大學教育資助委員會
University Grants Committee

香港中文大學
The Chinese University of Hong Kong

TRS symposium 2017

RESEARCH GRANTS COUNCIL THEME-BASED RESEARCH SCHEME PUBLIC SYMPOSIUM 2017

9 December 2017 (Saturday)

9:00 a.m. – 5:20 p.m.

G/F, Yasumoto International Academic Park

The Chinese University of Hong Kong

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MESSAGE FROM CHAIRMAN OF RESEARCH GRANTS COUNCIL
研究資助局主席歡迎辭

On behalf of the Research Grants Council, I welcome you to the Theme-based Research Scheme Public Symposium 2017.

Today is a long-awaited event. Launched in 2011, the Theme-based Research Scheme (TRS) aims to focus academic research efforts of the University Grants Committee-funded universities on themes of strategic importance to the long-term development of Hong Kong. Seven rounds of exercise have been conducted so far. Having worked hard for some five years, majority of the project teams with projects funded in the first two rounds have completed their research while those with projects funded in the third round are currently in their final stage. We are happy to have members of the project teams to share with us, through presentations, poster displays and demonstrations, the achievements of their frontier research in these TRS projects.

Taking this opportunity, I would like to express my sincere gratitude to members of the 14 project teams and their universities for their contributions in making this symposium a success. I would also like to thank the Office of Research and Knowledge Transfer Services of the Chinese University of Hong Kong in coordinating this event.

We look forward to seeing the impact and benefits brought by these TRS projects to the social and economic development of Hong Kong. I hope you would enjoy the symposium today.

Professor Benjamin W. Wah
Chairman
Research Grants Council

我謹代表研究資助局，歡迎您參加主題研究計劃研討會2017。

今天是一個期待已久的活動。主題研究計劃於2011年推出，計劃的目的是集中大學教育資助委員會資助大學的學術研究力量，對香港長遠發展具策略重要性的主題進行研究，至今已舉行了七輪計劃。經過近五年的努力，在首兩輪獲得撥款的項目團隊大部分已完成他們的研究，而在第三輪獲得撥款的項目亦已進入研究的最後階段。我們欣悉項目團隊成員將透過講座、海報和展覽，與我們分享他們在主題研究計劃項目所得的嶄新研究成果。

藉此機會，我衷心感謝14個項目的團隊成員和他們所屬的大學對是次研討會的支持，使研討會得以成功舉行。我亦感謝香港中文大學的研究及知識轉移服務處協助籌辦是次研討會。

我們期望這些主題研究計劃項目為香港的社會和經濟發展帶來影響及裨益。希望您熱烈參與今天的研討會。

華雲生教授
研究資助局主席

ABOUT THE THEME-BASED RESEARCH SCHEME
主題研究計劃概要

To reaffirm its continued support to research and development, the Government set up a Research Endowment Fund (REF) with a one-off grant of $18 billion in 2009. The investment income from up to $4 billion of the REF is deployed to support research projects on specific themes under the Theme-based Research Scheme (TRS). The objective of the TRS is to focus academic research efforts of the University Grants Committee-funded universities on themes of strategic importance to the long-term development of Hong Kong. The Scheme provides funding support of up to $75 million per project for a duration of up to five years. Seven rounds of TRS have been conducted since its inception, supporting 35 collaborative projects with the total awarded amount over $1.44 billion.

為進一步支持及推動本港的學術研究與發展，香港特區政府於2009年撥款一百八十億港元成立研究基金，並從當中不多於四十億元的投資收益，用作資助主題研究計劃，目的為集中大學教育資助委員會資助大學的力量，就對於香港長遠發展具策略重要性的主題進行研究。計劃所資助的研究，每項撥款上限為七千五百萬港元，為期可長達五年。迄今，研究資助局已推出七輪主題研究計劃，合共資助三十五個協作項目，金額逾十四億四千萬港元。

THEMES AND GRAND CHALLENGE TOPICS
研究主題及具挑戰性的題目

To focus academic research efforts on themes of strategic importance to the long-term development of Hong Kong, the following 4 research themes are identified, with 4 grand challenge topics under respective themes:

為推展於策略上有利於香港長遠發展的主題研究，香港特區政府訂定四個研究主題，並於個別研究主題下設置四個具挑戰性的題目：

1. Promoting Good Health
- Infectious Diseases
- Understanding Disease Mechanisms to Improving Health[1]
- Stem Cells and Regenerative Medicine
- Wellness Enhancement[2]

1. 促進健康
- 傳染病
- 剖析發病機制以保障健康[1]
- 幹細胞與再生醫學
- 提升健康[2]

2. Developing a Sustainable Environment
- Water Pollution and Water Treatment
- Sustainable Built Environment
- Energy Harvesting, Conversion and Conservation[3]
- Air Quality

2. 建設可持續發展的環境
- 水污染及水處理
- 可持續建築環境
- 採集、轉化及節約能源[3]
- 空氣質素

3. Enhancing Hong Kong's Strategic Position as a Regional and International Business Centre
- Hong Kong's Future as an International Financial Centre
- Promoting Hong Kong's Business through Networking Capability
- Promoting Hong Kong as a Centre of Excellence for Business Services
- Innovation and Business Creation

3. 加強香港作為地區及國際商業中心的策略地位
- 香港作為國際金融中心的未來發展
- 通過網絡能力推動香港商業發展
- 推動香港成為卓越的商業中心
- 創新與商業創意

4. Advancing Emerging Research and Innovations Important to Hong Kong[2]
- Big Data
- Imaging, Robotics and Smart Manufacturing
- Urban Infrastructure
- E-learning and Digital Citizenship

4. 促進對香港起重要作用的新興研究及創新項目[2]
- 大數據
- 造像、機械人技術及智能製造
- 城市基礎建設
- 網上學習及數碼公民身分

Notes:
[1] Topic for the 1st - 4th Rounds: Genomic Medicine
[2] Introduced in the 6th Round
[3] Topic for the 1st - 2nd Rounds: Organic Photo-voltaic and Light Emitting Diodes; Topic for the 3rd Round: Green Electronics

備註：
[1] 第一至第四輪題目：基因組醫學
[2] 自第六輪始加入
[3] 第一至第二輪題目：有機光伏發光二極管；第三輪題目：綠色電子

THEME-BASED RESEARCH SCHEME (TRS) PUBLIC SYMPOSIUM
主題研究計劃研討會

The TRS Public Symposium aims to share and communicate with the research community, stakeholders and general public the ground-breaking discoveries as well as the economic and social impact of the research projects funded by TRS. The Research Grants Council (RGC) will hold the TRS Public Symposium every two to three years and the Chinese University of Hong Kong is proud to be selected this year to coordinate this event on behalf of the RGC.

主題研究計劃研討會舉辦之目的為向學術研究界、各持份者及公眾，展示主題研究計劃資助項目的創新科研成果，以及所帶來的經濟與社會影響，並讓各界參與討論。研究資助局每隔兩至三年舉辦一次主題研究計劃研討會，香港中文大學榮獲研究資助局委任為統籌單位，承辦本年度之研討會。

At the TRS Public Symposium 2017, 14 inter-disciplinary TRS projects funded from the 1st to 3rd Rounds will showcase their achievements and impact through presentations, poster display, and demonstration of work. These 14 research projects, encompassing topics in Health, Environment and Business, received a total funding of HK$ 627 million from the RGC.

十四個於第一至第三輪主題研究計劃獲資助的跨學科研究項目，將於本年度的研討會中透過講座、海報展覽及項目演示，介紹其優秀科研成果及影響。此十四項研究涵蓋「促進健康」、「建設可持續發展的環境」及「加強香港作為地區及國際商業中心的策略地位」三個主題，共獲研究資助局撥款約六億二千七百萬港元。

PROGRAMME
研討會程序

- Theme 1 主題 1：Health 健康
- Theme 2 主題 2：Environment 環境
- Theme 3 主題 3：Business 商業

TIME	PROGRAMME	
9:00	Opening Ceremony Plenary Session - Funding Mechanism of the Theme-based Research Scheme < Venue: LT1 >	
	Presentations - Theme 1 < Venue: LT1 >	Presentations - Themes 2 & 3 < Venue: LT2 >
9:50	**The Liver Cancer Genome Project: Translating Genetic Discoveries to Clinical Benefits** *Prof. Nathalie Wong (CUHK)*	**Enhancing Hong Kong's Future as a Leading International Financial Centre** *Prof. Douglas W. Arner (HKU)*
10:40	**Massively Parallel Sequencing of Plasma Nucleic Acids for the Molecular Diagnostics of Cancers** *Prof. Allen Kwan-chee Chan (CUHK)*	**Transforming Hong Kong's Ocean Container Transport Logistics Network** *Prof. Chung-yee Lee (HKUST)*
11:25	Tea Break	
11:40	**Personalized Medicine for Cardiovascular Diseases: From Genomic Testing and Biomarkers to Human Pluripotent Stem Cell Platform** *Prof. Hung-fat Tse (HKU)*	**Challenges in Organic Photo-Voltaics and Light-Emitting Diodes - A Concerted Multi-Disciplinary and Multi-Institutional Effort** *Prof. Vivian Wing-wah Yam (HKU)*
12:30	**Cell-based Heart Regeneration** *Prof. Ronald Adolphus Li (HKU)*	**Sustainable Lighting Technology: From Devices to Systems** *Prof. Ron Shu-yuen Hui (HKU)*
13:15	Lunch Break	
14:30	**Functional Analyses of How Genomic Variation Affects Personal Risk for Degenerative Skeletal Disorders** *Prof. Kathryn S.E. Cheah (HKU)*	**Cost-effective and Eco-friendly LED System-on-a-chip (SoC)** *Prof. Kei-may Lau (HKUST)*
15:20	**Stem Cell Strategy for Nervous System Disorders** *Prof. Nancy Y. Ip (HKUST)*	Poster and Demonstration Session for Themes 2* & 3 < Venue: G/F Foyer >
16:05	Tea Break	
16:20	Poster and Demonstration Session for Theme 1* < Venue: G/F Foyer >	

* The following TRS projects will participate in the poster and demonstration session:

- **Systematic Development of Molecular Targets for Nasopharyngeal Carcinoma** *(Prof. Kwok-wai Lo, CUHK)*
- **An Integrated Trans-omics Approach to Diabetic Cardio-renal Complications: From Novel Discoveries to Personalized Medicine** *(Prof. Ronald Ching-wan Ma, CUHK)*
- **Smart Solar Energy Harvesting, Storage, and Utilization** *(Prof. Ching-ping Wong, CUHK)*

時 間	活 動	
9:00	開幕典禮 主題研究計劃撥款機制簡介 < 地點： 一號演講廳 >	
	講座 —— 主題1 < 地點：一號演講廳 >	講座 —— 主題2及主題3 < 地點：二號演講廳 >
9:50	**肝癌基因組研究計劃：轉化基因發現為臨床應用** *王昭春教授 (香港中文大學)*	**提升香港全球競爭能力，打造世界一流金融中心** *安納德教授 (香港大學)*
10:40	**大規模平行測序在癌症分子診斷的應用** *陳君賜教授 (香港中文大學)*	**振興香港海洋貨櫃運輸物流網** *李忠義教授 (香港科技大學)*
11:25	茶歇	
11:40	**心血管疾病個人化醫療：從人類基因及生物指標到幹細胞平台** *謝鴻發教授 (香港大學)*	**透過跨學科及多學院的協同努力迎接有機光伏打電池及發光二極管面臨的挑戰** *任詠華教授 (香港大學)*
12:30	**用萬能幹細胞複製「人類心臟」** *李登偉教授 (香港大學)*	**「可持續」照明技術：從模塊到系統** *許樹源教授 (香港大學)*
13:15	午膳時間	
14:30	**基因組差異影響退化性骨骼疾病的個人風險的功能性研究** *謝賞恩教授 (香港大學)*	**低本高效、綠色環保的LED晶片系統** *劉紀美教授 (香港科技大學)*
15:20	**神經系統疾病的幹細胞研究策略** *葉玉如教授 (香港科技大學)*	主題2*及主題3海報展覽及項目演示 < 地點：地下門廳 >
16:05	茶歇	
16:20	主題1*海報展覽及項目演示 < 地點：地下門廳 >	

* 以下研究項目將參與海報展覽及項目演示環節：

- **系統性開發鼻咽癌的分子靶標** *(香港中文大學羅國煒教授)*
- **對糖尿病心血管及腎臟併發症的跨組學基因研究 - 從創新發現至個性化治療** *(香港中文大學馬青雲教授)*
- **智能化太陽能技術：採集、存儲和應用** *(香港中文大學汪正平教授)*

LOCATION MAP OF POSTERS DISPLAY AND DEMONSTRATIONS
海報展覽及項目演示位置圖

Yasumoto International Academic Park
The Chinese University of Hong Kong
香港中文大學康本國際學術園

Theme 2 主題2 - Environment 環境

① Prof. Ching-ping Wong (CUHK)
汪正平教授 (香港中文大學)
T23-407/13-N

② Prof. Vivian Wing-wah Yam (HKU)
任詠華教授 (香港大學)
T23-713/11

③ Prof. Ron Shu-yuen Hui (HKU)
許樹源教授 (香港大學)
T22-715/12-N

④ Prof. Kei-may Lau (HKUST)
劉紀美教授 (香港科技大學)
T23-612/12-R

Theme 3 主題3 - Business 商業

① Prof. Douglas W. Arner
安納德教授 (香港大學)
T31-717/12-R (HKU)

② Prof. Chung-yee Lee
李忠義教授 (香港科技大學)
T32-620/11 (HKUST)

Theme 1 主題1 - Health 健康

① Prof. Dennis Yuk-ming Lo (CUHK)
盧煜明教授 (香港中文大學)
T12-404/11

② Prof. Nathalie Wong (CUHK)
王昭春教授 (香港中文大學)
T12-403/11

③ Prof. Kwok-wai Lo (CUHK)
羅國煒教授 (香港中文大學)
T12-401/13-R

④ Prof. Ronald Adolphus Li (HKU)
李登偉教授 (香港大學)
T13-706/11

⑤ Prof. Ronald Ching-wan Ma (CUHK)
馬青雲教授 (香港中文大學)
T12-402/13-N

⑥ Prof. Nancy Y. Ip (HKUST)
葉玉如教授 (香港科技大學)
T13-607/12-R

⑦ Prof. Hung-fat Tse (HKU)
謝鴻發教授 (香港大學)
T12-705/11

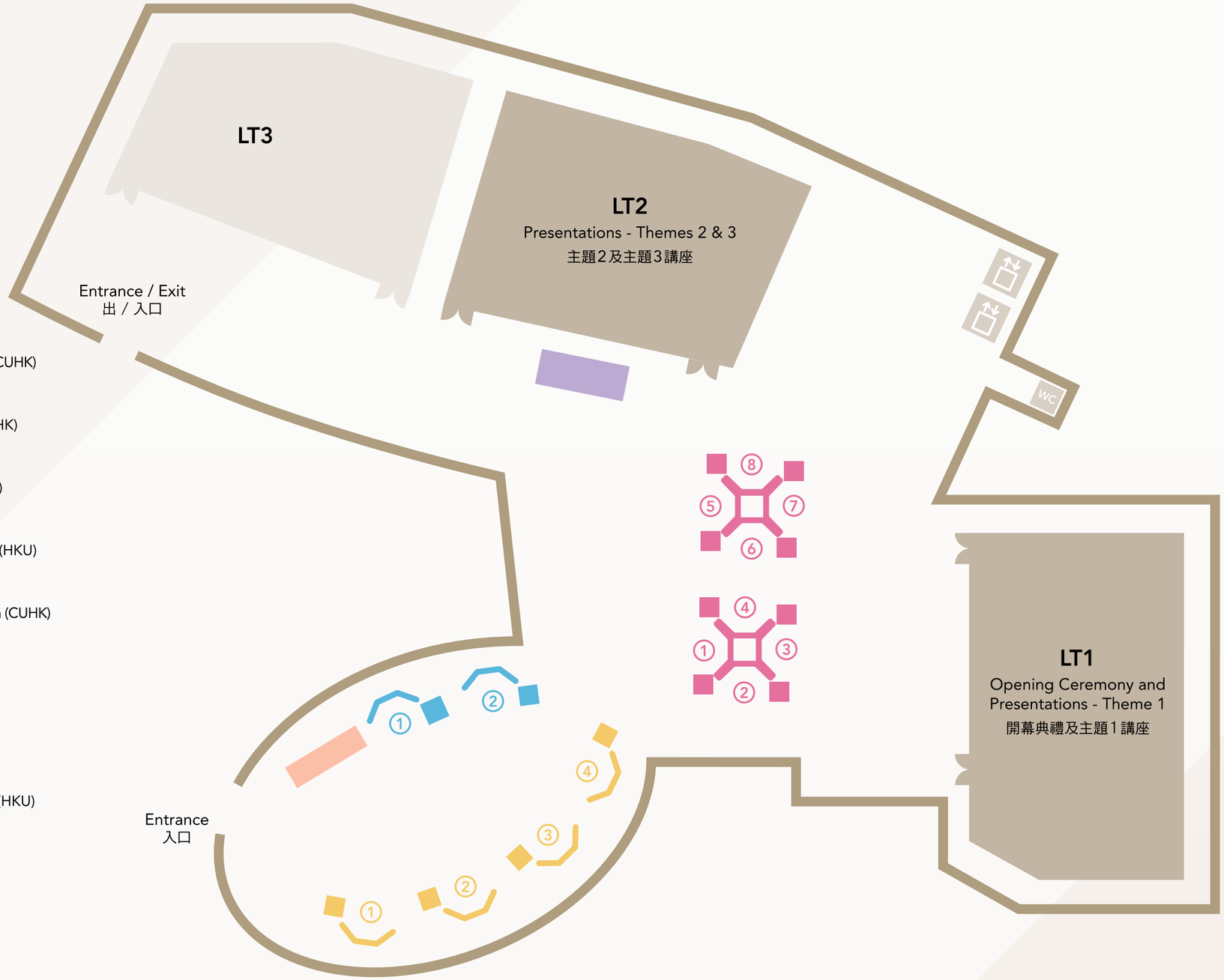
⑧ Prof. Kathryn S.E. Cheah (HKU)
謝賞恩教授 (香港大學)
T12-708/12-N

Reception 接待處

Photo Booth 攝影區

Lift 電梯

WC Restroom 洗手間



THE LIVER CANCER GENOME PROJECT: TRANSLATING GENETIC DISCOVERIES TO CLINICAL BENEFITS (T12-403/11)
肝癌基因組研究計劃：轉化基因發現為臨床應用

Prof. Nathalie Wong
王昭春教授

PROJECT COORDINATOR
Prof. Nathalie Wong
The Chinese University of Hong Kong

項目統籌人：
王昭春教授
香港中文大學

PARTICIPATING INSTITUTION
The Hong Kong University of Science and Technology
The University of Hong Kong
Beijing Genomics Institute (Shenzhen)

參與院校：
香港科技大學
香港大學
深圳華大基因組研究所

SHORT BIOGRAPHY OF PROJECT COORDINATOR 項目統籌人簡介

Prof. Nathalie Wong obtained her D.Phil. in Clinical Biochemistry from University of Oxford, UK, and post-doctoral training at King's College School of Medicine and Dentistry, University of London, UK. She is now Professor at Dept of Anatomical and Cellular Pathology, Chinese University of Hong Kong. Prof. Wong's research focuses on understanding the molecular carcinogenesis of human hepatocellular carcinoma (HCC). Her group has previously studied the genomic aberrations of HCC and defined a number of vital genetic loci. Her current research includes whole genome and transcriptome analysis of HCC, functional characterization of somatic variants for cancer-causing effects and elucidation of signaling pathways in HCC development and metastasis.

