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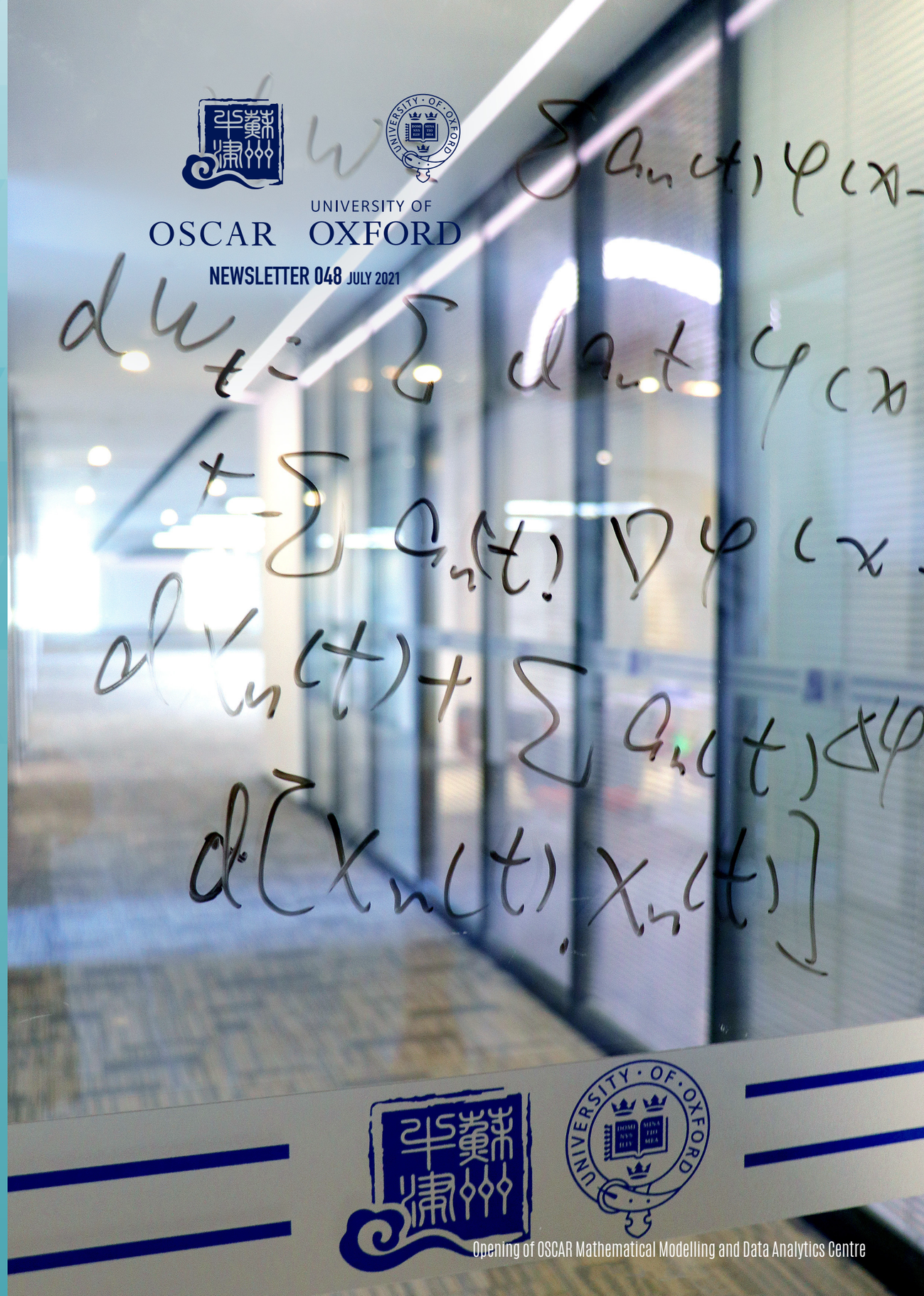
UNIVERSITY OF OXFORD

OSCAR

NEWSLETTER 048 JULY 2021



Opening of OSCAR Mathematical Modelling and Data Analytics Centre

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Opening of OSCAR Mathematical Modelling and Data Analytics Centre

OSCAR has opened its newest lab, with the OSCAR Mathematical Modelling and Data Analytics Centre now up and running in newly refurbished space on the 3rd floor of the OSCAR building. The Centre is led by four PIs from the University of Oxford, Mathematical Institute, and represents an increased level of research activity in the fields of mathematical modelling and data analysis.

