Contents

The origin of the Symposium

The International Symposium on Advanced Science and Technology (ISAST) is held by the College of Science of National Chung Hsing University (NCHU). NCHU, located in Taichung city, is the most historic university in Taiwan and the most prestigious academic research center in central Taiwan. It was founded in 1919 in the Roosevelt Road Campus of National Taiwan University, and was then moved to its present location in 1943. With overall 17,000 students and nearly 800 faculties and is one of the 100 top universities in Asia. NCHU is famous of its excellent Agricultural Science, Veterinary, Life Science, Biotechnology and Fundamental Science. Focusing on the developing into a comprehensive research university, NCHU devoted to researches on cutting-edge science and technologies. The main campus contains eight colleges and one school including the College of Liberal Arts, the College of Agriculture and Natural Resources, the College of Science, the College of Engineering, the College of Life Sciences, the College of Veterinary Medicine, the College of Management, the College of Law and Politics, and the School of Innovation and Industry Liaison.

The purpose of ISAST is to promote the collaboration between College of Science of NCHU in Taiwan and research institutes of distinguished world leader in a diverse array of scientific disciplines including Kyoto University, Okayama University, Kwansei Gakuin University, RIKEN, Toyo University, Kindai University, Tokyo University and California State University at L.A., establishing close cooperation in the field of forward-looking research and strengthening students' international vision. The symposium will mainly covered three fields: physics, mathematics, and chemistry. The scholars of participating the meeting will give professional lectures and conduct academic exchanges with the teachers and students after the meeting. This symposium is conducted by the form of online meeting due to the pandemic of COVID-19. Hopefully, all attending researchers and students have a fantastic opportunity to discuss interdisciplinary research in the fields of science and technology. We expect that all participating institutes can continue to deepen mutual exchanges and cooperation and establish closer cooperative relations in the field of forward-looking research, improving the university's international research standards and at the same time applying the research results to next-generation industrial upgrading.

Program

Time (Taipei)	Time (Tokyo)	October 16(Friday)					
Venue		Zhiping Hall, Information Science Building,NCHU					
08:30 | 09:00	09:30 | 10:00	Registration					
09:00 | 09:10	10:00 | 10:10	Opening Ceremony					
09:10 | 10:30	10:10 | 11:30	Keynote Speech Speaker: Koji Ishibashi Moderator: Jentaie Shiea					
Session		Chemistry		Applied Mathematics		Physics	
Venue		Chemistry Building		Information Science Building		Science College Building	
		T609	T628	501	502	S104	
10:30 | 12:30	11:30 | 13:30	**Session 1:** Green Chemistry for the Future	**Session 2:** New synthetic Strategy for the Future	**Session 1:** Computational Science	**Session 2:** Data Science	**Session 1:** Surface science and applications	**Session 2:** Nanomaterials and applications
		Attendee: Yasushi Nishihara Laurean Ilies	**Attendee:** Chien-Fu Liang Hideki Yorimitsu	**Attendee:** Masanori Kikuchi Der-Fen Liu	**Attendee:** Ryuji Shioya Yoshitaka Wada	**Attendee:** Hiroshi Daimon Ming-Way Lee	**Attendee:** Katsunori Wakabayashi Ming-Chiang Chung
12:30	13:30	Lunch					

Keynote Speech

Speaker

Koji Ishibashi

RIKEN

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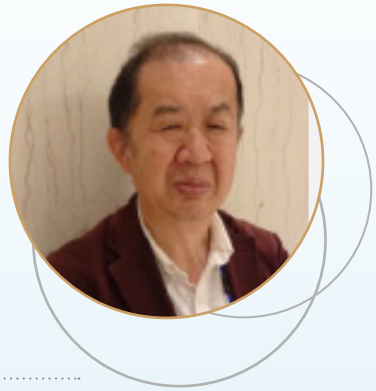

Presentation title

Topological Insulator/Superconductor Hybrid Structures -Towards Majorana Qubits -

Brief biography

He was born in Kyoto, Japan in 1960. After getting PhD in electrical engineering in Osaka University in 1988, he joined RIKEN as a posdoc and, in 1991 he became a research member in the semiconductors laboratory in RIKEN. In 2003, he became a head of the advanced device laboratory in RIKEN. In 1996-1997, he was a visiting researcher on leave in Delft University of Technology. He studied on the electron interference and high magnetic field transport in semiconductor nanostructures, Coulomb blockade and single electron transport in quantum dots fabricated in semiconductor nanowires and carbon nanotubes. His current interest is the topological insulator/superconductor hybrid structures for the Majorana qubits. He is a fellow of Japan Society of Applied Physics.