王昭春教授成為英國牛津大學生物化學專業博士，及倫敦大學國王學院醫學和牙科學院博士後，現為香港中文大學病理解剖及細胞學系教授，長期從事人類肝癌發病的分子機制研究。她的團隊研究了肝癌的細胞遺傳變異，並且定義了一些關鍵的基因位點。目前，王教授的研究方向包括肝癌全基因組和轉錄組測序，肝癌發生和發展過程中非編碼RNA分析和體細胞變異的致癌作用研究。

PROJECT SUMMARY 項目概要

- Hepatocellular Carcinoma (HCC) is a highly aggressive tumor that is prevalent in China, including Hong Kong, and Southeast Asia
- An annual incidence of ~320,000 new patients has been reported, of which >50% occur in China
- In Hong Kong, the mortality incidence from HCC is ~1,450 cases/year and it currently ranks the 3rd leading cause of cancer deaths
- In the clinical management of HCC patients, there are currently 2 major problems
  - Δ most patients are diagnosed late in the clinical course of disease progression due to the lack of effective early diagnostic markers
  - Δ HCC patients often show low efficacies to therapies. Consequently, the median survival for the majority of patients is estimated at ~11 months
- The Liver Cancer Genome Project aims to elucidate the genetic basis of liver carcinogenesis - from liver cirrhosis to HCC and disease progression to metastasis

- 肝癌是香港，中國及東南亞常見的高度惡性腫瘤
- 全球每年約有32萬新患者，其中過半數於中國發現
- 香港肝癌死亡率約是每年1450人，目前位列第三主要引致死亡的癌症
- 目前肝癌患者臨床管理的兩個主要的問題：
  - Δ 由於缺乏有效的早期診斷標誌物，大多數患者確診時病情進展嚴重
  - Δ 肝癌患者的治療效果普遍較差。中位生存期約為11個月
- 肝癌基因組計劃目的是闡明肝癌癌變，包括從肝硬化轉化到肝癌和肝癌擴散的遺傳基礎

ABSTRACT 項目簡介

Liver cancer is a highly aggressive tumor that is prevalent in China and Southeast Asia. An annual incidence of ~320,000 new patients has been reported, of which >50% occur in China. In Hong Kong, the mortality incidence from liver cancer is ~1,450 cases per year and it currently ranks the 3rd leading cause of cancer deaths. The dismal outcome for the majority of individuals diagnosed with liver cancer is largely attributed to (i) the lack of early diagnostic markers that render patients diagnosed late in the clinical course of disease progression; and (ii) most patients show low therapeutic efficiencies, which consequentially lead to an inferior survival prospect. The median survival for the majority of patients is estimated at about 11 months.

Like other cancer types, liver cancer is also a genetic disease. In the areas of liver cancer genome research, clinical diagnosis and treatment of patients with liver cancer, Prof. Nathalie Wong and research team have more than 15 years of broad and extensive experience. The Project is a joint collaborative program of clinicians and basic researchers from The Chinese University of Hong Kong, The University of Hong Kong, The Hong Kong University of Science and Technology, Beijing Genomics Institute – Shenzhen and The State Laboratory of Oncology in South China. Understanding that current limitations in the clinical management of liver cancer patients is largely due to the paucity of information related to its malignant transformation from liver cirrhosis and the biology of liver metastasis, this Project proposes to conduct large-scale genome-wide analyses to define genetic events which discriminate tumor from cirrhosis and progression to metastatic disease. The deployment of the innovative massively parallel sequencing will offer unprecedented depth, speed and capacity to widely elucidate somatic variations at the genome and transcriptome levels. The instigation of a 'Liver Cancer Genome Project' will have strategic importance in cataloguing the genetic blueprint of liver cancer which in turn will provide the foundation for research into identifying targets for therapies, biomarkers for early diagnosis, and prognostic indicators for predicting recurrence.

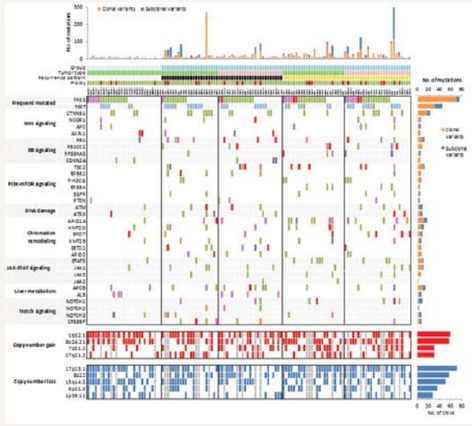
肝癌是中國及東南亞常見的高度惡性腫瘤。全球每年約有32萬新增患者，而中國佔半數以上案例。現時香港肝癌死亡率每年平均約為1450人，位列第三主要引致死亡的癌症。對於肝癌患者的臨床治療，目前醫療人員面對兩個重要問題：(1) 由於缺乏有效的早期診斷標誌物，多數患者確診時病情已進展為中期或晚期肝癌；(2) 肝癌患者的治療效果普遍較差，存活率低，造成大多數肝癌患者生存期短的主要原因（中位數約為11個月）。

肝癌和其他癌症都是由基因組突變引致的疾病。在肝癌的基因組研究及臨床診斷，治療等領域，王昭春教授和研究團隊有超過15年經驗和深厚基礎。此合作項目由多位來自香港中文大學，香港大學，香港科技大學，華大基因(深圳)研究所及華南腫瘤學國家重點實驗室的著名學者及醫生主持。現時治療肝癌病人的效果並不理想的主要原因是對肝硬化轉為肝癌及肝癌擴散的基因突變和生物機制的認識有限。此計劃將針對這些問題而利用大規模平行測序技術建立肝癌的全基因組藍圖。王教授認為先進的平行測序技術不但可以快捷有效地發現與肝癌有關的基因突變，更可全面分析其基因組結構變化及轉錄水平，確定引致肝癌轉化及擴散的基因改變。構建肝癌基因藍圖將為建立嶄新治療技術，發展肝癌特有早期診斷，預後和復發預測方法提供重要基礎信息及研究線索。

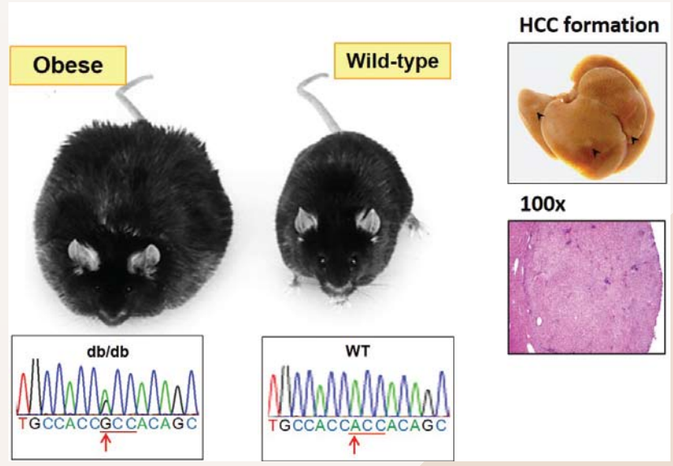
RESEARCH IMPACT 研究影響

The high resolution and high throughput next-generation sequencing has been used to establish the genetic blueprint of HCC. This map provides the foundation for research into identifying targets for therapies, biomarkers for early diagnosis, and prognostic indicators for predicting recurrence.

計劃利用最先進大規模平行測序技術建立肝癌的基因藍圖。研究基因藍圖將為建立嶄新治療肝癌技術，發展肝癌特有早期診斷和預後復發的預測方法提供重要研究基礎。



Mutation profile of putative driver gene mutations in hepatocellular carcinoma
肝癌的基因突變圖譜



Mouse model with genetic mutation to study liver cancer development
研究肝癌發展的具有遺傳突變的小鼠模型

MASSIVELY PARALLEL SEQUENCING OF PLASMA NUCLEIC ACIDS FOR THE MOLECULAR DIAGNOSTICS OF CANCERS (T12-404/11)
大規模平行測序在癌症分子診斷的應用

Prof. Dennis Yuk-ming Lo
盧煜明教授

PROJECT COORDINATOR
Prof. Dennis Yuk-ming Lo
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項目統籌人：
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SHORT BIOGRAPHY OF PROJECT COORDINATOR
項目統籌人簡介

Dennis Lo is the Chairman of the Department of Chemical Pathology of The Chinese University of Hong Kong. He obtained his undergraduate training from the University of Cambridge and his Doctor of Medicine and Doctor of Philosophy degrees from the University of Oxford. He discovered the presence of cell-free fetal DNA in maternal plasma in 1997. He then generalized many of such diagnostic concepts to the detection of cancer using plasma DNA. In recognition of his work, Dennis Lo has been elected as a Fellow of the Royal Society, a Foreign Associate of the US National Academy of Sciences, a Fellow of the World Academy of Sciences and a Founding Fellow of the Academy of Sciences of Hong Kong. He has also received many awards, including the 2016 Future Science Prize in Life Science, and the 2014 King Faisal International Prize in Medicine.

盧煜明教授現為香港中文大學醫學院化學病理學系系主任。盧教授於英國劍橋大學取得文學士學位，再於牛津大學取得醫學博士及哲學博士學位。在1997年，盧教授成為世界上第一位科學家發現母體血漿內有胎兒的脫氧核糖核酸(DNA)，從而開闢了一個新研究領域。盧教授亦在利用血漿DNA檢測癌症取得多項突破。為彰表其科學研究成就，盧煜明教授先後獲授英國皇家學會院士榮銜、美國國家科學院外籍院士榮銜、世界科學院院士、及港科院創院院士。盧教授亦曾獲頒多個獎項，包括2016未來科學大獎生命科學獎，及2014年度費薩爾國王國際醫學獎 。

Scientific Advisory Board (SAB) meeting on 12 January 2015. From left to right: Prof Brigette Ma, Dr Alice Cheng, Prof Winnie Yeo, Dr Kun Sun, Dr Peiyong Jiang, Prof Hao Sun, Prof Rossa Chiu, SAB member Prof Toshikazu Ushijima, SAB member Prof Philip Johnson, Project Coordinator Prof Dennis Lo, Prof Anthony Chan, Prof Allen Chan, Dr Gary Liao.
研究項目的科學顧問委員會會議（ 2015年1月12日）。
從左至右，馬碧如教授，鄭淑恒博士，楊明明教授，孫坤博士，江培勇博士，孫昊教授，趙慧君教授，牛島俊和教授（科學顧問委員會委員），莊立信教授（科學顧問委員會委員），盧煜明教授（項目統籌人），陳德章教授，陳君賜教授，廖嘉煒醫生

PROJECT SUMMARY 項目概要

- To develop a technology for detecting cancer using cell-free DNA floating in blood
- To demonstrate the clinical impact of this technology
- To build a patent portfolio in this area
- To transfer this technology to the commercial sector

- 發展一套科技利用血液內、並在細胞外浮游的DNA用作檢測癌症
- 證明這技術的臨床應用
- 發展這技術專利保護
- 把技術轉移生物科技行業

ABSTRACT 項目簡介

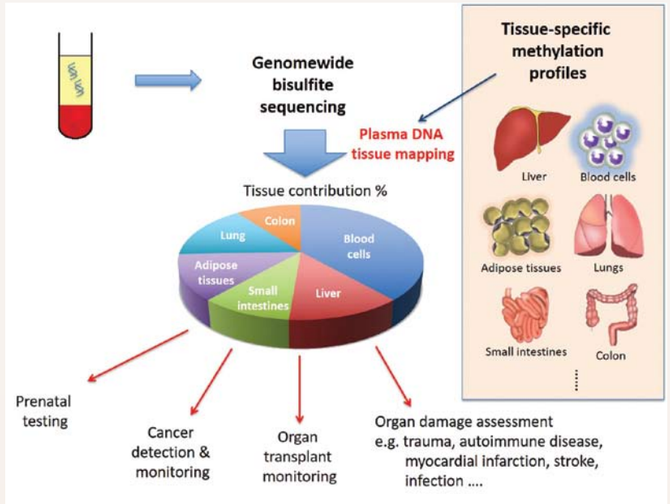
Cancer is the top killer in Hong Kong and many parts of the world. The lack of effective tools for the timely detection and dynamic monitoring of cancer has hindered efforts in combatting cancer. The Project Team is a world-leading group in the biology and diagnostic applications of plasma nucleic acids. The advent of massively parallel DNA sequencing has created a paradigm shift in genomics research. The group is among the first to demonstrate the use of massively parallel sequencing as a diagnostic tool. The group has pioneered a number of novel approaches for applying massively parallel sequencing for the detection and analysis of plasma nucleic acids at an unprecedented level of sensitivity, resolution and comprehensiveness. In this project, the group proposes to lay the conceptual and technological foundation for applying massively parallel sequencing of plasma nucleic acids as a detection and monitoring tool for cancer. The team aims to develop technologies that would allow a non-invasive genome-wide scan of cancer-associated genetic, transcriptomic and epigenomic alterations in plasma. Such an approach would allow the development of generic cancer detection tests with broad population coverage and unlike the approaches available to date where only a subset of cancer-related molecular alterations are targeted at each instance. Coupled with the proven analytical power of massively parallel sequencing, such developments are expected to enable the timely detection, real-time monitoring and accurate prognostication of cancer. These goals, when realised, would significantly impact cancer management and bring health benefits to the citizens of Hong Kong and worldwide. This project is also expected to generate valuable intellectual properties which would stimulate the developments of biotechnology in Hong Kong.

癌症是香港和世界許多其他地方的頭號殺手。直至目前為止，能準確及廣泛適用於診斷各種癌症的方法仍然缺乏，這對發展更有效的癌症治療是一大障礙。我們的研究團隊是國際上研究血漿核酸診斷的先鋒，大規模平行測序的開發是基因組研究的突破。在過去幾年，我們的團隊率先應用血漿基因大規模平行測序技術作為臨床診斷工具，並全面分析血漿核酸的分子特性。我們建議藉此研究項目，對以大規模血漿核酸平行測序作為診斷和監測癌症的平台的概念奠定技術基礎。這方向有別於現時只針對測試個別癌症基因組的異變，因而能更廣泛地應用於不同種類的癌症。有賴大規模平行測序強勁的分析能力，我們預期這研究項目最終能發展出可以及早診斷、實時監測和準確預測治療效果的癌症測試方法。這些發展將對癌症治療作出重大及正面的影響，在健康層面上惠及香港和世界各地的市民。這個項目預計還可以產生寶貴的知識產權，刺激香港的生物科技發展。

RESEARCH IMPACT 研究影響

The project team has developed a powerful suite of technologies for detecting cancer-related genomic signatures in blood plasma. Work by the project team had been selected as one of the top ten breakthroughs in 2015 by the influential technology magazine, MIT Technology Review (https://www.technologyreview.com/s/534991/liquid-biopsy/). In 2017, the project team has demonstrated in a highly publicized clinical study published in the New England Journal of Medicine that circulating DNA testing would greatly increase the proportion of early nasopharyngeal cancer (NPC) cases detected, resulting in improved progression-free survival (http://www.nejm.org/doi/full/10.1056/NEJMoa1701717). When launched, the project team believes that this test could potentially reduce mortality due to NPC in south China by 50%. The project team has created a valuable intellectual property (IP) portfolio covering these technologies. Members of the project team has set up a startup company, Cirina, in the Hong Kong Science Park. Cirina has licensed the IP portfolio from the Chinese University of Hong Kong (CUHK). In June 2017, Cirina merged with Grail in the USA. This combined company is the most highly valued one in the liquid biopsy space worldwide. This project is thus one notable example that has brought Hong Kong-based biotechnology into the global arena.

研究團隊已成功發展出一套技術用作偵察癌細胞釋放到血漿的基因組訊號。研究團隊的技術在2015年被權威科技雜誌MIT Technology Review選為當年的十大突破(https://www.technologyreview.com/s/534991/liquid-biopsy/)。在2017年研究團隊在新英格蘭醫學雜誌發表一篇受高度關注的臨床研究，證明血漿DNA測試可以提早鼻咽癌被發現的時候，及令至存活率大幅提升(http://www.nejm.org/doi/full/10.1056/NEJMoa1701717)。研究團隊相信如果這測試在將來可以在南中國普及應用的話，鼻咽癌的死亡率有可能被降低一半。研究團隊亦創造了一套十分有價值的知識產權。研究團隊的部份成員亦已在香港科學園建立一間初創公司 — 「思為諾」。「思為諾」在2017年6月和美國Grail公司合併。合併後的公司是全球在液體活檢領域內最有價值的公司。這研究項目是把香港生物科技帶進世界舞台的一個突出例子。



Schematic illustration of the principle of plasma DNA tissue mapping by genomewide methylation sequencing and its applications (Kun et al PNAS 2015).
利用全基因組甲基化測序推測各個組織對游離DNA的百分比貢獻及其應用

PERSONALIZED MEDICINE FOR CARDIOVASCULAR DISEASES: FROM GENOMIC TESTING AND BIOMARKERS TO HUMAN PLURIPOTENT STEM CELL PLATFORM (T12-705/11)
心血管疾病個人化醫療：從人類基因及生物指標到幹細胞平台

Prof. Hung-fat Tse
謝鴻發教授

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SHORT BIOGRAPHY OF PROJECT COORDINATOR 項目統籌人簡介

Professor Hung-fat Tse is the Chair Professor of Cardiovascular Medicine and William MW Mong Endower Professor in Cardiology, HKU; Chief in the Cardiology Division, Department of Medicine, Queen Mary Hospital; The University of Hong Kong - Shenzhen Hospital and Chief of Service in Cardiology, Gleneagles Hong Kong Hospital.

Professor Tse received his MB.BS, MD and PhD degree from the University of Hong Kong, Hong Kong. He completed his postgraduate training in Internal Medicine and Cardiology in the Department of Medicine, Queen Mary Hospital, University of Hong Kong, and his cardiac training fellowship at the University of Michigan, USA.

Professor Tse is an international expert in cardiac pacing and electrophysiology, and regenerative medicine. He has significantly contributed to the understanding of the mechanisms as well as development of novel therapies for treatment of heart disorders, and is at the forefront of applying stem cells in cardiovascular regenerative medicine.

Professor Tse has published over 550 original scientific reports in top ranking international scientific journals, including New England Journal of Medicine, Lancet, Nature Medicine, Nature Cell Biology, Nature Genetic, Nature Protocol, Nature Communication, Nature Biomedical Engineering, Cell Stem Cell, Journal of American College of Cardiology, European Heart Journal Circulation, Blood, and Archives of Internal Medicine.

