NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE | Graduate College

Joint PhD Program Description

The description for the Joint PhD program will be posted online as a sub-page to Joint/Dual PhD Programmes | Graduate College | NTU Singapore.

Name of Partner University	Sorbonne Université
City, Country	Paris, France
Year of Establishment	2015
Program	☒ Joint Degree ☐ Joint Supervision
Description of the Program (150-250 words)	Established in 2015, the NTU-Sorbonne joint PhD degree program is providing students with a unique opportunity to explore a thesis project in an interdisciplinary and intercultural environment. Students in the program will have two thesis advisors – one in NTU, Singapore and one in Sorbonne, Paris – and will have to fulfil a residency of 12 months at the Partner University. Upon completion of the degree requirements, the students will be awarded doctorate degrees jointly by NTU and Sorbonne. Candidates interested in any of the joint projects are advised to contact either the Sorbonne or NTU supervisors for additional information on the project as well as admission requirements.
Disciplines	• Natural sciences (physics, chemistry, materials science, energy) • Modelling and engineering • Life sciences, health and medicine • Social sciences • Humanities • Business and management
Programme Management/ Steering Committee Names and Emails	NTU: • Sierin Lim (SLim@ntu.edu.sg) • Leong Weng Kee (chmlwk@ntu.edu.sg) Sorbonne: • Souhir Boujday (souhir.boujday@sorbonne-universite.fr) • Bertrand Granado (bertrand.granado@sorbonne-universite.fr)

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Joint Projects

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE | Graduate College

1. Innovative strategies for selective targeting and delivery of Metal - based anticancer molecules for precision medicine

Date Posted:	8 May 2024	
Home University	Nanyang Technological University	
Supervisors	Home	Partner
Name	XING Bengang	Michèle SALMAIN
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Website	https://personal.ntu.edu.sg/bengang/xresearch.htm	https://ipcm.fr/index.php/recherche/presentation-equipe-chembio/composition-de-lequipe-chembio/michele-salmain/
Project Description (200-300 words)	Within the general context of precision medicine, drug development takes more and more into account the particular genomic, metabolic and physiochemical features of cancer cells and the tumor microenvironment. The objective of the proposed PhD project is to elaborate innovative strategies for selective targeting and delivery of cytotoxic metal -based therapeutic compounds to cancer cells, so as to improve drug efficacy and prevent possible side effects. To reach this objective, three approaches will be deployed: (1) smart nanoformulation; (2) receptor-mediated drug delivery by conjugation of specific ligands; (3) prodrug strategy based on the unique metabolism of cancer cells and / or the tumor microenvironment or external stimulus. The student in this project will be trained in a highly interdisciplinary areas at the interfaces of molecular chemistry, medicinal chemistry, chemical biology, and drug delivery. At NTU, we will be mainly working on the development of unique extracellular vesicles (EVs) delivery platforms and their functional characterization. Typically, the EVs will be designed and fabricated from various cancer cells. Their structure modification, bio-orthogonal surface labeling, drug loading and conjugation, in vitro and in vivo studies will be carried out at NTU too. Moreover, the EVs will be hybridized with liposomes or lipid nano-particles and the optimized platforms will be used for anticancer prodrugs delivery in vitro and in vivo. At Sorbonne, they will mainly focus on design and synthesize metal based prodrugs (e.g. iridium(III)-based therapeutic	

	compounds etc). They will develop the metal complexes together with suitable ligands as new types of prodrugs for anticancer studies. The detailed antiproliferative activity on 2D and 3D cell cultures will be proceeded in Sorbonne side. The mechanism of action of the lead compound and the main protein targets will be studied using a combination of click chemistry and chemoproteomics in Sorbonne too.
Program/Center Website(s)	Nil
Additional Information (e.g., files with project details)	Nil

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE | Graduate College

2. Froster Non-Radiative Energy Transfer in a Strong Coupling Light-Matter Interaction System

Date Posted:	8 May 2024	
Home University	Nanyang Technological University	
Supervisors	Home	Partner
Name	(Steve) Cuong Dang & Renaud Bachelot	Agnes Maitre
School	CNRS-International-NTU-Thales Research Alliance (CINTRA)	Sorbonne Université, Faculté des Sciences Institut des Nanosciences de Paris
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Project Description (200-300 words)	The research aims to explore the Froster non-radiative energy transfer (FRET) from donors to acceptors which are in strong coupling with the photonic mode of a micro- or nano-resonant structure. Unlike conventional FRET, the dipole-to-dipole coupling from donors to acceptors is now modified by exciton-photon interaction. We hypothesize that the strong coupling between the donor's exciton and the acceptor's exciton with the photonic mode of an optical cavity will enhance the FRET significantly. The system will be engineered such that the donor's polaritons and acceptor's polaritons are at the same energy then the FRET rate and FRET distance will be quantified to provide evidence of FRET enhancement. One of the objectives is to identify the role of polaritonic states in mediating energy transfer and explore the influence of system parameters such as coupling strength, detuning, and geometric configuration on FRET. The candidate will join both teams of physicists and engineers to conduct the research with analytical modeling, numerical simulations, and experimental validations. The detailed arrangement is as follows.	

