UNITED Scientific Group
A non-profit organization

Physics
July 18-21, 2022 | San Francisco, CA | Hybrid

INTERNATIONAL CONFERENCE ON

PHYSICS AND ITS APPLICATIONS

JULY 18-21, 2022 | SAN FRANCISCO, CA

VENUE

IN-PERSON

DOUBLETREE BY HILTON
SAN FRANCISCO AIRPORT, SAN FRANCISCO, CA

https://physics.unitedscientificgroup.org/

IN-PERSON MEETING GUIDELINES

COVID-19 safety policies

The health and safety of all our participants remains our top priority. We are closely monitoring government mandates and policy changes, Centers for Disease Control and Prevention (CDC) guidelines and public health advancements (https://www.cdc.gov/).

Face-coverings

Wearing mask is recommended in the meeting premises / in-doors.

Hand sanitizer stations

Hand and washing facilities and/or sanitizing systems easily accessible to everyone throughout the event.

No contact policy

To assist in minimizing potential physical contact, elbow bumps are a great alternative to handshakes.

Presentations (PPT/PPTX/PDF)

To avoid physical contact, we request all the in-person presenters to submit the presentation at: https://physics.unitedscientificgroup.org/submit_presentation

WiFi

WiFi network and pass code will be shared on arrival to the meeting room.

Q & A

Moderator/Chair will pick up questions from the audience in the meeting room (at venue) and also from the zoom chat function – and ask the speaker to answer live.

MEETING JOINING LINKS (LIVE STREAMING ON ZOOM PLATFORM)

PACIFIC TIME

As the conference is hybrid, the virtual attendees can access the in-person presentations and queries can be asked through zoom chat box.

Meeting links shared will be for the complete meeting to join at any point of time.

General Session

Physics and its Applications | JULY 18-21, 2022 | San Francisco, CA | Hybrid

Join Zoom Meeting – Pacific Time

https://us06web.zoom.us/j/87281685963?pwd=WHJYK1RsZGNZSWtEaDJlVE81Y0pydz09

Meeting ID: 872 8168 5963

Passcode: 633534

Keynote Presentations

Atomically Precise Chemical, Physical, Electronic, and Spin Contacts and Interfaces

Paul S. Weiss*

University of California, Los Angeles, CA

Abstract:

One of the key advances in nanoscience and nanotechnology has been our increasing ability to reach the limits of atomically precise structures. By having developed the "eyes" to see, to record spectra, and to measure function at the nanoscale, we have been able to fabricate structures with precision as well as to understand the important and intrinsic heterogeneity of function found in these assemblies. The physical, electronic, mechanical, and chemical connections that materials make to one another and to the outside world are critical. Just as the properties and applications of conventional semiconductor devices depend on these contacts, so do nanomaterials, many nanoscale measurements, and devices of the future. We discuss the important roles that these contacts can play in preserving key transport and other properties. Initial nanoscale connections and measurements guide the path to future opportunities and challenges ahead. Band alignment and minimally disruptive connections are both targets and can be characterized in both experiment and theory. I discuss our initial forays into this area in a number of materials systems.

Biography:

Paul S. Weiss is a nanoscientist and holds a UC Presidential Chair and is a distinguished professor of chemistry, bioengineering, and materials science at UCLA. He studies the ultimate limits of miniaturization, developing new tools and methods for atomic-resolution and spectroscopic imaging, chemical patterning, and quantum information science. He has won awards in science, engineering, teaching, publishing, and communications. He is a fellow of the American Academy of Arts & Sciences, AAAS, ACS, AIMBE, APS, AVS, Canadian Academy of Engineering, Chemical Research Society of India, Chinese Chemical Society, IEEE, and MRS. He was the founding editor-in-chief of *ACS Nano*.

Two-Dimensional Materials as Platforms for Exploring New Physics

Sunny Gupta[1]* and Boris I. Yakobson[2]

[1]University of California, Berkeley, CA;

[2]Rice University, Hous*ton, TX*

Abstract:

Two-dimensional (2D) materials [1], which are only a few angstroms thick, exhibit interesting physical properties due to the reduced dimensionality. The physics in 2D is different from

that in 3D and these exotic systems allow exploring many physical behaviors that have not been seen until now. The talk will cover a few such areas, where interesting new physical behaviors have become possible because of 2D materials. By combining 2D materials with topographical undulations, one can create exotic pseudo-electric and magnetic fields useful for electron-optics [2], and 1D strongly correlated electronic states [3], which will allow exploring physics in 1D, that has remained elusive until now. Additionally, by stacking different 2D materials in a vertical heterostructure, one can create an excitonic superfluid state [4] at high temperature, which was first envisioned by Mott, Knox, and others in 1960s and realizing it still remains a long-standing problem in physics and materials science. Defects which are omnipresent in any material are not so notorious in a 2D material. The defects in a 2D material have a unique advantage and can be engineered to create practical single-photon emitters [5], which are an important building block for quantum information processing and photonics-based quantum computing.

[1] *ACS Nano* 2021, 15, 4, 5959–5976 [2] *Nano Lett.* 2022, 22, 7, 2934–2940 [3] Nature Communications 13, 3103 (2022) [4] Nature Communications 11, 2989 (2020) [5] *Nano Lett.* 2019, 19, 1, 408–414

Biography:

Sunny Gupta is currently a postdoctoral scholar in the Materials Science department at University of California, Berkeley. He did his Ph.D. with Prof. Boris I. Yakobson at Rice University, thesis titled “Formulating design-rules to predict low dimensional materials for next-generation electronics”. He was a Nettie S. Autrey Fellow at Rice University and a KVPY fellow during his bachelors and masters at Indian Institute of Science, Bangalore.

Discovery of Novel Two-Dimensional Materials with Quantum Theory and Atomic-Resolution Microscopies

Sokrates T. Pantelides

Vanderbilt University, Nashville, TN

Abstract:

Since the advent of graphene 18 years ago as a single-atom-thick two-dimensional (2D) material with potential for applications, a major research focus has been the discovery of other 2D materials and the pursuit of applications. Quantum mechanics in the form of density-functional theory is the basis of powerful computational tools with predictive power for structures and properties. Scanning transmission electron microscopy (STEM) has reached extraordinary levels of atomic-resolution imaging of materials and structures and its electron beam can be used for in-situ processing. Scanning tunneling microscopy is another powerful tool for atomic-scale imaging and structure manipulation. This talk is a journey in the world of 2D materials highlighting the discovery of novel materials and structures with unique properties for applications by combinations of these techniques and nanoscale fabrication – from graphene origami to intrinsically patterned 2D materials, three-atom-thick robust conducting nanowires and novel electronic devices. I have had the privilege of working with first-class microscopists and other scientists around the world. You are invited to a journey of discoveries in the world of 2D materials made with a combination of theory, microscopy, and other experiments -- novel materials and classes of materials,

properties, heterostructures, and applications, from catalysis to electronic devices.

This work is supported by the U.S. Department of Energy and by the Chinese Academy of Science

Biography:

Sokrates T. Pantelides received a Ph.D. in physics from the University of Illinois at Urbana-Champaign in 1973. He served as Research Staff Member, Manager, Senior Manager and Program Director at the IBM T. J. Watson Research Center. He joined Vanderbilt University as the McMinn Professor of Physics in 1994. In 2010 he was appointed University Distinguished Professor of Physics and Engineering. His research work is theoretical/computational and spans semiconductor physics, device physics, 2D materials and nanostructures, complex oxides, nanocatalysis, magnetic phenomena, and interactions of light with matter. He is a Fellow of APS, MRS, AAAS, and IEEE.

New Thoughts, Suggestions, and Results about the Mysterious World of Elementary Particles, Dark Matter, and Dark Energy

Thomas J. Buckholtz*

Ronin Institute, Montclair, NJ

Abstract:

Physics has worked on each one of the following three tasks for at least eighty years. Complete the list of elementary particles. Describe dark matter. Describe dark energy. We discuss proposed progress and results regarding each one of the three tasks. Our work has bases in extensions to accepted modeling techniques. That our specifications for new elementary particles, dark matter, and dark energy seem to explain data might suggest usefulness for our results.

Along with pointing to all known elementary particles, our modeling points to the following possible elementary particles – a spin-zero inflaton, a spin-one boson that associates with Pauli repulsion, three zero-charge analogs to quarks, three heavy neutrinos, a graviton, a possible spin-3 relative of the photon, and a possible spin-4 relative of the photon. We suggest that most dark matter associates with five of six isomers of essentially all elementary particles except the graviton and possible higher-spin zero-mass bosons. The five all-dark-matter isomers plus the ordinary-matter-centric isomer's dark matter (hadron-like gluons-plus-zero-charge-quark-analogs or heavy neutrinos) seem to explain various observed ratios (one-to-0-plus, 5-plus-to-one, 4-plus-or-minus-to-one, 1-to-one, and 0-plus-to-one) of dark matter effects to ordinary matter effects. Our results seem to point to resolutions of so-called tensions (between data and modeling) regarding the rate of expansion of the universe and other large-scale phenomena. Our modeling has bases in solutions to Diophantine equations.

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.

Rotating Lepton Model (RLM): Coupling Relativity, Quantum Mechanics and Neutrinos for the Synthesis of Matter

Constantinos Vayenas[1,2,*], Dionysios Tsousis[1,3] and Dimitrios Grigoriou[1]

[1]University of Patras, Greece

[2]Academy of Athens, Greece

[3]Stanford University, Stanford, CA

Abstract:

A gravitational Bohr-type rotating neutrino model is formulated without any adjustable parameters using Einstein's Special Relativity coupled with the equivalence principle of inertial and Newton's gravitational mass and with the de Broglie equation of quantum mechanics to study the circular motion of three gravitating neutrinos of mass equal to the heaviest eigenmass measured at Superkamiokande (~ 43.7 meV/c^2) [1]. The three neutrinos rotational state is found to have a radius of r=0.63 fm and a mass of 0.939 GeV/ c^2, equal to that of a neutron [1,2]. The thus generated centripetal gravitational force is found to equal the Strong Force expression $\hbar c/r^2$ [2,3]. The same gravitational expression value is obtained upon consideration of a rotating relativistic electron-neutrino pair, forming a W boson. Consequently, denoting by m the neutrino rest mass, it is shown that the expressions $F_S=Gm^2\gamma^6/((3^{1/2})r^2)$ and $F_W=Gm_em_o\gamma^6/((3^{1/2})r^2)$ unify, respectively, the Strong and Weak nuclear forces with the Newtonian gravitational (γ=1) force. These equations have been shown to allow for the computation of the masses of fifteen hadrons, mesons and bosons with an accuracy of 2% [2,3].

References:

[1] C.G. Vayenas, S. Souentie, Gravity, special relativity and the strong force: A Bohr-Einstein-de-Broglie model for the formation of hadrons. Springer, New York, (2012).

[2] C.G. Vayenas, D. Tsousis and D. Grigoriou, Computation of the masses, energies and internal pressures of hadrons, mesons and bosons via the Rotating Lepton Model. Physica A, 545, 123679 (2020).

[3] The rotating lepton model: Combining fundamental theories, Research Features, **137**, 102-105 (2021)

From Triboelectric Nanogenerators to Maxwell Equations for Mechano-Driven Slow-Moving Media Systems

Zhong Lin Wang*

Georgia Institute of Technology/Beijing Institute of nano energy and nano systems, China

Abstract:

As inspired by the invention of the triboelectric nanogenerators (TENGs), interests on the

study of electromagnetic behaviour of moving media have been revived. The conventional Maxwell's equations are for media whose boundaries and volumes are fixed. But for cases that involve moving media and time-dependent configuration, the equations have to be expanded. Here, starting from the integral form of the Maxwell's equations for general cases, we first derived the Maxwell's equations for a mechano-driven slow-moving medium by assuming that the medium is moving as a rigid translation object. Secondly, the expanded Maxwell's equations are further developed with including the polarization density term $\boldsymbol{P}_s$ in displacement vector owing to electrostatic charges on medium surfaces as produced by effects such as triboelectrification, based on which the theory for TENGs is developed.

Biography:

Zhong Lin Wang is the Director of the Beijing Institute of Nanoenergy and Nanosystems, Chinese Academy of Sciences, and Regents' Professor at Georgia Institute of Technology. Dr. Wang pioneered the nanogenerators and the fields of piezotronics and piezo-phototronics. Wang has received the Albert Einstein World Award of Science (2019); ENI award in Energy Frontiers (2018).. He was elected as a foreign member of the Chinese Academy of Sciences in 2009, member of European Academy of Sciences in 2002, He is the founding editor and chief editor of an international journal Nano Energy, with an impact factor of 17.88.

Supercontinuum Generation of OAM Modes in Fiber

Yang Yue[1]* and Wenpu Geng[2]

[1]Xi'an Jiaotong University, China

[2]Institute of Modern Optics, Nankai University, China

Abstract:

Orbital angular momentum (OAM) beams, featuring with unique spatial field distributions, have been extensively investigated and applied into a wide range of fields, including laser beam machining, micromanipulation, sensing, imaging, nonlinear matter interactions, and communications. OAM beams usually cover limited spectral range, and supercontinuum (SC) is a feasible method to provide broadband OAM source. When a short pulse is incident into a waveguide, due to the nonlinear spectral broadening during propagation, a broadband SC could be generated. Over the past few decades, this process has attracted widespread attention from researchers due to its potential applications in precision metrology, optical coherence tomography, and spectroscopy.

Photonic crystal fiber (PCF) with periodically arranged air holes empowers excellent control of optical properties, especially for the dispersion. Flexible dispersion engineering is conducive to broadband SC generation. In addition, ring-core fiber, similar to the annular intensity distribution of the OAM modes, has been experimentally demonstrated to be an ideal waveguiding medium. In this talk, we will review the concept of OAM modes and its corresponding applications. We recently reported an arsenic trisulfide (As_2S_3) PCF with all-normal dispersion. A 1946-nm supercontinuum for the $OAM_{1,1}$ mode was formed from 959 to 2905 nm at -20 dB level over a 1.6-octave bandwidth, by launching a 100-fs 5-kW chirp-free hyperbolic secant pulse with wavelength at 2000 nm into a 1.0-cm PCF. Furthermore, a

dual ring-core fiber with four zero-dispersion wavelengths for beyond three-octave spanning supercontinuum generation of the $OAM_{3,1}$ mode will be introduced.

Biography:

Yang Yue is a Professor with the School of Information and Communications Engineering, Xi'an Jiaotong University, China. Dr. Yue's current research interest is intelligent photonics, including optical communications, optical perception, and optical chip. He has published over 200 peer-reviewed journal papers (including Science) and conference proceedings with >9,000 citations, five edited books, two book chapters, >50 issued or pending patents. He is an Associate Editor for IEEE Access, Editor Board Member for three other scientific journals, Guest Editor for >10 journal special issues. He also served as Chair or Committee Member for >80 international conferences, Reviewer for >60 prestigious journals.

Unification of Physics over Entire Range of Quantum-Atomic-Celestial World

Debabrata Saha

Independent Research Scientist, India

Abstract:

Contemporary Physics of 21st century that was inherited from 20th century relied significantly on wave theory of light and Quantum Mechanics that had its foundation based on wave particle duality. Second decade of this century witnessed down fall of wave particle duality and the down fall of wave theory of light. Amid this down-falls evolved a new fundamental entity of nature, named **Natural Field**. This new entity not only resolves a list of shortcomings of contemporary physics, but also demystifies a century old dilemma with the interpretation of wave function in Quantum Mechanics. The postulation of natural field was validated by half a dozen repeatable experimental results that are established over centuries and was thus established in the Quantum world. Then it was extended to atomic and celestial world.

Using customary notations, $F = G\,\frac{m_1 m_2}{r^2}$, $p_\varphi = \frac{nh}{2\pi}$, $\theta_i = \theta_r$ represent respectively Newton's inverse square law of gravitation of celestial world, Bohr's ad hoc postulate for stable electron orbitals in atomic world, and Heron's law of reflection of light in quantum world. Root cause of each of these three phenomena remained unknown in contemporary Physics. However, it is observed that each of these three equations can be derived from one common dynamical equation and a common self-interference property of natural field. The new fundamental entity thus brings a unification of Physics over entire range of Quantum-Atomic-Celestial World.

References

[1] Debabrata Saha, Abstract "Origin of Gravitation," Global Summit on Gravitation, Astrophysics, and Cosmology 2022, April, Tokyo, Japan (scheduled for presentation)

[2] Debabrata Saha, "Gravitation in the light of Natural Field: A closer look and a logical conclusion," unpublished report, Kolkata, India, February-March 2021

[3] Debabrata Saha, Natural Field: A new fundamental entity of nature, New Jersey, USA, BookBaby, 2020

[4] Debabrata Saha, Abstract "A detour in twenty first century Physics," 2nd International Conf. on Quantum Mechanics && Nuclear Engineering, September 23-24, 2019, Paris, France

[5] Debabrata Saha, Abstract “Natural Field: A new fundamental entity of nature,” J Phys Chem Biophys 2018, Volume 8, DOI: 10.4172/2161-0398-C1-027

Funding Support: This work has all along been performed in private capacity without any affiliation to or support from any institution, organization, group or government.

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 a 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., Radio Physics and Electronics (Calcutta University), (3) **Applied Science –** M.A.Sc., Communication (University of Toronto), (4) **Engineering –** PhD, Computer, Information and Control Engineering (University of Michigan).

Emergence of Floquet Topological Phases in Low Dimensional Systems

Alexander Lopez* and Carla Borja and Esther Gutierrez

Higher Polytechnic School of the Coast, Ecuador

Abstract:

The emergence of non equilibrium topological phases in low dimensional systems offers an interesting route for material properties engineering. First, we analyze the gate voltage dynamical modulation of two coupled one-dimensional chains, described by the Su-Schrieffer-Heeger model. We show that the interplay of driving interactions and interchain coupling leads to the emergence of non-equilibrium edge states with nontrivial topological properties. We quantify the emergent topological phases via the winding number and show that oscillations in the mean pseudospin polarization arise as a consequence of the periodic modulation, allowing for an indirect quantification of the topological nature of the emergent electronic phases. Next we show how the half filled band Hamiltonian for DNA, can be modulated by electromagnetic radiation to produce up to a tenfold increase of the effective SOC once, the intrinsic coupling is present. On the other hand, the chiral model, once incorporating the orbital angular momentum of electron motion on the helix, opens a gap for different helicity states (helicity splitting) that chooses spin polarization according to transport direction and chirality, without breaking time reversal symmetry. The observed effects are feasible in physically reasonable parameter ranges for the radiation field amplitude and frequency.

Biography:

Alexander Lopez did his PhD at Instituto Venezolano de Investigaciones Cientificas, in Venezuela. His thesis concerned the role of decoherence effects in the production of entanglement in electronic systems. Then he moved to Germany, for a three year postdoc at the Physics Department of the University of Regensburg. Here he was focused on the role of time-periodic interactions in the manipulation of the electronic properties of graphene. Then, he moved to Yachay Tech in Ecuador, for a two year assistant professor post, focusing on spin-orbit interactions in graphene, silicene and 2DEGs. More recently, he got a permanent position at ESPOL in Guayaquil, Ecuador. Here he works on the interplay among spin-orbit interactions and radiation fields in DNA and related chiral molecules.

Atomic Semiconductor via Flat Phonon Bands in HfO_2

Jun Hee Lee*

Ulsan National Institute of Science & Technology (UNIST), South Korea

Abstract:

Flat energy bands in the momentum space of electrons were known to generate spatially localized states and produce unconventional phenomena such as graphene superconductivity. However, flat bands in a phonon had not been discovered yet. We were the first to discover that they exist in a ferroelectric HfO_2 and produce localized polar displacement of individual atomic layers [1]. Strikingly, this atomic layer is freely displaced by external voltage for the densest information storage. Our theory of atom control directly in solid [1] is applicable to the Si-compatible HfO_2, so can be materialized in most electronic devices reaching up to ~100 TB memories.

[1] "Scale-free ferroelectricity driven by flat phonon bands in HfO_2", H.-J. Lee et al., Science **369**, 1343 (2020)

Biography:

Jun Hee Lee is a computational materials scientist. He obtained his Ph.D in physics from Seoul National University in 2008. Then he moved to USA as a postdoc at Physics Dept. of Rutgers U (2008~2011), Chemistry Dept. of Princeton U (2011~2013), and Materials division of Oak Ridge National Lab. (2013~2015). Now he joined UNIST in Korea in 2015 as an assistant professor and is an associate professor. Combining his interdisciplinary background, he has been actively working in various fields such as ferroelectrics, multiferroics, polymers, and energy materials including photocatalysts, fuel cells, and batteries. He published 70 SCI papers including a recent theory paper in Science "Scale-free ferroelectricity by flat phonon bands in HfO_2", Science **369**, 1343 (2022). Nowadays he is extending his theoretical research across industries to realize ultimate-density semiconductors reaching up to ~100 TB.

Novel Switching Characteristics of Metal-Oxide Based Bemory Devices Under Cryogenic Temperatures

H. Serhat Alagoz[1]*, Mehmet Egilmez[2], Jan Jung[1] and Kim Chow[1]

[1]University of Alberta, Canada

[2]American University of Sharjah, UAE

Abstract:

Metal/Metal-Oxide/Metal is one of the few fascinating multilayered thin-film structures that show resistive switching phenomena which is promising for next-generation non-volatile memory and neuromorphic applications.[1] Since the discovery of the memristor device, tremendous work has been devoted to understanding the physics behind the switching mechanism at room temperature. However, the underlying mechanism of the resistive

switching in these systems has not been understood under cryogenic temperatures. In particular, the formation of conducting filaments of the on-state and conduction mechanism responsible for the off-state of the device is yet to be studied in detail. Studying the physics of these devices as well as the endurance capabilities at cryogenic temperatures may offer new functionalities. As we see a growing interest in quantum computing, non-volatile cryogenic memory technology may play a key role to store data-related qubit states and error algorithms.[2]

We present resistive switching characteristics of two well-known metal oxides: Pt/NiOx/Pt and Pt/TiOx/Pt measured at cryogenic temperatures: TiOx-based devices exhibit threshold switching behavior upon cooling from 100 K to 65 K and an interesting combination of threshold and memory switching at temperatures between 65 K and 25 K. In the case of NiOx based devices, we found that the lowtemperature electroforming can create stable filaments and hence reliable resistive switching. Furthermore, we further present the latest findings of retention relaxation and discuss the thermally activated changes of these switching characteristics.

References:

1- Catherine E. Graves et al 2017 Appl. Phys. Lett. 110, 123501

2- Yann Beilliard et al 2020 Nanotechnology 31, 445205

Biography:

Alagoz received his Ph.D. in experimental Physics from the University of Alberta, Canada, where he is currently appointed as a research associate focusing on the physics of charge transport for resistiveswitching materials at cryogenic temperatures. Aside from research, Dr. Alagoz enjoys teaching Physics and Calculus courses at MacEwan University and Lakeland College. His passion for teaching and learning earned him the 2022's Higher Education Teaching Certificate obtained from Derek Bok's center at Harvard University.

Vacuum Energy and the Riemann Zeta Function

S. Tafazoli

Ronin Institute, Montclair, CA

Abstract:

Much has been written on the cosmological constant problem and the vacuum catastrophe where we have the worst discrepancy between theory and measurement of about a factor of more than 120 orders of magnitude. In this paper, we improve this discrepancy by more than half which still remains very high, but also propose 3 solutions, one of which is an exciting prediction of a new boson that can help resolve the vacuum catastrophe. We attack the heart of the problem which is the divergent sums and integrals that have also plagued many other areas of Quantum Field Theory (QFT), using as our tool, a new Riemann Zeta Function regularization technique to tame these infinities. This paper presents a new theoretical calculation of the vacuum energy density by summing the contributions of all quantum fields' vacuum states which turns out to indicate that there seems to be a missing bosonic contribution

in order to match the predictions of current cosmological models and all observational data to date. The paper also makes a few other contributions in the area of vacuum energy.

The Riemann Zeta function has been applied to physics in the past and also recently has had a surprising application to scattering amplitudes, where the physical properties of scattering amplitudes are mapped to the Riemann zeta function.

Biography:

Tafazoli obtained his Ph.D. in 2005 in the area of dynamic and controls, having made contributions to the study of the normal forms and zero dynamics of a class of nonlinear systems. He was able to prove a closed form solution for a class of nonlinear systems using techniques from differential geometry, Lie algebra and matrix theory. His research interests are mainly in mathematical techniques applied to dynamics, control and more recently to physics. He strongly believes that many interesting and surprising results can be achieved when ideas from one branch of science are applied to another.

The Influence of Quantum Computing in the Business World

Arit Kumar Bishwas

PricewaterhouseCoopers, India

Abstract:

Recent advancements in the field of quantum computing demonstrate promising impacts on the business world, and it is going to change the world the way we see it today. There are many interesting applications where quantum computing has already started to influence like cryptography and optimization. The other interesting application areas under consideration are artificial intelligence, finance, material science, logistics, etc. We still don't have a fully functional quantum computer at present time but the advancements to achieve the one are significantly remarkable by the industries and academic collaborations. We have many problems that can be solved by quantum computers more efficiently as compared to the classical computer or are extremely difficult to solve by a classical computer, so we should focus on developing the quantum solutions for these problems and should not wait till the time fully functional quantum computers arrive. We will discuss the advancements in quantum computers at present time from business impact prospects, and how we can plan to infuse this technology with the existing technologies to solve real business problems.

Biography:

Arit Kumar Bishwas is a director and the head of India's "AI & Emerging Technologies" R&D group at PricewaterhouseCoopers and is also a global leader in the quantum computing domain in PricewaterhouseCoopers. Dr. Arit is having 15+ years of industrial application-oriented R&D leadership experience in multiple fields of technologies, but at present, he primally focus 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 is having 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.

Impact of Nanostructure Core-Shell on the Dielectric Properties

Cecile Autret-Lambert, Samir Merad, Sonia De Almeida-Didry and Francois Gervai

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. In recent years, $CaCu_3Ti_4O_{12}$ (CCTO) with perovskite-related structure has attracted much attention because of its unusual giant dielectric properties. It has colossal dielectric constant in the order of magnitude close to 10^5 with weak temperature dependence (100 K – 600 K) in the frequency range from 100 Hz to 100 kHz. However, the high low-frequency dielectric loss (tanδ) and the low resistivity hinder its practical applications. To clarify the origin(s) of the giant dielectric properties, related electrical properties of CCTO ceramics have been studied extensively. It has been confirmed that CCTO ceramics are electrically heterogeneous, consisting of semiconducting grains and insulating grain boundaries. Based on the result, an internal barrier layer capacitance (IBLC) effect seems to be the most plausible explanation for the giant dielectrical properties of CCTO ceramics.

Several studies have been realized and shows the important role and the impact of the grain boundaries behavior on the dielectric properties. In order to control the grain boundaries behavior in this work, the coating of CCTO particles is proposed using insulating material like SiO_2, Al_2O_3 to prepare composites ceramics with core-shell structure. The ceramics were prepared by sol-gel-like method, and their crystalline structures, microstructures, dielectric properties and complex impedance were investigated systematically. The results show that the properties of these ceramics are better than CCTO properties attributed to the increasing resistance of the insulating grain boundary.

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 95 papers (H-index 20) 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 for industrial applications.

Some Applications of the Pulsed Photoacoustic in Biomedicine

Argelia Perez Pacheco[1]*, Marco Polo Colin Garcia[2], Misael Ruiz Veloz[3], Gerardo Gutiérrez Juarez[3] and Luis Polo Parada[4]

[1]General Hospital of Mexico Dr. Eduardo Liceaga, Mexico;

[2]Posgrado en Ingenieria, UNAM,

[3]División de Ciencias e Ingenierias, Universidad de Guanajuato, León, Guanajuato, Mexico;

[4]Dalton Cardiovascular Research Center, Universidad de Missouri-Columbia, Missouri, USA.