謝鴻發教授是瑪麗醫院內科學系心臟科主任教授及蒙民偉基金(心臟學)教授。謝教授先於香港大學取得醫學學士學位、再於香港大學瑪麗醫院醫學系內科和心臟病學完成其研究生課程，並於美國密歇根大學接受心臟電生理學的專業培訓。

謝教授作為心臟起搏、電生理學及心血管再生醫學國際專家、於治療心律失常的研究及新療法的研發上作出了重要貢獻。此外，謝教授亦致力推動將幹細胞應用於心血管再生醫學中的研究。最近、他領導的研究中心及基礎實驗室更聯同孫建業心臟研究及培訓中心為心血管疾病新穎設備和生物療法提供了培訓與開發的平台。

謝教授在國際科學期刊上發表了超過550篇原創科研報告，其中包括New England Journal of Medicine, Lancet, Nature Medicine, Nature Cell Biology, Nature Genetic, Nature Protocol, Nature Communication, Nature Biomedical Engineering, Cell Stem Cell, Journal of American College of Cardiology, European Heart Journal Circulation, Blood, and Archives of Internal Medicine 等著名學術期刊。

PROJECT SUMMARY 項目概要

- The project has discovered novel genetic markers that are associated with blood lipids and coronary artery disease (CAD) in our Chinese population cohorts.
- The project has established of iPSC model and humanized mouse model to investigate the effect of LDL-lowering medication
- The project has developed new genetic and biomarker-based diagnostic tools for risk stratification, prognosis and therapeutic monitoring of dyslipidemia and atherosclerosis.

- 研究在中國人口群體中發現血脂和冠狀動脈疾病（CAD）相關的新型遺傳標記。
- 研究建立iPSC模型和人性化小鼠模型，用作研究低密度脂蛋白降低藥物的作用。
- 基於遺傳和生物標記，研究開發新的診斷工具，用於血脂異常和動脈粥樣硬化的風險分層，預測和治療監測。

ABSTRACT 項目簡介

Cardiovascular diseases (CVD) are leading global cause of morbidity and mortality. Despite recent advances in the management of cardiovascular risk factors such as hypertension, diabetes, dyslipidemia and obesity, the prevalence of CVD continues to increase worldwide especially in Asian country, including China and Hong Kong. Beside life-style and environmental factors, blood lipid levels are under tighter genetic control than the related CVD. This highlights the need for new approaches beyond monitoring of conventional serum lipid levels to prevent, identify and treat individuals who are at risk of developing CVD.

In this project, we sought to discover novel genetic markers that are associated with blood lipids and coronary artery disease (CAD) in our Chinese cohorts. We performed genotyping using a custom-made state-of-art human exome chip which detects more than 0.3 million genetic variants. Next, we validated the identified association of genetic polymorphisms for blood lipids and CAD in a large cohort of Southern Chinese subjects in Hong Kong and China. Meta-analysis with data of ~40,000 East-Asians further revealed novel associations with blood lipids.

In order to understand the potential important of these novel genetic markers, we have established human pluripotent stem-cell systems that allow us to generate different human tissues, including liver and heart cells in a dish (in-intro). These human tissue platforms can allow us to study the relationship between those new genetic marker and cellular function in those tissues, and thus provide novel insights into the mechanisms of dyslipidemia and CVD. Currently, we successfully generated patients-specific liver cells using our established pluripotent stem cell platforms from several families with severe familial hypercholesterolemia due to genetic mutation on low-density lipoprotein receptor that lead to premature CAD for disease modeling and drug testing. Moreover, we also successfully create a mice model of severe dyslipidemia due to the similar genetic mutation at the low-density lipoprotein receptor to validate our in-vitro study finding and for the in-vivo assessment of the pathophysiology and drug testing for dyslipidemia.

Based on the above acquired knowledge, we develop new genetic and biomarker-based diagnostic tools for risk stratification, prognosis and therapeutic monitoring of dyslipidemia and atherosclerosis using the knowledge obtained from the in-vitro modelling of disease mechanisms and pathways, based on the above human iPSC platform.

Taken together, our study offer novel insight into the complex pathophysiology of dyslipidemia and CVDs that can potentially translate into new approaches to personalized medicine for prevention, diagnosis and treatment of CVD.

心血管疾病是全球發病率和死亡率最高的疾病。在云云危險因子中，血脂異常對心血管疾病的影響最為嚴重。因此，要更有效預防，鑒定和治療心血管疾病，一套能識別、預防及醫治個別高危患者的疾病監控系統是不可或缺的。

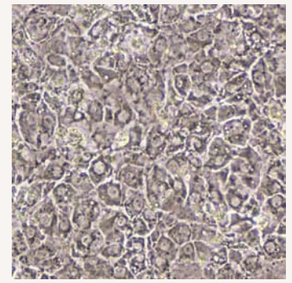
我們嘗試在中國人中探索嶄新的，與血脂和冠狀動脈疾病有關聯的遺傳標記。運用先進的人類外顯子芯片進行基因分型，檢測超過三十萬個人類遺傳變異。然後，在一個大型的南方華人研究中確認是次研究結果。另外，在一個四萬名東亞人的元分析中發現從未被證實與血脂相關的基因。

為了解這些新的遺傳標記的重要性，我們成功建立了人類多功能幹細胞系統。我們從幾個因低密度脂蛋白受體(LDLR)基因突變而引致嚴重家族性高血脂和早發冠心病的家庭中，獲得其多功能幹細胞，並定向分化為肝細胞，建立疾病模型和藥物測試平台。

此外，我們亦成功創建一個因LDLR基因突變而血脂異常的小鼠模型。此模型成功地驗證了相應的體外研究結果，以及體內評估血脂異常的病理過程和藥物測試。

從上述基因檢測和實驗研究的基礎上，我們開發一種嶄新的遺傳和生物標誌物的診斷工具，以助血脂異常與心血管疾病的風險評估。

綜上所述，本研究提供嶄新視野去探討血脂異常和心血管疾病複雜的病理機制，並轉化為個性化醫療，用於預防、診斷和治療心血管疾病。



Induced pluripotent stem cell derived hepatocyte
誘導多能幹細胞來源的肝細胞

RESEARCH IMPACT 研究影響

To our knowledge, our study is the first that used the exome chip to study impact of genetic traits on lipid and CAD among Southern Chinese. Overall, our findings demonstrated that exome-wide genotyping on samples of Southern Chinese: non-European ancestry can identify additional population-specific, possibly causal variants, shedding light on novel lipid biology and CAD. It also implicated the important contribution of population-specific rare variants to CAD risk, whose effect could only be detected by family-based study or population-based association analysis of large sample size. Moreover, our novel in-vitro cell based platform and in-vivo chimeric mice model established in this project can be used for future R&D for drug screening and discovery for dyslipidemia, which are major modifiable risk factors for CAD. In this project, we have been collaborated with pharmaceutical company on the new treatment of dyslipidemia. This provides another effective drug treatment to control patient blood lipid level.

In addition, the gene risk scores and biomarkers panel for LDL-C has been developed in this study. This can allow the early diagnosis and prediction of cardiovascular events in our Chinese population. In long term, our project can identify of high risk individuals (early prediction by genetics), improve patient living quality (better control of drugs) and reduce healthcare costs.

本研究是第一個使用外顯子組芯片來研究中國南方華人遺傳性狀對血脂和冠心病的影響。結果揭示了南方華人的獨特異性基因分型，此獨特異性對血脂異常及冠心病的形成有重要的啟示。研究亦指出稀有變體的獨特異性，必須通過大量樣本的檢測及分析才能找出，對評估冠心病風險有重要的作用。

血脂異常是冠心病的主要風險因素，本項目建立的新型體外細胞基平台和體內嵌合小鼠模型可用於未來血脂異常的藥物篩選和研發。我們已經與製藥公司合作，以新的藥物來治療血脂異常, 有效地控制患者的血脂水平。

本研究開發了低密度脂蛋白膽固醇的生物標誌物小組及基因風險評分。這可以改善對中國人心血管疾病的早期診斷和預測。從長遠來看，我們的項目可以識別高風險個體，提高患者生活質量，以及降低醫療成本。

FUNCTIONAL ANALYSES OF HOW GENOMIC VARIATION AFFECTS PERSONAL RISK FOR DEGENERATIVE SKELETAL DISORDERS (T12-708/12-N)
基因組差異影響退化性骨骼疾病的個人風險的功能性研究

Prof. Kathryn S.E. Cheah
謝賞恩教授

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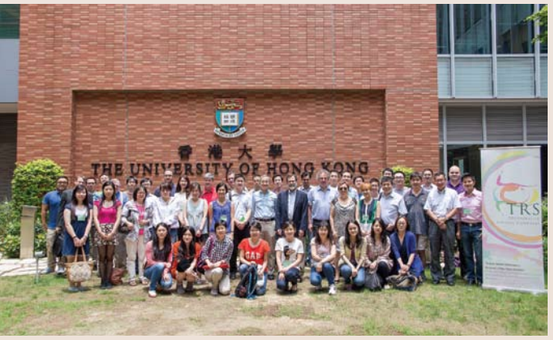
SHORT BIOGRAPHY OF PROJECT COORDINATOR
項目統籌人簡介

KATHRYN CHEAH is Jimmy & Emily Tang Professor in Molecular Genetics, Chair Professor of Biochemistry at the University of Hong Kong. She is a Fellow of The World Academy Sciences and was a Croucher Foundation Senior Fellow. She was founding President of the Hong Kong Society for Developmental Biology; President of the International Society for Matrix Biology 2006-2008; Senior External Fellow of the University of Freiberg Institute of Advanced Studies; member, Board of Directors of the International Society of Differentiation (2012-2018). Her research focuses on gene regulation and function and human diseases especially congenital and degenerative skeletal disease. Notable discoveries are that cartilage cells become bone cells in development and that cellular stress causes skeletal disorders. She is Director of a multidisciplinary team of scientists and clinicians aiming to identify genetic risk factors for degenerative intervertebral disc disease (IDD), which is a common cause of lower back pain and disability.

謝賞恩教授是香港大學鄧鉅明伉儷基金授席教授(分子遺傳學)及生物化學講座教授。同時，她是世界科學院院士，曾擔任裘槎基金會資深研究員，香港發育生物學會創會主席，世界基質生物學會2006至2008年度學會主席及2012-2018年度世界發育分化學會董事會成員。

謝教授多年來致力於研究人類疾病中致病基因的功能調控。她所帶領的團隊在先天性骨骼發育不良及後天退化性骨骼疾病的研究中獲得重大突破：她率先發現在骨骼發育中軟骨細胞可轉化成成骨細胞，同時指出細胞應激反應是先天及後天骨骼疾病的重要病因。針對椎間盤退化所引發的腰背痛症及生活工作不便，謝教授組建了一個由多位科學家和臨床醫生所組成的多學科團隊，有志於鑒定出此項疾病的相關遺傳性風險因子。



Last row: Wilson Chan, Julian Tanner, Keith Leung, Tommy Tan, Walter Bodmer (SAB), Nelson Chu, Yuelin Zhang, Mateusz Kudelko, Yan Li, Jaro Karppinen (Collaborator), Desmond Campbell, Charles Cheng, Caleb Chan, Rakesh Sharma, Ray Ng (co-I), Kwok-Yeung Tsang, Ron Wu, Simon Yip, Xueya Zhou, Yun Wah Lam (co-PI), Jin Gu (Visitor), Dino Samartzis (co-I)
2nd Row: Minting Yuen, Karine Ng, Shiny Guo, Barbara Chan (co-PI), Maggie Wang, Vivian Tam, Jason Cheung, Kenneth Cheung, Henry Kronenberg (SAB), Andreas Nagy (SAB), Kathryn Cheah (PC), Tiffany Au, Pak Sham (co-PI), Michael Zhang (Co-PI), Danny Chan (co-PI), Victor Leung
1st Row : Yiming Qin, Olivia Li, Irene Szeto, Angela Yao, Joyce Zhang, Sandy Poon, Katherine Gan, YuanYuan Yu, Pei Yu
第三行：陳卓榮，唐柱，梁啟雄，譚志佳，Walter Bodmer，朱子朗，張月林，Mateusz Kudelko，李艷，Jaro Karppinen，Desmond Campbell，鄺燕華，陳雋言，Rakesh Sharma，吳傑，曾國揚，胡明海，葉名琛，周學雅，林潤華，古權， Dino Samartzis
第二行：袁敏婷，吳婷婷，郭盛珍，陳佩，王承，譚闓勳，鐘培言，張文智，Henry Kronenberg, Andreas Nagy, 謝賞恩，區婉君，沈伯松，張奇偉，陳振勝，梁宇亮
第一行：秦一鳴，李康怡，司徒玉兒，姚青，張怡，潘紐燊，甘慧妍，于媛媛，于沛

PROJECT SUMMARY 項目概要

- IDD is a major cause of back pain.
- We discovered
  - Δ evidence for shared mechanisms for IDD and other disorders
  - Δ genetic risk factors and pathways that contribute to IDD pathology.
- We identified
  - Δ cellular stress response as a potential therapeutic target for IDD and other skeletal disorders
  - Δ potential disc stem cells that decline with age, implicating causal link to IDD.

- IDD是引發背部痛症的主要病因
- 我們確立：
  - Δ IDD和其他疾病享有共同機制的理論依據
  - Δ 引發IDD的病理性遺傳風險因素和細胞信號通路
- 我們發現：
  - Δ 細胞應激反應是IDD和其他骨骼疾病的潛在治療靶點
  - Δ 潛在的椎間盤幹細胞群，且幹細胞數目隨老化而減少是導致IDD一大潛因

ABSTRACT 項目簡介

Low back pain can be intolerable for millions globally, leading to a huge socioeconomic and health-care burden. In Hong Kong, 300,000 workdays are lost and $200 million are paid for worker's compensation. Intervertebral disc degeneration (IDD) is a major cause of back pain. Environmental and lifestyle factors can affect disc degeneration but there is also a genetic predisposition for IDD. IDD is very common and people are affected by the age of 50 or older. Only a few genetic factors have been found and the disease mechanisms of IDD are poorly understood, hampering preventative measures and the development of therapies.

We are an internationally recognized and leading multidisciplinary team of clinicians and scientists who have taken up the challenge, to identify the spectrum of genetic risk factors for IDD, and also to define how these contribute to differences in onset and severity of the disease. More than a decade ago we established a Hong Kong population cohort, the world' largest, comprising 3,500 individuals, with DNA samples, spine MRI scans, demographic, environmental, lifestyle and clinical information. Therefore we are uniquely positioned to assess the contribution of genetics to disease progression by longitudinal follow up. We identified new IDD subtypes, discovered new genetic IDD risk factors and genes and signalling pathways that correlate with disease severity. We found overlapping association between IDD with obesity, bone mineral density, osteoarthritis, implying shared mechanisms.

We have provided significant new insights into the biology of the intervertebral disc and the pathogenesis of IDD, with molecular therapeutic implications. We defined molecular signatures of disc cells and how these change from embryonic stages to adolescence, and middle age. We found embryonic-like cells in the disc that are potential "stem cells", and these decline with age and degeneration. By integrating genetic, molecular and clinical data, we identified an important role for the cellular stress response in IDD. In a mouse model of IDD, we found that a small molecule that targets this stress response can ameliorate congenital dwarfism and IDD associated with the activation of this stress response. These exciting findings suggest the stress response is an entry point for molecular therapy of IDD and possibly other skeletal disorders. The outcomes of this project will help us achieve our mission to lay the foundation for better prevention and intervention for IDD, thereby improving the healthcare and quality of life for the millions of people suffering from spinal problems.

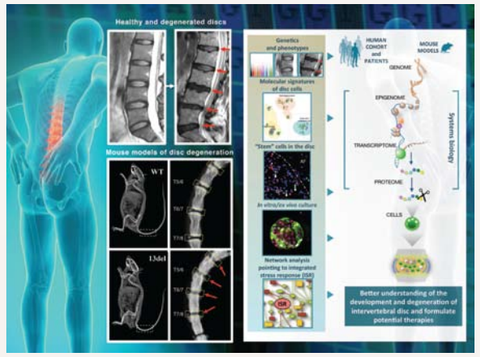
RESEARCH IMPACT 研究影響

Today we are facing an ageing society that demands improvement of "life quality". Low back pain (LBP) is a most disabling condition, representing tremendous socioeconomic and healthcare consequence. Such pain can lead to decreased function, psychological distress and loss wages. The costs for treating LBP are over 100 billion USD annually in the United States. In Hong Kong, 300,000 workdays are lost and $200 million are paid for worker's compensation. Prevention of LBP is imperative. Intervertebral disc disease (IDD) is a complex ageing disorder that is a major cause of back pain. Genetic factors influence the onset, progression and severity of IDD. Our project identified and mapped new sub-types of IDD and revealed their association with the severity, prediction and disabling aspects of pain. By linking clinical, genetic and biological data, we discovered genes and pathways that correlated with disease severity. Utilizing animal models, we discovered new patho-mechanism and novel therapeutic options that could be applied for the management, repair and prevention of IDD and other skeletal disorders in humans. Our project could also lead to risk profiling and evidence-based counselling for lifestyle changes, more cost-effective, personalized treatment options to achieve mobile and pain-free healthier ageing for millions worldwide.

腰背痛症嚴重影響人們的生活，帶來沉重的經濟負擔，單在香港就已耗費超過2億元的醫療開支。間椎盤退化（IDD）是引發腰背痛症的主要病因。雖然環境或工作因素都可引發IDD，但其遺傳傾向性也不可忽視。迄今為止，只有少數遺傳風險因子被確定，從而導致了預防及治療方案的滯後。

我們的研究團隊由臨床醫生和生物學家組成，致力於尋找IDD的遺傳風險因子。十多年前，我們開始對3500名病人進行DNA樣本採集，脊柱MRI掃描，生活方式和臨床信息的統計。通過這些數據，我們定位了遺傳學與IDD的直接相關性，確定了新的IDD亞型，鑒定出新的遺傳因子和相關的信號通路。我們還發現IDD與肥胖、骨質密度和骨關節炎之間存在關聯，暗示這些疾病可能共享致病機制。

我們對椎間盤的生物學提出了新的見解，確定了椎間盤細胞在胚胎期、青春期和衰老期的分子特徵，並發現了胚胎樣的"幹細胞"，其數目隨著年齡增長和椎間盤退化而下降。通過整合遺傳學和臨床數據，我們確定了細胞應激反應在IDD中的重要作用，通過小鼠模型發現了特異的小分子可以改善與這種應激反應相關的先天性侏儒症和IDD。這些成果表明應激反應可以是IDD和其他骨骼疾病治療的切入點，為更好地預防IDD奠定了堅實的基礎，從而改善脊椎病患者生活質量。



Overview of Programme
項目概述

社會老化提升了改善生活品質的需求。腰背痛嚴重影響日常活動，也為醫療系統及經濟帶來沉重負擔。患者會因工作能力下降而導致心理困擾及收入損失。美國每年花費超過一千億美元於治療腰背痛。香港亦因此損失三十萬個工作天及二億元的僱員補償，所以預防腰背痛是刻不容緩的。椎間盤疾病（IDD）是導致腰背痛的主要成因，遺傳因素影響其病發，退化及嚴重性。本項目把病例分類，並將其嚴重性，痛症及機能下降預測等聯繫。整合臨床及實驗室的研究，我們發現了與IDD相關的基因及信號網絡，亦在動物研究出新的病理機制及治療方案，對未來預防，控制及治療IDD提供了理據。本項目對病情風險、生活改善、治療方案等也提供了資訊，希望有助人類健康的渡過老年。

SYSTEMATIC DEVELOPMENT OF MOLECULAR TARGETS FOR NASOPHARYNGEAL CARCINOMA (T12-401/13-R)
系統性開發鼻咽癌的分子靶標

Team Photo (From left to right):
Kwok-wai Lo (PC); Anthony Tak-cheung Chan (co-PI); Ka-fai To (co-PI); Edwin Pun Hiu (co-I)
羅國煒 (PC)；陳德章 (co-PI)；杜家輝 (co-PI)；許斌 (co-I)

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SHORT BIOGRAPHY OF PROJECT COORDINATOR
項目統籌人簡介

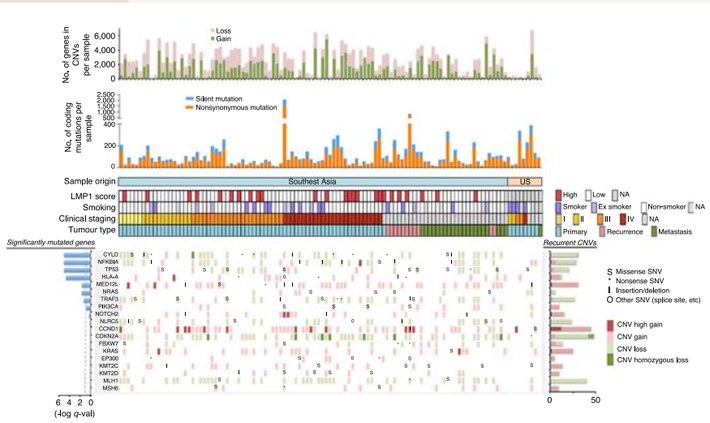
Dr Kwok-Wai Lo received his PhD from the Chinese University of Hong Kong (CUHK) in 1997. Currently, he is the Professor of Department of Anatomical & Cellular Pathology at CUHK. His long term research interest is to unveil the molecular basis of nasopharyngeal carcinoma (NPC). His research group has focused on identification and functional characterization of the NPC-associated tumor suppressor genes and oncogenes. He has successfully delineated the early events in NPC tumorigenesis and determined multiple recurrent genetic and epigenetic abnormalities in this EBV-associated cancer. Recently, he has systematically characterized the NPC genome by next-generation sequencing approaches. He is also working on establishing new tumor models, elucidating the mechanisms for immune evasion, and developing novel therapeutic strategies of NPC.

