香港科技大學
THE HONG KONG
UNIVERSITY OF SCIENCE
AND TECHNOLOGY

School of 理學院 Science

The School of Science is committed to pursuing cutting-edge research, making groundbreaking discoveries and establishing new research paradigms. Our quality and well-balanced education places particular emphasis on grit, curiosity and creativity.

We promote a vigorous and dynamic learning environment with continuous enhancement of our curriculum. Our division and departments, namely Life Science, Chemistry, Mathematics, Ocean Science, and Physics, offer a broad range of academic programs and learning opportunities to students.

School Facts

Figures at a glance

Division / Departments 5

UG programs 12

MSc programs 9

MPhil programs 6

PhD programs 6

Exchange partners 50

Student profile (as of Sep 2022)

Number of UG students

2,200+

students from 7 regions

Number of PG students

1,300+

students from 7 regions

Alumni profile (as of Jun 2023)

Number of alumni

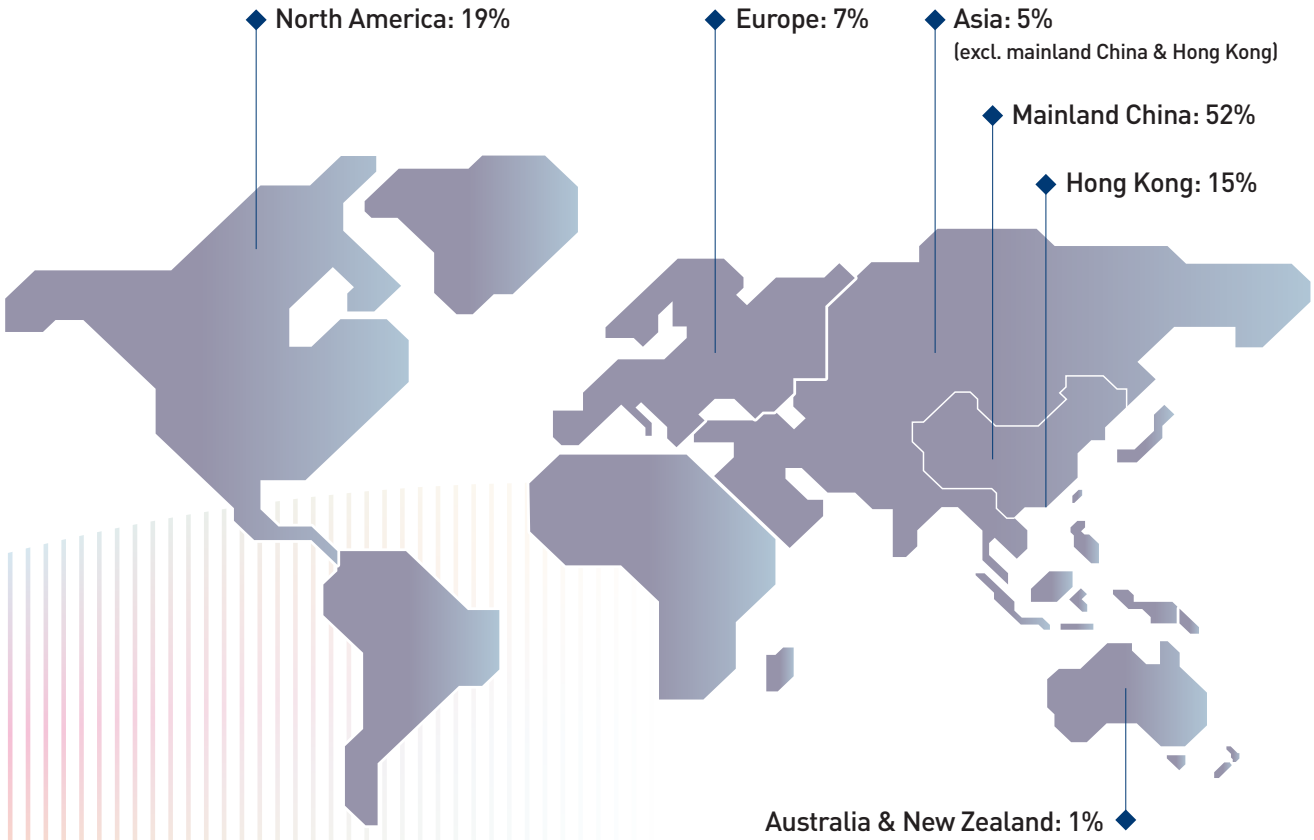
18,400+

Faculty profile

Number of faculty members (as of Aug 2023)

Division of Life Science	Department of Chemistry	Department of Mathematics	Department of Ocean Science	Department of Physics
35	23	40	14	36

Around 150 full-time faculty members from 6 regions



Highlights of Faculty Achievements

Awards at a glance

- 10 Science Stars of China by Nature
- National Natural Science (NSFC) Awards
- Chevalier de l'Ordre National du Mérite (National Order of Merit) by the French Government
- L'OREAL-UNESCO for Women in Science Award
- AmCham Women of Influence Awards by the American Chamber of Commerce in Hong Kong
- RGC Senior Fellowship
- RGC Research Fellow
- Croucher Innovation Awards
- Croucher Senior Research Fellowships
- Croucher Tak Wah Mak Innovation Awards
- Outstanding Scientific Research Output Award (First Class) of the China Ministry of Education
- American Chemical Society Young Investigator Award
- AI 2000 Machine Learning Most Influential Scholars Honorable Mention
- AMS-SIAM George David Birkhoff Prize in Applied Mathematics
- Deep Carbon Observatory Emerging Leader Award
- Higher Education Outstanding Scientific Research Output Awards by Ministry of Education of China
- Inaugural Brillouin Medal by the International Phononics Society
- Oceanic Engineering Science and Technology Award
- MIT Technology Review Innovators under 35 Asia

- The Royal Society of Chemistry Nanoscale Emerging Leader
- Tencent Foundation Xplorer Prize
- The Japan Agency for Medical Research & Development (AMED) and the New York Academy of Sciences (NYAS) Interstellar Initiative Early Career Investigators
- World Economic Forum Young Scientist
- Zhong Nanshan Youth Science and Technology Innovation Award

Fellowship / Elected Membership

- Academia Sinica
- American Academy of Arts and Sciences
- American Physical Society
- Association for the Sciences of Limnology and Oceanography
- Chinese Academy of Medical Sciences
- Chinese Academy of Sciences (CAS)
- East Asia Section of the Society for Industrial and Applied Mathematics (EASIAM)
- Greater Bay Area Association of Academicians
- Hong Kong Academy of Sciences
- Hong Kong Young Academy of Sciences
- Institute of Electrical and Electronics (IEEE)
- Karolinska Institute Ming Wai Lau Centre for Reparative Medicine
- Optical Society of America
- Royal Society of Chemistry
- National Academy of Sciences, USA
- The World Academy of Sciences
- Institute of Mathematical Statistics

QS World University Rankings by Subject 2023

#45 Materials Sciences
No.1 in Hong Kong

#55 Chemistry
No.1 in Hong Kong

#101 Physics & Astronomy
No.1 in Hong Kong

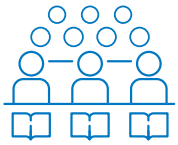
#46 Statistics & Operational Research
No.1 in Hong Kong

#59 Mathematics
No.1 in Hong Kong

#50 Environmental Sciences
No.2 in Hong Kong

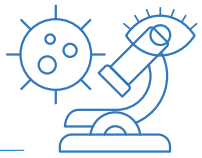
#92 Natural Sciences
No.2 in Hong Kong

12 Undergraduate Programs



- BSc in Biochemistry and Cell Biology
- BSc in Biotechnology
- BSc in Biotechnology and Bachelor of Business Administration (BSc & BBA Dual Degree Program)
- BSc in Biotechnology and Business (Jointly offered by the School of Science and the School of Business and Management)
- BSc in Chemistry
- BSc in Data Analytics in Science
- BSc in Data Science and Technology (Jointly offered by the School of Science and the School of Engineering)
- BSc in Mathematics
- BSc in Mathematics and Economics (Jointly offered by the School of Science and the School of Business and Management)
- BSc in Ocean Science and Technology
- BSc in Physics
- BSc in Risk Management and Business Intelligence (Jointly offered by the School of Business and Management, the School of Science and the School of Engineering)

21 Postgraduate Programs



- MSc in Analytical Chemistry
- MSc in Big Data Technology (Jointly offered by the School of Engineering and the School of Science)
- MSc in Biotechnology
- MSc in Data-Driven Modeling
- MSc in Environmental Health and Safety
- MSc in Financial Mathematics
- MSc in Financial Technology (Jointly offered by the School of Business and Management, the School of Engineering and the School of Science)
- MSc in Global Marine Resources Management (Dual Degree by HKUST and University of Southampton)
- MSc in Mathematics for Educators
- MPhil in Chemistry
- MPhil in Life Science
- MPhil in Marine Environmental Science
- MPhil in Mathematics
- MPhil in Nano Science and Technology
- MPhil in Physics
- PhD in Chemistry
- PhD in Life Science
- PhD in Marine Environmental Science
- PhD in Mathematics
- PhD in Nano Science and Technology
- PhD in Physics

Alumni Stories

The School of Science is dedicated to providing our students with an inspiring environment for studying science and appreciating its beauty. Many of our alumni have leveraged their scientific training to excel in their professional journeys and career endeavours, bringing their own unique insights and philosophy to their work and life. Here are some inspiring stories of our distinguished alumni.

