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ABSTRACT BOOK

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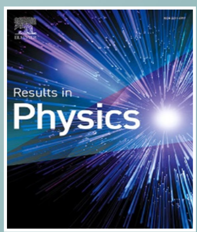

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Keynote Presentations

Elementary Particles, Dark Matter, Dark Energy, and Properties of Objects: Specifications that associate with data

Thomas J. Buckholtz

Ronin Institute for Independent Scholarship, USA

Abstract

This presentation suggests a technique for cataloging elementary particles, a specification for dark matter, an explanation for dark energy, and a technique for cataloging properties of objects. This presentation features two key hypotheses. First, this presentation assumes that nature includes six isomers of most elementary particles. Five of the six isomers associate with dark matter. Second, this presentation assumes that multipole expansions can prove useful regarding gravity. Some terms in the expansions associate with gravitational attraction. Some terms associate with dilution of attraction. Dilution can associate with mutual repulsion between objects and with dark energy. This presentation suggests that those two assumptions lead to explanations for data that pertain to the rate of expansion of the universe, the formation of galaxies, and other aspects of cosmology and astrophysics.

Biography

Thomas J. Buckholtz received a PhD in physics from the University of California, Berkeley, after receiving a BS in mathematics from the California Institute of Technology. His work includes publications in physics; mathematics; computer science; innovation; service science; and information usage, systems, and technology. His contributions to society span aspects of research and development, business, government, education, not-for-profit endeavors, startup enterprises, and the environment.

Quantum Electromagnetics: Hamiltonian Formulation via the Lorenz Gauge

W.C. Chew*, D.Y. Na, and C.J. Ryu

Purdue University, West Lafayette, IN, USA

Abstract

We will review the quantization of electromagnetic field using Hamiltonian formulation and Lorenz gauge. The Hamiltonian formulation allows the derivation of quantum Maxwell's equations in the coordinate space and elegantly using the Lorenz gauge. The Hamiltonian formulation can be derived from energy conservation arguments. Both classical and quantum Hamilton equations can be derived. For instance, the quantum Hamilton equations, via energy conservation, can be derived as

$$\frac{d\hat{q}}{dt}=\frac{\partial \hat{H}(\hat{p},\hat{q})}{\partial \hat{p}}, \quad \frac{d\hat{p}}{dt}=-\frac{\partial \hat{H}(\hat{p},\hat{q})}{\partial \hat{q}}$$

Where $\hat{p}$ and $\hat{q}$ are momentum and position observables in a quantum pendulum. Using the above, quantum Maxwell's equations can be derived.

Next, we will quantize electromagnetics fields using Lorenz gauge, which is a lot simpler than using Coulomb Gauge . For the Coulomb gauge case, transverse delta function is involved, making the commutator complicated. For instance, the commutator in the Lorenz gauge is

$$\left[\Pi_i(\mathbf{r}), A_j(\mathbf{r}')\right]=\frac{\hbar}{i}\delta_{ij}\delta(\mathbf{r}-\mathbf{r}')$$

where A is the vector potential, and $\Pi=\dot{A}$ is the conjugate variable. However, when Coulomb gauge is used, the above commutator becomes.

$$\left[\Pi_i(\mathbf{r}), A_j(\mathbf{r}')\right]=\frac{\hbar}{i}\delta_{ij}^{tr}(\mathbf{r}-\mathbf{r}')$$
$$=\frac{\hbar}{i}\left(\delta_{ij}\delta(\mathbf{r}-\mathbf{r}')+\frac{1}{4\pi}\frac{\partial^2}{\partial r_i \partial r_j}\frac{1}{|\mathbf{r}-\mathbf{r}'|}\right)$$

We have shown that classical Maxwell's equations can be derived from Hamiltonian theory.

We will also discuss the quantum theory of an electromagnetic dipole in a self-consistent manner. By invoking quantum Maxwell's equations in the coordinate space, the closed form solution of a quantum dipole can be derived. However, to make it consistent with the fluctuation dissipation theorem, quantum noise has to be added because of the radiation loss.

We will also demonstrate the solution to quantum electromagnetics using numerical methods (computational electromagnetics). In this manner, the numerical modes of a system governed by Maxwell's equations for inhomogeneous media can be solved numerically. We will demonstrate the simulation of the Hong-Ou-Mandel effect, and the nonlocal dispersion cancellation in a numerical model.

Biography

Weng Cho Chew was born in Malaysia, in June 1953. He received the B.S. degree in 1976, both the M.S. and Engineer's degrees in 1978, and the Ph.D. degree in 1980, from the Massachusetts Institute of Technology, Cambridge, all in electrical engineering. From 1981 to 1985, he was with Schlumberger-Doll Research, Ridgefield, CT, first as a Program Leader and then a Department Manager. From 1985 to 1990, he was an Associate Professor with the University of Illinois. He is currently a professor there and teaches graduate courses in waves and fields in inhomogeneous media and theory of microwave and optical waveguides, and he also supervises a graduate research program. From 1989 to 1993, he was the Associate Director the Advanced Construction Technology Center, University of Illinois. He is a Professor at Purdue University from past 6 years.

Accurate and Stable Methods for Full. Ill-condition S Equation Systems Arising from Radial Basis Functions

Edward J Kansa

Convergent Solutions. Livermore, CA, USA

Abstract

Meshless, continuously differentiable radial basis functions (C^∞-RBFs) are theoretically exponentially convergent in any dimensional space. Such RBFs have been applied to the solutions of integral and partial differential equations such as the collisions of black holes, quantum molecular mechanics, Maxwell's equations, Fokker-Planck equations, etc. However, some authors consider such basis functions considered impractical computationally because the coefficient matrices are full and can become very ill-conditioned. Similarly, the Hilbert and Vandermonde have full matrices and become ill-conditioned. The difference between a coefficient matrix generated by C^∞-RBFs for partial differential or integral equations and Hilbert and Vandermonde systems is that C^∞-RBFs are sensitive to small changes in the adjustable parameters. These parameters affect the condition number and solution accuracy. The error terrain has many local and global maxima and minima. To find stable and accurate numerical solutions for full linear equation systems, this study proposes a hybrid combination of block Gaussian elimination (BGE) combined with arbitrary precision arithmetic (APA) to minimize the accumulation of rounding errors. In the future, this algorithm can execute faster using preconditioners and implemented on massively parallel computers.

Biography:

Edward J Kansa was granted a Ph.D. from Vanderbilt University on many-body quantum mechanics. He worked at the US Bureau of Mines and Lawrence Livermore National Laboratory in environmental physics. He also taught at Embry-Riddle University (Oakland, CA branch) and the University of California, Davis. He was awarded the George Green medal his work on meshless solutions of partial differential and integral equations, He has 8400+ journal citations.

Oral Presentations

Quantum AI and it's Impact

Arit Kumar Bishwas

PricewaterhouseCoopers, USA

Abstract

Recent advancements in the field of AI demonstrate promising impacts on the business world, and it is changing the world the way we used to see it a few years back. There are vast interesting application areas where AI has already started to influence, some of the interesting application areas under consideration are finance, material science, logistics, etc. Apart from this, we are also witnessing the remarkable progress in the field of quantum computing – ranging from quantum H/W to quantum algorithms. Quantum computers promise extraordinary speed up gain for executing algorithms when executed on a quantum computer. The very interesting thing is to discuss the combined impacts of AI and quantum

computing together. We will explore the advancements in quantum AI at present time from business impact prospects, and how we can plan to infuse these two amazing technologies with the existing technologies to solve real business problems.

Biography

Arit Kumar Bishwas is a director and the head of quantum computing at Pricewater-houseCoopers's Innovation Hub. Dr. Arit has 16+ years of industrial application-oriented R&D leadership experience in multiple fields of technologies, but at present, he primarily focuses on quantum computing and artificial intelligence in research, business, engineering, and science. Dr. Arit is an expert in developing solutions to fundamental as well as applied technical R&D-focused business problems using AI, emerging technologies, and quantum computing skills. He has double masters in the field of computer applications and software systems respectively, and a Ph.D. in the field of quantum machine learning. At present, Dr. Arit is also a "Visiting Research Fellow" at Coventry University, UK.

Towards Quantum Computing and its Applications

Naveed Mahmud

Computer Engineering and Sciences, Florida Institute of Technology, Melbourne, FL, USA.

Abstract

Quantum computing promises a new paradigm of information processing that could revolutionize domains such as cryptography, image processing, and machine learning. However, implementation of real-life applications on current state-of-the-art quantum computers is challenging, as these devices are noisy and have limited resources. Due to the current state of quantum computing technology, there is also a heavy dependency on classical simulations using large-scale and costly supercomputing platforms. In this talk, I will give an introduction to quantum computing and discuss some of the critical challenges in the field. I will also discuss my research contributions towards mitigating these problems. One of the main components of my research is optimization of quantum algorithms for efficient implementation on quantum devices and investigation of new quantum applications such as quantum image processing. Another part of my research effort is the development of a cost-effective, hardware-accelerated framework for scalable emulation of quantum computation. Finally, I will talk about some of the state-of-the-art tools and software used in quantum computing research.

Biography

Dr. Mahmud completed his PhD from the University of Kansas, USA. He is an Assistant Professor of Computer Engineering and Sciences department at Florida Tech, a leading research university in Melbourne, Florida. His work involves developing reconfigurable emulation architectures for quantum algorithms, optimizing quantum algorithms for efficient implementation on near-term quantum devices, and developing applications for quantum computing. His publication record includes several peer-reviewed journal articles and conference papers. Dr. Mahmud also worked as a Senior Design Verification Engineer for Ulkasemi, where he was responsible for leading the Digital Design Verification team in addition to developing automated, self-checking testbenches for ASICs.

Access Quantum Relaxation Time Quantitatively Through Optical Probe

Xiaodong Xiang

Department of Materials Science and Engineering & Department of Physics, Southern University of Science and Technology, Shenzhen, China

Abstract

Quantum relaxation time (τ) is one of the most important physical properties affecting critical electron transport parameters in advanced materials. Accurately characterizing the quantum relaxation time of conducting electrons and clarifying the mechanism of different interactions, are of great significance for a better understanding of condensed matter physics and the design of next-generation IC devices. One hundred years ago, Drude model describing the oscillation of electrons under light provided theory for the measurement of τ via far-field light probe. However, large deviation between experimental data and the model exists. As a consequence, the quantum relaxation time of materials cannot be determined directly by Drude model. I will discuss the discovery of a new electron scattering mechanism-inelastic scattering of bound electrons at non-zero frequencies. This finding solves a century-old problem. Using the original innovative theoretical model and method, we will demonstrate independent extraction of quantum relaxation time and carrier density of materials, which revealed many puzzles of condensed matter physics.

The pioneer work of combinatorial materials chip invented by Dr. Xiang and Schultz in the 1990s lays the foundation for the Materials Genome Project. Although high-throughput preparation technique has gained a great advance, the lack of non-destructive, in-situ, micro high-throughput characterization techniques for electro-thermal-magnetic-force multi-parameter measurements causes the material data shortage. This research does not only break through the bottleneck of high-throughput electrical characterization, but also underlies the thermal, magnetic and mechanical characterization of materials. The new method will elevate materials science into a new age of AI-based “Fourth Paradigm”.

Biography

Xiao-dong Xiang, chair professor, joint appointment at Department of Physics and Department of Materials Science and Engineering in Southern University of Science and Technology, leading Expert of the Material Genome Project. Prof. Xiang is the inventor of “Combinatorial Material Chip” and has won the Discover Magazine Awards in 1996 and the R&D 100 Award in 2000. He was the PI in the US Berkeley National Laboratory and SRI International. As an outstanding academic, he has published over 100 papers and holds more than 100 patents. The main research field is high-throughput fabrication and characterization of combinatorial material chips and their applications in superconductor, fluorescence, dielectric, ferroelectric, magnetoresistance, phase-change storage, diluted magnetic semiconductor, catalysis, metallic glass and so on.

Burning Plasma Regime for Tokamaks

Leonid E Zakharov

LiWFusion, Princeton, NJ

Abstract

For more than 60 years the tokamak fusion program is locked in the high recycling regime when plasma edge is efficiently cooled by low energy (3 eV) atoms resulting from recycling of plasma particles escaping the confinement volume. All efforts to confront this powerful cooling mechanism with excessive external heating power essentially failed. The plasma confinement, although being the best on tokamaks relative to other concepts, remains highly insufficient for high performance burning plasma. Thus, the recent, second after the first one in 1997, attempt on JET, which is the most powerful tokamak ever built, to obtain fusion in a deuterium-tritium (DT) plasma has shown a very frustrating value of fusion amplification factor Q=1/3. No progress in this key performance parameter was made in the present approach to tokamak fusion. It was exhausted 24 years ago in the 1990s, while the result of 2021 on JET only confirmed its inappropriateness to fusion energy. In 1998, by analyzing DT data from TFTR tokamak (PPPL, Princeton) with Sergei Krasheninnikov (UCSD) we understood the critical role of recycling in limiting performance of tokamaks. A new regime was suggested when plasma, escaping from the core, is absorbed by flowing lithium, while fueling the plasma core is provided by the Neutral Beam Injection(NBI), which delivers the energetic atoms (120-130 keV) right to the plasma center. This eliminates or significantly suppresses the plasma edge cooling and creates a new plasma regime with an order of magnitude higher confinement. In contrast to Q=1/3, on still existing JET tokamaks Q=10 can be reliably predicted, what would open the path to fusion energy. The details will be explained.

Biography

Leonid E Zakharov was with Kurchatov Institute, Moscow, Russia, MIT, Cambridge, MA, USA, PPPL, Princeton, NJ, USA. In 1972 he invented the "Principle of Virtual Casing" widely used is design and simulations of magnetic systems of tokamaks, in 1978 he discovered the second stability regime of ballooning modes in tokamaks, in 1998 he invented magnetic propulsion of liquid lithium, in 2006 he completed the plasma physics concept of low recycling regime, in 2012 he invented its enabling technology tested in EAST tokamak and also in 2019 he revealed the possibility of burning plasma regime with Q>6 on JET tokamak.

Gravito-space Fluid Dynamics of General Relativity with Special Reference to Dark Matter of Rotating Galaxies

Tsutomu Kambe

University of Tokyo (Former), and Meiji University., Institute for Advanced Study of Mathematical Science, Japan

Abstract

By the Fluid Gauge Theory (FGT [1]), the isotropic pressure of Eulerian fluid field is extended to anisotropic stress fields which give rise to shearing flows of rotational nature within a perfect space-fluid. Very recently, astronomers (at UCSC) uploaded a web-news, stating as follows. At the outer part (halo) of our galaxy, although stars are very sparse there, the halo space is dominated by dark matter and actually contains most of the mass of the galaxy. According to the present study, the author takes this as follows. The dark matter is nothing but dark invisible space-fluids, not a mysterious new matter at all, and their motions in interstellar gravito-space interact with the galactic rotation mutually. In fact, in cosmic space,

various kinds of invisible space-fluid motions might be generated by the anisotropic stress fields caused by the galactic rotation.

It is known that observed rotation curves of galaxies do not match that expected from the Keplerian law and the rotations of luminous matters appear to be different from the solar planetary system. At distances away from the galactic center, the stellar orbital velocity-magnitude does not change much with increasing distance, rotating with almost constant velocity. From these observations, various views are proposed: spiral galaxies may contain large amounts of dark matter; alternatively, some consider existence of an exotic physics. Action of invisible component is observed to be progressively more conspicuous away from the galactic center. This hints, certain shearing motions (not generic within isotropic pressure) are generated at outer part of galaxies.

Present study takes rather a conservative approach, namely the dark object might be space-fluids. However, the action of the space-fluid must be a new type, predicted by the FGT theory. A new approach of Gravito-space Fluid Dynamics is taken and formulated by the variational principle for a perfect fluid in the presence of gravity. An important feature of the FGT theory is that it includes a new component of a gauge field □, which ensures explicitly the mass conservation law of fluid flows. Incorporation of a non-gravitational field to the gravity field is assured in the framework of general relativity by the Einstein Equivalence Principle. In addition to the well-known gravitational Lagrangian built of metric alone yielding gravitationally curved space, the FGT Lagrangians formulatedby the special-relativity describes fluid motions satisfying continuity.

Thus, governing equations of motion are derived for space-fluids in motion under influence of gravity and satisfying mass conservation. Remarkably, new terms are introduced in the equations of motion, having forms analogous to the electromagnetism, but derived for neutral fluids as well. One particular term to be remarked takes a form analogous to the Lorentz force, $\boldsymbol{v} \times \boldsymbol{b}$: a product of fluid velocity $\boldsymbol{v}$ with fluid-magnetic field $\boldsymbol{b}$ derived from the fluid gauge field $\boldsymbol{a}$. This FGT field has an amazing similarity with the Gravito-magnetic field known by the theory of Einstein-Thirring-Lense (ETL) studied recently by Ludwig [3] and Srivastava et al.

Although both theories predict deviation of stellar orbital velocity from the Keplerian law, the latter ETL-effect is the frame-dragging, namely a gravito-geometrical effect proportional to the small gravity constant G, while the former FGT-effect is a dragging by the fluid gauge field $\boldsymbol{a}$ to ensure the continuity condition of fluid. Comparing both, it is found that the gravitational ETL-effect is much smaller (in orders of magnitude) than the FGT-effect, i.e. a fluid-mechanical effect.

Biography

Tsutomu Kambe is a Former Professor at University of Tokyo; Born in 1940 (Japan). Living in Tokyo, Japan and he is a Member of IUTAM Bureau from 2004 to 2008. He serves as a Chairman of National Committee for Theoretical and Applied Mechanics (1997-2003) and acted as a Visiting Professor at the Chern Institute of Mathematics, Nankai University (Tianjin, China, 2003 – 2010) and a British Council Scholar at University of Cambridge (1974-75) and also Honorary Member of Japan Society of Fluid Mechanics.

SSHR, a New Solar Reference Spectrum Obtained from Space-based Observations and Modeling

Mustapha Meftah

National Center for Scientific Research, France

Abstract

The determination of many high-resolution solar reference spectra at high accuracy is crucial and represents a fundamental input for solar physics (Sun modeling), terrestrial atmospheric photochemistry and Earth's climate (climate's modeling). Thus, we present a new solar irradiance reference spectrum at high resolution representative of a solar minimum. The SOLAR Spectrum at High Resolution (SSHR) is developed by normalizing high spectral resolution solar line data to the absolute irradiance scale of the SOLAR-ISS reference spectrum. The resulting disk-integrated solar spectrum has at least 0.01 nm spectral resolution and spans 300-4400 nm. Below 1000 nm, the spectral resolution is less than 0.001 nm. One of our motivations is to develop a new radiometrically well calibrated solar spectrum with high spectral resolution for disk-integrated but also for the first time for disk-center or intermediate cases. These spectra must meet the needs of the MicroCarb mission and the 4AOP radiative transfer software.

Biography

Dr. Mustapha MEFTAH holds a PhD in Earth Sciences and Solar Physics from UVSQ (France). He is a graduate in aerospace engineering from high French engineering school. He also holds a master's degree in physics (Paul Sabatier University). He is an accredited research director (HDR) with 20+ years of experience in Astronomy & Astrophysics, Climate Physics and aerospace instrumentation. Specialist of space instrumentation. Teacher in spacecraft systems engineering and instrumentation for space science. PI, CoI or Instrument scientist of several instruments and CubeSat missions.

A New GPR Data Processing Method

Motti Haridim and Reuven Zemach

Holon Institute of Technology, Israel

Abstract

We present a new method for underground objects detection using Ground Penetration Radar (GPR), in which the electromagnetic (EM) fields reflected from B-scans are processed in a way that span statistical matrix EM components as Time Ensembles (TE) and Space Ensembles (SE). In this method, we calculate TE and SE ensembles correlation functions of raw data obtained by GPR B-scans for detection and allocation of underground objects. Using this method, The GPR system performances are significantly improved and yield more accurate allocation information both in detecting objects' positions along scanned area (TE) and in depths into-ground burry of object findings. This method can be added to GPR machines or simulation software to enhance raw data analysis.

We present, experiment results to validate the potential of the proposed data processing method for detecting underground objects under harsh conditions.

The simulation and experimental results corresponding to real cases show that the proposed method can improve the GPR performance in terms of detectability and resolution. It is clearly shown that the proposed method performs well even in harsh conditions, in which conventional GPR systems fail to yield results. SECFs and TECFs calculation results are found to be consistent using the derived raw data of the simulation. output of the model.

Experiments with non-metallic buried objects confirm successful object allocation, exhibiting the method potential, and the introduction of SC to the physical parameters via replicating simulation model to the experimental setup, presents a Sensitivity Analysis tool in using computations of SC-TE and SC-SE.

Biography:

Motti Haridim obtained his B.Sc. and Ph.D. (Electrical Engineering) from Technion- Israel Institute of Technology. In 1994, he joined the Faculty of Engineering at Holon Institute of Technology. During 2002-2008, he was Head Dept. of Communication Engineering, and during 2014-2017 he served as Vice President for academic development at HIT. His research interests are mainly in the physical layer of communication systems. He has published over 100 papers on theoretical and applied aspects of antennas, radiation, RF communications and optical communications. He is co-author of the Wiley textbook "Wireless Transceiver Design: Mastering the Design of Modern Wireless Equipment and Systems".

Search for New Physics Beyond the Standard Model at LHC

JeongEun Lee

Seoul National University, Republic of Korea

Abstract:

The Run-2 data set collected by the LHC led to a tremendous diversification of BSM searches at the energy frontier. The talk will review the most recent and interesting results in EXO searches (except DM, LLP) from the CMS collaboration.

Biography:

JeongEun Lee completed his Ph.D in Physics from Kyungpook National University, in 2018 he joined as a Postdoctoral Researcher at Kyungpook National University and now he is a Postdoctoral Researcher (Sejong Science Fellowship) at Seoul National University. His main research interests are New physics search at LHC; New heavy gauge boson, Extra dimension, RPV SUSY etc., and high accuracy on QCD and EWK correction, PDF and alphaS uncertainty calculation and also high level trigger, offline software and computing (reconstruction) development.

Relativistic Effects of Rotation

Wang Yang*, Yin Rui and Yin Ming

Beihang University, China

Abstract

For a rotational reference frame, define the distance from the axis to the point where the linear velocity is equal to light speed, as the critical radius, and the set of all points separated

from axis by critical radius as the critical cylinder. With this definition, we find two relativistic effects of rotation that are revealed before: (i) the linear velocity in the region of Outside Critical Cylinder (OCC) is not superluminal because of space-time exchange; (ii) some of physical quantities of rotational body will change direction or sign in math, if the location is changed from Inside Critical Cylinder (ICC) to OCC, or vice versa. We call them as the Critical Cylindrical Effect (CCE). Our lab experiments show that the repulsion exerted on anion by electrons will become attraction if the electrons are precessing and the anion is in the region of OCC of the precession. Thirty screenshots of our lab experimental videos are provided in this paper to shows the CCE exist experimentally. Then the theoretically derivation for both space-time exchange and CCE are given in this paper too. The application example of CCE is given in this paper at last section.

Natural Field: Origin of Inertia

Debabrata Saha

Independent Research Scientist, India

Abstract

Inertia of a material body is a passive property that does not enable the body to do anything except resist the action of an active force or a torque. It was Newton who first put implications of inertia formally in the form of a law: "Every object perseveres in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed thereon."

Root cause of inertia remained unknown since the days of Newton, though there were some speculations about its origin in Mach's conjecture which can be loosely stated as: "mass out there influences inertia here". Since time of Galileo, two other related areas that remained obscured in Physics till recent decades are (a) Origin of gravitation, and (b) Meaning of mass.