羅國煒博士於一九九七年獲得香港中文大學博士學位，現任中大病理解剖及細胞系教授。他的研究興趣主要是揭示鼻咽癌發病變的分子基理，集中鑑定與鼻咽癌相關的腫瘤抑制基因和致癌基因和分析其功能表徵。他成功展示了鼻咽癌早期腫瘤發生過程，並確定了這種與EBV相關的癌症中多種遺傳和表觀遺傳學變異。他最近利用大規模基因組測序系統地分析鼻咽癌基因組。現在，他正在建立新的鼻咽癌模型，研究其免疫逃避的機制和開發新型治療策略。

PROJECT SUMMARY 項目概要

- To catalogue the whole spectrum of genomic changes in NPC by genome sequencing.
- To define driver mutations, molecular and druggable targets and recurrent somatic alterations of NPC through integrative informatic analysis.
- To elucidate the functional roles of driver mutations and develop new targeted therapies in preclinical NPC models.

- 利用大規模基因組測序建立鼻咽癌基因組改變完整目錄
- 以生物信息分析方法系統地鑒定驅動突變和關鍵的分子標靶
- 分析驅動突變的功能作用，並利用臨床前鼻咽癌模型開發新型靶向治療。



Genome landscape of nasopharyngeal carcinoma – the largest whole-exome sequencing study of nasopharyngeal carcinoma
鼻咽癌基因組圖譜 ——
全球最大規模鼻咽癌全外顯子組測序研究

ABSTRACT 項目簡介

As the most prevalent cancer in our middle-aged workforce population, NPC is a major health-care problem in Hong Kong. More than 60% of newly diagnosed NPC patients are presented with advanced stage disease and show poor clinical outcome. The key problems of these patients are distant failure and lack of efficient treatment for recurrent diseases. New clinical interventions to treat the disease, prolong disease-free survival and improve quality of life of patients are therefore of strategic importance.

A comprehensive understanding of genetic changes involved in NPC tumorigenesis is expected to offer the basis for research to develop promising disease control strategies for this cancer. Systematic discovering driver genetic lesions and apprehending how they contribute to transformation and progression of NPC are essential information to underpin reliable biomarkers and novel molecular targets for therapy; the cornerstone of developing patient-specific personalized medicine. In this project, we have decoded the DNA sequence of entire NPC genome and thereby catalogue the whole spectrum of genomic changes involved in NPC tumorigenesis by massive parallel genome sequencing. Our team has systematically defined the driver mutations and identified key “molecular targets” through large-scale genome and transcriptome sequencing, bioinformatic analysis and extensive validation in primary NPC samples. Functional studies have confirmed the oncogenic activities and biological significances of candidate driver mutations. To translate the genomic findings to specific NPC biomarkers, statistical analysis has been conducted to determine the clinical correlation between somatic variants and patients’ clinical outcome. Importantly, candidate molecular targets and relevant tumour dependency can be elucidated for their therapeutic potentials in our unique panel of in vitro and in vivo NPC models. Our findings will provide important novel biomarkers and therapeutic targets for developing personalized cancer treatment strategies. We expect this project would make strategic breakthrough in molecular genetics of NPC and contribute significant impact to the control of this common cancer.

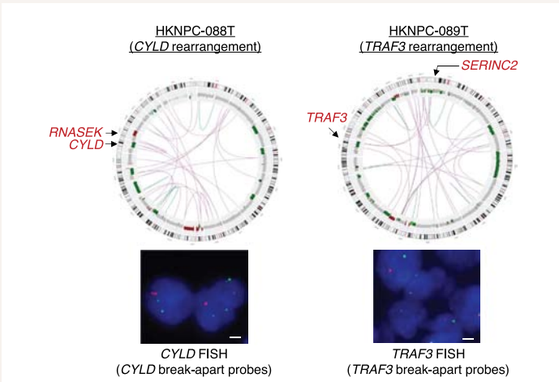
鼻咽癌是南中國方常見的致命惡性腫瘤，亦是香港的主要醫療健康問題。其中關鍵問題是超過60%的患者在初次診斷時已是晚期，治療對癌症擴散和復發效果較差。因此發展嶄新臨床治療方案以延長患者存期和提高生活質量對控制鼻咽癌非常重要。系統分析鼻咽癌致癌機理有關的基因改變是發展可靠的生物標誌和分子靶向治療的依據及個體化治療的基礎，對發展有效控制癌症的策略非常重要。在本研究中，我們使用大規模基因組測序方法對鼻咽癌的全基因組DNA序列進行解碼，由此建立鼻咽癌基因組改變完整目錄。我們對鼻咽癌腫瘤組織進行大規模全基因組和轉錄組序列，生物信息分析及廣泛驗證，並系統地鑒定驅動突變和關鍵的分子標靶。我們亦進行功能研究以確定驅動突變的致癌活性和生物學意義。為了把基因組的發現轉化成鼻咽癌的分子標誌，我們使用統計分析方法確定基因變異與病人臨床預後的聯繫。在我們建立的獨特的鼻咽癌體外和活體模型中研究腫瘤對候選分子標靶的依賴，更可以闡明它們的治療潛力。這些發現將為發展鼻咽癌個體化治療策略提供重要的新分子標誌和治療標靶。我們預期該項研究計劃將促使鼻咽癌分子遺傳學研究的突破和對控制此常見腫瘤產生顯著深遠的影響。

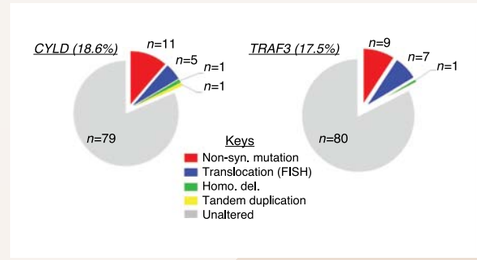
RESEARCH IMPACT 研究影響

With the support of TRS, we have reported the first NPC whole genome sequencing study and deposited the largest whole-exome sequencing datasets of 110 tumors to public database. We have established a comprehensive catalog of somatic alterations of NPC and revealed majority of NPC displayed activation of the NF-κB inflammation pathways as a result of somatic inactivating mutations in the NF-κB regulatory proteins.

The novel genome discoveries greatly enhance our understanding on the molecular basis of NPC and inform the development of new therapies to target these aberrant signaling pathways. The identification of multiple novel biomarkers including total mutation rate and mutated MHC class I genes will help to select the optimal treatment to the NPC patients. The TRS project will significantly advance the current clinical management and facilitate the development of personalized medicine for NPC patients.

在主題研究計劃支持下，我們發表了第一個鼻咽癌全基因組測序研究報告，並將最大型的鼻咽癌全外顯子序列數據集存儲到公共數據庫。我們建立了全面的鼻咽癌基因改變綜合目錄，並且發現大部分鼻咽癌的NF-κB炎症通路的激活是由於其調節蛋白基因失活突變導致的。這些全新基因組發現增強了我們對鼻咽癌分子基理的理解，並指導了開發針對這些異常信號通路的新療法。包括總突變率和人類白細胞抗原基因突變的多種新生物標誌物的發現和鑑定將有助鼻咽癌患者選擇最佳治療方法。此主題研究計劃項目將推進目前鼻咽癌的臨床管理，促進患者個性化醫學的發展。





Genome Sequencing identified Multiple somatic alterations of negative regulators in NF-κB signaling pathways.
基因組序列發現鼻咽癌中多個NF-κB信號通路負調節物基因變異

AN INTEGRATED TRANS-OMICS APPROACH TO DIABETIC CARDIO-RENAL COMPLICATIONS: FROM NOVEL DISCOVERIES TO PERSONALIZED MEDICINE (T12-402/13-N)
對糖尿病心血管及腎臟併發症的跨組學基因研究——從創新發現至個性化治療

Prof. Ronald Ching-wan Ma
馬青雲教授

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The Hong Kong University of Science and Technology

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香港科技大學

SHORT BIOGRAPHY OF PROJECT COORDINATOR 項目統籌人簡介

Ronald Ma is Professor at the Department of Medicine and Therapeutics, The Chinese University of Hong Kong and Honorary Consultant Physician, specialist in Endocrinology, Metabolism and Diabetes, Prince of Wales Hospital. As a clinician-scientist, Dr Ma's research focuses on the epidemiology and genetics of diabetes and its complications, gestational diabetes, and the developmental origins of diabetes. His group has a special interest in biomarker discovery and translational studies in diabetes. He is currently leading a multi-disciplinary project team to leverage on the large Hong Kong Diabetes Registry and accompanying biobank to identify novel molecular markers for diabetic complications, and is the principal investigator of the newly established Hong Kong Diabetes Biobank, which was initiated in 2014.

馬青雲是香港中文大學藥物及治療學系教授，亦是威爾斯親王醫院糖尿病和內分泌專科醫生。作為一位臨床醫生及科研家，他的研究重點為糖尿病及其併發症流行病學及遺傳學，及妊娠糖尿病。他的研究團隊特別專攻發掘糖尿病相關的生物標誌，並將研究轉化於臨床應用。他目前正在領導一個多學科項目團隊，發掘及驗證糖尿病新生物標記。他亦於2014年啟動了“香港糖尿病生物樣本庫”，對所發現的新生物標記進行大規模的驗證。

Photo of Project team taken at the Project Team Research Retreat in January 2016

(Front row) Professors Brian Tomlinson (Co-PI), Si Lok (Co-PI), Wing Yee So, Ronald Ma (Project Co-ordinator), Juliana Chan (Co-PI, deputy co-ordinator), Weichuan Yu (Co-PI), Hui-yao Lan (Co-PI), Yu Huang (Co-PI), Xiaodan Fan
(Back row) Professors Kevin Yu, Ting Fung Chan, Cheuk Chun Szeto, Nelson Tang, Stephen Tsui (Co-PI)
前排 ──湯寧信，駱樹恩，蘇詠儀，馬青雲，陳重娥，余維川，藍輝耀，黃聿，樊曉丹教授
後排 ── 葉旭立，陳廷峰，司徒卓俊，鄧亮生，徐國榮教授

PROJECT SUMMARY 項目概要

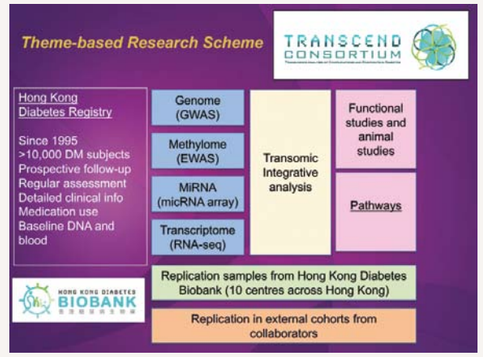
- Diabetes affects >10% of the population
- Heart and kidney complications are main causes of death for patients with diabetes. There are currently few treatments to prevent these complications, and it is difficult to identify people at risk of complications
- Our project aims to develop new tests to identify high risk individuals before they develop the complications, and develop better treatments

- 糖尿病影響超過百份之十的人口
- 糖尿病所帶來的醫療負擔，主要來自治療糖尿病導致的併發症，特別是心血管和腎臟併發症。
- 這個項目研究新發現與糖尿病併發症相關的基因和生物標誌，應用於識別高風險糖尿病人士，並旨在開發更好的治療方法。

ABSTRACT 項目簡介

Diabetes is a major health problem worldwide, including in Hong Kong. Most of the healthcare burden from diabetes is associated with the management of diabetic complications, in particular, cardiovascular and renal complications. Diabetes is the major cause of end-stage renal disease (ESRD), and increases the risk of cardiovascular disease (CVD) by 3-4 fold. Asian patients with type 2 diabetes (T2D) are particularly prone to renal complications when compared to patients of European origin. Only few genetic markers have so far been identified to predict diabetic cardiovascular-renal complications. Discovery of novel genetic or other biomarkers for diabetic complications can help identify at risk subjects for intensive risk factors management, advance our understanding of disease pathogenesis, revolutionize care and provide novel targets for drug development. In this Grand Challenge, we aim to utilize the unique resource from the Hong Kong Diabetes Registry, with more than 10,000 patients with T2D with detailed biochemical assessment of risk factors and documentation of medication history, who have been prospectively followed up for a mean duration of 8 years, with an accrual of 4,000 events of cardiovascular and renal complications. We will utilize a multi-omic approach and use new-generation sequencing (NGS) and other technologies to conduct a comprehensive evaluation of the genome, epigenome and transcriptome of diabetic patients with complications and diabetic patients free of complications despite long duration of disease. We will utilize advanced bioinformatics analysis to integrate findings from these different approaches. Insights from this multi-faceted investigation will be compared to findings from animal models of diabetic complications. We will use bioinformatics, in vitro experiments and animal models to characterize the functional significance and regulatory pathways of novel genes identified from the genomic studies. In addition to novel biological discoveries, we aim to translate our findings and examine the clinical significance of these novel biomarkers, as well as their interactions with different treatments on disease outcomes. Finally, we will leverage on the existing healthcare infrastructure and detailed clinical information available to establish an expanded diabetes registry and biobank with contribution from major diabetes centres across Hong Kong for large-scale replication of any novel biomarkers discovered. This resource will be a first-of-its-kind. In sum, the translation of our genomic discoveries to clinical care will consolidate Hong Kong as a centre for innovative biomedical research and chronic care excellence.

糖尿病已成為香港以及全球的主要疾病之一。糖尿病所帶來的醫療負擔，主要是由於對其併發症的治療，尤其是心血管和腎臟的併發症。探索和發現新的糖尿病併發症相關的遺傳或其它生物標記，將有助於識別高危人士而對其進行風險因素的強化控制；將進一步提高我們對發病機制的認識及促進治療水平的提升；還將為藥物研發提供新的靶向。面對這個巨大的挑戰，我們利用“香港糖尿病登記”，進行相關的研究和探索。“香港糖尿病登記”收錄了多個2型糖尿病病人的資料，包括糖尿病及其併發症相關風險因素的生化指標評估。這些病人的平均隨訪時間超過8年，累計了4000個心血管及腎臟相關的臨床終點事件。我們採用多組學的方法、新一代測序及其它先進分子生物學技術，研究和比較基因組、表觀基因組及轉錄組的變化和特徵。我們利用生物信息學、體外實驗和動物模型方法，分析和驗證所鑑定的新基因的功能和調節途徑。此外，我們還旨在將這些研究結果轉化為臨床應用，檢驗和分析這些新遺傳標記的臨床應用價值。最終，我們聯合香港多個糖尿病中心建立“香港糖尿病生物樣本庫”，對所發現的新生物標記進行大規模的驗證。研究的成果，將進一步鞏固香港作為創新生物醫學研究和卓越醫療中心的地位。



Overall design of Study to identify new markers and pathways for diabetic complications
整體研究項目的概述

RESEARCH IMPACT 研究影響

Healthcare costs associated with diabetes in China was 200 billion RMB in 2007, and is forecasted to exceed 360 billion RMB by 2030. In Hong Kong, diabetes accounts for annual healthcare costs of approximately 5 billion HKD, mostly due to burden from heart and kidney complications. Early identification of high-risk individuals with diabetes and multifactorial interventions can substantially reduce the burden of diabetic complications. Through work in the project, the project team has identified a panel of genetic and other molecular markers that can identify patients at higher risk of future diabetes complications. Ongoing work is focused on large-scale replication of these findings in different populations, application to patients in real-life clinical setting, and studies to understand how these genes affect development of diabetes-related complications. Findings from the project can help transform the way we treat patients with diabetes, whereby in future each patient can receive tailored treatment regimens that are most suitable and effective for them. Discoveries arising from the project are also providing us with new insights and leads for developing new drugs to treat diabetes and prevent its associated complications.

2007年中國與糖尿病相關的醫療保健費用為2000億元人民幣，預計到2030年將超過3600億元人民幣。在香港，糖尿病每年的醫療費用約為50億港元，主要是由於心臟和腎臟併發症的負擔。早期鑑定高危糖尿病患者可減輕糖尿病並發症的負擔。通過本研究項目的工作，項目組已經確定了一組基因和其他分子標記，可以識別未來糖尿病並發症風險較高的患者。正在進行的工作包括在不同人群中大規模確認這些標記，並對現實臨床環境中的患者的應用，並且研究了解這些基因如何影響糖尿病相關並發症的發展。本項目的結果將有助於改變我們對糖尿病患者的治療方式，從而在將來提供糖尿病患者可以獲得最適合和有效的治療方案。本項目的研究突破和發現也為我們提供了新的見解，為治療糖尿病並預防其相關並發症開發新藥提供新的方向。

CELL-BASED HEART REGENERATION
(T13-706/11)
用萬能幹細胞複製「人類心臟」

Prof. Ronald Adolphus Li
李登偉教授

PROJECT COORDINATOR
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SHORT BIOGRAPHY OF PROJECT COORDINATOR 項目統籌人簡介

Professor Ronald Li is currently Director of Ming-Wai Lau Centre for Reparative Medicine, Karolinksa Institutet (KI), Hong Kong, with a cross appointment at the Dr. Li Dak-Sum Research Centre, HKU. Professor Li is also CEO of Novoheart, a biotech company founded in HK in 2014, and listed in 2017. Professor Li received postdoc training and subsequently promoted to Assistant Professor of Cardiology/Cellular & Molecular Medicine at the Johns Hopkins University (JHU). During his tenure at JHU, he was a 2-time recipient of the Top Young Faculty Award (2002, 2004), Top Young Investigator (2001) and Top Postdoctoral Fellow (2001) of JHU Medicine, and recipient of Young Investigator Award 1st Prize of the Heart Rhythm Society (2002) and the Career Development Award from the Cardiac Arrhythmias Research & Education Foundation (2001). Professor Li became a tenured Associate Professor at the University of California, Davis where he founded and led the Human Embryonic Stem Cell Consortium. He later joined Icahn School of Medicine at Mount Sinai in Manhattan as Co-Director of the Section of Cardiovascular Cell & Tissue Engineering. With over 150 publications, Professor Li's group focuses on human heart engineering with accolades such as the Best Study of 2005 and Groundbreaking Study of 2006 by the American Heart Association, etc. In 2015, Professor Li received the Spirit of HK Innovating for Good Award by the South China Morning Post.