Ronan Ka Fat CHAN

Class of 1996, BSc in Biology
General Manager, Cardiac Rhythm Management,
Hong Kong & Taiwan, Abbott

Ronan Chan is an alumnus of the School of Science, majoring in Biology. From his early years as a medical sales representative in a local distributor to his current role as a General Manager of a leading global healthcare company, Ronan credits his undergraduate education for shaping his mindset and preparing him for the challenges in the business world.

For Ronan, failure is not something to be feared but rather embraced as a key to personal growth. As he recalls his years in the School of Science, “Biology is more of an artistic subject where things don't always go as planned". In scientific experiments, things could still go wrong even if one had followed the protocol closely. As he joined the workforce, he realized that it is, in fact, very similar to the daily challenges of his job. Ronan believes that the experience of coping with unavoidable failures is crucial to developing resilience and adaptability in a rapidly changing world. Reflecting on his time as an undergraduate, he emphasizes the importance of being humble and open-minded to accept and learn from failures as the key to developing oneself into "the fittest" in any field.

Ronan's leadership style is grounded in the principles of harmony and diversity, inspired by the biodiversity class taught by the late Prof. Fu-Shiang CHIA. As Ronan shares, "We have colleagues with very different personalities and mindsets in our office. Each of them has a unique mode of communication and motivation. We value this diversity because it can offer a wide range of insights and solutions to a question. This is the key to sustainable success." Ronan's idea of applying biological concepts to an everyday scenario is along the lines of the view on art of his biodiversity teacher, who wrote "There is almost no art which can be divorced from the natural world." in his translation of a Chinese classic *Airs of the States*《詩經 · 國風》under his second identity as a sinologist. Ronan’s approach to leadership is a testament to the transferable skills and vision that scientific education can provide, allowing one to cross the subject boundaries, and thrive in other niches.

As a lifelong learner, Ronan is committed to making a difference in the world of healthcare. With his expertise in cardiac rhythm management, Ronan is dedicated to working with medical professionals to save more lives and improve the well-being of patients. He shares with current and future science students that “Learning is a lifelong process, and there is still a long journey to embark on after graduation, so we should all treasure every learning opportunity and achieve continuous improvement”.

Clinton Kai Chun LI

Class of 2022, BSc in Physics
Co-founder, Inscie HK

Clinton Li, a graduate of BSc in Physics in 2022, has made impressive strides in his career as a science communicator and marketer. In addition to his full-time job in a marketing agency, Clinton is also the co-founder of Inscie HK, an online science communication platform that aims to educate the general public about science in a relatable and engaging manner. His studies at the School of Science played a crucial role in shaping his passion for promoting science.

Clinton places great value on a strong foundation in science, which has been instrumental in his role as a science communicator, "By pursuing double minors in business, and astrophysics and cosmology, I was able to explore the possibility of blending business practices with my scientific passion." Clinton gave special mention to the professors in his science major who have been a great source of academic and personal development for him.

Leveraging the success of Inscie HK, Clinton and his team co-authored a popular science book titled《我講理學—香港今昔未來微科學》*(Our City, Our Story: A Scientific Journey to the Past, Present and Future of Hong Kong)*. The book delves into the science behind various places in Hong Kong, and is a testament to Clinton's ability to apply his scientific knowledge to explain real-world phenomena to the public.

Clinton's experience at the School of Science is crucial to his current career trajectory. In particular, Inscie HK's inception was a serendipitous outcome of Clinton's participation in the School of Science's "Science is Everywhere" Competition. He also joined the Science Busking Team, where he met like-minded individuals who shared his passion for science and turned out to be great teammates at Inscie HK.

As he prepares to embark on his next adventurous journey to Australia to pursue further studies in Science Communication, Clinton suggests students who are studying or planning to study science to "remain persistent when exploring your interests." He believes that "one never knows what opportunities await them in the future unless they are willing to try and push themselves out of their comfort zone."

With this attitude, the possibilities for scientific discovery and innovation are endless.

Abigail Zhien WANG

Class of 2020, BSc in Chemistry (International Research Enrichment Program)
PhD candidate in Materials Science and Engineering,
Massachusetts Institute of Technology

Abigail Zhien Wang's academic journey began with her undergraduate studies at the School of Science at HKUST, where she pursued a BSc in Chemistry (International Research Enrichment (IRE) program). Her time at the School of Science was a transformative experience, as she gained the knowledge, skills, and experience necessary to prepare for her current postgraduate studies and future career in academic research.

During her four years at the School of Science, Abigail enjoyed a flexible curriculum that allowed her to explore different perspectives of science and discover her true passion. She expressed gratitude for her mentor, Professor Qing CHEN, who played a pivotal role in her academic journey, "Professor Chen encouraged me to think rigorously, critically and independently, and to develop my skills as a scholar and scientist. His guidance was invaluable, and I am so thankful for his support."

Abigail also took the opportunities for global exposure, participating in exchange programs and studying abroad at top institutions such as the Technical University of Denmark (DTU) and the Swiss Federal Institute of Technology in Zurich (ETH Zurich). These experiences broadened her horizons and gave her a global vision that would serve her well in her scientific research endeavours.

Abigail's experience working on various research projects, both locally and globally, held her in good stead as she looks ahead to a research career. She participated in the Undergraduate Research Opportunities Program at HKUST, which sparked her passion for research. The IRE program also enabled her to gain hands-on research experience, including an internship at the Massachusetts Institute of Technology (MIT). The dots will somehow connect in the future. Abigail is now pursuing a PhD degree in Materials Science and Engineering at MIT, where she continues to push the boundaries of knowledge and innovation. Her scientific mindset and interdisciplinary approach to research enable her to tackle every challenge with confidence and creativity.

Through interacting with other members of the School, Abigail is grateful that she has developed not only good interpersonal skills but also a growth mindset. She encourages undergraduate students to seize every opportunity with an open mind, walk out of their comfort zones, and discover new areas to learn. "The habit of studying and the mindset you gain from learning are more valuable than the knowledge or grades you receive, for these are the things that will accompany you throughout your life. There are many possible answers to your questions beyond the library, so please do not hesitate to talk to your mentors, professors, and classmates."

For Abigail, the School of Science is not just a place of learning but a place of endless possibilities and potential.

Dr. Eddy WU

Class of 2006, PhD in Biochemistry
Class of 2002, BSc in Biochemistry
Founder & CEO, Arctic Vision

Dr. Eddy Wu, a graduate with both a BSc and a PhD in Biochemistry, is an exemplary figure of how science education prepares students for a successful career. His education and experiences at the School of Science laid a solid foundation for his remarkable journey as a healthcare innovator and entrepreneur who has made a meaningful impact in the industry.

Dr. Wu is grateful for the diverse range of knowledge and skills, from biochemistry to business, that he gained, which allowed him to understand the global standards and competitive landscape of scientific research. One pivotal experience that continues to shape his career today was the process of applying to be a laboratory assistant with esteemed professors early on in his studies. "This empowered my personal growth and development in remarkable ways," he recalls. "I learned valuable life skills such as critical thinking, self-reliance, and strategic planning." This experience gave Dr. Wu the confidence to take control of his future and set him on a path to success. This was also the turning point of his study life, where Dr. Wu met his PhD supervisor, Prof. Yung Hou WONG, the Dean of Science and Chair Professor of Life Science, who helped him hone his skills and develop his vision for the future.

