澳門大學
UNIVERSIDADE DE MACAU
UNIVERSITY OF MACAU

UM RESEARCH | 澳大研究

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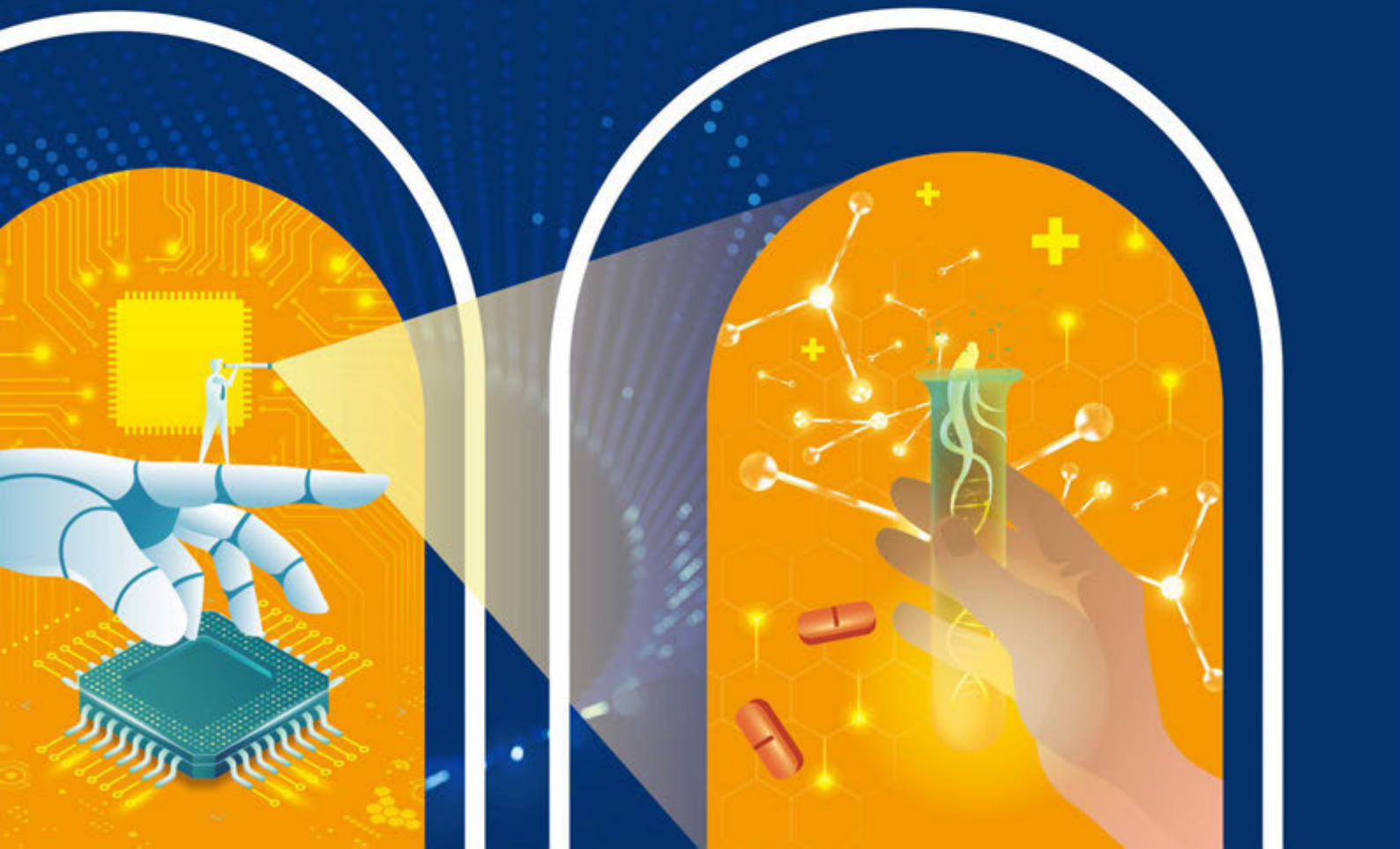