李登偉教授現擔任卡羅琳醫學院劉鳴煒復修醫學香港中心總監，並在香港大學李達三博士研究中心任職，同時亦是再心生物科技（Novoheart）的行政總裁。再心生物科技是一家於2014年在香港成立的生物技術公司，並於2017年上市。李教授於約翰霍普金斯大學接受博士後培訓，隨後獲該校晉升為心臟學／細胞與分子醫學助理教授。在約翰霍普金斯大學任職期間，他獲得兩次卓越青年教授研究獎（2002年、2004年）、青年研究者基礎研究最高獎（2001年）和頂尖博士後研究員獎（2001年），並獲得美國心律協會的青年研究者獎（2002）和心律不正研究與教育基金職業發展獎（2001年）。李教授其後獲加洲大學戴維斯分校聘任為終身副教授，成立並率領人類胚胎幹細胞研究組。他隨後加入了位於曼哈頓的西奈山伊坎醫學院，擔任心血管細胞與組織工程部的共同總監。李教授的團隊專注人類心臟工程，在國際期刊發表超過一百五十篇論文，曾獲美國心臟協會評為最佳基礎研究（2005年）、開創性研究（2006年）等。李教授於2015年獲南華早報頒發香港精神創新為社群獎。

PROJECT SUMMARY 項目概要

- Designed and constructed a series of engineered human heart constructs, including the world's first human mini-heart chamber, bridging the long-standing gap between animal testing and human trials to reduce time, cost and patient harm during therapeutic developments.
- Discovered new molecules and engineering tools for a better understanding of critical signaling and molecular pathways (such as those of the secondary messenger Ca^{2+}) in the heart, providing an important basis for future tissue engineering and rational drug design.
- Discovered new ways to mass produce human heart cells inside and outside of the body.

- 設計並構建了一系列人工人類心臟組織，包括世界上首個人類迷你心臟等，縮窄了以往動物測試與臨床測試之間的長期差距，從而減少醫藥開發過程的時間、成本和對病人的傷害。
- 開發了新的分子和工程工具，有助更了解心臟裡的關鍵訊號和分子途徑（如次級傳訊者鈣離子的途徑），為未來組織工程和理性藥物設計奠下基礎。
- 開發了在人體內外大量生產人類心臟細胞的新途徑。

ABSTRACT 項目簡介

Heart diseases are a major cause of death worldwide. Loss of cardiomyocytes (CMs) due to aging or disease is irreversible. Current therapeutic regimes are palliative, and in end-stage heart failure, transplantation remains the last resort but is significantly hampered by a severe shortage of donors and immuonocompatibility. Furthermore, numerous drugs have been withdrawn from the market or clinical trials due to induced cardiotoxicity undetected during developments as a result of the lack of suitable human models for drug discovery and screening. Self-renewing human pluripotent stem cells, including embryonic (hESCs) and induced pluripotent stem cells (iPSC), that can differentiate into all cell types, including CMs, offer unprecedented opportunities for disease modeling, drug discovery and cell-based cardiac regenerative therapies. Using a combination of state-of-the-art protein-, tissue- and bio-medical engineering approaches, coupled with bioinformatics, this TRS project aimed make fundamental discoveries in the cardiac space of the hESC/iPSC field, and to develop tools and lay the ground work for subsequent translations into tangible applications to facilitate the development of novel therapeutic approaches for patient benefits. In brief, our efforts attempted to address the following questions or issues: 1) immature Ca-handling; 2) immature electrical properties; 3) a small physical size (~10-fold less than adult); 4) an absence of ordered organization at the sub-, single- and multi-cellular levels; 5) high cell heterogeneity, even from directed cardiac differentiation, consisting of a mixture of pacemaker, atrial and ventricular derivatives; 6) sub-lineage specification is poorly understood; 7) no convenient cardiac/chamber-specific surface marker for robust purification; 8) poor graft survival; 9) poor understanding of immunobiology. With at least 97 peer-reviewed articles, chapters or other papers published, and 10+ more under review, a significantly better understanding of the above has been obtained. In addition, >$30M of extramural funding as an immediate extension of this project has been resulted. During the funding period, over 50 MS or PhD graduate students and postdoctoral researchers have been trained, with at least three currently on the faculty.

心臟疾病是全球主要死亡原因之一，因老化或疾病而喪失的心肌細胞是不能再生的。目前的治療方案均治標不治本，在末期心臟衰竭階段，移植是最後的方案，卻面對嚴重缺乏器官捐贈和器官排斥困難的問題。此外，由於缺乏用於藥物開發和篩選的合適人類模型，許多藥物在開發期間，其對心臟的毒性未被發現，現已被市場上或臨床試驗中撤回。擁有自我再生能力的人類多能幹細胞，包括胚胎幹細胞和誘導性多能幹細胞，可以分化為包括心肌細胞等所有細胞類型，為疾病模型、藥物開發和以細胞為本的心臟再生療法提供前所未有的機會。結合最先進的蛋白質、組織和生物醫學工程方法，再加上生物信息學，此主題研究計劃項目旨在胚胎幹細胞和誘導性多能幹細胞的心臟領域中尋找新發現、開發新工具，並為後續的臨床工作奠定實際應用的基礎，以促進新治療方法的開發。簡而言之，我們致力試圖解決以下問題：一、不成熟的鈣離子處理；二、不成熟的電特性；三、體積小（比成年心肌細胞小約十倍）；四、單細胞和多細胞層面上缺乏有秩序的組織；五、高細胞差異性（即使通過定向心臟分化技術，仍會產生出起搏細胞，心房細胞和心室細胞）；六、不明的子系規範；七、缺乏合適的心臟或心室表面標記物作高效純化；八、移植組織的存活率過低；九、不明的免疫生物反應。憑藉我們發表的至少九十七篇同儕評審文章、章節或其他論文，以及十多篇正在審核中的文章，我們已對上述的問題有更好的理解。此外，項目延伸出的研究已獲得超過三千萬元的校外資助。在資助期間，已有超過五十名碩士或博士研究生和博士後研究人員接受培訓，當中至少三名現為大學教員。

RESEARCH IMPACT 研究影響

Key investigators of this TRS project proposed and defended the topic of Stem Cell & Regenerative Medicine as one of the white papers submitted to RGC for consideration during the initial launch of the funding scheme. As one of the first awarded projects, the funding support allowed the team to build new infrastructures for stem cell research and to solidly launch a series of research efforts that did not previously exist in HK. Collectively, these laid the ground work for attracting world-renowned groups such as Harvard, MIT, Johns Hopkins, Stanford in the US and Karolinska Institutet in Sweden. Notably, KI as the home of Nobel Assembly, with the visionary donation of US$50M by Ming-Wai Lau, set up their first overseas R&D center, Ming Wai Lau Center (MWLC) for Reparative Medicine in HK, in over 200 years. The Cardiac Initiative, as a logical extension of this TRS project, was among the first to launch at the new MWLC. MWLC creates new scientific jobs, and offers a range of training, education and research opportunities to the local community via a series of workshops, seminars and routine investigator-initiated communications interchangeably held in Hong Kong and Stockholm. Economically, key findings of Project 1 of 4 of this TRS award significantly contributed to the birth of Novoheart, a stem cell biotech that focuses on drug discovery, in HK in 2014. Novoheart became publicly listed in the Toronto Stock Exchange in Oct 2017, with laboratories and offices in HK, US and Canada. Headquartered in HK, the local R&D center alone currently has over 20 employees, sharing the common mission of contributing to the development of a knowledge-based economy in HK and Pearl River Delta.

在主題研究計劃推出初期，本項目的主要研究員向研究資助局倡議以幹細胞及再生醫學為主題，成功在多篇白皮書當中脫穎而出。作為首輪獲資助的研究項目之一，團隊建立了在香港前所未有的用於幹細胞研究的新基礎設施，並開展了一系列研究工作，為吸引世界知名團隊如美國哈佛大學、麻省理工學院、約翰霍普金斯大學、史丹福大學和瑞典卡羅琳醫學院奠定了基礎。當中，作為諾貝爾議會的所在地的卡羅琳醫學院，藉著劉鳴煒先生捐贈的五千萬美元捐款，在香港開設了劉鳴煒復修醫學中心（MWLC），屬該校成立二百多年來首個海外科研中心。「心臟計劃」成為了首個MWLC推出的研究項目，作為此主題研究計劃項目的延伸。此外，MWLC創造了新的科學工作職位，並通過在香港和斯德哥爾摩交替舉辦的工作坊、研討會和研究員會議，向本地科研界提供了一系列培訓、教育和研究機會。在經濟上，此主題研究計劃中項目一的重點發現促成了再心生物科技公司於2014年在香港成立、專注於藥物開發的幹細胞生物技術公司。公司的實驗室和辦事處位於香港、美國和加拿大，公司於2017年10月在多倫多證券交易所上市。香港總部的研發中心目前已擁有二十多名員工，共同致力在香港和珠江三角洲發展知識型經濟。

STEM CELL STRATEGY FOR NERVOUS SYSTEM DISORDERS (T13-607/12-R)
神經系統疾病的幹細胞研究策略

Prof. Nancy Y. Ip
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項目統籌人簡介

Professor Nancy Ip received her PhD in Pharmacology from Harvard Medical School. Her research interests are in stem cell biology, neuronal development and function, as well as the pathophysiology and drug development for neurological and psychiatric disorders. She is well-known for her seminal discoveries in the biology of neurotrophic factors, which are proteins that promote the survival, development, and maintenance of neurons. Her recent research reveals novel signaling pathways underlying neuronal communication impairment during the progression of Alzheimer's disease, shedding new light on the development of therapeutic strategy. A highly accomplished researcher, Professor Ip has published over 280 papers with 20,500 SCI citations, and holds 44 patents. She was elected to the Chinese Academy of Sciences, the US National Academy of Sciences, the American Academy of Arts and Sciences, the World Academy of Sciences, and is also a founding member of The Academy of Sciences of Hong Kong.

葉玉如教授畢業於美國哈佛大學醫學院，獲藥理學博士學位。葉教授的研究領域包括神經幹細胞、神經系統的發育及功能、及神經和精神疾病的病理生理學及藥物開發。她因神經營養因子（一種促進神經元存活、發育及維持的蛋白質）的重要生物學發現而聞名。她的實驗室最近發現了阿爾茲海默氏症中誘導神經元通訊功能障礙的新信號機制，對研發相關的療法作出了重大貢獻。葉教授的研究成果獲得了科學界的廣泛認同，在頂尖國際學術期刊發表了超過280篇論文和綜述，文獻被引用超過20,500次，擁有44項國際科技發明專利權。她當選中國科學院院士、美國國家科學院外籍院士、美國人文與科學院外籍院士、世界科學院院士、亦是香港科學院創院院士。

Professors Kai Liu, Penger Tong, Mingjie Zhang, Robert Qi, Zhenguo Wu, Jun Xia, Sookja Chung, Nancy Ip, Tom Cheung, Xuhui Huang, Bo Feng, and Dr. Kim Chan and Prof. Wing-Ho Yung
劉凱、 童彭爾、張明傑、齊眾 、鄔振國、夏軍、金淑子、葉玉如、張曉東、黃旭輝、馮波教授、陳創雲博士和容永豪教授

PROJECT SUMMARY 項目概要

The overall aims of the project are:

- To understand the mechanisms underlying the generation of neural stem cells and the development of neural stem cells into functional neurons
- To understand how the newly-born neurons integrate into the neural circuit in the brain
- To develop drug screening platforms utilizing neural stem cells and identify therapeutic agents from Traditional Chinese Medicine with beneficial properties
- To evaluate the efficacy of the identified compounds in established animal disease models as clinical drug leads for nervous system disorders

本項目的主要研究目標是：

- 研究神經幹細胞產生及發育成為功能性神經元的機制
- 研究新生神經元整合進入腦部神經回路的機制
- 建立基於神經幹細胞的藥物篩選平臺，從中藥裏篩選具有神經活性的治療成分
- 利用已建立的動物模型測試活性物質的功效，鑒定針對神經系統疾病的先導藥物

ABSTRACT 項目簡介

The adult brain has the potential to repair itself. It possesses active neural stem cells that continuously develop into brain cells (also known as neurons) through the process of neurogenesis. However, the manner in which neural stem cells renew, proliferate, differentiate into neurons, and integrate functionally into existing circuitry, are unclear.

This inter-disciplinary project has aimed to shed light on the molecular and cellular controls of how neurons are generated and integrated into the existing neural circuit for proper functioning of the nervous system. We have also sought to identify therapeutic agents derived from traditional Chinese medicine (TCM) to treat nervous system disorders. Our significant achievements are as follows.

First, cutting-edge technologies were established to facilitate advanced research. These include optogenetic tools to manipulate the firing of a specific subset of neurons in the neural circuits, advanced microscopic techniques to image neurons and their activities in real time, and a chemical technique to render a brain transparent so that it can be imaged as a whole. These powerful tools have enabled us to study neural stem cells and newborn neurons more effectively and in greater depth.

Second, our studies have revealed novel findings on neurogenesis. We have identified distinct molecular pathways that regulate embryonic and adult neurogenesis. For example, the molecular signals that control the amplification and differentiation of neural stem cells during embryonic brain development have been determined. We have also demonstrated that deregulation of these specific pathways are associated with different neurodevelopmental disorders, such as epilepsy and autism. Furthermore, critical mechanisms underlying how neurons form functional connections have also been identified. These findings have provided important insights to the molecular basis of learning and memory. We have also revealed how the genetic mutations associated with neurological diseases affect neuronal development and their integration. Overall, these findings have advanced our understanding of neurogenesis and provided new avenues for developing therapeutic interventions.

Third, compounds with potential applications in treating certain nervous system disorders have been identified. Screening platforms utilizing human and mouse neural stem cells have been developed to identify compounds and extracts from TCM with neurogenic activities. Computational methods have also been employed to identify compounds with the ability to bind to key target molecules. The therapeutic effects of the identified compounds have been further evaluated in established mouse models for Parkinson's disease, Alzheimer's disease, depression, and spinal injury. These novel compounds represent promising leads for future drug development.

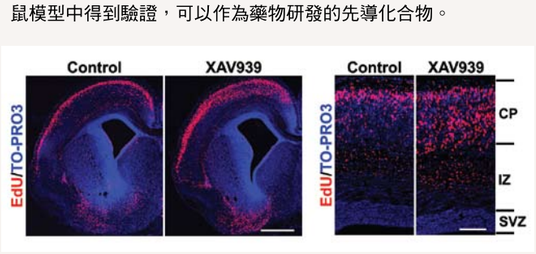
成年大腦具有自我修復的能力；神經幹細胞不斷發育成腦細胞（神經元），這個過程被稱為神經發生。然而神經幹細胞如何自我更新、增殖、分化為神經元並整合進入神經回路的機制還未清晰。

本跨學科項目旨在解析神經元產生及整合進入神經回路調控神經系統功能的分子細胞機制，並以中草藥為基礎研發治療神經系統疾病的藥物。我們已取得了一系列重要成果。

首先，我們已建立一系列高端技術平臺以促進前沿研究，包括光遺傳工具控制特定類型神經元的活性、顯微成像技術實時觀察神經元活動、透明腦技術實現對腦部的整體成像。這些技術使我們能更有效地研究神經幹細胞。

其次，我們在神經發生領域有多項重要的新發現。我們揭示了調節胚胎和成體神經發生的分子途徑，也證實這些信號的失調與神經發育性疾病有密切關聯。我們也闡明神經元之間通訊的關鍵機制。這些發現不但提高了我們對神經發生基本原理的認識，也為研究治療相關疾病的干預策略提供了新思路。

最後，我們發現了多種在治療神經系統疾病方面有應用潛力的化合物。我們通過神經幹細胞篩選平臺獲得了中藥來源的活性化合物，也應用電腦虛擬篩選鑒定了特異結合靶點分子的化合物。這些新化合物的功效在神經系統疾病小鼠模型中得到驗證，可以作為藥物研發的先導化合物。



The scaffold protein, Axin, is a key regulator of neurogenesis and brain size. Up-regulation of Axin protein in neural progenitor cells enhances the production of cortical neurons (red) and expands the cerebral cortex in mouse.
支架蛋白Axin是控制神經發生和腦部體積的重要因子。在神經前體細胞中增加Axin蛋白的含量促進了小鼠皮層神經元（紅色）的產生，擴大了大腦皮層的體積。

RESEARCH IMPACT 研究影響

Stem cells have rapidly emerged as an important research area as they hold enormous potential for novel therapeutics. Through this project, we have established the essential foundation for conducting advanced basic and translational neural stem cell research in Hong Kong. We have amassed critical expertise, developed advanced capabilities, and forged strategic collaborations with local and international institutes. These efforts will be instrumental in strengthening the local technology sector. Furthermore, the program has provided training opportunities to local young scientists on neural stem cell research to cultivate their passion and provide hands-on experience in state-of-the-art technologies. Our work has also highlighted the innovative research being conducted in Hong Kong, which will help attract leading biopharmaceutical companies to establish their R&D in Hong Kong. In terms of social impact, our program focuses on finding therapeutic treatments for diseases such as depression, and Parkinson's and Alzheimer's diseases. Populations in Hong Kong and around the world are getting older and many individuals are suffering from these devastating ailments, which are incurable and have limited treatment options. Furthermore, the costs of treating these diseases pose a heavy burden to our society. Our research offers new hope in finding effective neural stem cell-based cures for these diseases.

由於幹細胞在治療疾病方面具有巨大潛能，相關研究已經成為當今生命科學的重要領域之一。通過本項目，我們奠定了在香港進行神經幹細胞前沿基礎研究和轉化研究的堅實基礎，積累了豐富的經驗和科研實力，也促進了本港與國際科研機構的戰略合作，加强了香港在相關技術領域的核心競爭力。另一方面，本項目為本港年輕科學家提供了寶貴的機遇，不但激發了他們的科研熱情，也使他們掌握了最先進的幹細胞技術。本項目也向全球展示了在香港進行的創新研究，有助於吸引生物製藥公司在香港設立研發部門。在社會效益方面，本項目重點研發抑鬱症、柏金遜症以及阿爾茨海默病等疾病的治療策略。人口老齡化是香港和世界其他地區都面臨的問題，相關的疾病發病率不斷上升，但目前沒有治癒的方法，能夠採取的治療手段也非常有限。本項目的成果對於研發以神經幹細胞的策略來治療這些疾病有重要意義。

SUSTAINABLE LIGHTING TECHNOLOGY: FROM DEVICES TO SYSTEMS (T22-715/12-N)
「可持續」照明技術：從模塊到系統

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SHORT BIOGRAPHY OF PROJECT COORDINATOR 項目統籌人簡介

Professor Ron Hui received his Ph.D at Imperial College London in 1987. He held academic positions in the U.K. and Australia. He is currently the Philip Wong Wilson Wong Professor of Electrical Engineering and Chair Professor of Power Electronics at the University of Hong Kong, and is also a part-time Chair Professor at Imperial College London. He is a Fellow of The Institute of Electrical and Electronic Engineers (IEEE), the Australian Academy of Technological Sciences and Engineering and the Royal Academy of Engineering, U.K. He received the IET Achievement Medal and IEEE Technical Field Award in 2010 and 2015 respectively.

