constructed, in which edge detection and pattern recognition were realized without the need for external memory and computing units. The location and classification of corona discharges in real-world environments were also simulated and achieved an accuracy of 100%. The approach proposed here offers promising avenues and material options for creating non-volatile smart photodetectors.

Biography:

Chen Ge obtained his Ph. D. degree from the Institute of Physics, Chinese Academy of Sciences. He is currently a professor in the Institute of Physics, Chinese Academy of Sciences. His research interests include exploring novel physical properties of functional oxide heterostructures for advanced neuromorphic optoelectronic devices.

Claire LEVAILLANT
University of Southern California USA and Paris France

Quantum encryption/decryption scheme for multi-image using blocks of bit planes and images

We present a multi-image quantum encryption and decryption scheme. First, we introduce a novel quantum representation for a gray-scale multi-image, whose specificity is to allow for encrypting a large number of images. This representation is based on blocks of images. Namely, the images, up to adding some blank images, get split into blocks of size the number of bit planes. In this storage- efficient quantum representation, some qubits are used to encode the blocks and other qubits are used to encode the position of an image within a given block. The quantum gray-scale multi-image gets scrambled using a quantum baker map (QBM) which scrambles the pixel positions depending on the image and the bit plane. The quantum computer of the transmitter further scrambles the images belonging to a given block and the bit planes, using a controlled QBM, whose control depends on the block and on the pixel position. The two-stage scrambled quantum multi-image is then diffused with controlled CNOT gates. The secret bits used for the diffusions get generated from a sine chaotification of a 5D hyperchaotic system and Chebyshev polynomials. Using measurements, the quantum ciphertext multi-image is put back into classical representation and sent to the receiver. Using a quantum computer, the receiver puts the ciphertext multi-image into quantum representation and performs all the inverse quantum gates in the reverse order using the secret keys previously provided by the transmitter by post-quantum cryptography. The classical plaintext multi-image is finally retrieved by the receiver by measurements.

Biography:

Dr. Levaillant holds a Ph.D. in representation theory of algebras from California Institute of Technology. She spent her postdoctoral years at the University of California at Santa Barbara where she worked in topological quantum computation under Fields Medalist Michael Freedman, in collaboration with Microsoft Research Station Q. She later moved to the University of Southern California, where she worked in quantum image encryption as a visiting faculty. She also made important contributions to computational number theory while working as an independent researcher in Paris, France.

Feng Qi

Shenyang Institute of Automation, Chinese Academy of Sciences

Filling the Gap from THz to IR by Frequency Conversion Technique

For a long time, coherent mid-/far- infrared rays, especially THz waves, are quite difficult to generate, not to mention its detection. There are several technical approaches like QCL, laser (either gas or solid) to generate coherent signals. QCL is quite favorable, which is compact and easy for applications. Its tunability needs to be improved and it is still quite tough at terahertz frequencies. PPLN/ZGP are very nice materials, but far-infrared and THz is still not easy for them nowadays. As for detection, HgCdTe works well at infrared region, but we could not expect a huge improvement on performance in the near future. Golay and bolometer are popular THz detectors, also we could expect a sudden improvement for them. Frequency conversion technique, as a branch for nonlinear optics, has become a popular tool for quantum research. Of course, it has its own limitations, but in terms of frequency coverage, it might be the best way to fill the gap in electromagnetic spectrum. In this talk, I would like to introduce our work on effective generation and sensitive detection from THz to IR during the past ten years.

Biography:

Feng Qi got his bachelor's degree from Zhejiang University, China; then he pursued master and PhD studies' in Katholieke Universiteit Leuven,Belgium. Since 2011, he was working on THz in RIKEN (Japan), Goethe University (Germany), and University of Birmingham (UK). In 2015, he joined SIA-CAS and founded the THz Imaging Laboratory. Now he is a professor and head of Key Laboratory on Terahertz Imaging and Sensing, Liaoning Province. He has published over 70 international journal papers as the first/corresponding author and served as vice-chairman/TPC/session chairs in international conferences including IRMMW-THz, GSMM, ICC, etc. Now he is working on microwave, photonics and acoustics.

Mingsheng Xu, Yuwei Wang, Jiwei Liu

College of Integrated Circuits, State Key Laboratory of Silicon and Advanced Semiconductor Materials, Zhejiang Key Laboratory of Advanced Micro-nano Transducers Technology, Zhejiang University, Hangzhou 310027, P. R. China

Two-dimensional materials for quantum computing

The long-range ferromagnetic ordering in in an atomically thin layer together with their fascinating electric and optical properties will lead to magnetic, magneto-electric, and magneto-optic applications. The exploration of intrinsic magnetism in two-dimensional (2D) systems has promoted the development of novel nanodevices for next-generation spintronics and quantum technology. The pursuit of high Curie temperature ferromagnets in 2D materials has garnered significant interest towards their low-power, high-speed, and ultra-compact nanodevice applications. Despite the significant strides made in the theory and experimental demostrations of the 2D magnetism and its spintronic devices, the research on wafer-scale synthesis of 2D magnetic materials and property modulations in 2D magnetic materials is still in its early stages and is challenging to prepare and comprehend the low dimensional devices for spintronic applications. In this talk, we present our studies on the controllable synthesis of 2D 1T-CrS2 and 1T-CrTe2 and their magnetic properties. We have, for the first time, achieved pure 1T-CrS2 materials. The single crystalline 1T-CrS2 crystallites exhibit a metallic nature with a moderate conductivity of 1.78 × 102 S m-1 and a room-temperature ferromagnetism with a coercive field of 28.7 Oe, in line with theoretic predictions. We obtain wafer-scale 1T-CrTe2 layers at synthesis temperature below 400 ºC. The 1T-CrTe2 layers exhibit an out-of- plane easy axis along with the step-like magnetic transitions at room-temperature. Through DFT calculations, we find that the oxidation of 1T-CrTe2 surface layers plays a critical role in determining the magnetic easy-axis orientation and attributed the observed step-like features in magnetic hysteresis loops to the absence of local interlayer antiferromagnetic coupling in upper surface layers. The results suggest that it is possible to modulate the magnetic characteristics of 2D magnetism by doping. Our demonstration of room-temperation magnetisms in 1T-CrS2 and 1T-CrTe2 layers offer a new platform for the further physics research and spintronic device applications with their synthesis process compatible with Si-CMOS technologies.

Biography:

Dr. Mingsheng Xu is a Professor in the College of Integrated Circuits and in the State Key Laboratory of Silicon and Advanced Semiconductor Materials, Zhejiang University, China. He obtained his Ph.D. from the Department of Electronic Engineering at The Chinese University of Hong Kong in 2003. He had worked at The University of Tokyo, Chiba University, and the National Institute for Materials Science (NIMS), Japan. His current research interests are two-dimensional materials and systems, neuromorphic devices and systems, integrated circuit design, intelligent sensing and monitoring, software and artificial intelligence. Dr. Xu has published more than 120 refereed publications in such as Science, Nature Materials, Chemical Reviews, Advanced Materials, Biomaterials and ACS Nano.

Muriel Aparecida de Souza

Instituto Nacional de Metrologia, Qualidade e Tecnologia (Inmetro) - Brazil

Quantum Random Number Generation Using Cloud Quantum Computers: A Comparison Between Superconducting (IBM) and Photonic (Quandela) Technologies

Quantum Random Number Generators (QRNGs) are essential for cryptographic security, stochastic modeling, and metrological applications. This work presents a comparative study of two cloud-accessible quantum computing platforms: IBM's superconducting processor (127-qubit Eagle, Brisbane system) and Quandela's photonic quantum computer (Ascella). Both systems exploit quantum superposition as a source of intrinsic unpredictability, implementing basic circuits—a Hadamard gate in the superconducting case and a 50:50 beam splitter in the photonic architecture—to produce binary sequences. The raw data from IBM exhibited low bias, with bit-0 frequency close to the ideal 50%, and failed 5 out of 15 tests in the NIST SP800-22 suite. Quandela's results showed larger deviations, with approximately 1.3% imbalance and failures in 11 of the 15 NIST tests, reflecting imperfections in photonic components and detector noise. Entropy source evaluation under NIST SP800-90B confirmed both platforms as non-IID, with significant short-range correlations. To address these limitations, randomness extractors were applied. The Von Neumann (VN) method substantially improved IBM's performance, leading to over 90% success in most NIST tests, though Quandela still exhibited residual weaknesses. The sequential Samuelson + Von Neumann (SVN) approach proved decisive: IBM surpassed 90% in 14/15 tests, while Quandela reached comparable levels, with the exception of the Universal Statistical and Random Excursion

tests, affected by undersampling and persistent long-range correlations. Both platforms achieved compliance with NIST SP800-90B after SVN, with entropy values around 0.77–0.78 bits/bit. From a metrological perspective, the IBM platform demonstrated superior repeatability and robustness, consistent with the maturity of superconducting technology. Quandela, while more sensitive to environmental and optical imperfections, displayed rapid progress and promising results even under room-temperature operation. The comparative analysis underscores that appropriate post-processing is crucial to transform imperfect raw sequences into statistically robust outputs suitable for cryptographic and certification purposes. This integrated statistical and metrological assessment demonstrates that cloud-based quantum computers, despite architectural differences and distinct sources of noise, can serve as viable QRNGs when combined with extractor-based post-processing. These findings highlight both the maturity of superconducting processors and the potential of photonic platforms, while also pointing to future directions in improving randomness extractors and mitigating undersampling losses.