校長寄語 Rector's Message

四十餘載砥礪深耕，澳門大學始終秉持「仁、義、禮、知、信」的校訓精神，在中央政府的政策引領、澳門特區政府的資源保障以及社會各界的鼎力襄助下，書寫了一部敢為人先的奮進史詩。今天，作為一所國際化研究型綜合公立大學，我們正以更開放的胸襟擁抱變革，以創新思維破解發展課題，在服務國家戰略、引領區域發展中彰顯澳大擔當。

前沿引領，科技報國顯擔當：緊扣「國家所需、澳門所長」方針，我校以「3+3+3+3」為骨幹的科研戰略佈局，依託三間國家重點實驗室，開展中藥質量研究、超大規模集成電路和智慧城市物聯網領域的前沿科學研究；同時重點建設精準醫療、先進材料及區域海洋研究這三個新興科研領域。中醫藥團隊以現代科技破解中藥品質密碼，推動中醫藥國際化；微電子領域學者研發高效數據轉換器，引領集成電路設計前沿；而「AI+通信」的突破性研究，更在新一代移動通信技術中佔據先機。

學科融合，跨界創新開新篇：打破學科壁壘，方能激發無限可能。澳大學者開創水下與空中機器人協同研究，拓展智能系統應用邊界；不懈探索柔性機電融合技術，為未來智慧裝備注入新動能；通過多語境數據科學，構建人文與科技的橋樑。法律與科技的交叉研究，更直面數字時代的倫理與治理挑戰。這種「無界融合」的理念，正推動澳大成為跨學科創新的策源地。

澳琴和鳴，協同發展譜新曲：在「澳門研發+橫琴轉化+灣區應用」的立體生態中，珠海澳大科技研究院成為跨境合作典範。五大研發中心聯動灣區資源，與多家企業共建聯合實驗室，助力微電子、中醫藥等成果產業化。在AI領域，持續深化校企合作；在生物醫藥領域，與中國生物技術股份有限公司的聯合實驗室，更成為產學研融合標杆。隨著橫琴粵澳深度合作區澳門大學高等研究院的獲批，琴澳協同創新進入2.0發展階段，將進一步為大灣區高品質發展注入澳大智慧。

面向未來，揚帆啟航再出發：站在新起點，澳大將堅定踐行「立足澳門、共建灣區、融入國家、走向世界」的發展定位，以更務實行動服務國家大局。我們期待與各界攜手，以創新為舟、以使命為帆，在粵港澳大灣區的澎湃浪潮中，續寫澳大與時代同行的新華章！

校長
宋永華

Over forty years of dedication and growth, the University of Macau, guided by the motto 'Humanity, Integrity, Propriety, Wisdom and Sincerity', has flourished. With the guidance of the central government's policies, the resource assurance of the Macao SAR Government, and strong support from the society, it has blazed a trail of excellence. Today, as a comprehensive research-oriented public university of international standing, we embrace change, tackle development challenges with innovation, and actively contribute to national strategies and regional leadership.

At the forefront of innovation, UM serves the nation. Aligned with the principle of leveraging Macao's strengths to meet the country's needs, our '3+3+3+3' strategic research layout leverages three State Key Laboratories for cutting-edge work on quality research in traditional Chinese medicine, very-large-scale integration, and internet of things applications for smart cities. We also focus on emerging research fields including precision medicine, advanced materials, and regional oceanography. Our traditional Chinese medicine team utilises modern technology to explore Chinese medicine's potential and promote its internationalisation; microelectronics scholars to develop high-performance data converters, leading the frontier of integrated circuit design; and 'AI + communications' research to give us an edge in next-generation mobile communications technologies.

Interdisciplinary integration spurs innovation's new chapter. Transcend disciplinary silos to unleash boundless possibilities. UM pioneers underwater and aerial robot collaborative research, advancing intelligent system in its applications; persistently explores flexible electromechanical technology for future smart equipment; and 'builds' the bridges between humanities and technology through multilingual data science. Interdisciplinary research between law and technology confronts the ethical and governance challenges of the digital age. The concept of boundless integration is driving UM to become an interdisciplinary innovation hub.