New thoughts emerged in recent times with finding of Natural Field, a new fundamental, entity of nature, in second decade of this century followed by finding origin of gravitation in third decade. Mathematical theory of origin of gravitation establishes that mass of any object can be thought as an entity arising out of pull on the object by the distributed natural field induced by the object itself on rest of the universe. Inertia originates from intent of self-interference of object with this distributed field. This intent leads to resistance which for any change in state of motion requires work that is non-reversible. Natural field thus establishes a theoretical foundation for Newton's first law of motion.

Biography

Debabrata Saha is a research scientist and a teacher who most recently taught in NIT, Karnataka, India as Adjunct Professor. Before this, he taught for twenty-one years as tenured member of a faculty, and, thereafter, worked as President of a consulting firm, both in USA. He is a former Chairman of Washington D.C. - Northern Virginia Section of IEEE Information Theory Society, USA. His academic background includes earned degrees in (1) Science - B.Sc., Physics (Calcutta University), (2) Technology- B.Tech., Electronics (Calcutta University), (3) Applied Science - M.A.Sc., Communication (University of Toronto), (4) Engineering - PhD, Computer, Information and Control Engineering (University of Michigan).

Phenomenological Description of Itinerant Weak Ferromagnetic Materials

Kazuyuki Matsumoto

Hokkaido University of Education - Asahikawa, Japan

Abstract:

Itinerant weak ferromagnetism has been explained by spin fluctuation theory. However, it seems to be cumbersome for an exchange-enhanced magnetic system. In this study, we develop a simple phenomenological theory for itinerant weak ferromagnetism. This theory is an extension of our approach for heavy fermion compounds with metamagnetism. Free energy, including the terms m4 and hm3, is introduced and examined. We apply this theory to the typical itinerant weak ferromagnetic materials ZrZn2, MnSi2, and others. To determine the model parameters, we use magnetization under a large magnetic field or the extension of the Arrott plot with a functional form of a hyperbola. Thus, we obtain the zero-temperature magnetic susceptibility at H=0 with good agreement with experiments for itinerant weak ferromagnetic materials. Next, we discuss the Sommerfeld coefficient in the magnetic fields based on the present theory for ZrZn2. We also discuss the fascinating ferromagnetic superconductors URhGe and UCoGe since both compounds can be regarded as itinerant weak ferromagnetic materials and studied in detail experimentally.

Effect of B-site Donor Doping on Ferroelectric/Piezoelectric Properties of Nb-modified $BiFeO_3$-$BaTiO_3$ Ceramics

Myong-Ho Kim*, Tauseef Ahmed, Salman Ali Khan, Tae Kwon Song and Soonil Lee

School of Materials Science and Engineering / Department of Materials Convergence and System Engineering, Changwon National University, Changwon, Gyeongnam, Republic of Korea

Abstract:

Lead-free bulk BiFeO3-BaTiO3 system with small amount of donor dopant, 0.65BiFeO3-0.35BaTixNb(1-x)O3 (BF35BTNb, where x = 0.00 - 0.03), has been investigated as a potential piezoelectric material due to its large electromechanical performance and high Curie/maximum temperature (TC/Tm), as these are the primary desirable parameters for application in actuators. Large strain property (S = 0.2535% and d*33 = 724 pm/V at a field of 3.5 kV/mm, d33 ~201pC/N at RT and S = 0.3416% and d*33 = 991 pm/V at applied field of 3.5 kV/mm at 90 oC), d33 ~ 230pC/N at 90 oC and typical ferroelectric behaviors were obtained for x = 0.01 with maximum temperature (Tm) ~ 431 oC. It is believed that the excellent piezoelectric response could be attributed to enhance relative density, optimum grain size, lattice distortion and enhanced domain reorientation/switching due to donor doping. The excellent piezoelectric properties along with high Tm suggested that BF-35BTNb system is a favorable applicable material at elevated temperature for enhanced piezoelectric performance.

Biography

Myong-Ho Kim is a professor in School of Advanced Materials Engineering at the National University of Changwon.He received his B.Sc and M.Sc in Materials Engineering in 1981 from Korea University and Ph.D.degree in Materials Science and Engineering in 1987 from Erlangen-Nuremberg University, Germany. He then worked for the

MOCVD process at Fraunhofer Institute. He joined various research institutes as a visiting Professor; Material Research Laboratory of the Pennsylvania State University, USA (2002–2004) & Juelich research institute, Germany (2000). His research areas are oxygen sensor, lead-free piezoelectric and multiferroic materials using defect chemistry.

Amyloid Protein Self-Assembly at the Surface-Liquid Interface

Yuri Lyubchenko*, Mohtadin Hashemi and Siddhartha Banerjee

University of Nebraska Medical Center, Department of Pharmaceutical Sciences, 986025 Nebraska Medical Center, Omaha, NE, USA

Abstract

The aggregation of amyloid beta (Aβ) is a self-assembly process that results in the production of fibrillar structures along with neurotoxic aggregates. However, no aggregation of amyloid at the physiological relevant concentrations is observed. This suggests that the assembly of Aβ in aggregates in vivo utilizes pathways different from those used in experiments in vitro. We have discovered recently that surface plays a role of catalyst allowing the self-assembly of amyloid aggregates to occur at physiologically relevant concentrations at the surface-liquid interface. We proposed a model in which the monomers transiently immobilized on the surfaces work as nuclei for the next aggregation step. The model was verified by experimental time-dependent AFM measurements. AFM studies of aggregation of Aβ on supported phospholipid bilayer revealed a strong effect of the membrane composition on the surface aggregation catalysis. We combined AFM experimental studies with all-atom molecular dynamic (MD) simulations to characterize the on-surface self-assembly process of amyloid proteins. MD simulations show that the surface-protein interactions induce a conformational transition of the monomer facilitating binding of another molecule. The surface-mediated aggregation catalysis explains a number of observations associated with the development of Alzheimer's disease. The affinity of Aβ monomers to the membrane surface is the major factor defining the aggregation process rather than Aβ concentration. Therefore, the development of potential preventions for the interaction of monomeric amyloids with membrane can help control the aggregation process.

Biography

Dr. Yuri L. Lyubchenko is Professor of Pharmaceutical Sciences University of Nebraska Medical Center, Omaha, NE. His research spans a broad range of biomedical problems aimed at unraveling molecular mechanisms of such diseases as cancer, Alzheimer's and Parkinson's diseases. He has authored 320 research articles/book chapters. He was named UNMC distinguished scientist (2008). He is an Academic Editor for Nature-Scientific Reports, associate editor for New Journal of Science, Frontiers in Bioscience, Journal of Molecular Pharmaceutics and Precision Nanomedicine and serves as editorial member of a number of reputed journals. He also serves on NIH and NSF grant proposal review panels.

Generalized Carter[A]–Pleba´nski solutions to Einstein–Nonlinear Electrodynamics

Alberto A. Garcia

Physics department. Center for Research and Advanced Studies of the IPN.

Abstract

This presentation deals with families of solutions to the Einstein –nonlinear electrodynamics equations for a generalization of the Carter[A]–Pleba´nski metric. The reported solution is endowed with several parameters: mass m and magnetic mass l (NUT) constants, the angular momentum constant α equivalent to Kerr parameter a, an effective cosmological constant λ (Λ, n), the electric and magnetic charges associated to the nonlinear electrodynamics parameters $\{f_1, g_1, x_1, y_1\}$, and the nonlinear electrodynamics parameter β. The eigenvectors of the electromagnetic field $F_{\mu\nu}$ and $\star P_{\mu\nu}$ obey the alignments conditions $[F_{x\sigma} = y^2 F_{x\tau}, F_{y\sigma} = -y^2 F_{y\tau}]$, and $[{}^\star P x\sigma = y^{2\star} P_{x\tau}, {}^\star P y\sigma = -y^{2\star} P y\tau]$, along the null tetrad, thus, each of the F_{ab} and ▯Pab tensors are represented by a pair of eigenvalues: $\{F_{12}, F_{34}\}$ and $\{{}^\star P_{12}, {}^\star P_{34}\}$. The vector potentials A_τ and ${}^\star P_\tau$, satisfying the alignment conditions are given by $(x^2+y^2) A_\tau = f(x)+g(y)$, and $(x^2+y^2) \star P_\tau = X(x)+Y(y)$ with potential functions $\{f(x), g(y), X(x), Y(y)\}$, and ought to fulfil the KEY equation $A_{\tau,x,x} {}^\star P_{\tau,y,y} - A_{\tau,y,y} {}^\star P_{\tau,x,x} = 0$, arising from the closure condition $d^2L = 0$ of the differential 1–form $dL = \frac{\partial L(F,G)}{dx\mu} dx^\mu$. We restricted our search to cubic potentials functions of the form: $h(z) = h_0 + h_1 z + h_2 z^2 + h_3 z^3 + h_4 z^4$. This solution allows for event horizons, and consequently it could describe black holes. Moreover, for the set of points where $x^2 + y^2 \to 0$, "ring singularity", the curvature invariants Ψ_2, S and R blow up.

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The Dual Theory of Relativity and its Implications

Tepper Gill[1*] and Gonzalo Ares de Parga[2]

[1]EECS, Math. & Comp. Phys. Lab., Howard University, USA;

[2]Department of Physics, Higher School of Physics and Mathematics, Mexico

Abstract

I first show that Einstein's special theory and Maxwell's theory have dual versions. The duals arise from an identity relating observer time to proper time as a contact transformation. The theory is dual in the sense that, for n particles, every observer has two sets of variables (X, t) and (X, t) to describe them, where X is the canonical center of mass. In the (X, t) variables, time is relative, and the speed of light is c, while in the (X, t) variables, time is unique, and light-speed is relative. The Maxwell wave equations are not equivalent. A major outcome is the dual unification of Newtonian mechanics and classical electrodynamics with Einstein's special theory of relativity. The dual version also leads to a uniquely defined global for the universe.

Time allowing, I will then discuss the dual theory of relativistic quantum mechanics, which leads to three dual relativistic wave equations. The dual Dirac equation supplies a new formula for the anomalous magnetic moment of a charged particle, allowing us to obtain the exact value for the electron g-factor and phenomenological values for the muon and proton g-factors.

Biography

Tepper Gill earned all three of his degrees from Wayne State University- his B.S. in mathematics and physics (1966), his M.S. (1969) and his Ph.D. in Applied Mathematics (1974). His Ph.D. advisor was also an African American, A. T. Bharucha-Reid.

At Howard University, starting as an Assistant Professor in 1976, Dr. Gill was promoted to Associate Professor in 1981, and Professor in 1988. In 1987 he became the Chairman of the Department of Electrical Engineering. He has a joint appointment in the Departments of Electrical Engineering and Mathematics. He is also a Professor for the Division of Theoretical Physics at the Instituto per la Ricerca de Base in Italy. He is an editor of the HADRONIC JOURNAL, a periodical with a primary focus in theoretical and mathematical physics.

A New Class of Weighted CUSUM Statistics

Xiaoping Shi[1*], Xiang-Sheng Wang[2] and Nancy Reid[3]

[1]Department of Computer Science, Mathematics, Physics and Statistics, University of British Columbia, Kelowna, Canada;

[2]Department of Mathematics, University of Louisiana at Lafayette, Lafayette, LA, USA;
[3]Department of Statistical Sciences, University of Toronto, Toronto, ON M5S 3G3, Canada\

Abstract

A change point is a location or time at which observations or data obey two different models: before and after. In real problems, we may know some prior information about the location of the change point, say at the right or left tail of the sequence. How does one incorporate the prior information into the current cumulative sum (CUSUM) statistics? We propose a new class of weighted CUSUM statistics with three different types of quadratic weights accounting for different prior positions of the change points. One interpretation of the weights is the mean duration in a random walk. Under the normal model with known variance, the exact distributions of these statistics are explicitly expressed in terms of eigenvalues. Theoretical results about the explicit difference of the distributions are valuable. The expansions of asymptotic distributions are compared with the expansion of the limit distributions of the Cramér-von Mises statistic and the Anderson and Darling statistic. We provide some extensions from independent normal responses to more interesting models, such as graphical models, the mixture of normals, Poisson, and weakly dependent models. Simulations suggest that the proposed test statistics have better power than the graph-based statistics. We illustrate their application to a detection problem with video data.

Biography

Dr. Xiaoping Shi received his PhD in Statistics from York University. Following postdoctoral research at the University of Toronto, and teaching there and at York University and St. Francis Xavier University, he joined TRU in 2015 as an Assistant Professor in the Department of Mathematics and Statistics. His promotion to Associate Professor at TRU was announced in 2021. Later, he joined UBCO as an Assistant Professor in the Department of Computer Science, Mathematics, Physics and Statistics. His current areas of expertise include statistical distance in quantum mechanics, change point analysis, data sharpening, accurate approximation, k-sample inference, and cluster analysis.

Berezin Integral as a Limit of Riemann Sum

Roman Sverdlov

Department of Mathematics and Statistics University of New Mexico Science and Math Learning Center, Albuquerque, NM, USA

Abstract

Berezin integral is widely used in physics, but unfortunately its properties contradict the usual properties of Riemann integral. As a result of this, it was normally assumed that it can not be described as a Riemann sum and, instead, it was viewed as a formal algebraic operation. However, Roman Sverdlov wrote a paper in collaboration with Thomas Scanlon showing that Berezin integral can be modeled as a Riemann sum, after all. Accordingly, its properties were reconciled with the intuition we have from calculus. This was done in two steps. First, a single anticommuting product, was replaced with an algebra consisting of two separate products: one is Clifford product and the other is anticommuting wedge product. While wedge product is used in the "finite" part of the integral, the Clifford product is used between infinitesimal and the finite part. And, secondly, a usual integral over the whole space, was replaced with a choice

between three possibilities. One possibility is an integral over the closed surface (aka "surface integral"). The other is integral over space where usual measure is being replaced by weighted directed measure (aka "directed volume integral"). The third is an integral being replaced with a finite sum (aka "minimalist model"). In this talk some of those constructions will be outlined.

Age-structured Population Models. Numerical Integration in an Infinite Life Span Framework

Oscar Angulo*, Luis M. Abia, J.C. Lopez-Marcos, and M.A. Lopez-Marcos

University of Valladolid, Spain

Abstract

The choice of the age as a physiological parameter to structure a population and describe its dynamics involves the election of the life-span. An unbounded life-span is useful, not only new models appears in this framework, but also it is required by the study of the stability of equilibria. Its numerical integration is usually performed with bounded domains. However, we propose a new numerical method which employs the unbounded domain. It is completely analyzed and second order of convergence is established. We report some numerical experiments to show numerically the results and the behavior of the problem to simulate the evolution of Nicholson's blowflies model.

Thermal Solitons and Thermal Transfer Along Thin Wires

Michele Sciacca[1*], F.X. Alvarez[2], D. Jou[2], J. Bafaluy[2]

[1]Department of Engineering, University of Palermo, Avenue of Sciences, Italy

[2]Department of Physics, Autonomous University of Barcelona, Bellaterra, Spain

Abstract

We consider nonlinear heat propagation along a heat-conducting wire of radius r (composed of a material of mass density ρ and specific heat per unit mass c) but we assume that the longitudinal heat transfer along the cylinder and the transverse heat exchange per unit area have evolution equations characterized by different relaxation times [3–5]. For this purpose, we consider a mathematical model which takes the energy balance equation expressed in terms of the temperature field T, the so-called Maxwell-Cattaneo equation for the longitudinal heat transfer along the cylinder $q = q(z)\,\hat{z}$, and a nonlinear evolution equation for the transverse heat exchange per unit area qt from the cylinder to the environment.

We also consider soliton propagation of heat signals along the cylinder. Our motivation is to obtain and compare the speed of propagation, the maximum rate of information transfer, and the energy necessary for the transfer of one bit of information for different solitons, by assuming that a localized soliton may carry a bit of information. It is shown that a given total power (energy/time) may be used either to send a few bits in a fast way, or many bits in a slower way. This may be controlled by choosing the initial condition imposed at one end of the wire.

Collusion Indicators in the GameStop Short Squeeze

Michael J Campbell

StudioX, Anaheim, CA

Abstract

A new theory and model of the stock market that incorporates decision noise in the spirit of behavioral economics, collaboration in the spirit of experimental economics, and financial data and features in the spirit of econophysics is used to support a theory from 2005 that collusion should lower the level of decision noise. This idea is used to find two rare indicators of the GameStop short squeeze -- one of which occurred six days before the rapid price increase, which could have potentially reduced the over $19 billion in losses of short sellers by a significant amount.

Biography:

Michael Campbell does research in artificial intelligence, marketing, and psychology. His work in 2016 foresaw the recent collusion that occurred in the GameStop, AMC, and Longeveron short squeezes of 2021. He is also a wine judge for the second biggest competition in California.

TiO2 Supported Iridium Clusters for Low-Temperature CH4 Steam Reforming

Jyh-Chiang Jiang*, Shawn D. Lin*, Hou-Jen Lai, Yu-Cheng Liu, and Santhanamoorthi Nachimuthu.

National Taiwan University of Science and Technology, Taiwan

Abstract

Hydrogen production via low-temperature steam reforming of methane (SRM) has attracted increasing research attention due to its importance as an alternative, efficient, and environmentally benign energy carrier. However, low-temperature SRM reactions require catalysts with high methane activity and coking resistance, which conventional catalysts cannot meet. Herein, we reported a 2 wt % Ir/TiO2 catalyst that exhibited high methane activity in low-temperature SRM with higher turnover frequency (TOF) and lower activation energy than in the literature. Long-term catalytic tests demonstrated the resistance of coking and sintering during low-temperature SRM reactions. In-situ spectrums combined with density functional theory (DFT) calculations revealed that the small Ir clusters and Ir single atoms (SAs) on TiO2 surfaces are both active for methane, but the low-temperature SRM reaction could only occur on the small Ir clusters supported on the TiO2 (101) surface. In this work, microkinetic simulation based on the DFT calculations shows consistent product distribution with the experiment and confirms the superior SRM activity of the small Ir clusters supported on the TiO2 (101) surface.

Biography

Jyh-Chiang Jiang received his Ph.D. in Chemistry in 1994 from the National Taiwan University. After working as a postdoctoral fellow at IAMS, Dr. Jiang joined the faculty of the National Taiwan University of Science and Technology (NTUST) in 2001. He focuses on the theoretical and computational chemistry study of heterogeneous catalysis, optoelectronic materials, and Li-ion batteries. He has more than 200 papers in peer-reviewed journals. His research has also resulted in 4 patents. He is currently the chairman of the Taiwan Theoretical and Computational Molecular Sciences Association.

Efficient Space Data Retrieval Technique for Inhomogeneous Earth and Ocean Surfaces by using LBL Forward Model

Rajinder Kumar Jagpal[1,2,3*], Rehan Siddiqui[1,2,3,4], Sanjar M. Abrarov[1,2,3] and Brendan M. Quine[3,4]

[1]Epic College of Technology, ON, Canada ;

[2]Epic Climate Green (ECG) Inc., ON, Canada;

[3]Dept. Earth and Space Science and Engineering, York University, Toronto, ON, Canada;

[4]Dept. Physics and Astronomy, York University, Toronto, ON, Canada.

Abstract

We propose a new method of space data retrieval based on two weighted sums. This method accounts for the wavelength dependency of the surface albedo and enables us to perform efficient computation in radiative transfer model. The algorithm resolves many issues related to inhomogeneity of the Earth surface and can be used to accelerate line-by-line (LBL) computation in the forward model. We show that due to effect of the instrument slit function both proposed weighted sums are practically consistent with each other. Our results can be used for remote detection of the greenhouse gases (CO_2 CH_4, CO, O_3, etc.), aerosols and particulate matters. Furthermore, generalization of the cloud scene detection can also be applied for location of the smoke-originated aerosols due to forest fires and wildfires. Our work is in progress for the efficient detection of different ocean surfaces including plankton, algae and oil split. This approach may be especially promising for the real-time mode retrieval of the data obtained from the space orbiting micro-spectrometers like Argus 1000/2000 operating in the near infrared spectral region.

Biography

Dr. Rajinder K. Jagpal received his MSc in Applied Physics (1993) and PhD in Physics and Astronomy (2011). He is a recipient of the Canadian Astronautics and Space Institute Alouettaward in 2010. His specialization includes design, testing, calibration and validation of space instruments. He develops efficient algorithms for retrieval and analysis of remote sensing data from space-orbiting Argus 1000 micro-spectrometer.

Development of Real-time Time-dependent Density-functional-theory Code, INQ, and its Application to Nonequilibrium Quantum Dynamics

Tadashi Ogitsu[1*], Xavier Andrade[1], Alfredo Correa[1], Sangeeta Rajpurohit[2], Liang Tan[2], David Prendergast[2], Aaron Altman[3,4], Felipe Jornada[3,4], Jiaojian Shi[3,4], Iliana Porter[3,4], Aaron Lindenberg[3,4]

[1]Lawrence Livermore National Laboratory, USA;

[2]Lawrence Berkeley National Laboratory, USA;

[3]SLAC National Accelerator Laboratory, USA;
[4]Stanford University, USA.

Abstract

Time-dependent version of density functional theory (TDDFT), together with advancements in high performance computing (HPC), allows us to probe into non-equilibrium quantum phenomena that require the use of the time-dependent version of the Schrödinger equation, where spin, electronic, and ionic degree of freedoms evolve in a coupled manner.

Open source real-time (RT) TDDFT code, INQ, optimized for the current and future HPC systems [JCTC **17**, 7447 (2021)] is being developed and distributed under the DOE BES CMS Software Center for Nonperturbative Studies of Functional Materials Under Nonequilibrium Conditions (NPNEQ, https://sc-programs.llnl.gov/npneq). The code is available at https://gitlab.com/npneq/inq.

In this presentation, we will first describe the status of INQ and near future development plan. As of November 2022, INQ can perform (RT-)TDDFT simulations of relatively large systems such as 1000 aluminum atoms and demonstrated excellent scalability on up to 1000 GPUs. Implementations of fast hybrid exchange-correlation functional such as ACE algorithm [L. Lin, *J. Chem. Theo. Comp.* **12**, 2242 (2016)] and spin-orbit coupling (SOC) in Breit-Pauli formula are underway. Latter is to address the issue on time propagation of wavefunctions stemming from projection based conventional SOC calculations. We will then overview scientific studies conducted by our team members and external collaborators that are designed to fully leverage our method/software development under NPNEQ project.

Part of work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344

Biography

Tadashi Ogitsu has his expertise in ab-initio simulations and high-performance computing and is interested in applying these skills and investigate on fundamental aspect of coupled electron-ion dynamics and hydrogen production and storage technologies. He is a director of Center for Nonperturbative Studies of Functional Materials Under Nonequilibrium Conditions (sc-programs.llnl.gov/npneq) supported by DOE BES Computational Materials Sciences program and is the point of contact for DOE/EERE HydroGEN consortium (www.h2awsm.org).

Nanocoatings Applied in Smart Windows for a Dynamic Solar Radiation Control

Bjorn Petter Jelle

Norwegian University of Science and Technology, Department of Civil and Environmental Engineering, Trondheim, Norway.

Abstract

On a global scale there is a rapidly growing quest of addressing and solving the negative impacts of the current climate and energy crisis. A large part of the solution may be found in providing substantial improvements within the construction and building sector. Hence, an important area in this regard is the possibility of a dynamic and controlled utilization

of solar radiation through window panes and other glazing structures in buildings. That is, to transmit the desired solar radiation through the window panes and into the buildings according to demand with respect to comfort, daylight, solar heat and in general energy efficiency aspects throughout day/night and seasonal cycles and variations. Applying thin nanocoatings of different materials which are able to dynamically change their solar radiation transmittance upon demand, e.g. by a change in applied voltage in electrochromic smart windows, represent a very promising solution. These miscellaneous electrochromic materials may be tailor-made and combined in various material configurations and devices in order to exploit as much as possible of the different wavelength regions of the solar spectrum, either by absorption or reflection processes in the specific materials. This study is pinpointing such material combinations with given examples utilizing the electrochromic materials polyaniline, prussian blue and tungsten oxide, and also demonstrates how large solar radiation modulation capabilities may be achieved.

