15th Ewha-JWU-Ochanomizu Joint Symposium 2024

Ewha Womans University, Japan Women's University and Ochanomizu University for the Promotion of Education and Research for *Women* in Science

Dec 10 (Tue) – Dec 12 (Thu), 2024

Science Bldg. B 102, B 401-1, B 401-2, D 107

Ewha Womans University, Seoul, Korea

主催 College of Natural Sciences, Ewha Womans University

主管 Department of Mathematics, EWU
Institute of Mathematical Sciences, EWU
Department of Physics, EWU
IBS Center for Quantum Nanoscience (QNS), EWU
Department of Chemistry and Nanoscience, EWU
Center for Sustainable Molecular Design (Ewha Frontier 10-10 Program)
Center for Hybrid Interfacial Chemical Structure (SRC)
Priority Research Institute, Nanobio•Energy Materials Center
Department of Life Science, EWU
BK21 LIFE Talent Development Team for Future Response
College of Life Science Ewha Frontier 10-10 LIVE Program
College of Pharmacy, EWU
Center for Infectious Disease Treatment & Control (Ewha Frontier 10-10 Program)

後援 JWU Special Research Funds for Japan Women's University
Institute for Human Life Science (Ochanomizu University)
Naomi Miyajima International Exchange Fund (Ochanomizu University)

Welcome Address

Good morning, everyone.

As the Dean of the College of Natural Sciences at Ewha Womans University, it is my great pleasure to welcome all of you to this year's EJO joint symposium. We are honored to host participants from Japan Women's University and Ochanomizu University here in Seoul. This year is particularly exciting, as we are delighted to have the largest number of participants in the past three years. This demonstrates not only the continued success of our collaboration but also the growing enthusiasm for academic exchange among our students and faculty.

Since its establishment in 2000, this symposium has been a symbol of the close partnership among our three universities. Over the years, we have seen how collaboration accelerates progress and innovation. As science and technology play an increasingly critical role in addressing global challenges, the contributions of women scientists have become more important than ever. Events like this provide an essential platform for fostering the next generation of women leaders in science and research, empowering them to make a lasting impact on society.

This year's program features two distinguished talks, as well as 46 oral presentations and 49 poster presentations by our talented graduate students. I would like to express my sincere gratitude to the symposium committee members and all participants for their hard work and dedication in making this event a success.

I hope this symposium inspires meaningful discussions, encourages new ideas, and strengthens the bonds between our institutions. Welcome to Seoul, and may you have a wonderful and enriching experience here at Ewha.

Thank you.

Professor Sanghyuk Lee
Dean, College of Natural Sciences
Ewha Womans University

15th Ewha-JWU-Ochanomizu Joint Symposium

Symposium Chair

Prof. Sanghyuk Lee (Dean of College of Natural Sciences, Ewha Womans Univ.)

Organizing Committee

Chair: Prof. Kwangdong Roh (Ewha Womans Univ.)

Members: Prof. Chohong Min (Ewha Womans Univ.)
Prof. Sunshin Cha (Ewha Womans Univ.)
Prof. Wankyu Kim (Ewha Womans Univ.)
Prof. Jinha Yu (Ewha Womans Univ.)

Japanese Organizing Committee

Japan Women's Univ.

Chair: Prof. Shou Waga

Members: Prof. Koichi Akimoto
Prof. Azusa Muraoka

Ochanomizu Univ.

Chair: Prof. Kei Yura

Members: Prof. Kazue Kudo
Prof. Aya Tanatani
Prof. Kaoruko Iida

Student Representatives

Ms. Nanami Maehara (Japan Women's Univ.)
Ms. Naho Anzai (Japan Women's Univ.)
Ms. Yayoi Takahashi (Ochanomizu Univ.)
Ms. Marina Chikaraishi (Ochanomizu Univ.)
Ms. Juhyun Kim (Ewha Womans Univ.)
Ms. Jieun Sung (Ewha Womans Univ.)

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Program at a Glance

Dec 10, 2024 (Tue)

15:30-16:00	**Arrival and Registration** (Science Building B, 1st Floor)	
16:00-16:30	**Opening Ceremony** (Science Building B, Lecture Hall 102) Host: Prof. Kwangdong Roh (EWU)	
	Welcome Address	Prof. Sanghyuk Lee (Dean of College of Natural Sciences, EWU)
	Opening Remarks	Prof. Shou Waga (JWU)
	Professor Session (Science Building B, Lecture Hall 102)	
	Chair: Prof. Chohong Min	
16:30-17:00	[SP-1] Prof. Julien Tripette (Ocha)	
17:00-17:30	[SP-2] Prof. Kwangdong Roh (EWU)	
17:30-19:30	**Reception**	

Dec 11, 2024 (Wed)

-09:30	Breakfast		
	Morning Sessions		
	Session A Math/Computer/ Info Sci/Physics **(Science Building D, Lecture Hall 107)**	**Session B** Biology **(Science Building B, Lecture Hall 401-1)**	**Session C** Pharmacy/Food/Chemistry/ Biochemistry/Bio Engineering **(Science Building B, Lecture Hall 401-2)**
	Chair: Midori Numazawa (Ocha)	Chair : Haruka Oyama (JWU)	Chair : Ayano Watanabe (Ocha)
09:30-09:45	**[SA-01-M/C/I/P]** Akiko Morimura (JWU)		**[SC-01-P/F/C/BC/BE]** Nanami Maehara (JWU)
09:45-10:00	**[SA-02-M/C/I/P]** Mizuki Kikuya (Ocha)	**[SB-01-B]** Hae In Park (EWU)	**[SC-02-P/F/C/BC/BE]** Yukyeong Paik (EWU)
10:00-10:15	**[SA-03-M/C/I/P]** Yejin Kim (EWU)	**[SB-02-B]** Sara Tode (Ocha)	**[SC-03-P/F/C/BC/BE]** Runa Inagaki (Ocha)
10:15-10:30	Coffee Break		
	Chair : Yejin Kim (EWU)	Chair : Hae In Park (EWU)	Chair : Yukyeong Paik (EWU)
10:30-10:45	**[SA-04-M/C/I/P]** Jihye Jeong (EWU)	**[SB-03-B]** Haruka Oyama (JWU)	[**SC-04-P/F/C/BC/BE]** Nayeon Shim (EWU)
10:45-11:00	**[SA-05-M/C/I/P]** Midori Numazawa (Ocha)	**[SB-04-B]** Juhyun Kim (EWU)	**[SC-05-P/F/C/BC/BE]** Ayano Watanabe (Ocha)
11:00-11:15	**[SA-06-M/C/I/P]** Koyuki Izumi (Ocha)	**[SB-05-B]** Mayu Ishikawa (Ocha)	**[SC-06-P/F/C/BC/BE]** Seul-ah Kim (EWU)
11:15-13:30	**Lunch**		

	Afternoon Sessions		
	Session A Math/Computer /Info Sci/Physics **(Science Building D, Lecture Hall 107)**	**Session B** Biology **(Science Building B, Lecture Hall 401-1)**	**Session C** Pharmacy/Food/Chemistry/ Biochemistry/Bio Engineering **(Science Building B, Lecture Hall 401-2)**
	Chair : Saori Terauchi (JWU)	Chair : Anna Tode (Ocha)	Chair : Naho Anzai (JWU)
13:30-13:45	**[SA-07-M/C/I/P]** Mai Sarashino (JWU)	**[SB-06-B]** Yayoi Takahashi (Ocha)	**[SC-07-P/F/C/BC/BE]** Risa Mochizuki (Ocha)
13:45-14:00	**[SA-08-M/C/I/P]** Jiale Zhang (Ocha)	**[SB-07-B]** Asako Tsuda (JWU)	**[SC-08-P/F/C/BC/BE]** Nahyun Chi (EWU)
14:00-14:15	**[SA-09-M/C/I/P]** Seawoo Moon (EWU)	**[SB-08-B]** Soohyun Song (EWU)	**[SC-9-P/F/C/BC/BE]** Rika Fukatsu (Ocha)
14:15-14:30	**[SA-10-M/C/I/P]** Ikumi Yoshino (Ocha)	**[SB-9-B]** Miki Takahashi (JWU)	**[SC-10-P/F/C/BC/BE]** Mana Inoue (Ocha)
14:30-14:45	**[SA-11-M/C/I/P]** Hanseul Cho (EWU)	**[SB-10-B]** Misaki Hachinohe (JWU)	**[SC-11-P/F/C/BC/BE]** Yui Takemura (Ocha)
14:45-15:15	Coffee Break		
	Chair : Ikumi Yoshino (Ocha)	Chair : Soohyun Song (EWU)	Chair : Rika Fukatsu (Ocha)
15:15-15:30	**[SA-12-M/C/I/P]** Jaehyun Lee (EWU)	**[SB-11-B]** Anna Tode (Ocha)	**[SC-12-P/F/C/BC/BE]** Jaeyeon Lee (EWU)
15:30-15:45	**[SA-13-M/C/I/P]** Michiru Uwabo (Ocha)	**[SB-12-B]** Mizuki Saito (JWU)	**[SC-13-P/F/C/BC/BE]** Marina Chikaraishi (Ocha)
15:45-16:00	**[SA-14-M/C/I/P]** Saori Terauchi (JWU)	**[SB-13-B]** Jieun Sung (EWU)	**[SC-14-P/F/C/BC/BE]** Naho Anzai (JWU)
16:00-16:15	**[SA-15-M/C/I/P]** Nanako Hirano (Ocha)	**[SB-14-B]** Risa Uwatoko (JWU)	**[SC-15-P/F/C/BC/BE]** Abinaya Ganesh (EWU)
16:15-16:30	**[SA-16-M/C/I/P]** Mayu Koito (JWU)	**[SB-15-B]** Asuka Ota (JWU)	

Dec 12, 2024 (Thu)

-09:00	**Breakfast**	
09:00-11:00	**Poster Presentations** (Science Building D, 4th Lobby)	
11:00-11:30	**Closing Ceremony** (Science Building B, Lecture Hall 102) Host: Prof. Kwangdong Roh (EWU)	
	Closing Remarks	Prof. Kei Yura (Ocha)
		Prof. Sanghyuk Lee (Dean of College of Natural Sciences, (EWU)
	Best Presentation Award	Prof. Sanghyuk Lee (Dean of College of Natural Sciences, (EWU) and Shou Waga (JWU)

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Professor Session

(Dec. 10 16:30-17:30)

(Science Building B, Lecture Hall 102)

Chair: Chohong Min (EWU)

16:30-17:00 [SP-1] Prof. Julien Tripette (Ocha)

Physical activity monitoring: association with health outcomes and technology developments

17:00-17:30 [SP-2] Prof. Kwangdong Roh (EWU)

Next Generation of Photonic Sources from Epitaxial to Non-Epitaxial Semiconductor Materials

Parallel Sessions A, B, C

(Dec. 11, 9:30-16:30)

Session A

Mathematics / Computer Science / Information Science / Physics

(Science Building D, Lecture Hall 107)

Session B

Biology

(Science Building B, Lecture Hall 401-1)

Session C

Pharmacy / Food / Chemistry / Biochemistry / Bio Engineering

(Science Building B, Lecture Hall 401-2)

Session A

Mathematics / Computer Science / Information Science / Physics

(Science Building D, Lecture Hall 107)

Morning Session (9:30-11:15)

Chair : Midori Numazawa (Ocha)

09:30-09:45	[SA-01-M/C/I/P] Akiko Morimura (JWU) **Analysis of Water Transport in Porous Media with Finite Volume Methods**
09:45-10:00	[SA-02-M/C/I/P] Mizuki Kikuya (Ocha) **Mathematical analysis of polyhedral links**
10:00-10:15	[SA-03-M/C/I/P] Yejin Kim (EWU) **Image super-resolution method based on edge-sharpening MLS method and deep unfolding neural network**
10:15-10:30	Coffee Break

Chair : Yejin Kim (EWU)

10:30-10:45	[SA-04-M/C/I/P] Jihye Jeong (EWU) **Construction of infinite families of binary few-weight optimal linear codes**
10:45-11:00	[SA-05-M/C/I/P] Midori Numazawa (Ocha) **Supporting for creating a still image summarizing a system operation video**
11:00-11:15	[SA-06-M/C/I/P] Koyuki Izumi (Ocha) **Communication Volume Reduction of Homomorphic Ciphertext with Compressed Sensing**
11:15-13:30	Lunch

Afternoon Session (13:30-16:30)

Chair : Saori Terauchi (JWU)

13:30-13:45	[SA-07-M/C/I/P] Mai Sarashino (JWU) **Study on Visualization Considering Occluded Areas in Gait Motion**
13:45-14:00	[SA-08-M/C/I/P] Jiale Zhang (Ocha) **Testing Gravity Theories: Using Black Hole Quasinormal Mode and their Higher Overtones**
14:00-14:15	[SA-09-M/C/I/P] Seawoo Moon (EWU) **Fabrication and Characterizations of WS2 Monolayers Integrated with Ag Nanovoid Arrays**
14:15-14:30	[SA-10-M/C/I/P] Ikumi Yoshino (Ocha) **A hydrodynamic analog of critical phenomena: temporal crossover between different universality classes**
14:30-14:45	[SA-11-M/C/I/P] Hanseul Cho (EWU) **Using Raman and Photoluminescence Spectroscopy to study Dy3+-doped High Entropy Oxide**
14:45-15:15	Coffee Break