The OSCAR Mathematical Modelling and Data Analytics Centre will serve as a platform for scientific collaboration with universities, research institutes and the financial sector in China, and as a window towards China for Oxford mathematicians.

Research focus

The Centre will focus on multimodal streamed data and associated machine learning techniques based on applications of rough path analysis, Monte Carlo methods and high-performance computing (HPC) and analysis of financial models. Specifically, research projects will revolve around:

1. *Mathematical modelling of complex, large-scale random systems*
2. *Advanced methods for the analysis of complex structured and unstructured data sets, in particular financial data sets*
3. *Rough path analysis, signatures and data analysis*
4. *Quantitative finance, financial risk management, machine learning techniques in finance*

Existing collaborations with the financial sector and the Alan Turing Institute involving members of the Institute will also be leveraged.

Objectives

The Centre aims to:
▪ promote research projects with Chinese partners focused on the design and analysis of mathematical models and advanced algorithms for data analytics and the applications of these methods in quantitative finance and engineering;
▪ organise high visibility scientific events showcasing research done at the Mathematical Institute especially in the fields of Data Science and Computational Finance;
▪ build collaborative projects with Chinese partners, especially in the financial sector (exchanges, clearinghouses and financial institutions).

Principle investigators

Prof. Zhongmin Qian
▪ *Professor of Mathematics, University of Oxford*
▪ *Official Fellow in Mathematics, Exeter College, Oxford*
▪ *Fellow, University of Warwick*

Prof. Qian is interested in stochastic analysis, including diffusion processes, rough path analysis and machine learning, statistical fluid mechanics, condensed matter physics and quantum fields. Other interests of his are active portfolio management, exchange rates, stochastic volatility models and high-frequency data analysis.

Prof. Terry Lyons
▪ *Fellow of the Royal Society*
▪ *Wallis Professor of Mathematics, University of Oxford*
▪ *Professorial Fellow of St. Anne's College, Oxford*
▪ *Fellow of the Alan Turing Institute*
▪ *Director of the Wales Institute for Mathematical and Computational Sciences (WIMCS) (2008-11)*
▪ *Founding member (2007) and Director (2011-15) of the Oxford Man Institute of Quantitative Finance*

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Prof. Lyons's long-term research interests all focus on the calculus of rough paths, stochastic analysis, and their applications in finance and more generally. Rough path theory enables higher order methods for summarizing of complex multimodal data. This can be used for effective classification and decision making on a large scale and is cutting edge in the area.

His research utilizes a wide range of mathematical techniques. Effective outcomes require the integration of these techniques with other solutions (e.g., deep learning) to achieve novel and innovative standard.

Prof. Lyons has developed algorithms for Chinese and Arabic handwriting recognition, mood classification in mental health, as well as the recognition of actions in noisy observation of human movement.

Prof. Rama Cont
▪ *Professor of Mathematical Finance and Head of the Oxford Mathematical and Computational Finance Group, University of Oxford*
▪ *Senior Research Fellow, Institute for New Economic Thinking*
▪ *Director of EPSRC Centre for Doctoral Training in Mathematics of Random Systems*

Prof. Rama Cont joined OSCAR in April 2020 as one of four PIs at the new Mathematics Institute.

His research focuses on stochastic analysis, stochastic processes and mathematical modeling in finance, especially issues related to high-frequency modeling, quantitative risk management, regulation, financial stability and systemic risk. He is scientific advisor to the International Monetary Fund (IMF) and the central bank of Norway and has previously worked as advisor to the European Central Bank, the Bank of England, the New York Federal Reserve, the Chicago Mercantile Exchange and the Hong Kong Exchange (HKEX) on matters related to stress testing, risk management and financial stability.

Prof. Hanqing Jin
- *Professor at the Mathematics Institute, University of Oxford*
- *Non-tutorial Research Fellow in Applied Mathematics at St. Peter's College, Oxford*
- *Director of Oxford-Nie Financial Big Data Laboratory*

Prof. Jin earned his BS in Applied Mathematics and Mphil in Mathematical Finance from Nankai University and his PhD in Financial Engineering from the Chinese University of Hong Kong.

Prof. Jin's research is in Mathematical Finance, applied stochastic analysis and optimization, focusing on the study of portfolio selection (by stochastic control and martingale method) and optimal stopping in financial markets.

He is currently working on investors' decisions with non-utility behaviour in financial markets, as well as time consistency in portfolio selection models.