Abstract

Topological insulator/superconductor hybrid structures are an attractive and interesting system where Majorana zero-modes could be formed, and they can be used for the topological qubits that support the quantum information in a non-local way, resulting in an expected long coherence. In this talk, starting with introducing the basic idea on the Majorana qubit, where the Majorana zero-mode could be formed, we describe our effort, still on the preliminary level, to realize it with the 2-dimensional topological insulator or semiconductor nanowires coupled with the superconductor. Experimental results are mainly on the AC Josephson effect that appears to be unique to the topological Josephson junctions.

Keynote Speech

Moderator

Jentaie Shiea

Chair Professor of the Department of Chemistry, National Sun Yat-Sen University, Kaohsiung, Taiwan

Email: jetea@mail.nsysu.edu.tw

Brief biography

Jentaie Shiea received his B.S. in Chemistry from National Chung-Hsing Univ., Taichung, Taiwan and his M.S. and Ph.D. degrees from Montana State Univ., USA. His research for master and Ph.D. degrees focused on organic geochemistry and analytical/physical chemistry, respectively. After completed postdoctoral training at the Department of Material Science, Pennsylvania State Univ., he joined National Sun Yat-Sen Univ. (NSYSU) as a faculty member (1991), where he is currently a Distinguished Professor in Chemistry and director of Rapid Screening Research Center for Toxicology and Biomedicine. In the last decade, he has devoted himself to promoting mass spectrometric research in Taiwan and throughout Asia and Oceania. He served as the president of the Taiwan Society for Mass Spectrometry (TSMS, 2009-2012), and was an executive board member and the representative of Region B (Asia and Oceania) of the International Mass Spectrometry Foundation (2009-2016). He is one of the cofounders of the "Asia and Oceania Mass Spectrometry Conference (AOMSC)" in 2009 which has become the most important international conference in mass spectrometry in Asia and Oceania. His research interests have long involved in biological and organic mass spectrometry, and his current research centers at developing novel ambient ionization techniques and applying them to on-site detection of chemical compounds regarding food safety, antiterrorism, antidrug, forensic sciences, environmental chemistry, and precision and emergency medicine. He has published more than 150 scientific papers and owns 40 patents. He has been a Fellow of the Royal Society of Chemistry (FRSC since 2010) and on the editorial or advisory board of *J. Am. Soc. Mass Spectrom., Clin. Mass Spectrom., Mass Spectrom. (Tokyo), Int. J. Mass Spectrom., Mass Spectrom. Let., Anal. Methods, Cur. Chromatogr., and Technology as well as the guest editor of special issues for J. Mass Spectrom., Rapid Commun. Mass Spectrom., J. Food Drug Analysis, Clin. Chim. Acta., and Mass Spectrom. (Tokyo).* He received several outstanding research awards and invention awards from the Ministry of Science and Technology, National Science Council, Ministry of Economy, Chinese Chemistry Society Located in Taipei, Taiwan Soc. Mass Specrom., J. Am. Soc. Mass Spectrom., and NSYSU.

Chemistry Session - Speaker

Yasushi Nishihara

Research Institute for Interdisciplinary Science,
Okayama University

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Presentation title

Nickel or Palladium-Catalyzed Decarbonylative Transformations of Acyl Fluorides

Brief biography

1992	BS	Hiroshima University
1997	Ph.D.	The Graduate University for Advanced Studies
1994-2004	Assistant Professor	Tokyo Institute of Technology
2004-2010	Associate Professor	Okayama University
2010-present	Professor	Okayama University

Abstract

Taking into account growing concerns on the environmental and sustainable events of our society, utilization of carboxylic acid as an aromatic feedstock alternative is in high demand because they are natural abundant and readily available.[1] To continue our interest in transition-metal-catalyzed decarbonylative transformations of acyl halides, we focused on the simplest carboxylic acid derivative, acyl fluorides, which have attracted much attention in organic synthesis due to their greater stability, easier availability and unique intrinsic nature.[2] Herein, we established an efficient and practical method for nickel-catalyzed decarbonylative ethylation, methylation[3] and borylation[4] and palladium-catalyzed alkylation[5] of acyl fluorides with organoboron compounds, in which a diversity of acyl fluorides readily converted to the corresponding alkylated arenes and arylboronates in good to excellent yields. Mechanistic studies revealed that the added phosphine ligands enhanced the oxidative addition and reductive elimination steps and that Lewis-acidic organoboron compounds assist decarbonylation.