Biography:

I have a master's degree in Optical Metrology, a bachelor's degree in Medical Physics from the University of São Paulo (2006) and a degree in Physics. I have been a Research Technologist at the National Institute of Metrology, Quality and Technology (Inmetro) since 2010, and I am currently a PhD student in the Postgraduate Program in Metrology at Inmetro.

Sanjay Kumar

Dr. A.P.J. Abdul Kalam Technical University, Lucknow, Uttar Pradesh, India

Mn/Fe Co-Doped TiO_2 Nanostructures for Optical Modulation in Photonics, Sensors, and Quantum Computing

In this study, we present the synthesis of pure titanium dioxide (TiO_2) and its doped variants, specifically $Ti_{0.98}Mn_{0.02}$ (manganese-doped) and $Ti_{0.98}Fe_{0.02}$ (iron-doped), using a solid-state reaction method. The samples were sintered at temperatures between 500 °C and 1000 °C in both air and argon environments. X-ray diffraction (XRD) analysis confirmed the formation of the anatase phase of TiO_2 (space group 141/AMD) with no secondary impurity phases. The introduction of Mn and Fe (5 atomic %) preserved the crystal structure, confirming successful substitution at titanium lattice sites. Variations in lattice parameters and crystallite size are attributed to the difference in ionic radii of the dopant ions. Crystallite size estimations from XRD were in good agreement with scanning electron microscopy (SEM) results. Energy-dispersive X-ray spectroscopy (EDS) verified the homogeneous incorporation of Mn and Fe into the TiO_2 matrix.
Significantly, the doped samples exhibited ferromagnetic behaviour, with the Mn d-shell playing a crucial role in magnetic ordering. Hysteresis loops of the P–E glass-ceramic composites demonstrated low energy loss, suggesting efficient electric polarization characteristics. The ability to modulate magnetic and dielectric properties via controlled doping and thermal treatment positions these TiO_2-based nanostructures as promising candidates for spin-based logic devices and quantum memory components. These findings open avenues for their potential integration in next-generation quantum computing architectures, where tunable multifunc-

tional materials are essential for the development of scalable and energy-efficient quantum devices.

Biography:

Prof. Sanjay Kumar is a distinguished faculty member in the Department of Applied Science at G.L. Bajaj Institute of Technology & Management, Greater Noida, India. The institute is NBA and NAAC accredited, NIRF ranked, AICTE approved by the Ministry of HRD, Government of India, and affiliated with Dr. A.P.J. Abdul Kalam Technical University (formerly UPTU), Lucknow.

With a strong academic background and 15 years of teaching and research experience, Prof. Kumar plays a key role in shaping the foundational knowledge of engineering students in areas of science and humanities. He is known for his dedication to student development, academic excellence, and contribution to interdisciplinary education.

Sardar M N Islam
Victoria University

Quantum AI Agents: Quantum Science, Technologies, Computing and Artificial Intelligence Agents and Their Applications in Engineering and Other Disciplines

In this presentation, the issues of quantum foundations of quantum computing, quantum technologies, programming and applications will be reviewed systematically to try to understand and predict the future of mankind and the world. Profoundly disruptive emerging quantum technologies and quantum computing will change the world's computation machines, algorithms, methods, and technologies. Quantum computers have substantially different hardware and software and can solve complex, intractable problems exponentially faster than classical computers. The combination of quantum computing and artificial intelligence (QAI), particularly AI Agents, gives a new paradigm (Quantum AI Agents) and many new opportunities for fundamental changes in the world. This transformative potential extends to many areas of life, including engineering, fire management, quantum health, artificial intelligence, financial modelling and management, cryptography, health care, drug discovery, optimisation, climate modelling and weather forecasting. Quantum computing and Quantum AI Agents are expected to transform all areas of human life. It can address some of our most serious challenges, leading to improved performance of tasks and actions. However, they have some risks to security, ethics, and the potential to unlock new frontiers of knowledge. This leaves us with a sense of substantial uncertainty about the future of humanity and the world. The strategies for managing QAI and Quantum AI Agents will also be discussed to provide scenarios for saving humanity and the world.

Biography:

Professor Sardar M N Islam is a highly motivated and committed academic, distinguished by an excellent record of professional performance. This is evidenced by his prolific publication output, numerous appointments as a Distinguished or Visiting Professor at esteemed institutions, and frequent invitations as a keynote speaker at major international conferences. He serves on the editorial boards of 14 reputable journals and has successfully secured several large-scale research grants. A highly advanced, interdisciplinary researcher, he maintains an extensive international professional network. His work is centered on cutting-edge areas including advanced computational mathematical modelling and computer programming, computer science, quantum computing, artificial intelligence, data science, and data analytics.

He has an outstanding publication record, advanced skills, and international recognition and reputation in the areas of computer science, artificial intelligence, business analytics, decision support systems, game theory, and optimisation.

Sergey Sysoev
St.Petersburg State University

Some Practical Problems of Quantum Gate Teleportation

Quantum teleportation is unquestionably an important resource, especially in the one-way computation model. However, we will focus on the circuit-based model and explore what this technique can contribute to its toolset. Quantum algorithms can benefit from teleportation if we teleport gates rather than states. This idea was investigated two decades ago by Gottesman and Chuang, whose paper optimistically claimed that teleportation is a universal computational resource.
Apart from the originally suggested application to error correction, though, it is hard to find convincing practical uses for this technique in the circuit model. In this talk we will revisit the method of CX-gate teleportation, extend it to the Toffoli gate, offer fresh motivation for pursuing gate teleportation, and identify the obstacles encountered along the way.

Biography:

He received his PhD from Saint Petersburg State University in 2005. He has authored three online courses on quantum computing, a textbook, 18 research papers, one patent, and four software products. Since 2011 he has been teaching at Saint Petersburg State University.
His research interests include quantum computing (circuit model), computational complexity theory, and TRIZ.

Yi Yang

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Vector Diffraction: A New Interpretation of Hydrogen Wave Function and A Bridge From Classical Physics to Quantum Mechanics and String Theory

The vector diffraction equations and their approximation forms are deducted from Maxwell equations and light vector decomposition. The extra higher dimensions resonation was analysis from Maxwell equations. The scalar potential V could be interpreted as a vector potential (A^4 , A^5, A^6) at higher dimensions. From Gauss' law for electric fields and Lorentz Force Law, a static charge in our three dimension could be interpreted as moving in extra higher dimension with speed c relative to x0 or x7 coordinate and orthogonal to (x^4, x^5, x^6) coordinates. The time -ct , the vector potential for electric fields (A^4, A^5, A^6) and the vector potentials for magnetic and electric fields (A^1, A^2 , A^3) are components of a tensor potential A^u = (A0, A^1, A^2, A^3,..., An) in higher dimension. In this sense, electric fields and magnetic fields are the same thing, only with different vibrating directions. Electromagnetic force is the kinetics effect of the tensor potential A^u depicted by Lorentz force law in our three dimensions and higher dimensions. The tensor decomposition theory could also be applied to gravity and unification theory: different forces are different kinetics effect of different components of the tensor potential Au vibration in extra higher dimensions. Gravity should be interpreted as a kinetics effect induced by components of the tensor potential A^u vibrating in extra higher dimensions which was canceled mostly when decompose into our three dimensions compared to other fundamental forces, instead of the curvature of space. If we accept that

our three-dimension space is quantized, static and has only one, and the so-called particles' spin are vibration states in higher dimensions, then electron diffraction and all quantum mechanics phenomenon could be explained by classical physics. Quantum mechanics is an extension of classical physics. The similarity between vector diffraction and Hydrogen wave function was analyzed. The wave function in quantum mechanics is actually the tensor potential A^u, instead of a probability density of finding a particle. Hydrogen wave function should be interpreted as a tensor diffraction with higher dimensions' boundary condition. All quantum mechanics problem could be expressed in a summation of imaginary or super imaginary numbers. The bricks of our space are imaginary numbers.

1. Introduction

A vector diffraction expression was introduced by combining Huygens-Fresnel principle and vector decomposition [1][2][3]. It is proposed that light vector (electric and magnetic) decomposition and any optical devices' function with special phase and amplitude distribution (such as idea lens, lens with aberrations [4]) can be insert into the integrand of any scalar diffraction expressions directly [1][2][3][4]. In this manuscript, the flowchart of the deduction of Huygens-Fresnel principle was presented following Born&Wolf [5]. Then the light vector decomposition expressions were substitute into the scalar diffraction express of Huygens-Fresnel principle. Some approximations of amplitude and/or phase expressions in vector diffraction expressions for linear input light are given. The approximation from vector diffraction to scalar diffraction was also showed. In previous 1manuscripts [1][2][3], the method for any polarization input light was described, here the explicit expression was given. The scalar potential V and vector potential A in Maxwell equations were investigated in higher dimensions. It is shown that scalar potential V might be an appearance in our three dimensions of a higher dimensional vector potential (A^4 , A^5, A^6) . The electric field and magnetic field are unified by assuming a static charge in our three dimension is actually moving in x0 or x7 dimension with light speed c. A tensor potential Au with n dimensions was proposed, according to string theory n=11. The so-called spin should be regarded as total vibration state of tensor potential Au in all dimensions. The vector decomposition can be generalized to tensor decomposition of Au to explain different magnitude of four fundamental force. The peer similarity between vector decomposition in vector diffraction and four fundamental forces are analyzed. The similarity between vector diffraction and Hydrogen wave function was also analyzed. Hydrogen wave function is solved by Schrodinger equation which was deducted from wave function. The wave function of tensor potential A^{μ} can be deducted from Maxwell equations under Lorentz gauge. Together with the analysis of the tensor potential A^{μ} vibrating in higher dimensions, it is clear that the wave function in quantum mechanics is the tensor potential A^{μ}

2. Deduction of Vector Diffraction

Maxwell equations is as follow

$$\nabla \bullet E = \frac{\rho}{\varepsilon_0} \quad (1)$$

$$\nabla \bullet B = 0 \quad (2)$$

$$\nabla \times E = -\frac{\partial B}{\partial t} \quad (3)$$

$$\nabla \times B = \mu_0 J + \varepsilon_0 \mu_0 \frac{\partial E}{\partial t} \quad (4).$$

From (2) and (4), in vacuum under Lorentz gauge and J=0, we get Helmholtz equation [5]

$$\nabla^2 A - \frac{1}{c^2}\frac{\partial^2 A}{\partial t^2} = 0 \quad (5).$$

This wave equation describes magnetic field. We will show electric field and magnetic field has no fundamental different, they are different components of a tensor potential vibrating in different dimensions. Thus, it is reasonable only consider a strictly monochromatic scalar wave for electromagnetic wave instead strictly distinguish electric field or magnetic field,

$$V(x,y,z,t) = U(x,y,z)e^{-i\omega t} \quad (6).$$

Where U is space-dependent part of monochromatic scalar wave, $k = \omega / c$.