Abstract:

Since the discovery of photoacoustic (PA) effect in 1880 by G. Bell, the field of applications in biomedicine has increased considerably in the last two decades. The photoacoustic effect is based on the generation of sound by absorption of light. When a sample is irradiated with nonstationary light, produces a temperature rise, causing emission of acoustic waves, referred to as PA waves, which can be detected by ultrasonic transducers. This technique has recently been used to obtain images of biological tissues, offering high spatial resolution, good image contrast and a safe diagnosis as it does not use ionizing radiation. In this work, we will present some applications of the PA technique in soft and hard tissue. We studied the globular sedimentation from whole human blood. Our photoacoustic system allowed to distinguish the temporal profile of the PA signals according to sex and the erythrocyte-sedimentation time of healthy blood and blood with a diagnosis of hemolytic anemia. The PA signals during erythrocyte sedimentation process from the healthy blood remained without meaningful changes in the first 24 ± 5 min, while those with anemia changed from the first minute. This effect was attributed to the aggregation of erythrocyte, leading to a higher sedimentation rate in hemolytic anemia blood. In the case of hard tissue, a PA tomograph was designed for the reconstruction of images of molar samples using the k-wave toolbox. The PA images obtained provided information on the shape, size, and internal layers (enamel and dentin) of the teeth.

Biography:

Argelia Perez Pacheco is PhD in Materials Science and Engineering from National Autonomous University of Mexico (UNAM). She received the Physicist degree in 2003 from UNAM. She has carried out 5 postdoctoral stays. She is currently Researcher in Medical Sciences from the Hospital General de México. Her main scientific interest is in the biophotonic area with focus on biomedical applications. She runs research of optical methods in biofluids, instrumentation, and photoacoustic analysis of biological tissue. Currently she is Guest Editor from Springer Nature Applied Science del Topical Collections “Biophotonics”. She has more than 18 years of teaching

Projection-Based X-ray Blood Velocimetry: its Problem and Potential Solutions

Zifeng Yang* and Mark Johnson

Wright State University, Dayton, OH

Abstract:

Blood velocimetry based on X-ray imaging of the blood flow has become an emerging technique for diagnosis of vascular disease. However, the inherent problem for this technique is rooting in the nature of 2D projection of the 3D volumetric flow feature, in which the X-ray transmitting through the 3D flow field, attenuates depending on the local concentration of the radio-opaque contrast agent, and finally reach the scintillator plan to generate the projection image with different brightness distributions. Then, optical flow method (OFM) are applied to quantify the movement of the brightness patterns on the image to produce the velocity vectors representing the flow field. To understand the errors caused by the "projection", the experiment and numerical simulations using a vertical tube to simulate the contrast injection in the blood flow are designed and operated. CFD simulations for the same condition are conducted and compared with PIV measurements for velocity distribution and dye visualization images to validate proper boundary conditions and meshing. CFD simulation results provide more insights of flow characteristics of the dye diffusion. The projective images are then evaluated with OFM and compared with PIV measurements to quantify the error associated with projection-based velocimetry. Results has shown that an error range of 20-50% is observed in the comparison of velocity magnitudes. To obtain accurate velocity mapping using projection-based velocimetry, a correction method based on Levenberg-Marquardt algorithm is implemented to correct the OFM results.

Biography:

Zifeng Yang is an associate professor in the Department of Mechanical and Materials Engineering at Wright State University since 2017 and was an assistant professor at the same institute since 2011. He graduated from Iowa State University (ISU) with a PhD degree in Aerospace Engineering in 2009. Then he was appointed as a postdoc research associate at ISU until 2011. His research focused on the development of advanced flow diagnostic techniques, fluid dynamics, bioflows, and wind energies. His research was funded by NIH, RMD Inc, Ronald Houck II and IHE, LLC, and Premier Health Boonshoft School Endowment Funding.

What can and Cannot be Expected from Tokamak Fusion

Leonid E Zakharov*

LiWFusion, Princeton, NJ

Abstract:

The electricity from fusion always 20-30 years ahead. In fact, the research remains in the scientific phase. It developed neither vision nor prototype regime for a burning plasma. Two attempts in the 1990s to reach the breakeven value of fusion power amplification factor Q=1 were not successful. Only Q=0.27 was achieved on TFTR tokamak (Princeton, USA) and 0.67 on JET (Culham, UK). In 2021, JET generated the record 59 MJ of fusion energy from

a single plasma discharge. But Q as the figure of merit for fusion was only ≈0.4. Such a degraded Q on the best tokamak ever built, the only one now capable of deuterium-tritium fusion essentially devalued the current approach to fusion. For 64 years, tokamaks are using maximum heating power to confront plasma cooling by particles escaped from the plasma core and converted at the walls into cold atoms which bounce back and cool down the plasma edge. Amplified by charge exchange effect, this plasma edge cooling is, in fact, the root reason of all problems of tokamaks fusion. The talk explains that flowing lithium can continuously pump out the escaped plasma particles. In combination with plasma fueling by injection of energetic atom beams, available on tokamaks, this would suppress the edge cooling and return magnetic fusion to its original idea of insulating plasma from the walls. This new approach on modestly modified JET can demonstrate the real burning plasma with Q=5-10 and complete the scientific feasibility phase of tokamak fusion.

Fluid Gauge Theory Applied to Kundt's Experiment

Tsutomu Kambe*

University of Tokyo, Japan.

Abstract:

In the familiar Kundt's tube experiment (1866), an interesting anomaly is well-known, such that there exist two characteristic scales observed in the experiment. One is the wave-length of the sound wave in resonance within the tube, and the other is the dust striations formed in the resonant standing wave characterized with much shorter longitudinal scales. Little known is the formation mechanism of the second dust striations.

Fluid Gauge Theory has been proposed recently by the author in 2021. Its advantage is that it can describe rotational wavy motions of an inviscid fluid intrinsically. This enables to include new mmechanism of transverse waves in addition to the acoustic longitudinal waves described by the traditional Eulerian system. This is understood as a symmetry breaking of the acoustic system according to the Fluid Gauge Theory. The larger first scale of the resonance mode of Kundt's tube is the mode described by the Eulerian system. The second smaller scales are associated with rotational eddy modes excited over the surface of dust (piled at the pipe bottom) in the acoustic standing wave. Since the oscillation frequencies of both modes share the same excitation frequency, the difference of the two longitudinal scales might be associated with the difference of respective phase velocities of irrotational and rotational waves.

In the Fluid Gauge Theory, the isotropic pressure stress field of Euler system is extended to anisotropic stress field of Maxwell-stress type, and the continuity equation is ensured by the action of newly introduced gauge fields.

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 also acted as Visiting Professor at the Chern Institute of Mathematics, Nankai University (Tianjin, China, 2003 – 2010);

General Propose Devices as Radiation Sensors: MOSFET and Photodiodes

M.A. Carvajal[1]*, I. Ruiz-Garcia[1], Juan Roman-Raya[2], M.S. Martinez-Garcia, D. Guirado[3] and A.J. Palma[1]

[1] ECSens, CITIC-UGR, Department of Electronics and Computer Technology, University of Granada, Spain.

[2] Hospital Virgen de las Nieves, Servicio de Radiofisica, Granada, Spain.

[3] Universidad Autónoma de Madrid, Madrid, Spain.

[4] San Cecilio Clinical University Hospital, Granada, Spain. Instituto de Investigación Biosanitaria (ibs. GRANADA), Hospital Universitario Clinico San Cecilio Unidad de Radiofisica,Granada, Spain\

Abstract:

Some MOS transistors and photodiodes not aimed at radiation measurements can be used as dosimeters if some techniques of thermal compensation and signal amplification are applied. The use of multiple bias current for lateral MOSFETs improves the sensitivity and linearity, and compensates the thermal drift. However, this technique cannot be applied in DMOS transistors, due to its internal structure. The thermal compensation can be carried out measuring the temperature of the silicon dice, activating the parasitic diode. In the case of photodiodes, the dark current increases with temperature exponentially, therefore a thermal correction is required. To measure the silicon temperature, the photodiode is biased in forward state, as a standard diode, so the temperature can be measured using the forward voltage. These techniques have been implemented in two reader units, and dosimetry measurements have been carried out for photon beams produced by a clinical linear accelerator (LINAC). Our research group is currently working on dosimetry of protons beams.

In this work a summary and comparison of the different amplification and thermal compensation techniques is conducted. These are applied to several electronics devices not designed for radiation measurements with different types of irradiation clinical sources.

This research has been partially funded by Junta de Andalucia (Spain), projects numbers PI-0505-2017 FEDER/Junta de Andalucia-Consejerıa de Economia y Conocimiento Project B-TIC-468-UGR18, Proyecto del Plan Nacional I+D: PID2019-104888GB-I00 and Proyectos I+D+i Junta de Andalucia 2018: P18-RT-3237.

Biography:

Miguel A. Carvajal was born in 1977 in Granada (Spain), and work as tenured Professor at the University of Granada. Academic: MSc degrees in Physics (2000), MSc degree in Electronic Engineering (2002) and PhD degree in Electronic Engineering from the University. His research interests include the effects of irradiation and post-irradiation in MOSFET transistors and photodiodes, RFID tags with sensor capabilities, gas sensor and electro chemiluminescent sensors, and their applications to handheld instrumentation.

Electro-Physical Aggregate Sensors for Concrete Damage Monitoring

Jeong-Tae Kim[1]* and Quang-Quang Pham[1]

[1]Pukyong National University, Busan, South Korea

Abstract:

A piezoelectric sensor-embedded smart aggregate is proposed for electro-mechanical impedance monitoring to detect internal concrete damage. Firstly, a capsule-like smart aggregate model is analyzed for local dynamic responses of concrete structures. An impedance measurement model is analyzed for the PZT (lead zirconate titanate)-embedded aggregate under compressive loading conditions. Secondly, a prototype of smart aggregate is designed to sensitively catch impedance signatures induced by concrete damage. Thirdly, the feasibility of the proposed sensing mechanism is evaluated using finite element analysis. Variations in impedance signatures under compressive loadings are analyzed to predetermine frequency bands sensitive to local concrete damage. Lastly, concrete cylinders embedded with smart aggregate sensors and Raspberry-Pi platformed sensing units are experimented to estimate the performance of the proposed damage monitoring technique for concrete structures. Impedance signatures are quantified to comparatively evaluate the feasibility of the sensor-embedded smart aggregate for detecting internal concrete damage.

Biography:

Jeong-Tae Kim received his Ph.D. in civil (structural) engineering from Texas A&M University in 1993. He has worked on the faculty at Pukyong National University for 27 years, where he has led Brain Korea 21 Programs granted by Korean Government for the last 16 years. He currently serves as an editor-in-chief of Structural Monitoring and Maintenance, an international journal, Techno-Press. Dr. Jeong-Tae Kim's research has been primarily in the area of damage detection theories, structural health monitoring (SHM) techniques, smart sensors and wireless networks, and application of SHM techniques to civil infrastructures.

RIKEN Accelerator-Driven Compact Neutron Systems and their Capabilities for Material Science and Engineering

Yoshie Otake *

RIKEN Center for Advanced Photonics, Neutron Beam Technology Team, Saitama, Japan

Abstract:

The first compact accelerator-driven compact neutron system of RIKEN Accelerator-driven compact neutron system, RANS, has been operational since 2013. There are two major goals of RANS project. One of the objectives is to construct a floor-standing type of compact neutron source systems that enables non-destructive evaluation and analysis of materials and components using low-energy neutrons, which has not been possible until now on-site, and to demonstrate its achievements, thereby contributing to industrial applications and human resource development. Another major objective is to develop and demonstrate outdoors a new, transportable, compact neutron systems for preventive maintenance of bridges and other large infrastructure structures, thereby contributing to extending the

service life of social capital. This is a completely new field application use of neutrons. For the material science and engineering application, the low energy transmission imaging, neutron diffractometer, small neutron angle scattering instruments, fast neutron transmission imaging, fast neutron back scattering imaging, neutron induced prompt gamma-ray analysis and neutron activation analysis are available with RANS. For further compact neutron system, RANS-II with 2.49 MeV proton linear accelerator has started in operation and fast neutron scattering imaging experiments for non-destructive visualization of concrete degradation, and the suspension bridge cables are being successfully realized. Based on more compact and light proton accelerator tube and the solid state amplifier with 500 MHz, RANS-III development starts towards a transportable neutron system.

Biography:

Yoshie Otake conducted search for neutron EDM with crystal technique and neutron interferometry research at ILL, Grenoble, France and Kyoto Univ., Japan, became a RIKEN researcher from 1996. She started developing accelerator-driven compact neutron sources (CANS) from 2009 and concentrate on the development and up-grade of RANS (RIKEN accelerator-driven compact neutron source) as team leader and has developed such new technology as neutron back scattering imaging techniques and salt detection in the large scale structures for non-destructive observation of such infrastructures as bridges, highways. Now RANS, RANS-II are operational, RANS-III and RANS-μ are under development

Enhancement of Nonlinear Optical Response in the Mid-Infrared Induced by Hot Carrier Effect

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

In general, silicon-based detectors can only detect signals from visible light to near-infrared wavelengths. Although the Schottky structure can extend the cutoff wavelength to near-infrared wavelengths through the energy barrier formed between the metal and the semiconductor, it is unable to measure light in the mid-infrared wavelengths. In this work, we control the thickness of the surface Cr metal to 10 nm size and induce the conversion of the carriers that absorb photon energy into hot electrons.

The energy redistribution induced by the hot carrier effect can enhance the responsivity of the Si-based device in the mid-infrared band. As a result, the mid-infrared (5300 nm) responsivity exhibits nonlinear trend, which is different from the internal photoemission mechanisms. If the input power is 373 μW, the responsivity was only 0.00223 mA/W. When the input power is adjusted to 580 μW, the responsivity increased to 0.0225 mA/W.

In summary, we demonstrate a silicon-based infrared light detection device based on the hot carrier effect. In addition to detecting well below the silicon detection limit, we also reveal a non-linear trend in its response, which can be optimized by a factor of about 10 under

appropriate incident conditions.

Biography:

Ching-Fuh Lin, is a Distinguished Professor and IEEE Fellow, SPIE Fellow & Member of APAM. Innovative Photonics Advanced Research Center (i-PARC).

The Ultrasounds Utilized as Promoters of Heat Transfer Enhancement in Natural Convection

Carlo Bartoli* and Alessandro Franco

University of Pisa, Italy

Abstract:

Since the beginning of the second decade of the XXI century, one of the authors of this work has begun to take care of ultrasounds used as promoters of heat exchange in convection in the perspective of “Enhancement heat transfer”. At the beginning he studied the basic physical phenomenon taking into account a stainless steel circular cylindrical tube with a “sliding” thermocouple insulated from the thanks to a ceramic electric insulator using as distilled water fluid in various states of aggregation (phases). First, he studied the behavior of water in the form of subcooled liquid and (pool) completely developed boiling but found no significant results: the increase in convective exchange coefficient was lower of the experimental error (14%) of the order of 7%. Even in conditions of “pool boiling” the improvement is of the order of 15%. The same co-author then investigated the water in “subcooled boiling” and this time the improvement of the convective exchange coefficient was significant, reaching 60%, using distilled water as working fluid. In particular, he determined that the convective exchange coefficient depended, as a fundamental parameter, on the sub-cooling temperature gap (Tsat): in optimal conditions the Tsat = 30K. Then, both the authors took into consideration a real electronic card using as working fluid the Fluorinert Electronic Liquid FC-72. This paper refers to this type of experience using a NOVAL cleaning tank with ultrasonic generators placed near the lower edges, giving a power of 500W and with a frequency of 40 kHz.

Biography:

Carlo Bartoli was born in Castagneto Carducci (ITALY) on the June 18,1959. He graduated in Mechanical Engineering in 1986 at the University of Pisa. Then he joined Fiat in Turin and Officine Galileo in Florence. In 1989 he returned at the University of Pisa where he got the Ph. D. In 1994 he became researcher (former assistant professor) of “Fisica Tecnica” at University of Pisa. He became associate professor of “Fisica Tecnica” in 2002 and confirmed professor in 2005. Since 2003 he is head of the laboratory of thermo-fluid-dynamics of the Department of Energetics. He has five industrial patents and he has published more than on hundred papers.

Electrical Conduction Behaviour of Apatites

Sadhana Agrawal

National Institute of Technology Raipur, India

Abstract:

Apatites have been widely investigated owing to its good optical and electrical properties. Its general formula is given by $A_{10}(BO_4)_6X_2$, where A belongs to the family of larger cation (Ca^{2+}, Pb^{2+}, Ba^{2+}, Sr^{2+}, Mn^{2+} etc.) and X belongs to the family of anions (F^-, OH^- Cl^-, O^{2-} etc.) respectively. The structure of apatite is hexagonal close packed bunch of spheres with space group $P6_3/m$, in which each sphere specifies tetrahedral ion with octahedral interstial site that forms tunnels between cationic and anionic sites respectively. Apatites are large band gap insulating material with band gap value ~ 5 eV, hence they are good dielectric material for application in capacitors, sensors, actuators, electronic devices etc. When rare earth (RE) elements are doped into apatite lattice the band gap reduces ~ 3.8 eV and they show application as white light emitting diodes, laser hosts, display devices etc. When fluorine (F^-) ions are substituted in the anionic site it is termed as fluorapatite. Similarly, when Hydroxyl (OH^-), chlorine (Cl^-) ions and oxygen (O^{2-}) ions are substituted in the anionic site they are termed as hydroxyapatite, chlorapatite and oxyapatite respectively. Some of the apatite compounds discussed here are $Ca_{6-x}Na_2Y_2(SiO_4)_6F_2$:$xEu^{3+}$ fluorapatite, $Ca_{6-x}Na_2Y_2(SiO_4)_6(OH)_2$:$xDy^{3+}$ hydroxyapatite, $Ca_{6-x}Na_2Y_2(SiO_4)_6Cl_2$:$xGd^{3+}$ chlorapatite and $Y_{6-x}Ba_4(SiO_4)_6O_2$:xYb^{3+} oxyapatite synthesized by solution combustion, co – precipitation and hydrothermal method respectively. XRD analysis confirms the formation of hexagonal structure with space group P63/m. The SEM micrographs shows densely packed distribution of grains. FTIR spectra shows the presence of different functional group of SiO_4 tetrahedron. The frequency dependent dielectric studies decrease with increase in frequency due to dielectric relaxation phenomena. The electrical conductivity increases with increase in frequency which shows that the apatite follows universal power law and the hopping of charge carriers is due to small polaron hopping. The electrical conduction properties of the prepared compounds show its utilization as coatings in electronic systems, energy/charge storage devices (capacitors) and as electrolytes for solid oxide fuel cells etc.

Chemical Dynamics in Nanoparticles Derives In-Materio Computing AI Devices

Hirofumi Tanaka[1]*, Saman Azhari[1,2], Deep Banerjee[1], Takumi Kotooka[1] and Oradee Srikimkaew[1]

[1]Kyushu Institute of Technology, Japan

[2]Waseda Univ., Japan

Abstract:

In recent years, superior computational power of deep learning based on software has been widely recognized, and the practical applications of artificial intelligence are rapidly expanding. On the other hand, the hardware for replacing to such artificial intelligence (AI) algorithms is facing the physical limits of scaling in silicon CMOS technology, and performance improvement is expected to hit the ceiling. For this reason, there is a growing

interest in hardware technologies that physically implement artificial neural networks (ANNs), neuromorphic information processing systems, and the applications (hereafter referred as AI systems in this paper), as well as new materials and devices. A critical difference between the presently required device functionality and that in conventional computational systems is the use of dynamics. By cleverly using nanomaterials' nonlinearity and network structure, devices that spontaneously generate pulses, noise, and other physical phenomena are expected to be realized to utilize for the AI hardware. These devices will enable drastically lower power consumption and higher integration of AI systems. In the learning process of ANNs, it is necessary to constantly change and store the weights of the weighted sum (sum-of-products) part. To avoid such an energy consumption tasks, our research center has been working on materials that can complement CMOS for AI systems by using molecules and nanocarbon materials, and further, we are trying to apply them to autonomous AI robotics. This paper introduces these nanomaterials and networks' formation as devices, the key points of the devices' functionalization, application to robots, and other recent research results.

Biography:

Hirofumi Tanaka completed his doctorate at Osaka University in 1999, then moved to RIKEN as a special postdoctoral researcher. He moved to Pennsylvania State University as a postdoctoral researcher in 2002. He joined Institute for Molecular Science in 2003 as an assistant professor. He received an excellent journal award from Japan Society of Applied Physics in 2012. He moved to Kyushu Institute of Technology as a full professor in 2014 and concurrently became a director of Research Center for Neuromorphic AI Hardware in 2020. He is focusing on molecular, nanocarbon, nanoparticles electronics to realize a new world of materials intelligence.

Deep-Learning Method for Locating Sources in Underwater Acoustics with High Noise

Adar Kahana[1]*, Eli Turkel[2], Shai Dekel[2] and Dan Givoli[3]

[1]Brown University, Providence, RI

[2]Tel-Aviv University, Israel; [3]Technion, Israel

Abstract:

Locating sources in underwater acoustics is a very interesting task. We use a numerical method for the wave problem to approximate the solution. Based on the solution recorded in a small set of sensors, we aim to find the initial condition of the problem which is the initial source and find the location of that source. Common methods tend to struggle when trying to reconstruct the initial condition when the system has very high measurement noise. We propose a deep-learning based method that incorporates Time-Reversal (known for being robust to noise) and test it with highly noisy data. The proposed method can locate sources in that setup with high noise of varying noise distributions and shows better accuracy than the reference methods.

Biography:

Adar Kahana is a post-doctoral researcher at Brown university. His research focuses on combining methods from partial differential equations with machine learning. He is particularly interested in physically informed neural networks and their use for solving ill-posed problems. His recent projects focused on locating sources and identifying obstacles in underwater acoustics (the wave problem). Adar recently graduated from Tel-Aviv university while working at Microsoft as an applied scientist.

Introduction to Solitons and Applications

Solomon Manukure

Florida A&M University, Tallahassee, FL

Abstract:

Solitons are solitary waves that maintain their shape and speed while propagating with constant velocity. They are ubiquitous in nature and have many applications in nonlinear dynamics. In this project, we give a brief historical overview of solitons. We also discuss solitary, traveling wave solutions of the classical wave equation and the famous KdV equation. Finally, we highlight a few important theoretical and physical applications of solitons.

Ultrametric Diffusion, Rugged Energy Landscapes and Transition Networks

W. A. Zuniga Galindo [1*]

University of Texas Rio Grande Valley, Edinburg, TX

Abstract:

A central paradigm in physics of complex systems (such proteins or glasses) asserts that the dynamics of such systems can be modeled as a random walk in hierarchically organized energy landscape. The hierarchical structure of the energy landscapes of the mentioned systems was discovered in the 80s by Parisi et al in the context of the spin glass theory, and by Frauenfelder in the context of protein physics. A hierarchical energy landscape can be approximated by an ultrametric spaces and by a function on this space specifying the distribution of the energy barriers. The dynamics of the system is coded in a master equation depending on a very large matrix controlling the jumps between the states of the system. About 25 years ago Parisi, Sourlas, Avetisov, Kozyrev, among others discovered that the ultrametricity can be easily represented using p-adic numbers. The transition matrix associated with the mentioned master equation approximates an operator in a p-adic space, and the master equation approximates diffusion-type equation in an ultrametric space. The purpose of the talk is to review our recent work on p-adic models of complex systems emphasizing the models of biological evolution, relaxation of complex systems, neural networks, among other results. An important result is our new p-adic generalization of the Eigen-Schuster model where the genomes (sequences of variable length) are represented by p-adic numbers. In this model, Eigen's paradox is one, among the infinitely many, possible scenarios of the evolution in the long term.

Biography:

W A Zuniga Galindo is an electrical engineer and mathematician, with a D.Sc. in mathematics from National Institute of Pure and Applied Mathematics, Brazil. He has been university professor in Colombia, Mexico, and the United States. Currently, he holds the Lokenath Debnath Professorship in Mathematical Sciences at the University of Texas, Rio Grande Valley. His research focused on ultrametricity in physics using non-Archimedean mathematics. He is member of the Colombian Academy of Exact, Physical and Natural Sciences, and the Mexican Academy of Sciences. He received in 2010 the Alejandro Angel Escobar Medal in Exact, Physical and Natural Sciences in Colombia.

Recent Trend in Physics and Chemistry of Nuclear Transmutation for Sustainability

Il Soon Hwang

Ulsan National Institute of Science and Technology (UNIST), South Korea

Abstract:

Direct disposal of spent nuclear fuels has been met with proliferation concern due to long-living plutonium, included up to 1 % by weight in spent nuclear fuels. Nevertheless nuclear renaissance to fight climate change will prefer all actinide recycling to the direct disposal. Fast neutron reactors, either critical or sub-critical system receives increasing attention as long-living high-level transuranic actinides are transmuted by fission. Their physics however can

lead to the mass production of weapon-useable plutonium. Advancing chemistry of actinides recycling may prevent it to some extent. Aqueous processes using nitric acid and organic chelates have been advanced to extract collectively transuranic elements (TRU) including Np, Am and Cm as well as Pu. Pyroprocessings using molten salt and liquid metal are far more proliferation-resistant, especially when spent nuclear fuels from thermal reactors are treated. Final waste streams from either the advanced aqueous or pyroprocessing can leave behind only intermediate level wastes that require a few hundred years of institutional control, unlike formidable high-level wastes. However, even this technology present unacceptable proliferation risk for spent nuclear fuels from fast neutron systems as the fraction of fissile isotopes in recovered TRU stream is significantly high. The best solution to the proliferation control for fast reactors for global sustainability is, therefore, a multi-national fuel cycle sanctuary where member countries bring in spent nuclear fuels and take-back recycled fuels together with accrued intermediate level waste. Latest developments of transportable long-burning micro reactors can help realize the multinational 'cradle-to-grave' fuel cycle sanctuary for the sustainable world.

Biography:

Il Soon HWANG_has been leading Korea national R&D programs on nuclear transmutation and non-refueling micro reactor in support of global decarbonization at the Ulsan National Institute of Science and Technology (UNIST), also as the president of International Forum for Reactor Aging Management (IFRAM). When he was Professor of Nuclear Engineering at Seoul National University (SNU) and Research Scientist and Visiting Associate Professor at MIT, he focused on nuclear materials and spent nuclear fuel transmutation developments. His current research focus includes transportable micro reactor development in support of Gen-IV lead fast reactors (LFR) and nuclear fuel cycle technology.

Berezin Integral as a Limit of Riemann Sum

Roman Sverdlov

University of New Mexico, Albuquerque, NM

Abstract:

Conventionally, Berezin integral is thought of as a formal operation. The reason for this is that the properties of Berezin integral contradict the usual properties of integration, which makes it seem that expressing it as a Riemann sum is mathematically impossible. However, in joint paper of Thomas Scanlon and Roman Sverdlov it was shown that doing so is possible, after all. This was done in two steps. First, the single anticommutting product was replaced with combination of anticommutting (wedge) product and Clifford product denoted by a star. The Clifford product was used between infinitesimal and finite part of the integral while wedge product was used inside the finite part. And, secondly, the integral was restricted to specific class of closed surfaces as opposed to the whole space. Or, as an alternative option, an integral over the whole space was subject to a specific class of vector-valued measures. The journal link to the paper is https://aip.scitation.org/doi/10.1063/1.5144877 and the open access link is https://math.berkeley.edu/~scanlon/papers/BIRS-9May2020.pdf).

Biography:

Roman Sverdlov earned BA at UC Berkeley, with double major in Physics and Math. He earned Masters in Minnesota in Physics. He earned Ph.D. in Michigan in Physics. He did postdoc at Raman Research Institute in India, did visiting position at Institute of Mathematical Sciences in India and did another postdoc at Indian Institute of Science Education and Research in Mohali, India. He is currently working on second Ph.D. in Mathematics at University of New Mexico.

Path Integrals of the Vector Field: Covariance of a Path Integral

Seiji Sakoda

National defense academy, Japan

Abstract:

We discuss a formulation of the Euclidean path integral for vector fields basing upon the canonical quantization with the indefinite metric Hilbert space. For the case of the Feynman gauge, the time component of a vector field requires negative metric for quantization; its eigenvalue becomes a purely imaginary number on the eigenvector. It should be stressed here, unlike the Wick rotation $A_0 \mapsto iA_4$ in obtaining the Euclidean path integral, a pure imaginary number iA_0 naturally appears as an eigenvalue of the operator $\hat{A}_0$ to result in an action which differs from the classical one in the exponent of the path integral. Although one may suspect the covariance of such a path integral due to the difference of the action compared with the classical one, the effective action, however, obtained from the path integral recovers the classical form with the covariance.

