The 3rd International Conference on Nanomaterials, 2D Materials and Photonics

The 1st International Conference on Quantum Theory, Gravity and Cosmology

ICN-2DMP-QGC

November 10-12, 2022 | Angkor Paradise Hotel, Siem Reap, Cambodia

http://www.rupp.edu.kh/ICN-2DMP-QGC

Contents

Welcome message

It is my great pleasure to welcome you to the 3rd International Conference on Nanomaterials, 2D Materials and Photonics (ICN-2DMP) jointly held with the 1st International Conference on Quantum Theory, Gravity and Cosmology (ICQ-GC) that will take place from November 10 to November 12, 2022 at Angkor Paradise Hotel, Siem Reap, Cambodia.

Following the success of the 1st and 2nd International Conferences on Nanomaterials and Photonics, the 3rd ICN-2DMP is jointly hosted with the 1st ICQ-GC by the Graduate School of Science, Royal University of Phnom Penh, for gathering researchers in the fields of nanomaterials, 2D materials and photonics, and in quantum theory, gravity and cosmology, from the region and the world.

The purpose of ICN-2DMP is to provide a forum to share the most important and latest developments in the field of nanomaterials, 2D materials, and photonics, whereas ICQ-GC aims at bringing theorists who work on the theoretical and phenomenological study of quantum theory, gravity, and cosmology. Additionally, the conferences will be for exchanging of research ideas and future trends, collaboration opportunities, and for research students to learn.

We look forward to your participation and scientific contribution.

Chealy Chet, PhD
Conference Chair,
ICN-2DMP and ICQ-GC 2022
Rector, Royal University of Phnom Penh

Overview

Title	The 3rd International Conference on Nanomaterials, 2D Materials and Photonics & The 1st International Conference on Quantum Theory, Gravity and Cosmology
Date	November 10-12, 2022
Venue	Angkor Paradise Hotel, Siem Reap, Cambodia
Official Language	English
About the Conference	Following the successes of the 1st and 2nd International Conferences on Nanomaterials and Photonics before the COVID-19 pandemic as well as to cover more topics, The 3rd International Conference on Nanomaterials, 2D Materials and Photonics is to be jointly organized with The 1st International Conference on Quantum Theory, Gravity and Cosmology on November 10-12, 2022 in Siem Reap, Cambodia.
Conference Topics	The conferences will feature plenary talks, invited talks, and oral presentations covering: - Growth and characterization of nanomaterials - Nanosensors and nanodevices - Nanosafety and nanotoxicology - Nanoelectronics and nanophotonics - Graphene and 2D materials - Heterostructures and composites - Photonics and applications - Optical sensors - Quantum theory, gravity and cosmology - Quantum materials and technologies

Organized by	Graduate Programs in Physics, Graduate School of Science, Royal University of Phnom Penh, Cambodia School of Physics, Nankai University, China
Supporters	Main: SIDA, Sweden Others: Nanosurf, CDPSS (Supplies & Services), Dinamic Scientific Co., Ltd.

Committees

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Dr. Chealy Chet, Rector, Royal University of Phnom Penh

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Dr. Seang Hor Eang, Member
Dr. Sunly Khimphun, Member
Dr. Veasna Soum, Member
Dr. Chan Oeurn Chey, Member
Ms. Kakada Ham, Member

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Dr. Seang Hor Eang, RUPP
Dr. Sunly Khimphun, RUPP
Dr. Sopheak Sorn, Kalsruher Instut Fur Technologie, Germany
Dr. Kimleang Khun, RUPP
Dr. Sovann Khan, Kyushu University, Japan
Dr. Veasna Soum, RUPP
Dr. Gansukh Tumurtushaa, Jeju National University, Korea
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Prof. Magnus Willander, Linköping University, Sweden
Prof. Jonh S. Briggs, University of Freiburg, Germany
Prof. Feng Song, University of Nankai, China
Prof. Bum-Hoon Lee, Sogang University, Korea

Supporters

The conferences are mainly supported by the Swedish International Development Cooperation Agency (SIDA), Sweden under the Sweden-RUPP Bilateral Program (Physics-Sub Program).

Other supporters are Nanosurf, CDPSS (Supplies & Services), and Dinamic Scientific Co., Ltd.

Program at a Glance

November 10, 2022		
Time	Session	Speaker/Speech Deliver
08:00~08:30	Registration	
08:30~09:00	Opening Ceremony + Photo Session	Conference Chair
09:00~09:45	Plenary Talk (Theoretical)	Prof. Dr. Bum-Hoon Lee
09:45~10:15	Coffee Break	
10:15~11:00	Plenary Talk (Theoretical)	Prof. Dr. John S. Briggs
11:00~11:15	Short Break	
11:15~12:00	Plenary Talk (Experimental)	Prof. Dr. Feng Song
12:00~13:30	**Lunch Break**	
13:00~14:00	Invited Talk	Dr. Jinyuan Zhang
14:00~14:30	Invited Talk	Assist. Prof. Dr. Yingdong Han
14:30~15:00	Invited Talk	Dr. Seang Hor Eang
15:00~15:15	Coffee Break	
15:15~15:30	ICN2D-02	Miss. Chhor Yi Ly
15:30~15:45	ICNPH-01	Mr. Lim Lorn
15:45~16:00	ICNPH-02	Mr. Saren Vy
16:00~16:15	ICN2D-03	Mr. Somnang Seang
16:15~16:30	Short Break	
16:30~16:45	ICN2D-05	Mr. Vichet Thi
16:45~17:00	ICN2D-01	Mr. Khen Krisna Khuth
17:00~17:15	ICN2D-04	Mr. Sognhak Oun
17:15~17:30	ICNPH-03	Mr. Sophat Houn

November 11, 2022		
Time	Session	Speaker
08:00~08:45	Plenary Talk (Experimental)	Prof. Dr. Hyeonsik Cheong
08:45~08:55	Short Break	
08:55~09:40	Plenary Talk (Experimental)	Prof. Dr. Knut Irgum
09:40~09:55	Coffee Break	
09:55~10:40	Plenary Talk (Experimental)	Prof. Dr. Magnus Willander
10:40~10:50	Short Break	
10:50~11:20	Invited Talk	Dr. Chan Oeurn Chey
11:20~11:50	Invited Talk	Prof. Dr. Jiang Junfeng
11:50~12:20	Invited Talk	Dr. Veasna Soum
12:20~14:00	**Lunch Break**	
14:00~14:30	Invited Talk	Dr. Sopheak Sorn
14:30~15:00	Invited Talk	Dr. Sunly Khimphun
15:00~15:30	Invited Talk	Dr. Gansukh Tumurtushaa
15:30~16:00	Invited Talk	Dr. Yu Lin
16:00~16:30	Coffee Break	
16:30~17:00	Invited Talk	Dr. Yun-Long Zhang
17:00~17:15	ICQGC-01	Mr. Phearun Rithy
17:15~17:30	ICQGC-02	Mr. Vannthorn Chork
18:00~20:00	**Banquet**	

November 12, 2022		
Time	Session	Speaker
08:30~09:00	Invited Talk	Dr. Sovann Khan
09:00~09:30	Invited Talk	Dr. Tharith Sriv
09:30~10:00	Invited Talk	Dr. Xu Sang
10:00~10:30	Coffee Break	
10:30~11:00	Invited Talk	Prof. Dr. Linghai Xie
11:00~11:15	ICNPH-04	Mr. Sunly Khuy
11:15~11:25	Wrapping Up	Local Organizing Chair
11:25~11:35	Closing Remark	Scientific Committee Chair
11:35~14:00	**Lunch Break**	
14:00~18:00	TOUR TO ANGKOR WAT	

Plenary Speakers

Prof. Dr. Hyeonsik Cheong
Sogang University, Korea

Prof. Dr. Magnus Willander
Emeritus Professor
Linköping University, Sweden

Prof. Dr. John Stuart Briggs
University of Freiburg, Germany

Prof. Dr. Feng Song
Nankai University, China

Prof. Dr. Bum-Hoon Lee
Emeritus Professor
Sogang University, Korea

Prof. Dr. Knut Irgum
Umeå University, Sweden

Invited Speakers

Prof. Dr. Jiang Junfeng
Tianjin University, China

Dr. Sovann Khan
Kyusu University, Japan

Dr. Yingdong Han
Civil Aviation University of China, China

Dr. Chan Oeurn Chey
Royal University of Phnom Penh, Cambodia

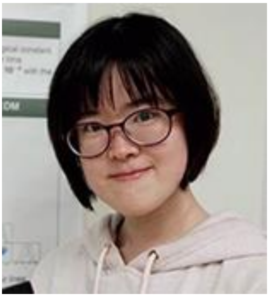
Dr. Jinyuan Zhang
Tianjin University Science & Technology, China