Chair : Ikumi Yoshino (Ocha)

15:15-15:30	[SA-12-M/C/I/P] Jaehyun Lee (EWU) **Interpreting X-ray absorption spectra of Vanadyl Phthalocyanines Spin Qubit Candidates using a Machine Learning-Assisted Approach**
15:30-15:45	[SA-13-M/C/I/P] Michiru Uwabo (Ocha) **Neutrinos as a Frontier in the Search for Dark Matter**
15:45-16:00	[SA-14-M/C/I/P] Saori Terauchi (JWU) **Consideration of the Positioning of Correction Filters in Optical Wireless Power Transfer**
16:00-16:15	[SA-15-M/C/I/P] Nanako Hirano (Ocha) **Viscous drag friction in a confined space: combined scaling and bifurcation**
16:15-16:30	[SA-16-M/C/I/P] Mayu Koito (JWU) **Detecting students showing dropout signs by using learning history data**

Session B

Biology

(Science Building B, Lecture Hall 401-1)

Morning Session (9:45-11:15)

Chair : Haruka Oyama (JWU)

09:45-10:00 [SB-01-B] Hae In Park (EWU)

Graph Attention Network Analysis of Whole Genome Sequencing Data Reveals Novel Genes in Autism

10:00-10:15 [SB-02-B] Sara Tode (Ocha)

Functional analysis of Syntaxin6-like protein in vascular plant (SYLK)

10:15-10:30 Coffee Break

Chair : Hae In Park (EWU)v

10:30-10:45 [SB-03-B] Haruka Oyama (JWU)

Analysis of melanin decomposition-related factors in a basidiomycete strain SLKO1702

10:45-11:00 [SB-04-B] Juhyun Kim (EWU)

The dysfunction of submucosal glands in chronic inflammation of the sinonasal cavity and its relevance to the "one airway, one disease"

11:00-11:15 [SB-05-B] Mayu Ishikawa (Ocha)

Identification of Bacteria Inducing Settlement Behavior to Coral Planula Larvae

11:15-13:30 Lunch

Afternoon Session (13:30-16:30)

Chair : Anna Tode (Ocha)

13:30-13:45 [SB-06-B] Yayoi Takahashi (Ocha)

Phylogeny of Japan-endemic species in Viola subsect. Vaginatae and related species using genome skimming

13:45-14:00 [SB-07-B] Asako Tsuda (JWU)

Analysis of giant mitochondria in unfertilized egg cells of Pelargonium zonale by electron microscopy

14:00-14:15 [SB-08-B] Soohyun Song (EWU)

Centrosome Amplification Promotes Cellular Senescence and Invasion via Innate Immune Response

14:15-14:30 [SB-09-B] Miki Takahashi (JWU)

Honokiol, a natural small compound, anti- tumor effects on human leukemia cells

14:30-14:45 [SB-10-B] Misaki Hachinohe (JWU)

Research on the Performance of Urushi as an Adhesive by Strength Tests - Potential of Urushi for Architectural Use

14:45-15:15 Coffee Break

Chair : Soohyun Song (EWU)

15:15-15:30 [SB-11-B] Anna Tode (Ocha)

Dynamics of the VAMP72 group during pollen tube elongation

15:30-15:45 [SB-12-B] Mizuki Saito (JWU)

Relationship between soil property, fermentation, and compressive strength in mud walls

15:45-16:00 [SB-13-B] Jieun Sung (EWU)

Deconvolution of Drug-Induced Transcriptomic Changes into Single-Target Effects Across Multiple Doses

16:00-16:15 [SB-14-B] Risa Uwatoko (JWU)

Role of Anionic Lipids in Etioplast to Chloroplast Differentiation Revealed by Electron Microscopy

16:15-16:30 [SB-15-B] Asuka Ota (JWU)

Cellulose production by mixed culture with Aspergillus spp. and Komagataeibacter xylinus

Session C

Pharmacy / Food / Chemistry / Biochemistry / Bio Engineering

(Science Building B, Lecture Hall 401-2)

Morning Session (9:30-11:15)

Chair : Ayano Watanabe (Ocha)

09:30-09:45	[SC-01-P/F/C/BC/BE] Nanami Maehara (JWU) **Development of a renal excretory nano-MRI probe for the diagnosis of chronic inflammation**
09:45-10:00	[SC-02-P/F/C/BC/BE] Yukyeong Paik (EWU) **Enhancing gefitinib brain penetration through P-glycoprotein and Breast cancer resistance protein inhibition**
10:00-10:15	[SC-03-P/F/C/BC/BE] Runa Inagaki (Ocha) **Exploration of Factors Contributing to Perceived Thickness (“noukoukan”) Using Tonkotsu Ramen Soup (Porcine Bone Soup) and Plant-Based Alternatives**
10:15-10:30	Coffee Break

Chair : Yukyeong Paik (EWU)

10:30-10:45	[SC-04-P/F/C/BC/BE] Nayeon Shim (EWU) **Structural Optimization of Cathepsin B-cleavable Linkers for Cancer-specific Peptide-DOX Prodrug Nanoparticle Development**
10:45-11:00	[SC-05-P/F/C/BC/BE] Ayano Watanabe (Ocha) **The Effect of Alpha-Ketoglutarate on Myocardial Metabolism in Chronic Heart Failure**
11:00-11:15	[SC-06-P/F/C/BC/BE] Seul-ah Kim (EWU) **Exploring HER2-driven regulation of glutamine metabolism in KRASG13D mutant colorectal cancer**
11:15-13:30	Lunch

Afternoon Session (13:30-16:30)

Chair : Naho Anzai (JWU)

13:30-13:45	[SC-07-P/F/C/BC/BE] Lisa Mochizuki (Ocha) **Use of Synthetic DNA in UV disinfection treatment**
13:45-14:00	[SC-08-P/F/C/BC/BE] Nahyun Chi (EWU) **Predicting melting point of organic crystals using molecular dynamics simulations**
14:00-14:15	[SC-09-P/F/C/BC/BE] Rika Fukatsu (Ocha) **Inhibition Method of Photoreactivation in UV Disinfection**
14:15-14:30	[SC-10-P/F/C/BC/BE] Mana Inoue (Ocha) **Investigation of virus removal in septic-tank in Ho Chi-Min city, Vietnam**
14:30-15:15	[SC-11-P/F/C/BC/BE] Yui Takemura (Ocha) **Evaluation of the effect of natural flavone on renal failure via the aryl hydrocarbon receptor**
14:30-15:15	Coffee Break

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15:30-15:45	[SC-13-P/F/C/BC/BE] Marina Chikaraishi (Ocha) **The Role of O-fucosylation of Coagulation Factor XII in the Acquirement of Structural Stability During Biosynthesis**
15:45-16:00	[SC-14-P/F/C/BC/BE] Naho Anzai (JWU) **Adsorption mechanism of Pt(II) on β-MnO2 : Elucidating mechanism of Pt enrichment in marine ferromanganese crusts and nodules**
16:00-16:15	[SC-15-P/F/C/BC/BE] Abinaya Ganesh (EWU) **Enhanced Sensitivity in Heavy Metal Ion Detection through Entity Formation using Single-Entity Electrochemistry**

Poster Session

(Dec. 12, 9:00-11:00)

(Science Building D, 4th Lobby)

A	Mathematics / Computer Science / Information Science / Physics
B	Biology
C	Pharmacy / Food / Chemistry / Biochemistry / Bio Engineering

[PA-01-M/C/I/P] Akiko Morimura (JWU)

Analysis of Water Transport in Porous Media with Finite Volume Methods

[PA-02-M/C/I/P] Mizuki Kikuya (Ocha)

Mathematical analysis of polyhedral links

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[PA-10-M/C/I/P] Ikumi Yoshino (Ocha)

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[PA-11-M/C/I/P] Hanseul Cho (EWU)

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Detecting students showing dropout signs by using learning history data

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Multiclass classification based on a quantum autoencoder

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[PB-10-B] Misaki Hachinohe (JWU)

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Deconvolution of Drug-Induced Transcriptomic Changes into Single-Target Effects Across Multiple Doses

[PB-14-B] Risa Uwatoko (JWU)

Role of Anionic Lipids in Etioplast to Chloroplast Differentiation Revealed by Electron Microscopy

[PB-15-B] Asuka Ota (JWU)

Cellulose production by mixed culture with Aspergillus spp. and Komagataeibacter xylinus

[PB-16-B] Shou Waga (Ocha)

Analyses of the G-quadruplex Binding Activity of the Intrinsically disordered Regions in Human Replication Initiation Proteins

[PB-17-B] Kei Yura (Ocha)

ThermusQ: Comprehensive Knowledge Base for Genome Information of Thermus thermophilus Strains

[PC-01-P/F/C/BC/BE] Nanami Maehara (JWU)

Development of a renal excretory nano-MRI probe for the diagnosis of chronic inflammation

[PC-02-P/F/C/BC/BE] Yukyeong Paik (EWU)

Enhancing gefitinib brain penetration through P-glycoprotein and Breast cancer resistance protein inhibition

[PC-03-P/F/C/BC/BE] Runa Inagaki (Ocha)

Exploration of Factors Contributing to Perceived Thickness (“noukoukan”) Using Tonkotsu Ramen Soup (Porcine Bone Soup) and Plant-Based Alternatives

[PC-04-P/F/C/BC/BE] Nayeon Shim (EWU)

Structural Optimization of Cathepsin B-cleavable Linkers for Cancer-specific Peptide-DOX Prodrug Nanoparticle Development

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The Effect of Alpha-Ketoglutarate on Myocardial Metabolism in Chronic Heart Failure

[PC-06-P/F/C/BC/BE] Seul-ah Kim (EWU)

Exploring HER2-driven regulation of glutamine metabolism in KRASG13D mutant colorectal cancer

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Use of Synthetic DNA in UV disinfection treatment

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Inhibition Method of Photoreactivation in UV Disinfection

[PC-10-P/F/C/BC/BE] MANA Inoue (Ocha)

Investigation of virus removal in septic-tank in Ho Chi-Min city, Vietnam

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Evaluation of the effect of natural flavone on renal failure via the aryl hydrocarbon receptor

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Facile Synthesis of δ-MnO2@C as a Solid Contact Material for K+ Ion Sensing

[PC-13-P/F/C/BC/BE] Marina Chikaraishi (Ocha)

The Role of O-fucosylation of Coagulation Factor XII in the Acquirement of Structural Stability During Biosynthesis

[PC-14-P/F/C/BC/BE] Naho Anzai (JWU)

Adsorption mechanism of Pt(II) on β-MnO2 : Elucidating mechanism of Pt enrichment in marine ferromanganese crusts and nodules

[PC-15-P/F/C/BC/BE] Abinaya Ganesh (EWU)

Enhanced Sensitivity in Heavy Metal Ion Detection through Entity Formation using Single-Entity Electrochemistry

Professor Session

[SP-1]

Physical activity monitoring: association with health outcomes and technology developments

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Abstract

Regular physical activity is now recognized as a powerful tool for promoting health and preventing non-communicable diseases, including cardiovascular disease, diabetes, and mental health disorders. Self-monitoring physical activity is an effective approach that helps people increase their physical activity level, and the recent growth of the activity tracker market has opened new opportunities to promote active, healthy lifestyles. These devices, commonly worn on the wrist, are equipped with multiple sensors to track detailed metrics such as step count and energy expenditure, providing a comprehensive view of activity patterns. Over the past two decades, substantial research has explored the connections between physical activity, measured objectively with activity trackers, and numerous health outcomes.

This presentation highlights recent physical activity studies from Ochanomizu University, including the *drePAnon* clinical trial conducted in Dakar, which examines the impact of physical activity on pain symptoms in patients with sickle cell anemia. Findings suggest that physical activity does not increase the risk of painful complications, possibly supporting flexible activity guidelines for this population. Other research projects at Ochanomizu focus on developing new measurement technologies, such as a smart shoe system that recognizes physical behaviors with 89% accuracy, algorithms for activity trackers that can identify skateboard and kick scooter commuting behaviors, and a floor vibration-based system for smart homes that estimates the energy expenditure of the inhabitant. These innovations aim to improve physical activity monitoring, especially when traditional trackers are unreliable or not worn.

Keywords: physical activity, physical activity measurement, health, wearable, smart shoe, smart home, accelerometer, sensor.

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Job history

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2020 - 2021	Researcher at NIBIOHN, Japan.
2014 - 2020	Project associate professor at Ochanomizu University, Leading Graduate School, Japan.
2012 - 2014	Postdoctoral fellow at NIBIOHN [2012-2013: FRSQ fellow, 2013-2014: JSPS fellow], Japan.
2009 - 2012	Postdoctoral fellow at CRCHUM, LBUM, Canada.

Education

2005 - 2008	PhD in Sports Science, French West Indies and Guiana University, France. *Sickle cell trait carrier and physical exercise: hemorheological and vascular abnormalities*
2002 - 2005	Master's degree in Sports Science, Lyon 1 University, France.
1999 - 2001	Bachelor's degree in Sports Science, Lyon 1 University France.