To demonstrate the feature of path integrals formulated in such a way, we consider a path integral for a harmonic oscillator described by

$$L = -\frac{1}{2}\dot{q}^2 + \frac{1}{2}q^2.$$

It will be impossible to formulate a Euclidean path integral for this Lagrangian if the eigenvalue of the operator $\hat{q}$ takes a real number; we can, however, obtain the one since its eigenvalue becomes pure imaginary. Moreover, the effective action found through the path integral restores the classical action with the Lagrangian above.

As a final comment we here notice that the path integral is a definite integral and the covariance of the action in its exponent does not mean the covariance of its result.

Frontiers in Fractional Schrodinger Equation and Results in B-Polynomial Basis Set

Muhammad Bhatti

University of Texas Rio Grande Valley (UTRGV), Edinburg, TX

Abstract:

The fields of fractional-order quantum mechanics and systems combine concepts from

fractional calculus into their modeling and design. These projects, focused on non-integer order differentiation and integration of mathematical operations, are discovered across many fields of science and engineering. Concentrating on their incorporation into quantum mechanical and electronic circuits, these ideas are being discovered to design oscillators, circuits, and control systems.

A technique is presented for approximating solutions to fractional-order differential equations (FDEs) that modeled Schrodinger equation and electric circuits using fractional-order polynomials (α as the fractional-order of polys). The technique accomplishes the desired solution in terms of continuous finite number of generalized fractional B-polys in an interval [a, b].

The focus of this research is to advance research on topics relating to the theory, project design, and application of fractional-order quantum systems and circuits. Topics of research include:

- Fractional order Forced Harmonic oscillator (FHO);
- Fractional-order Schrödinger and Dirac equations and prediction of compacted hydrogenic orbitals (so called hydrino particles which may lead to dark matter);
- Fractional-order Quantum Mechanical theory, commutators;
- Exploration of Atomic and molecular structure using Fractional-order theory;
- Applications of fractional-order circuit models for energy storage elements, supper capacitors and batteries.

Biography:

Muhammad Bhatti received his Ph. D. from the University of Notre Dame, Indiana, USA. He did post-doc work at Vanderbilt and Texas A&M Universities. He joined the University of Texas Pan American (UTPA) as assistant professor and merged into newly established University of Texas Rio Grande Valley (UTRGV). He is a recipient of various prestigious awards, including Regent's outstanding teaching award, Teaching in technology award, COS research award, grants awards. He serves as a Journal Editor, referee and a Guest Editor for Journal of Fractal and Fractional. His publications have been cited numerous times.

He is currently a professor and conducts research involving undergraduate and graduate students at UTRGV.

Defect in Gauge Theory, Quantum Spins, and Kz-Equation

Norton Lee[1*] and Nikita Nekrasov[2] and Saebyeok Jeong[3],

[1]IBS-Center for Geometry and Physics, Korea

[2]Simons Center for Geometry and Physics, USA

[3]Rutgers University, USA

Abstract:

In this talk I will introduce my work on the development on the BPS/CFT and Bethe/gauge

correspondence. This is a study about the relation between four dimensional gauge theories and two dimensional theories such as conformal field theory and integrable models such as spin chains. My researches show that when analytic continue the two dimensional theory parameters (such as conformal weight and spin in conformal field theories, or spins in XXX spin chain), the complexified two dimensional theory will have a four dimensional supersymmetric gauge theory origin. With the computational power of localization, we are able to verify that the gauge theory partition function, with proper defect introduced, are identified as conformal block in the two dimensional conformal field theory. At the Nekrasov-Shatashivilli limit, the partition function of gauge theory is identified as the eigenfunction of the corresponding integrable model. We established a relation between two dimensional conformal field theory, four dimensional gauge theory, and two dimensional integrable models, along with a dictionary of how the parameters of each theory translate between each other. In this talk I will talk about the example:

- N=2 SQCD – CFT current algebra on punctured sphere – XXX Heisenberg spin chain

Janus MXY (M = Pd, Pt; X, Y = S, Se, Te) Transition-Metal Dichalcogenide Monolayers: A First-Principles Study

W. A. Diery

King Abdulaziz University, Saudi Arabia

Abstract:

In the last century, it was a scientific spectacular for scientists to confirm the existence of two – dimensional (2D) materials when Novoselov and Geim exfoliated the 2D graphene form its three dimensional counterpart graphite. 2D Transitional metal dichalcogenides (TMDs), which are semiconductors that can be represented by MX2, where M stands for a transition metal that lays between two X chalcogen {S, Se, Te}, provide a promising alternative to graphene. They have received considerable attention due to their interesting properties and emerged as a competitive candidate for many applications including nanoelectronics, photocatalysts, spintronic, and thermoelectric materials. Very recently, a new class of asymmetric TMDs materials known as Janus TMDs started to entice considerable research interest. By substituting one layer of the X chalcogen in the MX2 by a different type of chalcogen Y, Janus structures can be formed having a general form of MXY (M = transition metal, and X/Y = S, Se and Te). The purpose of this project was to investigate the monolayer of Pd- and Pt- based Janus transitional metal dichalcogenides to fully understand their properties. We performed Density Functional Theory (DFT) to study the electronic, optical, and thermoelectric properties, as well as the dynamical stability of these materials. Our results showed that these emerging materials have remarkable properties that can be further modified by strain, thickness layer, and external electric field. Our results suggest that monolayer Pd- and Pt- Janus materials have a potential for diversified novel technological applications in various emerging fields.

Biography:

Wajood Diery is an assistant professor at the physics department of King Abdulaziz University. She received her PhD from Nottingham University (UK). Her research's interest is in computer simulations using first-principles approach to model, understand, and predict the properties of two-dimensional materials. Wajood is a former Ibn Khaldun Fellow for Saudi Arabian Women where she spent two years as a visiting professor at the Mechanical engineering department of MIT. She is recognized as a trusted reviewer and an Outstanding Reviewer for Nanotechnology Journal (IOP) in 2020.

Simulations of Cosserat Materials and Dynamic Recrystallisation

Thomas Blesgen*

Bingen University of Applied Sciences, Germany

Abstract:

A non-linear finite-strain Cosserat theory of crystal plasticity is studied which provides a detailed description of the behavior of a solid subject to mechanical forces. In a second step, a stochastic Kolmogorov-Avrami equation and a front-tracking algorithm for the propagation of domain walls are included to enable softening. The extended model is then applied to the simulation of dynamic recrystallisation in 3D.

In a final part, recent analytical results are presented regarding deformation microstructure in the limit of vanishing internal length scale and regarding a parameter-free identification of interfacial energies within the Cosserat theory.

Molecular Dynamics Algorithm for Simulating KeV Particles Bombardment

Ramon Xulvi Brunet

National Polytechnic School, Ecuador

Abstract:

A variable time step integration algorithm for simulating the molecular dynamics of particles subjected to relatively high potentials for very short periods of time is proposed to efficiently simulate the "hard collisions" of energetic particles . This adaptive algorithm is a simple modification of the well-known velocity Verlet algorithm. The algorithm is tested on some model problems that have exact solutions and is applied to a problem related to electron guiding.

Quantum Annealing via Path-Integral Monte Carlo with Data Augmentation

Yazhen Wang[1]* and Jianchang Hu[2]

[1]University of Wisconsin-Madison, Madison, WI

[2]Yale University, USA

Abstract:

This paper considers quantum annealing in the Ising framework for solving combinatorial optimization problems. The path-integral Monte Carlo simulation approach is often

used to approximate quantum annealing and implement the approximation by classical computers, which refers to simulated quantum annealing. In this paper we introduce a data augmentation scheme into simulated quantum annealing and develop a new algorithm for its implementation. The proposed algorithm reveals new insights on the sampling behaviors in simulated quantum annealing. Theoretical analyses are established to justify the algorithm, and numerical studies are conducted to check its performance and to confirm the theoretical findings.

Biography:

Yazhen Wang is Professor of Statistics at the University of Wisconsin-Madison and served as the Statistics Department chair during 2015-2018 and 2021-present. He obtained his Ph.D in statistics from University of California at Berkeley in 1992. He is the fellows of ASA and IMS. He has served as NSF program director during 2007-2009, various committees of ASA, IMS and ICSA; co-editors of Statistica Sinica and Statistics and Its Interface.

An Elementary Humanomics Approach to Boundedly Rational Quadratic Models

Michael J Campbell[1]* and Vernon L Smith[2]

[1]Aurislink and SAP Research, Anaheim, CA

[2]Chapman University, Orange City, FL

Abstract:

We take a refreshing new look at boundedly rational quadratic models in economics using some elementary modeling of the principles put forward in the book *Humanomics* by Vernon L. Smith and Bart J. Wilson. We consider gratitude/resentment to occur more slowly than economic equilibrium (quenched model) and homogeneous interactions – this turns out to be a non-frustrated spin-glass model. A two-agent quenched model with heterogeneous aligning (ferromagnetic) interactions is analyzed and yields new insights into the critical quenched probability p (1 - p) that represents the empirical frequency of gratitude (resentment). A critical quenched probability p_i*, i = 1,2, exists for each agent. When $p < p_i$*, agent i will choose action in their self-interest. When $p > p_i$*, agent i will take action sensitive to their interpersonal feelings of gratitude/resentment and thus reward/punish the initiating benefit/hurt. We find that the p_i* are greater than one-half, which implies agents are averse to resentful behavior and punishment. This was not built into the model, but is a result of its properties, and consistent with Axiom 4 in *Humanomics* about the asymmetry of gratitude and resentment. Furthermore, the agent who receives less payoff is more averse to resentful behavior; i.e., has a higher critical quenched probability. For this particular model, the Nash equilibrium has no predictive power of Humanomics properties since the rewards are the same for self-interested behavior, resentful behavior, and gratitude behavior. Accordingly, we see that the boundedly rational Gibbs equilibrium does indeed lead to richer properties.

Biography:

Michael Campbell does research in econophysics, sociophysics, and artificial intelligence. 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.

Studying Complex Systems: Formation of Opinion in a Society: A Physicist's Approach

Soham Biswas

Universidad de Guadalajara, Jalisco, Mexico

Abstract:

A complex system is a system composed of many components which may interact with each other and can't be characterized by any one of them. The concepts of statistical physics find application to different aspects of complex systems including formation of opinion in human society. I will first review few previous models of opinion formation and how opinions evolve in a social system. Then I shall be specific on a model of binary opinion in which the opinion of the individuals changes according to the state of their neighboring domains and the size of a domain represents a quantity analogous to "social pressure". I shall discuss the coarsening dynamics and the critical behavior of the model. The model exhibits a step function behavior of the exit probability in one dimension, in contrast to other well known opinion dynamics models where no such behavior has been observed so far. The connection between zero temperature quenching dynamics and this model will also be discussed.

High-Cycle and Very High-Cycle Fatigue Strength of Shot Peened Steel

Nak-Sam Choi[1]*, Liang Wang[2] and NohJun Myung[2]

[1]Hanyang University, South Korea.

[2]Graduate School, Hanyang University

Abstract:

This study investigated bending fatigue strength of shot-peened spring steel over the span of the high cycle fatigue (HCF) and very high cycle fatigue (VHCF) life , and analyzed the effects of shot-peening on the high strength spring steel under the fatigue bending test. The shot-peening of about 200% coverage was applied to form a large amount of compressive residual stress in the skin part. Most of the subsurface-originated fracture and scattering of the fatigue test data were definitely suppressed, and the fatigue strength in the cycle range below 3.0×10^7 cycles was considerably improved. The shot-peening effect on suppressing the subsurface cracks was clearly confirmed in improving fatigue life in the HCF range. On the basis of Goodman equation presupposing a uniaxial test specimen, the conventional fatigue limits at $N_f=1.0\times10^7$ were expected to be 56.4% and 66.8% of the tensile strength for unpeened and shot peened specimens, respectively. The difference in fatigue strength could be caused by specimen types, while it for shot-peened specimens was affected by residual stress distribution characteristics and microstructural changes.

When the fatigue was in the VHCF range, the fatigue limit values were slightly lower than those in the HCF range, but was reversed having values of 795 MPa and 805MPa for the

shot-peened and unpeened specimens, respectively. The decrease of the fatigue limit value for shot-peened specimen was definitely larger than that of unpeened one. The reversed situation in the fatigue limit by shot-peening need to be improved for assuring better reliability and longer service life in actual application.

Biography:

Nak-Sam Choi is a Professor of Mechanical Engineering at Hanyang University, south Korea. He is currently interested in the study of fatigue strength behaviors of fiber-metal laminates and the development of test technology for advanced functional composites. Dr. Choi received a BS degree of mechanical engineering from Seoul National University, an MS degree from KAIST, and a Ph.D from Interdisciplinary Graduate School of Engineering Sciences, Kyushu University, Japan. He has served as the Chairmanship of Program Committee for ACCM and ICCM to promote a promising field of composites science and technology in Asia and the world.

Control of Persistent Photoconductivity for Photoelectric Memory through the Bias Voltage in Van Der Waals Heterojunctions

Yaping Qi[1]*, Yucheng Jiang[2], Xinglong Ma[2,3], Lin Wang[3] and Yong P. Chen[4,5,6,7]

[1]Macau University of Science and Technology, Av. Wai Long, Macao, China

[2]Jiangsu Key Laboratory of Micro and Nano Heat Fluid Flow Technology and Energy Application, School of Physical Science and Technology, Suzhou University of Science and Technology, Suzhou, Jiangsu 215009, People's Republic of China

[3]School of Materials Science and Engineering, Shanghai University, Shanghai 200444, People's Republic of China

[4]Department of Physics and Astronomy, Purdue University, West Lafayette, Indiana 47907, United States

[5]Birck Nanotechnology Center, Purdue University, West Lafayette, Indiana 47907, United States

[6]Elmore Family School of Electrical and Computer Engineering, Purdue University, West Lafayette, Indiana 47907, United States

[7]Purdue Quantum Science and Engineering Institute, Purdue University, West Lafayette, Indiana 47907, United States

Abstract:

Persistent photoconductivity, which means the light-induced persistent enhancement of conductivity after turning off the light, is tunable by a gating voltage. In this study, we report bias-tunable persistent photoconductivity in van der Waals heterojunctions of black phosphorus/2D electron gas on $SrTiO_3$. As shown in Fig. 1, when a light pulse was applied, the resistance of a black phosphorus/2D electron gas heterojunction reduced significantly for more than five orders of magnitude. This low resistive state can be maintained over 5 days without any sign of recovery.

The device was tuned into a high resistive state after the application of the negative bias voltage.

By combining the bias voltages and light, the device enables it to change into any resistance value, indicating a potential application for multi-bit photoelectric memory. Furthermore, we demonstrate that the black phosphorus/2D electron gas heterojunction can achieve both electric writing/optical erasing and optical writing/electric erasing. In summary, our study provides a useful method to control the persistent photoconductivity through the bias voltage.

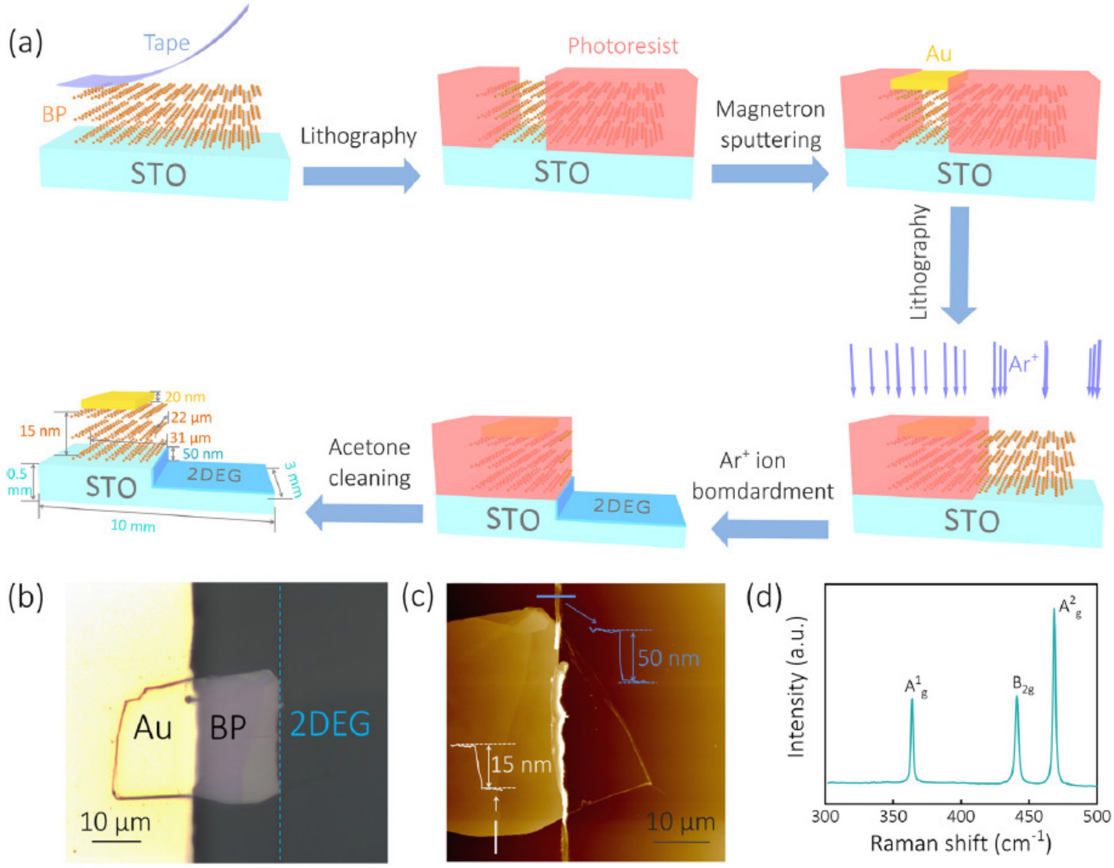

Fig. 1. (a) Schematic diagram of the fabrication process for the black phosphorus/2D electron gas (BP/2DEG) heterojunctions; (b) photographic; and (c) AFM images of the device. Line trace along the white and blue lines, showing the thickness of the BP layer and the etching depth of $SrTiO_3$ (STO); (d) the Raman spectrum of the BP layer.

Biography:

Yaping Qi is currently a postdoc researcher at Macau University of Science and Technology. She obtained her Ph.D. degree in Material Physics in 2019 at the University of Hong Kong. From 2017 to 2018, she was a Research Fellow under the supervision of Prof. David A. Weitz at Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS) at Harvard University. Then she worked as a Research Associate at Purdue Quantum Science and Engineering Institute from Oct 2019 for about 2 years. She has published 24 papers in journals including Physical Review Letters, Applied Physics Letters, etc.

AdS-dS Stationary Rotating Black Hole Exact Solution within Einstein--Nonlinear Electrodynamics

Alberto A. Garcia Diaz

Centro de Investigacion y de Estudio Avanzados del IPN, Mexico

Abstract:

The first exact rotating charged black hole solution to the Einstein--nonlinear electrodynamics theory with a cosmological constant is presented. This de Sitter--anti de Sitter black hole is equipped with mass, rotation parameter, electric and magnetic charges, cosmological constant Λ, and three parameters due to the electrodynamics: β is associated to the potential vectors A_μ and ${}^{\star}P_\nu$, and two constants, F_0 and G_0, due to the presence of the invariants F and G in the Lagrangian $L(F,G)$. This solution is of Petrov type D, characterized by the single Weyl tensor eigenvalue Ψ_2, the traceless Ricci tensor eigenvalue $S=2\Phi_{(11)}$, and the scalar curvature R; it allows for event horizons, exhibits a ring singularity and fulfils the energy conditions. Its Maxwell limit is the de Sitter-Anti--de Sitter--Kerr--Newman black hole solution.

Biography:

A.A Garcia is an Expert in Exact Solutions of the Einstein Equations coupled to matter and fields, emeritus professor of CINVESTAV with more than 40 years of experience and research.

Edge Modes in Narrow Nanoribbons of Transition Metal Dichalcogenides in a Topological 1T' Phase

Viktor Sverdlov[1,2*], Heribert Seiler[2], Al-Moatasem El-Sayed[2], Yiry Illarionov[1,3], Hans Kosina[2], and Siegfried Selberherr1

[1]TU Wien, IuE CD-Lab for NovoMemLog, Austria

[2]Institute for Microelectronics, TU Wien, Austria

[3]Ioffe Institute, Polytechnicheskaya, Russia

Abstract:

The use of novel materials with advanced properties is mandatory to continue with device scaling for high performance applications at reduced power. Topological insulators (TIs) belong to a new class of materials with an insulating bulk but highly conductive states located at the interfaces and edges. These states with nearly linear dispersion are lying in the bulk band gap of the TI. A very interesting property of these states attractive for practical applications is their topological protection against backscattering from nonmagnetic defects and disorder.

Monolayer-thin two-dimensional (2D) transition metal dichalcogenides can be in a TI phase. The fundamental band gap within which the edge states exist is reduced by the normal electric field due to the gate voltage and can close at some critical field. When the gap re-opens at higher fields, the TI becomes a normal semiconductor without edge states. The

topological transition between the TI with the conductive edge states and a semiconductor insulating phases can be exploited to build current switches.

To enhance the on-current due to the edge states it is mandatory to have multiple edges by stacking several nanoribbons. In this work we evaluate the edge states and their corresponding conductance in a nanoribbon. We present first principles results that evaluate topologically protected edge states in nanoribbons of various transition metal dichalcogenides. By varying the width of the nanoribbons, we show that they transition to trivial insulators below a critical width. We also confirm these findings with the help of an effective k·p theory. The small gap in the edge spectrum keeps increasing with the normal electric field. This increase results in a profound impact on the transport properties of the edge states.

Biography:

Viktor Sverdlov, Director, Christian Doppler Laboratory for Nonvolatile Magnetoresistive Memory and Logic. He received his Master of Science and PhD degrees in physics from the State University of St.Petersburg, Russia, in 1985 and 1989, respectively. From 1989 to 1999 he worked as a staff research scientist at the V.A.Fock Institute of Physics, St.Petersburg State University. During this time, he visited ICTP (Italy, 1993), the University of Geneva (Switzerland, 1993-1994), the University of Oulu (Finland,1995), the Helsinki University of Technology (Finland, 1996, 1998), the Free University of Berlin (Germany, 1997), and NORDITA (Denmark, 1998). In 1999, he became a staff research scientist at the State University of New York at Stony Brook. He joined the Institute for Microelectronics, Technische Universität Wien, in 2004 and he is currently on a tenure-track position. His scientific interests include device simulations, computational physics, solid-state physics, and nanoelectronics.

Transfer-Based Swabs for Surface-Enhanced Raman Scattering with Electrohydrodynamically Fabricated Nanostructures

Dae Joon Kang*, Hyunje Park and Tae Kyu Kang

Sungkyunkwan University, South Korea

Abstract:

Among the many techniques of surface-enhanced Raman scattering (SERS), the swab sampling strategy has gained much attention due to its effective signal enhancement by simply collecting the analytes. However, the conventional method synthesizes metallic nanostructures directly on the extremely rough surface of flexible supports, resulting in poor SERS performance caused by frequent signal/laser scattering. In this work, we propose a new fabrication protocol for SERS -active swabs to achieve SERS performance on a desirable substrate. The SERS-active nanostructures fabricated through electrohydrodynamic instability are released from the flat substrate and transferred to the flexible substrate, minimizing signal/laser scattering. In this way, we achieved excellent SERS performance in SERS-active swabs with a relative standard deviation of almost 10% and without severe structural damage in up to 60 swabs. In addition, our method allows the use of support materials with different structural designs, enabling customized SERS -active swabs. For example, our SERS-active swabs reliably detect pesticide residues (acephate and carbaryl)

on extremely rough surfaces, which has not been achieved before.

Biography:

Dae Joon Kang is with Sungkyunkwan University in Korea. He is the head of the Graduate School of Physics Department and director of the Brain Korea 21 Four Education and Research Division of the department. His main research interests are in non-conventional pattern replication technique based on electrohydrodynamic lithography, physics and application of 2-dimensional materials and metal oxide thin films. He has published more than 250 SCI peer reviewed journal articles in the field of nanophysics and nanotechnology.

Innovative Applications of Convergent Radiation Beam in Biomedicine

R. Figueroa, PhD.[1,2]*, J. Guarda[1,2], J. Leiva[2,3], F. Leyton[1,2], J. Velasquez[1,4], M. Serna[2], B. Casanelli[1], F. Malano[1,2],A. Cuadra[5] and M. Valente[1,2,6]

[1]Universidad de La Frontera, Temuco; Chile

[2]Depto. de Ciencias Físicas, Universidad de La Frontera, Temuco; Chile

[3]Depto. de Mecanica, Universidad de La Frontera, Temuco; Chile

[4]ICOS Inmunomédica, Temuco; Chile

[5]Clínica IRAM, Santiago; Chile

[6]Inst. de Física E. Gaviola, CONICET, Córdoba; Argentina

Abstract:

Different radiation beams have been used for biomedical applications for more than a century. Many therapeutic and diagnostic fields have profited this technology. Nowadays, existing radiation-based techniques have evolved to complex methodologies capable of tumor targeting and control. Nevertheless, most of modern techniques are based on divergent radiation beams, thus requiring the combination of many incident beams to attain high dose conformation. In this regard, recent developments focused on inherent convergent beams appear as suitable alternative to overcome some challenges by potentially improving the dose conformation performance. Moreover, promising results have been obtained suggesting that convergent beams integrate with confocal detection may be potentially capable of precise functional biomarked imaging.

The present work reports the main results about the CONVERAY® and OXIRIS® projects devoted to developing therapeutic and theranostic convergent systems; respectively. The CONVERAY system operates as independent device, or it can be adapted to existing linear accelerators, even for the new FLASH modality, as an external accessory in order to produce a photon/electron convergent mega-voltage beam capable of high fluence/dose concentration close to the geometrical focal spot, while the OXIRIS system represents an evolution in the theranostic field integrating tumor targeting, diagnose and therapy using kilo-voltage X-ray excited nanoparticles. The main dosimetry characteristics of the CONVERAY system, as applied to realistic clinical cases, are summarized along with preliminary performance of the OXIRIS system for tumor targeting using gold-nanoparticle infusion. According to the

obtained results, both the CONVERAY and OXIRIS systems have proven to constitute valuable alternatives to improve current therapeutic/theranostic technologies.

Biography:

Rodolfo Figueroa Saavedra, PhD. Is full professor at the Universidad de La Frontera, Temuco; Chile. He got his first degree in physics in Universidad de Chile and his PhD. in Physics in the Universidad Nacional de Córdoba; Argentina. Prof. Figueroa is author of dozens of peer-reviewed articles. Prof. R. Figueroa created the first post-graduation program in Medical Physics o Chile and he is an active member of many recognized international scientific societies.