Using Green's theorem, we get the integral theorem of Helmholtz and Kirchhoff,

$$U(P) = \frac{1}{4\pi}\iint_S \left[U \frac{\partial}{\partial n}\left(\frac{e^{iks}}{s}\right) - \frac{e^{iks}}{s}\frac{\partial U}{\partial n} \right] dS \quad (8).$$

Considering a point source passing through an aperture and apply Kirchhoff's boundary conditions, we get Fresnel-Kirchhoff diffraction,

$$U(P) = -\frac{i}{2\lambda}\iint_A \frac{e^{ik(r+s)}}{rs}\left[\cos(n,r) - \cos(n,s)\right] dS \quad (9\text{-}1).$$

If the point source is very far or a collimating lens is placed in front of the aperture generating a parallel input light,

$$U(P) = -\frac{i}{2\lambda}\frac{e^{ikr_0}}{r_0}\iint_A \frac{e^{iks}}{s}\left(1 + \cos\chi\right) dS \quad (10\text{-}1).$$

All symbols in above equations follows Born & Wolf [5]. From equation (9-1), Using our notation (Ref.[3] and Fig.1), and insert the light vector decomposition expressions into it, we get vector Fresnel-Kirchhoff diffraction with point source

$$E_m(x,y,z) = -\frac{i}{2\lambda}\iint_A E'_m(x,y,z,\xi,\eta)^{\wedge} \frac{e^{ik(r+r_{01})}}{rr_{01}}\left(\cos\theta_1 - \cos\theta_2\right) d\xi\, d\eta \quad (9\text{-}2).$$

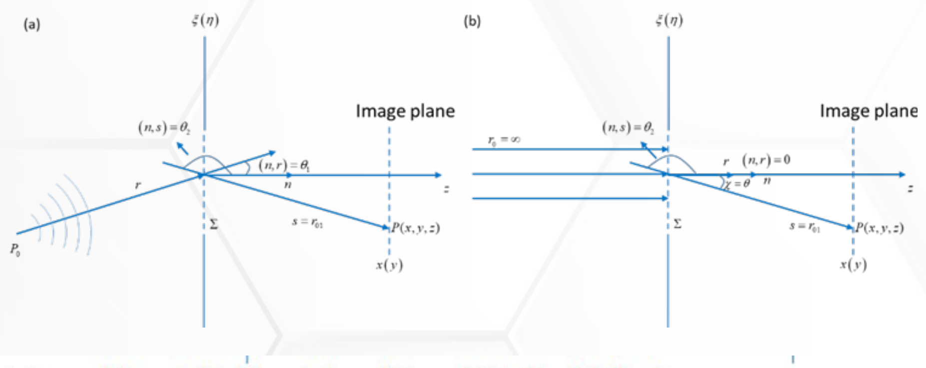


Fig.1 Our notation and Born & Wolf's notation of Fresnel-Kirchhoff diffraction

From equation (10-1), using our notation, and substitute the light vector decomposition expressions into it, we get vector Fresnel-Kirchhoff diffraction with parallel input source,

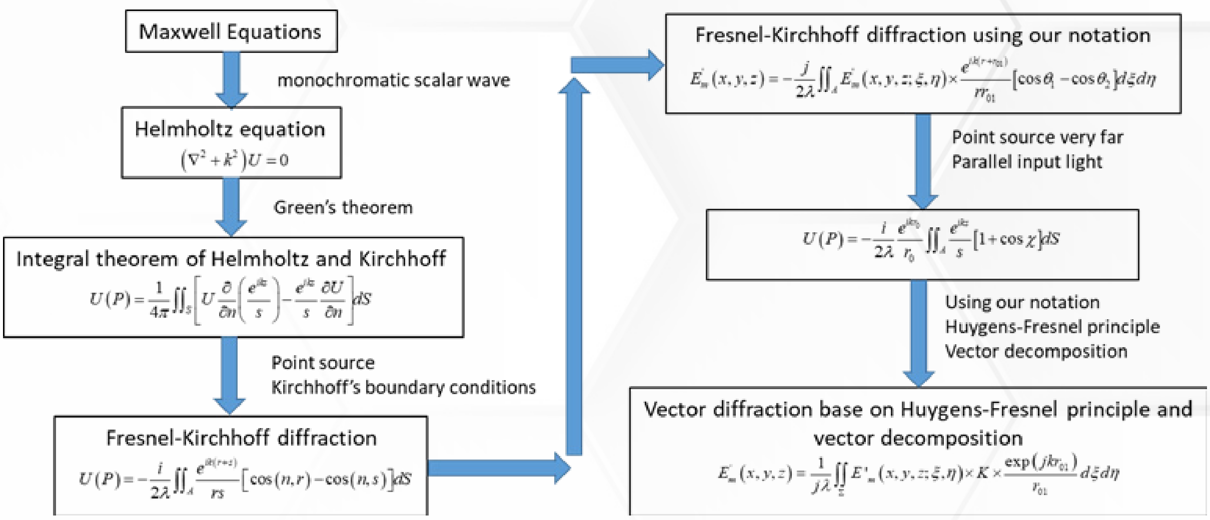
$$E'_m(x,y,z) = \frac{1}{j\lambda}\iint_\Sigma E'_m(x,y,z;\xi,\eta)\times K\times\frac{\exp(jkr_{01})}{r_{01}}d\xi d\eta \quad (10\text{-}2).$$

Where

$$E'_x(x,y,z;\xi,\eta) = E_s\sin(\pi-\beta)+E_p\cos\theta\cos(\pi-\beta) = E_x(\xi,\eta)\left(\frac{(y-\eta)^2}{r_{xy}^2}+\frac{(x-\xi)^2}{r_{xy}^2}\frac{z}{r_{01}}\right) \quad (11\text{-}1)$$

$$E'_y(x,y,z;\xi,\eta) = E_s\cos(\pi-\beta)-E_p\cos\theta\sin(\pi-\beta) = E_x(\xi,\eta)\left(\frac{(x-\xi)(y-\eta)}{r_{xy}^2}+\frac{(x-\xi)(y-\eta)}{r_{xy}^2}\frac{z}{r_{01}}\right) \quad (11\text{-}2)$$

$$E'_z(x,y,z;\xi,\eta) = E_p\sin\theta = E_x(\xi,\eta)\left(\frac{(x-\xi)}{r_{01}}\right) \quad (11\text{-}3)$$



2. Flowchart of deduction of vector diffraction from Maxwell Equations

$K/j\lambda$)is the inclination factor, different theory gives slightly different expressions. Eq.(10-1) by Stoke an expression of $K=-j(1+\cos\chi)/2\lambda$ (here $1/j\lambda$ included). The numerical results indicate $\cos\chi=z/r_{01}$ [1] [2] [3] may more accurate. However, these results need more experiments verification. ons follows Ref.[3].

he input light has E_y and E_z components, we could express the light vector decomposition in a matrix form

$$\begin{bmatrix} E_{x1} \\ E_{y1} \\ E_{z1} \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & 1 \end{bmatrix} \begin{bmatrix} E_{x0} \\ E_{y0}\bullet\exp(j\phi_y) \\ E_{z0}\bullet\exp(j\phi_z) \end{bmatrix} \quad (12\text{-}1).$$

Where E_{x0}, $E_{y0}\bullet\exp(j\phi_y)$ and $E_{z0}\bullet\exp(j\phi_z)$ represent input light's x,y and z components, $\exp(j\phi_y)$ and $\exp(j\phi_z)$ represent phase differences of y and z components with respect to x component. These phases could be contained in E_{y0} and E_{z0} , and be omitted in expression (12-1). E_{x1}, E_{y1} and E_{z1} represent x,y and z components in image plane.

$$\begin{bmatrix} a_{11} \\ a_{21} \\ a_{31} \end{bmatrix} = \begin{bmatrix} \frac{(y1-y0)^2}{r_{xy}^2}+\frac{(x1-x0)^2}{r_{xy}^2}\frac{z0}{r_{01}} \\ -\frac{(x1-x0)(y1-y0)}{r_{xy}^2}+\frac{(x1-x0)(y1-y0)}{r_{xy}^2}\frac{z0}{r_{01}} \\ -\frac{(x1-x0)}{r_{01}} \end{bmatrix} \quad (12\text{-}2)$$

$$\begin{bmatrix} a_{12} \\ a_{22} \\ a_{32} \end{bmatrix} = \begin{bmatrix} \frac{(x1-x0)(y1-y0)}{r_{xy}^2}\ \frac{(x1-x0)(y1-y0)}{r_{xy}^2}\frac{z0}{r_{01}} \\ \frac{(x1-x0)^2}{r_{xy}^2}+\frac{(y1-y0)^2}{r_{xy}^2}\frac{z0}{r_{01}} \\ -\frac{(y1-y0)}{r_{01}} \end{bmatrix} \quad (12\text{-}3).$$