Research Scientist

Liang Zhao
Research Scientist

Dr. Liang Zhao joined OSCAR in April 2021 as the first Research Scientist in the Institute. He earned his PhD degree in 2020 from the School of Mathematical Sciences, Shanghai Jiao Tong University.

His research interests include stochastic partial differential equations (SPDEs), the well-posedness and singular limit problems of models of partial differential equations (PDEs) arising from semiconductors and plasma physics, and machine learning methods for PDEs. During his PhD study, he spent two years as a co-supervised PhD student in Université Clermont Auvergne, France, working with Prof. Yue-Jun Peng.

At OSCAR, Dr Liang intends to apply PDE method and statistical learning techniques to the study of some mathematical finance problems.

Visiting student

Yihuang Zhang
DPhil candidate from the ESPRC CDT in the Mathematics of Random Systems at the University of Oxford

Yihuang is a visiting student OSCAR. His doctoral research in probability area focuses on the stochastic analysis with applications in fluid dynamics and machine learning in finance.

Recently, he is working on random vortex dynamics for the Navier-Stokes equation with Prof. Zhongmin Qian. They proposed a simple yet powerful vortex method to numerically approximate the dynamics of an incompressible flow. The idea is to sample the distribution of the initial vortices of the fluid flow in question then follow vortex dynamics along Taylor's Brownian fluid particles. The weak convergences of this approximation scheme are obtained for both two-dimensional (2D) and three-dimensional (3D) fluid flows. Based on their method, the simulation results are quite promising.

He is also working in a machine learning group in OSCAR. They use machine learning to tackle financial problems. The financial market is notoriously unpredictable, but with the aid of new machine learning techniques, some hidden patterns may be revealed.

Chao Zhang
DPhil student in the Department of Statistics, University of Oxford

Chao is co-supervised by Prof. Mihai Cucuringu and Prof. Rama Cont. He was awarded the Clarendon Scholarship, one of the most competitive scholarships by Oxford. Before his study at Oxford, he obtained his Bachelor's and Master's degrees at Peking University in 2016 and 2019. In 2018, he was a research assistant in the Business School, Chinese University of Hong Kong. In the meantime, he also completed several internships, including as a research intern in Intel Labs China and the Investment AI team in AIG.

Previously, Chao focused on studying robustness issues of machine learning models from the perspective of adversarial samples and some of his works were published at influential conferences in the field of machine learning. He devotes increasing time to applying Artificial Intelligence techniques and traditional statistical models to various financial problems, such as modelling limit order books, index tracking, international asset pricing, portfolio management, and simulating financial scenarios. He believes practice is the best (but not sole) criterion for testing truth.