Photon-Charge Counting X-ray Energy Dispersive Imaging Detector

Toru Aoki*, Junichi Nishizawa, Kento Tabata, Hiroki Kase and Katsuyuki Takagi*

Research Institute of Electronics, Shizuoka University, Japan

Abstract:

Since X-rays are photons, which are countable particles, we aimed to achieve low exposure by focusing on how to efficiently receive and accurately count X-rays. The technical term for this is photon counting. Instead of using the technique of accumulation and scanning, which has been common sense since the days of Professor Kenjiro Takayanagi, the current state-of-the-art LSI technology and ultra-high speed signal processing technology are used to process the X-ray photons randomly incident on the image pixels at each pixel. We are developing an extremely sensitive and highly functional image detector by accurately measuring each X-ray photon that jumps into a single pixel of the image detector and also accurately measuring the electric charge (electrons) converted in the detector. The concept of "nanovision science", a new academic field of research at the Research Institute of Electronics, Shizuoka University, is the basis of this research, and is achieved by using the most advanced semiconductor technology and the latest digital signal processing. We introduce the new world of radiation imaging, which is opened up by the cutting-edge science of handling the digital

Physics of Loewner Evolution: Theory and Applications

Yusuke Shibasaki*

Nihon University, Japan

Abstract:

The discovery of the stochastic Loewner evolution (SLE) by Schramm in 2000 has revealed a novel perspective on the 2D critical phenomena in statistical mechanics models. The SLE is a model comprised of Loewner differential equation and a Wiener process (Brownian motion). Although the studies on the SLE have been developed mainly in the mathematical context, in the recent works of the authors, physical interpretations of Loewner evolution are

gradually clarified. In this presentation, I introduce the perspective on the physics of Loewner evolution with its application method. First, I present the close relationship between chaotic dynamical systems and the discrete Loewner evolution by showing numerical results on the Ising system interface, while reporting the physical properties of Ising system newly revealed by the theory of Loewner evolution. Subsequently, I introduce "chaotic" Loewner evolution, a generalized model of SLE to discuss its similarity to other self-organization models, e.g., diffusion-limited aggregation (DLA), having the multifractal structures. The application method to real biological systems will be also remarked dealing with the neurite morphology of the cultured neurons. Finally, I discuss the non-equilibrium statistical physical property of the trajectory of SLE from the viewpoint of the Gibbs-Shannon entropy production to investigate the possible factors causing the time irreversibility of the SLE. Although the present study is work in progress, I would expect that it will provide a novel strategy for the unsolved problems on non-equilibrium statistical physics and biological physics.

Biography:

Yusuke Shibasaki is a Ph. D candidate at Nihon University, Japan and a research fellow of the Japan society for the promotion of science (JSPS) from 2020. He majors in non-equilibrium statistical physics, dynamical theory, and its biomedical applications. The current works of him focus on the physical theorization of the stochastic/chaotic Loewner evolution and its applications to the real biological systems. Inspired by complex phenomena in nature and arts, he is always seeking for the law governing the "living" state.

A Physical Interpretation of the Anomalous Phenomenology Underlying the Ionic-Electronic Defect Nature of Perovskite Optoelectronic Devices

Enrique Hernandez-Balaguera,[1,*] Belén Arredondo,[1] Laura Muñoz-Díaz,[1] Gonzalo del Pozo, Beatriz Romero,[1] Haibing Xie,[2] Carlos Pereyra,[2] Mónica Lira-Cantú,[2] Mehrdad Najafi,[3] and Yulia Galagan[4]

[1] King Juan Carlos University, Madrid, Spain.

[2] Barcelona Institute of Science and Technology, Campus UAB, Barcelona, Spain.

[3] TNO – Solliance, High Tech Campus 21, Eindhoven, 5656AE, the Netherlands.

[4] National Taiwan University, Taiwan.

Abstract:

Understanding the peculiar and puzzling phenomenology of perovskite-based solar cells is one of the most elusive issues prevalent in perovskite's community in the last years (e.g., complex transient behavior, rate-dependent *J-V* hysteresis and/or non-ideal capacitive effects). Here, we reevaluate the basic conceptual picture of anomalous ionic-electronic processes underlying the heterogeneous environment of perovskite solar cells. In this sense, fractional calculus emerges as the most adequate tool to model the cooperative relaxation phenomena at long time scales, which have a significant impact on the appearance of hysteresis (slow and anomalous memory-based hysteretic currents) and, more extensively, on the photovoltaic performance. We analyze perovskite solar cells with different architectures, both in the dark and under illumination, using stepwise-*JV* measurements and Impedance

Spectroscopy (IS). Our fresh interpretation establishes a key connection between the dynamic normal/inverted hysteresis, fractional-order capacitive/inductive responses, and device physics. Finally, we provide a discussion on the optimal configuration parameters in order to suppress reversible effects of hysteresis in device performance assessment (*J*-*V* modelling), with the aim of improving reproducibility and comparability between research laboratories. Our study outlines key guidelines for further dedicated works to adequately interpret the characteristic ionic-electronic phenomenology and evaluate the device performance.

Calculation of the Electromagnetic Self-Force of Spatially Extended Charged Objects

Georgeta Vaman

Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering, Romania

Abstract:

A rigourous study of the motion of a charged particle in an external electromagnetic field cannot neglect the interaction of the particle with its own electromagnetic field. The calculation of the electromagnetic self-force of spatially extended charged bodies requires complex and, sometimes, tricky mathematics. This is one of the main reasons for wich the scientific literature on this subject is not very rich. We present here some recent progress regarding such calculations.

Constitutive Laws for Continua with Partially Constrained Microstructure

Pasquale Giovine

Mediterranea University of Reggio Calabria, Italy

Abstract:

The thermo-mechanical balance and constitutive equations for microstructured media are derived from an expansion of the general Noll's axiom of frame indifference that takes into account the behavior of the measures of microstructural interactions; moreover, they are investigated by imposing perfect internal kinematic and thermal constraints on the microstructural parameters, in order to involve, in the constitutive relations, higher order derivatives of macro- and micro-displacements and/or temperature, avoiding the classical incompatibilities on the entropy inequality. After, some classes of particular continuum are provided, such as media with nano pores, granular materials, immiscible mixtures and pseudo-Cosserat continua, introducing partially internal constraints and adopting a principle of extended determinism to analyze the consequences of their presence in the constitutive laws. At the end, the complete thermo-dynamical system of differential equations for these peculiar material families is provided.

Causality and Linking and the Additional Steps Needed to Make These Results Applicable

Vladimir Chernov and Stefan Nemirovski

Dartmouth College, Hanover, NH

Abstract:

Jointly with Stefan Nemirovski we showed that linking of the spheres of light rays through

two points completely determines the causality relation – that is if you can get from one point to the other without exceeding light speed. The spheres are the light cones with each light ray becoming one point and the linking happens in the space of all light rays.

We discuss future steps needed to make these results applicable.

On the Philosophical Significance of Poo

Chris Jeynes[1]* and Michael C. Parker[2]

[1]University of Surrey Ion Beam Centre, UK

[2]University of Essex, UK

Abstract:

The Second Law of Thermodynamics can be stated as: generating information also generates waste. All living things are necessarily constantly generating "information", and consequently must produce waste (that is, "**entropy**", which we can reasonably accurately also call "**poo**"). It is proved, using the Quantitative Geometrical Thermodynamics (QGT) formalism, that just as for energy, so also entropy production is a conserved quantity in any closed system. It is required by the physics that "poo" (as one of the ways of excreting entropy) is produced in one form or another by all living things.

QGT rigorously shows (using the conventional methods of information science) how to combine information and entropy into a new and fundamentally important quantity **info-entropy**, so (for example) the entropic **Uncertainty Relations** are readily derived from the entropic Liouville Theorem.

Thermodynamics is intrinsically scale-less and should apply universally. QGT shows that it applies to the galactic (including black holes and spiral galaxies) and also to nuclear entities. In particular, QGT (without any quantum mechanics) yields the correct sizes of various interesting sub-atomic nuclei (http://dx.doi.org/10.1002/andp.202100278).

This treatment not only opens up fundamentally new ways of approaching a wide range of currently intractable problems, but also focusses attention on "non-local" effects allowing a deeper insight into the representation of reality and thereby bringing some basic questions into sharp focus, including an entirely new **physical** approach to **integrity**. In the postwar period it has been unfashionable to consider the philosophical questions suggested by the physics, but today this seems to be changing.

Biography:

Jeynes was awarded a PhD from Bristol University in 1981 and immediately invited to join the University of Surrey Ion Beam Centre (as it became). The following year, he became Liaison Fellow at the same centre, engaging many national and international scientists in multidisciplinary projects using the Surrey ion accelerators. He "retired" in 2020.

A Study of Structural, Vibrational, Electronic and Transport Properties of Singlewalled Carbon Nanotube – Single-Layer Graphene Hybrid Nanostructures

Juhi Srivastava* and Anshu Gaur

Indian Institute of Technology Kanpur, India

Abstract:

The properties of hybrid carbon nanostructures (van der Waals (vdW) heterostructures) based on single-walled carbon nanotubes (SWCNT) and single-layer graphene (SLG) are modified due to interactions between the two components. These interactions can be of various forms, such as electronic interactions at their interface, vdW forces between atoms of the two components, and localized structural deformations in the constituent structures that are caused by vdW forces. In this work, we present a computational study of these interactions and its effect on their structural, vibrational, electronic and transport properties using the density-functional tight-binding (DFTB) method. By deconvoluting the changes in vibrational properties to chart the effect of individual factors, it has been shown that structural deformation and vdW forces are the main factors influencing the vibrational properties of components within a hybrid, with structural deformation being the dominant factor. However, the electronic structure (and thus the electronic transport) in these hybrid systems are mainly modified due to the electronic interactions between the components, resulting in flattening, separation (breaking of degeneracy) and a decrease in curvature of the energy bands and opening of sub-band gaps. Effect of the electronic interaction further increases with decreasing separation between the components, as reflected in increasing flattening of bands, increasing sub-band gaps, increasing density of states, and a decrease in the drain current in hybrid devices. Additionally, the screening effect of transverse (gate) field by both the components with applied gate bias is also investigated.

Biography:

Juhi Srivastava is a researcher in the field of computational materials science with expertise in DFT and DFTB based simulation methods. She holds a Bachelor's and Master's degree in Physics from Banaras Hindu University, India, along with an integrated Master's + Ph.D. (submitted) in Materials Science and Engineering from IIT Kanpur, India.

Multi-Fidelity Bayesian Learning and Optimization for Physical Simulation and its Applications

Shandian Zhe

University of Utah, Salt Lake City, UT

Abstract:

Multi-fidelity learning involves using training examples at different fidelities or resolutions. High-fidelity examples are of high-quality but often are much more costly to collect than inaccurate, low-fidelity examples. How to retrieve and leverage examples at multiple fidelities is the key to reduce the learning cost while maximizing the efficiency.

I will introduce our recent work in multi-fidelity Bayesian learning and optimization. First, I

will introduce our deep auto-regressive models that can encode complex correlations across the fidelities and integrate examples of high-dimensional outputs. These are common in applications of physical simulation. Second, I will introduce our work of deep multi-fidelity active learning and Bayesian optimization that can improve the learning and optimization efficiency while reducing the cost of generating training examples, namely maximizing the benefit-cost ratio. Finally, a batch version of the active learning and optimization technique will be presented, which can reduce the query redundancy, improve diversity, and further boost the benefit-cost ratio. I will showcase the advantage of our methods in standard benchmarks of physical simulation, topology structure optimization, and hyper-parameter tuning in physics informed neural networks.

Biography:

Shandian Zhe is an assistant professor at School of Computing, University of Utah. His research area is mainly probabilistic machine learning, including Bayesian deep learning, Bayesian nonparametrics, Physics informed machine learning, tensor embeddings, meta learning, etc. Dr. Zhe's research has been supported by National Science Foundations and Department of Defense. His research contributions have been published at many top machine learning and artificial intelligence venues, such as NeurIPS, ICML, AISTATS, UAI, and AAAI. Dr. Zhe has received NSF Career Award in 2021. He obtained the Ph.D. degree from Computer Science Department at Purdue University in 2017.

Probing Complex Interfaces Using ab-initio Simulations and Experimental Characterizations

Tadashi Ogitsu

Lawrence Livermore National Laboratory, Livermore, CA

Abstract:

Electrochemical processes occurring at the interfaces is key factor to the performance and durability of hydrogen production technologies. Recent progresses in predictive modeling methods together with high-fidelity experimental characterization techniques that take device operation condition into consideration led to significant advancements in understanding how microscopic interfacial processes propagates to macroscopic device behavior. In this talk, we will overview our materials modeling efforts within HydroGEN consortium supported by the US Department of Energy, Hydrogen and Fuel Cells Technologies Office, which span ab-initio atomistic modeling to macroscopic device modeling, wherein the state-of-art characterization techniques are fully leveraged in order to ensure the fidelity of our interpretation. As concrete examples, we will present our recent activities to improve understanding about the mechanisms that dictate performance and durability of hydrogen production devices, where considering operating conditions and integration with experimental characterization often played critical roles. More specifically, we will discuss how computational models have helped to elucidate mechanisms of interface chemistry, formation of new phases, and the impact of interfaces on key reaction pathways that are intimately related to the device performance and durability, wherein experimental characterization data was used as the constraint for our models and obtain new understanding of interfacial phenomena relevant for the performance of hydrogen production techniques. Finally, we will discuss how the obtained knowledge can be used to develop strategies for improving

materials used in hydrogen production technologies. This 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 computational spectroscopy and is interested in applying these skills and investigate on fundamental aspect of electrochemical processes relevant for energy applications such as renewable hydrogen production. He is a deputy group leader of Quantum Simulation Group at Lawrence Livermore National Laboratory and is the point of contact for DOE/EERE HydroGEN consortium (www.h2awsm.org), which is designed to facilitate sustainable hydrogen production R&D by providing highly diverse and complemental research capabilities.

Properties of a THz-sub-THz Coherent Undulator and Cherenkov Radiations Driven by a Low Energy Electron Beam from a Thermionic RF Electron Gun

A.V. Smirnov[a]*, R. Agustsson[b] , W.J. Berg[c], J. Dooling[c], T. Campese[b], Y. Chen[b], D. Gavryushkin[b], L. Erwin[c], J. Hartzell[d], R. Keane[c], F.H. O'Shea[e], N. Sereno[c], E. Spranza[b], S. Pasky[c], M. Ruelas[b], Y. Sun[c], and A. A. Zholentsc

[a] Advanced Energy Industries, Mountain View, CA

[b]RadiaBeam Technologies LLC, Santa Monica, CA

[c]Advanced Photon Source, Argonne National Laboratory, Argonne, IL

[d]Nusano, Inc., Santa Monica Blvd., Los Angeles, CA

[e]Elettra-Sincrotrone Trieste, Basovizza, Italy

Abstract:

We overview observations of an intense sub-THz and THz radiations in a table top system comprising RF thermionic gun delivering ~2-3 MeV electron beam, an alpha-magnet forming a flat beam with quadrupoles and specially designed radiators of two types followed by a horn antenna and in-vacuum miniature bending magnet separating the mm-sub-mm-waves and electron beam. Undulator radiator having 3.25 mm gap, 1.3 cm period and ~20 cm length produced a multi-band radiation in an oversized ~ rectangular waveguide. Cherenkov variant of the radiator uses flat 45 cm long and 1 cm wide gratings having 0.13 mm period and 0.8 mm gap. Total radiated energy up to a sub-millijoule per a microsecond RF macro pulse is demonstrated in different bands with flux more than ten micro-Joules per centimeter squared. Among potential applications are solid state physics, biology, and cancer therapy where high peak intensities are required.

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.

Dualities of W-Algebras and Feigin-Semikhatov Conjectures

Thomas Creutzig[1], Naoki Genra[2]*, Shigenori Nakatsuka[2] and Ryo Sato[3]

[1]University of Alberta, Canada

[2]University of Tokyo, Japan

[3]RIMS, Kyoto University, Japan

Abstract:

The Feigin-Semikhatov algebra $W_n^{(2)}$ are a family of vertex algebras defined as the common kernels of screening operators associated to $\mathfrak{sl}(n|1)$, and generalizations of affine vertex algebras of $\mathfrak{sl}_n$ and Bershadsky-Polyakov algebras. The vertex algebras $W_n^{(2)}$ are isomorphic to the subregular W-algebras of $\mathfrak{sl}_n$, and Feigin and Semikhatov suggested the conjectural dualities between $W_n^{(2)}$ and W-superalgebras associated to $\mathfrak{sl}(n|1)$ (for example, N=2 super conformal vertex superalgebras). Their conjectures were checked in some examples by Creutzig and Ridout.

In this talk, we prove their conjectures. More precisely, we show that (1) Heisenberg cosets of the subregular W-algebras are isomorphic to Heisenberg cosets of the principal W-superalgebras of $\mathfrak{sl}(n|1)$, (2) the subregular W-algebras are related to the principal W-superalgebras along the Kazama-Suzuki type dualities, and (3) there exist blockwise correspondences of the module categories through the relative semi-infinite cohomologies.

These results can be considered as the special cases of Gaiotto-Rapčák conjectures, called trialities of W-algebras. While Creutzig-Linshaw recently proved lots of parts of the conjectures by using $W_{1+\infty}$-algebras, we use screening operators to prove our cases. We will explain the relationship between them if time permits.

Application of Ohmic Heating to Heat Transfer of Magnetohydrodynamic Flow with Variable Pressure Gradient: a Computational Approach

Sharidan Shafie[1]* and Hanifa Hanif[1,2]

[1]University of Technology Malaysia, Malaysia

[2]Sardar Bahadur Khan Women's University, Quetta, Pakistan

Abstract:

The aim of this research is to look at the significance of an external oriented inclined magnetic field on two-dimensional flow and dissipative heat transfer of a viscous fluid over a flat surface. The mainstream flow is subjected to pressure gradient and heat is induced

by Ohmic heating. For the convergent solutions, an implicit finite difference method is fully exfoliated with the aid of MATLAB software. The outcomes are displayed graphically, and showed that the fluid velocity increased when the magnetic field is applied normal to the flow direction. A positive correlation is found between temperature and viscous dissipation parameter.

Biography:

Sharidan Shafie obtained his Ph.D. (2005) in Applied Mathematics from Universiti Teknologi Malaysia. He is working as an Associate Professor at Department of Mathematical Sciences, Faculty Sciences, UTM. He is member of Malaysian Mathematical Sciences Society. His major research interests are fluid mechanics and heat and mass transfer.

Band Structure Computation and Analysis of Phononic Crystals Using the Petrov-Galerkin Finite Element Method

Liwei Shi[1]*, Liqun Wang[2] and Hui Zheng[3]

[1]China University of Political Science and Law, China

[2]China University of Petroleum-Beijing, China

[3]Nanchang University, China

Abstract:

Phononic crystal is a new kind of functional material formed by periodic arrangement of elastic solids in another solid or fluid medium. When elastic waves propagate in a phononic crystal, it is prevented from propagating in a certain frequency range, while in other frequency ranges it can propagate without loss. Phononic crystals are widely used in modern industry for this property. Due to the existence of continuity conditions and periodic boundary conditions at the interface of the scatterer, the band structure computation of phononic crystals is extremely challenging, especially for those with complex scatterer shapes. This talk will focus on the Petrov-Galerkin finite element method for the band structure computation of complex phononic crystals, and discuss the properties of various materials and structures.

Biography:

Liwei Shi received the Ph.D degree from Louisiana Tech University in 2013. She is a professor of China University of Political Science and Law. Her research interests include numerical solution of interface problems and phononic/photonic band structure computation.

Significance of Riga Plate on Hybrid Casson Nanofluid Flow Treated with Analytical Caputo-Fabrizio Fractional Derivative

Ridhwan Reyaz[1]*, Ahmad Qushairi Mohamad[1], Yeou Jiann Lim[1] and Sharidan Shafie[1]

University of Technology Malaysia

Abstract:

The innovation of the Riga plate has been proven beneficial in the fields of marine engineering,

nuclear engineering and biomedical sciences. The Riga plate, a plate that is made up of magnets and electrodes aligned together alternatingly, acts as an actuator to control fluid flow. It can either aid or hamper the movement of fluid depending on its position. Previous investigations lack in introducing fractional derivatives into the study of fluid flowing over a Riga plate. Fractional derivatives are derivatives with an arbitrary number as their order. Although the geometrical representations of fractional derivatives on fluid flow have yet to be discovered, analytical solutions are essential in proving future experimental or numerical studies. Thus, this study aims to investigate the repercussions of the presence of a Riga plate on a Copper-Alumina ($Cu-Al_2O_3$) hybrid Casson nanofluid treated with the Caputo-Fabrizio fractional derivative (CFFD). Governing partial differential equations (PDEs) are solved analytically using Laplace and inverse Laplace transform, utilizing the convolution theorem and compound function method for inverse Laplace transform. Obtained solutions are then verified with published results. Variations in the modified Hartmann number, fractional parameter and nanoparticle volume fractions are then analyzed graphically and numerically. It is observed that when the modified Hartmann number and nanoparticle volume fraction for Copper solid is increased, fluid movement slowed down while increasing the fractional parameter increases it. Skin friction and Nusselt number also correspond to these changes accordingly. Thus, the Riga plate impacts the fluid flow of a fractional Caputo-Fabrizio hybrid Casson nanofluid.

Biography:

Ridhwan Reyaz obtained his BSc (2012) in Mathematical Sciences, MSc (2019) in Engineering Mathematics from Universiti Teknologi Malaysia, Malaysia. Currently undertaking his PhD in Mathematics from the same university. His research interest includes fluid mechanics, fractional derivatives, heat and mass transfer as well analytical solutions of partial differential equations. He is a member of the Malaysian Mathematical Sciences Society (PERSAMA) and has contributed to the field through several academic publications and conferences.

Study of Electrical Conductivity of Solid Solutions Between Metal-Like Lead-and Mott Insulator Yttrium Ruthenate Pyrochlores

Sepideh Akhbarifar

The Catholic University of America, Washington, DC

Abstract:

In this study a metal-insulator transition (MIT) was observed when doping the strongly correlated electron system lead ruthenate pyrochlore with yttrium. All ceramics were synthesized by solid state reaction at high temperature and pressed into pellets. Electrical conductivity was measured from 25 to 300°C. Lead ruthenate ($Pb_2Ru_2O_{6.5}$) is metallic Pauli paramagnetic, whereas yttrium ruthenate ($Y_2Ru_2O_7$) is an antiferromagnetic mott insulator. At 0.2 moles of yttrium (Y) a temperature-independent metal-insulator transition was discovered, which was mathematically analyzed in a new way and explained by the Mott–Hubbard mechanism of electron localization. Obviously, only a small amount of yttrium is needed to open the Mott–Hubbard energy gap and to fill the lower Hubbard band (LHB) with localized electrons.

Biography:

Sepideh Akhbarifar is a postdoctoral researcher in physics-materials science and adjunct faculty in Mechanical Engineering Department at Catholic University of America. She holds a Ph.D. in physics, has master's degrees in Nuclear Environmental Protection and in Chemical Engineering. Her scientific interests focus on environmental protection, specifically energy efficiency. Her research comprises thermoelectricity, geopolymers, cyclone de-dusters. She was honored as a 'Young-Women-Inventor-2010' by Iran's National Elites Foundation. She publishes widely, including a chapter of a book on thermoelectricity and holds two patents. She is a member of several scientific societies, e.g., the 'Early Career Subcommittee' and lead organizer of the symposium on thermoelectricity (MRS Fall-2022) and reviewer for several journals.

Tunnel Magnetodielectric Effect: Experimental and Theoretical Progress

Yang Cao*

Frontier Research Institute for Interdisciplinary Sciences, Tohoku University, Japan

Abstract:

We recently discovered a room-temperature magnetodielectric (TMD) effect, i.e., tunnel MD (TMD) effect in nanogranular films, which is caused by the spin-dependent charge oscillation between granule pairs [Nat. Commun. 5, 4417 (2014)]. The frequency response of the TMD effect is closely correlated with the inter-granular spacing [Appl. Phys. Lett. 110, 072902 (2017)]. The structure comprised superparamagnetic magnetic nanoparticles homogeneously distributed in an insulator ceramic matrix. In this presentation, we will show recent theoretical and experimental advances of the TMD effect. We have performed theoretical derivation to tentatively predict the theoretical limit of TMD response with

different magnetic materials, which is determined by spin polarization (PT) and normalized magnetization (m). We also offer experimental evidence to prove the correctness of the derived formula. This study provides design guidelines for ultra-high TMD response, with big promise in high-performance microwave magnetoelectric applications.

Biography:

Yang Cao is an assistant professor at Tohoku University, Japan. He obtained a Ph.D. degree in materials science from Tohoku University in 2016. He continued as a postdoctoral researcher (2016-2019). In 2019, he joined the faculty at Tohoku University as an assistant professor. He was awarded as JSPS fellow (2015-2017) and Prominent Research Fellow of Tohoku University (2021-2024). His research is concerned with spin-dependent charge transport behavior in nanogranular composites with particular attention on tunnel magnetoresistance and magneto-dielectric effects.

Spintronics Based Field Programmable Gate Array Its Overview and Application to Edge AI Hardware

Daisuke Suzuki

The University of Aizu, Japan

Abstract:

A field-programmable gate array (FPGA) is a promising hardware platform for internet-of-thing IoT applications owing to its reconfigurable and fully parallel architecture. However, since the storage function 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.

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 cut off, a power-gating technique can be fully utilized and standby power consumption of idle function blocks is eliminated. Among several nonvolatile devices, a Spintronics device (e. g. magnetic tunnel junction device) 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. In addition, 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, and edge-AI hardware using nonvolatile logic LSIs.

Smart Textiles for Personalized Health Care

Jun Chen*

University of California, Los Angeles, CA

Abstract:

There is nothing more personal than healthcare. Health care should move from its current reactive and disease-centric system to a personalized, predictive, preventative, and participatory model with a focus on disease prevention and health promotion. As the world marches into the era of the Internet of Things (IoT) and 5G wireless, technology renovation enables the industry to offer a more individually tailored approach to healthcare with better health outcomes, higher quality, and lower cost. However, empowering the utility of IoT-enabled technologies for personalized health care is still significantly challenged by the shortage of cost-effective on-body biomedical devices to continuously provide real-time, patient-generated health data. Textiles have been concomitant and playing a vital role in the long history of human civilization. The textile forms endow biomedical devices with biocompatible, biodegradable, even bioabsorbable features, allowing them to serve as on-body healthcare platforms with incomparable wearing comfort. Merging biomedical devices and textiles becomes increasingly important owing to the growing trend of IoT. In this talk, I will introduce our current research on smart textiles for biomonitoring, therapy, and textile power generation as an energy solution for future on-body biomedical devices.

Biography:

Jun Chen is currently an assistant professor in the Department of Bioengineering at the University of California, Los Angeles. His current research focuses on nanotechnology and bioelectronics for energy, sensing, and therapeutic applications in the form of smart textiles, wearables, and body area networks. He has published 2 books; 1 book chapter; and 220 journal articles, 120 of them being a corresponding author in Chemical Reviews, Chemical Society Reviews, Nature Materials, Nature Electronics, Nature Communications, Science Advances, Joule, Matter, etc. With a current h-index of 80, he was identified to be one of the world's most influential researchers in the field of Materials Science by the Web of Science Group. Among his many accolades are the UCLA Society of Hellman Fellows Award, Okawa Foundation Research Award, Advanced Materials Rising Star, Materials Today Rising Star Award, ACS Nano Rising Stars Lectureship Award, Chem. Soc. Rev. Emerging Investigator Award, and many others. Beyond research, he is an associate editor of Biosensors and Bioelectronics.

3D Spatialization and its Relationship to Natural Acoustic Localization

Milind N. Kunchur[1]*

University of South Carolina, Columbia, SC

Abstract:

While the mechanisms responsible for natural acoustic localization are mostly well understood, if and how they apply to reproduced sound has remained a questionable

and controversial subject. In particular, it had not been scientifically verified or explained whether two-channel stereophony can or should reproduce all three dimensions, including elevation. The present work conducted IRB approved blind listening tests on human subjects to formally confirm—for the first time in the 70-year history of stereo sound—that an optimally set up audio system and recording can indeed portray a 3D virtual sound stage. For the reproduced sound, the auditory system appears to employ an alternative mechanism involving reflections instead of the standard anatomical-transfer-function based process. This talk also provides an overview of the various other conundrums and intricacies of high-end audio, and their association with the complexities of human auditory perception.

Biography:

Milind N. Kunchur is a Governor's Distinguished Professor and Michael J. Mungo Distinguished Professor at the University of South Carolina. He obtained his 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.