Chemistry Session - Speaker

Laurean Ilies

RIKEN Center for Sustainable Resource Science

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Presentation title

Catalytic C-H Activation with First-Row Transition Metals

Brief biography

Laurean Ilies was born in Romania (1978), and relocated to Japan in 1999 with a scholarship from the Japanese government. He received his B. Science (2004), M. Science (2006), and Ph.D. (2009) from the University of Tokyo (advisor: Prof. Eiichi Nakamura). He was appointed assistant professor (2009), then promoted to associate professor (2014) at the University of Tokyo. He moved to RIKEN Center for Sustainable Resource Science as a team leader in 2018. His research interests include synthetic chemistry, organometallic chemistry, catalysis, process chemistry, and the synthesis and properties of exotic molecules. He received several awards such as The Incentive Award in Synthetic Organic Chemistry (2015), The Young Scientists' Prize (2015), Thieme Chemistry Journal Award (2015), Banyu Chemist Award (2014), etc.

Abstract

Transition-metal-catalyzed C-H bond activation is of much interest because direct functionalization of simple substrates enables streamlined creation of molecular complexity. There is also much economic and environmental interest for using Earth-abundant metals for catalysis. This presentation will describe our journey in developing ligands that control the reactivity of organoiron species and enable iron-catalyzed directed C-H bond activation. Stoichiometric coupling of two C-H substrates and multifold C-H coupling will be highlighted. The exploration of other catalytic systems based on cobalt, manganese, and our recent work on chromium-catalyzed C-H activation will be also briefly discussed.

Chemistry Session - Speaker

Hideki Yorimitsu

Department of Chemistry, Kyoto University

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Presentation title

Electron Injection into Unsaturated Molecules in the Presence of Electrophiles

Brief biography

Born in Kochi in 1975. PhD in 2002 from Kyoto U (Prof Koichiro Oshima). Postdoc at U Tokyo (Prof Eiichi Nakamura). Assistant Prof (2003) and Associate Prof (2008) in Dept Material Chemistry, Kyoto U. Associate Prof (2009) and Prof (2015) in Dept Chemistry, Kyoto U. Project Leaders of JST-ACT-C (2012-18) and of JST-CREST (2019-). Visiting Scholar, Institute for Molecular Science (2014-16); Honorary International Chair Prof, National Taipei U Tech (2018-20); Visiting Lecturer by CRPC, Taiwan (2019); Associate Editor, SYNTHESIS (2019-). CSJ Award for Young Chemists (2009); Young Scientists' Prize from MEXT (2011); Mukaiyama Award (2016); Negishi Award (2018); JSPS Prize (2020); Japan Academy Medal (2020).

Abstract

As represented by dissolving metal reduction in liquid NH_3, reductive hydrogenations of unsaturated hydrocarbons using alkali metals constitute a fundamental class of reactions in organic synthesis. Such reductions mostly result in simply forming two new C–H bonds by in situ protonations. Introductions of substituents other than hydrogen by using aprotic electrophiles have been far less investigated, although they should pave the way for a new class of useful transformations that increase molecular complexity and diversity starting from simple unsaturated compounds. I will talk about our endeavor to develop new difunctionalization reactions of unsaturated molecules by electron injection from alkali metals in the presence of reduction-resistant electrophiles.