Here, the notation is changed: (x0,y0,z0) is coordinate at exit pupil plane, (x1,y1,z1) is coordinate at image plane. Substitute Eq.(12-1) into Eq.(10-2) we get

$$\begin{bmatrix} E_{x1} \\ E_{y1} \\ E_{z1} \end{bmatrix} = \frac{1}{j\lambda}\iint \begin{bmatrix} a_{11} & a_{12} & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & 1 \end{bmatrix} \begin{bmatrix} E_{x0} \\ E_{y0}\bullet\exp(j\phi_y) \\ E_{z0}\bullet\exp(j\phi_z) \end{bmatrix} \times \frac{z}{r_{01}} \times \frac{\exp(jkr_{01})}{r_{01}}\,dx_0\,dy_0 \quad (13).$$

Or write in a compact form:

$$E_1 = C\iint_{\Sigma} M\times E_0 \times K \times \frac{\exp(jkr_{01})}{r_{01}}\,dx_0\,dy_0$$

K can be included in M, $M_K = M\times K$. If any optical devices (such as a lens) was put on the exit pupil or in the path, it need only insert its phase and amplitude function into the integrand(kernel). Eq.(13) is actually equivalent to Feynman's path integral[6], or say it is an example of Feynman's path integral. It is also equivalent to Eq.(8.1) of Ref.[7]:

$$\langle \chi | \phi \rangle = \sum_{all\ i} \langle \chi | i \rangle \langle i | \phi \rangle \quad (13\text{-}2)$$

Here the base states are E_x, E_y and E_z. Traditional description of photon's base states are left-handed and right-handed circularly polarized light. This is not complete, perhaps the reason we use these two states is that we can use optical device to distinguish it. Base states (E_x, E_y, E_z), or write in traditional form $(|E_x\rangle, |E_y\rangle, |E_z\rangle)$, is more fundamental than $(|R\rangle, |L\rangle)$. Each states, or say components, are orthogonal to each other, that why $\langle i | j \rangle = \delta_{ij}$ [7]. The principle of vector decomposition is also equivalent to table 17-1 to 17-3 and table 18-1 to 18-7 in Ref.[7]. This property also extend to extra higher dimensions. This means the base states of a particle or a quantum system are components of their vibration states. These vibration states is described by the tensor potential A^{μ}. If we accepts space is quantized and static, Eq.(13) can be quantized and expressed in a form of summation of imaginary numbers. All quantum mechanics problem could be expressed in a summation of imaginary or super imaginary numbers. The propagation of any wave is the propagation of vibration states.

3. Approximation Form for Linear Polarize Input Light

Our expressions (10-2), (11-1)-(11-3) and (12-1)-(12-3) valid for any situation no mater near or far. For far field when Fresnel diffraction is satisfied, the phase term $\exp(jkr_{01})$ is approximated to $\exp(jkz)\exp\left\{j\frac{k}{2z}\left[(x-\xi)^2+(y-\eta)^2\right]\right\}$, in this case the vector Fresnel diffraction could be expressed in this form,

$$E_m(x,y,z) = \frac{z}{j\lambda}\iint_{\Sigma} E'_m(x,y,z;\xi,\eta)\times\frac{\exp(jkz)}{r_{01}^2}\exp\left\{j\frac{k}{2z}\left[(x-\xi)^2+(y-\eta)^2\right]\right\}d\xi d\eta \quad (14).$$

For far field more far than Fresnel diffraction, Fraunhofer diffraction is satisfied, $\exp\left\{j\frac{k}{2z}\left[(x-\xi)^2+(y-\eta)^2\right]\right\}$ can be replaced by $\exp\left[j\frac{k}{2z}(x^2+y^2)\right]\exp\left[\frac{-jk}{z}(x\xi-y\eta)\right]$ and r_{01} in amplitude can be replaced by z, in this case the vector Fraunhofer diffraction could be expressed in this form

$$E_m(x,y,z) = \frac{\exp(jkz)}{j\lambda z}\exp\left[j\frac{k}{2z}(x^2+y^2)\right]\iint_{\Sigma} E'_m(x,y,z;\xi,\eta)\exp\left[\frac{-jk}{z}(x\xi-y\eta)\right]d\xi d\eta \quad (15).$$

It should be pointed out, only in this approximation form that diffraction problem can be interpreted as Fourier transform, thus scalar OTF theory is only an approximation. Fraunhofer diffraction is very far, $r_{01} \approx z$ in amplitude coefficient is always satisfied, E_x and E_y components are very small, there might not necessary to consider vector diffraction.

For any situation such that we could use z replace r_{01} in amplitude coefficient of Eq. (10-2), the approximated from is

$$E_m(x,y,z) = \frac{1}{j\lambda z}\iint_\Sigma E'_m(x,y,z;\xi,\eta)\exp(jkr_{01})d\xi d\eta \quad (16).$$

This is the approximation 1 in Ref.[3].

For any situation such that we can use z replace r_{01} in vector decomposition part of Eq. (11-1)-(11-3), we get

$$E'_x(x,y,z;\xi,\eta) = E_x(\xi,\eta)\left(\frac{(y-\eta)^2}{r_{xy}^2} + \frac{(x-\xi)^2}{r_{xy}^2}\frac{z}{r_{01}}\right) \xrightarrow{r_{01}=z} E_x(\xi,\eta) \quad (17\text{-}1)$$

$$E'_y(x,y,z;\xi,\eta) = E_x(\xi,\eta)\left(-\frac{(x-\xi)(y-\eta)}{r_{xy}^2} + \frac{(x-\xi)(y-\eta)}{r_{xy}^2}\frac{z}{r_{01}}\right) \xrightarrow{r_{01}=z} 0 \quad (17\text{-}2)$$

$$E'_z(x,y,z;\xi,\eta) = E_x(\xi,\eta)\left(\frac{(x-\xi)}{r_{01}}\right) \xrightarrow{r_{01}=z} E_x(\xi,\eta)\left[-(x-\xi)/z\right] \quad (17\text{-}3).$$

Insert into Eq.(10-2),

$$E'_x(x,y,z) = \frac{1}{j\lambda}\iint_\Sigma \frac{E_x(\xi,\eta)}{r_{01}}\frac{\exp(jkr_{01})}{r_{01}}d\xi d\eta \quad (18\text{-}1)$$

$$E'_y(x,y,z) = 0 \quad (18\text{-}2)$$

Insert into Eq.(10-2),

$$E'_x(x,y,z) = \frac{1}{j\lambda}\iint_\Sigma \frac{E_x(\xi,\eta)}{r_{01}}\frac{\exp(jkr_{01})}{r_{01}}d\xi d\eta \quad (18\text{-}1)$$

$$E'_y(x,y,z) = 0 \quad (18\text{-}2)$$

$$E'_z(x,y,z) = \frac{1}{j\lambda}\iint_\Sigma E_x(\xi,\eta)\frac{\left[-(x-\xi)\right]}{r_{01}}\times\frac{\exp(jkr_{01})}{r_{01}}d\xi d\eta \quad (18\text{-}3).$$

The r_{01} in amplitude coefficient could also be replace by z if needed.

For any situation such that $|x-\xi| \ll z \le r_{01}$, Eq.(18-1) to Eq.(18-3) becomes

$$E'_x(x,y,z) = \frac{1}{j\lambda}\iint_\Sigma \frac{E_x(\xi,\eta)}{r_{01}}\frac{\exp(jkr_{01})}{r_{01}}d\xi d\eta \quad (19\text{-}1)$$

$$E'_y(x,y,z) = 0 \quad (19\text{-}2)$$

$$E'_z(x,y,z) = 0 \quad (19\text{-}3).$$

This is the expression of scalar diffraction. In this situation, if $z \approx r_{01}$ always satisfied (which means $|x-\xi| \ll z$ is because z is very large, instead of $|x-\xi|$ is very small), whether replace r_{01} by z is at will, to make the expression

simpler and physical meaning clearer, we could replace r_{01} by z in $E_x(\xi,\eta)/r_{01}$ while keep r_{01} in $\exp(jkr_{01})/r_{01}$:

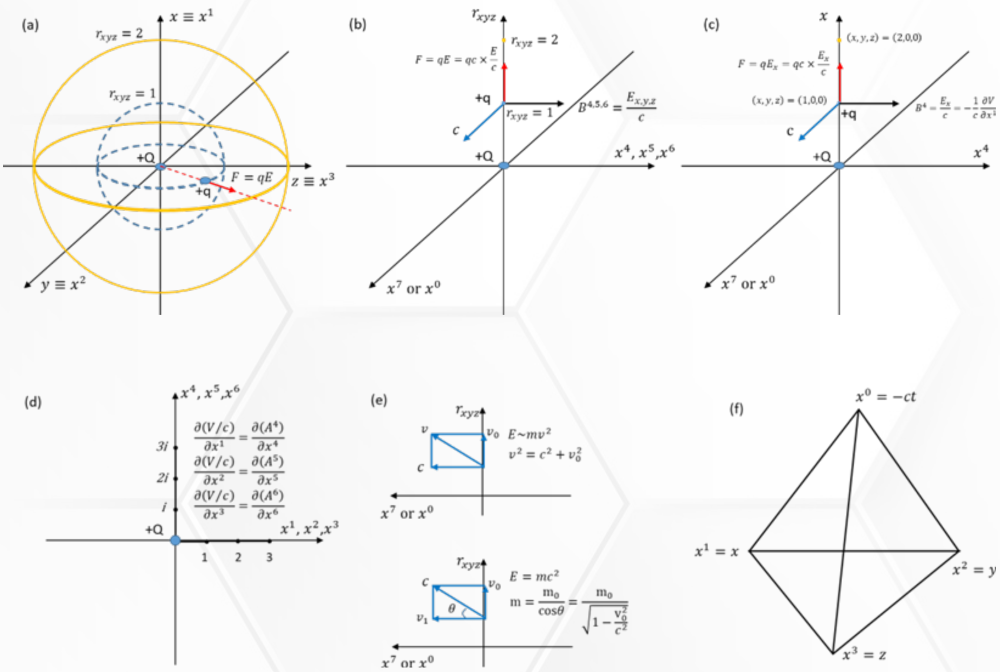


Fig.3 Analyzing Maxwell equations in higher dimensions. (a) Electrostatic force in our three dimensions. (b) Electrostatic force induced by extra higher dimensions (x^4, x^5, x^6) . (c) Electrostatic force in x dimensions. (d) Relationship between scalar potential V and vector potential (A^4, A^5, A^6) . (e) Two definition of energy. (f) $x^\mu = (x^0, x^1, x^2, x^3)$ constructs a Tetrahedral group.

The relationship between V and (A^4, A^5, A^6) should satisfy(Fig.3(d)),

$$\frac{\partial(V/c)}{\partial x^1} = \frac{\partial(A^4)}{\partial x^4} \quad (48\text{-}1)$$

$$\frac{\partial(V/c)}{\partial x^2} = \frac{\partial(A^5)}{\partial x^5} \quad (48\text{-}2)$$

$$\frac{\partial(V/c)}{\partial x^3} = \frac{\partial(A^6)}{\partial x^6} \quad (48\text{-}3)$$

In Fig.3 (b), the x,y and z coordinate are draw in a single coordinate r_{xyz} , each point on r_{xyz} represents a sphere surface in our three dimensions. For instance, $r_{xyz} = 1$ represents a unit sphere in our three dimension (equivalent to Fig.3(a) blue dashed line sphere). Fig.3(c) shows B^4 component induces a force along x direction.

If a particle, such as electron, is accelerated by an electric field E to the speed of v_0, according to relativity, the mass of this electron increased to[9](section 15-9),

$$m = \gamma m_0 = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} \quad (49).$$

This equation is deducted by assuming a particle's total energy can be expressed in this form

$E = mc^2$ (50),

and assuming a particle's mass will increasing with respect to its speed increasing. Under these assumption, the physical figure of a particle's energy is like this: if the electron is static in our three dimensions, its velocity of c in extra dimension x^7 or x^0 endows it with static energy of $E = m_0 c^2$. When the electron is accelerated to the velocity of v_0 in our three dimensions, for some unreasonable reason, the total velocity of the electron in all dimensions does not change and still be c, the increasing of total energy is attribute to the increasing of its mass(Fig.3(e)).

However, we may has another physical figure of energy: the total energy of an electron can be defined by

$$E = \frac{1}{2} mv^2 \propto mv^2 \quad (51)$$

Where v is electron's total velocity in all dimensions. When the electron is accelerated to the velocity of v_0 in our three dimensions, the velocity at extra higher dimension x7 or x0 does not change and still be c, but its total velocity in all dimension is increased (Fig.3(e)):

$v^2 = c^2 = v^2$ (52).

The mass does not changing, the increasing of total energy is attribute to the increasing of its total velocity. According to this physical figure, energy might be regarded as vector/tensor. From the analysis above, to fully describing electromagnetic field, the dimensions needed should be at least 7 or 8(depend on x7 is x0 or not). The quantity vibrating in all dimensions is a tensor potential A^μ, its components (A^4, A^5, A^6) vibrating in x^{-4} x^{-5} and x^{-6} dimensions and represent static electric field in our three dimensions, its components (A^1, A^2, A^3) represent magnetic field in our three dimensions. Infect, according to string theory, the dimensions needed should be 11, other dimensions may induces other fundamental forces, such as gravity.

4.2 Spin and Electron Interference

According to classical physics, wave interference phenomenon should satisfy these conditions: same frequency, same vibration directions and phase difference is constant. Interference and diffraction has no fundamental difference, both are wave propagate problem. In Fig.4, each slit is a diffraction problem, together are interference problem. We may say all wave propagate problem are diffraction problem, the different approximation leads to different branches. Same frequency is not necessary in white light interference. When we discuss interference in optics or electron interference experiments, usually photon and electron are regarded as scalar wave described by Eq.(6). The polarization state of photon or electron are ignored, this imply photon or electron propagate to any direction can be added together without any decomposition. As analyzed in section 2 and section 4, both photon and electron are some quantity (tensor potential A^μ)

vibrating in our three dimensions and extra higher dimensions. When they propagate to different directions, the quantity has different decomposition, only components with the same vibrating direction can be added together. That why we decompose Ex into x,y and z directions, and each components in directions of x,y and z can be handled separately. This property can be used to explain the dilemma of electron interference: the interference phenomenon is affected by observation[7]. If the spin of electron are regard as a vibration state(tensor potential A^{μ}) in higher dimensions, only components with the same directions can be added together. Fig.4(a) shows two electron beams with the same spin directions S(the true spin direction is in extra higher dimensions, since we cannot draw an arrow in extra dimension, we use the upper arrow S represent it. Infect, the so called spin should be regarded as total vibration state of tensor potential A^{μ}), the interference phenomenon is showed. If by any chance, the spin direction(or say the total vibration state) of electron is changed, there shall be no interference phenomenon (see Fig.4(b)). No matter the changing of spin direction is caused by observation or any other reasons

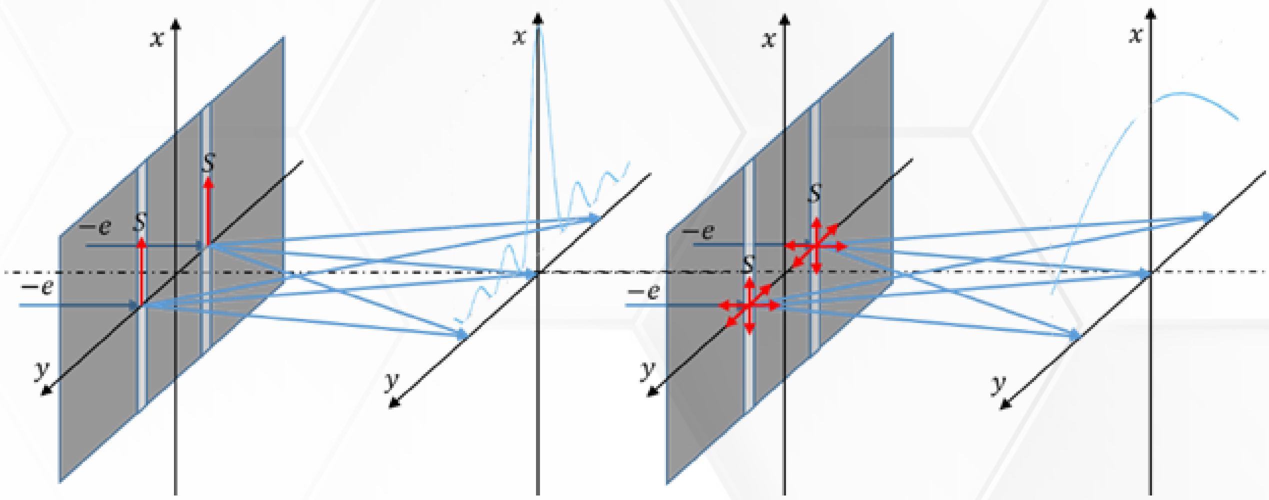


Fig.4 Electron Interference. (a) With the same spin state (tensor potential A^{μ}).(b) Spin state (tensor potential A^{μ}) is changed by any reason, such as ‘observation’.

4.3 Space, Wave Propagation and Unification

The Gravity is described by Einstein’s gravitational equation,

$$R_{\mu\upsilon} - \frac{1}{2} g_{\mu\upsilon} R = \frac{8\pi G}{c^4} T_{\mu\upsilon} \qquad (53)$$

Where $R_{\mu\upsilon}$ is Ricci tensor, $g_{\mu\upsilon}$ is space-time metric, R is curvature tensor, $T_{\mu\upsilon}$ is energy-momentum tensor.
Under the weak field approximation, define

$$h = \eta^{\mu\upsilon} h_{\mu\upsilon} \qquad (54)$$

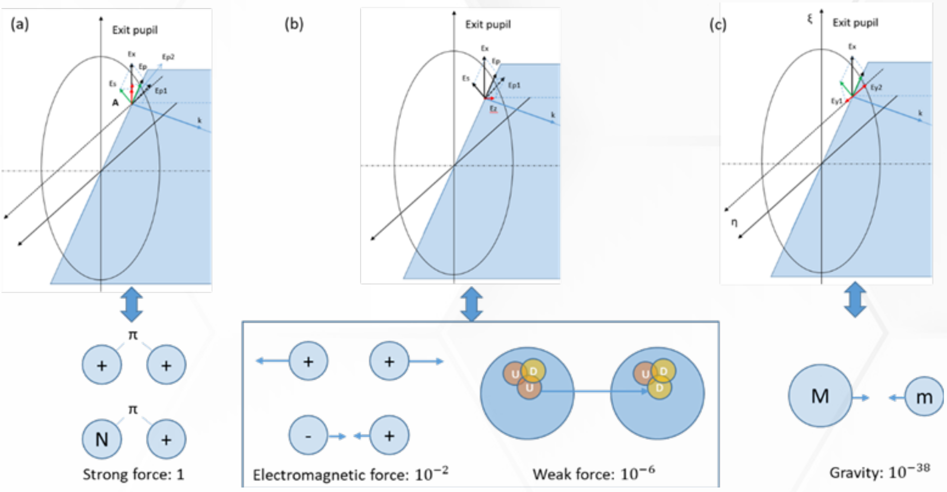
$$\bar{h} = h_{\mu\upsilon} - \frac{1}{2}\eta_{\mu\upsilon} h \qquad (55)$$

Where $\eta^{\mu\upsilon}$ is Minkowski metric, $h_{\mu\upsilon}$ is space-time perturbation metric, we get linear gravitational field equation,

$$\Box^2 \bar{h}_{\mu\upsilon} = \frac{16\pi G}{c^4} T_{\mu\upsilon} \qquad (56).$$

Once again it is a wave function the same as Eq.(39). Under this Equation, gravity wave is interpreted as space-time perturbation. However, it is more reasonable to interpret the gravity wave as a perturbation(vibration state) of the tensor potential A^{μ} .