Short bio

I am a versatile researcher in physical activity, sports science and human engineering. I obtained a PhD in exercise physiology from the French West Indies and Guiana University. I also completed my undergraduate and master's studies in sport science at Lyon 1 University. I have gradually shifted my research focus from clinical exercise physiology to the evaluation of physical behaviors. My current research focuses on the development of new hardware and software methods for measuring physical behaviors and explore the relationship between physical activity and health.

Current research activities

- Designing smart living environments to assess and promote physical activity at home.
- Developing algorithms to help wearable device to recognize physical behaviors and evaluate energy expenditure.
- Assessing physical activity in sickle cell anemia patients, exploring the relationship with symptoms.

Selected articles

- Objective Assessment of Physical Activity at Home Using a Novel Floor-Vibration Monitoring System: Validation and Comparison With Wearable Activity Trackers and Indirect Calorimetry Measurements (JMIR Formative Research, 2024; doi:10.2196/51874).
This study evaluated the feasibility of estimating physical activity through floor vibration monitoring. Accelerometer sensors were installed in a smart home floor to capture vibration data from 10 participants during four activities. Energy expenditure was measured via indirect calorimetry, and Actigraph trackers were used to estimate both energy expenditure and step count. Models based on features extracted from floor vibrations outperformed Actigraph trackers in estimating both metrics.

- Random forest algorithms to classify frailty and falling history in seniors using plantar pressure measurement insoles: a large-scale feasibility study (BMC Geriatrics, 2022; doi.org/10.1186/s12877-022-03425-5).
This study proposes an objective method to complement existing tools for identifying frailty in seniors. Seven hundred twelve senior participantscompleted a balance test and walking trial, with plantar pressure data collected via 7-sensor insoles. Frailty, assessed using the Kihon Checklist, was classified with 75% accuracy using random forest algorithms on 184 extracted features. These findings suggest smart insoles could help clinicians in early frailty detection.

- Random forest algorithms for recognizing daily life activities using plantar pressure information: a smart-shoe study (PeerJ, 2020; doi.org/10.7717/peerj.10170).
This study developed an algorithm to recognize activities using plantar pressure data from smart shoes. Seventeen participants performed nine sedentary and locomotive activities, and random forest models processed the data. A 20-second window length achieved 89% accuracy. "Running" showed 100% sensitivity, while "walking up a slope" had the lowest (63%). Minimal sensor setups (2-3 sensors) still performed well. Smart shoes could help assess daily activities.

Patents

[US20220280074A1] Ohta Yuji, Tripette Julien, Aubert-Kato Nathanael, Ren Dian. Behavior determination apparatus, behavior determination system, behavior determination method, and computer-readable storage medium. 2022 (status: pending). [US pattent only, see PCT/JP2019/046859 and WO2021106216A1 for the Japanese and World Intellectual Property Organization applications respectively]

[SP-2]

Next Generation of Photonic Sources from Epitaxial to Non-Epitaxial Semiconductor Materials

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Abstract

Over the past decade, significant advancements have been achieved in semiconductor research aimed at developing highly efficient light-emitting materials. Leveraging cost-effective solution-processed chemistry, nano-materials such as colloidal quantum dots and perovskites have emerged as promising candidates for the next generation of luminescent materials. This talk will begin by introducing the fundamental optical and electrical properties of these materials, highlighting key features like wavelength-tunable bandgaps, narrowband emission, and high internal quantum efficiency.

These remarkable characteristics have facilitated the creation of perovskite-based LEDs with exceptional external quantum efficiencies surpassing 20%. However, despite these achievements in optoelectronic applications, several challenges remain in the development of visible light emitters. Key issues include material instability under ambient conditions, phase separation of halide components, limited thermal conductivity, and constraints on achieving lasing capabilities. This talk will explore various strategies and recent breakthroughs aimed at overcoming these obstacles. Our research has shown that specially engineered mixed-halide perovskites can address halide redistribution by incorporating a tailored additive capping layer. This advancement has enabled the development of highly efficient wavelength-tunable LEDs and, notably, the successful demonstration of single-mode distributed feedback lasers operating at room temperature for the first time.

Additionally, we will discuss the design principles necessary for achieving lasing operation from functional perovskite LED devices under intense electrical excitation. These findings represent meaningful progress in unlocking the full potential of perovskite-based light emitters in optoelectronics.

Keywords: Halide Perovskites, Light-emitting Diodes, Lasers, Optoelectronics

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Ewah Womans University, Department of Physics (2022 - present)
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Princeton University, Department of Electrical Engineering (2015 - 2022)
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- **Postdoctoral Research Associate** (2015 - 2020)
  Principal Investigator: Prof. Barry P. Rand

Publication

(selected)

14. G. Lee, B. P. Rand, and **K. Roh**, "Halide Perovskite Thin Film Lasing Mode Control", ***ACS Applied Materials Interfaces***, 16 (41), 55650–55657 (2024)

13. G. Lee, Y. Jun, H. Lee, and **K. Roh**, "Progress on Coherent Perovskite Light Emitters: from Light-emitting Diodes to Electrically Driven Lasers ", ***Advanced Photonics Research***, 5 (9) 2400033 (2024)

12. A. J. Grede, R. Cawthorn, L. Zhao, J. P. Murphy, **K. Roh**, K. A. Kurdi, S. Barlow, S. R. Marder, B. P. Rand, and N. C. Giebink "Electrically Assisted Lasing in Metal Halide Perovskite Semiconductors", ***ACS Photonics***, 11 (5), 1851-1856 (2024)

11. **K. Roh** "Pixelated vertical-cavity surface-emitting laser arrays from colloidal quantum dot films", ***Current Applied Physics*** , 54, 5-9 (2023)

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Research Interests

- Perovskite synthesis, LEDs and lasers
- Ultrafast laser spectroscopy
- Optoelectronics from colloidal quantum dots, perovskites, organic semiconductors, etc
- Single photon emitters
- Solid-state masers, coherent microwave/THz sources, and coplanar waveguides
- Visible light communication by lasers
- Photonic system design
- Micro-nano fabrication techniques

Oral Presentation
Session A

[SA-01- Math/Computer/Info Sci/Physics]

Analysis of Water Transport in Porous Media with Finite Volume Methods

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Abstract

In this talk, I will present the results obtained for an initial-boundary value problem for nonlinear parabolic equations on the one-dimensional interval $(0,1)$ by applying the finite volume method. The study is based on a mathematical model describing water movement in porous media proposed by Fukui et al. in 2018. This model consists of two diffusion equations obtained from the mass conservation law for water and air, which are quasilinear parabolic forms whose diffusion coefficients depend on the unknown function. Here, we focus only on the diffusion equation for water and consider the following problem. Let $\mathrm{T} > 0$. The problem is to find a function v on $\mathrm{Q(T)} = (0,\mathrm{T}) \times (0,1)$ satisfying

$$\frac{\partial}{\partial t} h(v) = \frac{\partial}{\partial x}(v_x + b(v)p_x) \text{ in } \mathrm{Q(T)}$$
$$v_x + b(v)p_x = 0 \text{ at } x = 0, 1,$$
$$v(0,x) = v_0(x) \text{ for } x \in (0,1),$$

where h and b are continuous functions on $\mathbb{R}$, p and v_0 are given functions. This research is joint work with Toyohiko Aiki (Japan Women's University, Japan) and partially supported by EBARA Corporation, Japan.

Keywords: porous media, water transport, nonlinear diffusion equation, finite volume method.

[SA-02- Math/Computer/Info Sci/Physics]

Mathematical analysis of polyhedral links

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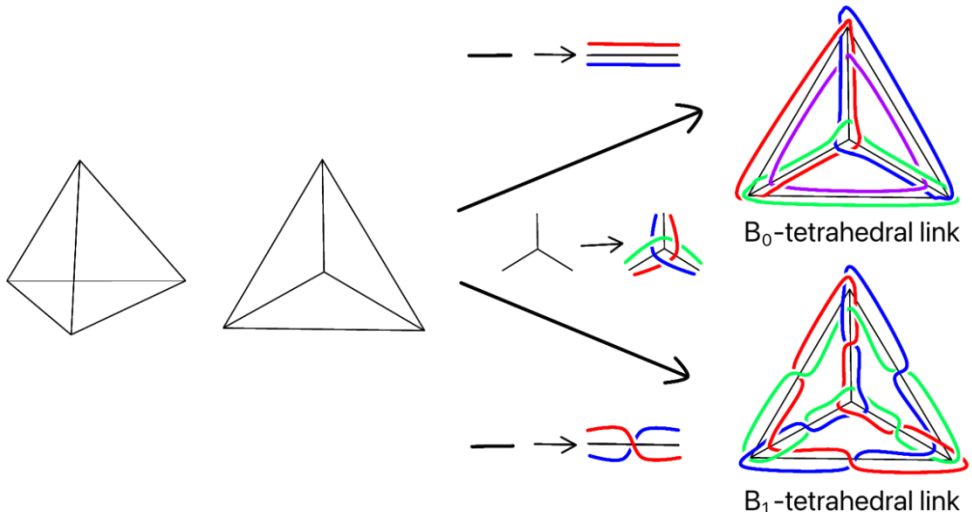
Abstract

Knot theory, a branch of topology in mathematics, studies the properties of knots and links in three-dimensional space. A simple closed loop in space is called a knot, and an entangled structure made of multiple components is called a link. In this talk, we will discuss the properties and the classification of polyhedral links. Polyhedral links are ones constructed by performing certain operations on the vertices and edges of a polyhedron. Polyhedral links were introduced mathematically in the 2000s; in 2019 they were found to appear as topological structures of supramolecules composed of peptides and metal ions. In this research, we obtained the following results: (1) We determined the number of components of polyhedral links of type B_{2k-1}. (2) We found examples of polyhedral links containing non-trivial components. Namely, the B_0-snub cubic link and the B_0-snub dodecahedral link.



Keywords: topology, polyhedral links, supermolecules

[SA-03- Math/Computer/Info Sci/Physics]

Image super-resolution method based on edge-sharpening MLS method and deep unfolding neural network

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Abstract

Image super-resolution aims to increase the resolution of an image, while maintaining its local structure as accurately as possible. Recently, a significant progress in image super-resolution tasks has been made through learning-based methods, among which convolution neural network based methods have been the most popular. In this paper, we present a novel super-resolution method for color image that improves deep unfolding super-resolution technique (USRNet) [1]. To this end, we suggest a modified edge-sharpening moving least square method and then combine it with the CascadedGaze Network (or CGNet) [2] that is a model built for denoising in the prior module to balance between sharpening and smoothing. Some numerical examples are provided to illustrate the performance of the proposed scheme.

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[SA-04- Math/Computer/Info Sci/Physics]

Construction of infinite families of binary few-weight optimal linear codes

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Abstract

Error-correcting codes were invented to correct errors on noisy communication channels since a paper by Shannon was published in 1948. A major issue in Coding theory is to construct good error-correcting codes (e.g., few-weight codes and optimal codes). We construct new infinite families of binary optimal few-weight codes by using the shortening method. Furthermore, we completely determine the weight distributions of our shortened codes. To achieve our goal, we use certain families of multivariable functions, and we interpret a shortening method followed by puncturing in terms of multivariable functions. According to this interpretation, we find explicit criterion for the shortened codes to have fewer weight or to have fewer weights and larger minimum weights after the shortening process. We emphasize that some infinite families of few-weight optimal linear codes have new parameters. As applications, we produce support t-designs (t = 2 or 3) and find many optimal quantum codes via our code families.

Keywords: Optimal code, few-weight code, weight distribution, multivariable function

[SA-05- Math/Computer/Info Sci/Physics]

Supporting for creating a still image summarizing a system operation video

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Abstract

When researchers explain the behavior of the system on paper, they can't use videos. For this reason, they usually use still images. At that time, they often manually use applications such as Microsoft PowerPoint or Adobe Illustrator. However, these tasks are time-consuming. Therefore, we propose web applications to support creating a still image from a video. The video refers to the system operation video. We expect that using the created still image will enable explanations of the video on paper. Moreover, we expect that researchers can create the image more easily than manually.

To date, we have developed two types of web applications. In both, the user inputs any video and our application outputs one summary image. The summary image shows the path of the object in the input video. One of our applications focuses on extracting any frame images from the input video. The other focuses on extracting moving object from the input video. A key feature of our algorithms is semi-automatic generation of the summary image. There are automatic part and user operation part.

In the future, we plan to conduct a user study. The target person is researchers or students of the field of Human Computer Interaction, Computer Graphics or User Interface. The user's task will be to creating a summary image both manually and using our two applications. We hope that the user study will reveal that our proposed application allows users to create an image more easily and interactively than manual methods.

Keywords: Human Computer Interaction, Image Processing, Video Summarization

[SA-06- Math/Computer/Info Sci/Physics]

Communication Volume Reduction of Homomorphic Ciphertext with Compressed Sensing

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Abstract

Homomorphic encryption (HE) enables the addition and multiplication of ciphertexts and is a technique that can be analyzed and utilized while maintaining data secrecy. In encrypted databases and regression analyses that are examples of HE applications, data obtained by the IoT device, etc., can be aggregated/analyzed while still encrypted, so the data analyst can only obtain the aggregated/analyzed results without knowing the content of the data. However, the size of the homomorphic ciphertext is larger than that of plaintext (non-encrypted text), which increases the communication volume, and this is a problem. In this study, we propose a method for reducing the communication volume by compressed sensing using a dictionary. In the proposed method, the communication volume is reduced by sending the compressed data with the compressed sensing technology. The compressed data can be used for aggregation/analysis while maintaining the accuracy of the reconstruction by reconstructing the original data with the dictionary learned from the public data in advance. The evaluation results demonstrate that when the compression ratio is set to 50%, the proposed method can reduce the communication volume by 50% compared to when the data are transmitted without compression. We demonstrate the usefulness of compressed/reconstructed data based on the accuracy of binary classification using Logistic Regression.