	NTU: Synthesize nanoplatelets of different thicknesses with or without Cu dopants. Thin nanoplatelets will be used as donors while acceptors can be the thicker nanoplatelets or the ones with dopants. Strong coupling experiments with dielectric cavities. **Sorbonne University:** Numerical simulation and theoretical study of the FRET in strong coupling regime of donors and acceptors with photonic modes. Strong coupling experiments with plasmonic cavities. Advanced fabrication techniques in cleanrooms in both **NTU and SU** will be utilized to fabricate micro/nano-cavities with embedded semiconductor nanoplatelets. The structures will be characterized by microscopy techniques optical and or electronic ones. Strong coupling characteristics will be measured by the back-focal plane imaging technique, while FRET characterization will be done with time-resolved spectroscopic techniques. The outcomes of this research are expected to provide new insights into the control of energy transfer in nanostructured materials with a novel fundamental physics of polariton states. The potential applications are broad, from advanced photonic devices, energy harvesting systems to quantum information processing technologies.
Program/Center Website(s)	https://www.ntu.edu.sg/cintra
Additional Information (e.g., files with project details)	NTU-SU thesis.pdf

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3. Merging Pyridylidenes and Main Group Element: From Highly Luminescent Molecules to Polymers and Applications

Date Posted:	20 Mar 2024	
Home University	Nanyang Technological University	
Supervisors	Home	Partner
Name	Rei KINJO	Jamal MOUSSA (Primary supervisor) Lydia Sosa Vargas Fabrice Mathevet
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Project Description (200-300 words)	**Overview of the project:** This project involves both fundamental and applied chemistry aspects. The team of Sorbonne Université has recently developed new powerful methodologies of preparation of pyridylidene complexes. On the other hand, a variety of p-block elements-based aromatic heterocycles have been developed by the team in NTU over the last years. By combining both research areas, this project aims to develop a new class of compounds incorporating p-block elements into the pyridylidene scaffolds, and elucidate their bonding and structural features as well as the optical properties. Furthermore, the luminescent properties of those compounds will be examined and modified which may lead to the potential application in the preparation of novel OLEDs. (NTU primary contribution) (i) The synthesis, spectroscopic characterization, structural authentication of the main group elements-incorporated pyridylidene building blocks. (ii) The screening of the basic reactivity of the developed compounds. (Sorbonne Universite primary contribution)	

	(i) Development, spectroscopic characterization, elucidation of the photophysical & optical properties of the main group elements-incorporated pyridylidene oligomers/polymers. (ii) Preparation and assessment of OLEDs Theoretical analysis will be done by both NTU and Sorbonne Universite collaboratively.
Program/Center Website(s)	NA
Additional Information (e.g., files with project details)	The candidate should ideally possess a strong background in synthetic organic and inorganic chemistry and/or organometallic chemistry with fundamental knowledge in optical properties (absorption and emission). Skills in polymer chemistry and DFT calculation methods would be a plus. The final compounds that exhibit important and are adequate will be used to prepare OLEDs in the laboratory of Prof. Adachi at Kyushu University, JAPAN.

4. Understanding Charge Transport on Hybrid BioNanoparticles

Date Posted:	31 May 2023	
Home University	Nanyang Technological University	
Supervisors	Home	Partner
Name	Sierin Lim	Olivier Pluchery
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Website	https://www.ntu.edu.sg/cceb	Institut des NanoSciences de Paris
Project Description (200-300 words)	Charge transport is found in nature under various forms such as electronic conduction, quantum tunnelling or ionic migration. These phenomena have strong connections and applications for organic/molecular electronics. While charge transport in inorganic nanostructures have been widely studied, explorations on the phenomena on hybrid bionanoparticles (hbNP) are scarce. hbNP provide an intermediate model for understanding the charge transport mechanisms, between the complexity of natural structures and the inorganic nanoparticles. Learning from nature will help replicating these principles into organic electronics. In this project, the student will: (1) design and synthesize hbNP made of various metals (e.g., gold) using ferritin (protein-based iron-storage molecule) as a template; (2) develop experimental approaches to study how electrical charges build up and shape the assemblies of HbNP using advanced techniques based on atomic force microscopy (AFM) such as Kelvin Probe Force Microscopy (KPFM); (3) formulate design principles for applications of bionanoparticles in organic electronics. Pre-requisites: practical knowledge on molecular biology and basic knowledge on nanoscience Beneficial prior knowledge/skills: operations of atomic force microscopy Skills to learn: hybrid nanoparticle synthesis, AFM, KPFM	
Program/Center Website(s)	NA	
Additional Information (e.g., files with project details)	NA	