Harmony of Macao and Hengqin pave new paths in collaborative development. Within the ecosystem of R&D in Macao, transformation in Hengqin, and application in the Guangdong-Hong Kong-Macao Greater Bay Area (Greater Bay Area), the Zhuhai UM Science and Technology Research Institute is setting an example of cross-border cooperation. Its five R&D centres connect with Greater Bay Area resources, jointly building laboratories with multiple enterprises to promote the industrialisation of microelectronics, traditional Chinese medicine, etc. In AI, industry-academia collaboration is deepened; in biomedicine, the joint laboratory with China National Biotec Group is a benchmark of integration. The approval of University of Macau Advanced Research Institute in Hengqin marked the entry into the 2.0 phase of Hengqin-Macao collaborative innovation, further integrating UM's wisdom into the high-quality development of the Greater Bay Area.

Looking ahead, UM sets sail for new horizons. At this new starting point, UM will firmly position itself as a university with firm roots in Macao, committed to participating in the development of the Greater Bay Area, integrating itself into national development, while reaching out to the world. With our innovation and mission, we look forward to working with all sectors to write a new chapter in UM's journey alongside the times, amidst the rising tide of the Greater Bay Area.

Rector
Yonghua Song

年度大事記 2024

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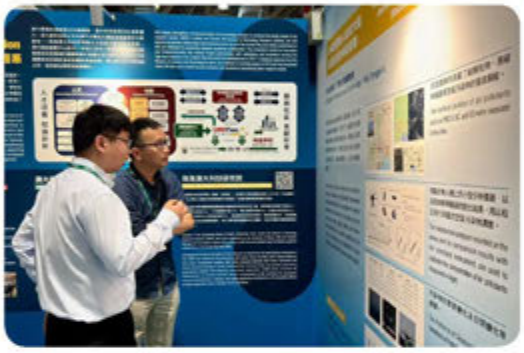

澳大科研成果於澳門國際環保合作發展論壇及展覽展出
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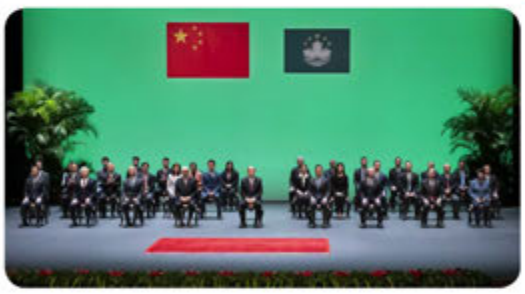