Dr. Sopheak Sorn
Karlsruhe Institute of Technology, Germany

Dr. Gansukh Tumurtushaa
Jeju National University,
Korea

Dr. Suly Khimphun
Royal University of Phnom
Penh, Cambodia

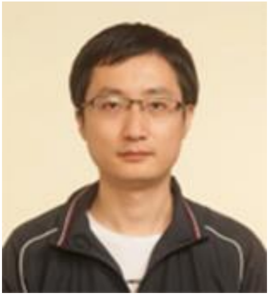
Dr. Tharith Sriv
Royal University of Phnom
Penh, Cambodia



Dr. Lu Yin
Asia Pacific Center for
Theoretical Physics, Korea

Dr. Seang Hor Eang
Royal University of Phnom
Penh, Cambodia

Dr. Veasna Soum
Royal University of Phnom
Penh, Cambodia



Dr. Yun-Long Zhang
National Astronomical Observatories
Chinese Academy of Sciences,
China

Prof. Linghai Xie
Nanjing University of Posts & Telecommunications,
China

Dr. Xu Sang
Nankai University, China

Detailed Schedules

November 10, 2022 (Kravan Hall)		
Time	Session	Speaker/Speech Deliver
08:00~08:30	Registration	
08:30~09:00	Opening Ceremony + Photo Session	Conference Chair
09:00~09:45	Plenary Talk (Theoretical)	Prof. Dr. Bum-Hoon Lee
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10:15~11:00	Plenary Talk (Theoretical)	Prof. Dr. John S. Briggs
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12:00~13:30	**Lunch Break**	
13:00~14:00	Invited Talk	Dr. Jinyuan Zhang, Chengguo Ming, Prof. Dr. Feng Song
14:00~14:30	Invited Talk	Assist. Prof. Dr. Yingdong Han, Prof. Dr. Feng Song
14:30~15:00	Invited Talk	Dr. Seang Hor Eang
15:00~15:15	Coffee Break	
15:15~15:30	**ICN2D-02**: Study of Degradation of Few-Layer HfS2 by using SEM	Chhor Yi Ly, Sokheng Hor, Tharith Sriv
15:30~15:45	**ICNPH-01**: Application of Balanced-Path Homodyne I/Q-interferometer for Measuring	Lim Lorn, Saren Vy, Sophat Houn, Sunly Khuy,

	Concentration of Mercury and Paracetamol Concentrations	Sovannary Ay, Kyuman Cho, Seang Hor Eang
15:45~16:00	**ICNPH-02:** A Compact Balanced-Path Homodyne I/Q-Interferometer and its Applications	Saren Vy, Sophat Houn, Lim Lorn, Sunly Khuy, Sovannary Ay, Kyuman Cho, Seang Hor Eang
16:00~16:15	**ICN2D-03:** Electroluminescence Enhancement of Light Emitting Diode- Based ZnO Nanorod Array/GaN Heterojunction by Doping Mn in ZnO and Insert $Zn_{1-x}Mn_xO$ Barrier Layer	Somnang Seang, Chan Oeurn Chey
16:15~16:30	Short Break	
16:30~16:45	**ICN2D-05:** Observation of Instability in Ambient Air of Two-Dimensional ZrX_2 (X=S, Se)	Vichet Thi, Sumkanhchna Onn, Keany Horn, Tharith Sriv
16:45~17:00	**ICN2D-01:** Stability Investigation of Anisotropic ZrS_3 and $ZrSe_3$ in Ambient Conditions by Using Optical and SEM Images	Khen Krisna Khuth, Bunsong Sey, Chomroeun Mao, Tharith Sriv
17:00~17:15	**ICN2D-04:** Development of Thermoelectric Nanogenerators Based on ZnO/Mn-doped ZnO Nanowires	Songhak Oun, Chan Oeurn Chey
17:15~17:30	**ICNPH-03:** Displacement Sensor Using Back Scattered Light Interferometer	Sophat Houn, Saren Vy, Sunly Khuy, Lim Lorn, Sovannary Ay, Kyuman Cho, Seang Hor Eang

November 11, 2022 (Kravan Hall)		
Time	Session	Speaker
08:00~08:45	Plenary Talk (Experimental)	Prof. Dr. Hyeonsik Cheong
08:45~08:55	Short Break	
08:55~09:40	Plenary Talk (Experimental)	Prof. Dr. Knut Irgum
09:40~09:55	Coffee Break	
09:55~10:40	Plenary Talk (Experimental)	Prof. Dr. Magnus Willander
10:40~10:50	Short Break	
10:50~11:20	Invited Talk	Dr. Chan Oeurn Chey
11:20~11:50	Invited Talk	Prof. Dr. Jiang Junfeng
11:50~12:20	Invited Talk	Dr. Veasna Soum
12:20~14:00	**Lunch Break**	
14:00~14:30	Invited Talk	Dr. Sopheak Sorn
14:30~15:00	Invited Talk	Dr. Sunly Khimphun
15:00~15:30	Invited Talk	Dr. Gansukh Tumurtushaa
15:30~16:00	Invited Talk	Dr. Yu Lin
16:00~16:30	Coffee Break	
16:30~17:00	Invited Talk	Dr. Yun-Long Zhang
17:00~17:15	**ICQGC-01**: Dynamical Analysis in Regularized 4D Einstein-Gauss-Bonnet Gravity with Non-minimal Coupling	Bilguun Bayarsaikhana, Sunly Khimphun, Phearun Rithy, Gansukh Tumurtushaa
17:15~17:30	**ICQGC-02**: Holographic Conductivity with Regularized 4D EGB Gravity	Vannthorn Chork, Phearun Rithy, Sunly Khimphun
18:00~20:00	**Banquet**	

November 12, 2022 (Kulen Hall)		
Time	Session	Speaker
08:30~09:00	Invited Talk	Dr. Sovann Khan
09:00~09:30	Invited Talk	Dr. Tharith Sriv
09:30~10:00	Invited Talk	Dr. Xu Sang
10:00~10:30	Coffee Break	
10:30~11:00	Invited Talk	Prof. Dr. Linghai Xie
11:00~11:15	**ICNPH-04**: Interferometer Application for High Sensitivity Weight Measurement	Sunly Khuy, Sophat Huon, Saren Vy, Lim Lorn, Sovannary Ay, Seang Hor Eang
11:15~11:25	Wrapping Up	Local Organizing Chair
11:25~11:35	Closing Remark	Scientific Committee Chair
11:35~14:00	**Lunch Break**	
14:00~18:00	TOUR TO ANGKOR WAT	

Abstracts: Plenary Talks

Einstein Gravity and Beyond

Prof. Dr. Bum-Hoon Lee, PhD
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ABSTRACT

Gravity still remains the least known interaction at the fundamental level, though much impressive progress has been made during the past few decades. In this presentation, we will describe the essential aspects of the universe with the Einstein gravity culminating by ΛCDM, the standard model of the cosmology. Then we move on to the possible candidate theories beyond the Einstein gravity theory. We mainly focus on the Gauss-Bonnet term, the simplest extension with the higher curvature. The properties of this theory will be explored first by looking at the Black Holes, which show some characteristic differences compared with those of the Einstein gravity and then by the implication to the cosmology.