Biography

Bjorn Petter Jelle is a professor at the Norwegian University of Science and Technology (NTNU). Jelle's background is as a physicist, chemist and material scientist, and examples of current work fields include building physics, materials science, solar radiation, thermal radiation, durability, climate exposure, accelerated climate ageing, radon ingress in buildings, solar cells, building integrated photovoltaics, high performance thermal insulation materials, nano materials, low-emissivity materials, and electrochromic materials for energy-efficient smart windows.

Phonon Dominated Thermal Transport in Metallic Niobium Diselenide from First Principles Calculations

Jorge Morales[1*], Zeyu Liu[2], Diego Celentano[3] and Tengfei Luo[4]

[1]Faculty of Science, Iingenieríaand Technology, Major University, Chile;

[2]Department of Applied Physics, School of Physics and Electronics, Hunan University, China;

[3]Department of Mechanical and Metallurgical Engineering, Research Center in

Nanotechnology and Advanced Materials, Millennium Institute on Green Ammonia as Energy Vector (MIGA), Pontifical Catholic University of Chile;

[4]Department of Aerospace and Mechanical Engineering, University of Notre Dame, Notre Dame, IN, USA;

[5]Department of Chemical and Biomolecular Engineering, University of Notre Dame,Notre Dame, IN, USA

Abstract

Niobium diselenide (NbSe2) is a layered transition metal dichalcogenide material which possesses unique electrical and superconducting properties for future nanodevices. While the superconducting, electrical, and bulk thermal transport properties of NbSe2 have been widely studied, the in-plane thermal transport property of NbSe2, which is important for potential thermoelectric applications, has not been thoroughly investigated. In this report, we study the lattice in-plane thermal transport of 2D NbSe2 by solving the phonon Boltzmann transport equation with the help of the first principles calculation. The thermal conductivity obtained at room temperature is 12.3 W/mK. A detailed analysis shows that the transverse acoustic phonon

dominates the lattice thermal transport, and an anomalously small portion of electron contribution to the total thermal conductivity is observed for this metallic phase. The

results agree well with experimental measurements and provide detailed mode-by-mode thermal conductivity contribution from different phonon modes. This study can provide useful information for integrating NbSe2 in nanodevices where both electrical and thermal properties are critical, showing great potential for integrating monolayer NbSe2 to thermoelectric devices.

Biography

Dr. Moralesis currently associate Professor of the School of Industrial Engineering at University of Mayor (UMayor), and Chair of the School of Industrial Engineering at UMayor. At the end of 2022, He was assistant Professor of Mechanical Engineering of the Department of Industrial Technologies at Universidad de Talca (UTALCA) and Vice Chair of the School of Mechanical Engineering and Dr. Morales' research interests center on nanoscale transport and energy conversion phenomena, and their applications in energy storage and conversion, and microfluidics phenomena, numerical, experimental and microfabrication.

A Study on the Thickness Dependence of $Ba_{0.5}Sr_{0.5}Fe_{12}O_{19}$/ rGO Nanohybrid on its Microwave Absorption Efficiency

D. Rajan Babu* and Shalom Ann Mathews

Advanced Materials Research Centre, School of Advanced Sciences, Vellore Institute of Technology, India.

Abstract

Reduced graphene oxide (rGO) has a unique structuring which is less dense and possess high conductivity. Chemically treated reduced graphene oxides are much efficient in its absorption performance than its contemporary carbon derivates. This coursed the reason for rGO to be composited with $Ba_{0.5}Sr_{0.5}Fe_{12}O_{19}$ to analyse its absorption efficiency at different thicknesses. Structural, morphological, magnetic and microwave absorption properties of the prepared nanocomposites at varied thicknesses were confirmed by XRD, Raman spectroscopy, FESEM, VSM and VNA respectively. The three thicknesses that were chosen for the waveguide material are1mm, 3mm and 5mm. The waveguides were designed as per the dimensions conferred by the X-band frequency band and analysed for its loss of reflection rate. A relatively high bandwidth of 2.07 GHz was obtained for the sample BRG10 with 3 mm thickness. A minimum reflection loss value of -48.7 dB was obtained at a frequency of 9.72 GHz with a bandwidth of 1.53 GHz for the sample BRG30. This least reflectivity was achieved for an absorber thickness of 3mm. The values of reflection losses prove the prepared samples to be remarkable microwave absorption materials.

Biography

Dr. D. Rajan Babu is a Professor (Higher Academic Grade) of Physics at VIT University, Vellore, India. He has thirty-two years of teaching experience. He has published seventy-five publications in peer-reviewed journals. He was the Convenor of the International Conference on Recent Trends in Advanced Materials (ICRAM – 2012), Organized by the School of Advanced Sciences, VIT University, Vellore, He organized the International Conference on Magnetic Materials and Application 2-4 December 2015 in association with Magnetic Society of India, DMRL, Hyderabad. He was the guest editor of ICRAM – 2012 Proceedings which had been published by Advanced Materials Research, Trans Tech Publications, Switzerland and also the guest editor of the Journal of magnetism and Magnetic Materials (JMMM), Elsevier, 2015. He had been invited as Visiting Professor to the Research Institute of Electronics, Shizuoka University, Japan.

Liquid Intelligence: Advancements Across the Synthetic Domain

Alessandro Chiolerio

Italian Institute of Technology – IIT, Bioinspired Soft Robotics, Center for Converging Technologies, Genova, Italy

Abstract

Intelligence, understood as cognitive process, can be described both through a symbolic approach, which couples itself well with the adoption of technological elements such as the digital world, and through a continuum approach, more familiar with biology. Current experiments performed with functional liquids will be discussed, with a reference to holonomic machines and to the achievement of liquid state analogue memories, artificial neural networks and reservoir computers, where the continuum approach is more appropriate. Recent results about the first liquid state, electrically programmable, in memory computing system will be discussed, highlighting novelties, opportunities and drawbacks of using liquid reservoirs for calculus.

Biography

Alessandro received his PhD at the Physics Department of Politecnico di Torino in 2009 with a thesis on spintronic devices. He obtained a full professor habilitation (Solid State Physics) in 2017 and worked as Visiting Researcher at NASA's Jet Propulsion Laboratory, at the Max Planck Institute for Microstructure Physics, at the University of the West of England where he is Visiting Professor, and at Istituto Italiano di Tecnologia, where he coordinates a group of researchers. His current interest is the study of cybernetic systems that develop a system of inter-subject relationships that can be described through holographic analogies, such as liquids. Since 2019 he is in the top 2% scientists (applied physics). He is co-author of over 130 scientific articles that have collected more than 5000 citations to date.

Direct-write Deposition of Functional Nanostructures with a Scanning Electron Microscope

Heinz D. Wanzenboeck[1*], Philipp Taus[1], Markus Pribyl[1], Sonia Prado Lopez[1], Markus Schinnerl[1], Marco Gavagnin[1], Mostafa M. Shawrav[1] and Walter M. Weber[1]

[1]Vienna University of Technology, Vienna, Austria (Europe)

Direct-write deposition with a scanning electron microscope uses a focused electron beam to induce a localized chemical vapor deposition on the surface of flat and non-flat samples. Due to the small, localized interaction volume of the focused electron beam the resulting deposits have a lateral dimension in the sub-µm down to the nm-range. Furthermore, guiding the electron beam with a pattern generator offers the exciting potential of fabricating 3D structures. We will present how different precursor gases can be used for additive direct-write nanofabrication of highly conductive nanowires, magnetic nanotips, and insulating layers for nanoelectronic circuits. Subsequently several application examples of FEBID-

made nanostructures will be shown. This includes the FEBID-fabrication of scanning probe microscopy tips, nanomagnetic majority gates, plasmonic structures and conductive 3D nanoelectrodes for electrophysiological recording of cardiac activity. As FEBID is a slow sequential technique, we have also developed a replication approach for FEBID-made 3D nanostructures using imprint lithography. Concluding, we will discuss the shortcomings and the future potential of focused electron beam induced deposition and discuss its future potential for optoelectronics, plasmonics, nanomagnetics and quantum physics.

Biography

Heinz D. Wanzenboeck received the M.Sc. degree in technical chemistry and the Ph.D. degree in Analytical Chemistry from Technische Universität Wien. After post-doctoral studies at the Catalysis Research Center (CRC) at Hokkaido University (Japan) and at the Stanford Nanofabrication Facility (SNF) at Stanford University (USA) he joined the Institute for Solid State Electronics at TU Wien where he focused on the development of direct-write nanofabrication processes with focused particle beams and their application for device repair, nano magneto logic as well as for microelectrodes for cell-based bioelectronics. His current research interest also includes nanofabricated devices for biomedical engineering

Understanding Tactile-Texture Sensation through Various Physical Properties; High Resolution Multi-Physics Tactile Sensing and the Device

Hidekuni Takao

Kagawa University, Japan

Abstract

Advances in science and technology have led to the emergence of a variety of sensing technologies with capabilities similar to those of the human senses. Among them, the function of obtaining the tactile and surface texture of an object is still poorly understood. Although the physiological functions of mechanoreceptors, thermoreceptors, and free nerve endings have been partially elucidated, the function of the neural network through their interaction is largely unexplored and in the dark. We have developed a semiconductor high-resolution tactile sensor that integrates various sensory functions close to the fingertip by making full use of the function integration capability of semiconductor silicon and microfabrication technologies such as MEMS technology. The surface of the sensor has fingerprint-like microstructures similar to a fingertip, and each structure detects tactile sensations independently. This allows the sensor to achieve a high spatial resolution equivalent or better than that of a fingertip. In addition to contact force and friction, various tactile stimuli such as hardness and thermal conductivity, as well as spatiotemporal changes in the physical properties of the fingertip when tracing an object can also be measured and recorded as electrical signals. This sensor can accurately capture the tactile sensations we experience at our fingertips, and its data analysis will make a significant contribution to the elucidation of the mechanisms of tactile sensation.

Biography

Prof. Hidekuni Takao was born in Kagawa, Japan in 1970. He received his Ph.D. degree in 1998 from Toyohashi University of Technology, Japan. Now, he is the director of Nano-Micro Structure Device Integrated Research Center, and a professor of Mechanical Engineering

Division with Kagawa University. His research interests are ultrahigh-performance tactile sensor and its application to undeveloped fields of tactile sensing. Since 2015, he has been the research representative of a CREST project on "multi-physics tactile sensing technology" which is a competitive national research project supported and managed by Japan Science and Technology Agency, Japan.

The Extended Cut-off Wavelength of Metal-Semiconductor Interface by Localized Surface Plasmon Resonance Structure

Ching-Fuh Lin[1, 2, 3*], Zih-Chun Su[1], Po-Hsien Chiang[1] and Du-Ting Cheng[1]

[1]Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taiwan;

[2]Graduate Institute of Electronics Engineering, National Taiwan University, Taiwan;

[3]Department of Electrical Engineering, National Taiwan University, Taiwan.

Abstract

As a new way to detect and harvest optical energy, hot electrons have attracted a lot of interest. The implementation of surface plasmon resonance (SPR) and localized surface plasmon resonance (LSPR) techniques can further enhance the optical response in optical response. However, most researches of the LSPR mainly focus on the enhanced optical response in the near-infrared range. Here we reveal the effect of LSPR on mid-to-far infrared response of metal-silicon Schottky device through different gradient structures. The strong LSPR effect caused by the inverted pyramidal array structure enables the Cr/Si Schottky photodetector to detect photons with energies below the Schottky barrier. Also, as the size of the pyramid in the silicon surface process becomes larger, the measured wavelength range of the sensor has been extended. The Cr/Si Schottky device without surface structure can only sense 4.26 μm signal. The surface-processed Cr/Si Schottky devices with 12/14/16 μm structures have significantly better sensing performance and are able to detect mid- and far-infrared signals at 6/7/8 μm, respectively. Moreover, the inverted pyramidal structure with gradient dimensional linewidth is also simulated to confirm the relation between resonance ability and the extended cut-off wavelength result.

In summary, we discuss one method to extend the detection range of photodetector. The strong LSPR effect can increase the optical response at photon energies below the silicon band gap. The cut-off wavelengths of the optical response measured for the different designed structures correspond to the normalized resonance spectral intensity trend of the structure.

Biography

Prof. Ching-Fuh Lin obtained the B.S. degree from National Taiwan University in 1983, and the M.S. and Ph.D. degrees from Cornell University, Ithaca, NY, in 1989 and 1993, respectively, all in electrical engineering. He is a joint distinguished professor in the Graduate Institute of Photonics and Optoelectronics, Graduate Institute of Electronics Engineering, and Department of Electrical Engineering at National Taiwan University. He has published over 180 journal papers and 500 conference papers and holds about 90 patents. His major research area includes Si-based photonics, solar cells, micro-LED technologies, etc. He is a Fellow of IEEE and a Fellow of SPIE.

An Example of Complex Modeling in Biology: Studying Molecular Regulation of Membrane Curvature During Endocytosis

Xinxin Wang[1*], Zhiming Chen[2], Sandra L. Schmid[3] and Gaudenz Danuser[1]

[1] University of Texas Southwestern Medical Center, USA;

[2]University of South China, China;

[3]CZ Biohub, USA

Abstract

Mathematical modeling of complex systems has become ever-increasingly demanded in the biology of living cells for validating experiments, creating hypotheses, and interpreting findings. Complex modeling is particularly effective for biological systems at nano-scales, where conducting experiments is challenging. Here, we built a complex model to study clathrin-mediated endocytosis (CME), an essential cellular pathway of internalizing surface-bound cargo molecules. CME plays central roles in many diseases, including COVID, cancer, and Alzheimer's. During CME, multiple endocytic proteins (EP) consecutively reshape the membrane to enclose the cargo into a ~100nm-wide vesicle within ~25 seconds before intracellular release. However, little is clear regarding the details of how the EPs work together to reshape the membrane efficiently. This gap is mainly for the insufficient understanding of the mechanical relation between the EPs and the cell membrane. To fill this gap, we developed a state-of-the-art stochastic model that incorporates the endocytic proteins, the cell membrane, and their mechanical interactions. Our model suggested that the endocytic proteins must collectively reshape the membrane by crossing two bending-energy barriers, occurring when the membrane was 1) initially bent and 2) halfway bent. This prediction helped us infer and experimentally verify that CALM was the first EP initiating the membrane curvature and that Dynamin2 was the second EP finishing the curvature. Particularly, Dynamin2 functioned as a checkpoint that recognized and finished partially-curved vesicles to enhance endocytic efficiency. In sum, complementing quantitative experiments with a complex model, this interdisciplinary study served as an example of bridging physics applications to cell biology.

Biography

Xinxin Wang is a postdoctoral researcher specializing in computational biophysics in the Lyda Hill Department of Bioinformatics at UT Southwestern Medical Center. He is mentored by Dr. Gaudenz Danuser and Dr. Sandra Schmid. Xinxin received his B.S. and M.S. from Beijing Normal University, China, and Ph. D. in physics from Washington University in St. Louis (USA) in 2016. Xinxin is dedicated in collaborative and interdisciplinary research using quantitative models to investigate physics-dependent mechanisms in cell biology. He is also a member of the Diversity, Equality, and Inclusion (DEI) committee in the department to promote DEI for current and prospective employees.

Space-Time Dependence Of The Neutron Multiplication Factor In Spent Fuel Storage

Mosebetsi J Leotlela* and Iyabo Usman

School Of Physics, University of The Witwatersrand, Johannesburg. South Africa

Abstract

The neutron multiplication factor of spent fuel in the spent fuel storage facility is both time-dependent and space-dependent f(x,y,z,t). At any given time and space the neutron multiplication factor (k_{eff}) will either be increasing or decreasing, thus displaying the scalar and vectors components of the k_{eff} .

This article presents the results of analyses of the behaviour of the neutron multiplication factor of spent fuel casks in spent fuel storage.

Biography

Dr Mosebetsi Leotlela was born in 1959 in the Standerton district of South Africa, In 1989, he began his tertiary education by enrolling at the Pretoria Technikon for a National Diploma in Nuclear Technology. For his in-service training, which was a Technikon requirement before one could graduate, he worked at Schonland Nuclear Research Centre (SNRC), which formed part of the University of Witwatersrand together with the Proton Induced Xray Emission (PIXE) group. He went on to do the second part of his in-service training at the Council for Nuclear Safety (CNS) and graduated in 1997.

Detection of Explosive Materials in Dual-Energy X-Ray Security Systems

Ozan Yalçın[1*] and İskender Atilla Reyhancan[2]

[1]Havelsan Teknoloji Radar A.S., Turkey;

[2]Istanbul Technical University, Turkey.

Abstract:

Due to the increasing security needs, X-ray devices have started to be used more and more in security systems. Dual-energy X-ray devices are preferred to conventional ones since they enable Effective Atomic Number ($Zeff$) estimation that cannot be provided by traditional devices, which use density-based segmentation. In this paper, pure material samples are used to obtain system characteristics. Linear mass attenuation coefficients (μ) of the materials can be calculated by using two leveled images, and these coefficients provide information about the $Zeff$ of substances. After that, they can be classified as organic and inorganic via the effective atomic number method and explicitly identified. As well as this, organic explosives can be detected thanks to this simple and effective approach.

Biography:

Ozan YALÇIN is an R&D Engineer at Havelsan Technology Radar (HTR) Co. He received his BS degree in engineering physics and MS degree in radiation science and technology from the Istanbul Technical University in 2016 and 2021, respectively. His current research interests include X-Ray imaging systems.

Entanglement Between Micro-magnetism, Electromagnetism and the Tensor Magnetic Phase Theory–symmetry, Invariance and Conservation Laws Analysis

Olivier Maloberti

UniLaSalle Amiens, France

Abstract

Ferromagnetic materials show magnetic structures with domains and walls [bitter, bloch]. Thanks to decades of research regarding the origin and behavior of magnetic domains [Landau, Lifshitz], we possess now a general foundation which has been verified experimentally in single crystals and powders [kittel]. The governing equations at the microscopic scale were built in the 1960s when Brown published calculations of the magnetic moments distribution inside domain walls [Brown]. This micromagnetic theory uses the so called LLG 'Landau-Lifshitz-Gilbert" equation and can include the damping effects. The LLG equation requires a coupling to the field derived from energy contributions: exchange, anisotropy, magnetostriction, stray-field ... and the anti-eddy field. At the macroscopic scale, such behaviors are lumped in a homogenized magnetization law for the electromagnetic field equations. Therefore, the inhomogeneous magnetic material nature is always ignored. The Tensor Magnetic Phase Theory (TMPT) describes the magnetic structure and the magnetization thanks to a tensor

variable at a mesoscopic scale. The material structuring is then explained thanks to an energy balance to be discussed. This work examines a connection between the TMPT and the LLG by deriving the main energy terms. Then, the TMPT must stay compatible and coupled to the Maxwell equations with volume and surface connections [russakof]. Additionally, this paper investigates the way to derive the domains structuring and magnetization laws through the Lagrange principle and the corresponding conservation laws with invariants kinked to the Noether theorem [noether]. Finally, the TMPT must be discussed while checking its coherence and formulation when changing the referential frame.

Efficiency of Fuel on Structural, Particle Size, Surface Morphology, Magnetic Behaviour and Cytotoxicity Measurements of Zinc Ferrite ($ZnFe_2O_4$) Magnetic Nanoparticles Prepared by Self-sustained Solution Combustion Synthesis and its Anti Microbial Properties

Vidya, R1* and Venketesan. K[2],

[1]VIT School of Agricultural Innovations & Advanced Learning, Vellore Institute of Technology Vellore, India;

[2]SRM Group of Institutions, Tiruchirappalli, India

Abstract

Magnetic nanoparticles have played a major role in several applications because of its interesting properties, and their size of the proposed material. Iron nitrate $Fe(NO_3)_3.9H_2O$, zinc nitrate $Zn(NO_3)_2.6H_2O$, were used as an oxidizer and alanine ($C_3H_7NO_2$) was used as a fuel for the solution combustion synthesis (SCS). As-prepared powder was studied by powder x-ray diffraction (PXRD), Raman, FE-SEM with EDAX & HR-TEM, VSM, anti-microbial and cytotoxicity measurements. By changing the fuel ratio, the adiabatic temperature of the flame could be controlled, also optimized the size of the particle as 28 ± 5 nm to 40 ± 5 nm, which had a great impact on its surface nature and magnetic properties [1, 2]. The particles shape was modified as triangle and spherical by changing the fuel, which was examined by HR-TEM analysis. The anti-microbial activity was performed to confirm the minimum inhibitory concentration (MIC) of 50 mg/L. It was observed that the lowest concentration of 40 - 60 μg/ml zinc ferrite magnetic nanoparticles were inhibited 50 % of MCF-7 cancer cell lines.

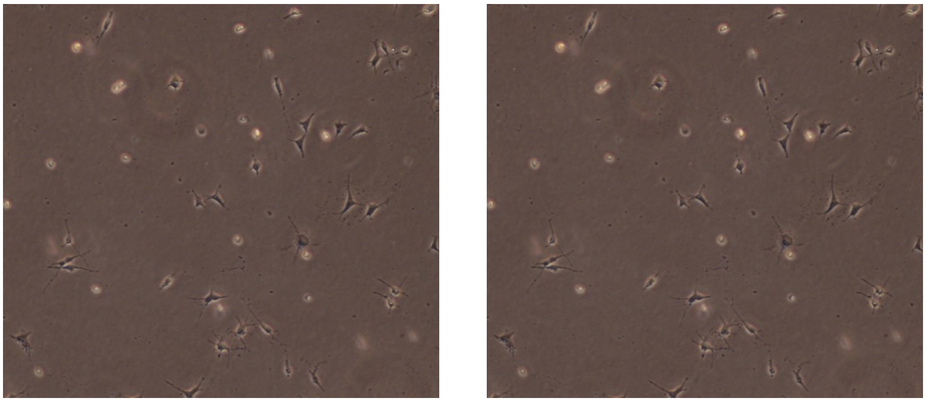

Fig.1. Cancer cells without and with treating $ZnFe_2O_4$ magnetic nanoparticles

On Fibrous Growth During the Discontinuous Precipitation: A Phase-field Study

Lynda Amirouche[1,2*], Aniss Ryad Ladjeroud[1] and Mathis Plapp[2]

[1]Laboratory of Theoretical Physics, Faculty of Physics, USTHB, Algiers;

[2]Condensed Matter Physics Laboratory, CNRS, Ecole Polytechnique, Institute Polytechnic of Paris, France.

Abstract

Taking place at grain boundaries, discontinuous precipitation is a solid-state phase transformation in which a supersaturated α0 matrix decomposes into a solute-rich β-precipitate and a depleted α-phase. The decomposition is systematically accompanied by a grain boundary migration, which is required for the growth of the two product phases. As a result, the rate-controlling step for the reaction is essentially grain boundary diffusion. Discontinuous precipitation results in morphologies that are typically lamellar. However, fibrous and globular structures are also observed, for example in the Cu-Co alloy. We have previously developed a phase-field model for discontinuous precipitation, and many two-dimensional (2D) simulations have been carried out to survey some fundamental features/aspects of discontinuous precipitation, such as the role of the ratio of volume to interface diffusivities. In particular, it has been observed that volume diffusion contribution, gave rise to a growth kinetics of β-precipitates analogous to a growing needle crystal in a channel. In the present contribution, three-dimensional (3D) phase-field simulations have been performed to investigate the morphological stability of lamellar precipitates during discontinuous precipitation. The effect of a numerically induced noise on the stability of the β-precipitates is investigated, in the presence of volume diffusion. The numerical noise has resulted in a symmetry breaking, which leads to a transition to fibrous growth for a sample thickness above a critical value. Due to the high supersaturations necessary to obtain tractable simulation times in our phase-field model, α-lamellae instead of β ones have been observed to form the minor phase. Consequently, the lamellar to fibrous transition has yield α-fibers rather than β ones.