As a committed PhD student, Dr. Wu published academic papers and presented his research findings at top-notch international conferences. Through this process, he learned to welcome constructive criticism and recognized that these interactions were crucial for scientific development. "This rigorous training has been particularly advantageous in my current role within the healthcare industry, where I restlessly push the boundaries of knowledge and innovation," he notes.

Dr. Wu's passion for science eventually led him to establish Arctic Vision, a company that provides medical treatments for millions of patients suffering from eye disorders. He attributes his success to the foundation he received during his studies at the School of Science, which ignited his passion for science and inspired him to pursue a career in healthcare. "The pursuit of cutting-edge technology is now part of my DNA, and I bring that determination to Arctic Vision," he says.

As a respected leader in the healthcare industry, Dr. Wu advises students interested in studying science to be prepared to embrace creativity and handle situations proactively. He believes that with a science education background and a positive mindset, everything is possible. "The world is constantly changing, and it is important not to solely judge the future based on one's fixed mindset and knowledge," he adds.

Research @HKUST Science

The research reputation of the School is built upon the strengths of its faculty members, who are renowned experts in multiple fields of science. Highlights of current research focuses include neuroscience, materials chemistry, scientific computing and data science, wave functional materials, ocean science and technology, quantum science, stem cell, environmental chemistry, and drug synthesis and development.

Research Strengths and Major Research Projects

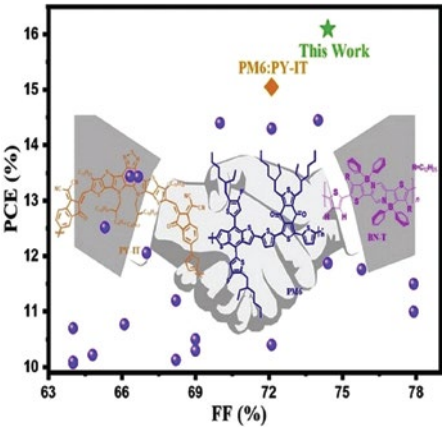
For details of respective research areas and projects, please visit our website.

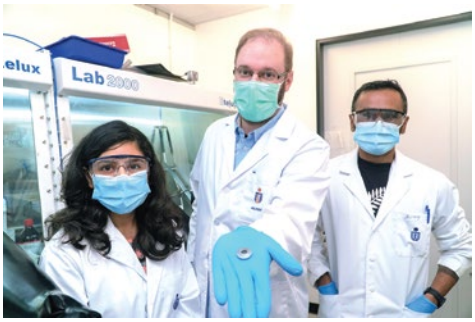
MATERIALS CHEMISTRY

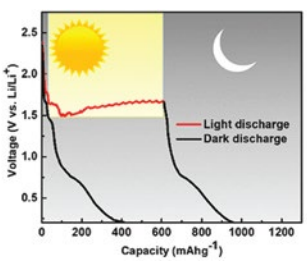
Design and Fabrication of Efficient Organic Solar Cells

(PI: Prof. Henry He YAN)

Organic semiconductors are important for various applications such as organic solar cells, transistors, and detectors. In 2014, Prof. Henry Yan discovered the Temperature-Dependent Aggregation behavior of certain polymeric donor materials, which led to the fabrication of high-performance organic solar cells for the first time. The group later achieved a record efficiency of 11.5% for single-junction organic solar, which was noted as a major technological breakthrough in NREL chart of "Best Research-Cell Efficiencies". They continue to improve the design and efficiency of organic solar cell materials and devices, which have the advantage of being able to mass produce thin, flexible solar cell films for various applications.







Metal Halide Nanocrystals for Energy Storage and Optical Emission

(PI: Prof. Jonathan HALPERT)

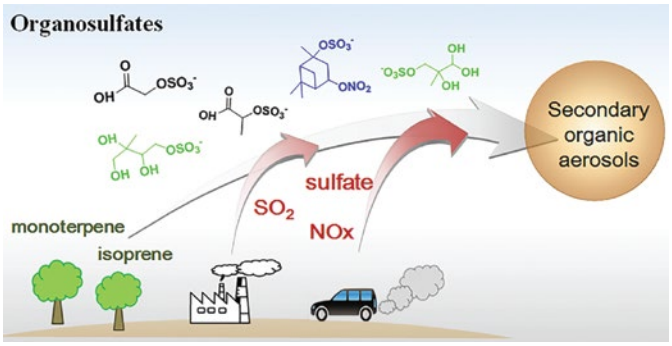
Semiconductor nanocrystals have unique properties compared to bulk materials. Their small size allows for tuning of the semiconductor band gap, which is important for their ability to emit light with tunable wavelengths. Prof. Jonathan Halpert has patents on semiconductor nanomaterials for display technologies and for energy storage. Lead-based perovskites are good for LEDs but contain toxic lead, so Prof. Halpert's group is using metal halides of copper and bismuth to produce efficient and non-toxic nanomaterials for energy storage and emission. Recently they have developed an inexpensive and lightweight photo-battery that can harvest and store solar energy in a single device.

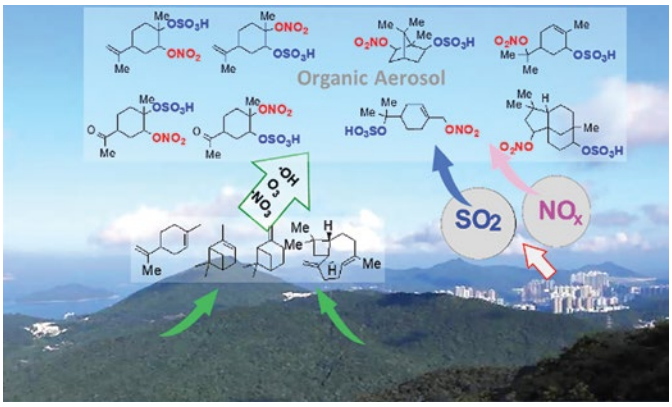
ENVIRONMENTAL CHEMISTRY

Characterizing Organosulfate Compounds in Atmospheric Aerosols

(PI: Prof. Jianzhen YU)

The Earth's atmosphere is a giant reactor where a wide range of chemical reactions occur.
The atmosphere's role as a reactor is crucial in regulating the Earth's climate and impacting air quality. Organosulfates, which are organic compounds containing sulfate groups, play a significant role in the atmosphere's chemistry, especially in the formation of secondary organic aerosols that contribute to air pollution and climate change. The lack of authentic standards for organosulfates derived from terpenes had hindered the study of their atmospheric chemistry.
Prof. Jianzhen Yu and her team have achieved the first concise chemical synthesis of these standards, thus enabling discovery of previously unrecognized transformation pathways in their formation and the quantification of their presence in four Chinese cities. Anthropogenic chemical factors were found to outcompete terpene emissions from nature in the formation of these organosulfates. This knowledge is crucial for developing effective strategies to mitigate the adverse impacts of air pollution and climate change.





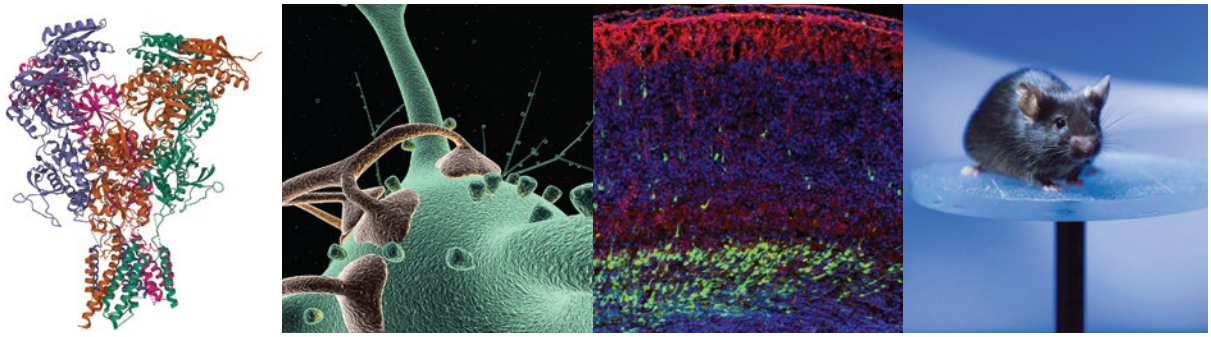
DRUG SYNTHESIS AND DEVELOPMENT

Total Synthesis of Potent Antibiotic Anthracimycins

(PI: Prof. Rongbiao TONG)

Due to the rise of antibiotic resistance, there is a need for new antibiotics with different molecular structures and modes of action. The discovery of anthracimycin, a novel macrolide natural product, is a major advance in the field of antibiotics. It has potent antibacterial activity against many strains of drug-resistant bacteria, low toxicity to human cells, and a novel mechanism of action. Prof. Rongbiao Tong and his team have developed a 10-step asymmetric total synthesis of anthracimycin and anthracimycin B, which provides a supply of anthracimycins for further studies and allows for the preparation of a library of analogues. The synthetic anthracimyins have not only exhibited similar antibacterial potency as the naturally occurring anthracimycins against Gram-positive strains but also inhibited MRSA biofilm formation with 60 times lower minimum biofilm inhibitory concentration (MBIC) than vancomycin.