Once again it is a wave function the same as Eq.(39). Under this Equation, gravity wave is interpreted as space-time perturbation. However, it is more reasonable to interpret the gravity wave as a perturbation(vibration state) of the tensor potential A^{μ}.
In classical wave theory, macro matter wave(such as water wave) does not propagate any material entity, but propagate vibration state, or say energy. Macro matter is made up of microscopic particles. It is reasonable to assume that particle wave and electromagnetic wave propagate has the same property. That means photon(light, electromagnetic field), electron and any other particle propagate is the propagation of vibration states of tensor potential $A\mu$. This applies to macro matters too, such as an apple fallen from a tree. It is apple's total vibration states (tensor potential A^{μ}) propagated/changed by gravity. The effect of gravity is to changing the vibration states of matter, the same as electromagnetic force.



effect of this tensor potential A^{μ} resulting in electromagnetic force(and other fundamental forces, depend on which dimensions included). Tensor potential A^{μ} induces forces, the light propagate is the propagation of a special form of tensor potential A^{μ} , that the reason why there is a similarity between light and forces.

Finally, Hydrogen wave function is solved by Eq.(59)[10][7]:

$$\psi_{nlm} = R_{nl}(r)Y_{lm}(\theta,\varphi) \quad (62)$$

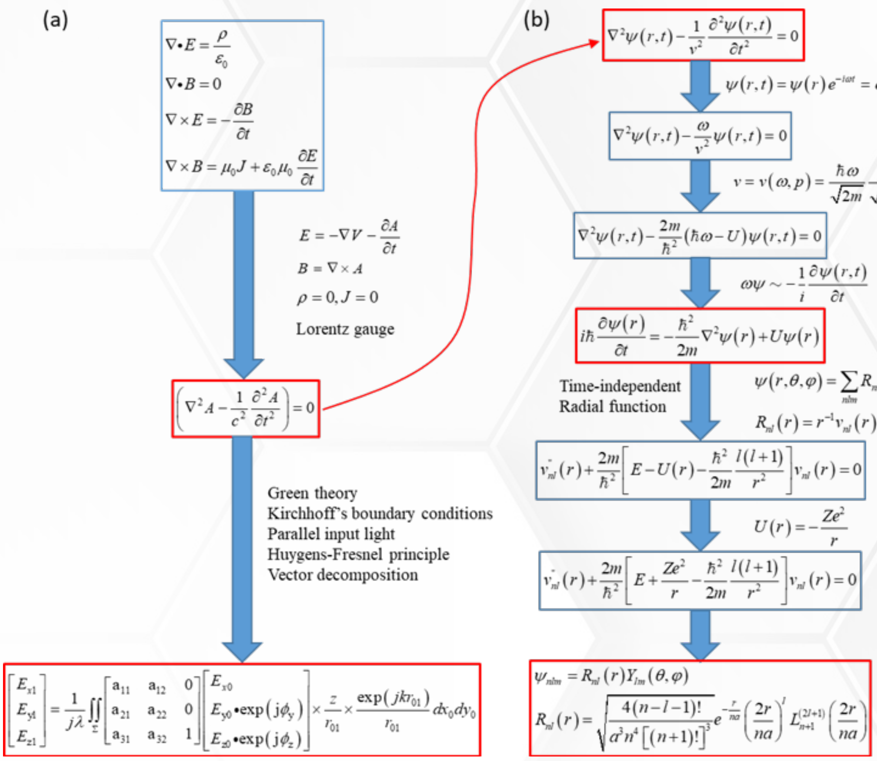
$$R_{nl}(r) = \sqrt{\frac{4(n-l-1)!}{a^3 n^4 \left[(n+1)!\right]^3}}\, e^{-\frac{r}{na}} \left(\frac{2r}{na}\right)^l L_{n+1}^{(2l+1)}\left(\frac{2r}{na}\right) \quad (63)$$

Where spherical harmonics $Y_{lm}(\theta,\varphi)$ illustrated the tensor decomposition property:

$$\sum_{m=-l}^{l} \left|Y_{lm}(\theta,\varphi)\right|^2 = \sum_{m=-l}^{l} \left|P_l^m(\cos\theta)e^{im\varphi}\right|^2 = 1 \quad (64).$$

This means for a fixed (n,l), $m=-l,\cdots,l$ are components of some quantity (tensor potential A^{μ}). For example, for p state, $l=1$, $m=-1,0,1$[7]:

$$\sum_{m=-l}^{l} \left|Y_{lm}(\theta,\varphi)\right|^2 = \left(\sin^2\theta + \cos^2\theta + \sin^2\theta\right) = 1 \quad (65).$$



A interest thing is that the wave function in Eq.(59) is assumed to be three dimensional, but the solution still manifest some higher dimension properties. This indicate that physics and mathematics have strong fundamental connection. Similar to the famous expression

$$\sum_{n=1}^{\infty} n = \zeta(-1) = \sum_{n=1}^{\infty} \frac{1}{n^{-1}} = -\frac{1}{12} \quad (66).$$

The deduction by Ramanujan without analytic continuation still get the correct result.

A infinite potential well is a one dimensional boundary condition problem(Fig.8(a)). Vector diffraction is a two dimensional boundary condition problem(Fig.8(b)). The Hydrogen wave in our three dimension is a tensor diffraction of the tensor potential A^{μ} under a three dimensional(in extra dimensions) or higher dimensional boundary condition(hyper-sphere)(Fig.8(c)).

Fig.9 shows the similarity between vector diffraction with linear input light and the Hydrogen wave of x-z cross-section. (n, l, m) = (n, 0, 0) states (s state) are similar to x component of vector diffraction, different n is similar to different NA of the optical system. This also means light diffracted by different aperture size or different lens with different diopters are similar to Hydrogen with different energy levels. (n,l, m) = (n,1, 0) states (p state) are similar to z component of vector diffraction. (n,l, m) = (n, 2,1) states (d state) are similar to y component of vector diffraction.

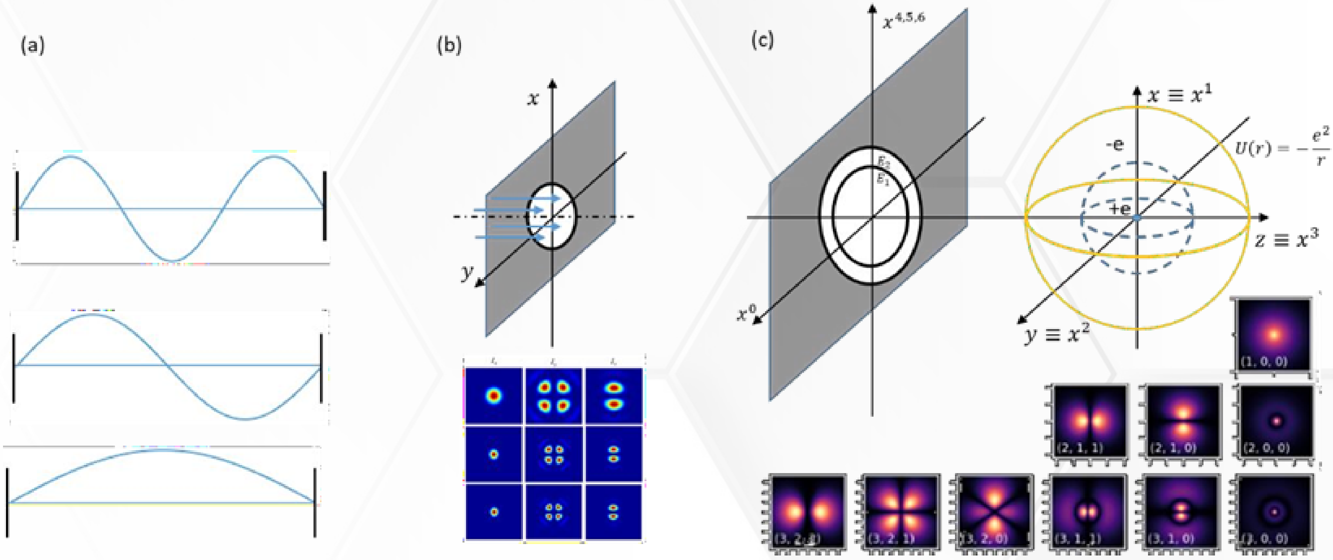


Fig.8 Boundary condition with different dimensions: (a) One dimension, infinite potential well. (b) Two dimensions, vector diffraction. (c) Higher dimensions, Hydrogen wave.