Novel Multifunctional Gold-Silver-Cinnamon Nanostructures for Biomedicine

Ali Aqeel Salim*, Sib Krishna **Ghoshal and Hazri Bakhtiar**

University of Technology Malaysia

Abstract:

New types of efficient and multifunctional fluorescent hybrid organic-inorganic nanomaterials became demanding in biomedicine, especially for anticancer and antimicrobal drugs formulation. In this insight, we prepared some novel surface functionalized gold-silver-cinnamon shell structure (Au-Ag-Cin SS) using the versatile pulse laser ablation in liquid (PLAL) method and characterized. The anticancer potential of these SS were tested in vitro against HCT-116 adenocarcinoma cancer cells and CCD-18co normal colon cell lines. In addition, the antibacterial effectiveness of the SS was tested against Escherichia coli, Pseudomonas aeruginosa, Bacillus subtilis and Staphylococcus aureus bacteria strains. These SS were produced by ablating a pure cinnamon, silver and gold target immersed separately in the liquid medium wherein a Q-switched Nd:YAG pulse laser with pulse duration of 10 ns, repetition rate of 10 Hz and wavelength of 1064 nm was used. The structure, morphology and fluorescence traits of these SS were tailored in terms of Au-Ag-Cin SS in Au-Ag-Cin SS chemical interfaces and characterized using varied physiochemical analytical tools. The produced tiny plasmonic Au-Ag-Cin SS enclosing active cinnamaldehyde and polyphenols chemical components showed excellent anticancer (high IC50 at 20 μg/ml) and promising antibacterial potency. It was demonstrated that new class of multifunctional plasmonic organic-inorganic SS with desirable biomedicinal potential can be made via the scalable, inexpensive, eco-friendly and accurate PLAL technique, opening new opportunities for smart health cure and living.

Biography:

Ali Aqeel Salim is currently a Postdoctoral Researcher at Laser Centre in Universiti Teknologi Malaysia (UTM). He received his M.Sc. and Ph.D. in Laser Technology and Nanomedicine Drug Development from UTM. He has over 8 years of research and teaching experience. He published 42 papers in peer reviewed journals of international repute and was the recipient of Academic Chancellor Award 2019 at UTM as best researcher. His current research focuses on laser ablation, nanomaterials production and their applications in bionanomedicine and photonics.

Towards Practical Implementation of Single-Electron Tunneling via Donor-Induced Quantum Dots in Silicon Nanodevices

Daniel Moraru

Shizuoka University, Japan

Abstract:

Silicon electronics has supported the accelerated progress in technology and innovation for decades. Breakthroughs in both engineering and physics have allowed the trend of miniaturization of the key components – the silicon transistors – to continue until reaching the single-digit-nanometer scales nowadays. This trend, known as Moore's Law, has recently also revealed the importance of the individuality of dopant (impurity) atoms in such nanoscale devices.

As we approach molecular and atomic dimensions, we propose a different paradigm for future computation, with alternative functionalities and implications: using dopant-atoms as the active components in a device, i.e., taking advantage of the capability of dopant atoms (such as phosphorus, P, donors) to work as quantum dots (QDs). For different doping concentrations and profiles, QDs can be formed by either individual donors or by coupled (clustered) donors. The nature of these donor-induced QDs can be quite diverse and their properties can be tuned to some extend.

The operation mechanism is also fundamentally different from conventional transistors: single-electron tunneling mediated by such donor-induced QDs – opening up the possibility to control charge transport at elementary level. However, the key hurdle is the limited operation temperature, which depends on how easily one can cut off the thermally-activated transport over the tunnel barriers of such QDs. Since conventional donors have shallow energy states, barrier heights must be increased. Here, we will present

our efforts dedicated to design, fabrication and characterization of donor-based Si nano-transistors, as we approach the practical implementation of single-electron tunneling towards room temperature.

Biography:

Daniel Moraru is an Associate Professor since 2015 in Shizuoka University, Japan, at the Research Institute of Electronics and Faculty of Engineering, Department of Electronics and Materials Science. He is a co-author of more than 50 peer-reviewed scientific publications, and 3 book chapters.

His research interests cover silicon nanodevice fabrication and characterization, with a key focus on dopant-based electronics and quantum-tunneling devices.

Single-Crystal Graphene Devices

Masao Nagase

Tokushima University, Japan

Abstract:

Single-crystal graphene epitaxially grown on a SiC substrate is the most promising candidate for post-silicon electronic devices. Epitaxial graphene with a 100 mm^2 size has been fabricated by a thermal decomposition method [1]. Graphene on SiC is suitable for electronic devices because of its high durability for chemical cleaning [2] and low contact resistivity for metal electrodes [3]. Because a clean graphene surface directly interacts with gas molecules or biomaterials, it can be used to realize highly sensitive gas sensors [4, 5] and biosensors [6]. A lithography-free device fabrication was fabricated by direct contact of metal electrodes. Furthermore, stacked graphene functional devices [7,8] and far- infrared emitting diodes [9] were fabricated by simple device fabrication processes. This presentation shows certain results pertaining to the single-crystal graphene devices will be presented. This study was supported by JSPS KAKENHI 21H01394.

Biography:

Masao Nagase received the B.E., M.S., and Dr.Eng. degrees in nanometrology for nanodevices from Waseda University, Tokyo, in 1982, 1984, and 1997, respectively. In 1984, he joined the LSI Laboratories of Nippon Telegraph and Telephone Public Corporation (now NTT) where he worked on R&D of VLSIs. In 1996, he moved to NTT Basic Research Laboratories, where he researched fabrication processes for mesoscopic devices, such as single-electron, NEMS, and graphene devices. He moved to the University of Tokushima in 2010. He is a member of the Japan Society of Applied Physics (JSAP).

Preparation and Processing of $SrFe_{10}Al_2O_{19}/Co_{0.6}Zn_{0.4}Fe_2O_4$ Hard/Soft Ferrite Nanocomposite for Microwave Absorption Application

D. Rajan Babu* and Shalom Ann Mathews

*Vellore Institute of Technology, India.

Abstract:

The nano-sized composite of (1-x) $SrFe_{10}Al_2O_{19}$/(x) $Co_{0.6}Zn_{0.4}Fe_2O_4$ hard/soft ferrite powders was prepared by 'one-pot' self-propagating combustion technique. The X-ray diffraction patterns demonstrate that all samples are composed of $SrFe_{10}Al_2O_{19}$ and $Co_{0.6}Zn_{0.4}Fe_2O_4$ phases. The magnetization curves for all the composite ceramic are single-step loops indicate the existence of exchange spring effect. Due to the competition between the exchange interaction and the dipolar interaction, magnetic properties like coercivity (H_c) and remanence (M_r) are sensitive to the weight ratio of the soft phase. It has been observed that with the incorporation of soft magnetic phase, exchange coupling behaviour between the hard and the soft ferrite phases had significant influence on the microwave absorption

capacity of the samples. Related electromagnetic parameters and impedance matching ratio of the nanocomposite system were discussed. A minimum reflection loss of -42.9 dB with an absorber thickness of 2.5 mm was attained by the nanocomposite (90wt%) $SrFe_{10}Al_2O_{19}$/ (10wt %) $Co_{0.6}Zn_{0.4}Fe_2O_4$ at a matching frequency of 11.45 GHz. This assured the candidacy of $SrFe_{10}Al_2O_{19}/Co_{0.6}Zn_{0.4}Fe_2O_4$ nanocomposite as a promising microwave absorption material in the X-band (8-12 GHz) region.

High-Definition and High-Contrast Ultrasound Imaging by Transmitting Multiple Pulses with Different Carrier Frequencies

Norio Tagawa* and Yuta Saito

Tokyo Metropolitan University, Japan

Abstract:

We are studying high definition ultrasound imaging of living organisms using array transducers. In previous studies, by transmitting multiple subband pulses while changing the transmission direction and compounding the obtained echo with adaptive weighting, high resolution has been realized. The principle of this effect is the use of echoes obtained by changing the wave number vector of the transmitted pulse. That is, changing the subband corresponds to changing the length of the wave number vector, and changing the transmission direction changes the direction of the wave number vector. Considering this straightforwardly, it is more appropriate to use wideband pulses having different carrier frequencies than to use a plurality of subband pulses. This makes it possible to suppress unnecessary interference caused due to the expansion of the pulse width because of the limitation of the bandwidth of the subband.

On the other hand, in the method, although resolution is improved, contrast is not always high. In this method, while the compound for the subband and the transmission direction is adaptively applied, a simple delay and sum is adopted for the compound related to the oscillator element.It has been reported that the use of coherence factor (CF) is effective for improving contrast.

Based on the above considerations, in this study, we proposed a new beamforming method that uses the change in carrier frequency instead of the subband and also adopts CF imaging for the element compound in the final stage of processing. Furthermore, the effect was confirmed through experiments.

Controlling Thermal Magnetization Switching in magnetic Nanowires for Storage Memory Nanodevices

Mohammed Al Bahri

A'Sharqiyah University, Oman

Abstract:

Background: Racetrack memory is the 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, many

remarkable studies have been devoted to manipulating and controlling static and dynamic DWs in ferromagnetic devices such as nanowires and nanostrips.

Objective: This study aims to study the influence of device temperature on DW generation and dynamics in planar nanowires with nanoscales dimensions.

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

Results: The domain wall (DW) random switching in planar magnetic nanowires is one of the crucial problems for storage data applications. Hence, a micromagnetic simulation was used to investigate the transverse domain wall (TDW) nucleation in the thinner and narrower nanomagnetic devices and the vortex domain wall (VDW) nucleation for the thicker and wider nanowires due to the device temperature. The TDW thermal creation was examined based on magnetic properties such as uniaxial magnetic anisotropy energy (Ku) and saturation magnetization (Ms). The thermal stability of TDW switching in nanowires is strongly dependent on the improvement of magnetic properties, whereas the TDW thermal nucleation decreases by increasing Ku or Ms. In addition, the TDW and VDW thermal creation in storage nanodevices such as nanowires could be controlled by nanowire geometry manipulation like width and thickness. Reducing the nanowire width or increasing its thickness helps both domain wall types (TDW and VDW) switching to be more stable against nanodevice temperature. TDW thermal switching was found to be stable under a device temperature of up to 500 K, which is higher than the room temperature. However, the VDW shows higher thermal stability switching reaches up to 900 k, which are good candidates for storage applications. Furthermore, the TDW dynamics in nanowires were affected by device temperature, whereas the TDW moves faster by increasing nanodevice temperature. All these findings will help to maintain the storage memory in nanodevices from failure due to device temperature.

Biography:

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.

Strong Resonance Effects in Ordered Layered Photonic Structures for Metrology, Sensoring, Collimation, Signal Processing and Spectroscopy

Eugene Ya. Glushko

Institute of Semiconductor Physics of NAS of Ukraine

Abstract:

A planar photonic resonator containing a unitary defect in the middle of the structure can exhibit a system of extraordinary narrow resonance peaks of transmission on the background of perfect reflection. Here, the properties of standing modes inside the polyethylene (polypropylene)/silicon plane resonators in the total intrinsic reflection region and unusual manifestations of THz transmission spectra in centimeter and millimeter wavelength range were studied. It is shown that the angle and frequency half-widths of the resonance peak can be less than 10-9 of the magnitude of angle and frequency depending on the number of periods. This allows to form a collimated beam with the divergence measured in a fraction of a microdegree. It is shown that a plane central defect containing resonator transforms the frequency divided peaks into the outgoing-transmitted beams of various directions like a prism transforms light. This opens the way for precision measurements of angle and frequency distribution of THz radiation. It is proposed to use the existing extremely sharp peaks of transmission in planar resonators containing a central defect for aims of spectroscopy and metrology. A new spectroscopy technique is proposed based on the existing sharp transmission resonances using the conception of accumulating reservoir of electromagnetic field. An extrahigh extent of collimation resulting from the usage of defected photonic resonators gives an opportunity to form long and stable channels of communication and energy transportation in the THz frequency range. The considered (Si/PE)n/D(Si/PE)n/Si layered resonator is supplied by an electromagnetic field reservoir allowing to concentrate inside the THz radiation of different directions with the angular white noise distribution. The collimation effect is expressed by the ratio between input and output beam divergences. We have obtained theoretically a strongly collimated 600 GHz beam with the angular HWHM close to 0.123 μDeg for the adopted parameters of the resonator.

Keywords: Photonic crystal resonator; THz waves; THz spectroscopy; Layered structures; Collimation effect.

Biography:

Eugene Ya. Glushko is a full Professor and Lead Scientific Researcher in the Institute of Semiconductor Physics of NAS of Ukraine in the Photonic Semiconductor Structure Department, where is leading theoretical research in the areas of solid state physics, phonon and heat transport in nanostructures, photonics, optical nonlinear phenomena, alloptical signal processing and logic gates, optical methods in metrology, optical sensing, and various applications of obtained results in novel kind of optical devices. Dr. Glushko obtained his M.Sc. degree in 1974 with cum laude honor Diplome from the Faculty of Physics, Chisinau University (USSR). In 1984, he obtained his Ph.D. degree from Theoretical Department of Institute for Spectroscopy (Troitsk, Moscow) in the area of Optics. From 1979 till 2001, he joined the Physics Department of Pedagogical University (Kryvyi Rih, Ukraine), as an Assistant Professor, Associated Professor, Professor and Head of the Physics Department. During this period, he is conducting theoretical courses in many areas of physics. From 2001 till 2005, he joined the Slavonic University (Kiev, Ukraine) as a Professor and Head of Advanced Study Laboratory. From 2005 up till now, he is a Lead Scientific Researcher in the Institute of Semiconductor Physics (Kyiv, Ukraine).

Reflective Digital Holographic Microscopy Using a Single-Element

Jose Angel Picazo-Bueno*, Javier Garcia and Vicente Mico

University of Valencia, Spain

Abstract:

Digital holographic microscopy (DHM) is currently a well-established optical microscopy technique. DHM employs a single-shot, non-invasive and non-scanning operating principle to provide quantitative phase imaging (QPI), using an interferometric architecture. When DHM is implemented in a reflection mode, it provides the quantitative phase delays of the light reflected or scattered by the sample, which are directly related to its surface topography. The inspection of the topography of technical microscopic objects is of great interest in fields as science, technology, and industry. Reflective DHM is commonly implemented using a Michelson interferometer. However, Michelson layouts are complex in design and their double-path configuration make them more sensitive to external perturbations than common-path interferometers (CPI). Inside CPIs, single-element CPIs (SE-CPIs) only employ one optical component to create the interferograms. Hence, SE-CPIs are particularly relevant due to simpleness, cost-effectiveness, and robustness. Nevertheless, SE-CPIs were only found in the literature working in transmission modality, thus restricting their applicability to transmissive/transparent objects. In this contribution, we report on the implementation of a single-element CPI layout under reflective mode. The proposed technique, named as single element reflective DHM (SER-DHM), utilizes a single diffraction grating for simultaneously illuminating the sample in reflection and providing holographic recording for QPI. SER-DHM is experimentally validated using different reflective objects.

Biography:

Jose Angel Picazo-Bueno is a postdoctoral physicist researcher from University of Valencia (UV), Spain. He received his BSc, MSc, and PhD in Physics from the UV in 2013, 2014, and 2020, respectively. His area of expertise is Optics, specially focused on interferometric microscopy, quantitative phase imaging, digital (and lensfree) holographic microscopy, super-resolved imaging, and biomedical optics. He is co-author of more than 20 papers on peer-reviewed journals and contributed with around 15 presentations in international conferences. Currently, he is a postdoctoral fellow at the Biomedical Technology Center in Münster, Germany.

Perceived Optical Uniformity of RGB LED Pixelated Light Guides

Karlheinz Blankenbach

Pforzheim University, Germany

Abstract:

Automotive interior lighting has become a major part of the customer experience. The latest trend is "pixelated" light for advanced effects and animations. The visualization of information on top of the dashboard is introduced in Volkswagen's ID.3. The light guide visualizes today comfort functions such as incoming calls. In future, animated warnings and wayfinding information will be displayed.

There are many challenges for "pixelated" light guides with RGB LEDs every few centimeters, a major one is uniformity of the luminance (brightness). The difficulty for luminance uniformity measurements is that even for pre-calibrated LEDs a too large difference in perceived brightness exist due to unavoidable tolerances by integration of the backlighted light guide. Furthermore, the measured luminance profile is noisy due to local pinches etc. In consequence, traditional approaches like tolerance bands fail: Rejections (out of tolerance) are judged by subjects to be acceptable and vice versa.

A new approach based on luminance profiles of each LED and the use of the Contrast Sensitivity Function (CSF) overcomes this difficulties. Measurements on many light guides proved that the luminance profile (over distance) can be fitted by a Gaussian function. Only two measurements are necessary by switching every second LED on. Only the non-overlapping regions are used for the fit in terms of center intensity and the "variance" (width of the curve). In most cases, the variance is nearly identical. This is then be used for a more precise fit of the maximum. The CSF provides via observer distance the threshold value. Under normal conditions, the ideal threshold can be reduced by 50% for acceptable uniformity. The method was used as well for forcing non-uniformity by grey levels of the LED or simulated images on a monitor to be judged by subjects. The new method, measurements and results will be presented.

Biography:

Karlheinz Blankenbach has three decades of experience in displays. After a successful career in the industry (display electronics, LCDs) he was appointed in 1995 to full professor at Pforzheim University, Germany, where he founded the university's Display Lab. His main R&D activities are display topics such as optical measurements, display systems, evaluations, HMI, and LEDs, as well as display hardware and software. Blankenbach is a member of the Society for Information Display's program subcommittee, Automotive/Vehicular Displays and HMI Technologies, and a member of SID's International Committee for Display Metrology. He serves as chairman (incl. honorary) of the Displayforum (DFF).

A Mathematical Formalism to Describe the Thermal Behavior During Spatial Anisotropic Intensity Femtosecond Laser-DNA Interaction

Mihai Oane*, Cristian N. Mihailescu, Carmen Ristoscu, Natalia Mihailescu, Ana V. Filip, Bogdan A. Sava and Ion N. Mihailescu

National Institute for Laser, Plasma and Radiation Physics, Magurele, Romania.

Abstract:

In this study, a novel analytical formalism is presented using the Quantum heat transport equation for a few femtosecond laser pulses-DNA strands interaction. The formalism can generate solutions by giving inputs, including speed of light, electron mass, Planck's constant, voltage, laser beam intensity and laser-DNA interaction time. The thermal waves generated within the irradiated DNA strands are defined and explained. It has been found that the DNA strands relaxation time affects rate of the heat energy propagation within the irradiated regime. For laser-DNA interaction, the formalism breaks down when the potential is $< 1.75 \times 10^{-3}$eV. It has been concluded that the laser beam spatial distribution plays an essential role in defining the shape and the magnitude of the thermal distribution within the irradiated DNA strands junction.

Biography:

Mihai Oane, is a senior scientist at the Electron Accelerators Laboratory from National Institute for Lasers, Plasma and Radiation Physics-Bucharest-Romania. He obtained a PhD in physics in the Bucharest University with thesis about: "Thermal effects on laser-matter interaction" in 2009. He did some specializations on Nuclear Physics at GSI Darmstadt, Laser Physics: Free University from Brussels, Particle Physics: CERN and Synchrotron Radiation, ICTP. He's main area of research are: laser-materials processing and electron beam-materials processing. He developed several original theoretical and computational models for heat transfer in laser and electron beam – matter interaction. He authored and co-authored over 60 ISI papers.

Structures of Ice Confined in Nanocarbons; WAXS and Neutrons Diffraction (ND) Studies

Malgorzata Sliwinska-Bartkowiak[1]*, Monika Jazdzewska[1] and Anatoli Beskrovnyi[2]

[1] Adam Mickiewicz University, Poznan, Poland

[2] Joint Institute of Nuclear Research, Dubna, Russia

Abstract:

We report X-ray diffraction and also ND studies of ice adsorbed in nanoporous activated carbon fibres (ACFs). The fibres are built of turbostratic nanoparticles separated by quasi two-dimensional voids, forming narrow slit-shaped pores. The structure of ice confined in cylindrical nanocarbons (CMK-3), which are the reverse carbon replica of silica SBA-15 porous matrices was also analyzed. The results shown the strong evidence for the presence of both hexagonal and cubic forms of ice inside the all kinds of pores studied. We were not able to obtain a good Rietveld refinement of our diffraction patterns with typical hexagonal and cubic forms of ice, so we can consider that the formation of disordered structure, rather than hexagonal or cubic structure in the pores, has been attributed to restrictions on the size of the crystallite. Our diffraction data (diffraction profile broadening) show features of stacking disorder ice Isd, the combination of intertwined cubic and hexagonal stacking sequences. The detailed analysis of the surface of the pores show that the hydrophilic surface of pores, characterizing the strong value of immersed wetting energy, creates Isd much more rich on cubic ice than hydrophobic surface.

The Enhancement of Light Absorption and Emission in Si Based Quantum Dot Heterostructures Coupled with Metamaterials

Anatoly Dvurechenskii[1,2]*, Andrew Yakimov[1] and Zhanna Smagina[1]

[1]Rzhanov Institute of Semiconductor Physics, Russian Federation

[2]Novosibirsk state university, Russian Federation

Abstract:

The approaches to obtain high-performance of infrared photodetectors and luminescent structure based on Ge/Si QDs silicon nanoheterostructures coupled with metasurfaces

and photonic crystals were studied. It was foubd that composite metasurface consisted of a two-dimensional regular array of silicon pillars and subwavelength holes array in a periodically perforated gold film on top of the detector active region displays about 15 times peak responsivity enhancement at a wavelength of 4.4 μm relative to the bare detector. The planar Ge/Si QDs photodetector coupled with plasmonic structure consisted of a two-dimensional regular array of Al nanodisks is able to increase the photodetectors efficiency by about 40 times at λ=1,2 μm and by 15 times at λ= 1,55 μm with an appropriate choice of the array periodicity and the size of the Al nanodisks. The other idea of the approach is to use photonic crystals in processes of optical absorption in thin layers of quantum dots embedded in photonic crystals. We found that the incorporation of Ge/Si quantum dot layers into a two-dimensional photonic crystal leads to multiple (up to 34 times) enhancement of the photocurrent and the photoluminescence (up to 30 times) in the near infrared range. The results are explained by the excitation of planar photonic crystal modes by the incident light wave propagating along the Ge/Si layers and effectively interacting with interband transitions in quantum dots. --- The work was funded by Russian Scientific Foundation (grant 19-12-00070-П).

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.

Elastic Strain Engineering of Diamond

Chaoqun Dang[1,2*]

[1]ZJU-Hangzhou Global Scientific and Technological Innovation Center, China

[2]Zhejiang University, Hangzhou, China

Abstract:

Diamond is not only the hardest material in nature, but is also an extreme electronic material with an ultrawide bandgap, exceptional carrier mobilities, and thermal conductivity. Straining diamond can push such extreme figures of merit for device applications. We microfabricated single-crystalline diamond bridge structures with ~1 micrometer length by ~100 nanometer width and achieved sample-wide uniform elastic strains under uniaxial tensile loading along the [100], [101], and [111] directions at room temperature. We also demonstrated deep elastic straining of diamond microbridge arrays. The ultralarge, highly controllable elastic strains can fundamentally change the bulk band structures of diamond, including a substantial calculated bandgap reduction as much as ~2 electron volts. Our demonstration highlights the immense application potential of deep elastic strain engineering for photonics, electronics, and quantum information technologies.

Biography:

Chaoqun Dang is currently an Assistant Professor at ZJU-Hangzhou Global Scientific and Technological Innovation Center and the School of Aeronautics and Astronautics, Zhejiang University (ZJU). She received her Ph.D. degree in Mechanical Engineering at City University of Hong Kong (CityU). Before joining ZJU, she did postdoctoral research in Nanomechanics Lab at CityU. Her research focuses on the experimental nanomechanics of metallic and covalent materials.

Comparative Analysis of High-Field Electron Transport in ZnO-Based Heterostructures

Linas Ardaravicius* and Oleg Kiprijanovic

Center for Physical Sciences and Technology, Vilnius, Lithuania

Abstract:

Zinc oxide (ZnO) is a transparent semiconductor with a direct and relatively wide bandgap. Pulsed current–voltage measurements used voltage pulse widths down to 3 ns in ZnO epilayers grown by molecular beam epitaxy at Virginia Commonwealth University (USA) and a high electron drift velocity (~2.7×10^{7} cm/s at an electric field of 320 kV/cm) was reported at room temperature [1]. High-field electron transport studies in two-dimensional (2D) ZnO channels at ZnO/ZnMgO and BeZnMgO/ZnO heterointerfaces have also been performed experimentally. The application of few ns voltage pulses minimized Joule heating and let us to achieve the electric field up to 360 kV/cm in ZnO/ZnMgO heterostructures. The highest electron drift velocity of ~2.0×10^{7} cm/s was extracted in BeZnMgO/ZnO heterostructures what is comparable to the electron velocity in AlGaN/GaN 2D channels. The effect of electron density variation on the estimated drift velocity for the investigated structures is considered. The transport results at high electric fields are explained in the framework of non-equilibrium longitudinal optical phonon approach (hot-phonon effect).

Biography:

Linas Ardaravicius received his Ph.D. in 2002 from Semiconductor Physics Institute, Vilnius, Lithuania and Kaunas University of Technology, Lithuania. He spent some time as a visiting scientist at the University of Montpellier, France and at Cornell University, USA. He is currently working as a Senior Research Scientist at the Center for Physical Sciences and Technology, Vilnius, Lithuania. His research focuses on high-field carrier transport measurements in novel semiconductor structures and graphene. He has published more than 40 papers in reputed journals and serving as a referee in physical, engineering and material sciences journals.

The Dependence of the Parton Distribution Functions on the Momentum Transfer from Structure Function of Nucleon

Hassan Haji Hosseini Mojeni * and Mohammad Reza Shojaei

Shahrood University of Technology, Iran

Abstract:

In this study, we have provided an improved ansatz for the dependence of the valence quarks distribution functions on the momentum transfer (GPD) via calculating the up and down valence quark distribution function for $Q^2 = 0.5 - 35 GeV^2$ using the nucleon structure functions and probing their changes due to momentum transfer changes at the Bjorken x-range $x \to 1$, so that this model describes the valence quark distribution functions changes due to changes in momentum transfer for $x \to 1$, then by using the presented ansatz, we obtained the Dirac and Pauli form factors of the proton and neutron. Finally, we have compared the calculated form factors in this work with the results of the other models and experimental data.

Suppression of Electromagnetic (EM) Nonradiative Transitions in Atomic Nuclei with a Decrease in the Intensity of Zero-Point Fluctuations of the EM Field

Vladimir Koltsov

JSC Khlopin Radium Institute, Saint-Petersburg, Russia

Abstract:

Spontaneous emission of a photon of energy ΔE by excited atoms or nuclei can be interpreted as stimulated by EM zero-point fluctuations (ZPFs) at the transition frequency ΔE/h. So, photon radiation is suppressed for an emitter in a cavity with reflective walls and diameter D smaller than the wavelength of the emitted photon, in which ZPFs are suppressed at the transition frequency for the energy ΔE < h c / D. In the case of a cavity of minimum size an emitter is in a continuous medium, for example, in a metal. In this case D ~ 1 Å, and one can expect some suppression of photon emission up to an energy of ΔE ~ 1 keV. As it turned out [1], the same idea can be extended to nonradiative transitions, for example, to nuclear transitions via internal electronic conversion. The isomeric nuclei 235U (ΔE = 76 eV), 154Eu (ΔE = 910 eV), and 99Tc (ΔE = 2172 eV) were convenient for experiments. A decrease in the probability of Pconv was found for transitions in these nuclei when they are placed from oxides into metals. This effect can't be explained by the chemical influence of the metals on Pconv or by scattering of conversion electrons on metals atoms. At least qualitatively, the effect corresponds to a decrease in Pconv due to a decrease in the ZPFs intensity in the metals at the transition frequency.

Biography:

Vladimir Koltsov in 1976 graduated from the Sub-faculty of nuclear physics, Faculty of physics and mechanics, St. Petersburg Polytechnic Institute, Russia. He works as a researcher at the Khlopin Radium Institute, St. Petersburg. On the topic of this work, he has published more than 20 articles in reputed journals.

Dominant Resonances in the Electrical Transmission of a Graphene-Based System

E. Carrillo* and G. Monsivais

Instituto de Fisica, Universidad Nacional Autonoma de Mexico

Abstract:

In various branches of science, it has been studied systems, where the main characteristic is that a part of the system, when isolated, has few eigenvalues. In nuclear physics, these eigenvalues are called simple states. The other part of the system has a much higher density

of eigenvalues. That density of states is called the sea of states. When the system is united, the different states act as a “doorway” to the states of the sea. So, the biggest-energy absorption occurs in the energetic coordinate of the doorway states. Herein, we show that it is possible to generate doorway states in a graphene structure. We study electronic transport as a function of the energy and the angle of incidence. It is described the charge carriers in a quantum-relativistic way. We also obtain the transmission properties by applying the transfer matrix method. We find that doorway states occur at energies where the single-barrier transmission coefficient is maximum. The doorway states, and the variation of the carrier angle of incidence, can be used in building optoelectronic devices, such as filters. That is because the transmission minimum will approach zero and the width of each resonance decreases as the angle increases.