Short Biography

Name: Bum-Hoon Lee

Education
Ph.D. Columbia University (1989)
B.S. Seoul National University (1976),

Employment
Distinguished Research Prof./Emeritus Prof., Dept Physics Sogang U (2022.03~)
Dean, School of Natural Sciences, Sogang U.(2017-2019);
Director, Center for Quantum SpaceTime, Sogang U.(2005-2020)
Professor, Dept of Physics, Sogang U(1996-Present),
Assistant & Associate Prof., Dept Physics, Hanyang U(1990-1996);
Researcher, Univ. N. Carolina (1989),Theo Phys Inst, U. Minnesota (1989-1991);

Activity Careers
President (2019-2020) *Korean Physical Society (KPS)*;
President *Asia Pacific Center for Theoretical Physics (APCTP)*
President *Korea Council for High Energy Physics (KCHEP)* (2013- 2017);
President *Korean SCOAP3 Association* (2017 – 2019)

Review Board, Division of Natural Sciences, NRF in Korea (2010-2014)
Heavy Ion Accelerator Committee (2019-21);

Basic Research Project Driving Committee (2012-2017);
Consultation Committee on Basic Research Promotion (2015-17);
Korea-CERN Cooperation & Moderation Committee (2006-2014);
Science & Technology Specialized Broadcasting Evaluation Committee (2016~ 2018)
Chair, Science Fellowship Review Committee *CheongAm Foundation* (2017-2021)
Editor, INT J MOD PHYS A (IJMPA); MODERN PHYS LETTERS A(MPLA) (2011–present)

Scientific Council Member, *Joint Institute of Nuclear Research, Russia* (2018~2023)

Perceptions of the Quantum to Classical Transition

Prof. Dr. John S. Briggs, PhD

University of Freiburg, Germany
Email: john.briggs@physik.uni-freiburg.de

ABSTRACT

An assessment is given as to the extent to which pure unitary evolution, as distinct from environmental decohering interaction, can provide the transition necessary for an observer to interpret perceived quantum dynamics as classical. This has implications for the interpretation of quantum wavefunctions as a characteristic of ensembles or of single particles and the related question of wavefunction “collapse". A brief historical overview is presented as well as recent emphasis on the role of the semi-classical "imaging theorem" in describing quantum to classical unitary evolution.

Keywords: *imaging theorem, semi-classical unitary evolution, quantum wavefunctions.*

Short Bio.: Obtained B.Sc. and Ph.D. from the University of Manchester U.K. and then was Research Fellow at the University of Chicago and Argonne National Laboratory U.S.A. From 1970 to 1979 Scientific Officer in the Theoretical Physics Division of the Harwell Laboratory of the U.K. Atomic Energy Authority. From 1979 to the present Professor of Theoretical Physics at the University of Freiburg, Germany. Fellow of the American Physical Society, Fellow of the Institute of Physics, Fellow of the Institute for Advanced Study, Berlin.

Optical Spectroscopic Studies of Two-Dimensional Materials

Prof. Dr. Hyeonsik Cheong, PhD

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Email: hcheong@sogang.ac.kr

ABSTRACT

Graphene is a hexagonal honeycomb structure of carbon atoms and has attracted much interest for its novel physical properties as well as its potential as a new material for many applications. Owing to its ultimate 2-dimensional nature, many novel physical phenomena such as the fractional quantum Hall effect, Klein tunneling and Hofstadter's butterfly have been observed. Furthermore, its high electron mobility and superb thermal properties are advantageous for use in future high-speed, large-integration electronic devices. In order to overcome some of graphene's limitations, other classes of 2-dimensional materials have begun to attract the interest of researchers. These materials, including transition metal dichalcogenides and other layered materials such as black phosphorus, exhibit a new set of interesting physical phenomena and are expected to complement graphene in future applications. Optical spectroscopy has been used extensively in the study of 2-dimensional materials to probe structural, electronic, mechanical, and thermal properties. In this talk, I will review the recent progress in 2-dimensional materials research with the emphasis on optical spectroscopy.

Keywords: *two-dimensional materials, optical spectroscopy.*

Short Bio.: Hyeonsik Cheong is a professor of physics at Sogang University, where he is currently serving as the Director of Sogang University Research & Business Development Foundation and Vice President for Research. He received his B.S. degree in physics from Seoul National University and A.M. and Ph.D. in physics from Harvard University. After working at Harvard as a postdoctoral fellow and as a postdoc and then as a senior scientist at National Renewable Energy Laboratory in Golden, Colorado, he joined the Department of Physics at Sogang University in 1999. At Sogang University, he has served as Director of International and Public Relations, Chair of the Department of Physics, and Vice President for Budget and Planning. His research interest includes spectroscopic studies of graphene and 2-dimensional materials, semiconductor nanostructures, and solar cell materials. He has served as the president of Korean Graphene Society from 2015 to 2016 and as the chair of the Division of Applied Physics of the Korean Physical Society from 2016 to 2020.

Porous Organic Monoliths – Versatile Sorbent Materials with a Wide Variety of Potential Applications

Prof. Dr. Knut Irgum, PhD

Department of Chemistry, Umeå University, S-90187 Umeå, Sweden
Email: knut.irgum@umu.se

ABSTRACT

Synthesis of space-filling polymeric networks with bicontinuous open pore structure, nowadays commonly referred to as porous organic monoliths, were pioneered by Švec and Fréchet thirty years ago [1]. Since then a variety of synthesis schemes based on a wide range of monomeric or polymeric precursors have been devised. In general, the synthesis of porous polymeric monoliths starts with monomers, which are dissolved in a non-polymerizing solvent mixture, often with addition of "porogens" with ability to control the pore-forming processes. Polymerization is thereafter triggered, whereby the monomers polymerize into three-dimensional networks with through-pores allowing bulk flow of fluids transecting the structure. Proper choice of solvents, porogens, and
conditions is also important for the formation of complementary mesopores inside the skeletons, providing interactive surfaces where a variety of processes can take place. This lecture will summarize the efforts to synthesize organic monolithic materials over the last quarter of a century by our group and others, and show the large applications span of porous organic monolithic materials.

Keywords: *In-situ prepared adsorbents, chromatographic separation media, scavengers.*

REFERENCE

[1] F. Švec, J. M. J. Fréchet, "Continuous rods of macroporous polymer as high-performance liquid chromatography separation media", Analytical Chemistry 1992, 64, 820-822.

ACKNOWLEDGMENTS

The is talk would not have been possible, had it not been for the long and fruitful collaboration with František Švec. Moreover, the practical work accounted for here would never have been carried out without the long array of PhD students and post-docs who have contributed to these group efforts – none mentioned none forgotten.

Abstracts: Invited Talks

Defect/Bandgap Engineering and Nanostructure Architecturing of ZnS-based material for solar-H2 production

Sovann Khan, PhD

International Institute for Carbon Neutral Energy Research (WPI-I2CNER), Kyushu University, Motooka 744, Nishi-ku, Fukuoka 819-0395, Japan

Email: khan.sovann.455@m.kyushu-u.ac.jp/ www.sovannkhan.weebly.com

ABSTRACT

Hydrogen (H_2) is considered as clean fuel used in fuel-cell technology, which emits zero greenhouse gas (e.g., CO_2). The demand for H_2 gas, typically for fuel cell electrical vehicles (FCEVs) is increasing. However, the current H_2 production relies on natural gas and coals related to carbon oxide gas emission, which gives back to global warming concern. To contribute to sustainable development goals (SDGs) of the United Nation, low-carbon production processes are needed. Water-splitting reaction enabled by photocatalysis is considered as very potential method for producing H_2 from water. Activated by light-energy, a semiconductor photocatalyst was considered to be a promising material to harvest the abundant energy from solar light to split water molecule to H_2 and O_2 gas. In this presentation, state-art-the art of ZnS-based materials for H_2 production will be reported. To maximize the efficiency, newly developed methods for diversifying the nanostructures and defect/bandgap engineering will be also presented. Variety of nanostructures such as quantum dot, nanosphere, nanosheet and core-shell have been synthesized by wet chemistry methods (e.g., hydrothermal, precipitation or hot-injection ...etc.). Furthermore, doping and heterojunction with other materials were effective methods to enhance photocatalytic activity. Newly developed ZnS-based materials showed better activity than that of conventional ZnS catalyst.

Keywords: *Hydrogen energy, photocatalysis, fuel cell, clean energy, ZnS.*

ACKNOWLEDGMENTS

I acknowledge the support by the Royal Government of Cambodia through the Higher Education Improvement Project (IDA Credit No. 6221-KH).