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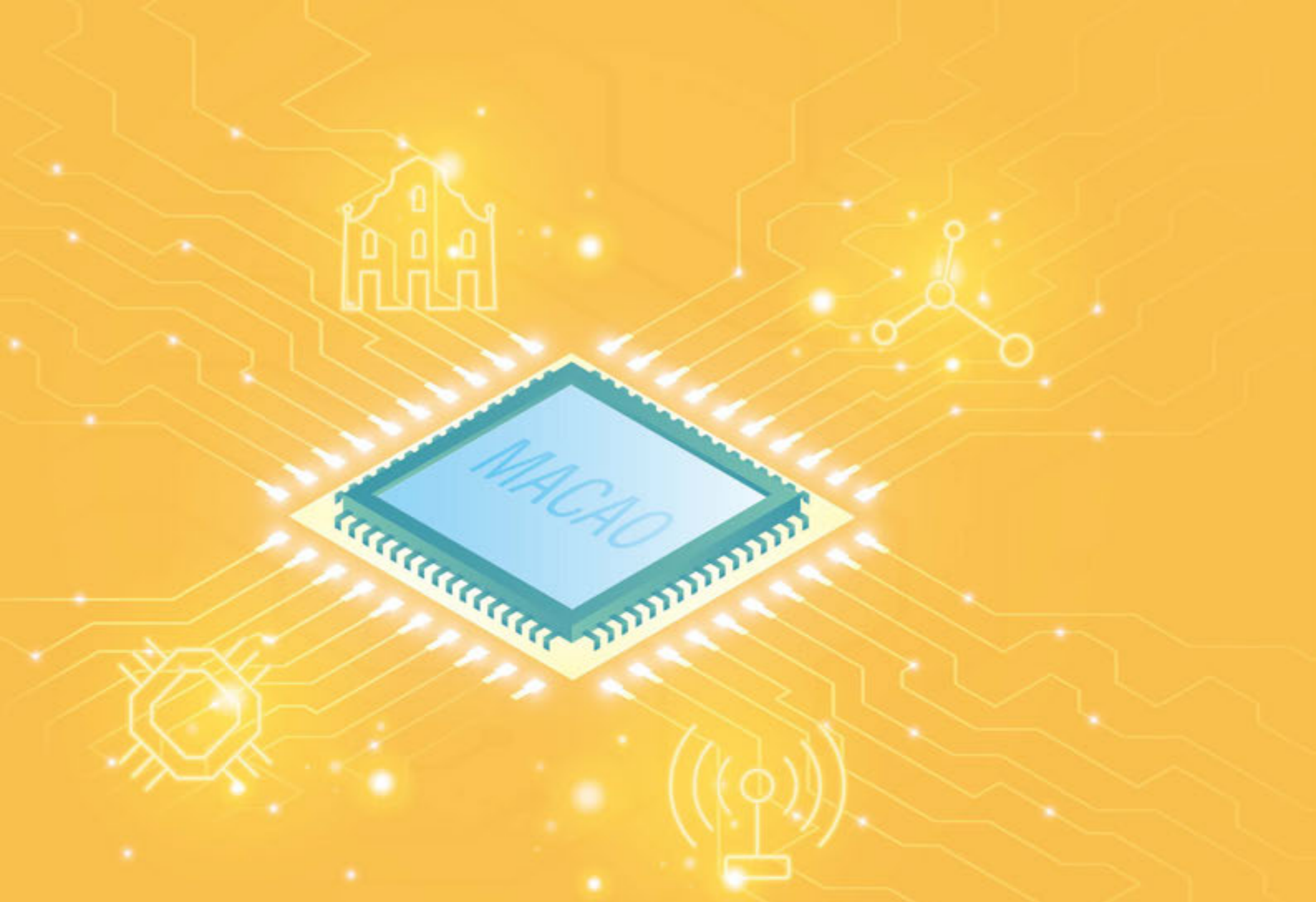


特稿

Feature Article

澳門本土科學家「點亮」工程與微電子研究

Macao Local Scientists Advance Engineering and Microelectronics Research

文：關詠瑜、趙怡瑋
Chinese & English Text: Christy Kuan, Eva Zhao

圖：部分由受訪者提供
Photo: Partially provided by the interviewee

為配合澳門特區政府「1+4」經濟適度多元發展策略，並強化澳門作為國家「科技創新走廊」的重要節點，澳門大學積極推動科研創新、人才培育及成果轉化。通過「五位一體」研究創新及轉化體系，澳大構建高水平產學研平台，培育兼具國際視野與本土情懷的科研人才，為澳門及大灣區發展賦能。

澳大作為本土科學家的培育搖籃，不僅專注於實驗室內的技術攻關，更激勵科學家以個人使命推動科研成果轉化，通過人才培育激活創新動能，快速融入灣區發展大勢。本篇以阮家榮教授和麥沛然教授為本地科研學者代表，他們分別在工程和微電子領域突破國際技術壁壘，更以導師身份培育出李家明、于維翰、郭善知等新生代科研力量，印證了本土科研的實用價值，並進一步推動「澳門研發＋橫琴轉化」的產學研實踐，將「澳門智慧」轉化為驅動灣區高質量發展的核心引擎。

To align with the Macao SAR Government's '1+4' strategy for appropriate economic diversification and to reinforce Macao's role as an important node in the country's 'Technology Innovation Corridor', the University of Macau (UM) actively promotes scientific research innovation, talent cultivation, and research results transfer. Through its '5-in-1' system for research innovation and results transfer, UM is building a high-level platform for industry-academia collaboration, cultivating scientific researchers who possess both international perspectives and deep local connections, thereby empowering the development of Macao and the Greater Bay Area.