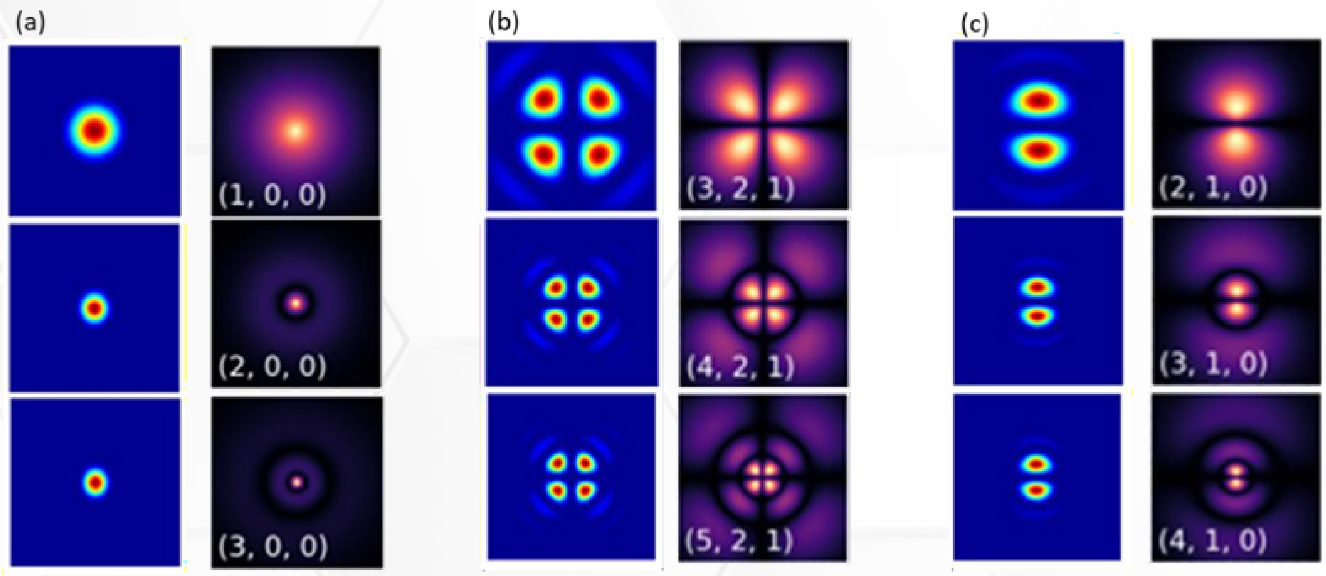


Fig.9 Similarity between vector diffraction and Hydrogen wave function.

From the analysis of Maxwell equations in higher dimensions and the similarity between vector diffraction and Hydrogen wave function, it is reasonable to say that all quantum mechanical problem could also be express in a higher dimensional integral, not necessary beginning from solving Schrodinger equations:

$$A^{\mu}_{1} = C \iint\cdots\int_{\Sigma} M^{\mu\nu} \times K^{\mu\nu}_{0}{}^{\mu} \frac{\exp(jkr_{01})}{r_{01}} dx^{0} dx^{1} \cdots dx^{n} = C \iint\cdots\int_{\Sigma} M^{\mu\nu}_{K} \times A^{\mu}_{0} \times \frac{\exp(jkr_{01})}{r_{01}} dx^{0} dx^{1} \cdots dx^{n} \qquad (67)$$

Where Σ is integral region, or say boundary condition. Eq.(67) should be a solution of Schrodinger equations include extra higher dimensions. Then all quantum mechanical problem need only investigate $M^{\mu\nu}_{K}$ and A^{μ}_{0}. When these quantities are quantized, Eq.(67) is a summation of imaginary numbers.

6. Conclusion

Light (electromagnetic field) vector decomposition expressions (Eq.(11) and Eq.(12)) can be directly substitute into the integrand of any scalar diffractions. If any optical devices(such as ideal lens, or lens with aberrations) in exit pupil or optical path, it need only substitute its function(phase and amplitude) into the integrand of vector diffraction expressions. The so called scalar potential V is a vector potential (A^4, A^5, A^6) vibrating in (x^4, x^5, x^6) dimensions. This vector potential satisfy Eq.(48). If we accept that a static charge in our three dimension is moving in extra higher dimension with speed c relative to x^0 or x^7 coordinate and orthogonal to (x^4, x^5, x^6) coordinates, according to Lorentz force law, electric field $\mathbf{E}/c$ and magnetic field $\mathbf{B}$ are physically unified, not only in the mathematical form of a tensor $F^{\mu\upsilon}$. The vector/tensor decomposition principle can also be extend to electron diffraction, gravity and other fundamental forces. In fact, tensor decomposition principle can be applied to any wave vibrating in higher dimensions. The electromagnetic force is induced by tensor potential (A^0, A^1, A^2, A^3) (or $(A^4, A^5, A^6, A^1, A^2, A^3)$) under Lorentz force law. The other fundamental forces (such as gravity) are induced by tensor potential $A^\mu = (A^0, A^1, A^2, A^3, \ldots, A^n)$. The Hydrogen wave function(or any wave function in quantum mechanics) solved by Schrodinger equation is also the vibration state of the tensor potential A^μ. The Hydrogen wave in our three dimension is a tensor diffraction of the tensor potential A^μ under a three dimensional(in extra dimensions) or higher dimensional boundary condition. The propagation of any wave is the propagation of vibration states A^μ, include light, macro object and gravity. All quantum mechanics problem could be expressed in a n dimensional integral with boundary condition Σ. We need only investigate tensor potential A^μ and tensor decomposition $M_K^{\mu\nu}$. If we accept that our three dimensional space is quantized, static and has only one, then all quantum mechanics problem could be expressed in a summation of imaginary or super imaginary numbers. The bricks of our space are imaginary numbers.

Biography:

Yi Yang finished his Master's degree at 22 years old years from China Jiliang University. After 2 years PhD study at Shanghai Institute of Optics and Fine Mechanics (CAS)(quit) and four years PhD study at Heriot-Watt University(quit), he joined a number of industry companies, such as Raintree Scientific Instruments (Shanghai), Nanchang Virtual Reality Research Institute and Toptics optics Technology (Jiangsu) Ltd. He is the former department maneger and company supervisor of Toptics. He has Published in excess of 15 papers in optics.

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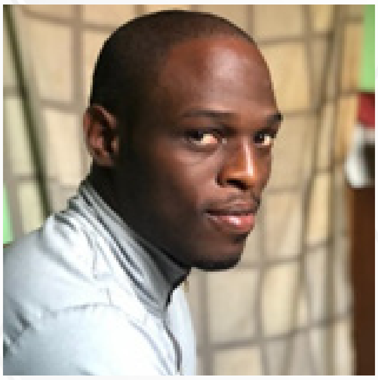
DFT and AI-assisting discovery and characterization of the ternary nanolaminate MAX and MAB phases

More and deeper understanding into the phase stability, fracture toughness and damage tolerance, elastic properties, thermal expansion, and heat capacity of the MAX and MAB phases is achieved by DFT simulations and machine learning using the appropriate approximations, with the following predictions some of which have been confirmed in experiments. For the recently-discovered S-group elements containing MAX borides, because the formation energy increases with increasing the number of M-B slabs (n), only M2AB is found to be stable after thermodynamic and intrinsic stability analysis, also in excellent consistence with experiments. Furthermore, a theoretical framework is proposed to evaluate whether any compound can be fabricated by combustion synthesis (SHS) or not, based on the full first-principles prediction on the thermodynamic properties by DFT simulations, which has been used for all the stable 106 MAX and MAB phases. Furthermore, some phases (Nb2SB, Nb2SC, V2PC, V5SiB2 and Mn5SiB2 with high adiabatic combustion temperature (Tad) are successfully synthesized by SHS, confirming the high reliability of the calculated thermodynamic properties and Tad. Of much interest, after the full first-principles and machine-learning predictions for the phase stability and Tad of SHS, the new MAB phases inlcuding V3PB4 and V5PB2 are discovered by self-propagating high temperature combustion synthesis (SHS). Using the "bond stiffness" model as well as the associated criterion for damage tolerance and fracture toughness, the ratio of bond stiffness of weakest M-S to the strongest M-X bonds (kmin/kmax) over 1/2 indicates their intrinsic brittleness of all S-containing MAX phases except Nb_4SC_3. Lastly, a well-established relationship between molar cp of the MAX and MX phases is theoretically deduced.

Biography:

Yuelei Bai works as a full professor at Harbin Institute of Technology (HIT) since 2021. In 2006, he graduated in the major of composite materials and structures from HIT, and was recommended for admission to Center for Composites Materials and Structures at HIT for his PhD degree in the major of engineering mechanics. In 2012, he got his PhD degree and a position as a lecture at HIT. From 2014 to 2016, he conducted 2-year postdoc research in Imperial College London and Nanyang Technological University. Since 2009, his 56 papers have been published in the international journal including Acta Mater., J. Am. Ceram. Soc. and so on, with the total citations of 2471 and H-index of 29, and 29 keynote/invited talks have been delivered in conferences. He got the first-class Science and Technology Awards (Natural science) of Heilongjiang province in 2019, and has served as associate editor of J. Am. Ceram. Soc. and member of editorial committee of J. Adv. Ceram. and referee for 48 international journals.