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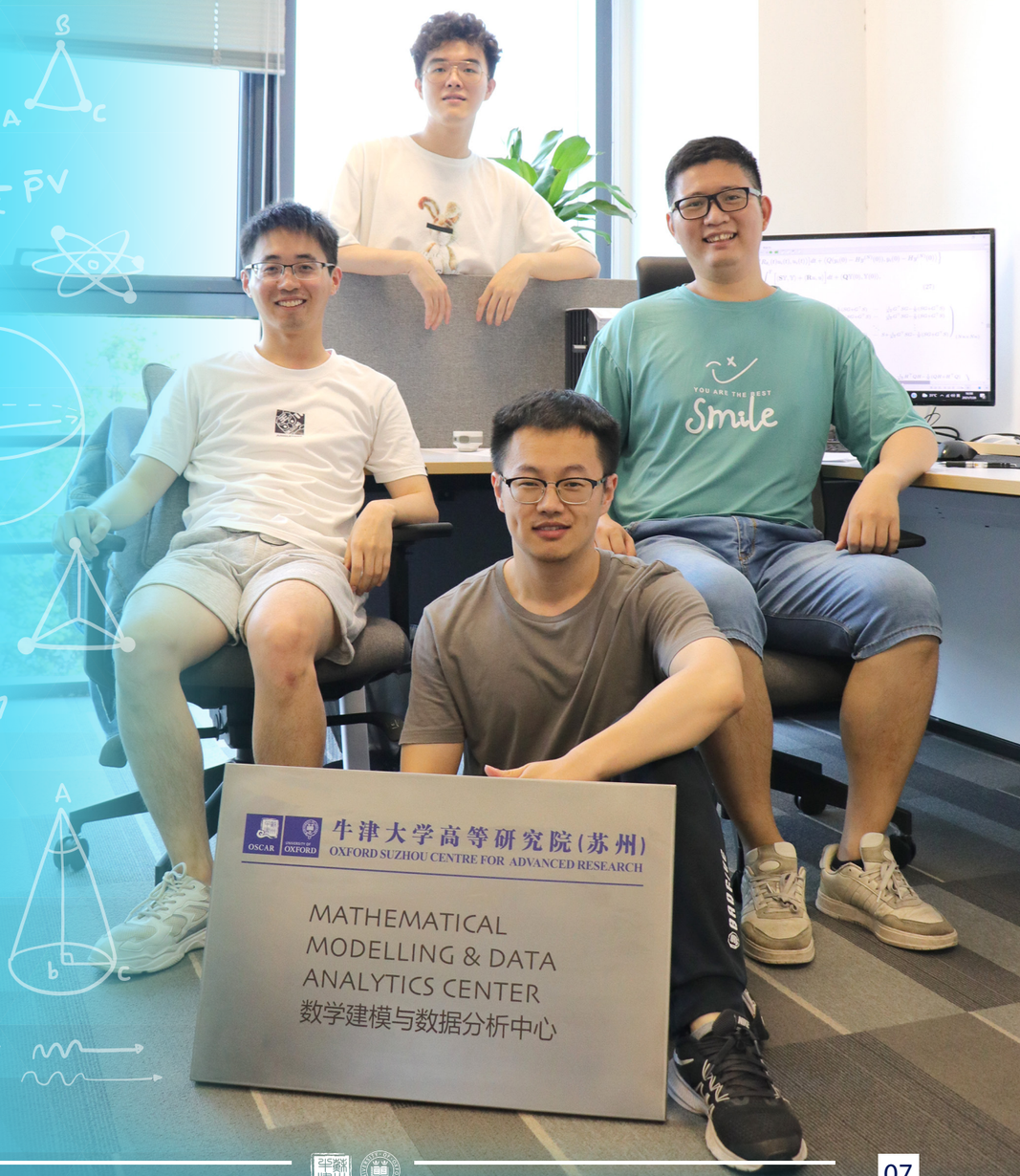
Visiting students and Research Scientist at the OSCAR Mathematical Modelling & Data Analytics Centre. Yiwei Lin (front) had been a visiting student from Shandong University from April to July.



OSCAR Academic Seminar Series: topics on biosynthesis and mathematical modelling spark cross-disciplinary discussion

OSCAR PIs, Visiting Academics, and Researchers met online for the monthly OSCAR Academic Seminar on Friday 16th July. Dr. Yang Cao, a Research Scientist led by Prof. Luet Wong within OSCAR's Chemistry lab, and Dr. Liang Zhao, a Research Scientists led by Prof. Zhongming Qian, in the Institute for Mathematical Modelling and Data Analytics at OSCAR, were invited to give talks on their respective research topics.

Dr. Cao was the first speaker at the seminar. His talk focused on biosynthesis of natural products and their oxidation by cascaded cytochrome P450 enzymes generated through directed evolution into the engineered biosynthesis pathway, a research project led by OSCAR PI Prof. Luet Wong.

Enzymes are nature's catalyst for performing chemically challenging reactions under physiological conditions to synthesise the complex and diverse molecules required to sustain life. Dr. Cao and his colleague's research harnesses the catalytic capacity of enzymes in synthesis which come with many advantages for biological processes, such as mild reaction conditions, control of selectivity and the absence of toxic waste. Dr. Cao also talked about how he and his colleagues are also working on the oxidative diversification of drug fragment molecules, a collaborative research project supervised by OSCAR PI Prof. Jeremy Robertson.

The second talk, delivered by Dr. Liang Zhao, informed participants of one of the research focuses of OSCAR's Institute for Mathematical Modelling and Data Analytics. The Black–Scholes equation, named after economists Fischer Black and Myron Scholes, is a mathematical model for the dynamics of a financial market containing derivative investment instruments. Based on the classical PDE theories, predicting the prices of options can be transferred into estimating the solutions to the BS equations. This is of great values for securities practitioners. Observing the drawbacks of several known methods, Dr. Zhao proposed to use numerical methods or classical PDE theories to deal with difficulties in working out the solutions of the BS equations.

The talks sparked cross-disciplinary discussions among OSCAR researchers. Seeing people bounce ideas off of each other, Prof. Mark Moloney, who chaired the seminar, said conversations like this across the varied research groups is exactly what we hope to achieve by holding the OSCAR Academic Seminar.