Professor Hui's research covers wireless power transfer, sustainable lighting technology, power electronics and smart grid technology. His inventions were incorporated into the world's first wireless charging standard "Qi", launched in 2010 by the Wireless Power Consortium, now comprising over 200 companies worldwide. He also pioneered the Photo-electro-thermal theory for LED systems, and co-invented coreless planar transformer and Electric Springs.

許樹源教授於1987年獲倫敦帝國學院頒授電機工程哲學博士，曾任教於英國和澳洲的大學，現任香港大學電機電子工程系講座教授、黃乾亨黃乾利基金教授(電機工程)，並兼任倫敦帝國學院電力電子講座教授。他亦是國際電機電子工程學會院院士、澳洲國家工程院院士和英國皇家工程院院士。許教授在2010年及2015年分別獲「英國工程及技術學會」頒授IET成就獎和「美國電機及電子工程師學會」授予IEEE電力電子領域最高獎項。

許教授的研究領域包括無線電力傳送、可持續照明技術、電力電子和智能電網技術。他所研發有關無線電力傳的發明，已被納入全球第一個無線充電的國際標準"Qi"中，被全球超過二百間公司採用。他亦是發光二極管系統之「光熱電統一理論」的原創者，並發明「平面無鐵芯變壓器」和「電力彈簧」等新技術。

Team Photo (From left to right) Dr. S.C Wong (Co-I), Prof. Michael Tse (Co-PI), Dr. Anthony Choi (Co-PI), Prof. Ron Hui (PC), Dr. S.C. Tan (Co-I), Dr. D.Y. Lin, Dr. Albert Lee, Dr. Raymond Ng, Dr. H.T. Chen and Mr. Yuk Fai Cheung.
黃少聰博士(Co-I)、謝志剛教授(Co-PI)、蔡凱威博士(Co-PI)、許樹源教授(PC)、陳秀聰博士(Co-I)、林德賢教授、李廷亮博士、吳偉民博士、陳換庭博士、張煜輝同學。

PROJECT SUMMARY 項目概要

- Development of the Photo-Electro-Thermal Theory for LED Systems for a general analysis and design tool
- Classifications of LED driver topologies LED
- Development of Sustainable LED systems without electrolytic capacitors
- High-efficiency LED display and current-balancing technology
- Technology transfer of several patent-pending technologies to industry
- 成功發展發光二極管系統之「光熱電統一理論」
- 驅動器之分類
- 發展沒有「電解電容」的可持續LED系統
- 高效率LED顯示技術和電流平衡技術
- 成功將數項專利技術產品化

ABSTRACT 項目簡介

This project is related to the "sustainability" of lighting systems (used in buildings and cities' large-scale infrastructures such as road lighting) that consume 20% of electricity globally. Sustainable Lighting Technology proposed here deviates from the traditional Energy-Star concept which focuses only on energy saving. It stresses a new principle that includes (i) energy saving, (ii) long product lifetime and (iii) recyclability of product materials. It highlights the important point that "energy-saving technology is not necessarily environmentally-friendly if it generates lots of harmful electronic waste within a short product lifetime".

This project involves a new investigation into a new General LED System Theory for "multiple non-identical" Solid-State LED devices. By linking LED "device" theory to "system" theory, novel LED systems with not only high energy efficiency and luminous efficacy, but also lifetime exceeding 10 years and over 80% product materials recyclable have been studied and developed. The project focuses on an "integrated system approach" that covers (i) new white LED device structures and manufacturing processes, (ii) novel passive and active LED drivers and control techniques including both power and color control, and (iii) current balancing techniques so that future LED systems can meet the 3 sustainability criteria.

This project has successfully led to both theoretical & practical breakthroughs. The outcomes of this project include (1) a novel Generalized LED System Theory for "multiple non-identical" LED devices, (2) new LED device structures with improved thermal management, (3) the generalization and classification of LED driver topologies with long lifetime, (4) a new design methodology & tool for optimization of a new generation of highly efficient and sustainable lighting systems, and (5) practical realization of the new "Sustainable Lighting" principle that can replace traditional "Energy-Star" concept with the aim of drastically reducing electronic waste worldwide.

With several major lighting research centers already based in Hong Kong and over 1000 LED product manufacturers in South China, this project will bring significant benefits to Hong Kong and its nearby regions. Besides the potential contributions made to industry, this project will involve training of research students.

German collaborator Prof. Eberhard Waffenschmidt (standing) giving his presentation in an Annual Meeting in front of our two industrial advisors (Dr. Sun Tam and Mr. Mike Mastroyiannis sitting on the left)
德國研究夥伴Waffenschmidt教授(站立者)在年會上作報告，兩位來自照明工業的專家顧問(Dr. Sun Tam and Mr. Mike Mastroyiannis)坐在左邊。

照明系統消耗全球百份之二十的電力，其電子控制電路已被確認為電子廢料的主要來源之一。自從近年發光二極管技術的突飛猛進，高光效和長壽命的發光二極管已經商品化。發光二極管有能力取代高損耗的鎢絲燈和含有水銀的螢光燈。發光二極管技術包括(一) 發光二極管模塊、(二) 推動器、(三) 電力控制和(四) 燈具的散熱設計。
本研究是有關大型照明系統的「可持續發展」，這裏提出的可持續發展的照明技術，與傳統只單一考慮節能果效的「能源標籤」不同。可持續發展技術包括 (i) 節能、(ii) 長產品壽命、 (iii) 可循環再用三項要求。新「可持續發展」概念強調壽命短的電子照明技術，雖然節能，但不環保，因為它們在短時間內，會變成大量有毒的電子廢料。
本研究包括一項適合不同類型發光二極管模塊的LED系統理論，這套「從模塊到系統」的LED系統理論，可用來發展高功效、高光效、長壽命和可循環再用的發光二極管照明系統。我們採用一種「結合式」的研究方法，結合(i) 白光LED模塊的結構和生產程序、(ii) 被動及主動式的LED推動器技術、(iii) 電流平衡技術，和(iv) 模塊的排列和散熱，目的是讓新一代的LED系統能符合「可持續發展」的三項要求。
本研究已經成功達致理論和實際應用的雙突破，其結果包括(1) 適合各類LED模塊的發光二極管系統理論、(2) 改進散熱的LED模塊結構、(3)具有長壽命的特性的LED推動器的分類、(4) 新LED系統設計和優化方法及工具， 和(5) 實現「可持續」照明技術的概念，從而取代「能源標籤」，並達致大量減少電子廢料的目的。數間著名的國際照明公司在香港設有研究中心，南中國也有超過一千間LED產品生產商，所以這研究將為香港和鄰近地區帶來重大利益。除了有利工業界外，本研究亦培養了新一代的研究生及科技人材。

RESEARCH IMPACT 研究影響

This project has successfully led to both theoretical and practical breakthroughs. We have successfully developed the Photo-Electro-Thermal Theory for LED Systems. It links up heat, light, power and colour in an LED system under one mathematical framework and can now be used by lighting industry as a general design tool for LED systems and products. We have classified all LED driver topologies and their suitability for various applications. This classification provides a guideline for lighting industry to select the appropriate topologies for their products. New LED structures with new features have also been studied. New approaches to highly efficient LED panel display and current-balancing technologies have been successfully developed. A group of high-quality research students in LED technology have been trained. In addition, we have published many influential papers in top-tier journals and have several patent-pending technologies transferred to industry for production. Installations of these new sustainable LED products have been made in China and Hong Kong for over 3 years. The outcomes of this TRS project are expected to be beneficial to thousands of LED companies in South China, Hong Kong and the nearby region.

本研究已經成功達致理論和實際應用的雙突破，我們成功展發光二極管系統的「光熱電統一理論」，將光學中的光、熱、電和顏色四個原素的互動關係結合，變成一種創新的分析理論，給照明工業作為LED系統的設計和優化工具。我們也有系統地發展出具有長壽命的特性的LED推動器的分類，改進散熱的LED模塊結構，和高效率的平面顯示屏及平衡電流技術，讓工業界能夠實現「可持續」照明技術的概念，從而取代「能源標籤」，並達致大量減少電子廢料的目的。
我們部份已申請專利的技術，已經被香港的科技公司採用，產品已在中國和香港安裝了三年多。本研究也訓練了十多名博士和博士後研究員，為照明業提供專業人才。數間著名的國際照明公司在香港設有研究中心，南中國也有超過一千間LED產品生產商，所以這研究將為香港和鄰近地區帶來重大利益。除了有利工業界外，本研究亦培養了新一代的研究生及科技人材。

CHALLENGES IN ORGANIC PHOTO-VOLTAICS AND LIGHT-EMITTING DIODES - A CONCERTED MULTI-DISCIPLINARY AND MULTI-INSTITUTIONAL EFFORT (T23-713/11)

透過跨學科及多學院的協同努力迎接有機光伏打電池及發光二極管面臨的挑戰

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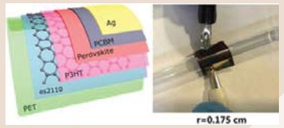
SHORT BIOGRAPHY OF PROJECT COORDINATOR 項目統籌人簡介

Vivian W.W. Yam is currently Philip Wong Wilson Wong Professor in Chemistry and Energy and Chair Professor of The University of Hong Kong. She was elected to Member of the Chinese Academy of Sciences, Foreign Associate of the US National Academy of Sciences, Foreign Member of Academia Europaea, Fellow of the TWAS and Founding Member of The Academy of Sciences of Hong Kong. She was the Laureate of the 2011 L'Oréal-UNESCO For Women in Science Award and recipient of a number of awards, including the RSC Centenary Medal, RSC Ludwig Mond Award, JSCC International Award, JPA Eikohsha Award, State Natural Science Award, etc. She currently serves as Associate Editor of Inorganic Chemistry and Member of International Editorial Advisory Boards of J. Am. Chem. Soc., Angew. Chem., Chem. Sci., Chem, Acc. Chem. Res., Chem. Rev., ACS Nano, Chem. Mater., etc. Her research interests include inorganic/organometallic chemistry, supramolecular chemistry, photophysics and photochemistry, and molecular functional materials for energy and sensing applications.

任詠華教授現任香港大學化學系講座教授及黃乾亨黃乾利基金教授(化學與能源)。她獲選中國科學院院士、美國科學院外籍院士、歐洲人文和自然科學院外籍院士、世界科學院(TWAS)院士及港科院創院院士。她亦獲得其他獎項包括2011歐萊雅－聯合國教科文組織“世界傑出女科學家成就獎”、英國皇家化學學會百周年講座獎、英國皇家化學學會路德維希·蒙德獎、日本錯體化學會國際獎、日本光化學協會亞洲和大洋洲區光化學家獎、國家自然科學獎二等獎等。任教授目前擔任美國化學會期刊《無機化學》的副主編，同時也獲邀為多份國際化學期刊任諮詢編委，如J. Am. Chem. Soc., Angew. Chem., Chem. Sci., Chem, Acc. Chem. Res., Chem. Rev., ACS Nano, Chem. Mater.等。任教授主要從事無機/有機金屬化學、超分子化學、光物理學和光化學、以及分子功能材料應用於能源和感測的基礎研究工作。

PROJECT SUMMARY 項目概要



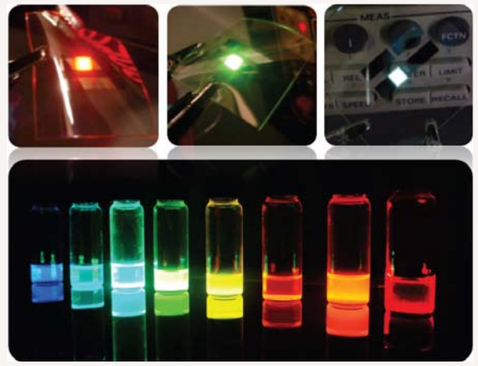
Ultrathin and flexible organic solar cells
超薄柔性有機光伏打電池

- Generate energy-efficient lighting/display systems and high-performance solar energy conversion systems for addressing grand challenges of sustainable energy development
- Provide clean renewable energy via the development of efficient OPV materials for solar energy conversion and reduce the energy demand by utilizing energy more efficiently for solid-state lighting via the discovery of structurally robust OLED materials
- Generate national- and Hong Kong-owned IP rights, patents and technological know-how
- 研發高效節能照明系統/顯示屏和高效率太陽能轉換系統以發展可持續能源
- 透過開發高效有機光伏打電池材料提供新一代的潔淨再生能源及開發高穩健性的有機電致發光二極管發光材料應用於固態照明系統以節省能源
- 提供香港及國家知識自主產權、專利和技術知識

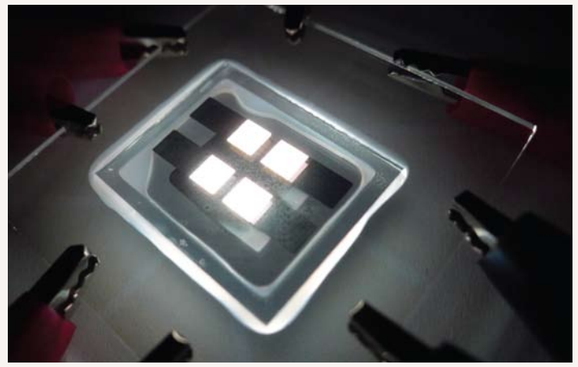
ABSTRACT 項目簡介

With the huge and fast-growing population and an upcoming depletion of fossil fuels, there is an urgent need and pressing demand for a low carbon or carbon-neutral energy economy. Development of clean renewable energy and new measures for reducing the energy demand are definitely needed to meet the grand challenges. Organic light-emitting diodes (OLEDs) are recognized as a viable candidate for launching of a more efficient solid-state lighting system, while the discovery and development of efficient organic photovoltaic (OPV) devices for solar energy conversion will have a major impact in addressing the energy issues. However, low power efficiencies, materials and device stability and relatively high manufacturing cost of OLEDs and OPVs present a major challenge for commercialization, and new breakthroughs in the development of new materials and fabrication processes that are much cheaper and more processable for efficient OLEDs and OPVs are highly desirable. In this project, we aim to integrate multi-disciplinary and multi-institutional efforts with complementary expertise to foster new interdisciplinary collaborations to meet the grand challenges related to energy. Particularly, we target to develop (i) libraries of patentable, robust, and industrial competitive phosphorescent materials for OLED applications, (ii) new classes of patentable low bandgap OPV materials, (iii) highly efficient and new synthetic methods for solution-processable OPV materials, (iv) in-depth understanding of the physics and controlling factors affecting the device performance of OLEDs and OPVs, and (v) industrial-competitive technologies for active matrix OLEDs and large area OLED and OPV devices. The success of the proposed project would not only generate Hong Kong- and China-owned intellectual property (IP) rights, patents and technological know-how, but also creates new opportunities for knowledge and technology transfer to national and international industrial partners. These would definitely promote Hong Kong towards a low carbon economy and to improve the image of Hong Kong as a city of high clean renewable energy and environment awareness.

為迎接未來的大挑戰，開發潔淨再生能源和節約能源的新方法是必需的。當中，有機電致發光二極管被視為可行的新一代高效的固態照明系統，而轉換太陽能的高效有機光伏打電池亦對解決能源危機起著關鍵的作用。可是，目前有機電致發光二極管及有機光伏打電池的功率效率偏低，加上材料和器件的穩定性低、生產成本高等問題，對產品商業化造成重大的挑戰。因此開發更便宜、可塑性高的高效新材料及其製備過程需要更多新的突破。本項目致力結合多學科及多學院的努力，配合不同領域的專家，促進新的跨學科合作，共同解決能源上的大挑戰。本項目針對研發一） 一系列可取得知識自主產權、高穩健性、具工業優勢及競爭力的磷光材料製造有機電致發光二極管，二） 新一類可取得知識自主產權的低帶隙有機光伏材料，三） 高效能及新合成技術以製造可溶液製備的有機光伏材料，四）深入認識物理及各項重要參數對器件效能的影響，五）具工業優勢及競爭力的主動式矩陣有機電致發光二極管及大型有機電致發光二極管和有機光伏打電池技術。預期本項目將不僅提供香港及國內知識自主產權、專利和技術知識，同時亦為本地及國際工業夥伴創造知識和技術轉移新機遇。



New OLED materials with rainbow emission colors and devices
新型有機電致發光材料及器件



High-performance WOLEDs for lighting purposes
可應用於照明系統的高效能白光有機電致發光器件

RESEARCH IMPACT 研究影響

With the dedicated efforts of the team, a significant impact to the fields of OLEDs and OPV devices has been made to address the grand challenges of sustainable energy development. The team has generated new knowledge and technology for dissemination. Specifically, exceptional performance has been demonstrated in the development of phosphorescent OLED materials with the generation of Hong Kong-owned intellectual property rights and patents. Collaborative links with renowned industrial partners have been established, as exemplified by the execution of sponsored projects and the setting up of joint laboratory. An exclusive license agreement on OLED material patents has been executed with one of the world's leading OLED display manufacturers. The licensing is anticipated to realize next-generation OLED technologies with superior performance based on proprietary metal complexes developed in the project. New classes of high-performance photoactive materials, novel device architecture for high-performance OPVs and various convenient and cost-effective techniques and technological know-how that can be easily adopted for applications in large area and flexible OPV devices have also been developed. This project provides a strategic alliance for multi-disciplinary research collaboration towards the demonstration of superior technology with world-class standard, but also facilitates technology transfer and collaboration with industries, motivating downstream R&D and commercialization activities in Hong Kong, the Mainland and in the international arena.

在團隊的努力下，本項目有機電致發光二極管和有機光伏打電池研究領域取得了重要成果，成功創造了新知識和技術。特別在研發新一類有機電致發光材料方面取得卓越表現，提供完全由香港擁有的知識自主產權和專利。團隊亦與多間知名產業透過贊助項目和聯合實驗室的設立等建立合作夥伴，更跟一間世界領先的顯示器製造商簽訂了有關金屬磷光發光材料專利獨家的授權合約，預計將應用及實現於新一代顯示技術中。團隊也研究了新一類高性能的光敏材料、嶄新的器件結構，和多種既方便、高成本效益，亦可應用於大面積及柔性器件上的技術和知識，以製備高效有機光伏電池。本項目成果除可提供跨學科合作研究的戰略聯盟，邁進世界水平的技術，亦為本地、國內及國際工業夥伴創造知識和技術轉移新機遇，促進更多下游研發及和商品化活動。

COST-EFFECTIVE AND ECO-FRIENDLY LED SYSTEM-ON-A-CHIP (SoC) (T23-612/12-R)
低本高效、綠色環保的LED晶片系統

PROJECT COORDINATOR
Prof. Kei-may Lau
The Hong Kong University of Science and Technology

項目統籌人：
劉紀美教授
香港科技大學

PARTICIPATING INSTITUTION
The University of Hong Kong

參與院校：
香港大學

Prof. Kei-may Lau, Prof. Hoi-wai Choi, Prof. Ricky Lee, Prof. Philip Mok, Prof. Johnny Sin, Prof. Patrick Yue, Prof. Wing-hung Ki
劉紀美教授、蔡凱威教授、李世瑋教授、莫國泰教授、單建安教授、俞捷教授、暨永雄教授

SHORT BIOGRAPHY OF PROJECT COORDINATOR
項目統籌人簡介

An LED light bulb with low flickering which provides healthy lighting by eliminating potential health hazard, and no electrolytic capacitor that lengthen product lifetime from 2000 hours to 5000 hours.
LED燈泡具有低閃爍，可提供健康的照明，並且產品壽命可從2000小時延長到5000小時。

A 400×240 micro-display system that can display text, image and video using in-house fabricated active matrix LED micro-array and self-design CMOS (external fabrication) LED driver and dc-dc converter.
一個400×240微顯示系統，使用自行製造的LED微陣列，可以顯示文字，圖像和視頻。

Professor Kei May Lau is Fang Professor of Engineering at the Hong Kong University of Science and Technology (HKUST). She received the B.S. and M.S. degrees in physics from the University of Minnesota, Minneapolis, and the Ph.D. degree in Electrical Engineering from Rice University, Houston, Texas. She was on the ECE faculty at the University of Massachusetts/Amherst since the fall of 1982 and initiated MOCVD, compound semiconductor materials and devices programs. She established the Photonics Technology Center for R&D effort in III-V materials, optoelectronic, high power, and high-speed devices. Since the fall of 2000, she has been with the ECE Department at HKUST.
Professor Lau is a Fellow of the IEEE (2001), a recipient of the US National Science Foundation (NSF) Faculty Awards for Women (FAW) Scientists and Engineers (1991), Croucher Senior Research Fellowship (2008), and the IEEE Photonics Society Aron Kressel Award (2017). She is an Editor of the IEEE EDL and Associate Editor of Applied Physics Letters.