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[2]. S. Khan, M. Je, N. Ton, W. Lei, T. Taniike, S. Yanagida, D. Ogawa, N. Suzuki, C. Terashima, A. Fujishima, H. Choi, K. Katsumata, C-doped ZnS-ZnO/Rh nanosheets as multijunctioned photocatalysts for effective H2 generation from pure water under solar simulating light, Applied Catalysis B: Environmental, Elsevier, 297 (2021) 120473.
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[4]. S. Khan, H.C. Choi, D.H. Kim, S.Y. Lee, Q. Zhu, J. Zhang, S. Kim and S.H. Cho, Self-assembled heterojunction of metal sulfides for improved photocatalysis, Chemical Engineering Journal, Elsevier, 395 (2020) 125092.
[5]. S. Khan, S.Y. Lee, J.G. Park and S.H. Cho, ZnS nano-spheres formed by the aggregation of small crystallites and their photocatalytic degradation of eosin B, Chinese Journal of Chemistry, Wiley, 35 (2017) 159-164.

Short Bio.: With more than 10-year research experiences in Nanomaterials and Hydrogen Energy, Dr. Sovann is expertise in high-throughput synthesis of nanomaterials, photocatalysis and fabrication of solid oxide fuel cell. His research experiences also cover on chemistry of materials such as defect and bandgap engineering for improving catalytic/optical properties. Currently, Dr. Sovann is a researcher at International Institute for Carbon Neutral Energy Research (WPI-I2CNER), Kyushu University, Japan working on solid oxide fuel cell. Before joining Kyushu University, Dr. Sovann was a JSPS Postdoc fellow at Tokyo University of Science, Japan. Dr. Sovann graduated doctoral degree of engineering in Nanomaterials Science and Engineering from Korea Institute of Science and Technology (KIST) and University of Science and Technology (UST) in 2017, South Korea.

Excitation Controlled Lifetime of Upconversion Luminescence

Yingdong Han[a], Feng Song[b,*]

[a]*College of Science, Civil Aviation University of China, Tianjin 300300, China.*

[b]*School of Physics, Nankai University, Tianjin 300071, China.*
Corresponding: fsong@nankai.edu.cn.

ABSTRACT

Temporal response characteristics, especially luminescence lifetime embedded in the decay edge property, endow the essential difference between luminescence and other photon generation processes, such as thermal radiation, light scattering and reflection. The temporal response characteristic is not only a unique optical dimension of luminescence, but also a link between internal electronic behavior and spectral output. Thus investigation on temporal response characteristics of lanthanide upconversion luminescence (UCL) enables us to reacquaint the dynamic response process of UCL, enrich the means of UCL regulation, and promote more reasonable designs for customized demands in diverse applications. In our recent work, we found that the rise and decay dynamics are readily influenced by the pulse width/power density of the excitation laser even in the same UCL system. Following this principle, we were able to tune the excitation and decay contours and consequently UCL profiles by only modulating the excitation laser, e.g., a record-wide, ~20-fold lifetime tuning was realized by simply varying the excitation pulse width. It further enables arbitrary operation at single-particle level, of the reversible green-red emission color evolution. Discoveries on the generation, mechanism, and tuning of dynamic UCL holds promise for opening a brand new chapter complementing nowadays prevalent steady-state UCL.

Yingdong Han, assistant professor, graduated from Nankai University in 2018 with a doctor's degree and joined the Civil Aviation University of China in 2021. His main research interests are the design, preparation and application of functionalized rare earth luminescent materials. He has published more than 40 papers in SCI journals including Angewandte Chemie, Advanced Science, Journal of Materials Chemistry C, etc., and has obtained 8 Chinese patent authorizations. He has presided over 8 research projects, including the Youth Program of the National Natural Science Foundation of China, the China Postdoctoral Science Foundation, and the Central University Program.

Future Prospect of Application of Metal Oxide Nanomaterials

Chan Oeurn Chey, PhD

Graduate School of Science, Royal University of Phnom Penh, Cambodia
Email: chanoeurn@rupp.edu.kh

ABSTRACT

Nanotechnology is a technology of the design and the applications of nanoscale materials with their fundamentally new properties and functions. When the size of materials is in the nanoscale regime the large surface area to volume ratio exhibited by nanomaterials, optical effects, electron/ion transport properties and confinement effects, which makes nanomaterials ideally suitable candidates for many types of neoichnology applications. Therefore, nanomaterials have opened up possibilities for new innovative functional devices and technologies. Currently, nanotechnology has been recognized as a revolutionary field of science and technology and have been applied in many applications, including environmental applications, medical applications, biomedical applications, healthcare and life sciences, agricultures, food safety, security, energy production and conversion applications, energy storage, consumer goods, infrastructure, building and construction sector, and aerospace. Among nanomaterials semiconductors, metal oxide nanomaterial is a potential semiconductors material for future nanotechnology due to these metal oxide nanomaterials can be synthesis via various low temperature growth methods with low cost and low emission. Therefore, this work aims to review all potential future applications of metal oxide nanomaterials, transition metal oxides, transition metal doped metal oxide and their impact on economic and environment. In short, the future applications of the materials are:

Metal oxide: biomedical, photonics, sensors, energy harvesting, water and air treatments applications.

Transition metal doped metal oxide: all types of metal oxide application and spintronic applications

Transition metal oxide: All type of metal oxide applications and energy storage application.

Keywords: *Metal Oxide Nanomaterials, Transition Metal Oxide Semiconductors, Doped Metal Oxide Nanostructures and Applications of Nanotechnology.*

ACKNOWLEDGMENTS

This project is funded by the Royal Government of Cambodia through the Higher Education Improvement Project (IDA Credit No. 6221-KH), Swedish International Development Cooperation Agency (SIDA) through Sweden and Royal University of Phnom Penh (RUPP)'s Pilot Research Cooperation Programme (Sida Contribution No. 11599) and RUPP.

Application of Rare Earth Luminescent Materials in Anti-counterfeiting Field

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ABSTRACT

Information Security has also been recognized as a major challenge due to the widespread existence of forgeries and information leaks in many areas. A new type of single-phase Tb3+ doped, Eu3+ doped and Tb3+, Eu3+ co-doped La1/3Zr2(PO4)3 rare earth luminescent material was prepared by hydrothermal method. At 376 nm excitation, part of the energy of Eu3+ is derived from Tb3+, that is, the energy transfer from Tb3+ to Eu3+ occurs in this phosphate matrix sample. When the excitation wavelength is constant, by regulating the ratio of Tb3+ to Eu3+, the multi-color luminescence of the material can be realized, so as to realize multi-color anti-counterfeiting.

Jinyuan Zhang was born in Shijiazhuang, Hebei Province, in 1998. In 2020, she received the B.S. degree in environmental ecological engineering at Hengshui College. In the same year, she pursued the master degree in College of Science, Tianjin University of Science & Technology, under the tutelage of Professor Chengguo Ming at the Rare-earth Luminescent Material Laboratory. Since 2020, she has been a physics teaching assistant with the school of Sciences, Tianjin University Science & Technology. Her research is focused in the luminous materials doped with rare earth and transition ions for fluorescent anti-counterfeiting, solar cells, biomedical technologies and optical devices.

Skyrmions in Chiral Magnets: Influence on Electronic Properties

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ABSTRACT

Skyrmions are noncoplanar magnetic objects consisting of many spins swirling from pointing in one direction at a center to the opposite direction away from the center. These topological spin textures are found in crystalline form in various materials. Such skyrmion crystals (SkX) can be stabilized by Dzyaloshinskii-Moriya spin interactions in non-centrosymmetric systems or by frustrating spin interactions. Itinerant electrons coupled to a SkX have their spins following the noncoplanar SkX adiabatically, resulting in a Berry phase. This leads to an additional Hall contribution, well-known as the topological Hall effect (THE), which modifies the conventional orbital Hall effect in the system. For nanoscale skyrmions, the non-coplanarity of spins in the SkX can become large, resulting in a large or even quantized THE. In this talk, it will be shown that a spin model can host a SkX featuring a tunable skyrmion density by varying the applied Zeeman field [1]. Systems of electrons coupled to such tunable SkX sense a tunable Berry phase, thereby exhibiting oscillations in physical quantities akin to Shubnikov-de Haas effect, which modifies the conventional quantum oscillations. The second part of the talk will be based on a recent work [2] demonstrating how the optical Hall conductivity of the electrons coupled to a SkX are altered as a result of the Berry phase.