Logistic Regression: A statistical method that can explain and predict the probability of a binary outcome (dependent variable) based on several factors (independent variables).

Keywords: Homomorphic Encryption, Compressed Sensing

[SA-07- Math/Computer/Info Sci/Physics]

Study on Visualization Considering Occluded Areas in Gait Motion

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Abstract

Japan's population is rapidly aging, and the number of people requiring nursing care is increasing. The main causes of this increase are falls, fractures, and musculoskeletal disorders due to joint disease. Early detection and intervention are important to prevent the decline of motor function. The Timed Up and Go Test (TUG Test) is often used in clinical practice to assess appropriate motor function in the elderly.

In this study, we propose a method to measure walking motions using the TUG Test, to complement and visualize the hidden regions of the body during the movement. One major challenge in gait analysis is the occlusion of certain body parts from the camera's view. To address this issue, we propose a system that integrates multiple depth cameras and range sensors to provide a full 360-degree view of the subject's movement. This approach allows for a more comprehensive analysis of gait by reconstructing movements from various angles.

Keywords: Gait Movement, Aging Society, 3D Visualization

[SA-08- Math/Computer/Info Sci/Physics]

Testing Gravity Theories: Using Black Hole Quasinormal Mode and their Higher Overtones

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Abstract

When two black holes merge, they generate gravitational waves that propagate through spacetime. As a consequence of this event, the ringdown phase (when the merging black hole settles into a stable state) after the merger is characterized by the emission of GWs with so-called quasinormal modes (QNMs). These QNMs represent a set of characteristic oscillations or vibrations resulting from perturbations to the black hole. In the following decades, the detection of gravitational waves through worldwide collaboration ushered in a new era of gravitational wave astronomy. Analyzing these gravitational wave signals allows us to extract valuable information about the QNMs, providing profound insights into the properties of the black holes involved in these mergers.

Throughout this study, we will explore how the study of GWs equips us with a powerful tool to comprehend black holes and push the boundaries of gravitational science. While GR has withstood numerous experimental challenges, alternative theories of gravity have been proposed to address various issues and explore new aspects of this fundamental force. The detection of gravitational wave signals not only holds the potential to confirm established GR predictions but also sheds light on deviations that may unveil discoveries in the realm of cosmological research, offering insights into alternative theories. The motivation of this talk is to discuss how to probe gravity theories using the quasinormal modes (QNMs) in the ringdown phase of binary black hole mergers.

In this talk, the speaker will introduce the parametrized black hole quasinormal ringdown formalism, a robust framework for analyzing the QNMs in systems resembling GR, with a focus on higher overtones. These overtones have been shown to provide critical insights during the early ringdown phases and to exhibit heightened sensitivity to the physics near black hole horizons. The speaker's findings indicate that larger deviations from general relativity typically appear in the quasinormal frequencies of the higher overtones. These deviations in quasinormal frequencies can be characterized using model-independent parameters, and an analytical method used to understand this trend will also be discussed. This talk will highlight how the QNMs, and especially their higher overtones, can be a powerful tool in testing gravity theories.

Keywords: General Relativity, Gravitational Waves, Black Holes, Modified Gravity

[SA-09- Math/Computer/Info Sci/Physics]

Fabrication and Characterizations of WS_2 Monolayers Integrated with Ag Nanovoid Arrays

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Abstract

The exceptionally large exciton binding energies of transition metal dichalcogenides (TMDs) have attracted significant interest in both fundamental research and technological applications. To control excitonic behaviors and enhance light-matter interactions in TMDs, TMD-metal integrated nanostructures have been explored. In this thesis, tungsten disulfide (WS_2) monolayers were integrated with periodic silver (Ag) nanovoid (NV) arrays using template stripping and exfoliation techniques. The ultrasmooth, contamination-free surface of the template-stripped Ag layer enables the direct exfoliation of monolayer WS_2 (1L-WS_2) flakes onto the AgNV arrays. Surface plasmon excitation enhances optical absorption in the 1L-WS_2/AgNV system, as demonstrated by reflectance, photoluminescence (PL), and Raman measurements, along with numerical simulations. Notably, the AgNV structures substantially increase the trion-to-exciton emission ratios in the 1L-WS_2 flakes. Nanoscopic surface photovoltage mapping via Kelvin probe force microscopy visualizes accumulation of photo-generated electrons in the suspended 1L-WS_2 regions under illumination, promoting trion formation. These findings highlight the potential of WS_2/AgNH systems to enhance trion emission through plasmon-induced light concentration and built-in potential gradients. This study presents a straightforward and effective approach for fabricating TMD-metal integrated systems for novel optoelectronic devices.

Keywords: Exciton; Surface plasmon; Trion; WS_2; Metal-assisted exfoliation; Template-stripping; Kelvin probe force microscopy

[SA-10- Math/Computer/Info Sci/Physics]

A hydrodynamic analog of critical phenomena: temporal crossover between different universality classes

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Abstract

The singularity in the shape of liquid interface has attracted wide interest, ranging from fundamental research to engineering applications. Understanding of daily phenomena, which involve the interfacial singularity, such as droplet formation, have attracted the interest from not only physicists but also mathematicians, and are crucial for applications, such as coating and spraying.

In a series of studies, we filled a quasi-two-dimensional space in a Hele-Shaw cell with a viscous liquid and examined the behavior of the air-liquid interface created by air dragged into the liquid by a disk dropped into the liquid (the dragged air could eventually breakup). In [2], we revealed clear scaling laws for characteristic lengths and demonstrated self-similar dynamics of the interface in the "before-breakup regime," in which the dragged air has yet to breakup.

In the present study, we focus on the "after-breakup regime," in which the interface recovers to a horizontal state after the breakup. As a result, we identify a scaling law for a characteristic length together with self-similar dynamics of the interface as in the before-breakup regime. Additionally, we demonstrate a close analogy of the present study with critical phenomena in thermodynamic phase transitions, pointing out that the present self-similar dynamics corresponds to the scaling hypotheses. We further derive the present self-similar dynamics from the governing equations. In addition, by combining the renormalization group (RG) theory [3] and the stability analysis of Dynamical System Description (DSD) [4], both developed in applied mathematics, we discuss how the solutions of the governing equations act as stable fixed points of the RG transformations (the solutions are, thus, attractors of the RG flow). The present RG analysis will also reveal that a wide class of partial differential equations, obtained by adding extra terms to the present governing equation, exhibit the same critical behavior. We thus demonstrate a deep connection with critical phenomena.

Keywords: Soft Matter, phase transition, interface, experiment

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[SA-11- Math/Computer/Info Sci/Physics]

Using Raman and Photoluminescence Spectroscopy to study Dy^{3+}-doped High Entropy Oxide

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Abstract

High entropy materials (HEMs) enhance thermodynamic stability by increasing the configurational entropy of the system, achieved through the incorporation of five or more elements in equiatomic or near-equiatomic proportions within a sub-lattice and yielding distinctive characteristics. We investigated the optical properties of High entropy oxide (HEO), with a pyrochlore structure ($A_2B_2O_7$) using Raman and photoluminescence spectroscopy to observe the emission spectra and thermal and structural stability. We focused especially on Dy^{3+}-doped HEO, where Gd and Dy^{3+} ions occupy the A-site. We analyzed the dominant role of Dy^{3+} ions and atomic transitions involving other elements through wavelength-dependent photoluminescence measurements, indicating the presence of Dy^{3+} ions at the A-site. In addition, Raman measurements revealed the temperature-dependent structural stability of Dy^{3+}-doped HEO, as well as variations in energy transfer mechanisms within a specific energy range. Through this study, we suggest that spectroscopic techniques can enhance our understanding of the properties of entropy-stabilized materials.

Keywords: Raman spectroscopy, Photoluminescence Spectroscopy, High entropy oxides

[SA-12- Math/Computer/Info Sci/Physics]

Interpreting X-ray absorption spectra of Vanadyl Phthalocyanines Spin Qubit Candidates using a Machine Learning-Assisted Approach

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Abstract

Vanadyl Phthalocyanines (VOPc) molecules, with spin 1/2 and long coherence times up to room temperature, are promising candidates for molecular spin qubits [M. Atzori et al., J. Am. Chem. Soc. 138, 2154 (2016)]. To optimize their quantum coherence, it is crucial to investigate orbital splitting on surfaces and interactions between molecular spins and substrates [I. Cimatti et al., Nanoscale Horiz. 4, 1202 (2019)]. Here we employ X-ray absorption spectroscopy (XAS), machine-learning-assisted multiplet calculations, and Density Functional Theory (DFT) to explore the 3d orbital structure of VOPc on Ag (100) and TiOPc/Ag (100) [K. Noh et al., Nanoscale Horiz. 8, 624 (2023)]. XAS measurements were conducted at the EPFL-PSI Xtreme beamline, and simulated spectra from atomic multiplet calculations were optimized with a Bayesian Optimization (BO) algorithm. Our combined BO-multiplet approach retrieves input parameters for crystal field and intra-atomic interactions efficiently. We confirm VOPc's spin 1/2 in all configurations, with orbital energies varying based on surface and TiOPc interlayer interactions [J. H. Lee et al., Phys. Rev. B, 109, 235427 (2024)]. Finally, we demonstrate this method's effectiveness in uncovering magnetic interactions in metal-organic frameworks on surfaces, such as in the case of supramolecular metal complexes on Niobium diselenide [V. Vaňo et al., Phys. Rev. Lett., Accepted (2024)].

Keywords: Molecular Spin Qubit, X-ray Magnetic Circular Dichroism, X-ray Linear Dichroism, Molecular Thin Films, X-rays

[SA-13- Math/Computer/Info Sci/Physics]

Neutrinos as a Frontier in the Search for Dark Matter

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Abstract

Although the Standard Model (SM) of particle physics has already been verified to a high degree of accuracy, cosmological studies have presented various physics problems that cannot be explained by the SM. One of them is the existence of dark matter (DM). Dark matter is the dominant component of the matter in our universe, but it has not yet been identified. People have tried to detect dark matter particles directly (direct search) or find traces of dark matter in optical signals (optical search). Unfortunately, however, no signals attributed to DM have been observed.

Neutrinos are expected to be a powerful tool for DM detection for the following three reasons. (I) Neutrinos have the advantage of complementing current direct and optical DM detection. Neutrinos are detectable particles thanks to today's superior technology. Moreover, because of the absence of electromagnetic interactions, their signals are much more stable than photons, and their astrophysical background is much less than that of optical detection. (II) Many next-generation detectors are under construction around the world. (III) The non-zero mass of neutrinos is another clear deviation from the SM and suggests a link to DM physics.

In our study we analyzed the sensitivity of future neutrino detectors to dark matter. My presentation is based on the following two studies. The first work [1] is to analyze the sensitivity of a future neutrino experiment, JUNO. We explicitly show the excellent sensitivity of JUNO to the neutrino signals from DM annihilation and decay in the Milky Way in a model-independent way. In the second paper [2], we study a specific DM model well motivated by the neutrino mass mechanism with lepton number symmetry breaking. We give constraints and future prospects on the energy scale of symmetry breaking in the wide DM mass range from MeV to TeV.

Keywords: Cosmology, Dark matter, Neutrino

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(Authors are listed in alphabetical order. “Niibo” is the previous surname of the speaker.)

[SA-14- Math/Computer/Info Sci/Physics]

Consideration of the Positioning of Correction Filters in Optical Wireless Power Transfer

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Abstract

Optical wireless power transfer has advantages over existing wireless power transfer methods, such as the ability to transfer power over long distances and the absence of the effects of electromagnetic noise. However, the long-distance propagation is affected by atmospheric turbulence, which results in attenuation of the reception strength. To improve this problem, we have proposed the use of a Laguerre-Gaussian beam for the carrier wave and a correction filter at the receiver.
The longer the propagation distance, the larger the beam diameter becomes, which requires a larger correction filter diameter. In addition, since the receiver is located far away, it is difficult to adjust the correction filter. Therefore, assuming that the optical system of the laser-based optical wireless power transfer is a linear system, we investigated whether the receiver strength can be improved even if the correction filter is positioned on the transmitter side.

Keywords : Optical wireless power transfer, Laguerre-Gaussian (LG) beam , correction filter

[SA-15- Math/Computer/Info Sci/Physics]

Viscous drag friction in a confined space: combined scaling and bifurcation

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Abstract

The dynamics of liquid drops, familiar in daily life, are important not only in the physical sciences but also in a variety of practical issues such as ink-jet printing and microfluidics manipulations. We here focus on a drag force acting on a fluid drop in a confined space and conducted experiments, which are performed in a vertical cell, whose thickness is smaller than its height and width. We fill the cell with olive oil and insert a drop of silicone oil (PDMS) from the top of the cell. Due to the difference in density, the drop goes down in the cell.