Biography

Lynda Amirouche is a teacher-researcher at Algiers University for Science and Technology USTHB. She is typically interested in both theoretical and experimental investigations in Materials Science. In particular, her main field of interest is modeling alloys microstructure's formation at different scales by using different techniques such as Molecular Dynamics and Phase-Field. She is also interested in correlations emerging between microstructures and alloy's physical and mechanical properties.

Keynote Presentations

The Human Auditory System and the Time-frequency Relationship

Milind N. Kunchur[1]

[1]Department of Physics and Astronomy, University of South Carolina, USA

Abstract:

Human senses have mind-boggling capabilities, sensitivity, and dynamic range. Our hearing has microseconds temporal resolution. And the ear's sensitivity extends down to the level of thermal motion, with a picometer detection threshold for the cochlear basilar-membrane amplitude. These extraordinary attributes of hearing impact the perception and reproduction of musical sounds, which have been shrouded in misconceptions and controversies for half a century. Consequently, consumer audio systems typically bear a distant resemblance to live music. This talk will explain how time plays an independent role, from just being the reciprocal of frequency, in the determination of spatial locations and timbre (tonal quality) of sounds.

Biography:

Milind N. Kunchur is a Governor's Distinguished Professor and Michael J. Mungo Distinguished Professor at the University of South Carolina. Ph.D. in Physics from Rutgers University, USA. Fellow of the American Physical Society. South Carolina winner of the CASE and Carnegie Foundation U.S. Professors of the Year award. Received the George B. Pegram Medal, Ralph E. Powe Award, Donald S. Russell Award, Martin-Marietta Award, Michael A. Hill Award, and Michael J. Mungo Award. Held a National Research Council Senior Fellowship. Served on panels for the National Science Foundation, US Department of Energy, Audio Engineering Society and other agencies.

Mechanics Meets Electronics at the Nanolevel Ruling Out Heat. Case Study: a Field Effect Transistor based on Ballistic Charge Transport

Manuel G. Velarde

Instituto Pluridisciplinar, Universidad Complutense, Spain

Abstract

I shall be reporting about a theory of nano-soliton-assisted electron (and positive hole) transport in anharmonic crystal lattices (kind of electron surfing on lattice solitons hence offering mechanical control of charges at the nano-level). And as a by-product I shall refer to a recently patented field effect transistor, SFET (and its inverter). One appealing feature

of this novel transistor is its ballistic, mostly supersonic velocity predicted along the (source-drain) channel. Such ballistic character rules out heat (no Ohm's law hence no Joule's heating); heat is only linked to the use of metals for Source, Drain and Gate ports. Another worth mentioning feature is the fact of not using silicon by replacing it by, e.g., polydiacetylene (PDA) or some similar semiconductor or insulating crystal. PDA is a non dopable, perfect crystal. Further it is an electronically one-dimensional chain/"wire".

Biography

Manuel G. Velarde was born on 14 September 1941. He is the Honorary Doctor at Univ. Aix-Marseiile-France, Saratov University-Russian Federation and University of Almeria-Spain. He is a Spanish physicist and university professor, currently a member of the Academia Europaea, the Royal Academy of Doctors of Spain and the European Academy of Sciences. He has worked in American and European universities and research organizations, focusing on fluid dynamics and other non-linear problems, including the kinetic and thermodynamic theories, hydrodynamic and interfacial instabilities, anharmonic lattices and electronics. Because of his research achievements and international cooperation, he received the insignia of Officer of the National Order of Merit of France, belongs to the Ordre des Palmes Académiques, and holds the Blaise Pascal Medal of EURASC and Dupont Science Prize.

Integrable Peakon Models in Nonlinear Mathematical Physics

Zhijun Qiao

University of Texas Rio Grande Valley, Edinburg, TX, USA

Abstract

In this talk, we will introduce integrable peakon models in nonlinear sciences developed in recent years and present a basic approach how to get the peakon models and peakon solutions. We will see that the well-known CH equation is included in the negative order CH hierarchy while the Dym type equation is included in the positive order CH hierarchy. In particular, the CH peakon equation is extended to the b-family quadratic and cubic peakon models with peakon and weak-kink solutions. We will also present new type of peakon solutions of partial differential equations, called rogue peakons provided with an non-traveling wave. Some linear and nonlinear models are taken to illustrate the rogue peakon solutions. In the end of my talk, some open problems are also addressed for discussion.

Biography

Dr. Zhijun Qiao, President's Endowed Professor, University of Texas Rio Grande Valley. Dr. Qiao received PhD degree of Mathematics 1997 from Fudan University. His research interests include nonlinear partial differential equations, integrable systems and nonlinear cusp solitary waves, KdV equations and soliton theory, integrable symplectic mapping, R-matrix theory, radar image processing and inverse problems in mathematical physics. In 1999, he won one of the hundred best doctoral dissertations in all natural and social sciences in China. From 1999 to 2001, he was Humboldt fellow in Kassel University, Germany. He was awarded the University of Texas Distinguished Research Award in 2013 and the University of Texas President's Endowed Professor in 2016. Dr. Qiao was the PI of more than 20 national and international research grants. He published more than 150 academic papers and 2 books including top ranking journals Communications in Mathematical Physics, IEEE Transaction on Geoscience and Remote Sensing (TGRS). He is currently serving on the editorial board of Studies in Applied Mathematics and deputy editor-in-chief of Journal of Nonlinear Mathematical Physics.

Oral Presentations

Nano-strained Quantum Dots with Siloxane Passivation

Xianghua Wang*, Shaoqi Zhuo and Xudong Zhao

Hefei University of Technology, China

Abstract

Lattice strain in a nanoscale colloid is largely unexplored as characterization of their lattice structure becomes less effective by X-ray diffraction (XRD). Stability of a colloid system is hindered by aggregation and sedimentation phenomena, which are driven by the colloid's tendency to reduce surface energy. Reducing the interfacial tension will stabilize the colloidal system by reducing this driving force. Matching of refractive index across a microscopic interface can dramatically relieve the attractive van der Waals force. These knowledges indicate that mechanical interaction and the resultant strain are sensitive to interface species, which eventually dictates the morphology, solution processability and optical properties of the colloids. Owing to the near unity photoluminescence quantum yield of colloidal perovskite quantum dots (PQDs), the effects arising from lattice strain are possibly studied systematically.

It is shown by experiment as well as theoretical calculation that siloxane passivation of PQDs prominently modulates the UV-Vis absorbance and photoluminescence brightness via lattice strain, which can be identified by powder and thin film XRD as fingerprint patterns. More recently, diagnostic vibrational peaks at 1641 and 908 cm^{-1} wavenumbers was observed for siloxane passivated PQDs, which can be ascribed to the silane group of the ligand molecules. These discoveries contribute to nanostrain characterization methodologies, meanwhile siloxane passivation favorably contribute to ion doping, producing novel blue light-emitting PQDs with intrinsically improved photostability as well as enhanced exciton confinement that inhibits Förster resonance energy transfer (FRET). Strain engineering with a siloxane shell is promising by virtue of emerging spectra-based metrologies.

Biography

Dr. Wang received a bachelor's degree in physics from Shandong University, a master's degree in materials science and engineering from Shanghai Institute of Ceramics, Chinese Academy of Sciences in 2003. Since then he has been interested in strain effects on nanomaterials. He worked as an engineer at SMIC for 3 years since 2003, and later graduated from The University of Hong Kong with a doctor's degree in electronic engineering. He has been an associate research fellow at Hefei University of Technology since 2011, where his research is focused on light-emitting materials and devices as well as micro and nanomanufacturing.

On Some Multiple Integrals Encountered in Relativistic Electrodynamics Calculations

Georgeta Vaman

Institute of Atomic Physics, Romania

Abstract

In the calculation of the electromagnetic field and the electromagnetic self-force of a Lorentz-contractible spherical shell in rectilinear arbitrary motion, we encountered some multiple integrals whose evaluation is not simple. As far as we know, these integrals were not evaluated in closed form in the literature. We evaluate and discuss them here.

Structural Aroperties and Antibacterial Activity of Zinc Sulfide Powders

Ftema W. Aldbea[1*], Ruqayah Abdulsalam Almahdi[1], Zenab Abdoorhman[1], Nada Abusalah Imrigha[1], Pramod. K Singh[2] and Carlos Vazquez Vazquez[3]

[1]Sebha University, Libya;

[2]Sharda University, India;

[3]Universidade de Santiago de Compostela, Spain

Abstract:

Zinc sulfide powders (ZNS) have been prepared using the sol-gel method at different pH values of 5, 6, and 7. The Samples dried at 200 °C. XRD results showed that samples at various pH values have a cubic crystal structure. The combination of ZnS and the antibiotics chloramphenicol (C30 mg, Gentamycin) and nalidixic acid (NA 30 mg) resulted in a significant decrease in the activity of both *Bacillus cereus* and *Salmonella typhi*. This result has been discussed in detail.

Biography:

Experienced Physics with a demonstrated history of working in the research industry. Skilled in EDX, Materials Science, Value Stream Mapping, Spectroscopy, and Nanotechnology. Strong professional with a Doctor of Philosophy (PhD) focused in Thin Film from School of Applied physics, Science and Technology, Univirsiti Kebangsaan Malaysia, Malaysia.

Optimal Geometry of the Vortex Domain Wall Pinning in Constricted Magnetic Nanowires

Mohammed Al Bahri

Department of Basic Sciences, A'Sharqiyah University, Oman

Abstract:

Background: Racetrack memory is the one technology based on magnetic domain wall (DW) motion in nanowires with the potential of application advantages such as fast access to the stored information, high storage capacities and low power consumption. Therefore,

a series of remarkable studies have been devoted to manipulate and control static and dynamic DWs in ferromagnetic devices such as nanowires and nanostrips.

Objective: This study aims to investigate the Vortex domain wall dynamics and its pinning through the stepped magnetic nanowire by using spin-transfer torque.

Methods: The micromagnetic simulation was conducted by object-oriented micromagnetic framework (OOMMF) software to investigate the domain wall pinning in magnetic nanowires.

Results: Controlling Vortex Domain wall (VDW) dynamics and stability in a nanowire is a crucial issue for DW storage memory. In this study, VDW pinning was investigated by using micromagnetic simulation. A new way is proposed for VDW pinning by creating a stepped notch. This way is a convenient way to pin DW with different structures. A stepped area is constricted at the center of the nanowire with proportions of depth (d)) and length (λ) to pin the magnetic domain wall (DW) with high barrier potential energy to achieve a high information storage capacity. It is found that the VDW stability structure and pinning at the stepped area depends on the magnetic material properties and the stepped area geometries. From this study, it can be concluded that the stability type of the VDW with CW chirality and up polarity during its propagation in stepped nanowire could be controlled by improving the magnetic properties like saturation magnetization (Ms), decreasing the current density and manipulating the stepped area dimensions (d)) and (λ).

Biography

Dr. Mohammed Al Bahri, is presently working as an assistant professor in Physics at A'Sharqiyah University in Oman. He has worked in the Ministry of Education in Oman for around 20 years in Monitoring and evaluating student learning. He got his Ph.D. degree from Sultan Qaboos University in Oman in 2018. He is working as a researcher in nanoscience magnetic materials, especially magnetic nanowires and magnetic domain walls. He has 12 papers published in various Web of Science journals 110 citations in Google scholar. He had been awarded the best presenter in International Conference on Magnetism and Magnetic Materials(ICMMM 2020), Spain, Barcelona, 17-18 August 2020. He had been assigned different responsibilities in his current institution, like a chair of the learning and teaching committee, the chair of the community service committee, and a member of different committees.

Bi-Complex Algebra Applications to Electromagnetic Waves and Beam Dynamics

A.V. Smirnov[1]

[1]Advanced Energy Industries, 888 E. Tasman Dr, Milpitas, CA, United States

Abstract

Among the elegant properties of scalar hyper-complex algebra is its Euler formula that can be written as Exp(ij□x) = cosh(x) + ij□sinh(x). Two simple examples of the algebra application are considered: eigenmodes of hybrid asymmetric modes in a waveguide as a generalization of Panofsky-Wenzel Theorem and dispersion equation describing charged beam breakup phenomenon in such a waveguide in presence of a solenoidal magnetostatic field. The analysis is performed in a very compact form with transparent physical meaning of all four components of the collective frequency f of the instability. Rotating polarization of the collective field is determined by $Im_i Im_j f$, which numerical estimate is in agreement with

prior experimental data. The other three components represent detuning of the collective frequency $Re_i Re_j f$, the "left-hand", and "right-hand" increments of the instability $Im_i Re_j f$ and $Im_i Re_j f$ respectively.

Biography

Alexei Vladimirovich Smirnov received his Ph.D. in 1986 from Moscow Engineering Physics Institute. Performed R&D on particle accelerators and radiation facilities in Former Soviet Union, Russia, Europe and in US. He has 13 patents, about 150 publications, and 25 invited talks. He led a number of DoE, DHS, and DoD funded projects including DARPA, Army, Navy, Air Force, and MDA. He introduced and developed a compact high power pulsed terahertz sources, innovative linacs/klylacs/klynacs, microtron+rhodotron, FEL/FEM and HV pulsed and directed energy systems/components. Designated by Visibly Better and ROAR awards (ViewRay), Navy SBIR/STTR Transition program, DoE Stewardship as well as NIM and RSI journals as a reviewer.

Using Fractal Geometry to Study Signals with Scale-Free Dynamics

Tahmineh Azizi

University of Wisconsin-Madison, Madison, WI, USA

Abstract

Sometimes when we study signal regularity, we may see some phenomena that do not have characteristic scale. These scale free signals have been observed in biomedical signal processing, geophysics, finance, and internet traffic. To clarify more, when data is translation invariant, we may need to estimate autocorrelation or power spectral density (PSD) means that signal statistics like mean and variance do not change over time. In another hand, those signals that do not have characteristic scale, called scale-invariant signals that means the signal statistics do not change if we stretch or shrink the time axis. When we study translation invariant or scale invariant signals, or the signals with different scaling behaviour, we are not able to use the classical signal processing and we need to perform fractal analysis. When we study real world signals in biology, finance and so on, depending on scale and higher order moments, we may confront with signals that display nonlinear power-law behaviours. For these type signals, we need to apply multifractal analysis. In multifractal analysis we discover whether some type of power-law scaling exists for various statistical moments at different scales. A process called mono-fractal, if it can be characterized using a single scaling exponent, or this process is a linear function of the moments. Likewise, a process called multi-fractal, if we see the scaling behaviour follows a function which is non-linear in the moments. In this study, we will review these type processes and will provide some examples to compare the multifractal spectra of two financial time series along with the brown noise

Physical-mathematical Modeling of Water Networks and Related Problems

Fabio Caldarola[1*], Manuela Carini[1] and Mario Maiolo[1]

[1]Department of Environmental Engineering (DIAm), University of Calabria, 87036 Arcavacata di Rende (CS), Italy

Abstract

In recent years, mathematical models applied to water networks have seen exponential growth. This has resulted in a copious series of results, indicators and parameters, often of a physical-energy nature, which have found great value and utility in the engineering field. For example, many variants of indices called resilience, entropy, robustness, flow deficit, failure, balance, mechanical redundancy, reliability, etc., have been introduced, and some of them have been implemented in computational and technical software spread all over the world. In the opinion of the authors, the biggest limitation that the mathematical models in current use possess, as well as the works present in the literature, is the fact that they are constructed as models of a global and/or cumulative nature. To overcome this, since 2019 the authors have begun to propose a series of papers focused on analyzes and models of a local nature. In this talk we will therefore show a number of indices of local nature (local {supply, pressure, piezometric head, power} surplus, etc.) together with a powerful mathematical framework which will not only allow to recover the classic global analyzes already known, but it will go much further. In this way it is in fact possible to give new and more hidden interpretations to already known measures, but also to highlight and correct their defects. As a further example we will also discuss some invariance problems with respect to reference systems and we will propose some mathematical solutions.

Biography

F. Caldarola received the PhD degree in Mathematics in 2013 with a thesis in algebraic number theory. He has taught mathematics and mathematical physics in many courses at University of Calabria (Italy) and is the authors of more than 30 papers in international journals. After some post doc positions, he currently is assistant professor at the Dep. of Environmental Engineering (DIAm) at the University of Calabria. His research interests range from chaos theory to cellular automata, from mathematical models applied to coastal equilibria and erosion, to shallow water waves.

Regularity, Profiles of Solutions and Evolution of Supports for Modeling a Flame Propagation in a Porous Medium

Jose Luis Díaz Palencia[1*], Saeed ur Rahman[2] and Julian Roa Gonzalez[1]

[1]Department of Education, Distance University of Madrid, Spain;

[2]Department of Mathematics, COMSATS University Islamabad, Abbottabad, Pakistan

Abstract

The analysis to be presented deals with a model of a flame propagation in a porous medium. To introduce the governing equations, we depart from previously reported models in flame propagation, and we propose a new modeling conception based on a p-Laplacian operator. Such an operator is intended to reproduce the diffusive principles given in a porous medium, that are linked with fast and slow diffusion mechanisms. In addition, we introduce a nonlinear reaction term, that generalizes the classical KPP-Fisher model, of typical use in combustion. Our analysis shows first the boundedness and uniqueness of weak solutions. Afterward, we reformulate the driving equations using the travelling wave technique; and we introduce a density and flux ansatz to analyze the stability of a critical point. We obtain asymptotic profiles of travelling wave solutions, by making use of the Geometric Perturbation Theory.

Eventually, we obtain upper solutions with self-similar forms, that provide an analytical expression for the propagation of a finite support, that can be understood as a propagating front. This is particularly applicable for flames departing from compactly supported initial pressure - temperature distributions

Biography

Dr. Jose Luis Diaz is PhD in Sciences and Technology and M.Sc. in Aerospace Engineering. He has developed his researches in Applied Mathematics, Fluid Mechanics and Biomathematics. He is currently Associate Professor of Mathematics at the Open Madrid University (UDIMA). Dr. Saeed ur Rahman is PhD in Mathematics. His area of research is related with pure and applied mathematics with emphasis in biomathematics and fluid mechanics. He is currently Assistant Professor of Mathematics at COMSATS University of Islamabad. Dr. Julián Roa González is PhD in Didactics of Mathematics and MsC in Engineering. His main area of research is related with the Interdisplinary Mathematics, from modeling to didactics. He is currently Dean at the Open Madrid University (UDIMA)

Strong Rate of Convergence of Time Euler Schemes for a Stochastic 2D Boussinesq Model

Annie Millet[1*] and Hakima Bessaih[2]

[1]University Paris 1, SAMM, France;

[2]Florida International University, Mathematics and Statistics, USA

Abstract

We prove the convergence of an implicit time Euler scheme for the 2D-Boussinesq model on the torus D subject to a multiplicative stochastic perturbation. Various moment of the $W^{1,2}(D)$-norms of the velocity and temperature, as well as their discretizations, are computed. We obtain the optimal rate of convergence in probability, and a logarithmic speed of convergence in $L^2(\Omega)$.

These results are deduced from a time regularity of the solution both in $L^2(D)$ and $W^{1,2}(D)$, and from an $L^2(\Omega)$ convergence restricted to a subset where the $W^{1,2}(D)$-norms of the solutions are bounded.

On the Algebraic Structure of General Mechanics

Jody Trout

Dartmouth College

Abstract:

Using ideas of Strocchi, Iochum & Loupias, and Faddeev & Yakubovskii, we give an operational derivation of the Jordan-Banach algebra structure of the kinematics of (bounded) observables in a general theory of mechanics (classical and quantum) from a set of four axiomatic assumptions. The central tools are the duality pairing between states and observables given by expectation values, the operational association of these expectation

values with measurement outcomes in experiments and polynomial rescalings of observable measuring devices. We then discuss how to include time evolution via a fifth axiom for an h-bar-dynamical correspondence via Alfsen & Schultz. This is current joint work with Shadi Ali Ahmad '22.

Biography:

Jody Trout is a Associate Professor of Mathematics at Dartmouth College. Research interests in operator algebras, noncommutative geometry, functional analysis and mathematical physics.

Geometric and Optical Properties of Pits in CR-39 Plastic Etched after Irradiation by 216 MeV/amu 12C Beam at Different Depths of Water-chamber

V. Ditlov[1], A. Bakhmutova[1] and M. Kolyvanova[2]

[1]A.I. Alikhanov Institute for Theoretical and Experimental Physics NRC "Kurchatov Institute", Moscow, Russia.

[2]State Research Center-Burnasyan Federal Medical Biophysical Center of Federal Medical Biological Agency, Moscow, Russia.

Abstract

This work belongs to the direction of multilateral research of the system of the accelerated beam 12C plus the CR-39 plastic detector. The use of a highly sensitive plastic detector, on the one hand, makes it possible to study the properties of the ion beam [1], on the other hand, it makes it possible to investigate the results of the action of the beam on the plastic detector itself [2]. Both results are very important for numerous physical studies medical applications, but in addition to these studies, the second result allows changing the properties of surfaces and the internal structure of materials by irradiation with ions, which can be important for the field of Nanocience. Beam of 216 MeV/amu 12C ions irradiated CR-39 plates in biochamber at the TWAC-ITEP accelerator. The plates were etched and dried. A system microscope-computer made about 50 scanned micrographs from each surface of eight plastic plates irradiated in different depths of biochamber filled by water (main experiment) and of one plate irradiated in the same biochamber but filled by air (auxiliary experiment). Publication [1] presents a method for finding and automatically recognizing etched pits. Publication [2] gives the geometric and optical parameters of the etched pores. This report presents some of the results from these publications and some additional parameters of the etched pores that may be of interest to Nanoscience.

Biography

V. Ditlov was a postgraduate student of Professor Bogomolov from 1972 to 1975, who developed a wide class of photo-materials. In 1985, at Flerov Laboratory (JINR), he defended his dissertation "Theory of nuclear solid-state track detectors" for the degree of candidate of physical and mathematical sciences. Since 1997, he has been a leading researcher at the Alikhanov Institute of Theoretical and Experimental Physics of Kurchatov Scientific Center, Moscow. In 2010 he defended his thesis "Application and Development of Theory of Solid State Track Detectors" for the degree of Doctor of Physical and Mathematical Sciences in the Veksler and Baldin Laboratory (JINR). From 2014 he is visiting professor at Moscow State University.

Autonomous Human-machine Teams: The Embodied Cognition of Interdependence Leads to the Discovery of Shannon Information Losses

William F. Lawless

Paine College, Departments of Math & Psychology, Augusta, GA, USA

Abstract

We have previously postulated mathematically that the entropy produced by the structure of a team occurs in a trade-off with the team's productivity, whether for humans or for autonomous human-machine teams and systems. Theoretically, these teams are interdependently embodied cognitive systems that mimic quantum mechanics, but, and surprisingly, where the perfect team's structure loses Shannon information in the limit. Although our theory began to take on a more formal nature in 2017, and although our theory continues to develop, it remains a work in progress. In addition to the results that we have published over the years, we also depend on findings in the published literature, especially findings reported by the National Academy of Sciences for human teams in 2015; and the Academy for human-AI (machine) teams in 2021. In that the science we pursue is not laboratory science but open science, we also depend on open sources of data for our results (e.g., as predicted, mergers seek to improve a team's fittedness, but with random outcomes, randomizing team choices; and oppression increases central power by reducing interdependence, optimization, innovation and defenses). If the loss of Shannon information is validated, this phenomenon will have a dramatic impact on advancing theory for the science of teams and systems.

Biography

William F. Lawless was in charge of nuclear waste management in 1983 when he blew the whistle on Department of Energy's mismanagement. For his PhD, he theorized about the causes of tragic mistakes by large organizations with world-class engineers. Afterwards, DOE invited him to join its citizens advisory board at its Savannah River Site, where he coauthored numerous recommendations (e.g., the regulated closure in 1997 of the first two high-level radioactive waste tanks). His research is on autonomous human-machine teams. He has authored over 300 peer-reviewed publications, 9 books, and 3 special interest issues.