Keywords: *Skyrmion, skyrmion crystal, chiral magnet.*

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Short Bio.: Sopheak Sorn did his Master at the Perimeter Institute of Theoretical Physics, Waterloo, Canada. In his Master final project, he studied strongly correlated spin-liquid phases in a Kagome magnet using a projective symmetry group analysis. He then moved to do his PhD at the University of Toronto, where he worked on novel phenomena in electron transports, optics, and thermodynamics, which are resulted from nontrivial topological characters in a variety of systems including skyrmion-hosting magnets, Chern insulators, and Weyl semimetals. He is currently a postdoctoral researcher at the Karlsruhe Institute of Technology in Germany. His current research focuses on impacts of quantum magnons and quantum fluctuations on various features of magnetic skyrmions such as their dynamics, response functions, as well as their stability.

Cosmic Inflation

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ABSTRACT

In this talk, I plan to speak about inflationary cosmology, including inflation models, inflationary gravitational wave production models, and primordial black hole formations originating from quantum fluctuations in the early universe in light of observational data.

Keywords: *inflation model, primordial black hole, quantum fluctuations.*

Short Bio.: Supervised by Prof. Bum-Hoon Lee, Dr. Tumurtushaa obtained his Ph.D. in Physics from Sogang University in 2016 and remained at Sogang, as a post-doc researcher in the Center for Quantum Spacetime (CQUeST), until 2017.

In 2017, he joined the Center for Theoretical Physics of the Universe, Institute for Basic Science, Korea, as a research fellow and worked there for three years until 2020.

He then moved to Taiwan to work as a junior research fellow for Leung Center for Cosmology and Particle Astrophysics at National Taiwan University in Taiwan between 2020 and 2021. Since 2021, he has worked for Jeju National University as a postdoctoral researcher.

Modified Gravity: From the Perspective of Higher Dimensions and Extra Degrees of Freedom

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ABSTRACT

In this talk, I will introduce the basic concepts and motivations of modified gravity theories from the point of view of higher dimensions and extra degrees of freedom. In particular, the Gauss-Bonnet gravity and scalar-tensor theories will be discussed which will be followed by several contexts of black hole and cosmology. Finally, some relevant phenomenological studies correspond to these modified theories will be discussed.

Keywords: *modified gravity, Gauss-Bonnet gravity, scalar-tensor theories.*

ACKNOWLEDGMENTS

This project is funded by the Royal Government of Cambodia through the Higher Education Improvement Project (IDA Credit No. 6221-KH), Swedish International Development Cooperation Agency (SIDA) through Sweden and Royal University of Phnom Penh (RUPP)'s Pilot Research Cooperation Programme (Sida Contribution No. 11599) and RUPP.

Raman Study of Semiconducting Tin Chalcogenides

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ABSTRACT

Raman spectroscopy is widely known as one of the most successful tools used to probe several physical properties of two-dimensional (2D) materials such as mechanical, thermal, electrical, magnetic and mainly optoelectronic properties. In this talk, I will demonstrate that the technique is successfully used to investigate optical phonons in tin chalcogenides such as 2H-SnS_2 [1], $SnSe_2$ and $SnSe_{(1-x)}S_x$ ($0 \leq x \leq 1$) [2] semiconductor materials. In the study of [1], low-frequency micro-Raman spectroscopy was to find the lattice dynamics of mechanically exfoliated few-layer 2H-SnS_2. Results of similar material, i.e., $SnSe_2$ will be shown in this talk. The investigation of these tin chalcogenides was done at room temperature in high vacuum condition (~10^{-6} Torr range) by using several different excitation wavelengths: 784.8, 632.8, 532, 514.5, 514.4, 488 and 441.6-nm. The interlayer in-plane (shear) and out-of-plane (breathing) modes for 2H-SnS_2 [1] and $SnSe_2$ show strong dependence on layer thickness resulting in robust criteria for determining few-layer sample thickness by using Raman spectroscopy. In addition, the interlayer in-plane and out-of-plane force constants were estimated by fitting the experimental data using the linear chain model (LCM). More importantly, in $SnSe_{(1-x)}S_x$ [2] the anisotropy and composition dependence of phonon modes will be demonstrated in this talk. It should be noticed that by comparing with a direct measurement of the crystal axes using electron microscopy, it will be shown that the Ag_2 mode in $SnSe_{(1-x)}S_x$ ($0 \leq x \leq 1$) [2] can be reliably used to determine the crystal axes. In conclusion, results for 2H-SnS_2 and $SnSe_2$ provide important parameters for optoelectronic device fabrications by using tin chalcogenides. Particularly, making unambiguous phonon mode assignments in $SnSe_{(1-x)}S_x$ and establishing their evolution as a function of the composition will benefit the analysis of other

compounds such as the solar cell materials $Cu_2ZnSn(S,Se)_4$ in which Sn(S,Se) is often found as a secondary phase material that limits the cell performance.

Keywords: *Raman spectroscopy, tin chalcogenides, 2H-SnS_2, $SnSe_2$,* $SnSe_{(1-x)}S_x$.

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[2]. Sriv, T., Nguyen, T.M.H., Lee, Y. et al. Sci Rep 10, 11761 (2020).

Short Bio.: Dr Tharith Sriv is with the Department of Physics, Faculty of Science, Royal University of Phnom Penh (RUPP). He is also the Program Coordinator of the Graduate Programs in Physics, Graduate School of Science, and a Coordinator for Physics of the Sweden-RUPP Bilateral Program, at RUPP, aside from being recognized as a Senior Researcher of the Cambodia Development Center. In December 2020, he was appointed an advisory board member of the National Council of Science, Technology and Innovation.

Tharith received a Master of Engineering (M. Eng.) in Electrical and Information Engineering from King Mongkut's University of Technology Thonburi (KMUTT), Bangkok, Thailand, and a PhD in Physics from Sogang University, Seoul, Republic of Korea, in 2005 and 2020, respectively.

Tharith's research interests are in 2D materials, nanomaterials and optical spectroscopy.

Does Hubble Tension Signal a Breakdown in FLRW Cosmology?

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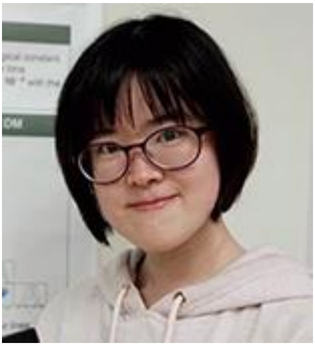
ABSTRACT

A 10% difference in the scale for the Hubble parameter constitutes a clear problem for cosmology. Here, considering the angular distribution of Type Ia supernovae (SN) within the Pantheon compilation and working within LCDM cosmology, we observe that a correlation between higher H0 and the CMB dipole direction can be extended from strongly lensed quasars to SN. Through simulations, we infer that similar correlations can arise as statistical fluctuations with probability $p = 0.12$ and $p = 0.065$, respectively. Thus, by combining lensed quasars and SN we find evidence at 2.4 sigma for H0 being higher in the CMB dipole direction. Taken in tandem with reported mismatches in the cosmic dipole and similar anisotropies in scaling relations in galaxies and high redshift probes, the observations point to a resolution to Hubble tension outside of FLRW.

Keywords: *Hubble tension, dark energy, modify gravity theory, Type Ia supernova.*



Short Bio.: Lu Yin's research focuses on theoretical cosmology with modified gravity models for releasing H0 tension. She is interested in numerically comparing the theoretical model with the observations, especially dark energy models in CMB power spectra, and Large Scale Structure.

I/Q-Interferometric Sensors in High Precision Measurements

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ABSTRACT

High precision measurements are essential in both scientific and high-tech industrial applications. Interferometer is an ideal equipment which can provide extremely high sensitivity in measuring changes in optical path length, which is limited by quantum noise [1-3]. The interferometer scheme has been used for various precision sensor applications [3-7]. It has been shown that an interferometer can be operated at the optimum sensitivity without any feedback control of optical path length difference between the probe beam (PB) and the reference beam (RB) to keep the interferometer at the quadrature demodulation condition [1], which makes the operation of the interferometer very simple and easy. In this research, I/Q-interferometric sensors such as chemical concentration sensor, low weight measurement sensor, backscattered light interferometric sensor and 3D image optical sensor will be discussed. The potential of I/Q-interferometers design and the challenge of each interferometric sensors will also be discussed.