NEUROSCIENCE



Unravelling Mechanisms of Synaptic Plasticity in Health and Neurodegenerative Diseases

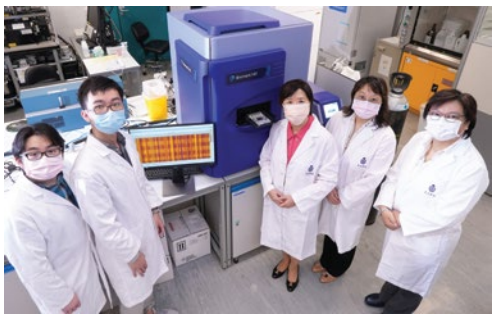
(PI: Prof. Nancy IP)

In 2017, this cross-institutional research project led by HKUST was selected as an Areas of Excellence (AoE) Scheme and awarded HK$63.578 million from the Research Grants Council of Hong Kong for an eight-year period consisting of two phases. This project aims to lay crucial groundwork for delineating the key molecular mechanisms underlying cognitive dysfunction in neurodegenerative diseases such as Alzheimer's disease. Advancement of this initiative will greatly facilitate the development of new therapeutics that improve the lives of millions of affected patients worldwide, while highlighting Hong Kong's excellent neuroscience research capacities and infrastructure.

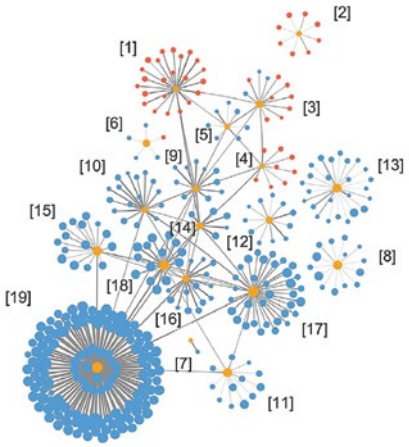
Between 2017 and mid-2020, efforts focused upon the AoE Scheme resulted in the publication of 92 scientific papers in high-impact journals, along with 132 invited talks at international conferences and academic institutions. By sharing expertise and insights as well as research technology and materials, team members have established collaborations both locally and internationally, successfully endeavoring novel developments and findings.

Identifying Biomarkers of Alzheimer's Disease for the Development of Targeted Therapy

(PI: Prof. Nancy IP)

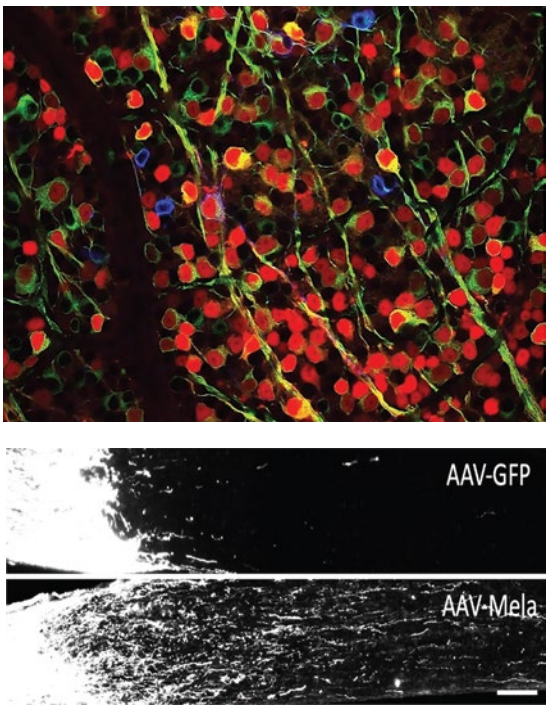


Alzheimer's disease (AD) affects over 50 million people worldwide; it involves the loss of brain cells and progressive memory loss. Traditional diagnostic methods are expensive, invasive, and often unavailable in many countries. Collaborating with researchers from University College London and clinicians at Hong Kong hospitals, Prof. Nancy Ip and her team have systematically quantified over 1000 plasma proteins with an ultrasensitive blood-based protein detection technology to identify dysregulated proteins in AD patients. They have developed a scoring system that can distinguish AD patients from healthy individuals with over 96% accuracy, and differentiate between early, intermediate, and late stages of AD for monitoring disease progression. This study has formed a strong foundation for the development of targeted therapy for AD, which can be optimized for different populations around the world.



Axonal Regeneration and Rewiring in Adult Central Nervous System

(PI: Prof. Kai LIU)



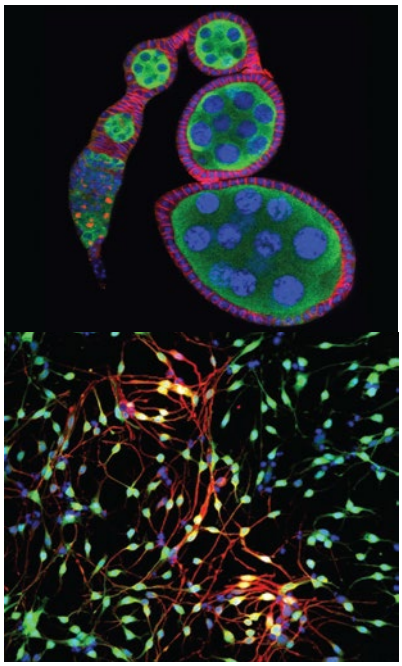
Neurotrauma, such as brain or spinal cord injury, can cause neurological deficits due to limited functional recovery caused by a lack of successful axonal regeneration and rewiring. This Collaborative Research Fund project aims to use a newly established optic tract lesion model to study functional reconnection.
Prof. Kai Liu and his team plan to use a novel combination strategy to boost the intrinsic growth capacity of retinal ganglion cells to regenerate retinal axons across the optic tract lesion site, reinnervate target neurons in the brain, and restore light reflex. The goal is to enhance functional recovery and understand the cellular and molecular mechanisms underlying axon regeneration and functional rewiring. Successful completion of this project will help establish strategies to rebuild disconnected neural circuits after brain injuries and improve understanding of the fundamental mechanisms that mediate functional reconnection after central nervous system injuries.

STEM CELL RESEARCH

Stem Cell-niche Interactions in Tissue Maintenance and Engineering

(PM: Prof. Ting XIE)

Stem cells can replicate and differentiate into specialized cells, supporting normal development and maintaining tissue homeostasis in adults. They serve as potential treatments for degenerative diseases, cancer, and age-related deterioration. Combining stem cells with biomaterial scaffolds, transplantable tissues or organs can be generated to treat degenerative diseases. However, the regulation of stem cell activities inside intact tissues is not well understood, hindering the full potential of stem cell therapy. This Theme-based Research Scheme project aims to investigate the molecular mechanisms underlying stem cell maintenance and differentiation, along with aging in model organisms like *Drosophila*, zebrafish, and mice. A team of investigators from HKUST, HKU, and CUHK will study how the microenvironment controls stem cell behaviors and functions using advanced genomic, genetic, molecular, biochemical, and developmental approaches.