Chemistry Session- Speaker

Chien-Fu Liang

Department of Chemistry, National Chung Hsing University, Taiwan

Email: lcf0201@dragon.nchu.edu.tw

Presentation title

Lanthanide(III) Triflate-Catalyzed the Chemo- and Regioselective Transesterification and Their Synthetic Applications

Brief biography

- Associate Professor, National Chung Hsing University (2019-)
- Assistant Professor, National Chung Hsing University (2015-2019)
- Postdoctoral research fellow: National Sun Yat-sen University, (2014.11~2015.7)
- Postdoctoral research fellow: Department of Biomolecular Systems, Max Planck Institute of Colloids and Interfaces, Potsdam, Germany. (2012.11~2014.10)
- Postdoctoral research fellow: National Tsing Hua University (2010.10~2012.9)
- PhD National Tsing Hua University (2005.9-2009.7)
- M.S. National Tsing Hua University (2003.9-2005.7)
- B.S. National Chung Hsing University (2000.9 – 2003.6)

Abstract

Lanthanide(III) triflates are mild Lewis acids that are currently of considerable research interest. Here, we report the use of $Ln(OTf)_3$ as a dual catalyst for preparation of peracetylated carbohydrates with a stoichiometric amount of acetic anhydride under solvent-free condition, and extend to the synthesis of per-*O*-acetylated hemiacetal *via* one-pot two steps method.[1] Moreover, the $Ln(OTf)_3$-catalyzed *S*-deacetylation and selective *S*-deacetylation of functionalized thioesters can be tuned by adjusting the reaction medium or additives.[2] Additionally, $Ln(OTf)_3$-catalyzed one-pot three-component thia-Michael addition, for carbon–sulfur bond formation can be performed from thiolate salts, organic halides, and α,β-unsaturated compounds.[3] Finally, based on lanthanide(III) triflate-catalyzed transesterification reactions, we developed two new hydroxyl protecting groups, which are 4-acetoxybenzyl carbonate and 2-(acetylsulfanyl)methyl benzoate as orthogonal protecting groups for carbohydrates.[4]

Reference:

1. Yan, Y.-L.; Guo, J.-R.; Liang, C.-F. * *Chem. Asian J.* **2017,** *12*, 2417-2479.
2. Guo, J.-R.; Huang, H.-Y.; Yan, Y.-L.; Liang, C.-F. * *Asian J. Org. Chem.* **2018,** *7*, 179-188.
3. Huang, H.-Y.; and Liang, C.-F. * *Asian J. Org. Chem.* **2018,** *7*, 955-963.
4. Yen, S.-Y.; Yan, Y.-L.; Guo, J.-R.; Lin, Y.-T.; Liang, C.-F. * "Submitted"

Applied Mathematics Session- Speaker

Masanori Kikuchi

Tokyo University of Science

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onikik2002@yahoo.co.jp

Presentation title

Computational Fracture Mechanics. --Future Problems

Brief biography

- B.S. University of Tokyo, 1973
- M.S. University of Tokyo, 1975
- Ph.D. University of Tokyo,1976
- Research associate in University of Tokyo, 1976
- Associate Professor of Tokyo University of Science, 1978
- Professor of Tokyo University of Science, 1992
- Professor Emeritus of Tokyo University of Science, 2015
- Consultant Professor of Northwestern Polytechnical University, China, 1995
- Doctor Honoris Causa, Galati University, Romania, 2001
- Professor Emeritus of Xinjiang University, China, 2010

Abstract

For the integrity of structure or mechanical components, fracture estimation is an important issue. A lot of computational simulation techniques to predict fracture have been studied and developed. Fatigue fracture problem is treated by many methods, and ductile fracture process is also simulated by using many fracture criteria. But there are several important problems which should be solved in near future. In the fatigue fracture simulation process, 2 problems should be considered in future. One is evaluation of crack closure effect and another is fatigue crack growth criteria in 3-d. fields. In the ductile fracture mechanics, J integral is now used widely over the limitation of J integral definition. New theoretical development on ductile fracture mechanics is needed. In the presentation, some advanced results are presented, and these problems are pointed out.

Applied Mathematics Session- Speaker

Ryuji Shioya

Toyo University, Japan

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Presentation title

Large-Scale Parallel Simulation of 3D Fluid–Structure Interaction Using MPS and FEM

Brief biography

Ryuji Shioya is Professor of Faculty of Information Sciences and Arts at Toyo University in Japan. He received the B.Eng. in Nuclear Engineering in 1991, the M.Eng. in Nuclear Engineering in 1993 and Ph.D in Quantum Engineering and Systems Science in 1996 from University of Tokyo, Japan. He was an Assistant Professor (1996-1997) at University of Tokyo, Lecturer (1998-2000) and Associate Professor (2000-2008) at Kyushu University, Japan before joining Toyo University.