Keywords: *interferometric sensors; I/Q-interferometer; precision measurements.*

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Deposition of Nanomaterials on Polymeric Substrates by Printing for Device Fabrication

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ABSTRACT

The deposition of functional material on typical substrates enables the fabrication of various devices, including displays, energy harvesting or storage devices, smart sensors, and healthcare devices. The fabrication begins simply by drawing a customized electronic design pattern and then printing that design pattern on a suitable substrate with a printing tool and inks containing functional materials. Thanks to recent technological advances, printing tools now provide high-resolution, large-scale, high-quality reproducibility printing and enable mass production. The performance of the resulting device is highly dependent on the material ink and substrate's properties. The material ink's properties, such as particle size, viscosity, surface tension, and solvent, must be optimized depending on the printing tool used. Despite these various properties of printing ink, the printing substrate's properties, such as surface roughness, wettability, thermostability, flexibility, elasticity, and transparency, must be carefully considered based on the fabricated device. This talk covers recent works in printing nanomaterials for the fabrication of devices, challenges, and outlook for this research area, especially for the low-resource setting.

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(SIDA) through Sweden and Royal University of Phnom Penh (RUPP)'s Pilot Research Cooperation Programme (Sida Contribution No. 11599).

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Ultralight Dark Matter and Pulsar Timing Arrays

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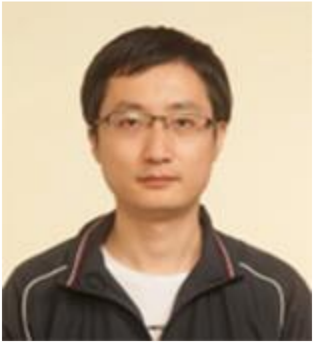
ABSTRACT

The coherent oscillation of ultralight dark matter in the mass regime around 10−23 eV induces changes in gravitational potential with the frequency in the nanohertz range. This effect is known to produce a monochromatic signal in the pulsar timing residuals. Here we discuss a multi-field scenario that produces a wide spectrum of frequencies, such that the ultralight particle oscillation can mimic the pulsar timing signal of stochastic common spectrum process. We discuss how ultralight dark matter with various spins produces such a wide band spectrum on pulsar timing residuals and perform the Bayesian analysis to constrain the parameters. It turns out that the stochastic background detected by NANOGrav can be associated with a wideband ultralight dark matter.



Short Bio.: Yun-Long Zhang is an associate researcher at the National Astronomical Observatories of the Chinese Academy of Sciences (NAOC). He received the PhD at the Institute of Theoretical Physics, Chinese Academy of Sciences (ITP-CAS) in 2014, and then performed the post-doctoral research in National Taiwan University and APCTP (Asia Pacific Center for Theoretical Physics, Korea). Since 2018, He became a JSPS fellow at Kyoto University and a research assistant professor at Yukawa Institute for Theoretical Physics (YITP). At the end of 2020, he joined NAOC. His research interest includes gravity and cosmology, such as black hole physics and gravitational holography, ultralight dark matter and gravitational wave detection.

Organic Grid-dot Nanomaterials for Wide Bandgap Luminescence

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ABSTRACT

One trend of intelligent information required the flexible and wearable integrated photonics with low cost and robust performance, which offer the many opportunities to innovate the advanced organic nanomaterials with intrinsic advantages such as diversity and tailorability, soft and intelligent feature, light and ultrathin, mechanical flexibility and elasticity [1]. Previously, a series of challenges of wide bandgap blue light emitters have been addressed by the molecular design of fluorene-based organic semiconductors. One successful example is to discover the spirofluorene-xanthenes (SFX) [2-3] with the low-cost and robust stability for the commercial OLED display and perovskite solar cells. Furthermore, the facile fluorenol's Friedel-Crafts functionalization method of diarylfuorenes have been established for the luminescence material design to give the OLED materials with more stability and higher efficiency [4-6]. More recently, we developed the gridization of organic semiconductors and optoelectronic materials and innovated one novel organic nanomaterial, that is organic nanogrid, which can be extended and expanded into 1-2-3-dimensional nanopolymers and frameworks [7-10]. This kind of organic nanomaterials exhibit high dielectric constants [9], unique mesoscale assembly as well as the excellent luminescent lasing behaviors [10]. Nevertheless, organic grid-dots based nanogridarenes open a unprecedent way to advanced flexible photonics in the future.

Keywords: *Hubble tension, dark energy, modify gravity theory, Type Ia supernova.*

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Short Bio.: Prof. Ling-Hai Xie was born in 1976 in Qingdao, China, and received his PhD degree from Fudan University under the supervision of Professor Wei Huang in June 2006. He then joined the Institute of Advanced Materials (IAM) at Nanjing University of Posts and Telecommunications and became a full Professor of organic/polymer nanomaterials chemistry in 2012. At present, He is a leader of the

Center for Molecular Systems & Organic Devices (CMSOD). His current research interests include Molecular Integrating Technology (MIT) for next-generation flexible semiconductors and optoelectronic materials, intelligent nanopolymers, organic intelligence and intelligent/robotic meta-chemistry for era of consciousness and cross-scale self-cycle/loop of chemical matter. Prof. Ling-Hai Xie has published more than 200 SCI papers as the first or corresponding author, including *Nat. Commun.*, *Adv. Mater.*, *Chem*, *J. Am. Chem. Soc.*, *Angew. Chem. Int. Ed.*, *Prog. Polym. Sci.* etc. All the published papers have been cited more than 6,000 times by other researchers. He applied for PCT and authorized 39 patents in Singapore and China, and coauthored 1 academic book. He is the principal investigator of National Natural Science Funds for Excellent Young Scholar, Major Program of National Natural Science Foundation of China (1) and participation in Basic Research Program of China (973 Program, 2). He won the second prize of National Natural Science Award (3/5) and the first prize of Natural Science of Ministry of Education (2/5).

Color regulation of Eu(tta)3phen/E7 composites based on interaction between rare earth complexes and liquid crystals

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ABSTRACT

The research of rare earth (RE)/ liquid crystal (LC) composites is a fast-growing field, which has greatly promoted the development of science and technology. Based on the interaction between Eu(tta)3phen complexes and E7 host, three different approaches are presented to implement tunable multi-color luminescence for RE/LC composites. Experimental and theoretical analysis demonstrates that the E7 host not only transfers energy to Eu(tta)3phen complexes through the radiative reabsorption mechanism and the Förster-type resonance energy transfer mechanism, but also regulates the distortion of symmetry around Eu3+ ions. Judd–Ofelt theory proves that the luminescence of Eu(tta)3phen is improved in the E7 host. This tunable emitting color fluorescent RE/LC composites may open a new gate for the development of multi-color displays and cryptography.

Short Bio.: Xu Sang is PhD student in Nankai University. She is currently involved in research on rare earth luminescence and solid spectrum, especially the preparation and application of rare earth flexible luminescent materials.

Dr. SONG Feng, a professor in Nankai University. His research interests include solid state lasers and their applications, fabrication and luminescence of rare earth doped materials, compact fiber lasers and amplifiers, broadband ASE light sources, emission enhancement by surface plasmon polariton, nanostructure and the influence on the radiative and nonradiative decay. He is the holder of several patents and has published over 200 papers in internationally recognized journals, and has given invited presentations at national and international conferences. He has been served as program chairs and members for national and international academic conferences including SPIE Photonics West (Section of optical components and materials). He is/was serving as vice editor-in-chief for Journal of University Physics (in Chinese), a topical editor of Applied Optics (2010-2016), executive member in sub-committee of optics- electronics of Chinese Optical Society, the vice executive chair for Tianjin Society of Laser Technology (2011-2019), the general secretary of Tianjin Society of Physics. In 2021, he was listed as one of the world top 2% scientists sponsored by Stanford University.

Abstracts: Research Student

Stability Investigation of Anisotropic ZrS_3 and $ZrSe_3$ in Ambient Conditions by Using Optical and SEM Images

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ABSTRACT

The anisotropic layered zirconium-trichalcogenides have eight atoms per unit cell and are members of the space group ($P2_1/m$) [1, 2]. Due to their various and unique physical and chemical features, ZrS_3 and $ZrSe_3$ have undergone substantial studies in few layers [2-4]. To further understand their potentials for applications in ambient condition, stability investigation of mechanically exfoliated few-layer ZrS_3 and $ZrSe_3$ in air is studied. We used optical images and scanning electron microscope (SEM) to observe degradation. A comparison of optical and SEM images of few-layer samples measured several hours and those observed after several days was done. The result showed significant change of the optical and SEM images because instability of these mechanically exfoliated few-layer ZrS_3 and $ZrSe_3$ samples in ambient air. This suggests a consideration of vacuum condition in further characterization and in future device designs.