A. D. Kammogne

African Institute of Mathematical Sciences

Spontaneous emission in an exponential model

The phenomenon of spontaneous emission can lead to the creation of an imaginary coupling and a shift. To explore this, we utilize the renormalized first Nikitin model, which features an exponential detuning variation with a phase, an imaginary coupling, and a shift. By employing the time-dependent Schrödinger equation, we investigate the behavior of our system. Our findings suggest that the imaginary coupling offers distinct insights. At the same time, the shift gives rise to allowed and forbidden zones in the energy diagram of the real part of the energy. In the diagram of the imaginary part of the energy, time determines whether the system exhibits order or chaos and helps identify the information transmission zone. Notably, the first Nikitin model exhibits similarities to the Rabi model in the short-time approximation. Our theoretical results are consistent with numerical simulations.

Biography:

Dr. Kammogne's research focuses on the theoretical modeling of dissipative quantum systems, spontaneous emission, and interference phenomena in non-resonant environments. His recent work addresses key challenges in quantum level-crossing physics and coherence loss. In 2025, he co-authored three papers: two in the Chinese Journal of Physics: "Effect of Spontaneous Emission on a Tanh Model,"(only author) "Spontaneous emission in an exponential model" (with Prof. Fai Cornelius) and one on arXiv: "A Closed-Form Approach to Oscillatory Integrals in Level-Crossing Physics" (with Dr. Maseim B. Kenmoe) and These studies offer novel insights into quantum dissipation mechanisms, with implications for quantum computing, nanophotonics, and next-generation quantum devices.

Dr. Aman Kumar
Department of Physics, KVSCOS, Swami Vivekanand Subharti University, Meerut-250005, India

A Comparative Study of $A_2AgInCl_6$ (A = Na, K) Double Perovskites: Stability and Suitability for Energy Technologies

Lead-free halide double perovskites, $A_2AgInCl_6$ [where A = Na and K], offer intriguing prospects for energy conversion and optoelectronic applications. This study carefully looks at their structure, optoelectronic properties, and mechanical strength with help of first-principles calculations. The optimized crystal structure, Goldschmidt tolerance factors, and negative formation enthalpies confirm the thermodynamic and geometric stability of both compounds within the cubic Fm3¯m space group. Mechanical electronics and elastic stability indicate that the material adheres to the Born stability criteria. According to the DFT calculations, $Na_2AgInCl_6$ and $K_2AgInCl_6$ are indirect band gap semiconductors with calculated band gap values of 2.724 eV and 2.701 eV, respectively. The optical spectra, comprising the dielectric function, absorption coefficient, and refractive index, clearly indicate strong optical absorption in the visible region, highlighting the material's potential for optoelectronic applications.

Biography:

My name is Dr. Aman Kumar. I obtained my Doctorate in Physics from Chaudhary Charan Singh University, Meerut, in 2024. I got fellowship during PhD from Government. He is currently an assistant professor in the Department of Physics at Keral Verma Subharti College of Science, which is part of Swami Vivekanand Subharti University in Meerut, Uttar Pradesh, India (250001).

In addition to three Indian patent publications and 1 Design Patent, I have authored 30 research articles that have appeared in international journals. In addition, I have published a book at the national level, 12 book chapters with a national publisher, and one book chapter with an international publisher. He has participated in and delivered presentations at numerous conferences, workshops, and seminars.

Zhu Huihui

ZJU-Hangzhou Global Scientific and Technological Innovation Center, Zhejiang University

Silicon-based Integrated Optical Quantum Computing and Artificial Intelligence

In recent years, quantum computing and its applications have advanced significantly, propelled by the development of integrated quantum photonic chips. These platforms provide key advantages in scalability, stability, and cost efficiency, opening new avenues for miniaturized quantum systems. In this work, we present our latest research on optical quantum neural networks implemented on integrated photonics architectures. Specifically, we explore a quantum generative neural network, Gaussian boson sampling (GBS)-assisted unsupervised learning, and their applications in graph-based data processing and molecular simulations.

Biography:

Dr. Huihui Zhu is a Researcher at the ZJU-Hangzhou Global Scientific and Technological Innovation Center. She received her Ph.D. in 2023 from the EEE of Nanyang Technological University, Singapore. Following her doctoral studies, she conducted postdoctoral research at The Hong Kong Polytechnic University before joining Zhejiang University in January 2025. Her research focuses on integrated silicon photonic devices, with an emphasis on the experimental realization and functional applications of silicon-based photonic chips for quantum computing.

In recent years, Dr. Zhu has published 12 SCI papers, including Nature Communications (2 papers), Laser & Photonics Reviews, npj Quantum Information, communication physics, and so on. Her work has garnered over 580 citations on Google Scholar, with one in the 2024 ESI Highly Cited Paperslist.

Byliole S. Djouda
University of Yaoundé 1, Cameroon

Impurity effects in a network of mean-field coupled Rössler oscillators

Introducing an impurity (a localized difference in the oscillator's properties) in the systems of coupled oscillators can have a large impact in the overall dynamics and can be sufficient to control chaotic behavior. This work aims to extend and establish a simple scheme to switch between regular oscillations and chaotic behavior in the same dynamical network. By using a mean-field diffusive coupling model of Rössler oscillator, it is shown in this study that impurity induces impurity enhanced system response and regular oscillation. In addition when the strength of the impurity varies a hysteresis loops appears indicating systems transition between limit cycle and a fixed point leading to complete synchronization. These results may bring new possibility in technological applications.

Biography:

Djouda earned her PhD in Theoretical Physics from the University of Yaoundé 1 in 2022. She is an Operational research project grantee, funded by the gates foundation though the African Consortium in the Modelling for Effective Vector Control (AComVeC) at the Centre for Research in infectious Diseases (CRID), Cameroon. Her research interest includes developing model to provide insights into the behavior of complex systems in general; with the aims to control mechanism in various technical and biological systems such as electronic circuits and vector-borne diseases. She has published three papers in the field of Materials Science and Engineering.

A. Shakeri

Department of Physics, Shi.C., Islamic Azad University, Shiraz, Iran

Analogy of quantum dot and quantum well spin-polarized lasers in steady and dynamical states

In this research, we explore the similar features of quantum dots and quantum wells that function as the optical gain materials in lasers. By utilizing the method of analogy, it allows for a clearer and more analytical interpretation of quantum well lasers, which are more complex than quantum dot lasers. In the article, we first discuss the time-dependent rate equations and occupation probabilities related to the rate equations model for classical and spin states of quantum dot lasers and quantum well lasers. The crucial insight in linking the two types of lasers is that the effect of restricted capture time in quantum dot laser function can be accurately mirrored by a suitable choice of the gain compression coefficient in quantum well lasers. Next, we present the two classes of analogies concerning the steady state and dynamical operation separately and explain their restrictions. Finally, we examine the differences between these two analogy models, since the two analogies are not identical, and we extend the correlation to spin lasers.

Biography:

Abuzar Shakeri finished PhD at 34 years old years from Islamic Azad University of Bushehr .Abuzar Shakeri has Published in excess of 25 papers in in different international journals.

Francisco Girela Lopez

Safran Electronics & Defense

White Rabbit-Enabled Synchronization in QICK-Based Quantum Control Systems

The advancement of quantum information science (QIS) hinges on ultra-precise timing, synchronization, and control across increasingly complex experimental infrastructures. We present the integration of Safran's High Accuracy Timing IP Core (HATI)—a sub-nanosecond synchronization solution based on the White Rabbit (WR) protocol—with the Fermilab-designed Quantum Instrumentation Control Kit (QICK). QICK, built on RFSoC technology, provides a comprehensive, open-source platform for fast signal generation, acquisition, and processing in quantum computing, networking, and sensing applications.

By embedding HATI into QICK-enabled systems, we extend WR capabilities directly to end nodes, enabling deterministic time and frequency distribution with picosecond-level precision over standard optical fiber links up to 80 km.

This integration ensures ultra-accurate synchronization and low-latency control, bridging the gap between scalable quantum hardware and real-time digital orchestration. The system architecture leverages the WR protocol's compatibility with IEEE 1588 and Synchronous Ethernet, providing robust, scalable, and easily deployable timing networks for distributed quantum experiments [6,7,8].

We detail the implementation and performance benchmarks of HATI-enhanced

QICK systems, demonstrating sub-nanosecond synchronization and deterministic event distribution. These results are validated in scenarios relevant to quantum computing and quantum networking, including quantum key distribution (QKD) and distributed quantum sensing.

The merged platform supports scalable, synchronized, and resource-optimized quantum infrastructures, facilitating the next generation of large-scale, distributed quantum experiments.

Our work highlights how the combination of HATI and QICK establishes a robust foundation for scalable quantum control, with direct implications for the realization of the quantum internet and advanced quantum technologies.

Biography:

Francisco is the Business Development and Sales Engineering Lead at Safran Electronics and Defense. He holds a Ph.D. in Telecommunications Engineering from the University of Granada. After some time in the private sector, Francisco joined the Timing Keepers group at the same university as a researcher. During his research, he specialized in ultra-accurate time transfer systems, and he focused on the development of the White Rabbit technology. During the last few years, Francisco has led the expansion of White Rabbit High Accuracy timing in the North American market and in the finance sector with Safran (former Orolia and Seven Solutions). His latest work involves the deployment of very long distance WR links and the integration of the HATI core in third party FPGA based devices.

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

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

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

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

Laboratory of Physics of Experimental Techniques and its Applications, Sciences Faculty, University of Medea, Ouezra Pole, Médéa, 26000, Algeria

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

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

College of Information Science and Electronic Engineering, Zhejiang University, Hangzhou 310027, China

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

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 $MN(2\log_2N - 1)/2$ to $N(M\log_2N - 1)/2$, 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

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.