He has extensive research experiences in the field of supercomputing and computational mechanics.

Abstract

A 3-dimensional large-scale Fluid-Structure Interaction (FSI) framework is developed for the simulation of strength of the coastal structures to withstand tsunami. One-way coupling is used in this framework. Moving Particle Simulation (MPS) is adopted for fluid computations involving free surface flow and Finite Element Method (FEM) is adopted for structural computations. To achieve high parallel efficiency and reduce development costs, the open parallel source named ADVENTURE_Solid is used as the structural analysis solver and LexADV_EMPS is used as fluid analysis solver.

Applied Mathematics Session- Speaker

Der-Fen Liu

Department of Mathematics California State University at Los Angeles

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Presentation title

Optimal Radio k-Labeling of Graphs

Brief biography

Liu is a graph theorist with a passion for both teaching and research. Her research interests include several types of graph coloring problems and their applications. She is the 2018 California State University Los Angeles (CSULA) President Distinguished Professor, and the recipient of the Distinguished Teaching Award by the Mathematical Association of America (MAA) Southern California and Nevada Section (2015).

Liu has published more than 50 research papers including many appeared at leading journals of the fields. Currently she is the principal investigator (PI) of a research grant funded by the National Science Foundation, and a co-PI for a NASA Data Science Center at CSULA (2015-2020) with collaboration with Jet Propulsion Lab (JPL) and UC Irvine. She has served as a symposium organizer twice for the SIAM Conference in Discrete Math, and has given more than 90 presentations, including invited or keynote speeches, world-widely.

Liu received her BS from the National Central University (where she took a graph theory course with Professor Jennhwa Chang) and Ph.D. from the University of South Carolina (under Professor Jerry Griggs). Before going to the US, she spent two years as a research assistant at Academia Sinica under the supervision of Professor Ko-Wei Lih.

Abstract

Radio labeling is motivated by the channel assignment problem. The task is to assign channels to stations or transmitters so that interference is avoided and the spectrum of the channels used is minimized. The interference is closely related to proximity of the transmitters, the closer the stronger interference that might occur. A graph model for this problem is to represent every transmitter (station) by a vertex, and connect two vertices by an edge if the two corresponding transmitters are too close (with the strongest interference). In order to avoid strong interference the channels assigned to those two stations has to be distant apart. Based on this model we assign a channel (which is a non-negative integer) to each vertex. Thus, a radio-k-labeling for a graph G is a function, f: $V(G) \rightarrow \{0,1,2,\ldots\}$, so that the following holds for every two vertices u and v: $|f(u) - f(v)| \geq k+1 - d(u,v)$,

where d(u,v) is the distance between u and v in G. The span of f, denoted by span(f) is the difference between the largest and smallest values in f(V). The radio-k-number for G is the minimum span among all radio-k-labelings admitted by G. Radio-k-labeling has been studied extensively in the past three decades, especially for the two well-known special cases: when k=-2, it is known as distance two labeling; when k is the diameter of G then it is called radio labeling. In this talk we introduce some recent developments on the radio-k-labeling for trees and discuss some open problems.

Applied Mathematics Session- Speaker

Yoshitaka Wada

Kindai University

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Presentation title

Data augmentation technique for construction of regression model in practical engineering problem

Brief biography

Notably, he was involved in the development of an earthquake simulation system for Earth Simulator, which was the world's fastest supercomputer at that time. In the fracture mechanics field, he developed a fully automatic crack propagation system using a reliable modeling technique and the s-version finite element method. The system was applied to many engineering crack propagation problems and evaluated appropriateness of several maintenance codes and standards for nuclear power plants. His research work is in computational mechanics and fracture mechanics where he specifically focuses on the development of a simulation system using automatic mesh generation and application of machine learning to practical engineering problems.