The Effect of Biaxial Strain on the Electronic Properties of (SnO2/TiO2)n Superlattices

Najwa Harrati[1*] and Adlane Sayede[1]

[1]Univ. Artois, UMR 8181, Unité de Catalyse et de Chimie du Solide (UCCS), F-62300 Lens, France

Abstract

The objective of this study is to develop more efficient semiconductor materials for photocatalytic water splitting by implementing a superlattice structure. While Metal oxides such as TiO_2 and SnO_2 show promise for water splitting, their large band gap limits their effectiveness in absorbing sunlight [1][2] . To address this issue, the study investigates the impact of biaxial strain on the structural and electronic properties of (SnO_2/TiO_2)n superlattices through first principles calculations. As the ratio of the two materials was changed (n=1,

2, 3), the study found that the superlattices displayed low band gaps, which were even smaller than those of the parent materials due to octahedral distortion. Under tensile and compressive strain, the band gap energy decreased except at -1% where opposite behavior was observed. Moreover, the material exhibited excellent stability as demonstrated by its phonon dispersion. These results suggest that implementing a superlattice structure is a promising approach for adjusting the band gap when biaxial strain is applied.

Powerful Ordered Collective Heat Engine

Carlos E. Fiore

Institute of Physics of University of Sao Paulo, Brazil

Abstract

The issue about building efficient engines is not only prominent but also pressing in thermodynamics since the pioneer work by Sadi Carnot and has been strongly strengthened with the growing of nonequilibrium and quantum thermodynamics of small-scale engines. Bearing this in mind, a sort of distinct approaches has been proposed, but most of them deal with engines composed of a single or few unities. Here we present a class of engines operating collectively under ordered array which can be harnessed for levering its performance and guiding the regime of operation. Our approach encompasses a setup composed of N interacting unities placed in contact with two thermal baths and subjected to a constant driving worksource.

The interplay between ordered arrays and optimal parameter choices provide maximal power and efficiency, the former and latter being able to reach CurzonAhlborn η_{CA} (including greater than η_{CA}) and Carnot η_c bounds, respectively. Engine portraits are captured by treating ordered effects by means of a (phenomenological) two state model. The present framework paves the way for the building of promising nonequilibrium thermal machines based on ordered arrangements.

Analytical Approximation of Optimal Thermoeconomic Efficiencies for a Stefan-boltzmann-type Heat Transfer Law

Angela M. Ares de Parga-Regalado

[1]Division of Mathematics and Engineering, Faculty of Higher Studies Acatlán, National Autonomous University of Mexico, Mexico;

[2]Mathematics Department, Higher School of Physics and Mathematics, National Polytechnic nstitute, Mexico

Abstract

From a semi-analytical method, analytical expressions for the optimal thermoeconomic efficiencies are found for a Novikov model using a radiative heat transfer law. All this is within the context of finite-time thermodynamics for the three modes of operation: maximum power, ecological regime, and efficient power regime. Included in the analysis are the fuel-related costs and the operation and maintenance costs of the power plants

that can be studied from the model considered. The obtained expressions are a reasonable approximation compared with the optimum efficiencies numerical results.

Biography

Angela Mercedes Ares de Parga Regalado was born in Mexico City in 1989 and graduated from ESFM of IPN of Mexico, where she completed her undergraduate and graduate studies. In all cases, with a major in physics. For her doctoral studies, she worked on black hole perturbations, and currently, she is researching topics related to finite-time thermodynamics. She has been a national research candidate since 2021 at the National System of Researchers of Mexico. Since 2015 she has been a lecturer at FES-Acatlan of UNAM and recently joined the faculty of the Mathematical Engineering degree program at ESFM

Ceramic Deposition by Low Pressure Cold Gas Spray

John Henao[1*], Astrid Giraldo[2], Carlos Poblano-Salas[3], Jorge Corona-Castuera[3] and Paola Forero[4]

[1]CONACYT-CIATEQ A.C., Mexico;

[2]CONACYT-CINVESTAV Queretaro Unit, Mexico;

[3]CIATEQ A.C., Mexico;

[4] National Technology of Mexico Campus of Queretaro, Mexico.

Abstract

Metallic materials can be deposited by cold spray (CS) through solid-state impacts that activate plastic deformation-based mechanisms. However, for brittle ceramics, the deposition process of solid-state brittle ceramic particles is not fully understood and there are still open research questions. Interestingly, recent literature about the deposition of TiO_2 and hydroxyapatite powders have shown that these brittle materials could be deposited by CS. In this work, computational fluid dynamics and kinetic and thermal analysis of ceramic particles at impact was performed in the low-pressure CS process (<10 bar) to gain a better comprehension of conditions required for the deposition of fragile ceramics. Additional above, experimental observation of deposited particles was carried out to visualize the type of impact that can led to the formation of a ceramic coating. Experimental and computational calculations are compared against previous literature reports. The results reveal that formation of material cumulus and contribution of thermal energy can be a key factor for successful deposition of ceramics by CS.

Biography

John Henao is a PhD in Engineering and Advanced Technologies, MSc. In Advanced Materials, and Materials Engineer. He has more than 10 years of experience in thermal spraying and several publications in the field of materials science and thermal spray coatings. He is currently research fellow from the National Council of Science and Technology (CONACYT) in Mexico assigned to the Advanced Technology Center (CIATEQ) in Queretaro, Mexico, where he is focused on the development of research projects related to bioactive coatings, thermal spraying, and materials for energy and water applications.

Optofluidic Devices: The Pinball Platform for Multiomic Disease Diagnosis

Sara Abalde-Cela

International Iberian Nanotechnology Laboratory, Avenida Mestre José Veiga s/n, 4715-330 Braga, Portugal

Abstract

The capacity of microfluidic platforms as tiny labs transitioned from a potential to a reality as demonstrated in the past 20 years. The microfluidics community developed extremely advanced systems able to perform almost any chemical and/or biological lab protocol. However, in order to develop integrated lab-on-a-chip diagnostic platforms, it is crucial to couple microfluidic devices with detection strategies able to match the inherent properties of microfluidics: highthroughput, automation and miniaturisation. One of those detection techniques is surfaceenhanced Raman scattering (SERS) spectroscopy, an ultrasensitive and highly selective analytical technique with multiplexing ability. SERS is based on the use of plasmonic nanoparticles that act as nanoantennas and augment the very specific Raman signatures of molecules close to the nanostructured surfaces. We have shown how the integration of different SERS sensing substrates and strategies within microfluidics and microdroplets offers a great flexibility for the diagnosis of several biological species and/or events. I will show examples in the context of liquid biopsy for single-cell multiplex phenotypic analysis, detection of panels of mutations in cancer or the differentiation of cancer versus healthy cells. These approaches may be transferred to different analytical fields, such as the detection and discrimination of foodborne pathogens, bacteria or viruses in food or water samples.

Biography

Dr Sara Abalde-Cela is a Principal Investigator at the Medical Devices group of the International Iberian Nanotechnology Laboratory (Portugal). Her experience ranges from nanotechnology, or Raman spectroscopy to microfluidics and microdroplets, liquid biopsy and technology transfer. She has also been active in teaching and start-up programs internationally (Cambridge, Boston, London, Vigo, and Braga). In the course of her career, Sara received research awards and recognitions, as well as attracted +5 million € in competitive international and European funding. Sara is also the co-founder and CTO of the start-up RUBYnanomed having raised more than 5 million € for innovation to date.

Dynamics of Covid-19 and Social Distancing: Insights from an Epidemiological SIRSi-Vaccine Model with Forced Limit Cycles

Diego Paolo Ferruzzo Correa[1*], Cristiane Mileo Batistela Gouvea[1], Atila Madureira Bueno[2] and Jose Roberto Castilho Piqueira[2]

[1]Federal University of ABC, Brazil

[2]University of Sao Paulo, Brazil

Abstract

In this study, we present an epidemiological SIRSi-vaccine model that describes the early

dynamics of Covid-19. We adjust the model parameters using official public data on confirmed cases and social distancing measures. Our analysis includes the global stability of the endemic and disease-free equilibrium and determines a transcritical bifurcation diagram that depicts the alternation of stability between the two equilibria when the vaccination rate and isolation index are varied.

Furthermore, we found numerical evidence suggesting that small amplitude oscillations observed in the social distancing time series can force stable oscillatory limit cycles in the phase portrait, breaking the endemic equilibrium even in the presence of vaccination measures. This mechanism of inducing forced oscillations in the spread of the disease may contribute to explaining the emergence of consecutive pandemic waves. Our study highlights the importance of effective social distancing measures in controlling the spread of Covid-19 and suggests the need for continued vigilance even with widespread vaccination.

Our findings offer insights into the early dynamics of Covid-19 and the potential impact of vaccination and social distancing measures on controlling the pandemic. This study will be of interest to researchers and policymakers in the fields of epidemiology, public health, and infectious diseases, and non-linear dynamics.

Resolution Capability of Resist and Throughput using Alkaline Treatment under Ultrasonic Irradiation

Hideto Onishi[1*], Mikio Miyake[2] and Hajime Shirai[1]

[1]Graduate School of Science and Engineering, Saitama University, Japan

[2] Japan Advanced Institute of Science and Technology, Japan

Abstract

Alkaline treatment of the photoresist under ultrasonic irradiation has been investigated to improve the resolution capability of resist patterns with higher throughput. The selectively dissolved phenol resin for the combination of the alkaline treatment with ultrasonic irradiation was increased by 2.3 times compared to the solely alkaline treatment. The sensitizing effect of naphthoquinone diazide (sensitizer) based on phenol was increased to 0.46 against dip treatment of 0.31. As a result, resist sensitivity was increased to 26% and the resolution capability was drastically improved. Consequently, the 0.5 μm line and space resist patterns were resolved completely with fine profile by using the photoresist with a 0.7 μm resolution limit together with g-line exposure machine with a 0.6 μm resolution limit. As a consequence, a high throughput of 25 wafers/min was achieved, which was more than 25 times higher than that of electron beam (EB) lithography.

Biography

Hideto Onishi is the doctoral student in the Graduate School of Science and Engineering, Saitama University, Japan. He has been engaged in the development of the semiconductor process in the power semiconductor company for 38 years, focusing on the lithography technology, sputtering technology, plasma etching technology and their combinations. He is also developing manufacturing processes to control electrical characteristics of the devices.

Resolution Improvement of Ultrasound 3D Imaging by Single Transmitter/ Receiver System

Norio Tagawa* and Mohd. Syaryadhi

Tokyo Metropolitan University, Japan

Abstract

3D ultrasound imaging can be achieved directly by using 2D arrays, but this involves complex electronics and is more expensive. Therefore, imaging with a single oscillator or a single transmitter/receiver system has been studied. In principle, imaging can be achieved by transmitting and receiving spatially encoded ultrasound pulses that can identify each point in the target medium. Spatial coding can be realized in various ways, and we are considering proposing some of them. In this report, we assume a simple and easy-to-realize random mask method that has already been proposed, and present our proposed high-resolution image processing method using this method.

Pulses are transmitted and a single time series of echoes are received through an uneven mask affixed to the front surface of the transducer, the height of which varies locally and randomly. By measuring the transfer function between the transducer and each point in the medium for each pulse transmitted or received, the reflectance of each point in the medium can be calculated algebraically. In our method, the received echo is sub-banded and the transfer function for each sub-band is also calculated, so that a high-resolution image can be obtained as a weighted sum of the images calculated for each sub-band. In addition, multiple transmissions with different phase modulations applied to the transmitted wave and weighted sums of the images from each echo can also produce a high-resolution image. Thus, the present study shows that high-definition imaging is possible even with a single transmitter/receiver system by using changes in the transmitted waveform to increase the amount of information.

Two Dimensional Micronozzle Array: Fabrication and Its Applications to Biosample Manipulation

Kyohei Terao* and Koki Takahashi

Kagawa University, Japan

Abstract

A microfluidic device with closely spaced, two-dimensional array of micro-apertures is a powerful tool in the broad fields of biomanipulation, including biopatterning and bioprinting for biosensors, cell analysis, regenerative medicine. The device allows us to induce laminar flow in the confined area with different flow patterns using it as a 2-dimensional micronozzle array driven by independent microchannels. There are still technical challenges in fabricating the device with high-density array and small nozzle apertures.

We developed two fabrication techniques to realize the high-density micron nozzle array:

stacking of microfabricated stainless steel substrates and molding with skew-positioned thin wires. We report the fabrication techniques and their applications for manipulation of biosamples: 2D biopatterning of antibodies and formation of heterogeneous biocompatible gel microfibers. The adaptability to form different 2D microflow patterns with a single nozzle array device can promote the development of various research fields based on biomanipulation of small biosamples.

Biography

Kyohei Terao is an associate professor at the Faculty of Engineering, and a deputy director of Nano-Micro Structure Device Integrated Research Center, Kagawa University, Japan. He received a B.E. degree from Kyoto University, M.E. degree and Ph.D. degree in mechanical engineering from The University of Tokyo in 2002, 2004, and 2007, respectively. He was a postdoctoral fellow at Kyoto University (2007-2009) and an assistant professor at Kagawa University (2009-2014). Since 2014, he has been in his current position. His research interests are bio, micro and nanotechnology for analysis of single cell and single biomolecule and nanofabrication technology.

Quantum Mutual Entropy on Classical-Quantum Boundary

Takashi Matsuoka[1*] and Dariusz Chruscinski[2]

[1]Suwa University of Science, Japan;

[2]Nicolaus Copernicus University, Poland.

Abstract

In classical probability theory a classical correlation of a physical composite system can be represented by a joint probability or a conditional probability. In quantum case a quantum state, for example a density operator, of a composite system describe a correlation between its marginal states. However, it is well known that there is no general concept of joint and conditional probabilities in the usual quantum mechanics. This fact means that it is not so easy to construct a quantum compound state describing a proper correlation existing between its marginal states, for example the correlation between an input state and an output state via a quantum channel in communication system.

On the other hand, we can define the entropic criteria which measure a correlation or an information for quantum states by using an analogical extension of classical entropies. A typical one is the so-called mutual information or mutual entropy which plays an essential role in both of classical and quantum information theories.

In this talk, using the duality between quantum states and linear maps, we will show that the quantum compound density operators have a similar structure just like Bayesian scheme in classical system. Applying the fact to the quantum analogue of mutual entropy it can be shown that the mutual entropy can be decomposed into several types of correlation. On the basis of such decomposition we discuss a border of classical-quantum correlation in the context of a generalization of information theory from a classical system to a quantum system.

Investigation on Errors of the Approximation Equation of Correction Factor G7 for Four-point Probe Resistivity Measurement

Pao-An Lin [2*], Bing-Yuh Lu[1], Linshu Zheng[1], Ruei-Yuan Wang[3] and Tzu-Feng Tseng[4]

[1]Faculty of Automation, Guangdong University of Petrochemical Technology, Maoming, Guangdong, China

[2]Department of Physics, Guangdong University of Petrochemical Technology, Maoming, Guangdong, China

[3]Department of Geographical science, Guangdong University of Petrochemical Technology, Maoming, Guangdong, China

[4]Faculty of Material Science and Engineering, Guangdong University of Petrochemical Technology, Maoming, Guangdong, China

Abstract

Four-point probe is a crucial method to measure the resistivity of specific samples such as electric cells and semiconductors. The accuracy of the measured results are much concerned by the circuit designs. Valdes derived the correction factor G_7 and its approximation for approaching an infinitesimally thin slice of the sample firstly. This is a standard process to correct the measured resistivity of samples. However, the error between G_7 and its approximation exists. This study investigated the influence of such errors that were present the possible mistake in circuit design through an example if thickness to probe space ratio is 1.5, the finding of the relative error is −22.8%. Therefore, resistance of the specific sample is with the error of 22.8%, and the real current passing the sample is with the error of 22.8% in the theoretical analysis. In the actual circuit, the error of the power is much larger than the engineering safety margin of 10% in most of the electric and electronic devices. The accuracy of the resistivity measurement for electric cells and power devices is concerned with the safety of the users. Consequently, it is very notable to remind the limitation of computing approximation for users' safety. The reason of the mistake might be the concise and memorable form of approximation of the equation whose limitation been emphasized in this study.

Biography

Pao-An Lin is currently an associate professor with Faculty and Department of Physics, Guangdong University of Petrochemical Technology, Guangdong, China. He received his BS degree in physics from National Tsing Hua University and his MS and PhD degrees in physics from National Tsing Hua University in Taiwan, ROC, in 1997, 1999, and 2006, respectively. He was an instructor at the Department of Physics, National Tsing Hua University, in 2004, and severed as a post-doctor in academica sinica, Taiwan during 2006-2012. He also joint department of physics in UIUC as a visitor scholar in 2009. He served as a Researcher in CMS, ITRI, Taiwan in the duration of 2014 to 2017. His academic interests focus on condensed matter physics, especially on superconductivity, multiferroics, and spintronics.

Direct Sampling Methods for Nonlinear Inverse Problems with Moving Inhomogeneous Medium Inclusions

Yat Tin Chow[1], Kazufumi Ito[2] and Jun Zou[3*]

[1]University of California, Riverside, USA;

[2]North Carolina State University, USA;

[3]The Chinese University of Hong Kong, Hong Kong SAR, China

Abstract

In this talk, we shall first review and discuss the motivations and fundamental principles of direct sampling type methods (DSMs) for solving nonlinear ill-posed inverse problems of time-dependent partial differential equations. We will then formulate a basic framework for constructing direct sampling methods for general nonlinear inverse problems with moving inhomogeneous medium inclusions. We shall also illustrate the basic and important features of DSMs and explain why DSMs are computationally cheap, highly parallel, robust against noise, as well as applicable to the physically important scenarios where very limited measurement data is available.

Biography

Jun Zou is currently Choh-Ming Li Professor of Mathematics of Chinese University of Hong Kong, and Head of Department of Mathematics. His research interests include numerical methods and analyses of direct and inverse problems of partial differential equations. He is currently president of Hong Kong Society for Industrial and Applied Mathematics and vice president of Hong Kong Mathematical Society. He serves currently as an editor of 12 international mathematics journals, including SIAM Journal on Numerical Analysis, SIAM Journal on Scientific Computing and Journal of Scientific Computing. Jun Zou was elected SIAM Fellow in 2019 and AMS Fellow in 2022.

Chaotic Oscillation Control in Memristive System

Chunbiao Li [1,2]

[1]School of Artificial Intelligence, Nanjing University of Information Science & Technology, Nanjing, China

[2]Collaborative Innovation Center on Forecast and Evaluation of Meteorological Disasters, Nanjing University of Information Science & Technology, China,

Abstract

Memristive circuit has attracted great interests for the reason that its complex oscillation behaviors including chaos and multistability demonstrate tremendous application in chaotic secure communication and circuit information storage; however, an effective method for regulating and controlling the complex oscillation in memristive circuits hasn't been found. This speech aims to discuss the issue of regulating and controlling chaotic oscillation in memristive system with different memristor models. Through the analysis of the degree distribution and variable-dependence relation according to the characteristics of nonlinear functions, a new method for controlling the size and position of the attractor is constructed based on non-bifurcation parameter; by means of revising the balance of polarity or introducing offset modulation function, a new structure of conditional symmetry can be constructed in memristive systems or a new type of self-reproducing system can be coined which output pairs or lattice of coexisting attractors. Based on the above exploration,

further joint regulation and control of the memristive oscillation can be achieved including geometric regulation and multi-attractor regulation in physical memristive circuits.

Biography

Chunbiao Li is currently a Professor with the School of Artificial Intelligence, Nanjing University of Information Science and Technology, China. From 2010 to 2014, he was a Post-Doctoral Fellow with the School of Information Science and Engineering, Southeast University, China. He was a Visiting Scholar with the Department of Physics, University of WisconsinMadison, from 2012 to 2013. His research interests are in the areas of nonlinear dynamics and chaos, including nonlinear circuits and systems, memristive circuits and corresponding applications. He was a recipient of several awards for his teaching and research from Jiangsu Pronivce, China.

A Comprehensive Experimental Investigation of Additives to Enhance Pool Boiling Heat Transfer of a Non-Azeotropic Mixture

Chen Xu[1*], Zuoqin Qian[1] and Jie Ren[1]

[1]Wuhan University of Technology, China

Abstract

Adding nanoparticles or surfactants to pure working fluid is a common and effective method to improve the heat transfer performance of pool boiling. The objective of this research is to determine whether additives have the same efficient impact on heat transfer enhancement of the non-azeotropic mixture. In this paper, Ethylene Glycol/Deionized Water (EG/DW) was selected as the representing non-azeotropic mixture, and a comparative experiment was carried out between it and the pure working fluid. In addition, the effects of different concentrations of additives on the pool boiling heat transfer performance under different heat fluxes were experimentally studied, including TiO_2 nanoparticles with different particle diameters, various kinds of surfactants, and mixtures of nanofluids and surfactants. The experimental results showed that the nanoparticles deteriorated the heat transfer of the EG/DW solution, while the surfactant enhanced the heat transfer of the solution when the concentration closed to a critical mass fraction (CMC). However, the improvement effect was unsteady with the increase in the heat flux density. The experimental results suggest that the mass transfer resistance of the non-azeotropic mixture is the most principal factor in affecting heat transfer enhancement. Solutions with 20 nm TiO_2 obtained a steady optimum heat transfer improvement by adding surfactants.

Biography

Chen Xu received her education in Marine Engineering from Wuhan University of Technology, China since 2016. During her study at whut, her average course score exceeded 85 points and she won academic scholarships every year. Her current interest focuses on the enhancement of pool heat transfer performance of non-azeotropic binary mixtures through experimental and theoretical methods.

Understanding the Urban Taxi Sharing Potential

Xianlei Dong[1*], Jie Xue[2,3], Xufeng Li[1], Huijun Sun[4], Minghe Sun[5] and Beibei Hu[1]

[1]School of Business, Shandong Normal University, Jinan, China

[2]National Science Library, Chinese Academy of Sciences, Beijing, China

[3]Department of Library, Information and Archives Management, School of Economics and Management, University of Chinese Academy of Sciences, Beijing, China

[4]Key Laboratory of Transport Industry of Big Data Application Technologies for ComprehensivTransport, Ministry of Transport, Beijing Jiaotong University, Beijing, China

[5]Carlos Alvarez College of business, the university of Texas at San Antonio, Texas, USA

Abstract

The emergence of taxi sharing is of great significance to the improvement of operations efficiency of urban traffic and low-carbon development. This work proposes a model to calculate, and to understand the changing patterns of the urban taxi sharing potential from the time and the space dimensions. The shareability of any two taxi orders is determined first, and their sharing travel mileage and sharing proportion are then calculated based on their GPS tracking data. Using Chengdu, Sichuan, as an example, the taxi sharing market is found to have great potential, e.g., 97.77% of the taxi orders in Chengdu can participate in sharing and the potential sharing travel mileage accounts for 31.28% of the total travel mileage. The taxi sharing potential in Chengdu is affected by the traveling purpose such as commuting, showing an obvious daily changing pattern. It is generally much higher on workdays, especially during the morning peak hours. The taxi sharing potential and the total taxi orders are usually positively correlated when the traffic is not congested, but are negatively correlated when the traffic condition becomes bad. The geographical distribution of the taxi sharing potential is uneven, because large gaps exist among administrative districts and among functional zones.

Biography

Xianlei Dong is an Associate Professor at School of Business, Shandong Normal University, China. He holds a PhD degree in Management Science and Engineering at School of Economics and Management, Beijing University of Technology. He is doing research in big data analyses and application, data mining, and sharing economy. Specifically, his research is devoted to exploring the causal relationship (or relationship beyond correlation) among socio-economic indices, including scientific collaboration, scientific research performance and so on. He also pays attention to individuals' behavior and their preference at traffic sharing and traffic travel modes.