劉紀美教授是香港科技大學方氏工程學教授。她在明尼蘇達大學獲得物理學士和碩士學位，在德薩斯州萊斯大學獲得電機工程博士學位。畢業後在微波聯合通訊(M/A-COM)任高級研發工程師兩年，從事於砷化鎵微波器件的外延生長。1982年秋季，劉教授加入馬薩諸薩大學 (University of Massachusetts at Amherst)電機工程系當教授，開發MOCVD外延，化合物半導體材料和器件等科研項目。她的科研小組對異質結構，量子阱，應變層結構，III-V族半導體化合物選擇生長，高頻器件和光電器件等作了深入的研究。2000年夏季，她正式加入了香港科技大學電機與電子學系並建立了光電技術中心。
劉教授是國際電氣和電子工程師協會(IEEE)院士。她是美國國家科學基金會(NSF)傑出女性科學家和工程師獎(FAW)獲得者。2008年獲裘槎優秀科研獎 (Croucher Senior Researcher Fellowship)。2017年獲IEEE光電 Aron Kressel 獎。她現是IEEE EDL的編輯，也是Applied Physics Letters的副主編。

PROJECT SUMMARY 項目概要

- Demonstrate integration technology to obtain small form factor solutions
- Develop high quality and long life time general lighting modules
- Develop high quality micro-display system
- Train new generation of researchers
- Technologies transfer to industry

- 展示集成技術以獲得小尺寸解決方案
- 開發高質量和長壽命的照明應用模塊
- 開發高質量的微顯示系統
- 培養新一代研究人員
- 技術轉移到行業

ABSTRACT 項目簡介

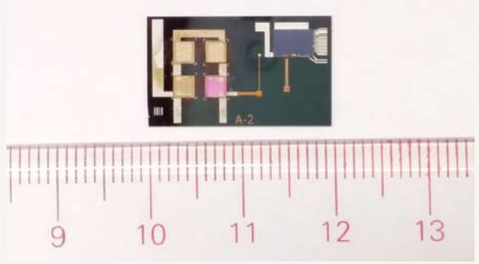
Fruitful results are obtained in the past 5 years with a team of world-class professionals in different aspects of LED technologies including materials, device, circuit and systems. New technologies on fabricating LED chips, GaN HEMTs, LED micro-arrays, nanowires, backside silicon embedded inductors, LED drivers for general lighting and display, on-chip power management units, packaging technologies are developed. Under effective collaboration among team members, modules that integrate research results of different team members on general lighting and LED micro-display applications are built, and they are introduced here.

LED lighting using switching mode LED drivers are common in the market. However, owing to the bulky components like power inductors, the size of existing solutions is large. To reduce solution size, the switching frequency of the circuit must be increase, leading to small inductor value, and allow embedding the inductor on the backside of silicon wafer, which further reduce the solution size. In our module, an LED driver chip and 4 LED chips are flip-chip bonded on a silicon carrier which consists of metal routing to connect the chips. The embedded inductor is fabricated on the backside of the silicon carrier. It is connected to the metal routing by through silicon vias. The size of the silicon carrier is 20 mm × 12 mm.

Apart from using switching mode LED drivers, an alternative solution for general lighting applications is non-switching LED drivers. Existing non-switching solutions suffer from the flickering problem which may be hazard to health. Our solution significantly reduces this problem. Our circuit divides a string of LEDs into different groups, and turns on these LED groups according to the input voltage, which is an AC input with varying instantaneous voltage. As the LED chips are in-house design and fabricated, a high flexibility in grouping the number of LEDs in the circuit design is allowed. All LED chips and the LED driver are flip-chip bonded on a silicon carrier. Underfill is dispensed under the LED chips to enhance the mechanical support and thermal dissipation, and phosphor is coated on the LED chips to obtain white light.

Other than general lighting applications, we also developed LED micro-display systems. A 400 × 240 pixels LED micro-array is designed and fabricated in-house, and an LED driver is also designed to drive the LED micro-array which is flip-chip bonded on the driver. The micro-display system can display text, image and video, and also supports visible light communication.

在過去五年中，我們一群世界一流的專業隊伍，通過有效協作，製成了照明和LED微顯示應用的模塊，並在此介紹。
市場上常見的LED照明是使用開關模式驅動器。然而，由於諸如功率電感器的體積較大的部件，現有解決方案的尺寸較大。為了減小尺寸，電路的開關頻率必須增加來減少電感值，從而允許將電感器嵌入矽晶片的背面，進一步降低尺寸。在我們的模塊中，LED驅動器芯片和4個LED芯片結合在矽載體上，該矽載體的正面有金屬佈線連接上述芯片，背面則有嵌入式電感器，它通過矽通孔連接到金屬佈線，矽載體的尺寸為20mm×12mm。
照明應用的另一方案是非開關LED驅動器。現有的非開關方案會產生可能危害健康的閃爍光，但我們的方案大大減少了這個問題，我們的電路將一串LED分成不同組，並根據瞬時輸入電壓打開不同LED組。由於LED芯片是自行設計和製造，所以我們可以按需要任意配置每組LED的數量，所有LED芯片和LED驅動器都接合在矽載體上，底部填充物分配在LED芯片下，用以增強機械支撐和散熱，磷光體也塗覆在LED芯片上以獲得白光。
除了照明應用，我們還開發了LED微型顯示系統。我們自行設計和製造了一個400×240像素的LED微陣列，也設計了相關的驅動器。微顯示系統可顯示文字，圖像和視頻，並且支持可見光通信。



Major power components including LED chips, LED driver and a backside silicon embedded inductor are integrated on a silicon carrier to provide a small form factor general lighting solution.
小尺寸照明方案：主要元件如LED，驅動器，背面矽嵌入式電感器，集成在矽載體上。

RESEARCH IMPACT 研究影響

System integration is one of the most important aspect in this project. By means of the fundamental technologies on fabrication and packaging developed in the project, we developed small form factor modules for general lighting applications and micro-display applications. For general lighting applications, high switching frequency LED drivers reduce components values so that fabrication of on-chip power inductors can be feasible. In-house design and fabricated LED chips provides high flexibility in terms of the size and number of LEDs in system design, which can be achieved according to specification of applications. We can even provide different circuit topology (e.g. inductorless topology), depending on customer requirement. For the micro-display applications, our in-house fabricated micro LED arrays are low pitch and large pixel size. This developed micro LED array technology was transfer to a local company in 2015, which is a good example on supporting industry by academic research outputs in universities. Considering the small size of components, packaging technologies developed in this project also play an important role in our integrated systems. Highly integrated systems and small form factor are promising future requirements, and the technologies developed and demonstrated in this project are significantly helpful to such direction.

系統集成是本項目的一個重要方向，我們開發了製造和封裝的基礎技術，用於照明應用和微顯示應用的小尺寸模塊。在一般照明應用，高開關頻率LED驅動器降低了元件值，使片上功率電感器成為可行。我們自行設計和製造的LED芯片在系統設計中，可以根據應用的規範，提供高靈活性的LED尺寸和數量，我們甚至可以根據客戶要求提供不同的方案（如無電感方案）。關於微顯示應用，我們自行製造的微型LED陣列具有低音高和大像素尺寸。技術在2015年轉移到了一家公司，這是通過大學學術研究成果支持行業的良好例子。考慮到組件規模小，項目開發的包裝技術也在我們的綜合系統中發揮重要作用。高度集成的系統和小尺寸是未來的一大方向，本項目開發和展示的技術對這一方向有顯著的幫助。

SMART SOLAR ENERGY HARVESTING, STORAGE, AND UTILIZATION (T23-407/13-N)
智能化太陽能技術：採集、存儲和應用

Prof. Ching-ping Wong
汪正平教授

PROJECT COORDINATOR
Prof. Ching-ping Wong
The Chinese University of Hong Kong

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The University of Hong Kong

參與院校：
香港理工大學
香港科技大學
香港大學

SHORT BIOGRAPHY OF PROJECT COORDINATOR
項目統籌人簡介

Professor C.P. Wong is currently Dean of Engineering of The Chinese University of Hong Kong and Choh-ming Li Professor of Electronic Engineering. He received his BS degree from Purdue University, and MS and PhD degrees from Pennsylvania State University. After doctoral study, he was awarded postdoctoral fellowship under Nobel Laureate Prof. Henry Taube at Stanford University. Prior to joining Georgia Tech, he was with AT&T Bell Laboratories for many years and became an AT&T Bell Laboratories Fellow (the highest technical award bestowed by AT&T Bell Labs) in 1992. Published extensively over 1,000 technical papers and 12 books, he yielded fruitful research results and holds over 65 US patents. He made significant contributions to the industry by pioneering new materials, which fundamentally changed the semiconductor packaging technology. He is a Member of US National Academy of Engineering (elected in 2000), and Foreign Academician member of Chinese Academy of Engineering (elected in 2013).

汪正平教授現為香港中文大學工程學院院長及卓敏電子工程學講座教授。汪教授在美國普渡大學取得科學學士學位，並在賓夕法尼亞州州立大學取得理學碩士及哲學博士學位。其後，他獲獎學金，赴史丹福大學師從諾貝爾獎得主Henry Taube教授從事博士後研究。汪教授在研究上取得豐碩的成果，已經發表了逾1,000篇專業論文，撰寫及編輯12本書籍，並持有超過65項美國專利。汪教授通過開拓新的材料，從根本上改變了半導體封裝技術，為業界作出重要貢獻。汪教授於2010年獲選為美國工程院院士，及於2013年獲選為中國工程院外籍院士。

Group photo of the RGC Monitoring and Assessment Panel with the project team. (Middle row from left) Miss Mandy Tse (Project Manager), (Forth left) Profs. Yi-Chun Lu, Zhao Xu, Jianfang Wang, Minghua Chen, Ching-ping Wong, RGC representatives (Profs Paul Yu, Edward Yeung and Dr Nim-kwan Cheung), Jianbin Xu and Xudong Xiao.
研資局評審團與研究團隊的合照。（中排左一）謝雯小姐（項目經理）、（左四起）盧怡君、許昭、王建方、陳名華、汪正平、研資局代表（余劼離、楊仕成教授及張念坤博士）、許建斌及肖旭東教授。

PROJECT SUMMARY 項目概要

- Enhancing solar harvesting efficiency by developing new materials / techniques for thin-film/emerging photovoltaic devices, artificial photosynthetic and photocatalytic processes.
- Elevating energy storage technology by devising new materials and processes for high performance batteries, supercapacitors and hybrid battery/supercap devices applicable for microgrids.
- Developing advanced strategies to integrate and control various subsystems for field demonstration of microgrids operations based on intelligent control.

- 研發高效薄膜/新型光伏、光催化劑及人工光合作用之材料及生產過程，提升太陽光能的採集效率。
- 研發適合微電網應用之高性能電池、超級電容器及兩者混合裝置之物料及製備，提升電力儲存效能。
- 研發先進微電網技術策略，結合及控制各種不同子系統，以高效智能電網應用為最終目標。

ABSTRACT 項目簡介

The fast-growing demand for energy and the recognition of man-made global climate change underscore the urgency of developing clean and renewable energy resources to replace fossil fuels. Harvesting energy directly from sunlight by photovoltaics (PV), photocatalysis, artificial photosynthesis, and other enabling technologies is a promising way to meet such requirements.

This 5-year research project is led by Professor Ching-ping Wong, Dean of Engineering, CUHK. The project has been funded by the Theme-based Research Scheme (TRS) of the Research Grants Council (RGC) of the Hong Kong Government (HK$ 60.33 million) since 2014, with another HK$ 13.8 million from CUHK and HK$ 3 million from other partner universities. More than 30 scholars from CUHK, The Hong Kong Polytechnic University, The Hong Kong University of Science and Technology and The University of Hong Kong have been working together to enhance the efficiency of solar power and the penetration of the technology.

The project aims to strengthen the competitive edge of Hong Kong in solar energy technologies and their market penetration by combining the newly developed PV modules with the intelligent system integration. The holistic approach covers:

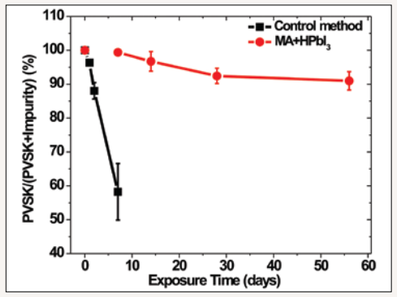
- Harvesting: The development of thin-film/emerging PV devices and modules to enhance the performance of solar harvesting;
- Storage: The design of highly performed electricity storage system;
- Utilization: To enhance the performance and security of solar smart grid systems to better meet the electricity demand under various operating modes.

隨着人類對能源需求的快速增長以及使用傳統化石燃料所導致的全球氣候惡化，人類急需開發和利用潔淨可再生能源以代替化石燃料的使用。從太陽光獲取能源是一種非常有前景的方式來滿足這些需求，具體的實現途徑有光電轉換、光催化、人工光合作用和其他太陽能收集技術。

此項研究是由中大工程學院院長汪正平教授領導，研究計劃為期五年。研究團隊自 2014 年起獲香港政府研究資助局 (RGC) 主題研究計劃 (TRS) 撥款 6,033 萬港元，另由中大及其他合作院校分別資助 1,380 萬港元及 300 萬港元。該項研究由 30 多位來自中大、香港理工大學、香港科技大學及香港大學跨學科、跨院校學者共同合作，以提升太陽能發電的效能、存儲和使用，讓相關技術更加普及。

為了發展薄膜太陽能電池和組件以提升香港在太陽能技術方面的競爭力及市場滲透，是項研究計劃的設計十分整全，目標包括三方面：

- 採集：提升太陽光採集技術的效能。
- 儲存：研發高效能電力儲存系統。
- 應用：研發高效能及安全的智能太陽能微電網系統，以滿足在不同運作模式下之各種用戶需求。



The team significantly improved the stability of MAPbI3 perovskite thin films from one week into two months at 65% humidity (left) and a world record of polymer solar cells (right).
有機無機雜化鈣鈦礦在65%濕度下之穩定性由一星期大幅提升至兩個月（左）並創聚和物基太陽能電池世@界記錄（右）。

An isolated microgrid laboratory is established with stand-alone or grid-connected mode, powered by either PV or the utility grid, overall power capacity reaches 4 kW.
團隊設立之智能微電網實驗室總容量達4 kW，能獨立或與多個電網並網操作；能自行以光伏供電，亦能與電力公司電網並網運行。

RESEARCH IMPACT 研究影響

The full-set technology of fabricating efficient CIGS cells and modules by the team leads to a high-efficiency CIGS PV system in CUHK, as well as a start-up company in Zhejiang of China, with estimated capacity 2MW/year. The prototype reactor developed is able to fabricate large-area perovskite thin film (5x5 cm2) at high speed with significantly improved stability, fostering its wide adoption in market. The low-cost zinc/iodine-bromide redox flow battery (ZIBB) which achieved the highest reported energy density to-date has high commercialization potential for electric cars and large-scale energy storage system due to compact volume, environment-friendly and low-cost materials. The developed platform for smart buildings and data analytic policies for encouraging energy conservation can be applied to many scenarios in HK. Also the online competitive optimization approach for microgrid management is applicable for addressing microgrids' key issue by significantly reducing the investment and operational costs. The proposed renewable investment / management schemes can help to choose the proper type and capacity for renewable energy generations, and coordinate the operations of multiple facilities to achieve the full benefits. The microgrid laboratory devised by the team can be powered by both PV and utility grid; also operated in stand-alone or grid-connected mode.

團隊發展的CIGS電池和組件科技，除了在中大組建了光伏系統，更於中國浙江省成立了啟動公司，估計產能達每年2 MW。氧固反應器能製出大面積鈣鈦礦薄膜（5 × 5 cm²），維持良好穩定性而生產過程快，向商業生產所需技術要求邁進一大步。新型鋅 — 碘溴液流電池(ZIBB)能量密度刷新了目前水系液流電池記錄且節省大量空間、便宜及安全，於電動車及大型儲能系統極具商業開發前景。智能大廈軟件及數據分析於香港不同場景均能廣泛應用。在線發電調度算法有效降低成本、提升效能，解決微電網關鍵問題。投資管理體系助設施管理者選出最適再生能源生產種類及容量，達最佳運作效果。智能電網實驗室能自行以光伏供電，亦能與電力公司並網運作；能獨立運作，亦支持多個電網並網運行。

Project Website 研究項目網頁：
https://sse.erg.cuhk.edu.hk/sse/

ENHANCING HONG KONG'S FUTURE AS A LEADING INTERNATIONAL FINANCIAL CENTRE (T31-717/12-R)
提升香港全球競爭能力，打造世界一流金融中心

Prof. Douglas W. Arner
安納德教授

PROJECT COORDINATOR
Prof. Douglas W. Arner
The University of Hong Kong

項目統籌人：
安納德教授
香港大學

PARTICIPATING INSTITUTION
The Chinese University of Hong Kong
University of Oxford
Hong Kong Polytechnic University

參與院校：
香港中文大學
牛津大學
香港理工大學

SHORT BIOGRAPHY OF PROJECT COORDINATOR
項目統籌人簡介

The Fourth Global Conference on Economic Geography 2015 held on 19-23 August 2015 at the University of Oxford
2015年第四屆全球經濟地理學大會於2015年8月19日至23日在牛津大學舉行

Douglas W. Arner is the Kerry Holdings Professor in Law at the University of Hong Kong, and Faculty Director of the Faculty of Law's LLM in Compliance and Regulation and LLM in Corporate and Financial Law. He is a member of the Hong Kong Financial Services Development Council, an Executive Committee Member of the Asia Pacific Structured Finance Association, and a Senior Visiting Fellow of Melbourne Law School, University of Melbourne. Douglas served as Head of the HKU Department of Law from 2011 to 2014 and as Co-Director of the Duke University-HKU Asia-America Institute in Transnational Law from 2005 to 2016. From 2006 to 2011 he was the Director of HKU's Asian Institute of International Financial Law, which he co-founded in 1999. He has published fifteen books and more than 120 articles, chapters and reports on international financial law and regulation, including most recently Reconceptualising Global Finance and its Regulation (Cambridge 2016) (with Ross Buckley and Emilios Avgouleas). His recent papers are available at: https://papers.ssrn.com/sol3/cf_dev/AbsByAuth.cfm?per_id=524849. Douglas has served as a consultant with, among others, the World Bank, Asian Development Bank, APEC and European Bank for Reconstruction and Development, and has lectured, co-organised conferences and seminars and been involved with financial sector reform projects around the world. He has been a visiting professor or fellow at Duke, the Hong Kong Institute for Monetary Research, IDC Herzliya, McGill, Melbourne, National University of Singapore, University of New South Wales, Shanghai University of Finance and Economics, and Zurich, among others.

