香港中文大學理學院
FACULTY OF SCIENCE
THE CHINESE UNIVERSITY OF HONG KONG

Collaborative Research
in the Faculty of Science and Beyond

SCIENCE FACULTY RESEARCH DAY 2020

5 AUG
0915 – 1140


Science
Empowers Your Dreams

PROGRAMME

09:15 – 09:25	**Welcoming Remarks** *Professor SONG Chunshan* *Dean of Science*
09:25 – 09:45	**Statistical Genomics: From Bulk Tissue to Single Cell** *Professor WEI Yingying* *Associate Professor, Department of Statistics*
09:45 – 10:05	**An Integrative Approach in Studying Jellyfish Bloom in the Environment under Climate Change** *Professor HUI Ho Lam Jerome* *Associate Professor, School of Life Sciences*
10:05 – 10:25	**Earthquakes Induced by Industrial Activities of Developing Unconventional Energy Resources** *Professor YANG Hongfeng* *Associate Professor, Earth System Science Programme*
10:25 – 10:35	**Break**
10:35 – 10:55	**Grazing Incidence X-ray Scattering Based Organic and Perovskite Solar Cell Studies** *Professor LU Xinhui* *Assistant Professor, Department of Physics*
10:55 – 11:15	**Data Driven Computational Techniques for Flow and Transport in Heterogeneous Porous and Fracture Media** *Professor CHUNG Tsz Shun Eric* *Professor, Department of Mathematics*
11:15 – 11:35	**Colloidal Particles at Interfaces: From Fundamentals to Materials** *Professor NGAI To* *Professor, Department of Chemistry*
11:35 – 11:40	**Closing Remarks** *Professor JIANG Liwen* *Associate Dean (Research)*

Excellence in Research

The Faculty of Science is proud to be home of over 100 dedicated scientists conducting cutting-edge research in various areas of science. Our staff and students remain committed to our Faculty's Mission in expanding the frontiers of human knowledge, aiming to build a better world for the future.

Message from the Dean of Science

Welcome to the Faculty of Science Research Day 2020. Every year, the Faculty organises a Research Day where faculty members are gathered together to share ideas and experiences in promoting research and collaboration in the Faculty and CUHK. Despite the outbreak of COVID-19, the Faculty launches the premiere online Research Day this year with the theme of "Collaborative Research in the Faculty of Science and Beyond".

CUHK is committed to encouraging faculty members to build research collaborations with the vision of advancing the frontiers of science and technology. The scientific breakthrough is enhanced by collaboration among individuals with diverse expertise but complementary perspectives. Collaborative research can maximise the synergistic effect from scholars with different expertise to overcome challenges in this fast-changing world and achieve the common goal of expanding scientific knowledge. Collaborative research has stoked the pace of research and stimulated the development of innovative and groundbreaking strategies in investigating increasingly complex and convoluted areas to generate greater research impact. We hope the Research Day 2020 can serve as a platform for researchers to exchange ideas from recent research advances and to encourage collaborative research across different disciplines.

Over the past seven years, the Faculty has successfully secured 13 CRF and 3 AoE projects. We are very pleased to have 6 distinguished speakers from different units this year, including Prof. Wei Yingying, Prof. Jerome Hui, Prof. Yang Hongfeng, Prof. Lu Xinhui, Prof. Eric Chung and Prof. Ngai To. They will share with us the highlights of their latest collaborative research projects across different disciplines to explore potential collaboration opportunities through this platform.

It is our hope that the Research Day will promote the discussion among faculty members for collaborative research and facilitate their application of future RGC Collaborative Research Fund (CRF).

Yours sincerely,

SONG Chunshan

Statistical Genomics: From Bulk Tissue to Single Cell

Professor WEI Yingying

Associate Professor, Department of Statistics

Thanks to high-throughput biotechnologies, it has become routine to measure tens of thousands of or even millions of genomic features for a single patient, which provides unprecedented opportunities to develop personalized medicine. Nevertheless, it is noteworthy that in traditional high-throughput experiments, we can only measure the average properties—for example, mean gene expression levels—of a collection of cells from patients' tissue samples. In contrast, with the rapid development of single-cell sequencing technologies, we can now dissociate tissues into single cells and measure the genomic features of each individual cell. However, due to the budget limit, it is still infeasible to conduct single-cell experiments for dozens or hundreds of patients. Therefore, it would be cost-effective if we can integrate bulk and single-cell genomic data.

In parallel with the technology development, there has been very active research on developing statistical methods for analysing bulk genomic data and single-cell genomic data, respectively. Our group has also developed methods for integrative analysis of bulk data, integrative analysis of single-cell data, and inference of cell-type-specific genomic profiles from bulk genomic data. Nevertheless, there is a lack of research on the joint analysis of bulk and single-cell genomic data.

In this proposed project, we will develop statistical methods for integrative analysis of bulk and single-cell genomic data, which will enable us to understand the cellular heterogeneity of a large number of tissue samples, thus opening doors to understanding the spatial and temporal cellular heterogeneity.