As a nurturing ground for local scientists, UM not only focuses on technological breakthroughs in laboratories but also inspires these scientists to drive research results transfer and cultivate talents through their personal missions, integrating seamlessly into the development of the Greater Bay Area. This article highlights Professor Ka-Veng Yuen and Professor Pui In Mak as representatives of local scientists, who have made international and technological breakthroughs in the field of engineering and microelectronics, respectively. As mentors, they have also nurtured a new generation of researchers, including Ka Meng Lei, Weihan Yu, and Sin Chi Kuok, demonstrating the practical value of local research and further advancing the industry-academia collaboration of 'R&D in Macao, transformation in Hengqin'. This initiative transforms the research output of Macao scientists into a core driving force for high-quality development in the Greater Bay Area.

科技工程之光：奠定土木工程貝葉斯研究基石

阮家榮教授
Professor Ka-Veng Yuen

在澳門土生土長的阮家榮，目前擔任澳大科技學院土木及環境工程學系特聘教授。他自博士畢業後便在澳大開展職業生涯，至今已在土木工程領域深耕超過二十年。阮教授在貝葉斯分析、隨機性量化、系統識別、結構健康監測、可靠度分析和動力系統分析等研究領域取得卓越成就。據Web of Science，他的工程領域貝葉斯分析學術期刊論文總量位居全球第二；據2020年全球科學家引用榜，他在所有土木工程領域為第一領域的學者中位列36。阮教授更在2024年榮獲第十五屆「光華工程科技獎」，成為該屆唯一來自澳門的獲獎科學家，該獎項被譽為中國工程界的最高榮譽。他的傑出成就對於激勵年輕科研人才起到了重要作用。

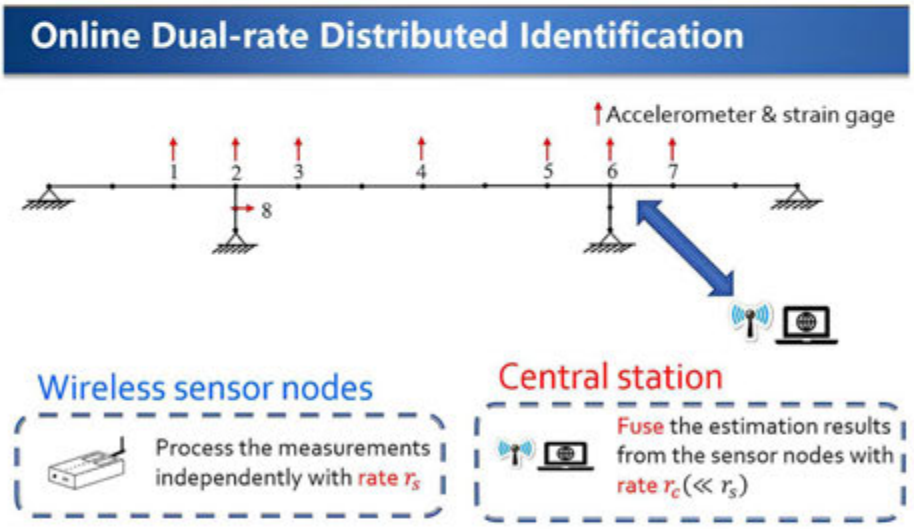
阮教授獲得「光華工程科技獎」如此崇高的榮譽，源於他在土木工程領域貝葉斯分析的卓越研究成果，也進一步奠定了他在該學術領域的領先地位。他成功研發出一系列無須外力數據的貝葉斯參數識別法，顯著推動了模型選擇研究的進步。此外，該研究除了涵蓋參數識別和模型選擇兩個層次，更發展到第三個層次——基於自我修復模型的系統識別，亦提出了雙時步分布式實時識別新範式。

在系統識別上，阮教授取得突破性進展，特別是在結構健康監測方面，推出了一系列結構損傷識別的實時算法。他以2015年香港汲水門大橋被船隻撞擊為例，指出該事件導致大橋被封近兩小時，造成了巨大的經濟損失。阮教授表示，無論橋樑是否受撞擊，如果能進行長期實時結構健康監測，及早評估結構安全狀況並識別受損位置和程度，就能避免不必要的交通封閉，有效降低社會成本，提升工程的安全性和運營效率。