A Stem Cell Approach to Dissect the Molecular Basis of Neurodegenerative Diseases

(PC: Prof. Nancy IP; Deputy PC: Prof. Zhenguo WU; Co-PIs: Profs. Tom CHEUNG, Amy K. T. FU, Kwok On LAI, Robert Z. QI, Jianan QU, Zilong WEN, Yung Hou WONG, Jun XIA, Wing Ho YUNG, Mingjie ZHANG; Co-investigators: Kenny CHUNG, Bo FENG, Jufang HE, Xuhui HUANG, Karl TSIM)

A cross-institutional research project led by HKUST was awarded HK$31.2 million in 2018 to develop new and innovative therapies for the treatment of age-related neurodegenerative disorders, including Alzheimer's disease (AD). This Theme-based Research Scheme (TRS) project aims to dissect the pathological mechanism underlying AD using state-of-the-art iPSC-derived platforms and CRISPR-Cas9 genome-editing technologies. The project builds upon a previous TRS-funded research project that identified regulatory mechanisms for the differentiation and proliferation of neural stem cells. To date, 94 publications have resulted, pushing our understanding of the disease forward. The project aims to bring us closer to the development of novel therapies, including personalized medicine, that can ameliorate or even reverse the devastating effects of AD, improving the quality of life for those affected.

Molecular Regulation of Quiescence and Early Activation in Muscle Stem Cells

(PM: Prof. Zhenguo WU)

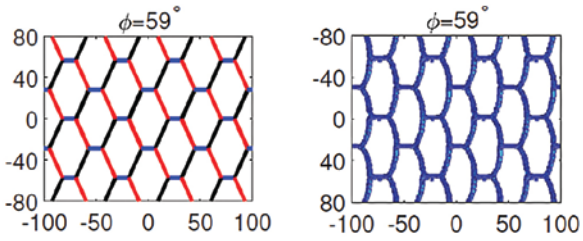
In vertebrates, adult muscle satellite cells (MuSCs) are crucial for muscle regeneration after injury, starting from a quiescent state to re-entering the cell cycle to differentiate and repair the damaged muscle. The transition from quiescent MuSCs to cycling myoblasts is tightly regulated, and dysregulation during this period can result in severe muscle regeneration defects. The mechanisms of this transition are not yet understood. This research project proposes to use mouse models to investigate the molecular, cellular, and mouse-based mechanisms that regulate the transition of adult quiescent MuSCs to cycling myoblasts upon muscle injury. The results of this study could lead to a better understanding of the regulation of MuSC and help develop MuSC-based regenerative medicine for muscle diseases, including muscle atrophy (e.g. sarcopenia) in the elderly.

SCIENTIFIC COMPUTING AND DATA SCIENCE

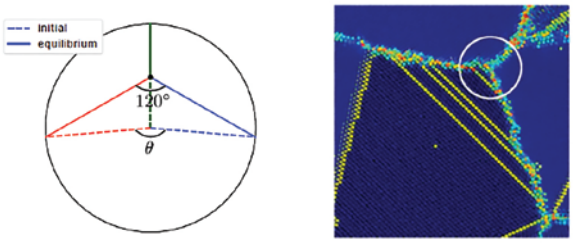
Energy and Dynamics of Grain Boundaries Based on the Underlying Microstructures

(PI: Prof. Yang XIANG)

Grain boundaries are important interfaces between grains with different orientations in polycrystals, and their properties affect the mechanical and plastic behaviors of materials. Existing models for grain boundary dynamics neglect important microscopic structures and mechanisms, limiting their ability to describe novel phenomena such as stress-driven and shear-coupling motions. In this project, continuum models were developed to incorporate the underlying microstructure of line defects in grain boundaries, which include both grain boundary and line defect densities. These models also consider the stress field due to long-range elastic interaction between line defects. Efficient numerical methods were developed to handle the computation of nonlocal and singular stress field. Continuum models were also developed for the dynamics of triple junctions in the grain boundary network microstructure of polycrystalline materials.



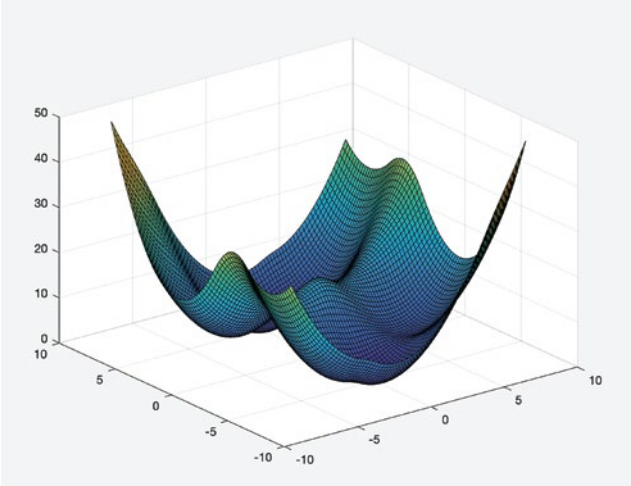
Dislocation structure of a grain boundary: Numerical result (left) and atomistic simulation result (right)



Dynamics of a triple junction: Numerical result (left) and molecular dynamics result (right)

Geometric Landscape Analysis of Some Non-Convex Optimizations

(PI: Prof. Jianfeng CAI)

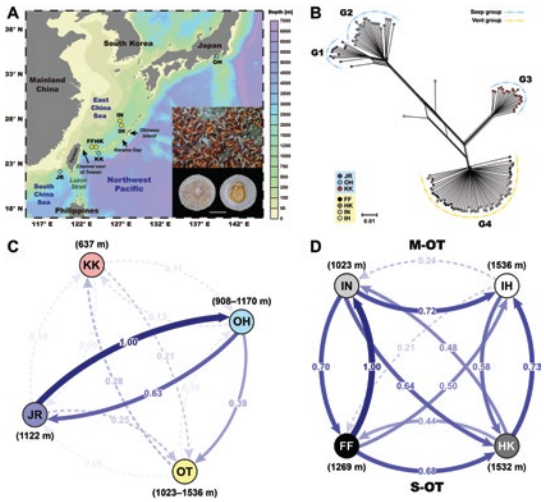


Non-convex optimization is a powerful tool for solving scientific and engineering problems, including low-rank approximation and deep neural network training. Simple algorithms like alternating minimization and gradient descent often work well for non-convex problems despite possible local minima. Recent research has shown that many non-convex functions arising in high-dimensional data analysis have no poor local minima, allowing efficient and effective solutions with a theoretical guarantee. In this project, the landscape of non-convex optimization arising from phase retrieval, a fundamental problem in imaging techniques, was investigated. The results reveal that a family of non-convex optimizations for phase retrieval can have a benign landscape, meaning that all local minima are global and all other critical points have negative directional curvatures. This allows for the development of new efficient algorithms with a theoretical guarantee for solving phase retrieval problems.

OCEAN SCIENCE AND TECHNOLOGY

Unlock Biogeographical Secrets and Population Connectivity of Deep-sea Animals

(PI: Prof. Peiyuan QIAN)

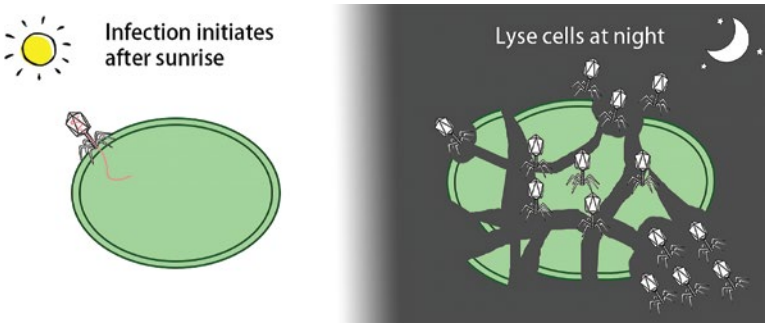


Population connectivity is a critical criterion in assessing the biodiversity conservation value of any particular habitat as stipulated by the Convention on Biological Diversity (CBD), International Maritime Organization (IMO) and other United Nations (UN) agencies, along with various international organizations. With the integration of population genomics analyses and physical ocean modeling data, Prof. Peiyuan Qian's research team has unlocked for the first time the demographic history, genetic structure, and population connectivity of deep-sea animals such as deep-sea limpet widely distributed in deep-sea vent and seep ecosystems in the Northwest Pacific. The results of their studies deepen our understanding of the demographical mechanisms and population connectivity of deep-sea organisms under the intricate interactions amongst local habitats, seafloor topography and ocean currents, lay a foundation for the conservation of marine biodiversity and sustainable utilization of marine resources, and pave the way for the establishment of regional environmental management plans as well as the designation of marine protected areas in the global ocean. The research findings of this project were published in the international academic journal *Molecular Biology and Evolution*.