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE | Graduate College

5. Understanding the Role of Transglycosylase in Bacterial Cell Wall Synthesis

Date Posted:	31 May 2023	
Home University	Nanyang Technological University	
Supervisors	Home	Partner
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Website	https://liuxuewei.wixsite.com/glycoscience	Institut Parisien de Chimie Moléculaire - ZHANG Yongmin (ipcm.fr)
Project Description (200-300 words)	Antibiotics resistance is an extremely serious problem in public healthcare, and the rapid spread of multidrug-resistant bacteria is becoming a pandemic of global proportions. On 1 November 2017, Singapore has launched national strategic action plan to support global call for action against antibiotics resistance. Peptidoglycan is the core component of all bacteria cell walls, and bacteria cell wall synthesis has become the primary target process for nearly all new antibiotics development. However, one of the key bottlenecks in developing antibiotics that target the bacteria cell wall synthesis process, has been the unavailability of peptidoglycan substrates, from either natural or synthetic sources, for mechanistic studies and novel antibiotics development. This program is to rationally design and synthesize functional peptidoglycan derivatives for diagnostic and therapeutic aims. We will investigate PG-based metabolic labelling of bacterial cell surface. We will also conduct structure-based drug design and transform transglycosylase (TGase) substrate into inhibitor by editing the structure of PG. With no doubt, this project is the platform that holds great promise for the development new generation of antimicrobial therapeutics and diagnostics. It will help Singapore to achieve the anti-infectious disease strategies and goals by building new capabilities and offering a differentiated value proposition.	
Program/Center Website(s)	NA	
Additional Information (e.g., files with project details)	NIL	

6. Electrocatalyst Design through Modulating Dual-Atomic Coordination on Monolayered Elemental Substrates

Date Posted:	31 May 2023	
Home University	Nanyang Technological University	
Supervisors	Home	Partner
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Project Description (200-300 words)	Developing high-efficient electrocatalysts for water electrolysis and fuel cell applications is crucial to the pursuit of a sustainable energy future. Constructing electrocatalysts by rational design at the atomic level has been increasingly regarded as a promising approach thanks to recent advances in material characterization and theoretical comprehension. In particular, dual-atomic nanoarchitecture is gaining significant interest due to the enormous possibility of structure modulation toward realizing novel reaction mechanisms. In comparison to the state-of-the-art single-atom electrocatalyst, the presence of two active sites in close proximity enables strong synergism, leading to significantly enhanced catalytic performance. Furthermore, the controlled coordination of two atoms allows precise control over the reaction intermediates and reaction pathways, thereby improving the selectivity toward the desired products. Besides, the dual-atom configuration provides mutual support, preventing atom agglomeration or detachment during catalytic reactions and thus enhancing operational stability. Recently, various post-graphene 2D elemental materials have been developed, attracting substantial interestowing to the rich structural chemistry and enhanced anisotropic electron transport triggered by unique Fermi surface topography. More importantly, in contrast to carbon-based materials, the non-carbon elemental 2D materials feature strong interaction with metallic atoms, allowing electronic modulating and stabilizing of the dual-atom structures simultaneously.	

	Herein, I hypothesized that the precise coordination modulating of dual-atomic moieties grown on monolayer elemental 2D materials will enable significantly enhanced catalytic performance. To explore the hypothesis, in this project, I will target three key objectives as follows • Devise a facile synthetic pathway to prepare dual atoms confined on monolayered elemental 2D substrates. • Characterize materials' chemistry, nanostructure, and electrocatalytic performances. • Investigate the structure-function relationship using theoretical simulation and Operando studies. The developed electrocatalysts with high performance and excellent long-term stability would be further characterized in pilot scale for real-life applications. More importantly, this project will provide insightful guidance for the rational design of advanced electrocatalysts, facilitating the translation of scientific research to industrial applications.
Program/Center Website(s)	Laboratoire de Réactivité de Surface http://lrs.sorbonne-universite.fr/ Graduate College https://www.ntu.edu.sg/graduate-college
Additional Information (e.g., files with project details)	(6) Project details.pdf