此外，阮教授提出的基於自我修復模型的系統識別，進一步提升了系統識別對複雜結構的實用性。他解釋道：「以往，面對若干個有問題的模型，我們只能在其中選擇相對問題較少的那一個。如今，我們的算法可以使模型的結構根據數據進行自我修復，而不僅僅是修復模型中的參數，最終有可能化廢為寶，演化出一個更完善且可用的模型。」

阮教授與他的學生黃可提出的雙時步分布式識別新範式，徹底改變了傳統的數據收集和處理方式。他指出：「與傳統的中心化數據處理不同，這種新方法允許每個傳感器節點先自行處理自身的數據。通過減少數據傳輸頻率，例如從每秒兩百次降低到每秒一次，顯著降低了傳輸負擔，減少了對中心節點的依賴。此外，這種方法還解決了不同傳感器之間時間差異導致的數據不一致問題，從而大幅提升了數據處理的效率和準確性。」這些成果不僅發表在一流學術期刊上，阮教授還與他的學生黃可於2023年合作出版了專著《Bayesian Real-time System Identification: From Centralized to Distributed Approach》。

阮教授的貝葉斯研究不僅在結構工程領域取得實質性應用，還擴展至空氣污染建模和岩土工程，展現了貝葉斯方法在多領域的廣泛價值與創新潛力。自2005年起，阮教授便與現任澳大副校長莫啓明教授合作，將貝葉斯模型應用於空氣質量的建模和預測，成功實現了動態污染源的擴散預測。該研究於2012年榮獲了澳門科學技術獎勵「技術發明獎」二等獎。2023年，他們和澳大土木及環境工程系黎永杰教授，許嘉賢博士出版專著《Air Quality Monitoring and Advanced Bayesian Modeling》。2021年，阮教授和澳大土木及環境工程系主任周萬歡教授，香港理工大學的尹振宇教授共同出版了貝葉斯方法在岩土工程應用的專著《Practice of Bayesian Probability Theory in Geotechnical Engineering》。



阮家榮教授和黃可提出的雙時步分布式識別新範式，能大幅減少數據傳輸量，並完全避免因數據時間不同步而引起的問題
The Online Dual-rate Distributed Identification paradigm proposed by Professor Ka-Veng Yuen and Ke Huang can significantly reduce the data transmission volume and completely avoid problems caused by data time asynchrony