He received the B.Eng. and the M. Eng. in Mechanical Engineering from Tokyo University of Science in 1993 and in 1995 respectively, and Ph. D. in Quantum Engineering and Systems Science from University of Tokyo, Japan, in 1998. He worked at the University of Tokyo (1997-2000), the Research Institute of Science and Technology (2000-2002) and the Tokyo University of Science, Suwa (2002-2012) before joining Kindai University.

Abstract

Fatigue crack propagation includes several governing laws and computation methods. We compute crack propagation as training data in 2-dimension using s-version finite element method. The prediction by neural network is conducted by three kinds of different data sets. The simplest data set is only geometrical information to predict crack propagation phenomenon. The simulation can represent curved crack path by incremental crack propagation computations. As a result, the data set including stress intensity factors exhibits the highest reproducibility. If the same computation results as the data set, the data set including only geometrical information requires 10 times training data and time to get convergence of neural network. The most important thing is data augmentation technique to avoid overfitting and to oversample less frequency in the physical phenomenon. We will discuss the results of several learning examples and show the applicability of the neural network technology to the actual engineering problems.

Physics Session- Speaker

Hiroshi Daimon

Toyota Physical and Chemical Research Institute

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Presentation title

3D atomic-resolution holography and display-type analyzer for holography microscope

Brief biography

Dr. Hiroshi Daimon was born on July 22, 1953. He graduated the Department of Chemistry, Faculty of Science, the University of Tokyo in 1976 and received his PhD in 1983. He worked in the Department of Physics, School of Science, the University of Tokyo as an Assistant Professor, in School of Engineering Science, Osaka University as an Associate Professor, and in Graduate School of Materials Science, Nara Institute of Science and Technology (NAIST) as a Professor. He is now a Fellow in Toyota Physical and Chemical Research Institute (Toyota Riken). He pioneered two-dimensional photoelectron spectroscopy using his original two-dimensional photoelectron spectrometer. He realized to take stereophotograph of atomic arrangement. These inventions were awarded by The Ichimura Prize in Technology-Meritorious Achievement Prize (2002), Prizes for Science and Technology in Research Category, The Commendation for Science and Technology (the Minister of Education, Japan, 2008), Surface Science Society Award, etc.

Abstract

Atomic-resolution holography reveals 3D local atomic structure around specific atoms by measuring the angular distribution (holograms) of the spherical wave (photoelectrons or fluorescent x-rays) emitted from the inner core of atoms of interest [1]. Because this technique can analyze local 3D atomic structure around specific atoms with no translational symmetry such as dopants, it is a powerful tool to understand and improve the role of additives in functional materials. Example of core-level-shifted photoelectron hologram for surface W atoms on W(110)1×1-O surface is shown in Fig. 1 top, and the reconstructed surface atomic structure is shown in Fig. 1 bottom. Hologram requires almost 2π sr angular distribution from specific atoms with high-enough energy–resolution to resolve valence states as shown in Fig. 1 top. This hologram was measured by a usual analyzer with small acceptance angle by changing detection angles point by point, which took almost one week. Hence a display-type analyzer is necessary to measure holograms efficiently. So far we have used a display-type spherical mirror analyzer called DIANA [2] which can display the angular distribution of 1π sr at once. We are developing a new high-energy-resolution display-type analyzer Compact-DELMA using Variable-Deceleration-ratio Wide-Acceptance-Angle Electrostatic Lens (VD-WAAEL) [3]. The angular distribution of the highly energy-resolved electrons emitted from the sample is displayed on the screen at once. Small SEM is used to excite Auger electrons from atoms of interest in functional materials, which realizes holography microscope for nano-area. At present the performance of lenses without energy analyzer has been finished [4].

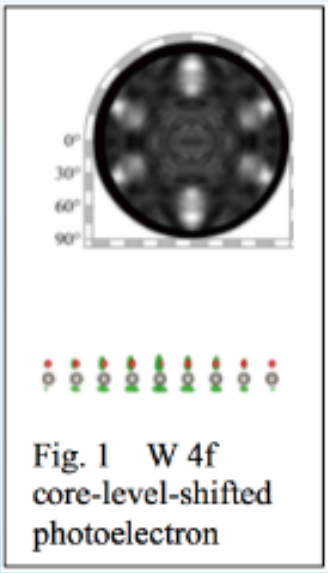

Fig. 1 W 4f core-level-shifted photoelectron

[1] H. Daimon, Jpn. J. Appl. Phys. 59, 010504 (2020). [2] H. Daimon, Rev. Sci. Instrum. 59, 545 (1988).