Prof. Wei is an Associate Professor in the Department of Statistics. She obtained her bachelor's degree in Mathematics from Tsinghua University in 2009 and her M. Sc. Eng. degree in Computer Science and Ph.D. degree in Biostatistics from Johns Hopkins University in 2014. Her research focuses on developing statistical methods for analysing noisy, complex and heterogeneous big genomic data. Her six Bioconductor R packages have been well received by the community, with more than 58,000 downloads to date. Prof. Wei received the Faculty Exemplary Teaching Award from Faculty of Science, CUHK in 2017 and the W. J. Youden Award in Interlaboratory Testing from the American Statistical Association in 2019.

An Integrative Approach in Studying Jellyfish Bloom in the Environment under Climate Change

Professor HUI Ho Lam Jerome

Associate Professor, School of Life Sciences

Prof. Hui is an Associate Professor in the School of Life Sciences, the State Key Laboratory of Agrobiotechnology (Partner Laboratory in The Chinese University of Hong Kong) and Simon FS Li Marine Science Laboratory of the School of Life Sciences. He is also the Director of Biology Programme, and members of Cell and Molecular Biology Programme, Environmental Science Programme, and Molecular Biotechnology Programme of the School of Life Sciences.

Jellyfish is the common name for the free-swimming form of gelatinous animals and play significant ecological roles from surface waters to the deep sea. They serve as an important part of the oceanic food chain, and are found in every major ocean in the world. Jellyfish in coastal seas interact with humans in several ways. For instance, several species have been adopted as a food source in some regions and are farmed in aquaculture systems. In addition, thousands of swimmers are stung with varying degrees of severity every year. Further, when their living conditions are favourable, jellyfish can form swarms which are also known as jellyfish blooms, which can damage fishing apparatus or clog the cooling systems of power stations. Climate change and ocean eutrophication have long been speculated to promote high frequencies in jellyfish bloom, nevertheless, remains as a beautiful hypothesis. Combining strengths, expertise and established track records from colleagues within the Faculty and University, we propose to join forces in using a multidisciplinary approach in studying jellyfish bloom in the environment under climate change.

Earthquakes Induced by Industrial Activities of Developing Unconventional Energy Resources

Professor YANG Hongfeng

Associate Professor, Earth System Science Programme

In recent decades, anthropogenic activities tackling climate change and energy demand (e.g. shale gas exploration, natural gas storage, CO_2 sequestration) are well known to induce earthquakes large enough to harm infrastructure and people. Due to the global increasing energy demand, most of these anthropogenic processes are inevitable and may become more intense. Consequently, it raises a heightened concern that how to assess the relevant seismic hazard and mitigate the risks of induced earthquakes. In addition, most of these processes involve injecting fluids underground. How the injected fluids migrate underground becomes a significant environmental problem, yet remains difficult to monitor and understand.

Many critical questions regarding induced earthquakes remain poorly understood, such as how they are induced, what the possible largest magnitudes of induced earthquakes are, and how they impact local environment and society. In this presentation, we introduce observations of recent induced earthquakes, list major scientific and societal challenges, and lay out plans to tackle these significant environmental problems. Induced earthquakes not only cause significant seismic hazard, but also bring outstanding questions on earthquake physics, which demand multidisciplinary research such as geophysics, geodesy, geomechanical modelling, statistics, and environmental science.

Prof. Yang joined CUHK in 2014 and is now an Associate Professor in the Earth System Science Programme. He is actively working on earthquake source physics, subduction zone dynamics, fault zone structure and evolution, and induced earthquakes. He is a committee member in several committees in Chinese Geophysical Society and Chinese Seismological Society, and serves in the editorial board for several journals and as an Associate Editor for Seismological Research Letters. In 2018, Prof. Yang received the Fu Chengyi Young Scientist Award, in recognition of his contributions to integrating earthquake rupture dynamics and observational seismology to advance our understanding of earthquake physics and seismic hazard evaluation. Prof. Yang is the first recipient of this prestigious award from Hong Kong.

Prof. Lu is an Assistant Professor in the Department of Physics. She received her bachelor's degree from Nanjing University and Ph.D. degree from Yale University. Then, she worked as a postdoctoral research associate at Brookhaven National Laboratory before joining CUHK. Her research interest lies in energy related material science and experimental soft condensed matter physics, including morphology and device performance of organic and perovskite photovoltaic materials, bulk and surface structure of functional thin films and synchrotron x-ray scattering techniques. She is now serving as the council member of Physical Society of Hong Kong and Chinese Neutron Scattering Society.