Biography:

Enrique Arturo Carrillo-Delgado has a bachelor’s and a master’s degree in physics from the Autonomous University of Zacatecas (UAZ). He got his Ph.D. in Engineering and Applied Sciences Research Center from the Autonomous University of the State of Morelos (UAEM) in 2019. He is currently a postdoctoral fellow at the National Autonomous University of Mexico (UNAM). His work focuses on theoretical studies of novel structures based on graphene, exploring innovative phenomena.

Traffic Models and Traffic-Jam Transition in Quantum (N+1)-Level Systems

Andrea Nava

University of Calabria, Italy

Abstract:

In the last decades the traffic behavior and the associated traffic-jam transition have been widely studied within the master equation formalism for stochastic exclusion processes of many-body systems, using models such as, for instance, the asymmetric exclusion process (ASEP) as well as the total asymmetric exclusion process (TASEP). Of particular relevance is the fact that the rules that define the master equations can be converted into a set of linear operators acting on the vectors of a proper Fock space, taking advantage of the formal analogy between classical stochastic processes and quantum mechanical formalism. In this talk we propose a model to implement and simulate different traffic-flow conditions in terms of quantum graphs hosting an (N+1)-level dot at each site, which allows us to keep track of the type and of the destination of each vehicle. By implementing proper Lindbladian local dissipators, we derive the master equations that describe the traffic flow in our system. To show the versatility and the reliability of our technique, we employ it to model different types of traffic flow (the symmetric three-way roundabout and the threeroad intersection). Eventually, we successfully compare our predictions with results from classical models. An advantage of the model we proposed is that it provides a microscopic simulation (by means of a system of quantum dots) of a macroscopic system, a junction between three roads. The aim is to investigate the use of space/time correlations to predict traffic congestions as our approach allows for exactly computing N-time correlators of nonlocal operators. If these comparisons will be successful, one could propose dot models (and possibly, a realization of them in a laboratory) as microscopic simulators of real traffic situations.

Future Devices and Circuits Popelled by Electron Spins

Jian-Gang (Jimmy) Zhu*, D. Bromberg, V. Sokalski, M. Moneck and L. Pileggi

Carnegie Mellon University, Pittsburgh, PA

Abstract:

Using electron spins to manipulate magnetic moment in magnetic devices at nanometer scale presents opportunities to integrate large scale nonvolatile logic and memory monolithically on top of CMOS circuits. Successes in this direction could enable on-chip access of sub-terabyte level of data storage and could bring revolutionary change in data-centric computing. For spin-based logic device design, fan-out capability presents a realistic challenge due to the fact that magnetoresistive devices have no intrinsic gain, especially the current gain which is required to propel the next stage logic change. mLogic technology employees the idea of power clock to create effective gain that drives the logic states of successive stages. This circuit innovation combining with spin Hall effect can create mCell-based logic circuits capable of carrying out any logic operation and can be used to build a general purpose microprocessor with inherent persistency at every logic node/state. In this talk, we will present experimental demonstrations of individual spin Hall based logic switch in terms of fabrication process and electronic testing. Combined micromagnetic study will also be presented. In this talk, we will also present an innovative idea of a metal-based 3D nonvolatile memory, referred to as the z-Link memory, which could be monolithically fabricated on top of CMOS chip to bring mass storage directly above semiconductor microprocessor. Micromagnetic modeling investigation of device level operation will be discussed.

Biography:

Jimmy Zhu, an IEEE Fellow, is the ABB Professor and the director of the Data Storage Systems Center at Carnegie Mellon University. Received his Ph.D. in Physics from University of California at San Diego in 1989. Awards received include the NSF Presidential Young Investigator Award in 1993, the R&D Magazine Top 100 Invention Award in 1996, IEEE Magnetic Society Distinguished Lecturer in 2004, IEEE Magnetic Society Achievement Award in 2011, and the Ruth and Joel Spira Award in 2021. He has authored and co-authored 300+ papers and has given 100+ invited talks at major conferences. He holds 23 U.S. patents.

A Novel View of Superconductivity

Jacob Szeftel

ENS Paris-Saclay/LuMIn, France

Abstract:

A comprehensive picture of superconductivity, accounting for the existence of persistent currents[1], superconducting-normal transition[2], thermal stability[3] of the superconducting phase, occurrence of a second order transition[4] at the critical temperature, and the Meissner[5,6,7] and Josephson[8] effects, is developed. The analysis proceeds within the framework of a two-fluid model, for which the conduction electrons comprise superconducting and independent electrons at thermal equilibrium. They are organized, respectively, as a many bound electron, BCS-like state, characterised by its chemical potential and a degenerate Fermi gas.

Neutrons for Cultural Heritage

Giulia Festa*

CREF - Museo Storico della Fisica e Centro Studi e Ricerche "Enrico Fermi", Italy

Abstract:

In modern investigation of Cultural Heritage, frontier advances are opened up by the synergistic use of physical and chemical characterization of the artefacts, creating the meeting point of science, conservation and archaeology. State of art technologies available for neutron-based methods are currently being applied to study of object of historical and cultural interest in several neutron beam facilities throughout the world. Thanks to the neutron interaction with matter, these techniques are non-invasive and non-destructive, ideal to provide us precious structural information, about the artefacts under study such as their composition, presence of alteration, inclusions, structure of the bulk, manufacturing techniques and presence of those elements which give us an overall fingerprint of the object's characteristics.

Biography:

Giulia Festa is an experimental physicist. Her research focuses on both development of neutron instrumentation and analysis of materials applied to cultural heritage. She is co-editor of the book "Neutron Methods for Archaeology and Cultural Heritage" (2017) edited by Springer. She is Principal Investigator of more than 30 neutron experiments carried out at International Neutron Sources. Giulia was listed in the New Virtual Special Issue on Women in Physics (2017) by Elsevier for 'Research opportunities with compact accelerator-driven neutron sources' and she is co-author of the viewpoint "From physics to art and back" in Nature Reviews Physics (2021).

Conformal Symmetry in Nuclear Physics

Panagioti E Georgoudis

GANIL, France

Abstract:

The introduction of conformal symmetry in nuclear structure has recently been achieved [1] by using symmetry-based methods applied in the unitary limit of systems of cold atoms. This is a remarkable result since, as known by the late '60s [2], conformal symmetry does not represent itself in elementary particles. However, later strings provided a paradigm for the representation of conformal symmetry and led into what is known today as string theory. In this talk, I will briefly present the representations of conformal symmetry on the intermediate states of A+2n (2 neutrons) compound nuclei [1]. The manifestation of conformal symmetry in nuclear physics is now experimentally examinable through a regularity pattern of the fluctuations of the cross-sections in compound nuclei - a proposal for a new phenomenon concerning the usual random appearance of such fluctuations. That result indicates the A+2n compound nucleus as a physical laboratory for examining the BCS-BEC crossover, an underlying critical point, and algebras with an infinite number of generators.

Biography:

Panagioti E Georgoudis is a theoretical physicist currently living in France. He has been a postdoctoral researcher and Marie Curie Individual Fellow at the Grand Accelerator of Heavy Ions (GANIL), a part of CEA Saclay in Caen, Normandie (2017-2021). Before that, he was a Golda Meir Fellow at the Racah Institute of Physics in the Hebrew University of Jerusalem, Israel (2015-2017). He holds a Ph.D. in physics from the National Technical University of Athens, Greece (2014). Recently he received the Higher Education Teaching Certificate, an online short course at the Derek Bok Center of Harvard University (2021).

Dynamical Abelianization and Anomalies in Chiral Gauge Theories

Kenichi Konishi[1,2]*, Stefano Bolognesi[1,2] and Andrea Luzio[2,3]

[1]University of Pisa, Italy

[2]INFN, [2], Italy

[3]Scuola Normale Superiore Italy

Abstract:

Dynamics of strongly-coupled chiral gauge theories is still largely unknown, after many years of studies and in spite of their potential role in constructing the theory of the fundamental interactions beyond the standard SU(3)xSU(2)xU(1) model of the strong and electroweak interactions. We explore the idea that in some class of four-dimensional chiral gauge theories the infrared dynamics might be characterized by bifermion condensate in the adjoint representation of the gauge group. A possibility is that the system dynamically Abelianizes, a phenomenon somewhat similarly to what happens in N=2 supersymmetric gauge theories. A few concrete SU(N) models are studied, by taking into account the conventional 't Hooft anomaly constraints on possible infrared degrees of freedom, and by analyzing the possible structure of the low-energy effective action. These consequences of dynamical Abelianization are then successfully confronted with the recent findings on the generalized symmetries and the associated mixed anomalies, which provide us with more stringent consistency checks on possible dynamical alternatives. Different possibilities, depending on the models, that bifermion condensates in the adjoint representation might lead to quiver-like nonAbelian gauge theories at low energies, instead of dynamical Abelianization, are also explored.

Yang-Mills Theory and its Generalized Extension

B.T.T.Wong

Imperial College London, United Kingdom

Abstract:

The celebrated Yang-Mills theory is the paradigm of modern particle physics, which explains the fundamental gauge field interactions of elementary particles. We study the generalized extension of Yang-Mills theory and its abelian counterpart with novel rotor mechanism, for

which the original Yang-Mills theory is a special case of the generalized framework. Under this mechanism, the non-abelian gauge field transforms as $T^a_\mu \to \Box^n T^a_\mu$, which generates high-order derivative of gauge fields. When the order of field derivative is n = 0, this restores back to the original Yang-Mills action. Our work gives an extensive generalization of the Yang-Mills theory with higher-order field derivatives. We also compute the equation of motion and Noether's current of the generalized theory. Finally, since high-order derivative field theories subject to dynamic instability, we study such issue by Ostrogradsky construction and analyze the 00-component of the energy-momentum tensor.

Biography:

Bengy Wong Tsz Tsun (B.T.T.Wong) obtained his Bachelor degree in physics with first-class honours from the University of Hong Kong, then he graduated from Imperial College London for his Master (MSc physics) degree with a distinction. He has worked on experimental CERN project and theoretical particle physics research, with 5 publications of which 4 of them are single-authored. His current research interest focuses on the generalized extension of abelian gauge-field theory and Yang-Mills theory.

100 Years... and Still No Identification

Jacek Krelowski

Nicolaus Copernicus University, Poland

Abstract:

The interstellar medium contains three identified substances: atoms in the gas state, molecules, and dust grains. Despite their well-known spectral features (atomic lines, molecular bands, extinction /polarization) one can observe the so-called diffuse interstellar bands (DIBs), which remain unidentified being apparently correlated to the above-mentioned features. They have been discovered in California (Lick Observatory) 100 years ago. The only difference is that in 1922 two DIBs have been known while their current list contains more than 560 entries. Since we know very well atomic line spectra as well as those of simple molecules, DIBs are most likely carried by some complex molecules, very likely prebiotic ones. DIBs' profiles are usually broader than those of the identified lines or bands. Also, their profiles are not just Gaussian curves but contain some substructures. The latter can be observed only while using really high-resolution spectra – the recently commissioned echelle spectrographs are the best tools for this task. Another problem is a low intensity (shallowness) of the vast majority of DIBs. Their investigations require a very high signal-to-noise ratio. Apparently, this is why DIBs remains unidentified for so long time, being the longest standing unsolved problem in all of the spectroscopy. I am going to analyze the observational problems, such as the DIB profiles, their intensities relations to other interstellar features, and their mutual correlations. The latter may allow forming "families" of DIBs being likely carried by the same molecule each. Since the interstellar medium plays a very important role in the evolution of the Galaxy (the bridge between generations of stars) – it is of basic importance to understand what kind of molecules can be present in the interstellar medium before new stars with planetary systems are formed out of the clouds belonging to this medium.

Biography:

Jacek Krelowski - born on July 10, 1946 in Kalisz (Poland). He studied astronomy in Toruń in the years 1963-68. He obtained his doctorate there in 1975 on the basis of a dissertation on the causes of variability of the mysterious R Coronae Borealis stars. In 1987 he obtained the degree of habilitated doctor and the position of professor at the university (associate professor). Since then, he has been on two long-term internships: 1992/93 in Austin (Texas) as a Fulbright Fellow and in 2003 at the University of Catania (Sicily - Italy) on a Marie Curie Fellowship. After his doctorate, he dealt with the physics of the interstellar medium and he is faithful to this subject to this day. He deals with the spectra of interstellar clouds, in particular the most long-lived mystery of spectroscopy - the identification of carriers of the so-called diffuse interstellar bands. He is the author of 251 publications, cited 4,895 times, his Hirsch factor is 38. He is married, has two sons and three grandchildren.

Key Outcomes of Classical Relativity in 5D

Detlef Hoyer

Technical University Hamburg, Germany

Abstract:

Einstein-Equation and Maxwell-Equations can be united in one 5D Relativity Equation. Starting with an arbitrary metric of 5D space and requiring its Ricci curvature to be zero, Theodor Kaluza was able to derive both, gravity and electromagnetism, and also additionally a scalar field equation from this basic $R_{AB}=0$ equation. In his publication from 1921 he stated that the new scalar field specifies the relation between mass and force or mass and curvature of spacetime, so far known as the Gravitational Constant γ.

Further analysis reveals that (i) the 5th diagonal element □ can generate mass, pressure, momentum and energy, (ii) the remaining 4 elements of the 5th column represent the vector potential A of a moving charge, (iii) the electric field lines of a charge are caused only by pressure, because the positive field energy of the electric field and negative field energy of the scalar field nullify, (iv) a charged black hole has only one event horizon in contrast to the Reissner-Nordström solution with two and a repelling gravity field between them, (v) there is a static soliton solution of RAB=0 consisting of a cloud of radiation particles of the scalar field (Radions, Dilatons or Scalarons) having kinetic mass around a center, and (vi) there is a new rectilinear component of the Lorentz-force causing acceleration or deceleration, which may look like a change in inertia.

These are key predictions of 5D-Relativity, which was the beginning of 11D String Theory.

Biography:

Detlef Hoyer born 1959 in Hamburg, Germany, 1980 – 1986 Study of Physics, finished with Diploma in Magnetism and Low Temperature Physics, 1988 – 1992 Doctorate at TU Hamburg Harburg in theoretical electrical Engineering, since 1992 working as Software Developer in a big German Insurance Company, 2017 start working with solution of Einstein Equation in 5D: Gravity Field and Vector Potential of a Charge with Mass, 2018 working on static electrical dipoles in 5D Kaluza Theory, 2019 Start working on radiating Dipoles in 5D Kaluza Theory.

Anisotropic Self-Gravitating System Class I Stellar Model: An Extended Gravitational Decoupling Approach

S. K. Maurya

University of Nizwa, Sultanate of Oman

Abstract:

The present article aims to discover the static astrophysical equilibrium configurations of compact stars via. Extended gravitational decoupling (EGD) approach under the embedding class I condition. The matter distribution is composed of an anisotropic fluid, which describes some viable compact star candidates. These compact stars are made by choosing a specialized metric function, Vidya-Tikekar ansatz [P. C. Vaidya and R. Tikekar: J. Astrophys. Astro., 3, 325 (1982)] together with linear EOS. For performing the detailed study of the models, we matched the inner region with Schwarzschild metric as an external region. The EGD anisotropic sphere satisfies all the energy conditions and hydrostatic equilibrium equation, i.e., the modified Tolman-Oppenheimer-Volkoff (TOV) equation and stability condition. However, we have also discussed some significant properties of the anisotropic star such as anisotropic behavior; mass- radius relation, surface redshift as well as the velocity of sound. The physical relevance of the solution is shown by graphical demonstration, which provides a strong evidence for the more realistic and feasible stellar model. Our anisotropic stars are compared with observational stellar mass data, namely, LMC X-4, SMC X-1, 4U1608-52, PSR J1903+327, PSR J1614-2230, SAX J1808.4-3658 and 4U 1538-52. Our results are also relatively significant both from theoretical and astrophysical scale to investigate other anisotropic compact stars such as white dwarfs, neutron stars, and quark stars etc.

Biography:

Sunil Kumar Maurya have completed is PhD in 2013 from Indian Institute of Technology Roorkee (IIT Roorkee), India. And he is working as an Assistant Dean for Graduate Studies & Research, and Associate Professor at University of Nizwa, Oman. He has published more than 96 research papers in very reputed with high impact journals as well as he also serving several journal's editorial board members. He published more than 35 research paper in Q1 quartile in last two years.

Quantum Theory from Conceptual Variables

Inge S. Helland

University of Oslo, Norway

Abstract:

In the literature, quantum mechanics is founded by a very abstract set of postulates. For several reasons I propose that this set should be replaced by straightforward postulates based on the notion of conceptual variables: In his mind, any observer/ actor in each given situation has several conceptual variables, say q, l, z and so on. Some of these are accessible, can in some future be given numerical values by measurements or by other means. The notion of a maximally accessible conceptual variable is crucial. This can be motivated by a simple model of the brain, but it can also be motivated by an assumption to the effect

that all physical variables in the actor's context have parallels in his mind. Under weak technical conditions, basic postulates of quantum mechanics can be shown to be implied by a postulate assuming that the actor in his mind has two related maximally accessible variables. The notion of being related has a precise definition. A parallel development can be based on conceptual variables shared by a group of communicating observers. The Born formula follows from some explicit additional assumptions. The technical details around all this, are given in a published book and in some recent articles.

Flow-Induced Reconfiguration of Two Tandem Flexible Cylinders

Anne Cros* and Alejandra Arroyo Moreno

Universidad de Guadalajara, Mexico

Abstract:

Reconfiguration is the phenomenon which describes the static bending of vegetation in the wind. Thanks to transversal area reduction and streamlining, a flexible body considerably reduces its drag when it is submitted to a transversal flow (Alben et al. 2004 ; Gosselin and de Lange, 2010). When a second body is set downstream of a flexible body, it will be sheltered by the upstream obstacle and its drag will be reduced even more. In this experimental study, we measure the static deflections of two tandem flexible cylinders when they are submitted to airflow. Each cylinder has a clamped extreme and a free end. Fluid velocity and distance d between clamped cylinder extremes are varied and different materials are tested. We show that for small enough d values, the downstream cylinder always deflects less than the upstream body. Therefore the cylinder free extremes get in contact from a critical velocity. An hysteresis just below this critical velocity is found: the distance between the cylinder free extremes is higher when the air velocity is increased than when the velocity is decreased. We show that the nondimensional number which corresponds to the ratio between the fluid kinetic energy and the cylinder elastic energy allows to almost collapse the critical velocity lower value in one curve.

Biography:

Anne Cros is a Titular Professor of the Physics Department of Guadalajara University, Mexico.

She received her Ph.D. in Universite Aix-Marseille, France. Her research interests include fluidstructure interaction, transition to chaos and rotating flows.

Astrophysical Phenomena Related to the Penrose process and its variants

Zdenek Stuchlik

Silesian University in Opava, Czech Republic

Abstract:

It is demonstrated how ionized Keplerian disks orbiting a magnetized black hole can give rise to interesting astrophysical phenomena, especially those occuring due to relevant variants of the Penrose process. In dependence on the intensity of the electromagnetic interaction of

slightly charged matter with the external magnetic field, there are three possible outcomes of the ionized disks, namely, creation of quasiperiodic epicyclic oscillations of the orbiting matter for weak intensity, creation of winds for mediate intensity, and, due to the strong Magnetic Penrose process, creation of jets and highly ultra-relativistic particles for large intensity of the interaction. In active galactic nuclei the accelerated particles can have energy corresponding to the most energetic particles observed in cosmic rays. These processes can occur in the effective ergosphere of the magneticzed black hole. Highly accelerated particles could be, however, created also due to the Electric Penrose process where no rotation of the black hole is involved. Of special interest is the Radiative Penrose process of acceleration of charged particles due to their synchrotron radiation inside the black hole ergosphere. The acceleration is caused by concentration of photons with negative energy relative to observers at infinity at the direction of the motion of the radiating particle.

First Tomographic Census of Intergalactic Gas in the Late Universe

Jonas Chaves Montero

Donostia International Physics Center, Spain

Abstract:

A complete census of baryons in the late Universe has remained elusive until recently; this three-decade discrepancy is commonly known as the missing baryon problem. The primary cause behind this problem is the intermediate temperate and rarefied character of most intergalactic gas, which hinders its detection via standard X-ray campaigns. To detect this gas, I took advantage of the kinematic Sunyaev-Zel'dovich (kSZ) -- the Doppler boosting of CMB photons as these scatter off free electrons moving relative to the CMB rest frame -- because it is sensitive to free electrons independently of the temperature and density of the medium in which these reside. I extracted the kSZ effect from the cross-correlation of angular redshift fluctuations, a novel observable containing precise information about the cosmic density and velocity fields, and high-pass filtered CMB observations. Using galaxies at low redshift and quasars at high redshift, I found significant correlation for a wide cosmic volume, obtaining the highest significance detection of the kSZ effect up to date. Then, I leveraged these measurements to set constraints on the location, density, and abundance of kSZ gas, finding that it resides outside dark matter haloes, presents densities ranging from 10 to 250 times the cosmic average, and comprises half of the cosmic baryons. Consequently, this novel technique provides a nearly complete census of intergalactic gas across more than 90% of the lifetime of the Universe, thereby solving the missing baryon problem.

Biography:

Jonas Chaves Montero did his PhD in astrophysics by the Complutense University of Madrid with cum laude distinction. He is a postdoctoral fellow at the Argonne National Laboratory (USA) in 2017-2020, and postdoctoral fellow at the Donostia International Physics Center (Spain) in 2020-2022. His research interests lie in the field of observational cosmology and revolve around increasing the constraining power of galaxy surveys by improving theoretical models in three areas: nonlinear regime, multiwavelength correlations, and multitracer analyses.

The Modular Dirac Equation

Christina Rugina

University of Bucharest, Romania

Abstract:

We introduce a new equation we dubbed the modular Dirac equation to see and reconstruct a spin 1/2 particle at the center of an AdS2 spacetime in the entanglement wedge reconstruction paradigm and we study hidden symmetries of this spacetime, too. Properties of the modular Dirac operator are presented.

Biography:

Christina Rugina is a PhD student at University of Bucharest in my final year in Gravitation and String Theory. She holds degrees from University of Bucharest, George Washington University and Brandeis University. In 2011 She was a visiting research student at DAMTP, University of Cambridge, a visting research student at IPhT, CEA, Saclay in 2010 and a master student at Imperial College in Theoretical Physics (QFFF). She was invited to give a talk at Osaka University workshop in Mathematical Physics in 2013. She specializes in classical and quantum black holes.

The Physics of Photon Induced Plasmas

Job Beckers

Eindhoven University of Technology, The Netherlands

Abstract:

The physical ecosystem of Ionizing photons interacting with gases – often at low pressure – is a breeding ground for exotic and highly-transient plasmas, i.e. photon-induced plasmas. While already investigated for decades for their importance to many fundamental processes in outer space, research on photon-induced plasmas has been boosted by the inherent presence of this kind of plasma in Extreme Ultraviolet (EUV) photolithography, where 13.5 nm EUV photon travel through a low pressure hydrogen background gas. The current contribution treats a general overview of the most important plasma physical processes leading to the formation and decay of photon induced plasmas. Moreover, the generally applied diagnostics to gain more in-depth understanding of these plasmas are introduced and discussed. The – in this contribution - most pronounced diagnostic is Microwave Cavity Resonance Spectroscopy (MCRS) which studies the dynamics of free electrons in the plasma by monitoring their interaction with microwave radiation in a resonant cavity.

As will be shown, applying MCRS in general provides fundamental information regarding the photoionization process itself, while applying MCRS in multi-mode configuration reveals spatiotemporal information that can be used to study interesting phenomena such as the transition from ambipolar diffusion of the plasma towards confining walls to free diffusion of the plasma species.

Biography:

Job Beckers is Associate Professor at the Eindhoven University of Technology, the Netherlands, and leads as Principle Investigator the research group CIMlabs. His research focuses on Complex Ionized Media where he discovers how nanometer- to micrometer-scale particles interact with plasmas on the most fundamental level. Researched plasmas include electrically generated discharges and plasmas induced by highly energetic photons and electrons.

On-Surface Trapping of Ba ions by Organic Monolayer

C. Rogero[1]*, P. Herrero-Gómez[1,2], J.P. Calupitan[1], M. Ilyn[1], A. Berdonces-Layunta[1,2], T. Wang[1,2], D. G. de Oteyza[1,2], M. Corso[1,2], R. Gonzalez-Moreno[2], I. Rivilla[2,3], B. Aparicio[4], A.I. Aranburu[4], Z. Freixa[3,4], F. Monrabal[2,3], F.P. Cossio[2,4] and J.J. Gómez-Cadenas[2,3]

[1]Materials Physics Center (CSIC-UPV/EHU), San Sebastian, Spain

[2]Donostia International Physics Center (DIPC), San Sebastian, Spain

[3]Ikerbasque, Basque Foundation for Science, Bilbao, Spain

[4] University of the Basque Country (UPV/EHU), San Sebastian, Spain

Abstract:

Chemical sensors are miniaturized devices widely used to get instant information on the presence of specific compounds or ions in even complex environments. Used in many fields, recently fluorescence chemo-sensors are under exploration as potentially unique tools in the field of neutrino particle physics. If neutrinos are their own antiparticles, the otherwise-forbidden nuclear reaction known as neutrinoless double beta decay can occur. However, albeit complex experimental programs has been conducted over more than fifty years, the extremely rare reaction is still making its detection almost impossible. It has been proposed that identifying (``tagging") the Ba^{2+} dication produced in the double beta decay of Xe in a high pressure gas experiment, could lead to a virtually background free experiment. To identify these ions, chemical sensors are being explored. Although used in many fields, the application of such chemosensors to the field of particle physics is totally novel and requires experimental demonstration of their suitability in the ultra-dry environment of a xenon gas chamber. Here we offer the demonstration that Ba^{2+} ions can be trapped (chelated) in vacuum by a monolayer of a crown ether based molecules, in particular a fluorescent bicolor indicators (FBI) which is a chemosensors developed within the NEXT collaboration. Thanks to the combination of complementary surface science techniques, we unravel the ion capture mechanism once the molecules are immobilized on a surface, and explain the origin of the emission fluorescence shift associated to the trapping of different ions.

I. Rivilla Nature 583, 48,2020

P. Herrero-Gómez arXiv:2201.09099

Biography:

Celia Rogero obtained the PhD in Physics and at present is Tenured Scientist at the Spanish Research Council, working at the Materials Physics Center (CSIC-UPV / EHU) in San Sebastian. She works in the field of experimental Surface Science in Ultra High Vacuum conditions, including the structural, electronic, and physico-chemical characterization of interfaces of metal-semiconductor (insulator) materials, with especial interest in the chemical processes (on-surface chemical reactions) taking place at those interfaces. Her actual main research line is the bottom-up fabrication with atomic precision of devices both organic based and inorganics.

A 3D CFD Modeling for Investigating the Effects of Ventilation within a Road Tunnel in the Event of Fire

Gianluca Genovese*, Ciro Caliendo, Isidoro Russo

University of Salerno, Italy

Abstract:

We have developed a Computational Fluid Dynamics (CFD) modeling for investigating the effects of ventilation on the environmental conditions (air flow velocities, smoke, temperatures, radiant heat fluxes, and CO and CO_2 concentrations) within a road tunnel in the event of fire. Natural ventilation due to the piston effect of traffic flow or mechanical ventilation are methods commonly adopted to limit the concentration of air pollutants during ordinary functionality and to transport smoke out of the tunnel in the event of fire. According to the European Directive 200/54/EC, mechanical ventilation is required only for tunnels with length (L) over 1 km. This means that for tunnels with L < 1 km, safety conditions for users are affected only by natural ventilation. However, it is to be stressed that the effects of natural air flow in tunnels appear to have been investigated to a lesser degree. For example, it is not known a priori if natural ventilation is satisfactory and/or risk level in situations of adverse wind (i.e., wind blowing in a direction opposite to the traffic flow). Depending on the tunnel geometry, traffic flow, percentage of heavy goods vehicles, as well as the likelihood of traffic congestion, different effects might be found. Therefore, additional studies are needed for making further progress of knowledge, which is within the scope of our study. For this purpose, the Fire Dynamic Simulator (FDS), version 6.7.3, was used. The FDS tool is a fire-driven fluid flow in which the Navier-Stokes equations are solved numerically and coupled with sub-models to describe the complex process of turbulence, combustion, and thermal radiation.