Since its initiation in early 2020, nine sessions of the OSCAR Academic Seminar have been held. The Seminar was first proposed for the purpose of maintaining a healthy level of interaction among the research groups at a time when the Covid-19 pandemic has prevented PIs from visiting OSCAR. Over time, the Seminar is taking shape as a mechanism for stimulating creative thinking with regular academic exchanges.

About the speaker

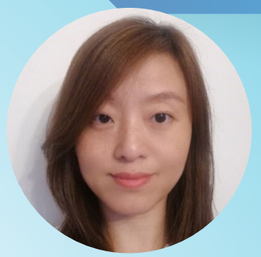
Dr. Yang Cao is a Research Scientist at OSCAR, led by Professor Luet Wong and Jeremy Robertson. His research interests lie in the synthesis of complex natural compounds and their derivatives via biotransformation, and in developing sustainable and environmentally friendly production processes.

Dr. Cao received his doctoral degree from the Department of Chemistry, Oxford University. He is one of the first researchers to have joined OSCAR in 2018.

Dr. Liang Zhao earned his PhD degree in 2020 from the School of Mathematical Sciences, Shanghai Jiao Tong University. His research interests include stochastic partial differential equations (SPDEs), the well-posedness and singular limit problems of models of partial differential equations (PDEs) arising from semiconductors and plasma physics, and machine learning methods for PDEs. During his PhD study, he spent two years as a co-supervised PhD student in Université Clermont Auvergne, France, working with Prof. Yue-Jun Peng.

At OSCAR, Dr Liang intends to apply PDE method and statistical learning techniques to the study of some mathematical finance problems.

Meet OSCAR's New Researchers



Dr. Hong Chang
- *Senior Research Scientist and Industrial Fellow*
- *OSCAR-Prenetics Innovation and Technology Centre for Advanced Diagnostics*

Dr. Hong Chang has been a Industrial Fellow at OSCAR since July 2020. In July this year, Dr. Hong Chang joined OSCAR as a Senior Research Scientist in the OSCAR-Prenetics Innovation and Technology Centre for Advanced Diagnostics.

Before joining OSCAR, Dr. Chang was Chief Technology Officer and QA/RA manager at MEStar (an Oxford spin-out company) and is experienced in obtaining CE/MHRA, ISO13485 application approval and maintaining QMS systems. She was heavily involved in development of the rapid test kit for COVID-19 created by Prof. Zhanfeng Cui, Prof. Wei Huang and their teams. She participated in early lab-based research at Oxford's IBME and was instrumental in demonstrating compliance and seeking regulatory approval. Her contribution helped the test kit, Oxsed RaVid Direct, gain its CE mark in early July 2020.

Dr. Chang completed her doctoral degree in Materials Science at Queen Mary University of London. She undertook a postdoctoral position in The Institute of Biomedical Engineering (IMBE) at the University of Oxford. Her research there involved fabrication of crosslinked protein membranes in microfluidics channels for use as 3D cell cultures.

After completing her postdoctoral research at Oxford, Dr. Chang started developing her career in industry, specialising in *in-vitro* diagnostic medical devices. She has been involved in biomedical product design and development at all stages. Her expertise in technology transfer, and particularly regulatory approval and end-user interaction, presents an excellent learning opportunity for OSCAR researchers.

Linfang Zhang
- *Research Engineer*
- *OSCAR-Prenetics Innovation and Technology Centre for Advanced Diagnostics*

Linfang Zhang joined OSCAR on July 1st, 2021, as the first Research Engineer in the OSCAR-Prenetics Innovation and Technology Centre for Advanced Molecular Diagnostics (ITC). She graduated from Shanghai University of Traditional Chinese Medicine. During her Master's degree, she engaged in research related to gut microbiota based on in vivo experiments. The specific topic was to study the modulation of the gut microbiota by Jiang-zhi Granules in the treatment of high-fat-diet-induced Nonalcoholic Fatty Liver Disease.

"I am very happy to join the OSCAR family, where there is first-class scientific research equipment, professional scientific research teams and a comfortable working environment" Linfang said, "It is a great honour for me to join the ITC team at OSCAR led by Prof. Huang and Prof. Cui, and I have great interest in and strong expectations for single-cell Raman technology in the forthcoming work. "

Under the guidance of Prof. Huang, Linfang will be working on the application of single-cell Raman technology in the study of the intestinal microbiome, with a focus on the detection and cultivation of single microbial cells. She believes that single-cell Raman technology presents great potential for application.