How can a Stochastic Memory Work for a Random Number Generator?

Chao-Yao Yang

Department of Materials Science and Engineering, National Yang Ming Chiao Tung University, Hsinchu, Taiwan.

Undergraduate Degree Program of Systems Engineering and Technology, National Yang Ming Chiao Tung University Hsinchu, Taiwan

Abstract

Antiferromagnet (AFM) has currently participated in the spin-orbit torque (SOT) magnetoresistive random access memory (MRAM) technology due to its great potential to be applied to the field-free SOT switching and to promote the thermal stability of MRAM. However, effects of the introduction of AFM into the basic structure of SOT-MRAM composed of a heavy metal/ferromagnet (FM) bilayer was still not comprehensively understood. This work reports the effects of how an antiferromagnetic (AFM) order modifies the strength of Dzyaloshinskii-Moriya interaction (DMI) in a heavy metal (Pt)/FM (Co)/AFM (IrMn) trilayer, studied by SOT switching and loop-shift method. Increasing the AFM order reflected on exchange bias (H_{ex}) through increasing the thickness of IrMn appears to significantly reduce the DMI strength of the trilayer, which leads to the reduction of the required external field for yielding a complete SOT switching. The reduced DMI strength may be ascribed to the enhanced uni-directional anisotropy, suppressing the neighboring spin canting in the FM layer. This stabilization for the magnetic moments via the uni-directional anisotropy, induced by strong AFM order, also improved the stability of multi-levels for SOT switching, which would promote the memristivity for neuromorphic application. On the other hand, the the weak AFM order in the samples with reduced IrMn thickness would give rise to the stochasticity for the purpose of physically unclonable functionality. This work demonstrates an intrinsic tuning over the AFM order would serve as a switch to turn the SOT device into a stochastic/memristive cell to bridge probabilistic and neuromorphic computing.

Biography

Dr. Chao-Yao Yang completed his doctor degree of material science and engineering at National Chiao Tung University. During his Ph. D., he focused on the studies of crystalline/ electronic structure of materials and the related physical properties. After he graduated, he re-orientated his research topic to the valleytronics of two-dimensional materials and spin-orbit torque (SOT)-related device. His current focus is strongly associated with antiferromagnet (AFM), which is conventionally a passive role in the magnetic society but currently appears to be more active and promising for the advanced MRAM applications.

Uphill Diffusion During Silicide Formation in Si Nanowires Through Point Contact Reaction

Yi-Chia Chou[1*], Lih-Juann Chen[2] and King-Ning Tu[3]

[1]National Taiwan University, Taiwan;

[2]National Tsing Hua University, Taiwan;

[3]City University of Hong Kong, China

Abstract

Many electronic devices, such as field-effect transistors, depend on achieving precise control of both a semiconductor nanostructure and its contact with the larger scale circuit. The control of the contact between nanowire and circuit is a key step that involves integrating different types of materials and bridging between length scales. In Si nanowires, we show that silicide formation can occur through a point contact reaction and we demonstrate that the reaction shows different kinetics from those already known in thin film silicide technology. We discuss the strain effect on the nucleation and growth of silicides in nanowires. Such

nanowires have an oxidized surface and this controls the reaction pathway and kinetics. To follow up the present model, the gradient of stress potential is treated as the driving force for “uphill diffusion” of metal atoms in Si to migrate to the epitaxial interface. Additionally, the strain effect is taken as a reason that an extremely high degree of supersaturation of Ni, over a factor of 1000 needed for NiSi formation, can take place near the interface. The need of an extremely high super-saturation, about a factor of 1000, of Ni interstitials for the nucleation is because of the extremely low equilibrium solubility of Ni in Si.

Biography

Dr. Yi-Chia Chou is a Professor in the Department of Materials Science and Engineering at National Taiwan University, Taipei, Taiwan. She received her Ph.D. degree from University of California Los Angeles in CA, USA. Her postdoc research was at IBM Thomas J. Watson Research Center and Brookhaven National Laboratory. She was a recipient of UCLA Graduate Fellowship, UCLA Dissertation Fellowship Award, TSMC Outstanding Graduate Student Award. For her achievement on the growth of novel nanostructures and in situ TEM investigation, she was awarded Presidential Postdoctoral Award from Microscopy Society of America, Taiwan Promising Women in Science, IBM Faculty Award, and Ministry of Science and Technology Young Scholar Fellowship.

Neural Networks with Local Converging Inputs (NNLCI) for Solving Conservation Laws and Other Differential Equations with Greatly Reduced Complexity

Yingjie Liu*, Haoxiang Huang and Vigor Yang

Georgia Institute of Technology, USA

Abstract

This talk is based on a series of joint works (arXiv:2109.09316 and 2204.10424) with Haoxiang Huang and Vigor Yang. We are able to predict discontinuities and smooth parts of solutions of the Euler equations in 1D and 2D by a neural network accurately. For example, in order to predict the solution of the 1D Euler equations at a space-time location, one can design the output of a neural network to be the solution value at the location. If one tries to design the input as the low-cost numerical solution patch in a local domain of dependence of the location (where the information comes from), can the neural network tell if the input is across a shock or in a smooth region ? The answer is no ! Our approach uses two numerical solutions of a conservation law from a converging sequence, computed from low-cost numerical schemes, and in a local domain of dependence of a space-time location as the input for a neural network to predict its high-fidelity solution at the location. Despite smeared input solutions, the output provides sharp approximations to solutions containing shocks and contact discontinuities. The method reduces the complexity by one or two orders of magnitude compared to a fine grid numerical simulation, and has relatively low cost to train because it's a local method. And it can be applied to other differential equations, e.g., the Maxwell's equations for solving electromagnetic waves scattered around complicated PECs (Cobb, Lee and Liu, arXiv:2302.02860).

Biography

Yingjie Liu got his Ph.D in applied mathematics from the University of Chicago in 1999. He then worked as a postdoc at SUNY at Stony Brook. In 2002 he became an assistant professor in school of mathematics, Georgia Institute of Technology. He has been a professor there since 2013. He works on developing and analyzing numerical methods for solving differential equations related to physics problems, in particular, conservation laws.

Electrochemical Study of Bi-doped ZnO as an Electrode Material for High Performance Supercapacitor Applications

A.T. Ravichandran[1*] and M.Dhivya Angelin[1]

[1]PG & Research Department of Physics, National College (Autonomous), Affiliated to Bharathidasan University, Tiruchirappalli, Tamil Nadu, India

Abstract

Many researchers have focused on enhancing the performance of energy storage devices to satisfy the growing demand for energy worldwide. This paper is an attempt to tune the capacitive behavior of pristine ZnO through its Cd doping via the simple synthetic method. To examine their electrochemical behavior, samples of modified ZnO with three concentrations of the dopant (Cd) (3, 6, and 9 wt% Cd-doped ZnO) were prepared. The as-prepared products were characterized by spectral as well as analytical techniques. The 9 wt% Cd-doped ZnO electrode, featuring fast electrolyte permeation and rich electrochemically active sites, showed an excellent specific capacitance (Csp) of 627 Fg-1 at a current density of 1 Ag-1 and substantial cycling stability of 93.3% even after 5000 GCD cycles. The addition of dopants enhanced electrical conductivity due to effective charge transfer and electron transport. The unique nanorod-like structure was found to be responsible for the exceptional electrochemical properties of the samples. Until now, there were no reports on Cd-doped ZnO nanorods as electrode material for supercapacitors. This work provides a simple and cost-effective method for fabricating a 9 wt% Cd-doped ZnO electrode, which may open up new possibilities for efficient electrodes in next-generation supercapacitors.

Biography

Dr. A.T. Ravichandran, Associate Professor of Physics. Material science is a broad topic of my research. The impact of enormous demand raised on the need for flexible and extremely effective energy storage devices such as supercapacitors in our day-to-day lives. My most recent published two articles have been about the fabrication of electrode materials for supercapacitor to solve energy crisis. My long-term goal is to develop promising electrode materials with high specific capacitance for supercapacitor applications.

Keynote Presentation

Computation of the Deuteron Mass and Force Unification via the Rotating Lepton Model

Constantinos G. Vayenas[1,2*] and Dionysios G. Tsousis[3]

[1]University of Patras, Greece

[2] Academy of Athens, Greece

[3]Stanford University, Stanford, CA

Abstract

The rotating lepton model (RLM), which is a 2D Bohr-type model of three gravitating rotating neutrinos, combining Newton's gravitational law, special relativity, and the de Broglie equation of quantum mechanics, in order to model the Strong Force as Newtonian gravity between relativistic neutrinos and thus to compute the masses of hadrons and bosons [Vayenas, Souentie, "Gravity, Special Relativity and the Strong Force: A Bohr-Einstein-de Broglie Model for the Formation of Hadrons", Springer, 2012] has been extended to 3D and to six rotating neutrinos located at the vertices of a normal triangular octahedron in order to compute the Lorentz factors, gamma, of the six neutrinos and, thus, to compute the total energy and mass of the deuteron, which is the lightest nucleus [Vayenas, Tsousis and Grigoriou, Physica A 2020, 545, 123679]. The computation includes no adjustable parameters, and the computed deuteron mass agrees within 0.05% with the experimental mass value. This very good agreement suggests that, similarly to the strong force in hadrons, the nuclear force in nuclei can also be modeled as relativistic gravity. This implies that, via the combination of special relativity and quantum mechanics, the Newtonian gravity gets unified with the strong force, including the residual strong force [Vayenas, Grigoriou, Tsousis, Parisis and Aifantis, Axioms, 2022, 11, 657].

Biography

Professor Constantinos (Costas) Vayenas was born in Athens on September 22, 1950, studied Chemical Engineering at NTU Athens (1968-1973) and got his PhD in 1976 from the University of Rochester in the USA. He then taught as Assistant Professor in the Department of Engineering and Applied Science at Yale University (1976-77) and as Associate Professor at MIT (1977-82) before moving voluntarily to the University of Patras in Greece. He is an International member of the National Academy of Engineering (NAE) of the USA and a member of the Academy of Athens. He has authored three books and more than 300 papers on Catalysis, Electrochemistry and Particle Physics.

Development of 230 nm AlGaN-based Far-UVC LEDs for Application to Human-Safe Virus Inactivation

Hideki Hirayama*, Noritoshi Maeda, Yukio Kashima and Eriko Matsuura

Quantum Optodevice Laboratory, Japan

Abstract

Attention is paid to the inactivation of SARS-CoV-2 by using deep ultraviolet (DUV) LEDs. We are developing "human safe wavelength" 220-230 nm far-UVC LEDs for virus inactivation applications used in the "human working space". An AlGaN-based 230 nm LED structure was grown on a sapphire/AlN template by a low pressure metal-organic vaper phase epitaxy (MOVPE). We introduced polarization doped (PD) p-type transparent AlGaN contact layer in order to achieve high electron injection efficiency (EIE) by obtained high hole conductivity, as well as to achieve high light-extraction efficiency (LEE) by light reflection from highly reflective p-type electrode. Significant increase of EQE was observed for far-UVC LEDs by introducing the PD transparent AlGaN contact layers. We obtained the maximum EQE of more than 1.5% and the output power of 8.0 mW for a 236 nm far-UVC LED. We have fabricated flipchip LEDs mounted on a ceramic sub-mount. Quartz lenses were also attached to improve the radiation pattern. The maximum output power of the single chip 230 nm LED for was 2.7 mW. We mounted 80 pieces of 230 nm LEDs to produce a panel with total output power approximately 90 mW. We also investigated the inactivation effects for SARS-CoV-2 by using 230 nm LEDs. It was confirmed that the 230 nm LED irradiation dose at which the virus decays by three orders of magnitude was about 10 mJ/cm2.

Biography

Hideki Hirayama received his PhD of Eng. from Tokyo Institute of Technology in 1994. In the same year, he became a research scientist at RIKEN. He became a Team Leader to manage the Terahertz Quantum Device Team in 2005. In 2012, he was appointed as a Chief Scientist & Director of Quantum Optodevice Laboratory. He has also concurrent positions as visiting professor of Saitama University, Tokyo University of Science and Tokushima University. His research focuses on crystal growth of AlGaN/AlN nitride-semiconductors and development of deep-UV LEDs. He is also developing terahertz quantum-cascade lasers (THz-QCLs).

The Effective Dirac Algebra by Gauge Field Interaction in Relativistic Electrodynamics and its Application

Wong Tsz Tsun

The University of Hong Kong

Abstract

Conventional relativistic electrodynamics is set on flat Minkowski spacetime, where all computable quantities are calculated from the flat metric $\eta_{\mu\nu}$.We can redefine the metric of spacetime from the Dirac algebra. In this paper, we study how an electrodynamic interaction can alter the normal gamma matrix to an effective one and result in a shift in

the metric perturbatively. The curvature properties inferred from the curved metric are also investigated. We also study how the spin operator is changed under the interaction that contributes to an effective spin operator and how the spin of an electron will be slightly deviated from 1/2. Then we perform canonical quantization of the effective Dirac algebra. Finally, we apply our results to the relativistic hydrogen case and demonstrate how such system curves the spacetime metric.

Biography

Wong Tsz Tsun obtained his BSc from the University of Hong Kong with a first-class honours. He then graduated from Imperial College London with an MSc in Physics with a distinction, where he worked in the field of high energy particle physics. He is now a PhD student in the University of Hong Kong.

Non-Supersymmetric Strings, Self-Adjoint Extensions and (In)Stability Issues

Augusto Sagnotti[2*] and Jihad Mourad[1]

[1]APC, UMR 7164-CNRS, Université Paris Cité

[2]Scuola Normale Superiore and INFN, Pisa

Abstract

I shall address some of the main lessons drawn so far from the tadpole potentials that emerge in the ten–dimensional strings with broken supersymmetry. These lessons include weak-string-coupling cosmologies that appear to provide clues on the onset of the inflation and spontaneous compactifications to lower–dimensional Minkowski spaces at corresponding length scales. The cosmological solutions exhibit an intriguing "instability of isotropy" that, if taken at face value, would point to an accidental origin of compactification. On the other hand, while highly symmetric AdS × S vacuum solutions driven by fluxes and tadpole potentials are unstable due to mixings induced by their internal fluxes, the original Dudas–Mourad solution is perturbatively stable, and we have gathered detailed evidence that instabilities can be held under control in a similar class of type–IIB compactifications to Minkowski space where the string coupling is everywhere weak.

Biography

Laurea, U. Rome "La Sapienza", 1978,; Ph.D., Caltech, 1983. Professor of Theoretical Physics, Scuola Normale Superiore, Pisa, since 2005. Previously Research Fellow st Caltech, Miller Fellow at U.C. Berkeley, then Assistant (1986), Associate (1992) and Full Professor (2000) at U. Rome "Tor Vergata". Main contributions: analysis of ultraviolet behavior of Einstein gravity, orientifold construction in String Theory; different scenarios for supersymmetry breaking in String Theory in the presence of open strings. About 12000 Inspire citations, h=54. Premio Carosio (1979), SIGRAV Prize (1992), Andrejewski Lecturer (1999), Margherita Hack Prize (2014), Alexander von Humboldt Research award (2018).

Probing the Gas in and around Galaxies with Quasar Observations

Varsha P. Kulkarni[1*], David V. Bowen[2], Lorrie A. Straka[3], Donald G. York[4], Neeraj Gupta[5] Pasquier Noterdaeme[6] and Raghunathan Srianand[5]

[1]University of South Carolina, USA

[2]Princeton University, USA

[3]Leiden University, The Netherlands

[4]University of Chicago, USA

[5]Inter-University Centre for Astronomy and Astrophysics, India

[6]Institut d'Astrophysique de Paris, France

Abstract

Understanding how galaxies interact with their surroundings is essential to understanding how they evolve. Inflowing gas from the intergalactic medium provides new material for star formation, while outflows driven by supernovae take enriched gas out of the galaxy. Combined observations of both the galaxies and their circumgalactic medium (CGM) are essential to constrain these gas flows. The CGM can be studied by means of absorption spectroscopy of background sources such as quasars. We will report results from our recent studies of the gas in and around galaxies based on observations of quasars with the Hubble Space Telescope and the Sloan Digital Sky Survey. These results are providing new insights into the connections between galaxies and their CGM.

Biography

Varsha P. Kulkarni is a Professor in the Department of Physics & Astronomy at the University of South Carolina, USA. She received her Ph.D. at the University of Chicago, and did postdoctoral research at the University of Arizona. She conducts research in observational extragalactic astronomy using a variety of space-based and ground-based telescopes. She works primarily on the gas and dust in and around galaxies, and the implications for galaxy evolution.

Optoelectronic Control of Surface Plasmon Polaritons Waves at Metal-Doped Semiconductor Interfaces

R. K. Vinnakota*, Mayra M Schliemann

Troy University, Troy, USA

Abstract

We present a Metal-semiconductor (M-S) based electro-optic modulator for functional plasmonic circuits based on the active control of surface plasmon polaritons (SPPs) at M-Sjunction interfaces. Self-consistent multi-physics simulations of the electromagnetic, thermal and IV characteristics of the device have been performed to estimate bias dependent SPP modulation and switching times. Here, we consider Ge based Schottky contacts and carry out parametric analysis to find the optimal device parameters and size for higher optical confinement and faster operation. The optimal device is shown to operate at signal modulation surpassing -50dB, responsivity more than -100dB/V and switching rates up to 100GHz, potentially providing a new pathway towards the design and utilization of Schottky junctions as active plasmonic switch for plasmonic based integrated circuitry.

Biography

Vinnakota is an Assistant professor and an Electronics Engineering Technology program coordinator at Troy University, Alabama, USA. He received his PhD in Engineering from Louisiana Tech University, Louisiana, USA and completed his postdoctoral work from Computational Electromagnetism Research Lab (CERL) and Institute of Micro Manufacturing (IFM), at Louisiana Tech University. His research interests include Novel Optoelectronic Devices, Metal and Semiconductor based Plasmonics and enhanced light matter interactions, Nanophotonics, Heat Transfer. Vinnakota has published more than 15 peer reviewed papers and conference proceedings in leading journals and conferences.

Effective and Organ Dose during SPECT/CT Examinations

Ali Aamry[*1] and Abdelmoneim Sulieman[2]

[1]Nuclear Medicine Department, King Saud Medical City, Saudi Arabia

[2]Radiology and Medical Imaging Department, College of Applied Medical Sciences, Prince Sattam Bin Abdulaziz University, Saudi Arabia

Abstract

Parathyroid glands are 1 to 12 small endocrine glands, with 85% of the individuals having four glands, and have a vital role by production and secretion of parathyroid hormone. Single-photon emission computed tomography combined with computed tomography (SPECT/CT) radionuclide scintigraphy is the gold for parathyroid gland disorders with 98% sensitivity. However, the patients received a high radiation dose to sensitive organs, leading to radiation-induced cancer risks. Therefore, measurement and optimization of patient doses are crucial. This study aims to evaluate patients' radiation dose during parathyroid SPECT/CT procedure and extrapolate the cancer risks for sensitive organs. Radiation dose were assessed for 42 patients (28 (66.7%) female and 14 (33.3%) males) underwent SPECT/CT procedure. The patients' organs and the effective dose were calculated using the 99mTc-MIBI administered activity (AA, MBq) and the dose from the external CT procedure. All procedures were carried out using two-hybrid systems (GE and Siemens SPECT/CT) installed at King Saud Medical City, Riyadh, Saudi Arabia. The mean and standard deviation (SD and range of patient age (y), weight (kg) and AA (MBq), and dose length product (DLP, mGy.cm) were 48.6±15 (19-85), 72±12 (50-100), 844±93 (666-925), and 216±67 (69-335) respectively. Patient effective dose range from 1.4 to 3.6 mSv per procedure. For all patients, a constant tube voltage of 120 kVp was employed. Patients undergoing parathyroid SPECT/CT scanning procedures receive high radiation doses to the sensitive organs. Optimization of imaging protocol is recommended to avoid unnecessary radiogenic risks.

Biography

My name is Ali Aamry, I was born in the Riyadh, Saudi Arabia. I had medical imaging / nuclear medicine doctorate in 2018 from Saudi Commission for Health Specialties. I had worked for a total of nineteen years as a medical imaging / nuclear medicine technologist in the King Saud Medical City, Riyadh. Also I certified as radiation safety officer from the Statute of the Nuclear and Radiological Regulatory Commission. Indeed, through my work experience, I have enhanced a greater understanding, which has benefited my working environment that can only add to the full functionality of my process in the field

Radiation-induced $CaSi_2$ Crystal Nucleation and Growth during the CaF_2 Epitaxy on Si

Anatoly Dvurechenskii[1,2*], Alexei Kacyuba[1,2] and Vladimir Volodin[1,2]

[1]Rzhanov Institute of Semiconductor Physics, Russian Federation

[2]Novosibirsk state university, Russian Federation

Abstract

The effects of electron-beam irradiation (electron energy 20 keV, current density 50 μA/m^2) on CaF_2 films epitaxially grown on Si(111) has been studied with reflection high-energy electron diffraction (RHEED) and Raman spectroscopy (RS). It was found that the electron beam action leads to the $CaSi_2$ layer synthesis as during the epitaxial growth of CaF_2 films and with irradiation after formation of CaF_2 films. The radiation-induced phenomena of $CaSi_2$ crystal growth were investigated, both directly during the epitaxial CaF_2 growth on Si (111) and film irradiation with fast electrons on Si(111) after its formation of CaF_2 films with keeping the specified film thickness, substrate temperature and radiation dose. Irradiation in the process of the epitaxial CaF_2 film growth leads to the formation of $CaSi_2$ nanowhiskers oriented along the direction <110>. The electron irradiation of the formed films, under similar conditions, leads to the homogeneous nucleation of $CaSi_2$ crystals and their proliferation as inclusions in the CaF_2 film. It was shown that both approaches lead to the formation of $CaSi_2$ crystals of the 3R polymorph in the irradiated region of a 10 nm thick CaF_2 layer. The crystal structures of $CaSi_2$ was found to depend on thickness of deposited CaF_2 films: it is trigonal rhombohedral modification tr3 for thin (<20nm) CaF_2 films and trigonal rhombohedral modification tr6 for thicker one.

The reported study was funded by RFBR and ROSATOM, project number 20-21-00028

Biography

Anatoly Dvurechenskii has completed in his Doctor degree in physics from Rzhanov Institute of Semiconductor Physics. From 2002 to 2018 he was the Vice-Director of this Institute and currently he is the Head of the Lab. of Nonequilibrium Semiconductor's Systems, Professor of Novosibirsk State University. As a guest scientist he worked at New York State University in Albany (1979), Research Center Rossendorf, Dresden, Germany (1980 – 2006) and at Fudan University in Shanghai, China (2001, 2002, and 2006). He has published more than 400 peer-reviewed papers in reputed journals.