The descending velocity of such a drop could be given by a balance between a gravitational energy change with a viscous dissipation in a viscous regime. Such a balance results in a scaling law for a viscous drag force acting on a moving object. One of the well-known examples is Stokes' drag law acting on a sphere in three-dimensional steady flow. However, it is not straightforward to understand how Stokes' law changes in a confined space. Previous studies have identified viscous dissipations of different physical origins and have revealed that, when one of them is dominant, we can predict a scaling regime for the velocity and drag force.

In the present study, we propose a theoretical formula, which is obtained by a combined balance: we sum up dissipations of different physical origins to balance it with the gravitational energy change, on the basis of energy conservation. As a result, we find that this theory is in good agreement with our experiments.

Our simple example provides a novel scenario to explain viscous drag observed in crossover regimes, in which pure scaling regimes fail. Furthermore, the idea of the combined balance could be useful for reconsidering various scaling behaviors known in many fields of science, such as biology and astronomy. We will also discuss our observation of bifurcation in the descending velocity.

Keywords : Soft Matter, Drops and bubbles, Wetting

[SA-16- Math/Computer/Info Sci/Physics]

Detecting students showing dropout signs by using learning history data

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Abstract

Although the teaching methods and teaching styles of higher education are evolving and diversifying day by day, the issue of a certain number of students who cannot keep up with the lectures and may be dropout remains. While numerous studies using learning history data have been conducted previously, the analysis methods and analysis data have not been generalized yet.

The purpose of this study is to visualize commonly available learning history data using an analysis method written with a relatively easy-to-understand algorithm (SOM: self-organizing map), in order to detect and support students showing dropout signs at an early stage. The authors have previously analyzed learning history data from lectures in which review tests are assigned, proposed a method to detect students showing dropout signs, and confirmed its effectiveness.

In this presentation, we analyzed learning history data from lectures in which report are assigned, and examined whether it is possible to detect students showing dropout signs. We also evaluated whether the method for early detection of students showing dropout signs is versatile when used in lectures with different types of assignments.

Keywords: Dropout students, Learning history data, Self-organizing map

Oral Presentation
Session B

[SB-02-Biology]

Graph Attention Network Analysis of Whole Genome Sequencing Data Reveals Novel Genes in Autism

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Abstract

Autism spectrum disorder (ASD) is a highly heritable neurodevelopmental disorder, yet its underlying genetic mechanisms remain elusive. Both coding and non-coding variants have been implicated in ASD, with rare inherited variants (RIVs) increasingly recognized for their role in ASD pathology. We developed a Graph Attention Network (GAT) model using whole genome sequencing (WGS) data from 2,186 individuals in a Korean ASD family cohort. Our model, which consists of 1,138 genes with RIVs and incorporates the STRING network, achieved an accuracy of 0.9018 and an AUC of 0.8985 in identifying ASD patients. Subsequent analysis of attention scores identified 89 significant genes associated with ASD, including 41 novel genes. Functional analysis revealed enrichment in ASD-related pathways such as synapse function, calcium activity, and cell communication. Thus, our RIV-based GAT model successfully classifies ASD patients and identifies a novel class of genes and variants that have not yet been associated with ASD.

Keywords: ASD, Autism, WGS, Rare inherited variants, Deep Learning, Graph Attention Network

[SB-03-Biology]

Functional analysis of Syntaxin6-like protein in vascular plant (SYLK)

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Abstract

Various membrane-bound organelles exist in eukaryotic cells. These organelles exchange proteins and other molecules to maintain cell functions by membrane traffic. SNARE (soluble N-ethylmaleimide sensitive factor attachment protein receptor) is one of the important factors in the membrane traffic system. It causes membrane fusion between a transport vesicle and a target membrane. Model plants *Arabidopsis thaliana* have over 60 SNARE proteins localized to specific organelles and vesicles. SYP6 (Syntaxin of plant6) is the TGN (the *trans*-Golgi network)-localized SNARE and contains a SNARE domain and a N-terminal domain highly homologous to animal Syntaxin6 (Syntaxin6-N-terminal domain). Interestingly, *in silico* analysis found three novel membrane proteins that have a Syntaxin6-N-terminal domain but not a SNARE domain. These novel proteins exist only in vascular plants. Therefore, I named them Syntaxin6-like protein in vascular plant (SYLK). We aim to reveal the intracellular functions of SYLK and the physiological functions that SYLK contributes to. Here, we report their subcellular localization observed by super-resolution confocal live imaging microscopy (SCLIM) and the *sylk* mutant phenotypes. The results showed that SYLK is localized to *trans*-Golgi, and SYLK is associated with the plant immune system and stomatal closure. This suggests that SYLK has distinct functions from SYP6.

Keywords: Eukaryotic cells, Proteins, Membrane traffic, *Arabidopsis*, Golgi, TGN

[SB-04-Biology]

Analysis of melanin decomposition-related factors in a basidiomycete strain SLKO1702

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Abstract

Melanin is a natural persistent pigment found in several organisms including animals, plants, protozoa, certain fungi, and eubacteria. It plays various defensive roles in the body, such as providing photoprotection by shielding cells from sunlight and acting as an antioxidant to remove reactive oxygen species generated within cells. However, excessive deposition of melanin can cause spots and freckles. Although substances that inhibit or suppress melanin production have been discovered, they cannot break down melanin that has already been produced. Furthermore, there have been cases of health damage, such as vitiligo, caused by the use of cosmetics containing substances that inhibit the melanin biosynthesis pathway. Therefore, it is necessary to find a substance that can safely degrade existing melanin without affecting its biosynthesis. In this study, we show a fungus strain SLKO1702 isolated in Japan exhibits melanin-degrading activity. We have cultured strain SLKO1702 in wheat bran medium at 30°C for 6 days and partially purified the culture extract. The degrading activity was detected by decreasing of the absorbance of the extract with a spectrophotometer. In addition, some other characterizations were done, suggesting that the candidates for melanin-degrading factor were proteins. The characteristics are heat sensitivity, molecular weight over 10,000, and inactivation by protease treatment. To limit the scope of the candidates, we have further advanced purification. So far, several proteins around 30-100 kDa were deduced to be involved in melanin degradation.

Keywords: melanin, fungus, protein, wheat bran

[SB-05-Biology]

The dysfunction of submucosal glands in chronic inflammation of the sinonasal cavity and its relevance to the "one airway, one disease"

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Abstract

Chronic rhinosinusitis with nasal polyps (CRSwNPs) is characterized by chronic sinusitis, inflammation of the nasal mucosa, and the development of nasal polyps (NPs). These symptoms frequently occur together with inflammatory conditions of the lower respiratory tract, such as asthma and bronchiolitis. The underlying mechanism of this interdependence is still unknown. Herein, we performed single-cell and spatial transcriptomics on sinonasal tissues obtained from both healthy controls and patients with CRSwNPs to clarify this mechanism. A consistent decline in the glandular subset of epithelial cells was noted in NP tissues relative to the contralateral mucosa without NP in each case. Then, these glandular cells in the nasal cavity were matched with consensus cell type markers of lower respiratory tract from available datasets and shown to be similar to submucosal glandular cells present in the proximal airways such as trachea and bronchus. These cells, unlike other subtypes of nasal epithelial cells, were also enriched with gene modules known to be associated with specialized secretory progenitor cells in the distal airways. Notably, inferred cellular fates using cellular differentiation trajectories among CRS patients based on the spatially resolved deconvoluted distribution provided insights into the clinical evaluation of disease severity based on the functionality of the glandular cells. Finally, receptor-ligand interactions that lead to the decreased glandular cell function were inferred based on spatial transcriptomic data, and then numerous immune cells such as plasma cells were suggested to be implicated in these interactions. Our results suggest that the dysfunction of a subset of glandular epithelial cells that contains signatures of genes associated with both proximal and distal lower respiratory function in the sinonasal cavity may be crucially involved in the pathophysiology of CRSwNP. Its disarray may serve as a proxy, reflecting the simultaneous occurrence of disease processes at different levels of the lower respiratory tract.

Keywords: Submucosal gland, Chronic rhinosinusitis with nasal polyps, One airway one disease, Single-cell RNA sequencing, Spatial transcriptomics

[SB-06-Biology]

Identification of Bacteria Inducing Settlement Behavior to Coral Planula Larvae

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Abstract

Threats to biodiversity in coral reef ecosystems are rapidly becoming more serious as results of human activities and climate changes. In the propagation of corals utilizing sexual reproduction, a major challenge is to improve the rate of settlement of larvae obtained from large numbers of fertilized eggs. Settlement and metamorphosis of planula larva are critical steps in the life cycle of the coral *Acropora*, that shift from planktonic to sessile life, and larvae are known to strictly select suitable settlement places. Behavior of planula larvae prior to settlement is thought to be that to seek and select settlement places, and the settlement behavior is considered to be necessary for settlement as normal development of *Acropora*. Thus, we screened bacteria on the substrate that induce settlement behavior of planula larvae. Terracotta tiles were conditioned in a coral reef for 3 months *Acropora tenuis* larvae were faced to the tile. Bacteria from settlement sites were cultured and screened, and successfully isolated four bacterial strains that induce the settlement behavior of *Acropora* larvae. Each strain induced different aspects of settlement behavior, such as circular swimming or upright spinning. Their species were examined by 16S rDNA sequences. In the future, identification of the active substances and corresponding genes is expected to further elucidate the mechanism of settlement behavior.

Keywords: Coral, Planula Larva, Settlement Behavior

[SB-07-Biology]

Phylogeny of Japan-endemic species in *Viola* subsect. *Vaginatae* and related species using genome skimming

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Abstract

The genus *Viola* (Violaceae) contains approximately 580–620 species, with particularly high diversity in East Asia. Previous phylogenetic studies using chloroplast and nuclear ITS regions lacked sufficient resolution to clarify relationships, particularly among closely related species. This study focuses on the subsection *Vaginatae*, which includes three Japan-endemic species (*V. vaginata*, *V. bissetii*, and *V. shikokiana*), to examine whether diversification occurred in Japan and investigate the evolutionary processes underlying that diversification. Recent advances in next-generation sequencing (NGS) have highlighted the utility of genome skimming. This technique generates organelle genome, nuclear ribosome, and multiple nuclear gene sequences from shotgun sequencing data. Especially in plants, chloroplast genome sequences (about 150,000 bp) have become a common tool for phylogenetic analyses. Chloroplast genomes for many *Viola* species from Korea and China have been sequenced. However, no such data are available for Japanese *Viola* species, which have created gaps in our understanding of phylogenetic relationships across East Asia. Additionally, genome skimming for obtaining multiple nuclear gene sequences has been underutilized in plant phylogenetic studies.

In this study, we conducted phylogenetic analysis of *Viola*, focusing on subsect. *Vaginatae* and related species, using the genome skimming method. We obtained short-read sequence data for 25 samples of 17 species by NGS and reconstructed whole chloroplast genome sequences. We also downloaded short-read sequence data or chloroplast genome sequences from NCBI for 21 *Viola* species. We performed phylogenetic analysis using the chloroplast genome and estimated the divergence times. Our results showed that the three Japan-endemic species formed a monophyletic group with *V. rossii*, a species common to both Japan and the continent, as their sister species. The Japan-endemic lineage diverged from *V. rossii* approximately 2.9 million years ago (Ma), with divergence times among the three species ranging from 2.6 to 1.6 Ma. These findings suggest that these endemic species diversified within the Japanese archipelago mainly during the Quaternary period. Additionally, *V. yazawana* and *V. diamantiaca*, previously classified within subsect. *Vaginatae*, do not form a monophyletic group with the four focal species. We will also present results of phylogenetic analysis based on multiple nuclear genes obtained from shotgun sequencing data and discuss the utility of the genome skimming approach.

Keywords: *Viola*, endemic species, speciation, next-generation sequencing (NGS), chloroplast genome

[SB-08-Biology]

Analysis of giant mitochondria in unfertilized egg cells of *Pelargonium zonale* by electron microscopy

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Abstract

Mitochondria are essential organelles that generate and supply energy and found in almost all eukaryotes. Generally, mitochondria are shaped round or oval about 1 μm in diameter, however, their length is variable via repeated division and fusion depend on the cell type and physiological state. Although few studies of giant mitochondria have been reported, the fluorescence images of large mitochondrial DNA (mtDNA) rings have been observed in mature unfertilized egg cells of *Pelargonium zonale* (Kuroiwa 1996, Protoplasma 192:235-244). However, it remains unclear the morphology of giant mitochondria in detail. To elucidate that, we used scanning electron microscopy (SEM). The function of stitching in SEM allows us to obtain wide range images that make us possible to observe each mitochondrion in high resolution. We observed several forms of giant mitochondria, not only round or oval but donut-shaped or elongated as dumbbells. Furthermore, we found that giant mitochondria appeared to include vacuoles, suggesting interactions between giant mitochondria and other organelles. To understand the structure of giant mitochondria, we try to reconstruct three-dimensional (3D) images using serial section scanning electron microscopy (S^3EM). In this study, we would like to clarify how and why mitochondria has become giant.