Douglas W. Arner是香港大學嘉里基金教授(法學)，法律學院法學碩士(合規和監管)課程主任和法學碩士(公司與財務)課程主任。他也是香港金融發展局成員，亞太結構融資公會執行委員會委員，和墨爾本大學法學院高級客座研究員。Douglas於二零一一至二零一四年擔任香港大學法律學院系主任，並於二零零五年至二零一六年擔任杜克大學-香港大學 Asia-America Institute in Transnational Law聯席總監。此外，Douglas除了是香港大學亞洲國際金融法研究院在一九九九年成立時的創辦人之一，同時亦於二零零六至二零一一年擔任研究院主任。他出版了十五本書和120多篇文章關於國際金融法和監管法，其中包括最近的書籍Reconceptualising Global Finance and its Regulation（重新認識全球金融及其監管）(劍橋2016年)（與Ross Buckley和Emilios Avgouleas編著)。他最近的文章可以在以下網站閱讀https://papers.ssrn.com/sol3/cf_dev/AbsByAuth.cfm?per_id=524849。Douglas擔任世界銀行，亞洲開發銀行，亞太經合組織和歐洲復興開發銀行等顧問，並主講、共同舉辦會議和研討會，及參與世界各地的金融改革項目。他曾於杜克大學、香港金融研究中心、赫茲利亞跨學科研究中心、麥基爾大學、墨爾本大學、新加坡國立大學、新南威爾士大學、上海財經大學和蘇黎世大學等擔任客座教授或研究員。

PROJECT SUMMARY 項目概要

- Hong Kong has emerged over the past three decades to become one of the world's most important financial centres.
- Important elements underlying major financial centre development include legal, political, geographical, economic, financial and demographic factors.
- The 2008 Global Financial Crisis highlighted the risks inherent in being a leading international financial centre but also a range of opportunities for Hong Kong as financial globalisation evolves, particularly the role of China.
- Looking forward, Hong Kong's future as a leading international financial centre with hinge on globalisation, legal and regulatory infrastructure, technological evolution, and human capital development.

- 過去三十年來，香港已經漸漸成為世界上最重要的金融中心之一。
- 發展成為主要金融中心的重要因素是包括法律，政治，地理，經濟，金融和人口元素。
- 二零零八年全球金融危機突顯了成為國際金融中心領先地位的風險，也是香港金融全球化發展的一系列機遇，特別是中國的角色。
- 展望未來，香港作為國際金融中心的領導者，關鍵是全球化，法律法規基礎設施，技術進步和人力資本的發展。

ABSTRACT 項目簡介

By the end of the 20th century, Hong Kong had emerged as one of the world's major international financial centres. Today, while finance remains central to Hong Kong's future, it is facing unprecedented challenges, both in China and globally. In the context of China, the continuing process of economic reform and financial development raises many opportunities but at the same time brings into question Hong Kong's traditional role as the primary intermediary between China and the global financial system. At the same time, the global and European financial crises have raised fundamental questions about finance, exchange rate systems, the global position of China, and the future role of the renminbi, including Hong Kong's role therein. Reflecting the centrality of finance to Hong Kong, Article 109 of the Hong Kong Basic Law, ascribes the Hong Kong Government an obligation "to provide an appropriate economic and legal environment for the maintenance of the status of Hong Kong as an international financial centre." However, it has yet to take a comprehensive approach to this obligation or to consider its strategic and practical implications. This project, built around a team of internationally recognized experts from economics / finance, geography, law, and international relations, will analyze the elements required not only to maintain, but also enhance, Hong Kong's future as an international financial centre, focusing on its role in China's ongoing financial liberalization and economic development.

在20世紀末，香港已成為世界上主要的國際金融中心。金融業是香港發展未來的核心產業，然而現時不論是在中國或全球，金融業正面臨著前所未有的挑戰。在中國經濟發展的大環境下，持續的經濟改革和金融發展過程中造就了許多機會予香港的經濟發展，但在同一時間給香港作為中國與全球金融體系主要中介人的傳統角色帶來了重要的問題。同時，全球和歐洲的金融危機引起了探討有關根本的金融制度問題，包括匯率制度、中國在全球金融發展的位置、人民幣在未來的角色及香港在其中的作用。香港基本法第109條反映金融中心對香港經濟的重要性和核心性，要求香港特別行政區政府「提供適當的經濟和法律環境，以保持香港的國際金融中心地位」。但是，當局目前尚未採取全方位的方式履行這一義務，或考慮其戰略意義和實際價值。因此，本研究項目將建立一支包含世界經濟/金融、地理、法律以及國際關係的國際專家團隊，不僅將分析維持及提升香港作為國際金融中心的基本元素，但也重點討論香港在中國正進行的金融自由化和經濟發展中的角色和作用。

RESEARCH IMPACT 研究影響

Financial services along with professional and business services comprise a major portion of Hong Kong's economy as well as a major source of employment. In addition to its domestic importance, Hong Kong has emerged over the past 30 years as one of the 5 most important international financial centres, taking its place alongside London, New York and Singapore. This project analysed factors underlying Hong Kong's emergence and role as an international financial centre, centering on legal, economic, financial, geographical, political and demographic factors, all of which have played a significant roles in supporting Hong Kong's future as well as those of other major financial centres. Looking forward, globalisation of finance (in particular the increasing financial importance of China and Asia), legal and regulatory infrastructure, technological evolution and human capital will be central to the future of Hong Kong's evolution. Similar factors underpin the development of other major financial centres. At the same time it is essential to not only pursue opportunities but also guard against risks inherent in the role, with crises being an inherent feature of global finance.

金融服務以及專業和商業服務是香港經濟的主要部分，也是主要的就業來源。除了對本地的重要性，香港在過去三十年中已經成為五大最重要的國際金融中心之一，與倫敦，紐約和新加坡並列。本研究項目分析了香港作為一個國際金融中心的發展和角色，以法律、經濟、金融、地理、政治和人口因素為中心，這些因素是支持香港發展成為金融中心。展望未來，金融全球化（特別是中國和亞洲日益增長的經濟重要性），法律和法規基礎設施，技術演進和人力資本將是香港未來發展的範疇。其他主要金融中心的發展也是類似的因素。與此同時，不僅要追求機會，還要防範角色所帶來的風險，危機是全球金融的內在特徵。

HKIMR-HKU International Conference on Finance, Institutions and Economic Growth held on 22 May 2015 at the Hong Kong Monetary Authority
HKIMR-HKU國際會議：金融，機構和經濟增長於2015年5月22日在香港金融管理局舉行

The Political Economy of Financial Regulation held on 2-4 June 2016 at CUHK
政治經濟學的財務條例研討會在2016年6月2日至6日在香港中文大學舉行

TRANSFORMING HONG KONG'S OCEAN CONTAINER TRANSPORT LOGISTICS NETWORK
振興香港海洋貨櫃運輸物流網 (T32-620/11)

PROJECT COORDINATOR
Prof. Chung-yee Lee
The Hong Kong University of Science and Technology

項目統籌人：
李忠義教授
香港科技大學

PARTICIPATING INSTITUTION
The University of Hong Kong
City University of Hong Kong

參與院校：
香港大學
香港城市大學

SHORT BIOGRAPHY OF PROJECT COORDINATOR 項目統籌人簡介

The 5th International Conference on Logistics and Maritime Systems has been held in Hong Kong on 27-29 August 2015. 140 participants from 17 countries joined the event.
2015年8月27日至29日，由李忠義教授主辦的第五屆物流與海運系統國際會議在香港科技大學成功召開。來自世界各地17個國家140名嘉賓參加了此次會議。

Dr. Chung-Yee Lee is a Visiting Professor at IELM Department, Director of the Office of Institutional Research, and Senior Advisor to the Vice-President for Research & Graduate Studies, HKUST. He served as IELM Department Head for seven years (2001-2008), and held the Cheong Ying Chan Professorship in Engineering (from January 2013 to June 2017). He is a Fellow of the Institute of Industrial Engineers in U.S. and also a Fellow of Hong Kong Academy of Engineering Sciences. Before joining HKUST in 2001, he was Rockwell Chair Professor in the Department of Industrial Engineering at Texas A&M University.

His research areas are in logistics and supply chain management, scheduling and inventory management. He has published more than 160 papers in refereed journals. According to an article in International Journal of Production Economics, which surveyed all papers published in the 20 core journals during last 50 years in the field of production and operations management, he was ranked No. 6 among all researchers worldwide in h-index.

李忠義教授是香港科技大學工業工程及物流管理系的客座教授，香港科技大學副校長辦公室學院研究部高級顧問，香港科技大學物流與供應鏈管理研究所主任及創始人。他曾任香港科技大學工業工程及物流管理系主任(2001-2008)，並榮任張英燦工程學教授(2013-2017)。他是美國工業工程師協會會士，香港工程科學院院士。在2001年加入香港科大之前，李教授在美國Texas A&M大學擔任Rockwell講座教授。

李教授的研究領域包括港口物流、物流和供應鏈管理、調度和庫存管理。李教授在國際期刊發表的論文達160餘篇。2009年《International Journal of Production Economics》中的一篇研究論文顯示，在過去50年內, 在生產和運營管理領域, 李忠義教授的研究影響力(h-index)在全球學者中名列第6。

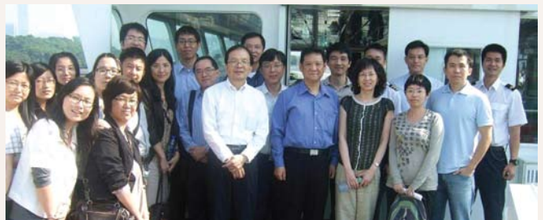
PROJECT SUMMARY 項目概要

- The logistics industry, especially ocean container logistics, plays a critical role in Hong Kong's economy.
- Our project makes holistic study on container logistics, involving academics, industry and the government.
- We achieve global excellence by establishing Hong Kong as the research hub for maritime logistics management.
- We make local impact by providing recommendations to different stakeholders.

- 物流業，特別是海洋貨櫃運輸，在香港經濟中扮演重要的角色。
- 我們從全球網絡的角度，研究分析業內各界之間及與政府的策略互動關係及角色。
- 本研究計劃可助本港提昇為環球海運物流及供應鏈管理的科研樞紐。
- 本研究計劃對本港作為航運及物流中心的角色作深入理解和分析，並就未來的最佳發方向提出切實建議。

From left to right: Prof. James Wang, Prof. Rachel Zhang, Prof. Houmin Yan, Prof. Jeff Hong, Prof. Chung-Yee Lee, Prof. Xiangtong Qi, Prof. Qian Liu, Prof. Hongtao Zhang, Prof. Albert Ha, Prof. Ho-Yin Mak, Prof. Jiheng Zhang
從左至右：王緝憲教授，張荃教授，嚴厚民教授，洪流教授，李忠義教授，齊向彤教授，劉倩教授，張洪濤教授，夏耀祥教授，麥浩然教授，張季恆教授

Twenty team members visited Hong Kong International Terminals (HIT), and Oriental Overseas Carrier Lines (OOCL) on 17 Oct 2011
2011年10月17日，二十位團隊成員參觀了香港國際貨櫃碼頭公司及香港東方海外公司。



ABSTRACT 項目簡介

Hong Kong as a port of city is facing ever increasing competition from other ports in mainland China and doubts have been cast on its future as a logistics center. The major cities in the world, for example London and New York, have evolved from port cities that mainly handled physical goods into modern financial and information hubs, moving most of the ocean container business to less expensive neighboring port cities. On the other hand, ports such as Rotterdam still depend on physical flows. It is important to consider what path Hong Kong should follow. A unique distinction is that the future of Hong Kong will largely depend on the cooperation between Hong Kong and the Pearl River Delta (PRD). Against this backdrop, we believe that Hong Kong should follow a mixed model, i.e., it should shift its focus from physical flow toward financial flow and information flow, yet still maintain logistics as the foundation for other types of flows and services. Hence, Hong Kong and Shenzhen's ports can be viewed as a joint node in the global supply chain network. This logistics foundation will serve to promote Hong Kong as a regional and international financial and service hub. Ocean container logistics, the lifeline of almost any global supply chain, if developed properly, can serve as a solid foundation for old and new businesses alike and attract new opportunities to other important business sectors such as the financial industry.

The proposed project has two major goals. (1) To establish Hong Kong as the research hub for logistics and supply chain management. Our team study holistically ocean container transport supply chain networks around the world, at both the strategic and tactical levels. We have addressed those issues that are both intellectually challenging and have huge potential impact on Hong Kong. The team has generated some state-of-art research on ocean container logistics networks, which is a very important emerging area in academia. The team has also developed prototype decision support systems for Hong Kong's ocean container supply chain network. (2) To develop an in-depth understanding of Hong Kong's role as a port city and its future direction. This proposed project hopes to be able to contribute to the transformation of Hong Kong's ocean container transport logistics network in the city's quest to remain and grow as a regional and international business center.

面對鄰近地區的急速發展，本港作為航運及物流中心的地位正面臨重大挑戰。香港物流業的未來定位確實值得深思。背靠著珠江三角洲地區的龐大生產力，本港物流業應該採取一種雙軌發展模式 — 在把物流焦點轉移到資金與信息流通的同時，香港可利用現有於物流管理的優勢，以開拓新的商用服務。同時，本港應與鄰近的深圳港口加強聯繫及合作，共同發展成環球供應鏈網絡上的聯合樞紐。在環球供應鏈上，海洋貨櫃運輸是不可或缺的一環。如果鞏固這方面的發展基礎，本港可望在舊有的業務上開展新的一頁，在各新興及傳統行業中創造更多商機。

本研究項目共有兩項主要目標：

一、把本港提昇為環球海運物流及供應鏈管理的科研樞紐。我們的團隊從宏觀及微觀角度，全面性地展開圍繞海洋貨櫃供應鏈網絡的研究項目。各項研究課題不但對本港及世界物流發展有深遠的影響，更具有很高的學術價值。專家小組亦開發一套決策支援系統，以助業界將研究成果付諸實行。

二、對本港作為航運及物流中心的角色作深入理解和分析，並就未來的最佳發展方向提出切實建議。本項目的研究成果希望有助振興本港海洋貨櫃運輸物流業，更望對本港作為地區性以至環球商業中心的發展具指標作用。

RESEARCH IMPACT 研究影響

The ocean container logistics, as a foundation supporting the global supply chain, plays a critical role in Hong Kong's economy. Though Hong Kong may shift its focus from physical flow toward financial flow and information flow, it should still maintain logistics as the foundation for other types of flows and services. This will sustain the position of Hong Kong as a regional and international financial and service hub.

Our project has conducted state-of-art research on ocean container logistics networks, especially for improving the effectiveness and efficiency of the network, an important function a modern port city management must possess. Some innovation has been shared with industry through either direct collaboration or workshop dissemination, and has received positive feedbacks. The prototype decision support systems we developed for Hong Kong's ocean container supply chain network will help Hong Kong shipping industry. Furthermore, the report our team member has generated regarding the suggestion of a relocation of Hong Kong container terminals provides new options for the government's strategic plan.

海運物流是環球供應鏈上不可或缺的一環，對香港經濟具有舉足輕重的地位。雖然焦點可能轉移到資金與信息的流通，香港應加強維護物流業發展的基礎，以開拓新的商用服務，協助穩固香港作為國際金融及商業服務中心的地位。

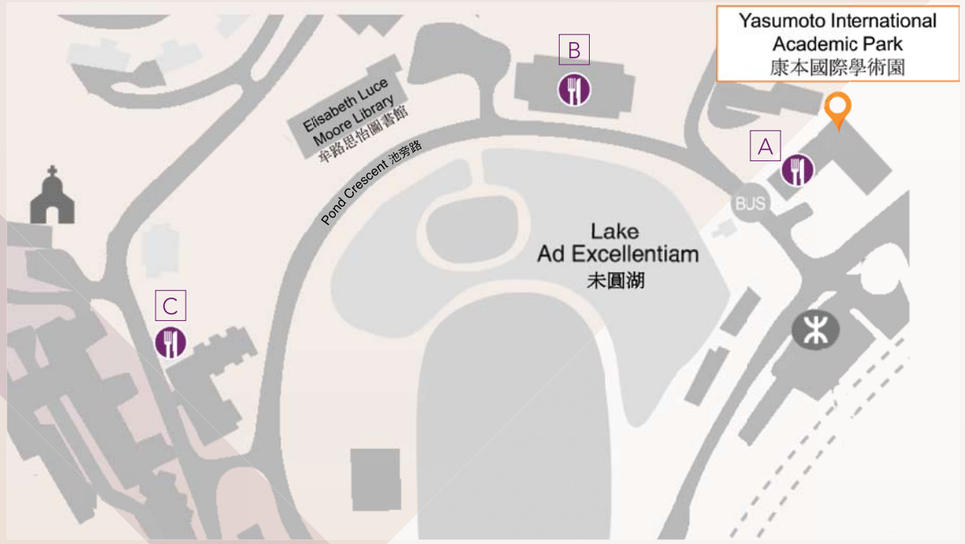
我們的團隊已經針對海洋貨櫃供應鏈網絡特別在網絡的有效性和效率 — 現代港口城市管理不可或缺的功能 — 進行尖端學術研究。一些創新研究成果已經透過企業界的直接合作或論壇的成果發表會與業界分享,也獲得正面的回應，專家小組開發的一套決策支援系統，希望對海洋貨櫃業界有所助益。同時團隊成員也提供了一份有關香港碼頭重新佈局的建議給政府決策計劃作參考。

The RGC Retreat Meeting has been held at Crowne Plaza, Hong Kong Kowloon East on 23 June 2015.
2015年6月23日團隊成員研討會於香港九龍皇冠假日酒店成功舉行。

USEFUL INFORMATION
有用資訊

CANTEENS NEARBY 鄰近食堂

	Canteen 食堂	Location 位置	Walking Distance 步行距離	Phone No. 電話號碼
A	Café 330	101A, 1/F, Yasumoto International Academic Park 康本國際學術園1樓101A	1 minute 約需1分鐘	2994 3932
B	Chung Chi College Student Canteen 崇基學院學生膳堂	Chung Chi Tang 眾志堂	5 minute 約需5分鐘	2603 6623
C	Orchid Lodge 蘭苑	Orchid Lodge 蘭苑	8 minute 約需8分鐘	2603 5922



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是次研討會所有研究項目均為研究資助局在第一輪（2011/12 年度）至第三輪（2013/14 年度）主題研究計劃撥款資助的項目。

NOTES 筆記

ORGANIZER 主辦院校

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香港中文大學

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Information as at 20 November 2017
資料截至2017年11月20日