Radiation Physics in Medicine

John F Sutcliffe

MIPEM, FinstP

Abstract

The chance discovery of x-rays by Wilhelm Roengen in November1895 and radioactivity by Henri Becquerel two months later in 1896 was the beginning of the application of radiation to health care. Within months ionizing radiation was being used both for treating cancer and for diagnosis, though at that time the hazards were not appreciated and many pioneers died of radiation induced cancers. The ability to treat deep seated tumours required the generation of high energy electron beams so that by the 1930s voltage multipliers could achieve one

million volts. It was the invention of radar that led to the development of linear accelerators producing x-ray beams of up to 25 million electron volts, and with it skin sparing at the point of entry of the therapy beam. Also with the post-WW2 development of nuclear reactors, alternative radioactive sources to radium 226 became available, cobalt 60 as a teletherapy source and cesium 137 and iodine 131 from fission products for brachytherapy sources. In addition nuclear reactors enabled the production of other sources such as molybdenum 99 from which the daughter nuclide technecium 99m is widely used in nuclear medicine. More recently positron emitting nuclides such as fluorine 18 produced in a local cyclotron are used in functional imaging which in a hybrid combination with an anatomical imaging scanner (computerized tomography (CT) or (nuclear) magnetic resonance imaging (MRI)) can give a functional image superimposed on an anatomical image. In radiotherapy X-rays have become a standard method of treating cancer, and every treatment is planned by computer, with particular concern to both cover the gross tumour volume (GTV)and minimise the dose to organs at risk (OAR). Since the X-ray beam is able to penetrate through the patient, the exit beam image is compared with the planned exit beam image as a method of quality control. The latest development is proton beam therapy to further reduce the dose to organs at risk, particularly for tumours in children, since the maximum dose is delivered at the end of the range of the protons and beyond that point there is no dose. 250 million electron volt proton beams are generated in a cyclotron or synchrotron and steered to the patient as pencil beams whose energy and depth of penetration is varied to match the dimensions of the tumour. Another recent development is a hybrid MRI and linear accelerator to both image and treat a cancer on one machine, to take account of the day to day changes of position and shape of the patient and the shrinkage of the tumour.

On Quantum Foundation

Inge S. Helland

University of Oslo, Norway

Abstract

Three theorems are formulated and discussed, and it is proposed that the premises of these theorems should be used as a basis for quantum theory. This leads to a simpler and more intuitive foundation than the ordinary Hilbert space formulation. The basic concept is that of conceptual variables, variables which during measurement exist in the mind of an observer or in the joint minds of a group of communicating observers. Variables are accessible if they through experiment or measurement can be given specific values. Different maximally accessible variables may be seen as complementary. Under certain symmetry assumptions it is shown that the basic quantum follows if there, in some context, are two related maximally accessible variables. The implied interpretation of quantum mechanics is epistemological.

Biography

Inge S. Helland was born in 1947. He has a background as a statistician at the University of Bergen, the Norwegian University of Life Science, and the University of Oslo. He retired as a full professor from the last institution in 1996 and has since been occupied by investigation the basis of quantum theory, as seen from his point of view. The result has been a book (Epistemic Processes 2021 on Springer) and several articles, some in leading journals in theoretical physics.

Consequences of a Rigid Analysis of the Schrödinger Equation for the Interpretation of the Wavefunction of Bound States and the Foundations of Quantum Mechanics

Emil Roduner[1,2*] and Tjaart P.J. Krüger[2]

[1]University of Stuttgart, Germany

[2]University of Pretoria, South Africa

Abstract

A rigid analysis of the undisputed Schrödinger equation, its solutions for the wavefunctions of bound states and the consequences for the particles wave nature and the Heisenberg uncertainty relation are presented. All interpretations are compatible with the equation but contrast to several alternative views which we are often encountered in quantum mechanics literature. It is essential to distinguish between the time-independent and the time-dependent solutions. Often debated keywords like the position-momentum uncertainty, hidden variables, collapse of the wavefunction, smeared out versus point-like particle integrity, deterministic classical-like trajectories (orbits) versus density distributions (orbitals) as well as the intriguing consequences of the strictly periodic time evolution of the wavefunction of eigenstates are discussed and shown to possess clear interpretations within the Schrödinger picture.

Biography

Emil Roduner is a retired chair of physical chemistry of the University of Stuttgart. He has worked on various topics, with a focus on muonium chemistry, proton conductivity and degradation of polymer electrolyte fuel cells, nanomaterials, superatoms, elementary steps of catalysis in transition metal doped zeolites and electrocatalytic conversion of CO_2 to liquid solar fuels. A more recent focus is on selected long-standing problems of the description of matter and processes, like the origin of irreversibility in thermodynamics and the foundations of quantum mechanics. He has written several tutorial reviews and advanced textbooks

Testing Precision and Accuracy of Weak-value Measurements in a Quantum Computing System

Francisco De Zela*, David R. A. Ruelas Paredes, Mariano Uria, and Eduardo Massoni

Physics Section, Department of Sciences, Pontifical Catholic University of Peru, Lima, Peru

Abstract

Quantum weak values (WVs) were introduced in 1988, by Aharonov, Albert and Vaidman, as a counterintuitive feature of quantum mechanics. WVs later evolved into a practical tool which is being used for various purposes. The theoretical basis of WVs is von Neumann’s model of quantum measurement. In this model, a system’s observable is coupled to a “pointer”. The system-pointer coupling-strength was originally assumed to be weak. Later, it was shown that WVs can be measured also with a strong coupling. Experiments in neutron interferometry showed that precision and accuracy of WVs performed better for a strong coupling value than for a weak coupling value. We have conducted tests of precision and accuracy in a more versatile quantum computational context and for a full range of coupling strengths. We conducted our tests with a quantum computing system provided by IBM,

which is based on superconducting qubits. Our results show that strong measurements do not always perform better than weak ones. Our tests can also be conducted in a quantum optics platform using single photons or in a classical optics platform using light beams.

Biography

Francisco De Zela is a Full Professor at the Department of Sciences, Physics Section, of the Pontificia Universidad Católica del Perú (PUCP). He holds a Licenciatura in Physics from PUCP, a Diplom-Physiker from Bonn University, Germany, and a PhD from PUCP. His research interests in quantum optics focus on fundamental tests of quantum mechanics, the Rabi Hamiltonian, geometric and topological phases, open quantum systems, weak values, and wave-particle duality.

In Silico Biofluid Mechanics for Cardiovascular Problems

Asimina Kazakidi*

Department of Biomedical Engineering, University of Strathclyde, United Kingdom

Abstract

Cardiovascular diseases are the leading cause of death globally and may affect all ages across the life span, from children to adults to elders. Over the past decades, computational blood flow modelling has offered valuable insights into cardiovascular problems, highlighting key aspects of the underlying blood flow mechanisms, while contributing to the development of novel prediction tools. In this invited talk, I will give a short overview of the contribution of computational biofluid mechanics research in cardiovascular problems through a selection of studies and ongoing activities on understanding the role of hemodynamic factors. These studies help evaluate the hemodynamic shear stresses along the arterial walls, while addressing design and mesh generation challenges of idealized and anatomically-realistic vascular geometries.

Biography

Asimina Kazakidi is a Senior Lecturer in Biofluid Mechanics at the University of Strathclyde, where she joined as Lecturer and Marie Sklodowska-Curie Fellow. Asimina was previously a Research Associate and Fellow at Imperial College London in UK and the Foundation for Research & Technology Hellas in Greece. She obtained her PhD in Biofluid Dynamics from the Department of Aeronautics at Imperial College London, and an MSc from the Department of Bioengineering. She studied Physics at the Aristotle University of Thessaloniki, Greece. Her work has focused on complex biofluid problems, utilizing a range of computational fluid dynamics methods.

Bound for Spin-dependent Noncommutative Parameter based on Pauli Equation

C. A. Stechhahn

Criminalistic Institute – Center of Physics, São Paulo, Brazil

Abstract

In this work, we consider a particle moving on a 2-D noncommutative plane immersed in

a constant magnetic field. The noncommutativity of spatial coordinates, the conjugate momentum, and spin variables are supposed to satisfy a "non-standard" Heisenberg algebra. The parameter θ which characterizes the noncommutativity here is not constant and that we call "noncommutativity of spin". Using the Pauli equation and perturbation theory, after some considerations of the degeneracy of energy levels the noncommutativity parameter can be shown to be bounded as $\theta \ll 10{-}20\ cm$.

Biography

Graduated in physics from the University of São Paulo (1997), master's degree (2005) and doctorate in Physics (2011) from the University of São Paulo. He is a criminal expert in the Laboratory of the Physics Center of the Institute of Criminalistics (2002). He has experience in Physics, with an emphasis on Physics of Elementary Particles and Fields. Acting mainly on the following topics: general theory of particles and fields, non-commutativity, non-commutative quantum mechanics.

Polarization-induced Phase Transitions in InGaN-based Coupled Quantum Well

Sławomir P. Łepkowski*

Institute of High Pressure Physics - Unipress, Polish Academy of Sciences, Poland

Abstract

The topological phase transition from the normal insulator to the topological insulator and the nontopological phase transition from the topological insulator to the nonlocal topological semimetal have so far been realized only in HgTe/CdTe and InAs/GaSb/AlSb quantum wells.

In this talk, a theoretical study on the topological and nontopological phase transitions in InGaN/GaN and InN/InGaN coupled double quantum wells will be presented[1]. These phase transitions can occur in InGaN-based quantum wells thanks to the large built-in electric field arising from the spontaneous polarization and the piezoelectric effect. In the structures with the widths of individual quantum wells equal to 2 and 3 monolayers and sufficiently thin interwell barrier, one can observe the topological phase transition from the normal insulator to the topological insulator via the Weyl semimetal, and the nontopological phase transition from the topological insulator to the nonlocal topological semimetal. Negative spin-orbit coupling in these nanostructures is not an obstacle to induce the topological insulator with sizable bulk energy gap. The topological insulator phase disappears when the interwell barrier is wider than 5 or 6 monolayers. In this case, two novel phase transitions occur, namely the nontopological phase transition from the normal insulator to the nonlocal normal semimetal and the topological phase transition from the nonlocal normal semimetal to the nonlocal topological semimetal.

Biography

Sławomir P. Łepkowski is a professor of theoretical solid state physics in the Institute of High Pressure Physics, Polish Academy of Sciences. His research focuses on modeling of group-III nitride nanostructures, ab-initio calculations of mechanical properties of solids, high-pressure effects and the topological phase transitions in semiconductor nanostructures. He has published more than 70 papers in reputed journals and has been serving as an referee in more than 20 highly regarded journals. Presently, he is a guest editor of special issues in the journals Nanomaterials and Crystals. His google scholar h-index is 19.

Effect of Boundaries on the Surface Superconducting Critical Temperature

R. H. de Bragança[1*], M. D. Croitoru[1,2] and J. Albino Aguiar[1]

[1]Department of Physics, Federal University of Pernambuco, Brazil

[2]National Research University Higher School of Economics, Russia

Abstract

As early as 1964 L. N. Bulaevsky and V. L. Ginzburg proposed the concept of "surface ordering" [1], in which surface coupling between the bulk quasiparticle states occurs.

Recently, it has been theoretically revealed, using the tight-binding version of the Bogoliubov-de Gennes (BdG) equations, a sufficient elevation of the superconducting critical temperature at the surface (superconducting surface effect). Surface superconductivity survives even far above the bulk critical temperature .

Currently, the studies are based on the superconducting critical temperature at the surface within the model for a clean sample with infinite potential barrier at the metal surface. However, it remains still an open question whether the superconducting surface effect reacts to changes in surface/boundary conditions and how.

In this work, we have used a detailed description of the surface potential within the self-consistent Lang-Kohn effective potential[4] and studied its influence on the critical temperature of surface superconducting in the framework of the tight-binding Bogoliubov-de Gennes formalism. The details of the surface barrier potential in some materials is a very important factor. It can change the entire spectrum of superconducting properties at the surface and cannot be ignored when discussing real consequences of the surface/interface in such materials. Our work suggests that in real samples, the deviations of the surface potential from the most optimal shape do not lead to a significant decrease in the surface critical temperature in materials with a low carrier density. We expect that its manifestation is minor in such samples, especially in narrow-band materials.

Structural and Dielectric Properties of Hexagonal Perovskite Ceramics

Cecile Autret

Greman laboratory, France

Abstract

Giant dielectric materials have become increasingly important, as their promising usage in high-performance capacitive devices for microelectronic applications and high energy density storage. More particularly, the ceramic capacitors with high performance is recurrent in many areas of Electrical Energy. In this context, new materials with colossal permittivity were discovered such $CaCu_3Ti_4O_{12}$ (CCTO). Nowadays, different mechanisms can explain the exceptional dielectric response observed in such materials; nevertheless, the Internal Barrier Layer Capacitance mechanism, so called IBLC mechanism, describing semiconductor grains together with insulating grain boundaries, is currently the most widely accepted model. However, the origin of the semiconductor grains together with the insulating character of the grain boundaries is an open question. Kuang et al. (1) described the colossal permittivity of a 12R hexagonal perovskite: $Ba_4YMn_3O_{11.5\pm\delta}$ which displays a permittivity value around

100 000 at room temperature. In order to clarify the different prospects proposed for CCTO for explaining the colossal permittivity measured, this presentation, mainly focused on the $Ba_4YMn_3O_{11.5\pm\delta}$ hexagonal perovskite, will described the relationship between the crystallographic structure and the dielectric properties.

Biography

Cecile Autret-Lambert is an assistant professor of materials science of the Materials, Microelectronics, Acoustics and Nanotechnology Research Institute (GREMAN) at Tours University (France). She has authored/co-authored over 101 papers (H-index 22) in the field of oxide ceramics. As a solid-state chemist, she focuses on establishing relationships between the structures and the electrical and/or magnetic properties of functional oxides compounds that she has synthesized. A part of her work consists to the design of functional materials with different processing and characterization methods

Control of High-speed Flows Over Aerodynamic Bodies using Plasma Formations Located in Various Flow Areas

Olga Azarova[1*], Tatiana Lapushkina[2] and Oleg Kravchenko[1]

[1]Federal Research Center of the Russian Academy of Sciences, Russia

[2]Ioffe Institute, Russia

Abstract

The invited talk presents the results on the control of the bow shock wave and the aerodynamic characteristics of the body using a near-surface high energy region initiated by a gas discharge, as well as the main approaches to controlling high-speed flows and increasing the stability of the flow using stratified energy sources. The possibility of controlling the position of a steady bow shock wave by creating a volumetric plasma region using a surface gas discharge organized on the entire front surface of the semi – cylindrical body is shown experimentally and numerically. It was shown that the position of the steady bow shock wave, in addition to the specific power of the discharge, is affected by the value of the adiabatic index in the plasma region created by the discharge, as well as the degree of ionization and the degree of nonequilibrium of the discharge plasma. A good agreement of numerical and experimental data is obtained. New approaches have been developed to control the bow shock wave, drag and lift forces (at zero angle of attack), as well as flow stability of a supersonic flow past an aerodynamic body using a thermally stratified energy deposition. The possibility of initiating and damping self-sustained flow pulsations, influencing drag and lift forces, as well as other aerodynamic characteristics of the body due to temperature changes in the layers of a thermally stratified energy source has been shown.

Biography

Prof. Dr. Olga Azarova, PhD, DSci, AIAA Senior Member, Full Member of the Russian Academy of Natural Sciences, Leading Research Scientist of Federal Research Center “Computing Science and Control” of the Russian Academy of Sciences, Moscow, Russia. Olga Azarova graduated from the Lomonosov Moscow State University. Olga Azarova received her PhD and DSci degrees at Dorodnicyn Computing Centre of RAS. Field of her research interests: fluid mechanics, CFD, aerodynamics, flow control, Richtmyer-Meshkov instability, vortex dynamics, shock waves. List of publications of Prof. Azarova includes 144 names.

A Practical Investigation of Wind Turbine Blade Erosion and Particle-Laden Flows

Reza Hassanian[1,2*], Hemanadhan Myneni[1,3], Ásdís Helgadóttir[1,2] and Morris Riedel[1,4]

[1]The Faculty of Industrial Engineering, Mechanical Engineering and Computer Science, University of Iceland, Iceland

[2]Simulation and Data Lab Computational Fluid Dynamics, University of Iceland, Iceland;

[3]Quantum Simulation and Data Science Lab, University of Iceland, Iceland

[4]Juelich Supercomputing Centre, Germany

Abstract

This study aimed to empirically simulate straining turbulent flow in a novel approach, which directly resembles vast naturally occurring flows and engineering applications. Since the stagnation point is subject to straining motion, this 2D experiment is an effort to simulate the stagnation plane, which applies to studying the particle behavior at the airfoil's leading edge. Wind turbine airfoil is impacted by airborne particles, which lead to erosion. Also, the pollutant particles in the gas/air compressor cause erosion. The literature has revealed that flow geometry and gravity affect particle dynamics statistics. This study suggests a practical method to generate a deformed turbulent flow, opening sight to examine the dynamics of particle statistics. The current study presents the behavior of both passive and inertial particles from the novel experiment conducted on initially homogeneous turbulence undergoing a sudden axisymmetric expansion. The flow was generated in $100<R_\lambda<500$ and seeded with passive and inertial particles. The Lagrangian particle tracking technique based on the 4-frame Best Estimate method of Ouelette et al. (2006) was employed to measure the velocity field. We represent the result with two different mean strains and Reynolds numbers. However, in contrast to the previous numerical studies in turbulent flow, this study considers the fields of inertial particles in the presence of gravity. The result discloses that the novel designed and conducted experiment simulated the flow satisfactorily. Furthermore, it provides a transparent window to investigate how the particle with different sizes with distinct strain rate flow and its relationship to the turbulence intensity affected the erosion.

Biography

R. Hassanian is currently a Ph.D. candidate researcher at the University of Iceland and is working on Parallel & Scalable ML Approaches in CFD Applications and fluid dynamics experiments. He is leading the Simulation and Data Lab CFD at Iceland HPC community.

Dr. H. Myneni, received his PhD from Indian Institute of Technology Kanpur in Physics. He is currently Research Assistant Professor leading The Quantum Simulation and Data Science Lab at the University of Iceland.

Prof. Á. Helgadóttir, received her PhD in Mechanical Engineering from University of California. Currently she is head of Mechanical department and member of the Simulation and Data Lab CFD at the University of Iceland.

Prof. Dr. – Ing. M. Riedel received his PhD from the Karlsruhe Institute of Technology (KIT) and worked in data-intensive parallel and distributed systems since 2004. He is currently a Full Professor of High-Performance Computing with an emphasis on Parallel and Scalable Machine Learning at the University of Iceland. Since 2004, Prof. Morris Riedel has held various positions at the Juelich Supercomputing Centre of Forschungszentrum Juelich.

Cosmic Radiation Monitoring with Health Canada's Fixed Point Surveillance Network

Chuanlei Liu* and Kurt Ungar

Radiation Protection Bureau of Health Canada, Ottawa, Canada

Abstract

The Radiation Protection Bureau of Health Canada has a long-standing commitment to protecting Canadians from the terrestrial radiation exposure through its Fixed Point Surveillance (FPS) network. The network is currently comprised of more than eighty sodium iodine spectrometers distributed across Canada. It was designed for terrestrial radiation monitoring but is also capable of registering cosmic radiation at a high-energy channel.

Recent development has explored the potential and flexibility of utilizing this channel for monitoring cosmic rays. A linear relationship is established by parameterizing the detector data and reference cosmic dose rates, which is then used to derive the cosmic dose rates for both the historical and live data in Canada. This development promotes the FPS network as an environmental dosimetric system capable of monitoring radiation of both terrestrial and cosmic ray origins. The network has also been demonstrated to be promising for space weather monitoring through the observations of the ground level enhancement and forbush decrease events. These detections support the use of the network for space weather applications such as modelling, risk assessment and even forecasting.

Biography

Chuanlei Liu is a radiation coordinator at radiation protection bureau of Health Canada. His current research interests mainly focus on the environmental radiation monitoring, radioactivity analysis and health impact assessment. Chuanlei holds a Ph.D degree from McGill University. Before joining Health Canada, he worked at CERN on particle physics and at Defence R&D Canada on radiological defense and analysis.

Tackling Scattering in X-ray Imaging with Time of Flight

Julien Rossignol*[1,2], Romain Espagnet[1,2], Gaétan Lemaire[1,2], Gabriel Bélanger[1,2], Louis-Daniel Gaulin[1,2], David Gaudreault[1,2], Frédéric Gagnon[1,2], Philippe Marcoux[1,2], Delband Roshani[1,2], Seyed Arash Katourani[1,2], Edouard Villemure[1,2], Quentin Wingering[1,2], Lamyae Jdid[1,2], Marc-André Tétrault[1,2], Audrey Corbeil Therrien[1,2], Yves Bérubé-Lauzière[1] and Réjean Fontaine[1,2]

[1]Electrical engineering and Computer engineering department, Université de Sherbrooke, Sherbrooke, Québec, Canada

[2] Interdisciplinary institute for technological innovation (3IT) Université de Sherbrooke, Sherbrooke, Québec, Canada

Abstract

Scattered photons cause a significant degradation of the contrast-to-noise ratio in X-ray imaging. Although anti-scatter grids are used to prevent those photons from reaching the detector, they also block up to 50% of the primary contribution and, thus, require an increased radiation exposure. Université de Sherbrooke propose to measure the time of

flight (ToF) of X-rays by synchronizing a time-resolved detector and a pulsed X-ray source to remove scattered photons based on their longer travel path. A resolution of 10 ps allows identifying most scattered photons and remove their adverse effects with no dose penalty. More recently, similar improvements in image quality were obtained in simulations in systems with up to 300 ps FWHM timing resolution by estimating the number of scattered photons from the measured time-of-flight distribution. However, implementing such system in the real-world is a challenging task. In addition to the new requirements for a tabletop pulsed X-rays source and time-resolved detector, the system must compete with existing X-ray imaging systems in terms of spatial resolution, angular coverage and acquisition time. Three generations of systems are in development in Sherbrooke. Firstly an 8-channel testbench with 200 ps resolution to evaluate prospective scintillators, SiPMs and X-ray source is currently under test and has demonstrated the feasibility of measuring ToF with sufficient precision. Secondly, a modular 1024-channels system with off-the-shelf front-end electronics is currently being built to evaluate the scalability of the approach. Thirdly, a first complete fan-beam system with a dedicated ToF-CT ASIC front-end is in early design phase

Biography

Julien Rossignol completed his master's thesis in electrical engineering at the Université de Sherbrooke in 2019. In this work, he pioneered and put the base on time-of-flight computed tomography, a research field in expansion today. He is completing his Ph.D. at Université of Sherbrooke where he is trying to demonstrate the technical feasibility of the technique. He was recently awarded the IEEE Jaszczak Graduate Award for outstanding graduate student in the field of medical imaging for his work on time-of-flight X-ray imaging.

Thoughts on the Build-up of Electromagnetic Radiation and on the Notion of Process Time

Tibor Berceli

Budapest University of Technology and Economics

Abstract

Numerous papers have been published on the problems of electromagnetic waves. In spite of that a proper physical picture of the process how the electromagnetic field builds up and propagates is missing.

By separating an electron from its proton a static electric force is created. However, the complete field of electric force does not build up immediately, but it is extending from the site of generation with the speed of light in the free space.

When the generation of electric force is periodically varied it is associated with a periodic magnetic force. This way an electromagnetic field is created. The periodic variation of the electromagnetic force is propagating from its source. That is called electromagnetic wave radiation. The electromagnetic field has potential energy. That energy can be utilized when the field interacts with material.

There is a question: is time an artificial notion or is it a real physical phenomenon? In this paper some basic relationships are presented concerning the meaning of time as a physical phenomenon.

Time as a physical concept is associated with the changes in the state of material. Any change in the state of material, i.e. in its location, energy, composition, etc. needs some time which is called process time. Time is an inherent phenomenon of physical processes. Based on the special relativity theory it can be stated: any change in the state of material cannot occur immediately, it always needs some time.

Biography

Prof. Berceli made significant contributions in the field of microwave and optical technologies. He published 416 papers and 6 books. He has 26 patents. He received the Microwave Career Award from IEEE in 2016.

He contributed to the European ACCORD, Copernicus, MOIKIT, FRANS, LABELS, GANDALF projects, to the NEFERTITI and ISIS Network of Excellence and several COST co-operations.

He was visiting professor at Polytechnic Institute of Brooklyn (1964), University College London (1986), Drexel University (1988-89), Technical University of Hamburg (1991), Osaka University (1992), Technical University of Grenoble (1994), Helsinki University of Technology (2001) and The Sydney University (2004).