Keywords: Mitochondria, SEM, Three-dimensional image

[SB-09-Biology]

Centrosome Amplification Promotes Cellular Senescence and Invasion via Innate Immune Response

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Abstract

Centrosome amplification is a hallmark of human cancers and correlates with tumor malignancies and poor prognosis. The causal relationships between this numerical centrosome abnormality and human cancers have been reported, but molecular mechanisms underlying its pro-tumorigenic roles are not fully understood. Here, we show that extra centrosomes trigger cellular senescence and senescence-associated secretory phenotype (SASP) through a cytosolic DNA response, promoting cellular invasion. Centrosome amplification promotes the formation of micronuclei, small nuclear structures spatially isolated from the main nucleus, and the rupture of their nuclear envelope. Subsequent DNA leakage into cytosol leads to the activation of the cytosolic DNA sensing inflammatory pathway. Inhibiting this mechanism suppresses not only the senescence and SASP, but also cell-autonomous and non-cell autonomous invasion induced by centrosome amplification.

Moreover, preventing micronuclear rupture markedly rescues these consequences induced by supernumerary centrosomes. Our findings highlight that the activation of innate immune pathway that senses the self-DNA from micronuclei can link centrosome amplification to cancer progression, providing a novel framework for developing cancer therapeutics.

Keywords: Centrosome, Cancer, Invasion

[SB-10-Biology]

Honokiol, a natural small compound, anti- tumor effects on human leukemia cells

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Abstracts

Acute myeloid leukemia (AML) is a type of haematopoietic malignancy, and its subtype, acute promyelocytic leukemia (APL), has shown improved outcomes with a combination of all-trans-retinoic acid (ATRA) and chemotherapy. However, some AML cases remain resistant to standard treatments even after haematopoietic stem cell transplantation, leading to frequent relapses and the need for new therapeutic approaches. Honokiol (HNK), a natural small-molecule compound with relatively low toxicity, has been reported to have potent antitumor activity against several malignancies, including AML, through selective activation of the retinoid X receptor (RXR). Although HNK is thought to act through mechanisms similar to ATRA, its effects on transcription factors and erythroid gene expression remain unclear. In this study, we aimed to elucidate the molecular mechanisms of the antitumor effects of HNK using HEL cells, a cell line derived from human erythroleukemia, a rare subtype of AML. HEL cells were treated with ATRA and HNK, and we evaluated their effects on cell proliferation, metabolic activity and gene expression. The results showed that high concentrations of HNK caused cell death independent of non-apoptotic and necroptotic pathways. In addition, lower concentrations inhibited cell proliferation without inducing cell death, suggesting that HNK may induce differentiation in HEL cells.

Keywords: AML, HEL cell, Honokiol, ATRA, Cell differentiation and proliferation

[SB-11-Biology]

Research on the Performance of Urushi as an Adhesive by Strength Tests - Potential of Urushi for Architectural Use

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Abstract

Urushi has a history of use dating back about 9,000 years. The main component of Urushi is a compound called urushiol, which forms a tough lacquer film when dried and cured. It is not only aesthetically pleasing, but also has excellent water, heat (approx. 200°C), acid, alkali, and chemical resistance, as well as antibacterial and thermal insulation properties. It has been concluded that the strength of Urushi varies with changes in temperature and humidity. As such, the drying mechanism of Urushi may be related to microorganisms.

In this study, I conducted research to elucidate the adhesive strength and excellent bonding properties, and its high potential for use in construction as a structural material. Shear tests were conducted using polyvinyl acetate resin adhesives, which are also used in building materials such as plywood and laminated timber as a comparison. The shear test was conducted to compare the following, the shear strength of Urushi and, polyvinyl acetate resin adhesives the bonding strength of the two glues depending on the grain of the adherend, and the fracture properties after the shear test. As a result, it was found that the shear strength was slightly higher with Urushi than with polyvinyl acetate resin adhesives. In addition, compared to vinyl acetate adhesives, Urushi was found to be more stable in adhesion. The results and observations above confirm that Urushi has sufficient potential to be considered for use as a structural adhesive in construction. However, since cohesive failure, a form of failure was observed in both Urushi and polyvinyl acetate resin adhesive specimens, it is necessary to examine and improve adhesion methods, such as surface treatment, compaction method, curing environment, and adhesive management.

Keywords: Nature material, Glue, Urushi, Shear strength, timber

[SB-12-Biology]

Dynamics of the VAMP72 group during pollen tube elongation

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Abstract

In eukaryotic cells, the transport of proteins and lipids among organelles is regulated by membrane traffic. One of the key steps in membrane traffic is membrane fusion between the transport vesicles and the target membrane mediated by SNARE (soluble N-ethylmaleimide sensitive factor attachment protein receptor) proteins. VAMP72 (vesicle-associated membrane protein 72) family, a subgroup of the SNARE proteins in *Arabidopsis* has a remarkable diversification. Several VAMP72 members are highly expressed in pollen tubes, essential structures for fertilization in flowering plants. However, it is unclear how these proteins are functionally differentiated in pollen tubes. In this study, we aim to elucidate how VAMP72 members functionally differ during pollen tube elongation by a live imaging system. Here we report the dynamics of the VAMP72 group in pollen tubes observed by super-resolution confocal live imaging microscopy (SCLIM). Localization analysis by SCLIM revealed that each VAMP72 member was independently localized. This suggests that each member may be localized in independent transport vesicles and functionally differentiated to carry different cargoes. We also performed a co-localization analysis between VAMP72 and cargo proteins to determine what transport pathways VAMP72 members are involved in. The results showed that VAMP72 low co-localized with PRK6 and ANX2, cargo proteins that play important functions in pollen tube growth, suggesting that other factors may be involved in their transport.

Keywords: Eukaryotic cells, Proteins, Membrane traffic, *Arabidopsis*, Pollen tubes

[SB-13-Biology]

Relationship between soil property, fermentation, and compressive strength in mud walls

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Abstract

In the field of architecture, I focus on the relationship between mud walls and microorganisms. Clay has been used as a structural material in many parts of Japan since ancient times, especially in the traditional method of mixing clay and straw, known as mud walls. This process is called "*Nerioki*". *Nerioki* means the fermentation mixture of soil and straw for an extended period of time. I was told last year that *Nerioki* makes mud walls stronger. We cultured microorganisms in the soil. It showed different colonies of microorganisms for different kinds of soils. Then, we prepared Arakida soil, Nagaoka soil, Komaki soil, and Kyoto soil. After that, we did compression test to clarify the characteristics of the soil and the effects of fermentation. In addition, Kyoto soil and Komaki soil are made by the experience of the plasterer.

I guess that invisible microorganisms affect strength. The soil in each region is fermented and we periodically sampled to reveal the phenomenon of the *Nerioki* process. The soil in each area is fermented and sampled periodically to clarify the phenomena of the kneading process by genome analysis (analysis of genetic information) and compression tests. Genomic analysis revealed an increase in Myxococcales. Also, we have not been able to identify the microorganisms in this. Currently, we don't have any Microbial identification. The relationship between microorganisms and strength will be clarified. This is a report that has progressed from the last time.

Keywords: Mud wall, Compression test, Natural material, Microorganisms, Genome analysis

[SB-14-Biology]

Deconvolution of Drug-Induced Transcriptomic Changes into Single-Target Effects Across Multiple Doses

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Abstract

Understanding a drug's mode of action (MoA) is essential yet challenging in the drug discovery and development process. Analyzing gene expression changes resulting from drug perturbations provides a systematic and comprehensive approach to elucidate a drug's impact on cellular processes. However, due to the mixed effects by multiple targets, including on-targets and off-targets, it is complicated to clearly decompose the transcriptomic effects by each individual target protein. Additionally, varying drug doses alter the number of affected targets, further increasing this complexity. Here, we propose an interpretable matrix factorization model to uncover the relationships between gene expression changes and their causal targets across different doses. This model allows us to observe how target protein-gene interactions change across different drug doses. Our approach deconvolutes transcriptomic changes induced by multi-target drug perturbations down to single-target effects at each dose. We utilized KMAP, an in-house large-scale drug-induced transcriptome dataset comprising two cell lines treated with 2,700 drugs at three different doses (100nM, 500nM, 2500nM). Our model takes a vector of target profiles as input and generates normalized transcriptomic changes as output, resulting in a weight matrix that captures the hidden relationships between targets and expression changes at each dose. Consequently, the model accurately predicted known drug-target interactions for unseen drugs with a median AUROC of 0.85. Furthermore, after validating the target-gene interaction matrix, we refined the drug-target interaction matrix at each dose using expectation maximization. We filtered out interactions that appear to occur only at high doses (e.g., 10 μM) but not at low doses or added unknown interactions. We iterate this process until the loss between predicted perturbed expression changes are the real values was minimized. To validate the dose-specific drug-target interaction matrix, we compared the interaction values at specific doses with IC_{50} values. We observed that lower IC_{50} values were associated with larger interaction values at low doses, whereas interactions with higher IC_{50} values were penalized in the drug-target interaction matrix generated at low doses. Additionally, we applied our model to predict potential therapeutic targets for triple-negative breast cancer, successfully identifying targets currently being investigated in clinical trials.

Keywords: Drug-target interaction, Transcriptome, Expectation Maximization, Matrix Factorization, Triple-Negative Breast Cancer

[SB-15-Biology]

Role of Anionic Lipids in Etioplast to Chloroplast Differentiation Revealed by Electron Microscopy

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Abstract

Dark-germinated angiosperm seedlings develop plastids called etioplasts in cotyledon cells. Etioplasts contain lattice membrane structures called prolamellar bodies (PLBs) and lamellar prothylakoids. When dark-germinated seedlings are continuously illuminated, PLBs are transformed to the thylakoid membrane, and consequently etioplasts differentiate to chloroplasts. The plastid membrane (both of PLB and thylakoid membranes) contain the characteristic anionic lipids sulfoquinovosyldiacylglycerol (SQDG) and phosphatidylglycerol (PG), which account for 20% of the total membrane lipids. We believe that these anionic lipids may have an important role. To investigate the role of anionic lipids, we used electron microscopy to observe the differentiation process from etioplasts to chloroplasts in *pgp1-1* (PG reduced mutant), *sqd1* (SQDG completely deficient mutant) and *sqd1pgp1-1*. Due to concerns about room light exposure during conventional sampling at 0 h light exposure, we devised and performed a sampling method using an infrared night vision camera. The results showed that *pgp1-1* and *sqd1pgp1-1* exhibited faster PLBs disruption but slower thylakoid membranes development than the wild type. This suggests that PG has an important role in the appropriate disruption of PLBs and development of thylakoid membranes.

Keywords: etioplast, anionic lipid, electron microscopy, prolamellar body (PLB), thylakoid membrane

[SB-16-Biology]

Cellulose production by mixed culture with *Aspergillus* spp. and *Komagataeibacter xylinus*

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Abstract

Cellulose is the largest biomass on earth and is commonly produced from plants. Recently, consumption of cellulose from plants causes one of deforestation, resulting in a serious environmental problem. From the background, practical use of bacterial cellulose (BC) which is the cellulose produced by bacteria, has been expected to solve the problem. BC is mainly produced by Komagataeibacter xylinus and has a finest mesh structure compared with that of the plant-based cellulose. Moreover, it is being recognized as a new material because of the superior characteristics such as high water content, high strength and biodegradability. Therefore, BC is expected to apply to a broad range of our life. On the other hand, its high production cost hampers several practical use. From these standpoints, we conceived of using leftover rice as culture medium to cut the medium cost. We also believe that reducing food waste contributes to one of the Sustainable Development Goals.

We refer to the process of producing Japanese Sake. In this process, two different types of microorganisms are utilized. First, amylase secreted by Aspergillus oryzae breaks down starch of rice, then alcohol is made from the resulting sugar with yeast through fermentation. In our study, we try to produce BC using K. xylinus instead of yeast because K. xylinus is expected to use the resulting sugar as a carbon source.

Keywords: *Aspergillus*, *Komagataeibacter*, bacterial cellulose, leftover rice

Oral Presentation
Session C

[SC-01- Pharm/Food/Chem/Bio Chem/Bio Engine]

Development of a renal excretory nano−MRI probe for the diagnosis of chronic inflammation

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Earlier diagnosis their by earlier medical intervention before diseases become serious are more important to extend healthy life expectancy. To this end, detecting the signs of diseases as early as possible in noninvasive manner is a key issue. It is recently addressed that mild chronic inflammation called "inflammaging" occurs, which ultimately leads to various age-related diseases, such as atherosclerosis, diabetes, autoimmune diseases, and cancer. One of its symptoms is an increased permeability in blood vessels with its "pore" size ranging from a few to several tens of nanometers depending on the progression of the disease. MRI is a suitable modality for diagnosis because it allows for non-invasive visualization of vascular structures with the spatial resolution close to 100 μm in three-dimension without radiation. It is expected that clinically used conventional MRI contrast agents, such as Gd-DOTA, leak through the pore and accumulate at the inflammaging sites due to their sub-nanometer size. However, they are rapidly cleared from the body through kidney, giving rise to poor accumulation for detection. The properties of probe demanded for detecting the inflammaging would be (i) prolonged circulation in bloodstream, (ii) the size smaller than the pore size of impaired vasculature for leakage, (iii) possessing high sensitivity, while (iv) elimination from the body after the imaging. For such properties, we focused on the "nano-ruler polymer" [*J. Controlled. Rel.* **347**:607-614, 2022]. The polymer can circulate in blood without being captured by reticuloendothelial system (RES), covers the size range of the pore size, and permits renal clearance by controlling its size. This study aims to develop a nanoprobe to detect inflammaging by MRI based on the nano-ruler polymer.