Grazing Incidence X-ray Scattering Based Organic and Perovskite Solar Cell Studies

Professor LU Xinhui

Assistant Professor, Department of Physics

Nowadays, solar industry becomes the fastest growing industry due to the rising demands to solve energy crisis and environmental problems. Third generation solar cells such as organic and perovskite solar cells are all relying on a semiconducting thin-film active layer to harvest the solar energy. The bulk morphology of the active layer in terms of crystal structure, orientation, grain size and nanophase separation behaviours is known to be critical to the solar cell device performance. Here, we will present our recent studies on organic and perovskite solar cells. We revealed for the first time the existence of "backbone ordering" due to the π-π stacking of FREAs' end-capping group. And we investigated the crystallisation pathways of mixed perovskites fabricated by one-step anti-solvent method and revealed the existence of "annealing window". The incorporation of Cs^+ could simplify the crystallisation pathway and extend the annealing window.

In these studies, state-of-the-art synchrotron-based X-ray scattering techniques were employed: grazing incidence wide-angle X-ray scattering (GIWAXS) for Angstrom-scale structure ordering and grazing incidence small-angle X-ray scattering (GISAXS) for nano-scale structure ordering. In situ GIWAXS was used to investigate the crystallisation process of thin films during spin-coating and thermal annealing. These techniques can also be applied in material science, chemistry, biology and condensed matter physics studies. By modifying the wavelength of the probing beam and the experimental geometry, a variety of sample types, such as solutions, powders, surfaces and thin films, can be studied, covering wide length scales as well as versatile dynamic and kinetic behaviours.

Data Driven Computational Techniques for Flow and Transport in Heterogeneous Porous and Fracture Media

Professor CHUNG Tsz Shun Eric

Professor, Department of Mathematics

The flow and transport in heterogeneous media have been of interest to many application communities in chemical engineering, petroleum engineering, hydrology, energy recovery, geophysics, biological sciences and so on. With today's microscopic imaging techniques, one can map the pore size and geometry distributions at very fine resolutions. These high resolution data allow one to obtain better understandings of the physical, chemical or biological mechanisms arising from applications. Due to small-scale variations of media, the flow and transport of constituents can experience very tortuous paths, which are difficult to resolve computationally.

The objective of our research is to design a systematic mathematical data driven model reduction approach that can allow engineers and domain scientists to efficiently resolve important features of the flow and the transport at a desired accuracy and make accurate predictions. The methodology combines rigorous mathematical and modern data science concepts to give cutting edge numerical simulators. The proposed research has a wide range of applications, including but not limited to, material science, geoscience, subsurface flow, energy recovery, filtration and geomechanics.

Prof. Chung is a Professor in the Department of Mathematics. He obtained his Ph.D. from University of California at Los Angeles in 2005, and joined CUHK in 2008 after working at University of California at Irvine and California Institute of Technology. His research interests are computational multiscale methods, numerical upscaling and scientific machine learning for flow and transport in heterogeneous porous and fracture media. The research works are widely used in many scientific and engineering disciplines. Prof. Chung has published more than 150 papers with some of them are Institute for Scientific Information (ISI) highly cited and is a recipient of the Young Scholar Award by the Hong Kong Mathematical Society.

Colloidal Particles at Interfaces: From Fundamentals to Materials

Professor NGAI To

Professor, Department of Chemistry

The adsorption of colloidal particles at fluid interfaces, both air/liquid and liquid/liquid is becoming a central topic in colloid and surface science. Hierarchical structures, including 2D films, 3D capsules, and structured porous materials, have been generating significant interest and are showing promise for food, personal care products, pharmaceutical and biomedical applications.

In this talk, I would like to explore the possibility in collaboration with: i) theoreticians and material scientists to help in providing a quantitative understanding of interparticle interactions, nanoparticle dynamics at interfaces, and nature of the assemblies in order to develop and design robust processing strategies to generate 2D and 3D materials; ii) chemists and scientists to evaluate the particle-laden interfaces for studying the biphasic catalysis by encapsulating different catalysts and enzymes in particles or particle-stabilised emulsion systems; iii) food scientists to apply our developed particle-stabilised emulsions or foams in making low-fat and healthier food products; and iv) scientists who would need hierarchical porous materials for biomedical, tissue regeneration or other applications such as separation and energy storage.

Prof. Ngai is now a Professor in the Department of Chemistry, Assistant Dean (Research) of the Faculty at the Chinese University of Hong Kong (CUHK), and Fellow of the Royal Society of Chemistry (FRSC). He received his B.Sc. in Chemistry at CUHK in 1999. In 2003, he obtained the Ph.D. at the same university, where he worked on light scattering and polymer interaction in solution. He moved to BASF (Ludwigshafen, Germany) in 2003 as the postdoctoral fellow for two years, working on colloids and surface chemistry. After a short postdoctoral training in the Chemistry Department at the University of Minnesota in 2005, he joined the Chemistry Department at CUHK in 2006 as a Research Assistant Professor. He has been appointed as an Assistant Professor in 2008, and promoted to Associate Professor in 2012. In 2017, he was promoted to Professor. His current research interests centre around the colloids, surface chemistry, polymers and soft matter.

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