[3] H. Matsuda, et al., Rev. Sci. Instrum. 89, 123105 (2018). [4] H. Momono, et al., e-J. Surf. Sci. Nanotech. 18, 1 (2020).

Physics Session- Speaker

Katsunori Wakabayashi

Kwansei Gakuin University

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Presentation title

Topological Properties of Graphene and Photonic Extension

Brief biography

K. Wakabayashi gained his Ph.D in 2000 from the University of Tsukuba in Japan. From 2000 to 2009 he was an Assistant Professor at Department of Quantum Matter in Hiroshima University, Japan. From 2009 to 2015, he was an Independent Scientist at World Premier Research Center Initiative for Materials Nanoarchitectonics (WPI-MANA), National Institute for Materials Science (NIMS) in Tsukuba, Japan. From 2015, he is a full professor at Department of Nanotechnology for Sustainable Energy, School of Science and Technology, Kwansei Gakuin University, Japan. Beside the above primary research position, he was a visiting scholar at Institute for Theoretical Physics, ETH-Zurich, Switzerland from 2003 to 2005, also had a concurrent position as PRESTO researcher in Japan Science and Technology Agency (JST). His main research interests are theoretical nanoscience and condensed matter theory. His total citation accumulates about 8000.

Abstract

In atomically-thin 2D materials such as graphene, the electronic properties crucially depend on the size, edge structures and topological properties of the system. It is well-known that graphene zigzag edges possess edge states at Fermi energy. The origin of edge states can be understood from the topological properties of bulk wavefunctions.

The origin of graphene edge states is attributed to the existence of nonzero Zak's phase (line integration of Berry connection) of bulk wavefunction. This is distinct difference from conventional topological insulators where the existence of topological edge states is guaranteed by the nonzero Berry curvature owing to the presence of spin-orbit interactions.

In my talk, I will briefly give overview of edge and nanoscale effects on electronic transport properties of graphene nanostructures [1]. After that, we shall discuss a 2D lattice model which exhibits a nontrivial topological phase in the absence of the Berry curvature on the basis of two-dimensional Su- Schrieffer–Heeger (SSH) model [2]. In spite of the absence of Berry curvature, the system leads to the robust edge states. Also, we discuss the extension to photonic crystals [3] and higher-order topology [4]. Our approach will serve to design the topological 1D and 2D materials in absence of spin-orbit interactions.

[1] K. Wakabayashi, et.al., Sci. Technol. Adv. Mat. **11**, 054504 (2010), Sold Stat. Comm. **152**, 1420 (2012).

[2] F. Liu, and K. Wakabayashi, PRL **118**, 076803 (2017), J. Phys. Soc. Jpn. 123707 (2017).

[3] Y. Ota et.al, Optica **6**, 786 (2019). F. Liu and K. Wakabayashi, Phys. Rev. B**97**, 035442 (2018).

[4] F. Liu and K. Wakabayashi, PRL **122**, 075426 (2019), arXiv: 2009.08195.

Physics Session- Speaker

Ming-Way Lee

Institute of Nanoscience and Department of Physics,
National Chung Hsing University

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Presentation title

Ternary Semiconductor Quantum Dot-Sensitized Solar Cells

Brief biography

1.B. S. National Tsinghua University, Taiwan, Physics (1976).

2.Ph. D. University of Texas at Dallas, Physics USA (1985)

3.Research Associate, University of Maryland, USA 1985-1989

4.Professor, National ChungHsing University, Taiwan, 1997-now.

My research has been focused on solar cells. Special emphasis is on the development of new materials, particularly ternary metal chalcogenides, for applications in quantum dot-sensitized solar cells.