Keywords: MRI contrast agents, Diagnosis, Drug Delivery System

[SC-02-Pharm/Food/Chem/Bio Chem/Bio Engine]

Enhancing gefitinib brain penetration through P-glycoprotein and Breast cancer resistance protein inhibition

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Abstract

The Blood-Brain barrier (BBB) presents a significant obstacle to drug delivery to the brain. P-glycoprotein (P-gp) and breast cancer resistance protein (BCRP) are the primary efflux transporters at the BBB, hindering drug entry into the brain. As these transporters function cooperatively, dual inhibition of P-gp and BCRP is essential to enhance drug delivery to the brain. Gefitinib is a first-line treatment for metastatic non-small cell lung cancer (NSCLC), which frequently metastasizes to the brain. However, gefitinib is ineffective against brain metastases due to its inability to cross the BBB. This study aims to evaluate whether the brain penetration of gefitinib increases when co-administered with three dual P-gp/BCRP inhibitors – CDK 4/6 inhibitor IV, BX795, and CGP60474 – thereby expanding its indications as a treatment for brain tumors. We compared the cytotoxicity of gefitinib alone and in combination with the dual inhibitors *in vitro* using hCMEC/D3 cells. The results showed a significant increase in cytotoxicity with three dual P-gp/BCRP inhibitors. In animal experiments, dual inhibitors were co-administered intravenously with gefitinib. While the plasma concentrations of gefitinib were unaffected, the brain-to-plasma ratio significantly increased in the group treated with gefitinib in combination dual inhibitors. Although not all time points showed statistical significance in the groups treated with dual inhibitors except for elacridar, positive control, the fact that the brain-to-plasma ratio significantly increased at specific time points is notable. These findings demonstrate that co-administration of gefitinib with dual inhibitors improves drug delivery to the brain without affecting its plasma profile. In conclusion, the dual inhibitors hold promise in overcoming BBB-related challenges, thereby enhancing the efficacy of anticancer drugs in treating brain tumors.

Keywords: BBB, P-gp, BCRP, gefitinib, B/P ratio

[SC-03-Pharm/Food/Chem/Bio Chem/Bio Engine]

Exploration of Factors Contributing to Perceived Thickness ("*noukoukan*") Using Tonkotsu Ramen Soup (Porcine Bone Soup) and Plant-Based Alternatives

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Abstract

In Japan, "*noukoukan*" (i.e. thickness) is commonly used to describe the sensory characteristics of food. However, the usage of thickness in everyday life indicates it is a complex concept, reflecting a combination of taste, flavor, and texture. Moreover, individual perceptions of thickness vary due to personal differences in how each sensory attribute is weighted. This study aims to explore the factors that influence the perception of thickness, particularly in porcine bone ramen soup and plant-based alternatives. A trained sensory panel evaluated the intensity of 12 ramen soup samples with 33 descriptive terms including characteristics like saltiness and fattiness. Additionally, 34 consumers were asked to rate the thickness of 4 samples and completed a questionnaire about their eating habits and lifestyles. By analyzing trained panel data and consumer ratings, the perception of animal ingredients was found to be a main factor in thickness, although the perception of aromatic vegetables also had some effect as well. Moreover, by analyzing consumer ratings and questionnaires, consumers were grouped into 4 clusters based on their thickness evaluation tendencies. For instance, individuals who preferred sweet flavors tended to rate the thickness of less sweet samples lower. This suggests that a preference for sweetness may influence the perception of thickness.

Keywords: Sensory evaluation, Ramen soup, Thickness

[SC-04-Pharm/Food/Chem/Bio Chem/Bio Engine]

Structural Optimization of Cathepsin B-cleavable Linkers for Cancer-specific Peptide-DOX Prodrug Nanoparticle Development

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Abstract

A carrier-free prodrug nanoparticle has emerged as a promising strategy for enhancing cancer therapy by improving tumor targeting and reducing systemic toxicity. In this study, five derivatives of cathepsin B-cleavable prodrugs were synthesized *via* chemically conjugating different cathepsin B-cleavable peptides (*Phe-Arg-Arg-Gly, Phe-Arg-Arg-Leu, Phe-Arg-Arg-Leu-Gly, Phe-Leu-Arg-Arg-Gly*) to doxorubicin (DOX). These peptide-DOX prodrugs spontaneously assembled into nanoparticles, with their structures influenced by amphiphilicity and flexibility and they were evaluated for stability and cellular uptake *in vitro*. Among the five prodrugs, the *Phe-Arg-Arg-Leu*-DOX (FRRL-DOX) nanoparticle demonstrated the most promising results, forming nanoparticles that remained stable in saline for 3 days. The FRRL-DOX nanoparticle showed enhanced cellular uptake by tumor cells and induced effective cancer cell death with minimal toxicity to normal cells. *In vivo*, the FRRL-DOX nanoparticle demonstrated significantly higher tumor-specific accumulation than other prodrug candidates and free dox, indicating potential for enhanced therapeutic efficacy. Notably, the FRRL-DOX nanoparticle exhibited minimal toxicity in repeated intravenous administration at a high dose. In conclusion, the peptide sequence for cathepsin B-cleavable prodrug nanoparticle was successfully optimized to increase tumor selectivity and lower toxicity to normal tissues.

Keywords: Prodrug, Carrier-free nanoparticle, Cancer-targeting therapy, Cathepsin B-sensitive linker

[SC-05-Pharm/Food/Chem/Bio Chem/Bio Engine]

The Effect of Alpha-Ketoglutarate on Myocardial Metabolism in Chronic Heart Failure

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Abstract

Heart failure (HF) is one of the leading causes of mortality worldwide. HF is characterized by alterations in cardiac metabolism, which contributes to the severity of HF. However, the details of energy metabolic changes in HF remain unclear and there is not enough evidence regarding nutritional therapeutic strategies for HF. We previously found that the substrate for energy (ATP) utilization may shift from fatty acids to glucose in the heart of a mouse model of angiotensin II (AngII)-induced heart failure. Additionally, we discovered that under impaired ATP production, the heart adaptively compensates for energy supply by increasing the production of alpha-ketoglutarate (αKG). In this study, we aimed to verify the hypothesis that supplementation with αKG helps energy production and improves cardiac insufficiency. We treated wild-type mice (C57BL/6J, male) with AngII to induce cardiac insufficiency and added 2% αKG to their diet.

Unexpectedly, supplementation with αKG did not attenuate AngII-induced cardiac insufficiency; instead, the progression of fibrosis was promoted. Mice fed αKG still had low levels of intracellular ATP. These results suggest that the increased production of αKG in the failing heart contributes to myocyte expansion and fibrosis in heart failure, rather than to energy replacement. It is necessary to review the dosage and the effect of αKG in different HF models in the future.

Keywords: heart failure, energy metabolism, alpha-ketoglutarate

[SC-06-Pharm/Food/Chem/Bio Chem/Bio Engine]

Exploring HER2-driven regulation of glutamine metabolism in KRAS^{G13D} mutant colorectal cancer

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Abstract

Colorectal cancer (CRC) is a highly prevalent cancer worldwide, and its 5-year survival rate drops significantly to 14.7% when diagnosed at stage 4, underscoring the need for effective cancer therapies. Over 80% of CRC patients exhibit EGFR overexpression, which makes anti-EGFR therapies such as Cetuximab the recommended first-line targeted treatment. Notably, the KRAS^{G13D} mutation is associated with a worse prognosis compared to other subtypes and shows a unique therapeutic response to Cetuximab. Our study identified HER2 as an important factor driving this response and demonstrated that HER2 plays a key role in modulating the therapeutic efficacy of Cetuximab in CRC with KRAS^{G13D} mutations.

KRAS^{G13D} mutant CRC exhibits a unique metabolic dependency on glutamine metabolism. In this study, we investigated how HER2 regulates glutamine metabolism in KRAS^{G13D} mutant CRC and explored the underlying molecular mechanisms. Through metabolomics analysis, we found a significant correlation between HER2 and the expression of glutaminase (GLS1) in KRAS^{G13D} mutant CRC. Specifically, HER2 inhibition in KRAS^{G13D} mutant cells led to a marked decrease in GLS1 expression. Additionally, the expression of key glutamine metabolism-related genes, such as SLC1A5, GLS1, GLUD1, and GOT2, was also reduced upon HER2 inhibition. Functional experiments showed that KRAS^{G13D} mutant cells were highly sensitive to glutamine deprivation, but this sensitivity was reduced when HER2 was knocked down, suggesting that HER2 regulates glutamine dependence in KRAS^{G13D} mutant cells.

Our ongoing research is focused on further investigating how HER2-mediated regulation of glutamine metabolism impacts tumor growth and survival, and evaluating the potential of combining HER2 inhibition with GLS1-targeted therapies. Overall, this study identifies a novel metabolic vulnerability in KRAS^{G13D} mutant CRC and provides insights into potential new therapeutic strategies targeting glutamine metabolism in HER2-positive tumors.

Keywords: Colorectal cancer, KRAS^{G13D}, HER2, glutamine metabolism.

[SC-07-Pharm/Food/Chem/Bio Chem/Bio Engine]

Use of Synthetic DNA in UV disinfection treatment

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Abstract

Ultraviolet (UV) has been used as one of powerful water and air disinfection tool. If the UV germicidal effect on target microbes can be predicted by analyzing the genetic information of newly emerging viruses and pathogenic microorganisms, it would be very helpful for UV implementation. UV damage on gene is caused by absorbing UV light at regions where pyrimidine bases (thymine, cytosine, and uracil) are consecutive, forming pyrimidine dimers. Using synthetic DNA which can be arbitrarily designed, the relationship between base sequence and UV reactivity. PCR can evaluate the UV reactivity of the synthetic DNA because the damaged DNA cannot be multiplied by PCR. Previous studies have shown that the UV reactivity was proportional to the number of consecutive thymine bases.

To explore factors other than nucleotide sequences that affect UV reactivity, I created both single-stranded and double-stranded synthetic DNA and examined the differences in UV reactivity depending on the presence or absence of complementary strands. When comparing the UV reactivity of synthetic DNA with identical nucleotide sequences in single-stranded and double-stranded forms, the double-stranded DNA had lower UV reactivity than the single-stranded DNA.

This result is consistent with previous studies using single-stranded and double-stranded DNA viruses, which found that viruses with double-stranded DNA had lower UV reactivity. In previous studies, the reason for this was that repair enzymes act only on double-stranded DNA, resulting in lower apparent reactivity, but the present study was conducted in a system without repair enzymes, so the main reason was thought to be the difference between the double- and single-stranded structures rather than the involvement of enzymes.

Keywords: water treatment, UV disinfection treatment, Synthetic DNA, single-strangled DNA, double-strangled DNA

[SC-08-Pharm/Food/Chem/Bio Chem/Bio Engine]

Predicting melting point of organic crystals using molecular dynamics simulations

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Abstract

Accurate prediction of melting point is the starting point to investigate the molecular mechanism of crystal growth and melting using computer simulations of molecular models. Here, we report melting point predictions derived from molecular dynamics (MD) simulations of two simple organic crystals, nitromethane and acetic acid. This work has two main objectives. First, we evaluate the validity of popular generalized force fields including CGenFF, OPLS, and GAFF. Second, we assesses different MD simulation approaches: systems of solid/liquid, vapor/solid/liquid/vapor, vapor/solid/vapor, and solid alone. MD simulations were performed for these systems at various temperatures to find the minimum temperature at which melting occurs. Additionally, we employed continuous heating simulations of the vapor/solid/vapor system. Our simulations reveal that none of the popular force fields accurately predict the melting points, requiring further improvements. Among the simulation approaches, the results from MD simulations of all these systems agree well except for those from the simulations of the solid-alone system. In addition, the continuous heating method proved effective for melting point prediction. This study provides the guideline to perform the MD simulations for melting point prediction of molecular crystals.

Keywords: Melting point prediction, Molecular dynamics (MD) simulations, Force Fields, organic crystals

[SC-09-Pharm/Food/Chem/Bio Chem/Bio Engine]

Inhibition Method of Photoreactivation in UV Disinfection

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Abstract

In recent years, UV disinfection has attracted attention as a method of water disinfection because there is less concern about persistence and harmful by-products. However, it is known that in UV disinfection, bacteria inactivated by UV irradiation regain activity when exposed to visible light, a phenomenon known as photoreactivation.

Previous reports have shown that dark storage after UV irradiation inhibits photoreactivation, even when followed by visible light irradiation. However, no significant effect was observed on *Escherichia coli* in influent wastewater and secondary treated water, though *E. coli* was stored in the dark after UV irradiation. Therefore, I investigated the conditions under which a large inhibitive effect of dark storage is observed using isolated *E. coli* strains and found that a large inhibitive effect tends to be observed when the activity state of *E. coli* during dark storage is high. The same level of inhibition was also observed for *E. coli* from influent wastewater using the same method. This suggests that an increase in the activity state of *E. coli* promotes inhibition by dark storage.