An innovation in used car Windscreens for Post Accident Dose Reconstruction in the Periphery of Nuclear Installations

Norfadira binti Wahib[1], Mayeen Uddin Khandaker[1], S. F. Abdul Sani [2], K. S. Al-mugren[3*], D. A. Bradley[1,4], A. Sulieman[5,] Mohammad Rashed Iqbal Faruque [6] and M. I. Sayyed[7,8]

[1]Centre for Biomedical Physics, School of Healthcare and Medical Sciences, Sunway University, Malaysia

[2]Department of Physics, University of Malaya, Malaysia

[3]Department of Physics, Princess Nourah Bint Abdulrahman University, Saudi Arabia

[4]Department of Physics, University of Surrey, Guildford, UK

[5]Department of Radiology and Medical Imaging, College of Applied Medical Sciences, Prince Sattam Bin Abdulaziz University, Saudi Arabia

[6]Space Science Center (ANGKASA), National University of Malaysia, UKM, Selangor, Malaysia;

[7] Department of Physics, Faculty of Science, Isra University, Jordan

[8] Department of Nuclear Medicine Research, Institute for Research and Medical Consultations, Imam Abdulrahman bin Faisal University, Saudi Arabia

Abstract

Cars of a variety of brands are usually parked at a fixed but increasing distance in the periphery of nuclear installations. Herein we focus on the potential use of car windscreens for post-accident dose reconstruction from unplanned nuclear events and natural disasters, also in regard to unexpected events arising during large-scale use of radioactive and nuclear materials. The situation requires identification of analytical techniques that could both readily and reliably be used to assess absorbed dose, sufficient to prompt remedial action where necessary. Samples from three widely used car brands—Honda, Toyota and Proton—are studied in respect of their thermoluminescence (TL) yield. Key TL dosimetric features in the gamma-ray dose range of 1–100 Gy are examined. An ERESCO model 200 MF4-RW

X-ray machine has also been used for energy response studies; a Harshaw 3500 TLD reader equipped with WinREMS software was used for the luminescence measurements. All brands exhibit linearity of TL yield versus dose, the samples from Honda showing the greatest response followed by that of the Toyota and Proton brands. The marked energy dependence reflects the effect of the strongly Z-dependent photoelectric effect. Signal fading was investigated over a period of 28 days, the Toyota and Proton brand windshield glass showing a relatively low loss at 52.1% and 52.6% respectively compared to a 56.7% loss for that of the Honda samples. This work forms the first such demonstration of the potential of car windshield glass as a retrospective accident dosimeter.

Biography

Prof. Kholoud Saad Al-Mugren" is considered one of the distinguished leadership and academic administrative competencies in Saudi Arabia. She has a record of accomplishment of giving and hard work at her university (Princess Nourah bint Abdualrahman University). She is an internationally well-known Scientist in the area of Nuclear Science & Radiation. She has worked and contributed in various projects related to Nuclear, Materials Science and radiation in Environments.

An Anti-Photon: Way to Explain the Gamma Ray Burst

Soon-Tae Hong

Sogang University, Korea

Abstract

To astrophysicists, the gamma ray burst remains mysterious because it is intense radiation flare released from a supernova which is located far from the Earth. To explain this enigmatic gamma ray burst phenomena, in this talk I assume that the photon from the gamma ray burst could be distinct from the ordinary photon. About 100 years ago, Dirac has formulated the relativistic quantum mechanics for an electron, with which he has theoretically discovered a new type electron named as an positron (or anti-electron) in addition to the ordinary electron. The positron later has been experimentally confirmed by Anderson. Applying Dirac idea to the photon case, I theoretically find a new type photon, the so-called anti-photon, which is massive and could contentedly explain the gamma ray burst mystery. Moreover I confirm the covariances of the relativistic equation of motion for the massive photon and its probability continuity equation under the Lorentz transformation.

The talk is based on the paper: S.T. Hong, ``Dirac type relativistic quantum mechanics for massive photons," Nucl. Phys. B980 (2022) 115852 [arXiv:2108.07299].

Biography

Soon-Tae Hong graduated from the Seoul National University with BS degree, and then received his PhD from the State University of New York at Stony Brook. He joined the faculty members at the Ewha Womans University, and currently he is a Research Professor at the Sogang University.

On the Numerical Exact Solution for Many-Body Problem Based on the Differential Forms

Shin-ichiro Kondo

Department of Materials Science and Engineering, Nagasaki University, Japan

Abstract

Based on the differential forms, we developed the new method to evaluate the numerical exact solutions for many-body problem. Our method is very simple and is based on Schrödinger equation as shown below

$$i\hbar \frac{d}{dt}\left|\psi\right\rangle = \hat{H}(t)\left|\psi\right\rangle$$

From above equation, we deduce

$$\frac{d}{dt}B(t) = \frac{d}{dt}\left\langle\psi\right|\hat{B}\left|\psi\right\rangle = \frac{1}{i\hbar}\left\langle\psi\right|[\hat{B},\hat{H}(t)]\left|\psi\right\rangle$$

Operator $\hat{B}$ denotes arbitrary operator. From eq.(2), simultaneous differential equations are derived. Especially when Hamiltonian is composed of only electrons, the number of simultaneous differential equations is found to be finite because of Pauli's exclusion rule, which means that exact solutions can be numerically obtained even if Hamiltonian includes many body terms. Furthermore correlation between many electrons can be calculated exactly from simultaneous differential equations. In this presentation, we will show the merit of this method including finite temperature through the comparison with Green's function methods.

Light Quantum Beyond the Fermi Golden Rule

Kenzo Ishikawa

Hokkaido University, Japan

Abstract

New perspective of light quantum is presented.

Light is a fundamental matter and plays inevitable roles in natural phenomena especially in energy transfers and information transfers in wide area. These processes occur following transition probabilities, and their computations are first steps toward complete understandings. A probability per unit of time computed with the Fermi's golden rule has universal properties necessary for uncovering an underlying theory and dynamics. An additional term in the probability was found and leads further phenomena to occur and to modify whole scenario. This talk presents that the transition probability in accord with natural phenomena includes these corrections of universal properties. In Rayleigh scatterings of the visible light with molecules, light absorptions of molecules, excitation energy transfer, and other processes, the corrections give sizable contributions. These have unusual properties

totally different from those of the golden rule and give new physical effects.

An example: From the golden rule, the rate of Rayleigh scattering in the atmosphere is proportional to a molecule density, and that the light scattering is very small in high altitude. Now, our theory leads a completely different behavior of the scattered light, which in agreement with the observations. This resolves puzzling behaviors of observed light.

Quantum Compilation for Entangled State Preparation

Vu Tuan Hai[1,2], Nguyen Tan Viet[3] and Le Bin Ho[4,5*]

[1]University of Information Technology, Ho Chi Minh City, Vietnam

[2]Vietnam National University, Ho Chi Minh City, Vietnam

[3]FPT University, Hanoi, Vietnam

[4]Frontier Research Institute for Interdisciplinary Sciences, Tohoku University, Japan

[5]Department of Applied Physics, GraduateSchool of Engineering, Tohoku University, Japan

Abstract

Entangled states are essential resources for quantum computing and quantum information technology. Recent advancements in quantum technologies have introduced a new approach to entangled state preparation using quantum computers. However, even with the assistance of quantum algorithms, preparing these states still involves exponential or sub-exponential scaling of circuits. This study introduces a variational quantum algorithm that utilizes quantum compilation to address the challenges of entangled state preparation effectively. The method involves a trainable unitary (**U**) that operates on a fiducial state to generate a target state (ψ), as illustrated in Figure 1. The method offers the advantage of utilizing a low-depth trainable unitary and a minimal number of measurements to prepare target states, significantly reducing the complexity of the process. We discuss numerical results for the state reparation of wellknown entangled states such as GHZ and W. Quantum circuit for entangled state preparation. (b) The unitary **U** is parameterized into **U**(θ) with several ansatzes, including the star and polygon ansatzs. Other notations: Rj is a rotation gate around the j-axis, j = {x, y, z}; CZ stands for controlled-rotation-Z gate.

Biography

Le Bin Ho is an assistant professor at Tohoku University in Japan, where his research focuses on variational quantum algorithms for enhanced quantum metrology applications. He received his Ph.D. in quantum physics from Osaka University in 2018 and worked as a postdoctoral researcher from 2018 to 2022. In 2022, he joined the Frontier Research Institute for Interdisciplinary Sciences (FRIS) at Tohoku University as an assistant professor. He has been recognized for his outstanding research contributions with several awards, including the MEXT fellowship from 2015-2018, the JSPS fellowship from 2020-2022, and the Prominent Research Fellow of Tohoku University from 2022-2025.

Generation of 10dB Squeezed Light with Higher-order Spatial Mode with Optical Parametric Amplifier

Kui Liu*, Zhi Li and Jiangrui Gao

State Key Laboratory of Quantum Optics and Quantum Optics Devices, Institute of Opto-Electronics Shanxi University, China

Abstract

The squeezed light with spatial modes (e.g. Hermite-Gaussian mode or Laguerre-Gaussian mode) have shown to significantly enhance the sensitivity of spatial measurements, such as spatial displacement, tilt and rotational angle measurement. Especially, using a higher-order spatial laser mode instead of the fundamental mode is one proposed method to further mitigate mirror thermal noise, which will be a main limitation for the sensitivities of the future ground-based detectors (Einstein Telescope (ET) and Cosmic Explorer). How to generate the squeezed state with the higher-order modes is a key issue. The generation of squeezed state with Hermite-Gaussian (HG) modes has been studied by many researchers and recently, the squeezing level is up to 10dB, However, to date, the efficiently generation of squeezed state with LG modes remains a major challenge and have no report.

Here, we report an effective technique for the generation of higher-order spatial mode squeezed light with optical parametric amplifier (OPA). Firstly, we generated the squeezed state with HG modes using a doubling resonated OPA and performed spatial tilt and displacement measurements, Then, adopting an effective way to solve the astigmatism in OPA, we generate the High-order LG mode squeezed state up to a mode order of 9 and the squeezing level is up to 10dB. It paves the way for squeezed light with spatial modes applications in future gravitational-wave detectors as well as in other quantum measurements.

Biography

Kui Liu, professor of Shanxi University in China. He received the B.Sc. degree in physics from the Department of Physics of Shanxi University in 2005 and the Ph.D. degree in optics from the Institute of Optoelectronics of Shanxi University in 2012. He has published more than 50 articles on the academic journals. His research interests include all aspects of continuous-variable quantum information, in particular, quantum measurement and quantum communication based on multi-mode quantum states.

Electronic Structure and Orbital Properties of Perovskite Ruthenates $SrRu_{1-x}Mn_xO_3$

Pao-An Lin[1*], Ruei-Yuan Wang[2], Jiang-Yang Huang[1], Tzu-Feng Tseng[3], Bing-Yuh Lu[4], W. Qin[1] and Xiao-Fang Wang[1]

[1]Department of Physics, Guangdong University of Petrochemical Technology, Maoming, Guangdong, China

[2]Department of Geographical science, Guangdong University of Petrochemical Technology, Maoming, Guangdong, China

[3]Faculty of Material Science and Engineering, Guangdong University of Petrochemical Technology, Maoming, Guangdong, China

[4] Faculty of Automation, Guangdong University of Petrochemical Technology, Maoming, Guangdong, China

Abstract

In this study, the electronic structures of manganese-doped perovskite ruthenates $SrRu_{1-x}Mn_xO_3$ were investigated using local-density approximation (LDA) and the LDA plus Hubbard U (LDA+U) method with x = 0, 0.25, 0.50, and 0.75. The substitution of Mn in $SrRuO_3$ was discovered to drive the ferromagnetic coupling into the antiferromagnetic ground state. Moreover, the observed metal–insulator transition at x = 0.39 was successfully reproduced with the onsite Coulomb interaction U accounted for. The favorable agreement between the LDA+U results and published experimental observations reveal that the electron correlation plays a crucial role in $SrRu_{1-x}Mn_xO_3$.

Biography

Pao-An Lin is currently an associate professor with Faculty and Department of Physics, Guangdong University of Petrochemical Technology, Guangdong, China. He received his BS degree in physics from National Tsing Hua University and his MS and PhD degrees in physics from National Tsing Hua University in Taiwan, ROC, in 1997, 1999, and 2006, respectively. He was an instructor at the Department of Physics, National Tsing Hua University, in 2004, and severed as a post-doctor in academica sinica, Taiwan during 2006-2012. He also joint department of physics in UIUC as a visitor scholar in 2009. He served as a Researcher in CMS, ITRI, Taiwan in the duration of 2014 to 2017. His academic interests focus on condensed matter physics, especially on superconductivity, multiferroics, and spintronics.

Cosmic Censorship of Smooth Structures on Spacetimes

Vladimir Chernov and Stefan Nemirovski

Mathematics Department, Dartmouth College USA

Abstract

It is observed that on many 4-manifolds there is a unique smooth structure underlying a globally hyperbolic Lorentz metric. For instance, every contractible smooth 4-manifold admitting a globally hyperbolic Lorentz metric is diffeomorphic to the standard R4. Similarly, a smooth 4-manifold homeomorphic to the product of a closed oriented 3-manifold N and R and admitting a globally hyperbolic Lorentz metric is in fact diffeomorphic to N x R. Thus one may speak of a censorship imposed by the global hyperbolicty assumption on the possible smooth structures on (3+1)-dimensional spacetimes.

Biography

PhD Uppsala University, Sweden and University of California Riverside. Postdoc and Scientific Visitor at ETH Zurich, Max Planck Institute for Mathematics Bonn, and University Zurich. Assistant, then Associate and Full Professor at Dartmouth College.

High Single-Mode Selectivity V-cavity Tunable Semiconductor Laser based on GaAs

Tuo Chen[1*], Yuxia Song[1], Kai Chang[2], Yonggang Zou[3], Jian-Jun He[2] and Mingyu Li[1]

[1]School of Optoelectronic Engineering, Changchun University of Science and Technology, Changchun, China.

[2]Centre for Integrated Optoelectronics, State Key Laboratory of Modern Optical Instrumentation, Zhejiang University, Hangzhou, China.

[3] State Key Laboratory on High Power Semiconductor Lasers, Changchun University of Science and Technology, Changchun, China.

Abstract

With the development of integrated optoelectronic devices in the past decades, tunable semiconductor lasers with compact structure and simple fabrication have become the focus of semiconductor research. In this presentation, a V-Cavity tunable semiconductor Laser (VCL) with center wavelength at 940nm is proposed. The threshold conditions of laser with waveguide layer structure and different cavity length difference were analyzed theoretically. A VCL with waveguide width of 3μm and channel interval of 0.6nm is demonstrated. The transmittance of the V-cavity laser can reach more than 99.4% by optimizing the polynomial parameters of the curved waveguide. In addition, the optimal parameter range of half-wave coupler was solved by adopting EigonMode Expansion (EME) solver, and the optical field distribution was simulated by finite difference time domain (FDTD). The simulation results showed that the half-wave coupler with optimized parameters could achieve high single-mode selectivity when the central wavelength was 940nm. When the half-wave coupler length was 40μm and the waveguide gap is 1.5μm, the transmission loss could reach less than 0.001dB. This design promotes the research of high performance, low cost and small size tunable laser which also has potential value in vehicle lidar and sensor detection.

Biography

Tuo Chen was born in Heilongjiang, China, in 1995.She obtained her B.Eng. from Changchun University of Science and Technology in 2017 and Master degrees from Russia's ITMO University in 2019. She is currently a PhD student at Changchun University of Science and Technology. Her main research fields include semiconductor lasers and optoelectronic devices.

Reconfigurable Valley Topological QED Platform for Qubit Operation

Yongyou Zhang[1*], Junhua Dong[1] and Bingsuo Zou[1]

[1]Beijing Key Laboratory of Nanophotonics & Ultrafine Optoelectronic Systems, School of Physics, Beijing Institute of Technology, Beijing, China.

[2]MOE & Guangxi Key Laboratory of Processing for Non-ferrous Metals and Featured Materials, School of Physical science and Technology, Guangxi University, Nanning, China.

Abstract

Multifarious topological crystals are extensively explored because of their unique advantages in manipulating wave transport and immunity against local perturbations.

Regretfully, most widelyexplored topological structures are settled after fabrication, and so are their corresponding topological properties, which, generally speaking, are not friendly to tunability and practicability. The reported tunable schemes are mainly to tune the refractive index distribution of topological structures by different kinds of techniques. Though these techniques demonstrate extensive potential application in controlling topological edge states, they face a difficulty in working with quantum processing, since their structures are classical in essence. The common solution is to add quantum emitters or units to them, so that the topology of classical platforms can protect or influence quantum emitters, similar to topological lasers and topologically protected qubits. These structures also face a difficulty in turning on or off the system topology. To overcome the difficulties, we here design topological quantum platforms by cavity-QED or circuit-QED cells, since these cells have been achieved in experiments. The main advantage of QED-based platforms relies upon controllable geometry and interactions. The parity symmetry of the honey lattice of Jaynes-Cummings emitters is broken to form a dynamically reconfigurable valley topological QED platform. Based on such a reconfigurable platform, this work firstly designs a dynamically tunable topological quantum router and then demonstrates how to achieve topological quantum storage and reading. They both signify the remarkable potential of the suggested reconfigurable topological QED platform for qubit operation.

Biography

Yonyou Zhang is an associate professor in Beijing Institute of Technology in the field of topological photonics, quantum optics, and light-matter interaction. He has been published extensively as author and co-author of over 30 papers in highly regarded, peer-reviewed journals, such as Nature photonics, Physical Review A/B/Applied, Optics Letters/Express, and so on. Now, he is also interested in optical inverse design with neural network or deep machine learning.

Relativistic Effects of Rotation

Yin Rui, Yin Ming and Wang Yang

Beihang University, China

Abstract

For a reference frame rotating with a fixed angular velocity, there are points whose tangential velocity reaches the speed of light, the distance between the rotating axis and these points is called the critical radius, and the cylindrical surface formed by these points is called the critical cylinder.

According to this definition, two natural laws are discovered in this paper: (i) the tangential velocity in the region of Outside Critical Cylinder (OCC) is never superluminal due to space-time exchange, (ii) some of physical quantities of rotational body will change direction or math sign, if the location is changed from Inside Critical Cylinder (ICC) to OCC, we call it as Critical Cylindrical Effect (CCE). Above all, 30 screenshots of experimental video made in our lab show that the repulsion exerted on anion by electrons will become attraction, if the electrons are precessing and the anion is in the region of OCC. Then, we provide the theoretical proof of space-time exchange and CCE. At last, the application of the relativity for rotational frames in theoretical research and deoxidation therapy is provided.

Biography

Yin Rui, Professor of School of Electronic Information Engineering, Beihang University. The research interests are Theory of Relativity, Biomedicine Engineering, and Digital Signal Processing.

Pulsed Laser Ablation of Nanoparticle-embedded PMMA Composite

Kaung Waiyan Lin[1], Phyu Sin Oo[1] and Tanant Waritanantc[1*]

School of Material Science and Innovation, Faculty of Science, Mahidol University – Salaya, Bangkok, Thailand

Abstract

Surface texturing of polymers by using pulsed laser systems has been attracting a lot of attentions as many polymers are widely used in biomedical science because of their biocompatibility and good mechanical properties. Among them, Polymethyl Methacrylate (PMMA) is used as biomaterial applications such as bone cement, lenses, bone substitutes, and drug delivery systems since it has good porosity, electrical and thermal properties, and low modulus of elasticity in addition to being biologically and chemically inert. PMMA can also be substituted for missing dental roots due to similarities with human dentine in mechanical and physical qualities. In recent decades, many researchers are trying to induce antimicrobial properties in PMMA: by surface texturing or through incorporating nanoparticles into PMMA resins. Among several surface processing techniques, laser-based technique has been popular as an interesting alternative technique. At the same time, the laser-based technique could also be used as a technique for the synthesis of nanoparticles. However, nowadays, most surface texturing is done in UV-green lasers as the polymer structures greatly absorbed photon energy in that range while for IR laser, only femto- and picosecond laser are widely used. In this work, we aim to ablate PMMA polymer by using fundamental frequency of Neodymium laser through the incorporation of nanoparticles such as Copper (Cu) and Zinc (Zn) nanoparticles to make it easy to absorb photon energy and induce antimicrobial properties.

Biography

Tanant Waritanant received his Ph.D. in Electrical & Computer Engineering from University of Manitoba, Canada. He has a background in Nanomaterials, Laser optics, Optical design, and holography. He had an experience with a med-tech startup in New York city, USA, where he worked as a head of engineering overseeing product engineering and design plans. He is currently a full-time lecturer and an undergraduate program chair at the School of Materials Science and Innovation, Mahidol University, Thailand.

Spintronics-Based Nonvolatile FPGA and Its Application to Edge-IoT Devices

Daisuke Suzuki

The University of Aizu, Japan

Abstract

A field-programmable gate array (FPGA) is a promising hardware platform for edge internet-of-things (IoT) applications owing to its reconfigurable and fully parallel architecture. However, since the storage element of the conventional SRAM-based FPGA is volatile, all the data are lost if the power supply is cut off. Thus, the power supply must be continuously applied during the operation to keep the stored information, which causes a large amount of standby power consumption in the idle state.

A nonvolatile FPGA (NV-FPGA) where all the data are stored in nonvolatile devices is a fundamental solution for this problem. Since all the data are remained in the nonvolatile devices even if the power supply is turned off, wasted standby power consumption in the idle state is completely eliminated. Among several nonvolatile devices, a Spintronics device (e. g. magnetic tunnel junction devices, spin-orbit-torque devices) is one viable candidate own to its virtually unlimited endurance, 3D-stacking capability, fast read/write access, and so on.

In this presentation, the overview of the Spintronics-based NV-FPGA, thus, its basic behavior, architecture, several circuit technologies where the feature of the Spintronics device is fully utilized. The potential of an NV-FPGA based edge-AI hardware is also presented as an important application.

Biography

Daisuke Suzuki received the B.E., M.E., and D.E. degrees from Tohoku University, Sendai, Japan, in 2004, 2006, and 2009, respectively. From 2010 to 2014, he was a Research Associate with Tohoku University. From 2014 to 2020, he was an Assistant Professor with Tohoku University. He is currently an Associate Professor with the University of Aizu. His main interests and activities are nonvolatile logic, its EDA tools, edge-AI hardware using nonvolatile logic LSIs, and their functional emulation using commercial FPGA board.

Enhanced Infrared Optical Responsivity and the Carrier Dynamics in Metal-semiconductor Interface

Zih-Chun Su[1*] and Ching-Fuh Lin[1, 2, 3]

[1]Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taiwan.

[2]Graduate Institute of Electronics Engineering, National Taiwan University, Taiwan.

[3]Department of Electrical Engineering, National Taiwan University, Taiwan.

Abstract

Hot carriers are unstable high-energy carriers. Because they are generally excited by light, they could be useful in the field of light sensing and solar energy. However, due to its extremely short carrier lifetime, it is very challenging to harvest the hot carriers before decay. Because of their short lifetime, we expect that the optical response of hot carriers should be enhanced at high frequency modulation conditions. We investigate such phenomena through numerical simulation of hot carrier diffusion dynamics and experimental measurement. The relationship between optical response and the modulation frequency is revealed through an experimental setup with a lock-in amplifier (SR560) and a 115 W 4300 nm light-emitting diode light source. Under 0~100kHz optical signal modulation, the hot carrier induced optical

response increases with the frequency. The amplified signal amplitude at 100 kHz is 6.04 V, which is 4.17 times signal enhancement, compared to 1.45 V at 500 Hz.

Biography

In summary, the extraction of hot carriers before rapid cooling enables the increase of photo response. Under kHz frequency domain, the improvement, which was expected larger in frequency domain up to MHz and GHz, is already about 4 times. in future, such an advantage will make the hot carrier devices exhibit great potential for real-time sensing applications.

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