Keywords: *Ambient condition, two-dimensional materials, oxidation, and degradation.*

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Study of Degradation of Few-Layer HfS_2 by using SEM

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ABSTRACT

The recently discovered two-dimensional transition metal dichalcogenide (TMD) HfS_2 has drawn interest since it has the potential in both electrical and optoelectronic devices due to its extremely high photoresponsivity (over 890 A W^{-1}), well-balanced carrier mobility (1800 cm^2 V^{-1} s^{-1}), and suitable band gap (~1.2 eV) [1–3] for optoelectronic devices. Moreover, superconductivity was reported in 3L-HfS_2 [4], that makes the material more interesting. However, significant material degradation in ambient air has been reported in thin-film HfS_2 [5], although no significant degradation was observed by thick-layer HfS_2 in a study by using Scanning Electron Microscope (SEM) [3]. In our study, we investigated degradation of mechanically exfoliated few-layer HfS_2 by using optical contrast and SEM. A comparison of optical and SEM images of 12 hours and those of several days reveal clear sign of degradation of few-layer HfS_2 in ambient air. This confirms fast degradation evidence in few-layer HfS_2 in ambient air and suggests that further study of mechanically exfoliated few-layer HfS_2 must be conducted in vacuum condition. Moreover, device design by using two-dimensional HfS_2 requires degradation consideration, especially when the devices are used in ambient air.

Keywords: *2D materials, HfS_2, ambient condition, degradation, optical microscope, scanning electron microscope*

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Electroluminescence Enhancement of Light Emitting Diode-Based ZnO Nanorod Array/GaN Heterojunction by Doping Mn in ZnO and Insert $Zn_{1-x}Mn_xO$ Barrier Layer

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ABSTRACT

In recent years, zinc oxide (ZnO) has received a lot of attention as a potential material for optoelectronic devices due to its relatively large exciton binding energy of 60 meV, wide direct band gap (3.37 eV), and ability to grow in the nanostructure form which use a wide range of methods on any substrate [1]. One of the best candidates for LEDs is a light-emitting diode based on the n-ZnO/p-GaN heterojunction since ZnO and GaN both have the same wurtzite hexagonal structure and similar lattice characteristics, which results in low lattice mismatch (1.8%) [2]. However, radiative recombination primarily results from defect-related states in the p-GaN due to a dominant electron injection from the n-ZnO with weak holes injection from the p-GaN [3-4]. The electroluminescence of this kind of heterojunction could be improved by introducing dopant, dielectric layer or polymers [5]. Moreover, the Mn-doped ZnO material has the potential to be a multipurpose material with optical properties that makes it useful in light-emitting diodes [6-8]. In this study, in terms of improving electroluminescence of heterojunction, we introduced the $Zn_{1-x}Mn_xO$ barrier as an electron barrier to obtain more combination at the ZnO side and reduce interface mismatch we also doped ZnO with manganese to enhance optoelectronic properties of ZnO nanorod array/GaN heterojunction. In Recent results, all Nanorods had a preferred orientation along the (002) c-axis, according to structural measurements. The bandgap energy of $Zn_{1-x}Mn_xO$ was lower in comparison to pure ZnO nanorods, as shown by the UV-visible spectra. According to SEM images, pure and doped Mn-ZnO

had a homogeneous dense growth, and well-aligned morphology, and almost all of its nanowires were perpendicular to the substrate's surface. Mn ions are substituted in the Zn sites, revealed by EDS data. We also expected that fabricated LEDs with $Zn_{1-x}Mn_xO$ barrier layer introduction and manganese doping in ZnO have lower turn-on voltages, good ohmic contacts, and the typical rectifying characteristics of a diode. With an increasing current injection, the intensity of the electroluminescence increased. $Zn_{1-x}Mn_xO$ inter-layer introduction increased the probability of recombination on the ZnO side. In conclusion, by doping the ZnO with manganese and inserting a $Zn_{1-x}Mn_xO$ interlayer, we were capable of fabricating LEDs based on ZnO nanorod array/GaN heterojunction and increased electroluminescence.

Keywords: *ZnO nanorods, doping, $Zn_{1-x}Mn_xO$ barrier, light emitting diode based on ZnO, Heterojunction devices.*

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Development of Thermoelectric Nanogenerators Based on ZnO/ Mn-doped ZnO Nanowires

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ABSTRACT

Numerous studies are now being conducted to increase the effectiveness of thermoelectric (TE) technology by utilizing various TE materials and techniques. Nanotechnology is a field of engineering that makes use of nanomaterials and designs them with novel fundamental features. It is also one of the suggested methods for enhancing TE performance. Due to electric and pyroelectric properties, ZnO is one of the exhibits a variety of useful qualities, including a high melting point (~1023K) and non-toxic material [1-3]. Doping is among the simplest methods to adjust the TE characteristics of ZnO. Because its atomic radii are comparable to those of zinc, Mn is thought to be a great dopant in ZnO. These mixed or secondary phases for thermoelectric are the main means of increasing the effectiveness of the thermoelectric device [4]. For this reason, it was possible to compare the thermoelectric properties of ZnO with Mn-doped ZnO utilizing this phenomenon. ZnO and Mn-doped ZnO nanowires were prepared by hydrothermal method. In this work, we developed an experiment to generate electricity from heat termed a single nanogenerator (NG) under temperatures below 100°C [5]. The electrical conductivity could be enhanced by selecting 5% of manganese doping concentration in ZnO nanowires. Vertical structure (through plane) approaches were developed to determine the Seebeck coefficient [6]. In conclusion, doping manganese in ZnO instantly increased the Seebeck coefficient and power factor, which would also improve thermoelectric performance.

Keywords: *Thermoelectric, Hydrothermal method, Mn-doped ZnO, ZnO nanowires, nanogenerator.*

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Observation of Instability in Ambient Air of Two-Dimensional ZrX_2 (X=S, Se)

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ABSTRACT

Layered transition metal dichalcogenides (TMDCs) semiconductors have been very interesting in recent years, due to their physical and electrical properties for application in electronics and optoelectronic devices. Most of the devices are used in ambient condition due to material stability, which has widely been known for several materials. Zirconium disulfide (ZrS_2) and Zirconium diselenide ($ZrSe_2$) are of trigonal structure and belong to the space group $D_{3d}^{3}\ (P\overline{3}m1)$, which each has three atoms per unit cell (one atom of Zr and two atoms of S) [1–3]. Moreover, the indirect band edge from bulk to the monolayer of each is (1.78 eV-1.19 eV) for ZrS_2 and (1.12 eV-0.50 eV) for $ZrSe_2$ at 300 K [4,5]. In the previous research, Atomic Force Microscopy (AFM), Cross-sectional Transmission Electron Microscopy (TEM) (<50 nm thick, <10 mm in lateral size), and Energy-dispersive X-ray (EDX) can be effectively used to study the oxidation and degradation of ZrS_2 and $ZrSe_2$ [6]. In this work, we reported the mechanical exfoliation of ZrX_2 (X = S, Se) from bulk down to few-layer and we studied the instability in ambient condition. The oxidation and degradation of these materials were first observed by using Optical Microscopy and then checked by using Scanning Electron Microscopy (SEM) analysis in ambient condition. As a result of optical and SEM images after several hours and days, we observed signs of degradation of few-layer ZrS_2 and $ZrSe_2$ samples caused by ambient air. Therefore, the characterization of few-layer ZrS_2 and $ZrSe_2$ samples by using spectroscopic techniques such as Photoluminescence (PL) and Raman

spectroscopies must be performed in vacuum condition. Most importantly, the realization of device designs and applications require consideration of degradation.