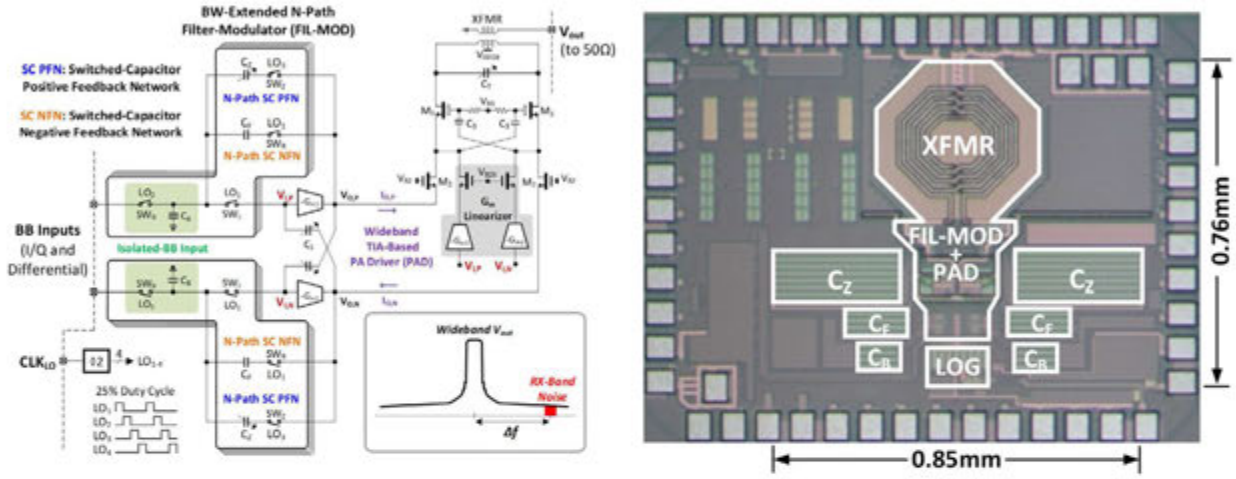
「芯」突破：解鎖模擬與射頻的未來密碼

麥沛然教授
Professor Pui In Mak

澳大模擬與混合信號超大規模集成電路國家重點實驗室主任麥沛然教授是澳大培養的傑出本地科學家。他專注於模擬和射頻集成電路設計、交叉學科科學和工程創新。麥教授屢獲「澳門首獲」的殊榮。2018年，他獲被委任為《IEEE固態電路期刊》副編輯，是當時唯一獲委任該職位的中國學者，同年當選英國工程技術學會（IET）會士；2019年成為國際電機電子工程師學會（IEEE）會士，是首位獲此殊榮的土生土長澳門人； 2022年，憑研發「無電池智能電子芯片」成為澳門首位獲「科學探索獎」的學者；2024年，當選葡萄牙里斯本科學院首位在澳門出生並接受教育的外籍通訊院士，並獲澳門特區政府頒授教育功績勳章。他曾獲國家科學技術進步二等獎，並獲得澳門科學技術獎勵「技術發明獎」八次和「特別獎勵」一次。目前，他擔任電子領域頂級的科學期刊《IEEE固態電路簡報》的主編。麥教授與研究團隊已在*IEEE Journal of Solid-State Circuits*（JSSC）、*IEEE Transactions*系列期刊上發表論文 150 餘篇，已獲授權美國及中國發明專利 30 餘項。這些彰顯了他在微電子與集成電路領域的卓越貢獻。

麥教授及其團隊長期專注於模擬和射頻集成電路設計，致力於解決該領域的痛點問題。他們在高性能多頻段無線收發器電路方面取得了重要進展。這種電路能夠支持多個頻段的無線信號發送和接收，是5G通信中的關鍵技術，因為5G需要同時處理多個頻段的信號以實現穩定高效的通信。

團隊開發了一系列創新的多路（N-path）開關電容前端電路設計。這種設計將濾波功能融合到收發器中，通過多個路徑的開關電容網絡實現信號的採樣和濾波，具有高增益、低噪聲和良好的線性度等特點。它能夠有效替代傳統SAW濾波器，克服了傳統SAW濾波器頻率覆蓋不靈活、體積較大、成本較高以及難以實現動態調整等局限性，顯著降低了5G通信系統的成本和提升效能。

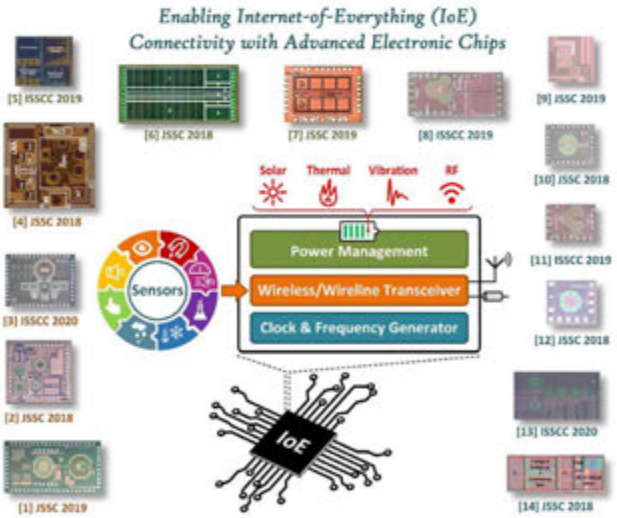


麥沛然教授和團隊開發的 N-path 開關電容前端電路設計方法
The N-path Switched-Capacitor Front-End Circuit Design Method developed by Professor Pui In Mak and his team