Diurnal Infection Rhythm of Cyanophages and Its Implication on Marine Carbon Cycle

(PI: Prof. Qinglu ZENG)

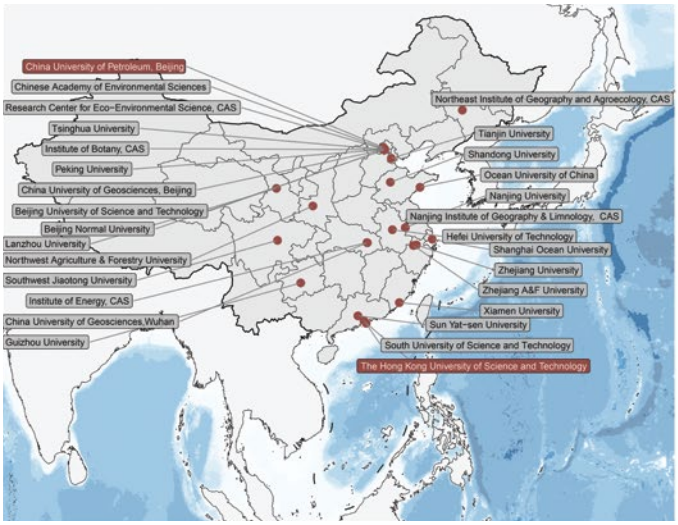
The research team led by Prof. Qinglu Zeng investigated how cyanophages use light-dependent and light-independent adsorption strategies to adapt to the natural light-dark cycle in the oceans. They found that the time of infection affects the relative fitness of cyanophages with different adsorption strategies and built a mathematical model to describe the infection kinetics of cyanophages with different adsorption strategies. They also unveiled diel infection rhythms of field cyanophage populations in the North Pacific Subtropical Gyre. The findings of this project have led to publications in scientific journals *PNAS, mSystems* and *Microbiome*. The study provides insights into the interaction of cyanophages and cyanobacteria and its influence on marine carbon cycling.

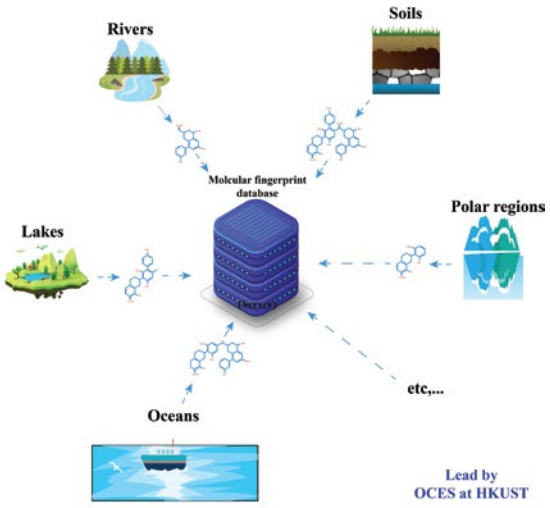


Constructing and Decoding the Molecular Fingerprint Database of Organic Carbon

(PI: Prof. Ding HE)

Organic carbon is the most reactive carbon pool on earth and undergoes physical and biochemical alteration during its transport along the land-ocean continuum. The composition, sources, biogeochemical cycling, and environmental fate of organic carbon in estuaries and coastal oceans are of interest to marine biogeochemists. Prof. Ding He's group is constructing a molecular fingerprint "big database" by integrating molecular data from different natural environments, including oceans, using ultra-high-resolution mass spectrometry. They aim to assess molecular signatures, extract associations between different environments using big data techniques, predict the fate of organic matter, and drive the development of future case studies. The big data results will provide a basis for future organic matter research directions.





Internal Waves as a Driver of Cryptic Diversity in Reef Corals under Threat

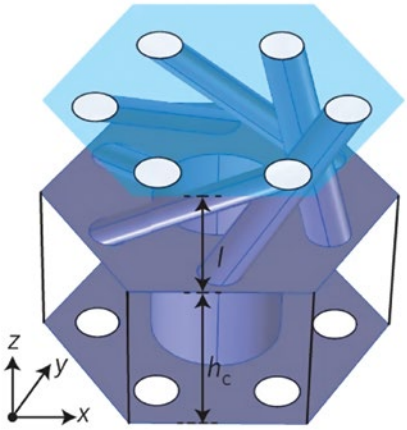
(PI: Prof. Alex WYATT)

In collaboration with researchers from Florida State University, Scripps Institution of Oceanography and California State University, Northridge, recent outputs from this work have demonstrated how differences in internal-wave exposure across coral reef depths may support cryptic diversity in the reef coral *Pocillopora* spp. By creating different thermal environments on reefs, internal waves might promote more resilient reefs, by increasing the diversity of corals and thus their responses to disturbances such as mass bleaching events.

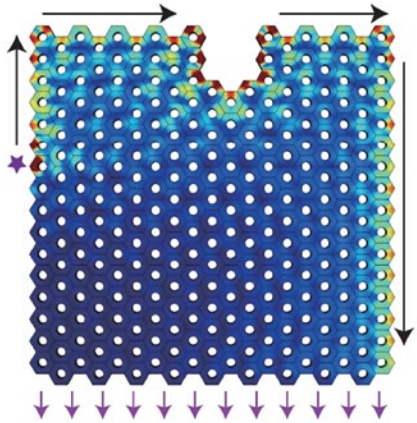
WAVE FUNCTIONAL MATERIALS

Novel Wave Functional Materials for Manipulating Light and Sound

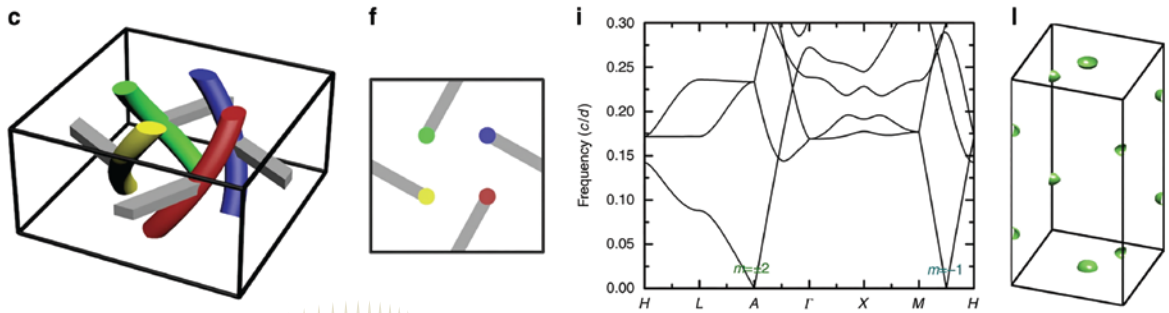
(PC: Prof. Che Ting CHAN; Co-PIs: Profs. Ping SHENG, Penger TONG, Ho Bun CHAN, Wing Yim TAM, Weijia WEN, Kam Shing WONG, Zhiyu YANG)



This Areas of Excellence (AoE) project aims to set up an inter-disciplinary research platform to generate fundamental knowledge and innovation in the field of wave functional materials, by designing, fabricating, and characterizing new materials that can manipulate light waves, sound waves, and other types of waves in ways that are not possible with conventional materials.



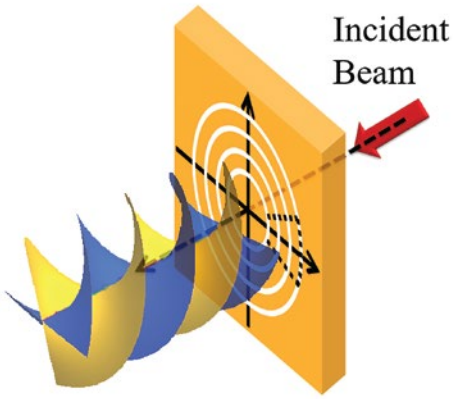
The research team explore the potential applications of these new materials, some of which can be used for the development of advanced devices, such as lenses, filters, and sensors. Some materials, such as super-absorbers, can be used immediately in daily applications. The team have also pushed the boundaries of knowledge by observing new physics and phenomena through the realization of photonic and acoustic materials that possess topological and non-Hermitian characteristics. As a result, numerous findings have been published in high-impact journals.