Keywords: *Transition metal dichalcogenide, 2D materials, ZrS_2, $ZrSe_2$, mechanical exfoliation, ambient condition, oxidation, and degradation.*

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Application of Balanced-Path Homodyne I/Q-interferometer for Measuring Concentration of Mercury and Paracetamol Concentraions

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ABSTRACT

In recent years, the issue of environmental pollution has received widespread world- wide attention. Among these environmental issues, heavy metal pollution has become an increasingly serious problem in many countries. Mercury is a typical and highly toxic heavy metal [1-2]. The detection of heavy metal ion has been widely studied in many fields, including water quality control, soil quality management, and human- heath. Since heavy metal are accumulated in human body even at very low concentration, a highly accurate and sensitive heavy metal ion sensor is necessary [3]. Paracetamol is a common analgesic and antipyretic drug that is used for the relief of fever, headaches and other minor aches and pain. Their determination in pharmaceuticals is of paramount importance, since an overdose of paracetamol can cause fulminating hepatic necrosis and other toxic effects. Many analytical methodologies have been proposed for the determination of paracetamol [4-5]. The Balanced-path Homodyne I/Q-interferometer has many applications with very high sensitivity [6-9]. In this research the Balanced-path Homodyne I/Q-interferometer combine with fluidic channel system is used to measuring concentration of standard mercury solutions in which the concentrations are prepared in between 1 mM to 25 nM and paracetamol solutions

in between 0.5mg/ml to 0.01 mg/ml. The minimum detectable concentration of the system is 21.41 ng/ml.

Keywords: *I/Q-interferometer, mercury, paracetamol, fluidic channel system.*

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A Compact Balanced-Path Homodyne I/Q-Interferometer and its Applications

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ABSTRACT

Recently, the requirement for the accurate measurement of Micro-electromechanical systems (MEMS) movement is highly significant [1-6]. Hence, we present a new compact balanced-path homodyne I/Q-interferometer system for displacement and chemical concentration sensors. In this new interferometer arrangement, the probe beam and the reference beam are geometrically balanced so that the environmental noise is sufficiently rejected [7]. On the other hand, the interferometer system is much more compact; therefore, this system has high sensitivity down to the picometer. Moreover, the potentiality of this system will be applied to scan the very low chemical concentrations application. By this measurement, the linearity of NaCl refractive index and concentrations is having good agreement with the previous works. The noise level is about 10^{-6}rad/Hz$^{1/2}$ corresponding to the minimum displacement calculated at approximately 0.50 × 10^{-13} m by using our new scheme interferometer. A new interferometer system has been applied to measure the NaCl concentration solutions. As we can see from the result, the very low concentration was sufficiently detected and the linearity of the refractive index and concentration which has been measured by our new system is well confirmed with the previous studies.

Keywords: *balanced-path, homodyne I/Q-interferometer, fluidic channel.*

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Displacement Sensor Using Back Scattered Light Interferometer

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ABSTRACT

Most interferometers are used highly reflected mirror mounted behind the sample, so the high-intensity signal will be detected without any challenge [1-5]. However, in the case of a rough surface sample, the scattered light will dominate the signal. Therefore, interferometers will be suffered due to a large amount of lost intensity. Hence, the new scheme of the I/Q-interferometer will be introduced to study the back-scattered light from the scattering surface materials. In this work, Lambertian surface, a piece of paper, is mounted on a plate which is attached to the piezoelectric transducer (PZT). In this preliminary study, we will prove that the I/Q interferometer can detect the signal resulted from the backscattered ray of the rough surface in which the intensity is very low. The sinusoidal displacement of PZT will be measured by using this backscattered light and signal to noise ratio (SNR) will be calculated. The sensitivity-dependent distance and the measurement regardless of surface angle will be further studied. This developed interferometer will be applied to study the surface roughness of other materials without having a mounted mirror behind.

Keywords: *I/Q-demodulator, back scattered light, Lambertian surface, sensitivity.*

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Interferometer Application for High Sensitivity Weight Measurement

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ABSTRACT

Weight measurements is a significant technical and useful indication for many industrial and scientific application, such as lab precision measurements, the pharmaceutical industry, food industry, aviation industry, civil industry, highway engineering, and traffic management [1]. For intensity-modulated optical fiber sensors could be applied in mass measurements. The signals due to mass loading have been measured by using a voltmeter. The sensitivity of about $11.5\ \mathrm{mV/g}$ with a dynamic range of $80\ \mathrm{g}$ is obtained [2]. Atomic Force Microscope (AFM) with Microfluidic Cantilever is used as a weight sensor that has measurement capability of cellular mass changes of living single cells in sub-nanogram. Additionally, the smallest measured weight goes to $280 \pm 95\ \mathrm{pg}$ [3]. Another hand, the weight sensing using fiber optics based on single-mode-multimode-mode-single-mode (SMS) fiber structure has been proposed with sensitivity up to $-11.3\ \mathrm{pm/g}$ [4]. Force sensor based on Sagnac Interferometer with a simple structure by embedding a short of polarization-maintaining photonic crystal fiber (PM-PCF). For the length $3\mathrm{cm}$ of PCF, the sensitivity reaches to $16.32\ \mathrm{mm/N}$ as the various force from $0\mathrm{N}$ to $0.392\mathrm{N}$ [5]. Single-fiber Mech-Zehnder Interferometer (SFMZI) can be used for weight sensing. Interference mode and mathematical basis corroborating mode will be considered on the shifting output pattern. Whereas the sensitivity is observed to be $112\ \mathrm{pm/gm}$ for the applied weight ranges 0 to $100\ \mathrm{gm}$. However, the sensitivity has been still improved [6]. The applicable Balance-path Homodyne I/Q-Interferometer with Polarizing Beam Displacer (PBD)

on weight measurement by using a load cell has been performed. Another hand, the minimum detectable reach to $1.00\ \mu g$ with a repeatability $100\ \mu g$ [7]. However, the small measured mass method and the minimum detectable are still in improvement levels especially the application of interferometer. In this preliminary study, we are going to apply Balanced-path Homodyne I/Q-Interferometer for measuring small masses in range between 5 mg to 200 mg by using spring. The linearity of measurement results and sensitivity will be plotted and calculated, respectively.

Keywords: *Spring, I/Q-Interferometer.*

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Dynamical Analysis in Regularized 4D Einstein-Gauss-Bonnet Gravity with Non-minimal Coupling

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ABSTRACT

Recently, Glavan & Lin [1] proposed the four-dimensional Einstein-Gauss-Bonnet (4DEGB) theory by re-scaling a constant $\alpha \to \alpha/(D-4)$ coupled to gravity by considering an arbitrary dimension D and then taking the limit $D \to 4$. Hence the role of a scaling coupling constant gives rise to non-trivial contributions to gravitational dynamics that can render the term of the overall factor $(D-4)$ coming from the GB term. From this concept, we investigate the regularized 4DEGB gravity with a non-minimal scalar coupling function, which is an extension of the regularized 4DEGB theory [1]. By introducing the non-minimal coupling to the Gauss-Bonnet (GB) term, we derived the well-defined equations of motion by regularizing the coupling function $\xi(\phi) \to \xi^{(D-4)}(\phi)$ and demonstrate the additional contribution to the dynamical equations. Furthermore, we analyze the system's stability by applying the dynamical system approach based on fixed points [2-6]. In addition, we consider time evolution to investigate the history of the universe and constraints with observational data to obtain the cosmological parameters of the model.

Keywords: *4D Gauss-Bonnet gravity, non-minimal coupling, dynamical analysis, fixed points, accelerating universe.*

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Holographic Conductivity with Regularized 4D EGB Gravity

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ABSTRACT

Einstein Gauss-Bonnet theory of gravity is the utilization of general relativity in higher dimensions$(D > 4)$ which causes questions and further regularization [1, 2, 3]. We investigate the regularized 4D Einstein Gauss-Bonnet gravity model with a negative cosmological constant to investigate the holographic transports. In this regularization scheme, we use the Lagrange multiplier to regularize the action [3]. Then, we consider the static background of black brane solutions and perturb the metric, scalar, and vector fields to study the AC and DC conductivity where the charge is being transported. We also investigate the spatially anisotropic background which is one of the motivations for studying finite DC conductivity. In this setting, we observe that the dimensional regularization advocated in [1] yields the inconsistency in EoM in xx and yy-components when taking the limit D→ 4. Introducing the GB term and tuning its coupling constant is a natural way to investigate the effect of higher curvature term to the conductivity in 4D EGB gravity.

Keywords: *Holography, AdS/CFT Correspondence, Black Hole, Anisotropy, Transport Coefficient.*

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