Keywords: UV inaction, Photoreactivation, Escherichia coli

[SC-10-Pharm/Food/Chem/Bio Chem/Bio Engine]

Investigation of virus removal in septic-tank in Ho Chi-Min city, Vietnam

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Abstract

In many parts of the developing countries, On-Site Sanitation (OSS) systems is prevalent for treating human waste water. OSS treat manure by sedimentation and anaerobic digestion, after which the effluent is released into the surrounding soil. This type of system provides temporary containment of manure, but does not guarantee sanitary conditions in the surrounding environment. However, there is limited research on the presence and removal of pathogenic viruses within these systems. This study aimed to investigate the removal efficiency of virus index in operational OSS. A bacteriophage MS2 as a model virus was pulse-fed into the operating septic tank which was commonly used in Ho Chi Minh City, Vietnam, and collected effluent samples over a six-day period to measure MS2 concentrations. Our results revealed that MS2 was detectable in plaque assays, peaking two days post-injection, with a removal rate of approximately 5.6 log. this study serves as a preliminary trial, providing a foundation for future research on viral dynamics in septic systems.

Keywords: On-Site Sanitation, OSS, Septic tank, MS2

[SC-11- Pharm/Food/Chem/Bio Chem/Bio Engine]

Evaluation of the effect of natural flavone on renal failure via the aryl hydrocarbon receptor

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Abstract

The number of patients with chronic kidney disease (CKD) in Japan continues to increase. This issue should be addressed because of the risk of complications and death, as well as the enormous medical costs associated with the disease. In CKD patients, a uremic toxin indoxyl sulfate (IS) accumulates in the body and activates the aryl hydrocarbon receptor (AhR). It then induces inflammatory reactions and oxidative stress, which further progresses renal damage.

In this study, we aimed to establish a mouse model of CKD in which AhR is activated by accumulation of IS. Furthermore, using this model, we examined whether apigenin, a natural flavone reported to act as an AhR antagonist, inhibits AhR activation and thereby ameliorates IS-induced renal damage.

In Study 1, ICR mice were divided into four groups; a standard diet (Control) group, a high adenine diet (AD0.25) group, a low adenine diet (AD0.2) group, and a low adenine diet with no recovery period (AD2wk) group. The mice in AD0.25 and AD0.2 groups were fed standard diet containing 0.25% and 0.2% (w/w) adenine for 2 weeks, respectively, followed by a standard diet only for 2 weeks. The mice in AD2wk group were fed a standard diet containing 0.2% (w/w) adenine for a week and 0.1% (w/w) adenine for an additional week. In Study 2, mice in AD0.2 group were used as a model of CKD. The mice were intraperitoneally injected with IS (100 mg/kgBW), and orally administered apigenin for 4 weeks to examine the effect of apigenin on renal injury.

The results in Study 1 showed that, in the mice in AD0.2 group, renal function was reduced without the severe inflammatory response directly induced by adenine. Therefore, we selected these mice as the CKD model. Study 2 is an ongoing project, and the results of which will be presented at the symposium.

Keywords: chronic kidney disease, indoxyl sulfate, aryl hydrocarbon receptor (AhR), flavone

[SC-12-Pharm/Food/Chem/Bio Chem/Bio Engine]

Facile Synthesis of δ-MnO_2@C as a Solid Contact Material for K^+ Ion Sensing

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Abstract

Accurate measurement of potassium ion concentration in blood is an important diagnosis technology regarding the disease of acute renal failure. A solid contact material that connects ion selective membrane and carbon electrode is a critical component of a potassium ion sensor. In this work, carbon-coated δ-MnO_2 nanosheets (δ-MnO_2@C) are developed as a solid contact material for the potassium ion sensor. Facile and scalable synthesis of the δ-MnO_2@C is achieved by coprecipitation of manganese acetate and oxamide, and subsequent oxidation reaction, in which crystallization of δ-MnO_2 and carbon coating simultaneously occur. The δ-MnO_2@C exhibits crystal structure of birnessite and morphology of nanoflowers. In cyclic voltammetry, the δ-MnO_2@C exhibits high capacitance of ~12,000 F/g, indicating its good capacitance to accommodate potassium ions through not only electric double layer formation but also redox reaction. When the δ-MnO_2@C is applied as the solid contact material in the potassium ion sensor, sensing response for the potassium ions is rapidly increased as compared to that carbon materials are used as the solid contact material. It is highly expected that this work contributes to addressing challenges in monitoring potassium ion concentration in blood of patients with chronic renal failure.

Keywords: Manganese oxide, Carbon coating, Solid contact materials, Potassium sensors, Supercapacitors

[SC-13-Pharm/Food/Chem/Bio Chem/Bio Engine]

The Role of *O*-fucosylation of Coagulation Factor XII in the Acquirement of Structural Stability During Biosynthesis

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Abstract

Blood coagulation factor XII (FXII) initiates the intrinsic coagulation pathway, which is associated with thrombus formation, and is a potential target for new anticoagulants. FXII is a glycoprotein produced in the liver and secreted into the blood as an inactive protease. Our laboratory has shown that one of the glycosylations of FXII, threonine (Thr) 90-linked *O*-fucosylation on EGF1 domain, might play an important role in the structural stabilization of the inactive form of FXII, but the molecular mechanism is still unknown. Therefore, this study aimed to elucidate the regulatory mechanism using molecular biological methods. The result of cell-based assay indicated that a defect of *O*-fucosylation increases endoplasmic reticulum-associated degradation (ERAD) in the biosynthesis pathway. Considering the structure of FXII predicted by AlphaFold2, it was estimated that EGF1 domain was likely to interact with the neighboring FN2 domain through the interaction with *O*-fucose. Mutational analysis of FXII showed that the replacement of proline (Pro) 31 with alanine (Ala) in FN2 domain significantly decreased the FXII secretion and promoted the intercellular fragmentation in accord with a defect of *O*-fucosylation. Taken together, it is suggested that *O*-fucosylation might stabilize the structure of inactive FXII through the interaction with Pro31. The stabilization of the interaction between EGF1 domain and FN2 domain of FXII could be an effective approach for anticoagulation.

Keywords: Coagulation factor XII (FXII), *O*-fucosylation, Structural stability

[SC-14-Pharm/Food/Chem/Bio Chem/Bio Engine]

Adsorption mechanism of Pt(II) on β-MnO_2 : Elucidating mechanism of Pt enrichment in marine ferromanganese crusts and nodules

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Abstract

Seafloor sediments are known to be highly enriched in Pt within the MnO_2 phase. The specific enrichment mechanism is unknown, but if elucidated, it could help us understand the movement of elements within the Earth and contribute to the recycling of Pt. It has been reported that Pt(II) is oxidized to Pt(IV) after adsorption onto MnO_2 [1]. This suggests that both adsorption and redox processes may play important roles in the solid-liquid interface reaction between MnO_2 and Pt. Therefore, in this study, the mechanism of adsorption and redox reactions of Pt(II) on MnO_2 will be elucidated.

Distribution curves for Pt(II) complex ions were generated, and the experimental conditions were investigated. The pH was set to 4 to allow Pt(II) to dissolve and to prevent re-precipitation of Mn(II). The average chemical composition was $[PtCl_{2.02}(H_2O)_{1.98}]$. Adsorption experiments were performed at 25℃ using a suspension containing 1 g/dm^3 MnO_2, 0.2 mmol/dm^3 K_2PtCl_4 and 0.1 mol/dm^3 $NaNO_3$.

After the adsorption reaction, the solids were collected and analyzed by XAS, confirming that all Pt was in the Pt(IV) state. In contrast, CV measurements indicated that Pt in solution existed as Pt(II). This confirms that Pt(II) is adsorbed onto MnO_2 and subsequently oxidized to Pt(IV). In addition, 2 mol of H^+ are released for every 1 mol of adsorbed Pt(II) ions, indicating that Pt(II) forms an inner-sphere complex via bidentate coordination. Experiments varying the number of Cl^- ligand coordinated to Pt showed that Pt(II) ions form complexes on the surface of MnO_2 with two H_2O ligands. To clarify the reaction after complexation, the number of Cl^- ligands coordinating to Pt on the solid was measured each hour, revealing that ligand exchange occurred after adsorption.

Keywords : Pt(II) complex ion, MnO_2, Adsorption

Reference

[1] M. Maeno, et al., Sorption behavior of the Pt(II) complex anion on δ-MnO_2, *Mineralium Deposita* 51 (2016) 211-218.

[SC-15-Pharm/Food/Chem/Bio Chem/Bio Engine]

Enhanced Sensitivity in Heavy Metal Ion Detection through Entity Formation using Single-Entity Electrochemistry

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Abstract

This study presents an advanced electrochemical sensing method for detecting toxic heavy metal ions, addressing the critical need for monitoring elevated concentrations to protect human health. Utilizing Single-Entity Electrochemistry (SEE), this method achieves precise detection of individual entities, significantly enhancing sensitivity and selectivity. By enabling the detection of single entities in aqueous environments, SEE provides distinct advantages over traditional methods, such as increased sensitivity, improved selectivity, and effective trace detection without requiring electrode surface modification. This approach reliably captures individual interactions and redox behavior, offering a robust platform for trace heavy metal analysis in environmental and health-related applications.

Keywords: Heavy metal ions, Single-Entity Electrochemistry, Metal detection, Collision signals.

Poster Session

[PA-17- Math/Computer/Info Sci/Physics]

Multiclass classification based on a quantum autoencoder

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Abstract

Autoencoder is an unsupervised learning method and consists of an encoder and a decoder. The encoder transforms the input $\boldsymbol{x}$ into a latent expression $\boldsymbol{z}$, and the decoder transforms $\boldsymbol{z}$ into the output $\hat{\boldsymbol{x}}$. Parameters in the encoder and decoders are optimized to achieve $\boldsymbol{x} \approx \hat{\boldsymbol{x}}$. Quantum autoencoder is a quantum machine learning method that implements an autoencoder. The encoder and decoder in the quantum autoencoder are parameterized quantum circuits. The quantum encoder is a hybrid algorithm using quantum and classical computers. In the training phase, parameters are optimized by a classical computer based on measurements in the quantum circuits. This work proposes a multiclass classification method based on a quantum autoencoder. Although quantum autoencoder is unsupervised learning, multiclass classification is a supervised learning task. In the proposed method, labels are encoded in qubits that are discarded in the original quantum encoder. The proposed method shows high accuracy in the binary and four-class classification of handwritten images.

Keywords: Quantum autoencoder, Multiclass classification

[PB-16-Biology]

Analyses of the G-quadruplex Binding Activity of the Intrinsically disordered Regions in Human Replication Initiation Proteins

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Abstract

In eukaryotic cells, origin recognition complex (ORC), Cdc6 and Cdt1function in pre-replication complex formation at replication origins in eukaryotic cells. However, how these proteins specifically binds to the origins is not clear yet. My lab has been focusing on the G-quadruplex (G4) binding activities that reside in the intrinsically disordered regions (IDRs) of human ORC, Cdc6 and Cdt1. G4 is a folded DNA/RNA structure consisting of four strands with G-stretches. Although G4-formable sequences are found in approximately 80% of human replication origins, the functional relation between these sequences and G4 binding activities of human replication initiation proteins is still obscure.

To elucidate the roles of G4 binding activity of these proteins, we transiently expressed the G4 binding-deficient proteins in human cultured cells and examined the nuclear localization of the mutant proteins. We have found that compared to the wild-type proteins, some mutants markedly changed nuclear localization and binding of mitotic chromosomes. These results suggest that G-quadruplex binding activity in the IDRs may be important for proper chromatin/chromosome binding of replication initiation proteins.

Keywords: DNA replication proteins, intrinsically disordered region (IDR), G-quadruplex

[PB-17-Biology]

ThermusQ: Comprehensive Knowledge Base for Genome Information of *Thermus thermophilus* Strains

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Abstract

Thermus thermophilus is an appropriate organism to study the mechanisms of high temperature adaptation ever since its discovery in 1968 at Mine Onsen hot spring in Japan. The mechanisms of thermostability of proteins have been extensively studied and we now know several principles for gaining stability under the condition of high temperature including loop elimination, substitution of amino acid types, and so on. In parallel to these studies, the genome sequences of HB8 and HB27 strains were determined in 2004 followed by the determinations of the sequences of other strains. The knowledge of protein stability and the data of genome sequences are, unfortunately, not well integrated for understanding the thermostability of cell system as a whole and no clear explanations of the thermostability of biosynthetic pathways and membranes, for example, are given so far. To understand thermostability of cell system, we launched ThermusQ, a knowledge base that collects data for *T. thermophilus* including genome sequences, genes, expression, biosynthetic pathways, and others at https://www.thermosq.net. ThermusQ comprises the genome sequences of 22 strains from *T. thermophilus* and *T. oshimai* strains, plus the sequences of known *Thermus* phages. By gathering the whole data of *T. thermophilus* strains, the strain-specific characteristics was discovered. This bird's-eye view of the whole data will lead the research community to identify missing important data, and the integration will provide a platform to conduct future biochemical experiments on the bacterium.

Keywords: comparative genomics; data science; genome bioinformatics; Thermophiles.

Reference

Atsushi Hijikata, Tairo Oshima, Kei Yura, Yoshitaka Bessho (2023) ThermusQ: Toward the cell simulation platform for *Thermus thermophilus*. *Journal of General and Applied Microbiology*, **69**(2), 59-67. doi:10.2323/jgam.2023.07.001.