Biography:

Gianluca Genovese is a PhD student in Risk and Sustainability in Civil, Architecture, and Environmental Engineering Systems at the University of Salerno under the supervision of Professor Ciro Caliendo. The main topics of his research concern fire safety in road tunnels, computational fluid dynamics modeling, and traffic simulation.

Radiation Physics in Medicine

John F Sutcliffe

IPEM, IOP, UK

Abstract:

The chance discovery of x-rays by Wilhelm Roengen in November1895 and radioactivity by

Henri Becquerel two months later in 1896 was the begining 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 synchotron 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.

Gravity-Driven Granular Avalanches in an Inclined Chute

Xinjun Cui[1]*, Martin Howarth[2] and Alec Anderson[3]

[1]Department of Engineering & Maths, Sheffield Hallam University, UK

[2]National Centre of Excellence for Food Engineering, Sheffield Hallam University, UK

[3]Koolmill Systems Limited, UK

Abstract:

Granular flows are among the most common processes in industry (chemicals, food, pharmaceuticals and mining etc.) and nature (snow avalanches, debris flow, volcanic flow, lahars etc.), but understanding the granular media behavior still remains as the most challenging task. Upon a granular material impacting an obstacle at supercritical speed, shock waves and granular vacua may form around the obstacle. As the flow properties such as thickness, velocity undergo a dramatic change across granular shocks, the study of the granular flow around obstacles can not only gain important understanding of the flow behaviors, but also provide a unique benchmark for examining the modelling and simulation methods. The correct determination of granular shock conditions is also important in

applications for example in the design of a defensive obstacle to snow avalanches or debris flows. In this presentation we will discuss some of our recent study on granular flows, where different obstacles (circular, rectangular and wedge) will be investigated from experiment, simulation and analytical perspectives by allowing a granular material to flow past the obstacles in an inclined chute. By using a calibration method for the velocity profiles between experiment and simulation, the rheological relations such as the coefficients of friction arising from the contacts for particle-particle, particle-wall are determined, where the formation of the shock waves and granular shows a good agreement between experiment, simulation and analytical calculation of continuum theory.

Biography:

Xinjun Cui is a senior lecture in the Department of Engineering and Maths at Sheffield Hallam University, U.K. He did his PhD in Applied Maths, and BEng and MSc in Mechanical Engineering. His research interests have been involved in the fields of aerodynamics, rotating flows, multiple-phase flows, granular flows, industrial and natural hazardous flows, to rigid-body dynamics and flight mechanics. His recent research has been focused on the study of granular flows in industrial and natural processes. He is a Research Theme Lead at the National Centre of Excellence for Food Engineering, and a Royal Society Short Industry Fellow.

Supercritical Thermodynamic Geometry

Jose Luis Lopez-Picon*, Jose Torres-Arenas and Jaime Jaramillo Gutierrez

Universidad de Guanajuato, Mexico

Abstract:

The Thermodynamic Geometry (TG) of Mie fluids in the subcritical and supercritical region is studied using a third order thermodynamic perturbation theory equation of state (EOS). The Rcrossing method of TG is applied to reproduce the coexistence curves related to Mie fluids and it is found that the validity of this methodology is range dependent. Besides, defining the RWidom line, as the curve obtained from the extreme of the isotherms of the scalar curvature in the (P,T) plane, the behavior of this Widom line is analyzed varying the range and stiffness of Mie potentials and it is compared to the locus of the maxima of some response functions. Several thermodynamic properties derived from the thermodynamic geometry formalism are reviewed.

Biography:

Jose Luis Lopez Picon is an Associate Professor at the Physics Department of University of Guanajuato (Mexico) with physical interest in Riemannian Geometry and its applications in physics and Gravitation.

Transition Probability Beyond the Fermi's Golden rule

K. Ishikawa

Hokkaido University, Japan

Abstract:

We present that the rigorous transition probability computed using normalized states, wave packets, deviates from the standard expression obtained from the plane waves. The plane waves gives the correct rate, which is expressed by the Fermi's golden rule. However, since these waves are not normalized, there remain an ambiguity in the calculation of the probability. The wave packets are normalized, and the calculation is not involved with an ambiguity. The probability is uniquely computed, and has an additional term that is not included in the Frmi's golden rule. This probability behaves with the time interval T as $P(T) = \Gamma T + P^{(d)}$ for a large T and $P^{(T)}$ 1, where Γ is the rate and $P^{(d)}$ is a new constant. The transition probability is one of the most important physical quantities of the quantum mchanics and determines why and how physical processes occur in nature. The new term in the transition probability plays physical roles which have not been considered with the rate. In the Talk, the derivation and implications of $P^{(d)}$ in various phenomena will be presented.

Perspective for Direct Production of Dark Components in the Universe by Multi-Wavelength Electromagnetic Field Collisions

Kensuke Homma*

Hiroshima University, Japan

Abstract:

The dark components in the Universe: dark energy and dark matter are the most intriguing unresolved problems in fundamental physics. These components are necessary to simultaneously explain several observations in the Universe. In this sense, they have been observed only through the gravitational window so far. In order for the dark components not to be observed in laboratory-based experiments utilizing particle accelerators as well as cosmic-ray observations, they commonly would have very weak coupling to matter. If we could have a generic way to directly probe a very weak coupling domain in laboratory-based collider experiments, we might be able to unveil some of the dark components. We have invented such a way to directly produce weak-coupling dark components by colliding multi-wavelength coherent photon beams in laboratories [1]. We will present the prospect such a novel experimental approach to the challenging problems.

[1] Perspective of Direct Search for Dark Components in the Universe with Multi-Wavelengths Stimulated Resonant Photon-Photon Colliders, Kensuke Homma*, Yuri Kirita, Fumiya Ishibashi, Universe 7 (2021) 12, 479.

Biography:

Kensuke Homma is a high-energy particle physicist. At present his interest is in colliding coherent electromagnetic fields to produce very light pseudo Nambu-Goldstone bosons.

Holographic β Function in de Sitter Space

Yoshihisa Kitazawa

KEK, Japan

Abstract:

The scale invariance of the universe is slightly broken by slow roll parameters. It is likely the slow roll is dual to the random walk. We investigate the distribution function of the conformal zeromode. We identify de Sitter entropy SdS with the distribution entropy of the conformal zeromode ρ(ω). We have collected convincing support on our postulate. The semiclassical evidence is that the both are given by the gravitational coupling 1/g=logN/2 where g=GNH2/π and N is the e-folding number. We show the renormalized distribution function obeys gravitational Fokker-Planck equation (GFP) and Langevin equations . Under the Gaussian approximation, they boil down to a simple first order partial differential equation. The identical equation is derived by the thermodynamic arguments in the inflationary space-time. GFP determines the evolution of de Sitter entropy of the universe. It coincides with β function of g. We find two types of the solutions of GFP:(1) UV complete spacetime and (2) inflationary spacetime with power potentials. The maximum entropy principle favors the scenario: (a) born small ε and (b) grow large by inflation. We like to convey the emerging notion of de Sitter duality. The inflationary universe: (bulk/ geometrical) is dual to the stochastic space-time on the boundary (cosmological horizon) as the both are the solutions of GFP.

Biography:

Yoshihisa Kitazawa has completed his PhD at the age of 25 years from Princeton University and postdoctoral studies from Enrico Fermi Institute, University of Chicago. He has served the director of KEK Theory Center, a premier High Energy Physics research organization. He has published more than 75 papers in reputed journals.

Aharonov–Bohm Scattering for Relativistic Particles in (3 + 1) -Dimensional Noncommutative Space with Spin Dependence

C. A. Stechhahn

Faculdades Integradas Campos Salles, São Paulo, Brazil

Abstract:

We study the effects of the noncommutativity of the spacetime with a mixed spatial and spin degrees of freedom in a relativistic situation. Using the Dirac equation in (3 + 1)-D and in a symmetric gauge, we calculate the invariant amplitude for a small flux of the magnetic field. The parameter θ which characterizes the noncommutativity here is not constant and the model preserves Lorentz symmetry. A correlation with the scattering in the context of canonical noncommutativity is done.

Biography:

C. A. Stechhahn 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 PhD assistant professor at Faculdades Integradas Campos Salles (2016), teaching classes in the areas of Exact and Humanities, in the Courses of Information System, Accounting, Administration and Technologists in HR Management, Finance, Marketing, Logistics and 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.

Study of the Non-Relativistic Energy Spectra of Hyperbolic Function Position Dependent Mass with Symmetric Modified Poschl-Teller Potential Under External Hyperbolic Magnetic Force and AB force Using Laplace Transform

A Suparmi*

Universitas Sebelas Maret, Indonesia

Abstract:

In this paper, we have solved the Schrodinger equation of hyperbolic function with position dependent mass for a symmetrical Modified Poschl-Teller potential under the external hyperbolic magnetic and AB forces using Laplace transform. By using Laplace Transform the second order differential equation of Schrodinger equation reduced to the first order differential equation and so the eigen function and the eigen energy values are obtained.

Surface-Enhanced Raman Scattering at Metal-Molecule-Metal Junction

Satoshi Kaneko

Tokyo Institute of Technology, Japan

Abstract:

Developments in the field of nanotechnology enable the realization of various efficient nanometer-scale devices. The metal-molecule interface needs to be studied in detail because it has a huge impact on the charge injection in the organic semiconductor, solar cells, etc. The electron transport in a single-molecule junction (SMJ), which can be regarded as the ultimate metal-molecule-metal interface structure, has attracted significant attention in the areas of interface science, nanoscience, and fundamental physics. Although the junction structure is important for the electron transport of an SMJ, the experimental technique for the detection of the structural information of an SMJ under operation is limited.

Surface-enhanced Raman scattering (SERS) is a highly suitable option for detecting the vibrational mode from a single-molecule; however, detecting the single-molecule under operation, which is trapped in the metal nanogap, and obtaining its vibrational mode remains a challenge. Our research group has investigated SERS in an SMJ by collaboration with the electric measurement. We found the relationship between SERS signal and the electric current of SMJ and succeeded in the detection of the SERS signal from an SMJ[1-5]. The vibrational shift and change in the SERS intensity revealed the structural change concomitant with the electron transport modulations[1-3]. The electric states, which are revealed by the current measurements, in turn, revealed the effect of the charge transfer on the signal enhancement and vibrational mode observation in SERS enhancement[4,5].

Biography:

Satoshi Kaneko, Ph.D. is an assistant professor at the Tokyo Institute of Technology (Tokyo Tech.) in Japan. In 2010, he earned a Bachelor's degree in Chemistry from Tokyo Tech. Later, he also earned a Ph.D. from Tokyo Tech. for his work on the fabrication and electron transport measurement of single-molecule junctions. Since 2014, he has been working as an assistant professor at Tokyo Tech., investigating the precise fabrication and control of metal nanogaps and localized surface plasmon-induced chemistry. Additionally, he served as a researcher at PRESTO of the Japan Science and Technology Agency (2018- 2022). His current research interests include energy transport at single-molecule junctions and reaction dynamics on a single-molecule scale. In 2018, he was awarded the Inoue Research Award for Young Scientists.

Studies in Effect of Ionizing Radiation on Polymeric Films as Dosimeter

Priyanka Oberoi[1]*, Chandra Maurya[1] and Prakash Mahanwar[2]

[1]Guru Nanak Khalsa College of Arts Science and Commerce, Matunga, Mumbai, India

[2]Institute of Chemical Technology, Matunga, Mumbai, India

Abstract:

Ionizing radiation exposure have widespread applications in the arena of industries, medical sectors, educational, research institutes and nuclear provisions. And it can cause a drastic change in the physical and chemical properties of the material exposed. A branch of physical science well-established and advanced in the the filed of ionizing radiation is dosimetery, to measure the dose of ionizing radiations exposed. Dosimeters absorb the dose and prompting a visual response in the form of coloration in the visible region bringing a physical change there within. Several innovative developments in radiotherapy have introduced new challenges for dosimetry with small and dynamically changing radiation. The awareness of low doses given to the target region is very crucial. Accurate dosimetry is important not only for treatment optimisation in the medicine but also in the filed of radiation. This work focuses on the effect of gamma radiation on the water-based polymer film dosimeter inducing permanent change in color of the film containing radiation-sensitive dyes. The film samples exposed low doses of 0 to 30 kGy by exposing gamma rays using ^{60}Cobalt gamma source at 0.95 kGy/hour. The visual change of the film dosimeter is then measured and the change in color is confirmed by different characterization techniques such as Colorimetric analysis shows differentiation between the visual color changes by comparing colorimetric coordinates. UV–Visible spectrophotometer showing changes in the absorption with an increase in the doses. The FT-IR analysis reveals the change in structural groups. The reproducibility and post-stability studies established and further considered to be used as a routine dosimeter.

Biography:

Priyanka Oberoi has completed her Bachelor's degree (2011), Masters (2013) in Bio-analytical Sciences and holds a Ph.D. (2019) in Science from Mumbai University and Institute of Chemical Technology, Mumbai, India. Her doctoral studies focused on Polymer radiations and specialized in Dosimeter labels to be used by healthcare industry. During her research years, she also worked in Bhabha Atomic Research Centre (BARC) as a researcher trainee. She has also completed her PGDM in Chemical Technology Management from Institute of Chemical Technology, Mumbai, India. In total she have 4 publications in well renowned journals and few under communication with over 16 citations and 3 as H-index. She is currently working as an Associate Consultant in an Anonymous multi-national Clinical Research Organization.

Study of Two-Body Interaction and Three-Body Correlation Between Baryons in a Quark Model

Choki Nakamoto

National institute of Technology, Suzuka College, Japan

Abstract:

We study the interaction between two and the three octet-baryons (proton, neutron, □□□□□□□) based on the quark model. We have succeeded in construction a realistic interaction between two-baryons by using a one-gluon exchange potential and the effective meson-exchange potential between quarks with the spin-flavor SU_6 wave-function in a unified framework of the resonating-group method. Unlike well-known nucleons (protons, neutrons), the interactions between baryons containing hyperons (□□□□□□□) are poorly understood due to the lack of experimental data. A unified description of nucleons and hyperons in a quark model is a very promising way to understand them. It is recognized that the appearance of hyperons is certain inside neutron stars, but in that case, the equation of state that described neutron stars becomes too soft(hyperon puzzle). The origin of the internal repulsive effect necessary to solve this is unclear. We focus on the many-body effect as its origin. We found from a two-body baryon system study that the inclusion of □ hyperon produces a strong quark-Pauli effect. Therefore, it is understood that □ hyperon is unlikely to appear inside neutron star. We investigated the quark-Pauli effect in a three-body baryon system as a candidate for the origin of the repulsive effect inside a neutron star that solves the hyperon puzzle. However, it was found that the content of □□hyperon, which is the lightest except for nucleon, does not produce a strong quark-Pauli effect. We also investigate the three-body baryon force resulting from the quark-quark interaction.

Biography:

Choki Nakamoto is a professor of National Institute of Technology, Suzuka College. He has long been involved in reseach on the baryon-baryon interactions in a quark model. He finds that his long-standing research is highly relevant in neutron star research and has recently been interested in trying to solve hyperon puzzle in terms of a quark model.

Three-Nucleon Problem with Solving Relativistic Faddeev Equations

H. Kamada[1]*, A. Arslanaliev[2,3], J. Golak[4], A. V. Shebeko[2], R. Skibiński [4], M. M. Stepanova[5], and H. Witala [4]

[1]Kyushu Institute of Technology, Japan

[2]Kharkov Institute of Physics and Technology, Ukraine

[3]Karazin Kharkiv National University, Ukraine

[4]Jagiellonian University, Poland

[5]St. Petersburg State University, Russia

Abstract:

A Poincare-invariant Faddeev formulation of the three-body system is used [1,2]. The relativistic nucleon-nucleon potential is introduced by using the framework of the instant form of relativistic dynamics starting with the total Hamiltonian of interacting meson and nucleon fields and using the method of unitary clothing transformations. We call it Karkov Potential [3,4]. In the oral, we would like to demonstrate some observables of the 3-nucleon system, for example, the binding energy of the triton, the differential cross section and polarizations of elastic proton-deuteron scattering to compare with the data.

[1] H. Kamada, W. Glöckle, J. Golak and Ch. Elster, "Lorentz boosted NN potential for few-body systems: Application to the three-nucleon bound state", Physical Review C 66, 044010 (2002).

[2] H. Witala, J. Golak, W. Glöckle, H. Kamada, "Relativistic effects in neutron-deuteron elastic scattering", Physical Review C 71, 054001 (2005).

[3] E. A. Dubovik and A. V. Shebeko, "The method of unitary clothing transformations in the theory of nucleon– nucleon scattering", Few-Body Syst 48, 109–142 (2010).

[4] H. Kamada, A. Shebeko, A. Arslanaliev, H. Witala, J. Golak, R. Skibiński, M. Stepanova, and S. Yakovlev, in Recent Progress in Few-Body Physics, Caen, France, 2018, Ed. by N. Orr, M. Ploszajczak, F. Marques, and J. Carbonell (Cham: Springer Nature, 2018), pp. 449– 453.

Physics and Technology of Photon Collider

Tohru Takahashi

Hiroshima University, Japan

Abstract:

Since its proposal in the 1980s, the photon collider has been studied as a new type of facility in particle physics. The basic idea is to generate a high-energy photon beam by inverse Compton scattering of laser photons onto a high-energy electron beam. This has been studied as an option for high-energy electron and positron linear colliders, such as the International Linear Collider (ILC), for example. In high-energy interactions, photon-photon collisions provide an opportunity to study the Higgs boson in a complementary way to electron-positron interactions. However, despite vigorous research in both physics and

technology, photon colliders have not been realized to date. Recently, we have started to study the possibility of constructing a MeV-class photon collider for the purpose of observing light by light scattering. We have shown that it is possible to observe the signal within one year against the background. In this talk, we will briefly introduce the photon collider; principle, technology, and physics. Then, we will discuss the idea of constructing a photo collider in the MeV region and the feasibility of observing by light scattering with a realistic collider design. In addition, application of inverse Compton scattering as a new light source will be discussed.

Biography:

Tohru Takahashi was Graduated from Nagoya University in 1989. Stanford Linear Accelerator Center 1989-1993. Hiroshima University 1993- . Staring TOPZA experiment at TRISTAN in KEK as a graduate student, he has been working about high energy electron-positron colliders. His current objective is to realize the International Linear Collider in Japan. In addition to the electron-positron interaction, he has studied physics and technology of photon colliders as an option of the electron-positron linear colliders. He is also interested in laser related physics and technology such as physics in intense fields and the development of a resonant optical cavity for coherent laser pulse accumulation.

Cuprate Superconductor Driven not by CuO2 Planes but by Chains

Susumu SASAKI[1]*, Sotaro Nishioka[2], Shunsaku Nakagawa[2], Mitsuharu Yashima[2], Hidekazu Mukuda[2], Mamoru Yogi[3] and Jun-ichi Shimoyama[4]

[1]Niigata University, Japan

[2]Osaka University, Japan

[3]University of the Ryukus, Japan

[4]AoyamaGakuin University, Japan

Abstract:

Although the mechanisms of high-Tc cuprate superconductors still remain to be seen, one thing widely believed is that the CuO2 planes drive the superconductivity (SC). The other well-known fact is the “Pr-issue”: neither PrBa2Cu3O7 (Pr123) nor PrBa2Cu4O8 (Pr124), exhibits SC.

Here, we have succeeded in preparing Pr247 (=Pr123+Pr124) powder material with perfect SC with the onset Tc of 18 K. In this talk, we report that the Cu-NQR signals, coming from the CuO2 planes observed at 300K, are completely wiped out down at low temperature of 2K. Instead, the planar Cu signals at 2K are observed only at higher frequencies. This indicates that the CuO2 planes, which are paramagnetic at 300K, are in an AF ordered state down at 2K. Taking into account that the internal magnetic field of the AF ordered state is found to be as large as that in the insulating cuprates, it is natural to argue that the AF ordered Cu planes are insulating. Therefore, we have clarified that the CuO2 planes in Pr247 are in an insulating and AF state, despite the emergence of bulk SC with the faction of 100%. Moreover, we found recently that, from the temperature dependence of the Cu sites T1 in both the double-

and single-chains, the SC is driven by the double chains.

Biography:

Susumu SASAKI was given a Master degree from the University of Tokyo in 1989 for "NMR Study of High-Tc Superconductors". After that I joined NTT Basic Research Labs as a solid-state NMR researcher. In 1996 I was given a PhD from the University of Tokyo for "NMR Studies of the Electronic State in Superconducting Fulleride". Since 2000 I have been a professor at Niigata University in Japan. Since 2018 I have been a PI in Japan Medical Research and Development (AMED: counterpart of NIH). My research field covers not only condensed matter, but also spintronics, quantum computation and innovative MRI.

Exchange Spring Effect at Antiferromagnet/Ferromagnet Interface Studied by Spin-Orbit Torque

Chao-Yao Yang[1,2]*, Chih-Hsiang Tseng[2], Sheng-Huai Chen[2] and Chih-Huang Lai[2]

[1]National Yang Ming Chiao Tung University Hsinchu , Taiwan

[2]National Tsing Hua University, Taiwan

Abstract:

The antiferromagnet (AFM) and ferromagnet (FM) interface is a unique branch of magnetics of broad scientific interest. AFMs play an important role in spin-orbit torque (SOT) devices based on their ability to generate spin-polarized current and exchange bias when combined with FMs. Since the exchange bias of the AFM/FM bilayer appeared to be tailorable by SOT, it opens a great opportunity for AFM-based spintronics technology that the SOT can modify the spin texture of AFM and FM can serve for detection. In this talk, several AFM/FM systems will be demonstrated for studying the interfacial dynamics of AFM spins. An interesting spin-orbit torque (SOT) ratchet involving the exchange spring effect in an IrMn/CoFeB bilayer device with perpendicular anisotropy and exchange bias is developed. The combined use of electrical and spectroscopic analysis reveals that the exchange spring in IrMn/CoFeB bilayer yields unidirectional anisotropy, resulting in a collinear/orthogonal AFM/FM spin configuration at the interface upon switching CoFeB magnetization upward/downward. The ratcheting characteristics resulting from unidirectional anisotropy manifest in SOT switching. In this process, magnetization against the exchange spring features digital-like switching with a sharp transition, whereas the reverse function is characteristic of analog switching with a gradual transition tail. The dual digital-analog characteristics of the IrMn/CoFeB bilayer may be of benefit in neuromorphic and memory applications.

Biography:

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.

Study of Mechanism on Piezoelectricity in Pseudo-Cubic Structure by Material Structural Physics

Sangwook Kim*

Hiroshima University, Japan

Abstract:

The ABO_3 type perovskite $BiFeO_3$-$BaTiO_3$ (BF-BT)-based electroceramics are promising materials as the lead-free piezoelectric materials because of their prominent electrical properties and high operating temperature. The ceramics seem to have a cubic structure at first glance when the electric field is not applied which is often called as pseudo-cubic structure. However, if such a pseudo-cubic structure with a very small lattice distortion is stabilized even under applied electric field, the large spontaneous polarization revealed in the polarization-electric field hysteresis loop and the large piezoelectric strain obvious in the strain-electric field butterfly loop are not explicable. In this study, we revealed the origin of piezoelectricity in pseudo-cubic structure. The crystal structure was identified with atomic level by synchrotron radiation X-ray diffraction, and confirmed that Bi ions were present in disorder in the local structure. Bi ions disordering causes direct transmission to the piezoelectric machine. Bi ion disordering is contributed direct origin of piezoelectricity in pseudo-cubic structure.

Biography:

Sangwook Kim is an assistant professor in Physics program on Graduate School of Advanced Science and Engineering at Hiroshima University, Japan. He received his PhD degree from the University of Yamanashi, Japan. His research interests include piezoelectric and ferroelectric materials with material structural physics.

Anisotropic 3D Quantum Hall Effect in Weyl Semimetals

Xiao-Xiao Zhang*

Center for emergent matter science, RIKEN, Japan

Abstract:

Quantum Hall effect (QHE) and the interesting physics is one of the most distinguished phenomena in condensed matter physics and is related to various research areas including topological phases, electron correlations, quantum computing and so on. However, whether it is possible to extend the effect into higher dimensions remains to be an outstanding question to the whole community. One possibility of considerable history is stacking two-dimensional (2D) layers of QHE system, which resembles the original QHE physics to a large extent. More interestingly and distinctly, a type of three-dimensional (3D) version of the QHE has recently been proposed based on the semiclassical Weyl orbit, which combines surface Fermi arc states and bulk Dirac states under a magnetic field. Although this proposal immediately started to attract wide attention and especially experimental effort, a crucial question remains unclear and probably even unnoticed, i.e., whether this 3D QHE is essentially the same phenomenon as its 2D counterpart. The common understanding

tends to imply it to be basically a similar QHE with merely quantized Hall conductance. We theoretically examine the quantum transport in such a Weyl semimetal under magnetic field in a systematic way. Surprisingly, we find out that it is significantly different from the conventional QHE and manifests itself as a highly nontrivial and fully 3D anisotropy. This identifies a new 3D quantum state of matter different from the conventional 2D QHE and facilitates the ongoing experimental investigation.

Biography:

X.-X. Z. is interested in the broad theoretical condensed matter physics. He received his PhD from the University of Tokyo in 2018 and moved to Vancouver as a postdoctoral fellow of the Max Planck-UBC-UTokyo Center for Quantum Materials. He currently works as an SPDR fellow in RIKEN.

Dirac Quantization and Baryon Intrinsic Frequencies in Hypersphere

Soon-Tae Hong

Sogang University, South Korea

Abstract:

The Dirac Hamiltonian scheme has been developed to convert the second class constraints into the first class ones. Exploiting the Dirac quantization, there have been attempts to quantize the constrained systems. In this talk, quantizing a soliton on a hypersphere embedded in an (1+4) dimensional spacetime, I will construct the first class Hamiltonian, and evaluate the baryon physical quantities which are in good agreement with the corresponding experimental data. For instance, the prediction for delta baryon mass having the Weyl ordering correction obtained in the first class Dirac quantization is improved comparing with that in the second class canonical quantization performed on the hypersphere. Making use of the same input parameters associated with the baryon masses, I will also investigate the hypersphere soliton and standard Skyrmion models to compare the corresponding predictions for the physical quantities effectively. Next I will evaluate the intrinsic frequencies of the pulsating baryons, to find that the intrinsic pulsating frequency of more massive particle is greater than that of the less massive one. Explicitly I will evaluate the intrinsic frequencies of the nucleon and delta baryon.

The talk is based on the paper: S.T. Hong, "Dirac quantization and baryon intrinsic frequencies in hypersphere soliton model," Nucl. Phys. B 973, 115611 (2021), doi:10.1016/j.nuclphysb.2021.115611 [arXiv:2105.11456 [hep-ph]].

A Study on the Material Properties of Flexible Structural Deformation of Mg and Mn-Based Oxygen Carrier Particles Used in Chemical Cycle Combustion.