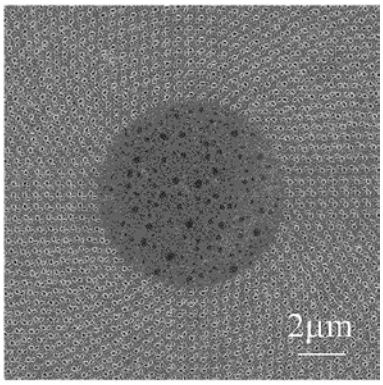


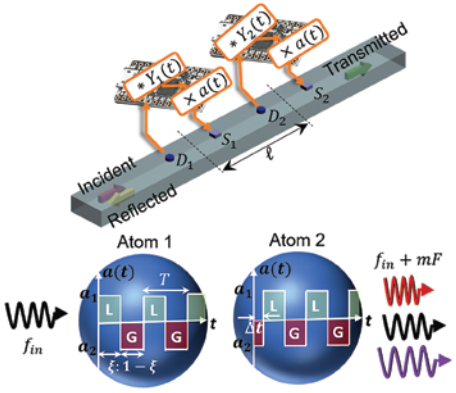
Non-Hermitian Systems in Optics and Acoustics

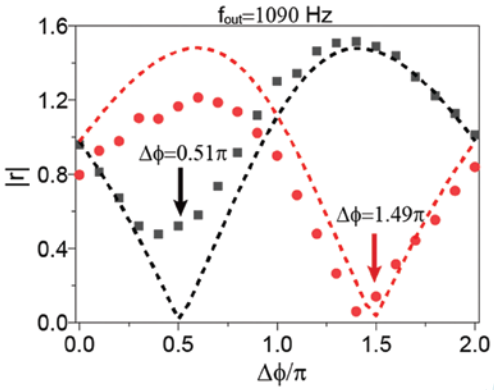
(PC: Prof. Jensen LI; Co-PIs: Profs. Che Ting CHAN, Wing Yim TAM)

This Collaborative Research Fund project aims to investigate how non-Hermitian physics can be used to manipulate wave propagation in both optical and acoustic systems. Recent explorations of loss and gain within non-Hermitian systems predict important roles for loss and gain in wave propagation due to the appearance of exceptional points. These exceptional points affect the system response in peculiar and sensitive ways, making potential applications of non-Hermitian physics virtually limitless, with some promising applications such as enhanced sensing, laser-mode selection, and unidirectional invisibility. The project explores new geometric structures of exceptional points, metasurfaces equipped with exceptional points, and dynamically tunable non-Hermitian systems to achieve these goals.







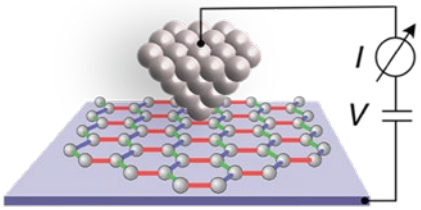


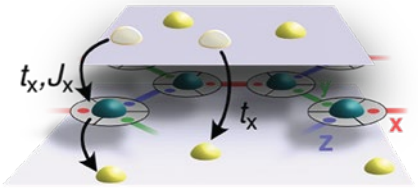
QUANTUM SCIENCE

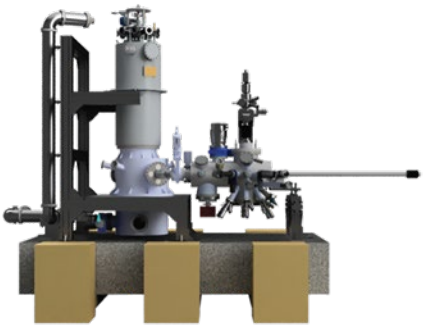
Quantum Matter and Microscopy

(PI: Prof. Berthold JÄCK)

New quantum materials with exotic properties can be designed using the rules of quantum mechanics. These materials can have new macroscopic quantum properties, such as fractionalized Majorana quasiparticles, that promise applications ranging from topological quantum computation to energy-efficient electronic devices. Prof. Berthold JÄCK and his team combine molecular beam epitaxy with scanning tunnelling microscopy and electric transport measurements to fabricate and investigate a variety of low-dimensional quantum materials, with the goal of revealing the microscopic mechanisms underlying their global quantum properties. They also strive to develop novel microscopy methods to investigate the local electric properties of quantum materials and devices at high spatial and temporal resolution.

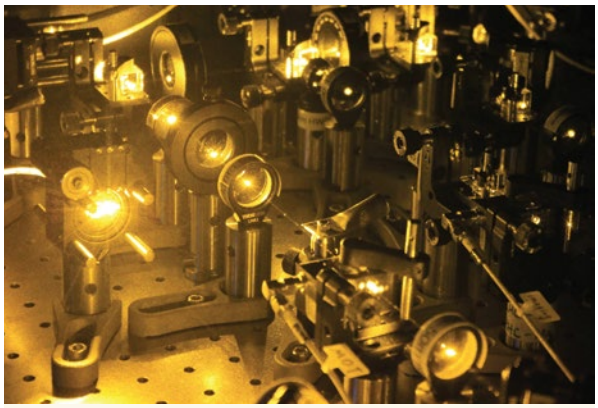


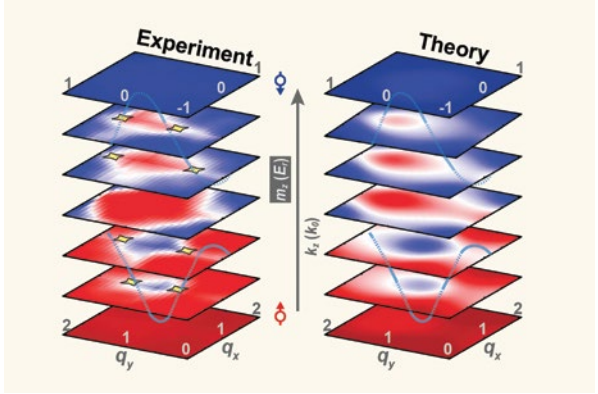




New Phases of Quantum Matter in Engineered Atomic Systems

(PI: Prof. Gyu Boong JO)





This Collaborative Research Fund project aims to search for new quantum matter and understand the underlying physics in engineered atomic systems.

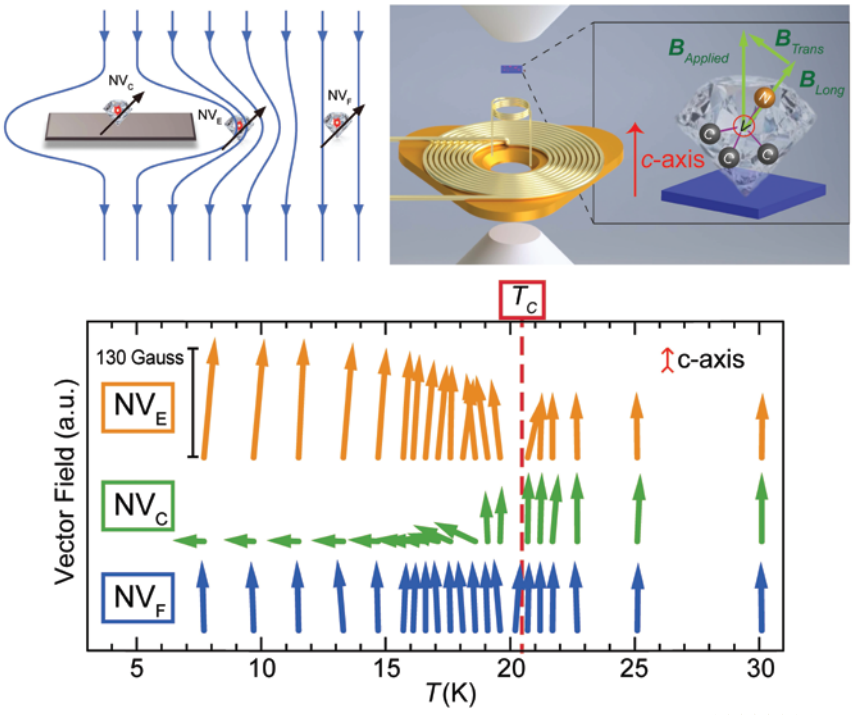
Prof. Gyu Boong Jo and his team will quantum-simulate fundamental Hamiltonians with non-trivial topology, interactions, and dissipations, and develop advanced tools and methods for emulating new phases of quantum matter. The project will use various state-of-the-art platforms in tabletop experiments and collaborate with theoretical groups. The goal is to create, characterize, and understand the physical principles behind new quantum matter. The research is highly interdisciplinary and requires a collaborative approach, which will contribute to a valuable workforce in quantum science and strengthen the research capacity of Hong Kong.