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Linxue Feng
- *Research Assistant*
- *Prof. Luet Wong's group*

Linxue Feng joined OSCAR on July 1st as a Research Assistant in Prof. Luet Wong's group after receiving her Master's degree in sugar engineering from Jiangnan University. During her graduate years, Linxue studied biocatalysis based on molecular biology.

"It's my honour to join Prof. Luet's group," Linxue says, "As a fresh graduate stepping into the working world for the first time, I feel so lucky to have landed a job that has a close connection to my Master's research. I read a paper about the redesign of P450 cytochrome oxidase during my graduate years and I find molecular simulation very interesting. OSCAR has exactly the advanced technologies about that. In addition, OSCAR has excellent research teams led by top scientists in different fields. I believe I can make great progress working with them and make my contribution to OSCAR."

"OSCAR feels like a second home", Linxue says, "Though I haven't been here long, the atmosphere between my colleagues is just like family. They are very kind to help me, whether with work or life. Suzhou is a city with beautiful sceneries, and I like it very much. I will do my best in my role at OSCAR."

At OSCAR, Linxue will be performing microbiology experiments as directed by the PI and Research Scientists and assisting in keeping lab equipment in good working order.

OSCAR Impact and Collaboration

Prof. Mauro Pasta gives invited talk at the 3rd Future Energy Convention

The 3rd Future Energy Convention was held in Beijing on July 8, 2021, with the theme of "Carbon Neutral and Future Energy".

Prof. Mauro Pasta, Principal Investigator of OSCAR's Energy Storage and Conversion (ESC) Laboratory was invited to give a talk on the topic of "Hydrogen from Renewable Energy" via virtual link. Dr. Zongqing Liu and Dr. Chenbo Wang, Research Scientists of the ESC lab, were invited to attend the conference in Beijing.

In his talk, Prof. Mauro Pasta highlighted the research direction of hydrogen energy against a context of rapid development of new energy sources. He moved on to present his project at OSCAR, single atom catalysis for the preparation of hydrogen energy, and the role of single-atom catalysis in driving technologies for the preparation of hydrogen energy, noting the challenges yet to be overcome. Prof. Mauro Pasta closed his presentation with an invitation for cooperation with the ESC lab.

The 3rd Future Energy Convention brought together experts from government, academia, and industry to explore the trends and pathways of future energy development under the vision of carbon neutrality. Prominent academicians attended the event. Representatives from renowned universities such as Peking University, Tsinghua University and Renmin University of China were also present at the event.

Japan Science and Technology Agency visits OSCAR

Shuichi Chayama, Japan Science and Technology Agency China Head, stopped by OSCAR on 16th July, as part of his programme in Suzhou to promote the Sukura Science Exchange Programme. OSCAR General Manager Leah He met with Shuichi Chayama and led him on a brief tour of OSCAR's laboratories.

After the lab tour, Shuichi and Leah sat down in a meeting to talk more about each other's activities in China.

Tianjin Science and Technology Bureau sends delegation to visit OSCAR

Senior officials of the Institute of Hematology & Blood Diseases Hospital, Chinese Academy of Medical Sciences visited OSCAR on 22nd July, as part of a study trip of Tianjin Science and Technology Bureau, to understand Suzhou Industrial Park's best practices in promoting international science collaboration and the commercialisation of research outputs. OSCAR General Manager Leah He and her team met with the delegation. The visitors expressed particular interest in collaborating with the Regenerative Medical Engineering group and the Digital Health group at OSCAR.

SIP News in July

China's first industry-university-research college opened

On 15th July, Suzhou Industry-University-Research College, the first-of-its-kind in China, was inaugurated at Soochow University. The city of Suzhou has, in recent years, made remarkable achievements in terms of industry-university-research collaboration, and is considered a model city in China for the sound dynamics between academia and industry.

The Suzhou Industry-University-Research College will seek to establish stable cooperative relationships with key participants in industry-university-research collaboration, including training institutions, universities and research institutes, innovative enterprises, and fintech institutions at home and abroad. Integrating global innovation and training resources, the College also aims to engage in a wider range of activities that span from the provision of academic education and talent training, theoretical research, to networking, and policy promotion.

During the opening ceremony, the College released the schemas for industry-university-research-based teaching in 10 areas, covering multiple hi-tech industries, such as biomedicine, artificial intelligence, aerospace, and research services.