Namgyu Son* and Misook Kang

Yeungnam University, Republic of Korea

Abstract:

This study is a study on oxygen transfer particles used in CLC (Chemical Looping Combustion). This study identifies active species in the polycrystalline spinel structure composed of Mg and Mn fired at various temperatures, and the oxidation state of internal elements and oxygen transport. The relationship between abilities was identified. The obtained oxygen-transporting particles were obtained with the same structure as $[Mg_{1.5-x}Mn_{2+y}]^{td}[Mg_xMn^{(3+ or 4+)}_{1.5-y}]^{oh}O_4$ and were greatly distorted due to the Jahn-Teller effect. The structural transformation of the oxygen carrier particles to $Mg_{0.43}Mn_{0.57}O$ occurred due to the presence of oxygen vacancies in the lattice upon methane reduction and the migration of cationic metals into the inner crystals, resulting in tremendous shrinkage between the M–O bonds. These structural transformations created maze-like large spaces 50-75 nm in size, but when oxidized, oxygen molecules filled the maze and the structure returned to the original mixed inverse spinel $[Mg_{0.73}Mn^{2+}_{0.27}]^{td}[Mg_{0.77}Mn^{(3+, 4+)}_{1.23}]^{oh}O_4$ It was confirmed that the polyhedron was recovered. To confirm the oxygen transfer ability, the oxidation-reduction system was constructed and evaluated in TGA. In addition, oxygen transport particles were analyzed by XRD, Chemisorption, and XPS to compare their structure and physicochemical properties. Oxygen transfer capacity of MMO-1100 fired at 1100 °C was improved to 8.10% in CH_4-CO_2/air redox system, with abundance ratio corresponding to oxygen transfer to $[(Mn^{3+})+(Mn^{4+})]^{oh}/(Mn^{2+})^{td}$ The redox species was 4.5.

Biography:

Namgyu Son, entered the Department of Chemistry at Yeungnam University, South Korea in 2012. He is currently working towards a PhD degree in Prof. Misook Kang's group, department of Chemistry, Yeungnam University. Previous research has been conducted on various photocatalysts and thermal catalysts. current main research is oxygen carrier particles used for chemical looping combustion of methane. He has written various papers related to this and has a history of presentations at international conferences.

Highly Efficient Hydrogen Evolution Reaction Performance of Bi_2S_3/rGO in Carbon Paper Electrodes.

Su jeong Kim*, Misook Kang

Yeungnam University, Republic of Korea

Abstract:

As the energy crisis caused by fossil fuels intensifies today, interest in eco-friendly and limitless renewable energy is growing. Among them, hydrogen produced using the earth's abundant water is receiving great attention as a clean energy. As is known, the more water adsorbed on the catalyst surface, the more hydrogen evolution reactions occur. Therefore, in this study, we investigated how surface area affects water degradation. Bi_2S_3 is used as a basic catalyst because of its nanoflower structure, large surface area and large theoretical capacity. rGO is in the form of large sheets with improved charge transfer properties. It is synthesized by thermally varying the Bi_2S_3/rGO/CuS ratio for optimal binding and stability. First, as a result of checking through SEM images, it was confirmed that Bi_2S_3 synthesized in the form of hollow nanorods had a rod shape with a wider surface area due to self-assembly. By collecting thin sheets, it was confirmed that CuS was also synthesized in the form of porous flowers with a large surface area. In fact, it was confirmed that the surface area was large through BET measurement. Also, a rather low proportion of S in the EDS results is associated with S sulfur defects in photoluminescence. We found that these surface S defects affect the XPS VB location and alter the hydrogen production performance. Ultimately, the surface area and surface S defects are factors that control the hydrogen production capacity.

Biography:

Su jeong Kim is graduate student, she entered the Department of Chemistry at Yeungnam University in 2018. She is currently working on a master's degree in MiSook Kang's group, Department of Chemistry at Yeungnam University. Currently, major studies are conducting photocatalysts among catalysts.

Switching of a Type I to an All-Solid-State Z-Scheme Heterojunction by an Electron Mediator rGO Bridge

Hyerim Park* and Misook Kang

Yeungnam University, Gyeongsan, Republic of Korea

Abstract:

The photocatalyst used for water splitting must have a narrow band gap, an appropriate band edge location that overlaps with the water split, and effective photocharge separation. Among them, the effective separation of photocharge carriers is mentioned as the most important factor, and among the various junction types discussed, the charge transfer system of Z-scheme photocatalyst, in particular, is the Gibbs free energy barrier ($\Delta G = 237$ $kJmol^{-1}$) for oxidation and reduction during water decomposition. However, the problem of charge transport at incomplete contact interfaces within heterozygous particles remains unresolved. In this study, we experimentally show that rGO, an electron transport mediator between p-type and n-type semiconductors with a Type I band arrangement connected between the contact interfaces, promotes the diffusion of charge carriers and completely

dissociates them. First, through SEM image analysis and surface charge analysis of Zeta Potential, it was confirmed that electrostatic repulsion was generated between the two particles of ZnS and Bi_2S_3 having the same surface charge, so they were well dispersed and loaded on the rGO sheet. EDS, Photoluminescence, and XPS measurements were used to detect S defects and to determine the change in performance and stability according to the change. Finally, EFM images confirmed the movement of electrons from the surface to Bi_2S_3 through the rGO sheet from ZnS as the voltage was increased. This indicates that the ZnS/rGO/Bi_2S_3 ternary junction particle follows a robust Z-scheme charge transfer mechanism.

Biography:

Hyerim Park, Graduate student, she entered the Department of Chemistry at Yeungnam University, South Korea in 2017. She is currently working towards a master degree in Prof. Misook Kang's group, department of Chemistry, Yeungnam University. Current research is catalyst used for Photochemical/Electrochemical. She published several papers and attended various domestic and international conferences.

Surface Defects, Optical Properties of CdS@WS_2 Photocatalyst and the Efficiency of Hydrogen Generation

Tae Seong Kim* and Misook Kang

Yeungnam University, Republic of Korea

Abstract:

Hydrogen is the spotlight as a next-generation fuel because the final product of combustion is water. One of the methods for generating hydrogen is a photocatalyst. When a photocatalyst receives light electrons are excited and creating electrons and holes. The generated electrons and holes are used for reduction and oxidation reactions when the band gap includes the redox potential of hydrogen and oxygen. There are several conditions for the photocatalyst to well produce hydrogen from water. If the number of active sites increases, the hydrogen generating ability is improved, and when surface defects increase, charge carrier separation becomes more effective. In this study, cadmium sulfide is heterojunction to tungsten sulfide and the surface area is measured by BET. Pure CdS is $22.59m^2g^{-1}$ when WS_2 is conjugated at a ratio of 2:1, it increased to $25.11m^2g^{-1}$. Based on BET, OH surface adsorption is measured through TGA. 2CdS@WS_2 catalyst is measured to be 0.3034#OH/nm2 larger than pure CdS. This means that the catalyst surface is more hydrophilic and can generate a positive charge to delay the aggregation of particles. Additionally, surface defects measure by PL, XPS, Raman and EPR. Hydrogen production efficiency is measured by Gas Chromatography, and the 2CdS@WS_2 catalyst (10vol% Lactic acid, 150W Xe lamp) produce hydrogen as much as 3935□mol/g per hour. This is about three times more than pure CdS.

Biography:

Tae Seong Kim as a graduate student, he entered the Department of Chemistry at Yeungnam University in 2016. He is currently pursuing a master's degree program under Professor Misook Kang. Catalyst Surface Chemistry Lab, Department of Chemistry, Yeungnam University. He is conducting research on photocatalyst. He has published a paper and attended various conferences.

Optical Properties and Physicochemical Properties of Photocatalysts Manufacturing Copper and Zinc Oxide Hydrolysis Hydrogen

Byung Hyun Park* and Misook Kang

Yeungnam University, Republic of Korea

Abstract:

Semiconductor photocatalysts are receiving widespread attention for their application of solar energy-based hydrogen production. Since hydrogen is an energy carrier with high calorific value and no pollution, photocatalytic hydrogen generation from water decomposition reactions is currently being studied extensively to address energy demand. Zinc and copper are metals with excellent oxidation and reduction properties, respectively. In this study, we tried to obtain oxides of zinc and copper and synthesize an appropriate redox-bonded composite semiconductor and use it as a photocatalyst for hydrogen production. Each oxide was synthesized into Cu_2O and ZnO, and was synthesized into cubes and starfish shapes, respectively. The Kubelka-Munk and Mott-Schottky plots show that ZnO and Cu_2O have band gaps of 3.2 and 1.9 eV, respectively, and are n-type and p-type semiconductors, respectively. The crystals of the prepared catalysts were confirmed through X-ray diffraction (XRD), and the sizes and shapes of the catalysts were confirmed through a scanning electron microscope (SEM) and a High-Resolution transmission electron microscope (HRTEM). Optical characteristics were confirmed through Photocurrent and Photoluminescence, and performance was confirmed through gas chromatography. As a result of the confirmation, the performance of the $2Cu_2O/1ZnO$ heterojunction catalyst was about 2000 micromole/hour, which is more than 30 times higher than the base catalyst ZnO.

Biography:

Byung Hyun Park is a graduate student, he entered the Department of Chemistry at Yeungnam University in 2015. He is currently pursuing a master's degree program under Professor Misook Kang. Catalyst Surface Chemistry Lab, Department of Chemistry, Yeungnam University. He is conducting research on hydrogen evolution reaction (HER) with photocatalyst and electrochemical catalyst. He has published several papers, attended various national conferences, and has won awards in the poster presentation section.

Measurement of Transmission Length by X-ray Photon Counting Method

Hiroki Kase[1,2]*, Junichi Nishizawa[1], Kento Tabata[2], Katsuyuki Takagi[2] and Toru Aoki[1,2]

[1]Graduate School of Medical Photonics, Shizuoka University, Japan;

[2]Research Institute of Electronics, Shizuoka University, Japan

Abstract:

Recently, X-ray imaging is widely beginning to be used not only in the medical field but also in nondestructive testing field. The usage of X-ray transmission images has been evolved from evaluation by the human eye to image measurement. Conventional X-ray imaging devices are storage-type, energy-integrating devices that produce output at each frame. However, in storage-type imaging devices, the number of X-ray photons incident on the detector is

not strictly proportional to the output current. Of course, in practice, they are approximately proportional, so the image is represented as a "transmitted" image, but the contrast is reduced and the S/N ratio is lower. In order to use this method as an image measurement, it is necessary to obtain physically accurate coefficient values for these problems. In this study, Photon counting detector is used for obtain physically accurate measurements by reducing the adverse effects from beam hardening phenomenon that occur in principle with a detector of this type discriminate energy and output data. Beam hardening is the phenomenon that occurs when an x-ray beam comprised of polychromatic energies passes through an object, resulting in selective attenuation of lower energy photons. As a conclusion, it is now possible to accurately determine the X-ray transmission length, which has been difficult with a storage-type detector, and to identify input data that are suitable for calculations by machine learning. These data will be useful for the inspection of thickness deviations and unevenness of products in the field of nondestructive testing in the future.

Biography:

Hiroki Kase is a doctoral student at the graduate school of medical photonics, Shizuoka University, admitted in April 2020.

Quadruplex DNA Nanostructures for Biomedical Applications

Gayong Shim*

Soongsil University, Seoul, South Korea

Abstract:

From among the genetic materials, DNA has recently emerged as a biocompatible biomaterial whose biodegradable and nonimmunogenic features make it attractive for biomedical applications. Among them, quadruplex structures of oligoguanine have been reported to show thermostability and nuclease resistance. In this study, we hypothesized that DNA aptamer-modified oligoguanine quadruplex nanostructures could be used to specifically deliver therapeutic molecules to target cells. Amphiphilic Protein tyrosine kinase (PTK)7-specific DNA aptamer sequences were linked to 15 consecutive guanines. The resulting aptamer-modified product, AptG15, self-assembled into a Y-shape structure. The presence of a G-quadruplex at AptG15 was confirmed by circular dichroism and Raman spectroscopy. Utility of AptG15 as a nanocarrier of therapeutics was tested by loading the photosensitizer, methylene blue (MB), to the G-quadruplex as a model drug. The generated MB-loaded AptG15 (MB/AptG15) showed specific and enhanced uptake to CCRF-CEM cells, which overexpress PTK7, compared with Ramos cells, which lack PTK7, or CCRF-CEM cells treated with a PTK7-specific siRNA. Therapeutic activity of MB/AptG15 was tested by triggering its photodynamic effects. Upon 660-nm light irradiation, MB/AptG15 showed greater reactive oxygen species generation and anticancer activity in PTK7-overexpressing cells compared to cells treated with MB alone, those treated with AptG15, and other comparison groups. AptG15 stemmed DNA nanostructures have significant potential for the cell-type-specific delivery of therapeutics, and possibly for molecular imaging of target cells.

Cooperation Behavior of Evolutionary Game on Networks

Xingwen Liu

Southwest Minzu University, China

Abstract:

Human activities in the real world can usually be viewed as evolutionary games on complex networks. As an important aspect of evolutionary games, cooperation exists widely and therefore becomes a hot topic in this field. However, how to enhance cooperation is a long-term challenge which is far from being solved. This talk will present our recent progress. First of all, we have designed some memory-based mechanisms to enhance cooperation in evolutionary games. The novel mechanism of diversity has also been introduced and proved to be effective. Furthermore, we have studied how cooperation is influenced by the topology of underlying networks of evolutionary games. Particularly, a comprehensive disconnection-reconnection-elite mechanism works well on spatial lattice networks, and cooperation is inherently high on Erdős-Rényi random heterogenous hypernetworks which perfectly capture realistic multi-level relationship among game players. Finally, I will mention our work in progress which addresses evolutionary games by semi-tensor product. Semi-tensor product has emerged as a powerful tool and attracted much attention from the community of game theory.

Biography:

Xingwen Liu is a professor and chair of the School of Electrical Engineering, Southwest Minzu University. His main research interest is control theory and engineering, including complex systems, robust control, and game theory. He has established some fundamental results in this filed, for example, fully characterizing the asymptotic stability of delayed positive systems and the exponential stability of cascade switched nonlinear systems with delays. Prof. Liu served as a general co-chair of the 6th International Conference on Positive Systems, and is on the editorial boards of Mathematical Modelling and Control, the Journal of Engineering and Technology Research.

The Story About the Pick-Up Resonances

Chi Yu Hu

University of California Long Beach, Long Beach, CA

Abstract:

The pick-up resonances, also named Gailits resonance, are nature's powerful pick-up tool. Using a simple physical mechanism, nature produces pick-up action in both organic and inorganic systems. Due to their great demand in computer capability, they were not discovered until recently. The first indication of their presence will be presented. The purpose of this calculation was to find the scattering cross to produce antiHydrogen from the S-state collision between antiproton and Positronium atom. In a small energy region, just above the Ps(n=2) energy level looks like the superposition of a number of antiHydrogen production resonances. This calculation will be presented and discussed during the conference. In order to be sure that these large antiHydrogen production peaks are real, not due to some kind of error, we waited 10 years later until 2011-2012 when the Ranger computer

was barely large enough to do a 6X6 multichannel scattering calculation within the energy region discussed above. This large calculation will be presented in complete details, such that future calculations in this area can be used for debugging purposes. The complete details increase the 6X6, K-matrix, the real version of the T-matrix. The 6X6 scattering cross section matrix and all the parameters used in the calculation.

Synthesis and Study on Structural, Morphological, Optical Properties and Photocatalytic Activity of CuO: Er_x^{3+} Photocatalysts

Suganya Velliyan* and K. Sakthi Murugesan[1]

Presidency College (Autonomous) Affiliated to University of Madras, India

Abstract:

This work reports on the synthesis and photocatalytic activity of Copper oxide (CuO) and Erbium doped Copper oxide (CuO:Er_x^{3+}) nanoparticles with three different doping concentrations (x = 0.025, 0.05, 0.1) synthesized via combustion method on degradation of MB dye under visible light illumination. The microstructural, morphological, optical and vibrational properties of the synthesized nanoparticles were investigated. Structures of the nanoparticles were found to be monoclinic from XRD results. Blue Shift in the Raman modes was observed with the addition of dopant. Field Emission Scanning Electron Microscopy (FESEM) images of CuO and CuO:$Er^{3+}_{0.05}$ displayed agglomerated nano-spheres transformed to nano-flowers like morphology. Band gap calculated from Ultra Violet Diffuse Reflectance spectra (UV-DRS) showed a red shift in band gap values from ~1.31 eV to ~1.22 eV. Photoluminescence (PL) spectra revealed a significant decrease in the band emission intensity with doping due to the suppression of recombination of the photogenerated electron hole pairs. Photocatalytic studies indicated that doping has significantly enhanced the photocatalytic performance of the CuO nanoparticles especially, the CuO:$Er^{3+}_{0.05}$ sample with eminent exhibition of higher degradation efficiency of ~93%. A mechanism of the photocatalytic degradation of MB dye by CuO and CuO:Er_x^{3+} nanoparticles has been proposed.

Biography:

Suganya Velliyan, a Research scholar working on Rare earth elements (REEs) and Transition metal oxides (TMOs) for Photocatalytic applications. She also possess great interest on exploring further new concepts and deeper facts about REEs and TMOs in connection with photocatalytic activity. She has also planned for some selected rare earth materials for gas sensor application with host TMO. She presented both poster and oral presentations at number of national and international conferences. She published couple of articles in Elsevier Journals. Her first Research article has attracted people from various part of scientific world.

Astrophysical Molecular Properties of MgCa

Samir N. Tohme[1,2]*, Giovanna C. Rizkallah[3] and Antoine A. Assaf

[1]Temple University, Philadelphia, PA

[2]Zentrum für Optische Quantentechnologien, Fachbereich Physik, Universität Hamburg, Germany

[3]Universität Rostock, Fakultät Informatik und Elektrotechnik, Germany

Abstract:

The present investigations on the MgCa compound, structure our study into two main parts. The first presents a thorough electronic structure analysis, and the second offers an examination of the vibronic transitions for laser cooling applications. Since a few studies were performed previously, we carry out an extensive ab initio calculation using various basis sets for the potential energy curves. The previous theoretical and experimental studies on the molecular structure of the MgCa resulted in 4 electronic states. The primary outcome of this research project was the improvement of the previous assignment of the experimental molecular states. The results of this analysis showcase 9 missing electronic states. In total, 13 molecular states were calculated of which 9 new states were established in this work for the first time. The potential energy curves, permanent dipole moments, spectroscopic constants, and rovibrational constants were investigated for the 13 electronic states. Theoretical studies were performed within the framework of the multi-reference configuration interaction method using 4 different basis sets to reach optimal accuracy. The accuracy of the adopted ab initio approach is proven through our work when agreements are attained between two different experimental approaches and the present work. The second part explores the molecular properties needed for laser cooling schemes. The Franck-Condon factors, transition dipole moments at R-centroid, vibrational branching including transition rates, and lifetimes were produced. These calculations were shown in a vibrational branching illustration. Ultimately, this paper aims to contribute to the electronic structure and molecular properties of this astrophysical molecule.

Biography:

Samir Tohme is an Adjunct Research Assistant Professor at Temple University and a Guest Scientist at the National Institute of Standards and Technology (NIST). He is a recipient of the KAAD award for postdoctoral research which he carried out at the University of Hamburg. He received a PhD degree in Molecular Physics from the Beirut Arab University. His work focuses on electronic structure studies, computational chemistry, and vibrational spectroscopy of diatomic molecules. Currently, he is interested in finding magic trapping conditions for multiple rotational states of diatomic polar molecules.

Characterization of a Novel Irradiation Method for Small Animal Radiotherapy Using Monte Carlo Methods

Amir Entezam[1, 2, 3], Andrew Fielding[2, 4] and Davide Fontanarosa[1, 2]

[1]School of Clinical Sciences, Queensland University of Technology, Brisbane, QLD, Australia,

[2]Centre for Biomedical Technologies, Queensland University of Technology, Brisbane, QLD, Australia,

[3]Translational Research Institute, The University of Queensland, QLD, Australia,

[4]School of Chemistry and Physics, Faculty of Science, Queensland University of Technology, Brisbane, QLD, Australia

Abstract:

Preclinical radiotherapy applications require dedicated irradiation systems which are expensive and not widely available. Our research team has devised and constructed an add-on collimator to allow for targeted irradiation of mice using a standard clinical ^{137}Cs cell irradiator (Fontanarosa et al., 2020). In previous studies, we showed that our irradiation system is an effective method for irradiating mice with xenograft tumours (Entezam et al., 2021). The aim of this study was to evaluate the mouse doses irradiated with our irradiation system as a function of the collimator design, mainly the thickness of the collimator.

We generated a MC mouse phantom from a tumour-bearing mouse micro-CT image set. The MC modelling of the mouse phantom irradiation was performed and the dose delivered to the mouse phantom was calculated, and dose volume histograms (DVHs) were generated for the tumour and organs at risk (OARs). To investigate the effect of the collimators thickness variations on the MC mouse phantom, the thickness of the collimator was modified in MC modelling of the collimator and the DVHs were reanalysed.

DVHs analysis results indicate that the dose was effectively delivered to the tumour while dose to other critical organs was minimized. Variation of the collimator thickness did not exhibit any significant effect on tumour's DVHs. However, as the thickness of the collimator increased the out of field dose decreased and DVHs of the OARs improved.

This method provides a quantitative method for characterizing the irradiation systems for small animal RT.

Biography:

Amir Entezam (MSc (University Malaya), BSc (University Malaya)) is a PhD candidate at Queensland University of Technology, Australia. He has active research interests in small animal RT, Monte Carlo simulations, and development of silica-based fibres as thermoluminescent dosimeters (TLDs).

The Estimation of Parameters New UAV-TEM System on Baikal

Yuriy Davydenko[1], Ayur Bashkeev [2], Sergey Iakovlev[3], Alexander Parshin[4] and Marina Persova[5]

[1-4]Federal State Budget Educational Institution of Higher Education «Irkutsk National Research Technical University» Siberian School of Geosciences, Russia;

[5]Novosibirsk State Technical University, Russia

Abstract:

Experimental and methodological work on the new technology of electromagnetic soundings of the UAV-TEM was carried out on Lake Baikal in March 2021. Transient processes are recorded by an inductive sensor attached to an unmanned aerial vehicle (UAV), which moves along lines over the survey area at a given height with terrain envelope. The source of a non-stationary electromagnetic field is a horizontal electric line, into which a sequence of bipolar current pulses is fed, alternating with current pauses. The work was carried out in order to determine the optimal registration parameters of the measuring system, as well as to assess the depth and resolution. To test this measuring system, Lake Baikal was chosen, which is a unique geological test site, where huge volumes of fresh water make it possible to carry out measurements both in half-space conditions and in conditions of one-dimensional and three-dimensional models. Information about the structure of the upper part of the sedimentary sequence was obtained from the results of drilling and seismic surveys. Most gas hydrate formations are found near of the bottom surface at depths of 360-400 m – below their stability is hindered by heat flow, above - insufficient pressure. According to the MTS and EMS-IP measurements carried out on ice, at a depth of 600-1000 m, a high-resistivity granite base is located under the sedimentary layer. The heterogeneity of the sedimentary stratum is reflected in the resistivity sections according to the EMS-IP data and the mTEM – shallow near-field time-domain electromagnetic sounding: the upper layer, probably corresponding to the layer of diataceous sludge, is significantly heterogeneous; layers with a resistivity of 10-40 Ω·m, the lower, denser and isotropic layer (probably clay sediments) has a resistivity of about 50-60 Ω·m. Interestingly, according to VES data, the Baikal water near the mouth of the river Goloustnoye is divided into 2 layers: the upper layer is 28-35 m thick and has a resistivity of 170-185 Ω·m, and the lower one is with a resistivity of 200-235 Ω·m.

Biography:

Yuriy Davydenko graduated from Irkutsk State Technical University with a Master degree in “Geology and Mineral Exploration” in 2000. He got his post-graduate academic degree in Technical Sciences in 2005, with a dissertation entitled: «Development of hardware-software complex for the differential-normalized method of electro-investigation». From 1996 to 2011 he worked in SGRP company and took part in onshore and offshore geophysical expeditions; e.g. Arctic, Cuba, Kazakhstan, European part of Russia, Far East and Siberia. He cooperated with ORG Geophysical in Norway. He provided methodical support for marine electromagnetic surveying for hydrocarbons exploration in the Kara, Barents and Caspian Seas. From 2012 to present he has been working at INRTU as Assistant Professor, with teaching duties in geoelectrics. He is also CEO of Gelios LLC EM Service Company. His scientific interests are: EM/IP sensing technologies, forward modeling and inversion, complex analysis and interpretation of geophysical data sets. He has 7 international publications.

Circular Economy: New Opportunities in Sustainable Nano Materials and Polymer Bio-Nanocomposites

Sabu Thomas

Mahatma Gandhi University, India

Abstract:

Green chemistry started for the search of benign methods for the development of nanoparticles from nature and their use in the field of antibacterial, antioxidant, and antitumor applications. Bio wastes are eco-friendly starting materials to produce typical nanoparticles with well-defined chemical composition, size, and morphology. Cellulose, starch, chitin and chitosan are the most abundant biopolymers around the world. Cellulose nanoparticles (fibers, crystals and whiskers) can be extracted from agrowaste resources. Chitin is the second most abundant biopolymer after cellulose, it is a characteristic component of the cell walls of fungi, the exoskeletons of arthropods and nanoparticles of chitin (fibers, whiskers) can be extracted from shrimp and crab shells. Starch nano particles can be extracted from tapioca and potato wastes. These nanoparticles can be converted into smart and functional biomaterials by functionalization through chemical modifications due to presence of large amount of hydroxyl group on the surface. The preparation of these nanoparticles includes both series of chemical as well as mechanical treatments; crushing, grinding, alkali, bleaching and acid treatments. Since large quantities of bio wastes are produced annually, further utilization of cellulose, starch and chitins as functionalized materials is very much desired. The cellulose, starch and chitin nano particles are currently obtained as aqueous suspensions which are used as reinforcing additives for high performance environment-friendly biodegradable polymer materials. These nanocomposites are being used as biomedical composites for drug/gene delivery, nano scaffolds in tissue engineering and cosmetic orthodontics. The reinforcing effect of these nanoparticles results from the formation of a percolating network based on hydrogen bonding forces. The incorporation of these nano particles in several bio-based polymers have been discussed. The role of nano particle dispersion, distribution, interfacial adhesion and orientation on the properties of the ecofriendly bio nanocomposites have been carefully evaluated.

Biography:

Sabu Thomas is currently the Vice-Chancellor of Mahatma Gandhi University, Kottayam, Kerala, India. He is a Professor at the International and Inter University Centre for Nanoscience and Nanotechnology and Full Professor of Polymer Science and Engineering at the School of Chemical Sciences of Mahatma Gandhi University, Kottayam, Kerala, India. His ground-breaking research has covered the areas of polymer science and engineering, polymer nanocomposites, elastomers, polymer blends, interpenetrating polymer networks, polymer membranes, green composites and nanocomposites, nanomedicine and green nanotechnology. Prof. Thomas has received several national and international awards in recognition for his work, and recently received Honoris Causa (DSc) from the University of South Brittany, Lorient, France, in recognition for his contributions to polymer science and engineering. Prof. Thomas has published over 1400 peer- reviewed research papers, reviews and book chapters. He has co-edited more than 160 books. Currently he is having an H index of 118.

Monodromy, Weight Modules and Monodromy

Dotsenko Egor

Higher School of Economics, ITEP, Russia

Abstract:

Quantum group U_q(g) is connected to monodromy problems of two types. The first theorem relates the R matrix and the monodromy of the Knizhnik-Zamolodchikov (KZ) equations. This theorem was proven by Drinfeld-Kohno and Kazhdan-Lusztig. As it was noted by G. Lusztig, A. Kirillov-N. Reshetikhin and Ya. Soibelman the generalized braid group B_g could be embedded into the corresponding quantum group. It appears that these operators also have monodromic interpretation. The corresponding compatible system of equations is called Casimir system. The theorem of V. Toledano-Laredo relates the action of the generalized braid group to the monodromy operators for finite-dimensional representations of g. I will report on my work in progress which is devoted to a generalization of these theorem to more general representations such as highest weight modules and more generally weight modules with finite-dimensional weight multiplicities. Quite unexpectedly trace of some monodromy operators are modular-type functions (for some particular modules). It is worth to mention the work of S. Park [1, 2], where he constructs interesting q−series using R matrix evaluated in tensor product Verma modules.

We wish to see you at

Physics-2023

USG-United Scientific Group

(A non-profit organization)

8105, Rasor Blvd - Suite #112, PLANO, TX 75024

Tel: +1-469-854-2280/81; **Fax:** +1-469-854-2278; **Toll free:** +1-844-395-4102

Email: physics@uniscigroup.net (or) secretary@physics-conference.com

Web: https://physics.unitedscientificgroup.org/