Abstract

New, better materials are important for continued progress in solar cells. Here I introduce a simple, low cost method - sequential ionic layer adsorption reaction (SILAR)- for the preparation of ternary semiconductor nanoparticles (NPs). The SILAR method is most suitable for quantum dot-sensitized solar cells (QDSSCs). Using SILAR we have developed more than 15 new ternary materials such as $AgSbS_2$, $Pb_5Sb_8S_{17}$ and $NaSbS_2$ for QDSSCs. Two examples: $Pb_5Sb_8S_{17}$ and $Pb_xCd_{1-x}S$ will be presented. $Pb_5Sb_8S_{17}$ has a band gap of 1.5 eV that is close to the optimal E_g (1.4 eV) for the Shockley-Queisser limit. It also has large optical absorption coefficients of $\alpha > 10^4$ cm^{-1}, making it a potential solar material. Here $Pb_5Sb_8S_{17}$ NPs were synthesized by a two-stage SILAR method. First, Pb-S NPs were prepared by SILAR. Second, Sb-B NPs were grown on top of Pb-S. Subsequent post annealing transformed the Pb-S/Sb-S structure into the ternary $Pb_5Sb_8S_{17}$ semiconductor. Solid-state $Pb_5Sb_8S_{17}$ QDSSCs with spiro-OMeTAD electrolyte yielded a power conversion efficiency of 6%. The SILAR method can also be used to tune the E_g in nonstoichiometric ternary semiconductor through band gap engineering. Incorporating Pb into the binary CdS host reduces the E_g from 2.44 eV to 1.77 eV in $Pb_xCd_{1-x}S$ with controlled Pb content x. The reduced E_g increases the light absorption range and the $J_{sc.}$ The best $Pb_xCd_{1-x}S$ yielded a PCE of 8.48%, which can be categorized into one of the high-efficiency QDSSC.

Physics Session- Speaker

Ming-Chiang Chung

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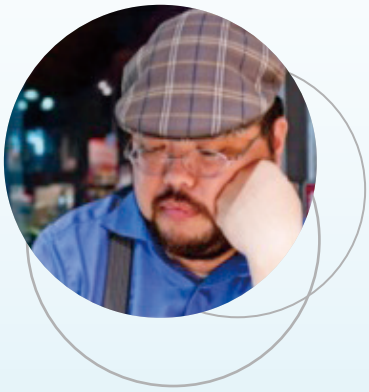

Presentation title

Deep learning of topological phase transitions from entanglement aspects

Brief biography

As a Ph.D. graduated in Free university Berlin, I have worked in different physics Institutes such as Ames Laboratory USA, RWTH Aachen, Max-Planck-Institute for Physics of Complex Systems, Dresden Germany, Academia Sinica and NCTS Taiwan. Now I am full Professor in National Chung-Hsing University. I am interesting in statistical mechanics, quantum information and computation, topological systems, BEC, and novel materials.

Abstract

The one-dimensional p-wave superconductor proposed by Kitaev has long been a classic example for understanding topological phase transitions through various methods, such as examining the Berry phase, edge states of open chains, and, in particular, aspects from quantum entanglement of ground states. In order to understand the amount of information carried in the entanglement-related quantities, here we study topological phase transitions of the model with emphasis of using the deep learning approach. We feed different quantities, including Majorana correlation matrices (MCMs), entanglement spectra (ES) or entanglement eigenvectors (EE) originating from Block correlation matrices, into the deep neural networks for training, and investigate which one could be the most useful input format in this approach. We find that ES is information that is too compressed compared to MCM or EE. MCM and EE can provide us abundant information to recognize not only the topological phase transitions in the model but also phases of matter with different $U_{(1)}$ gauges, which is not reachable by using ES only[1].

[1] Phys. Rev. B **102**, 054512 (2020)

Transportation to NCHU

Orange Line from Wucyuan W. Rd. Interchange:

Wucyuan W. Rd. turn right → Wucyuan S. Rd. turn left → Cingda Rd. go straight → NCHU

Blue Line from Taichung Port Rd. Interchange:

Taichung Port Rd. turn right → Yingcai Rd. → Guoguang Rd. → turn right → NCHU

Green Line from Taichung Train station:

Taichung Rd. turn right → Xingda Rd. → NCHU

Bus :

Taichung Bus No. 33 & No. 35 / Ubus No. 50 & No. 59 & No. 73 / Chbus No. 58 & No. 65

Campus Map

Opening Ceremony & Keynote Speech: Zhiping Hall, Information Science Building,NCHU
Chemistry Session: Chemistry Building T609、T628
Applied Mathematics Session: Information Science Building 501、502
Physics Session: Science College Building S104