Quantum Sensing of Phenomena under Extreme Conditions

(PI: Prof. Sen YANG)

Extreme conditions like ultra-low temperatures and high magnetic fields are frequently required for the elimination of thermal noise and fluctuations to unravel the underlying intrinsic physics. For example, cooling down solid state quantum computing nodes made of point defect or dopant to tens of milli-Kelvin temperatures will quench the relaxation channels which hamper intrinsic long decoherence time and manipulate coupling with photon and phonon fields in a controlled manner; and the pairing of the electrons when a given quantum material undergoes. Furthermore, pressure is a clean, continuous, and systematic tuning parameter among the competing ground states in strongly correlated electron systems such as superconductivity and magnetism.

Sensing with qubits and novel quantum measurement techniques can provide higher resolution and sensibility. In this project, Prof. Sen Yang and his team use qubit based on point defect in diamond to realize sensing under extreme conditions.



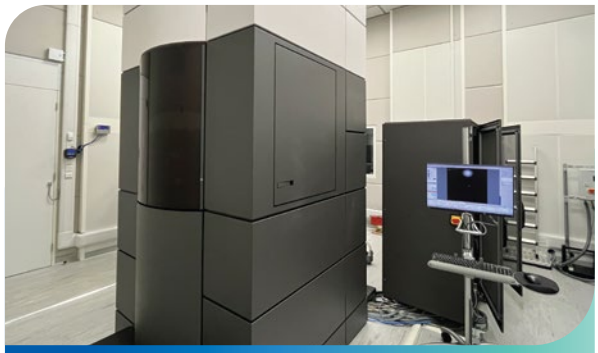
Research Infrastructure

Faculty members from the School of Science have played leadership roles in different research platforms which form important pillars of the University's overall research infrastructure in supporting group research efforts and interdisciplinary collaborations.

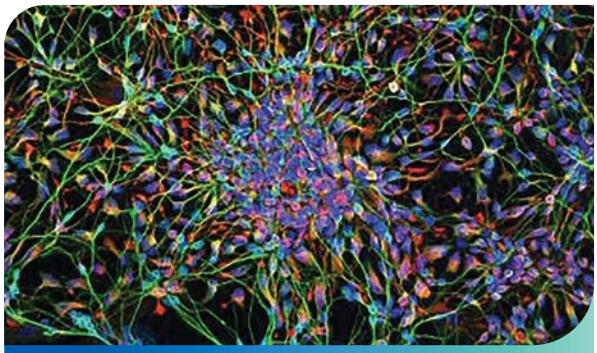
Central Research Facilities and National Labs and Centers

Biosciences Central Research Facility

Ocean Research Facility

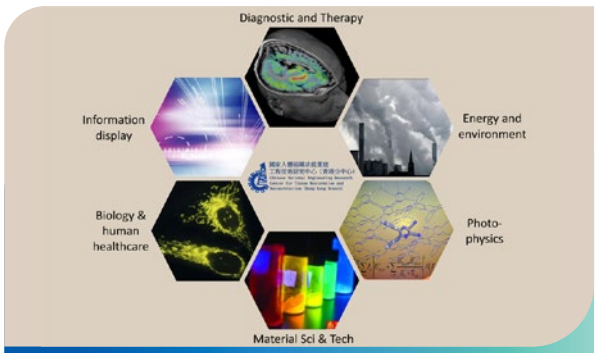


Laboratory Animal Facility
- Animal Facility
- Cryo-EM Center



State Key Laboratory of Molecular Neuroscience

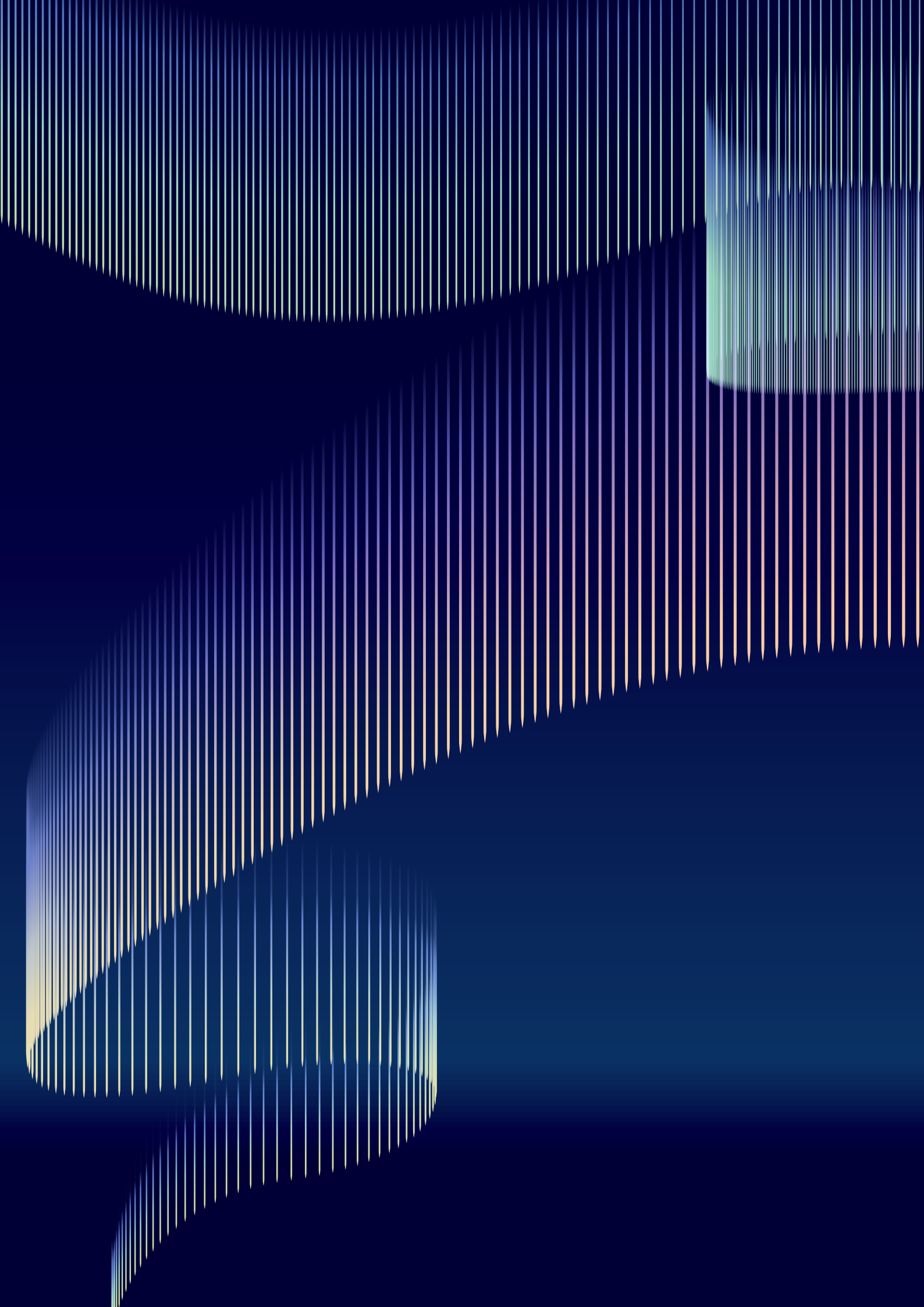
Materials Characterization and Preparation Facility



Chinese National Engineering Research Center for Tissue Restoration and Reconstruction (HK Branch)

Research Institutes and Centers

- Big Data Institute
  - Biotechnology Research Institute
- Center for Chinese Medicine R&D
  - Center for Epigenomics Research
- Center for Fundamental Physics
  - Center for Metamaterials Research
- Center for Quantum Materials
  - Center for Stem Cell Research
- Energy Institute
  - Glassblowing Facility
- HKUST The Big Data for Bio Intelligence Laboratory
  - IAS Center for Quantum Technologies
- Molecular Neuroscience Center
  - William Mong Institute of Nano Science and Technology



Website - School of Science

Instagram - Student Recruitment & Admissions

Instagram - Science Focus

The Hong Kong University of Science and Technology

School of Science

Address: Office of the Dean of Science
Room 6515, 6/F, Lifts 25/26
The Hong Kong University of Science and Technology
Clear Water Bay, Kowloon, Hong Kong

Phone: +852 2358 7261

Fax: +852 2358 1464

Email: ssci@ust.hk

MTPC-G22944