此外，團隊還提出了一種全動態功率信號鏈芯片處理技術。這種技術能夠在動態信號條件下實現高效率的功率管理，同時優化信號處理的質量。它解決了模擬信號採集界面與模擬計算協同融合中的成本與性能權衡問題，廣泛應用於噪聲檢測、關鍵詞識別及核磁共振系統等領域。

在超低功耗無線收發器方面，團隊通過超低電壓及無源器件技術，研製出能效卓越的收發器。這種技術利用低工作電壓和無源器件（如電容、電感等）來實現高效率的電路設計，特別適用於低功耗設備，能夠在有限的電源條件下最大化信號傳輸質量和設備壽命。

研究團隊還開發了「無電池智能電子芯片」，解決了物聯網設備中電池更換和環境污染的問題。這種芯片能夠透過收集環境中的微型能量來替代傳統電池，對物聯網產業的綠色發展具備重大意義。麥教授更憑藉這一成果獲得2022年度「科學探索獎」，成為澳門首位獲獎者。

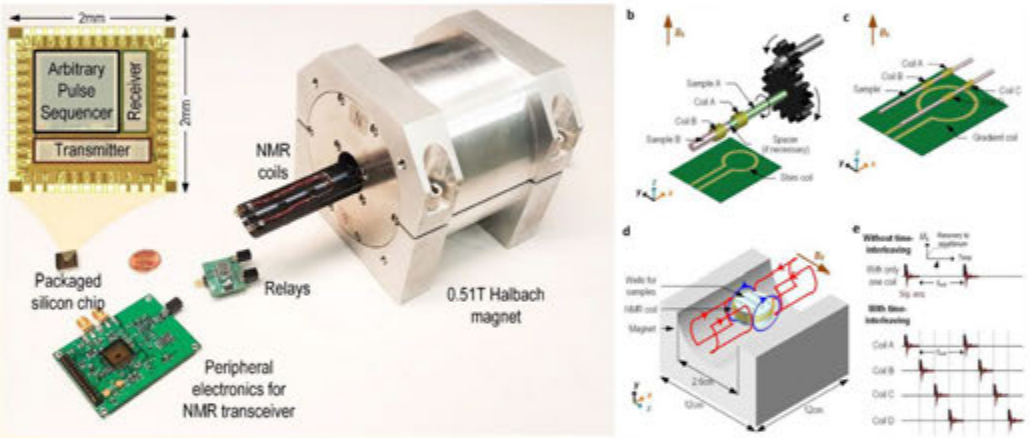


麥沛然教授和團隊開發的高效信號鏈芯片處理技術
Efficient Power Signal Chain Chip Processing Technology developed by Professor Pui In Mak and his team

薪火相傳：本地人才培養與科研啟發

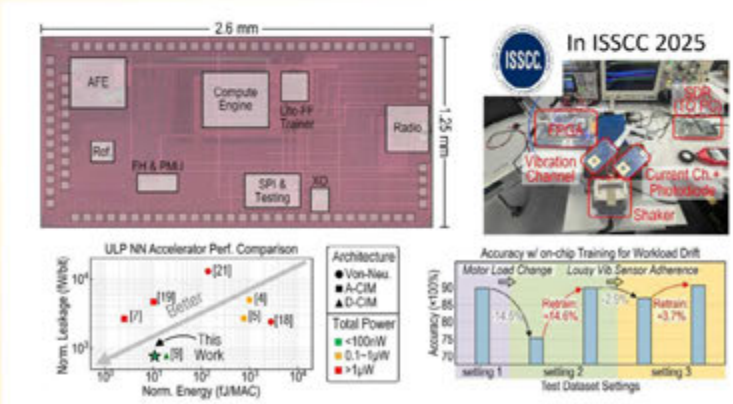
麥教授和阮教授除了致力於推動科研創新，更一直秉持著薪火相傳的精神，培養了眾多出色的本地科研人才。麥教授的學生李家明和于維翰，以及阮教授的學生郭善知，均為澳大在本地青年科研人才培養方面的傑出典範。他們憑藉卓越表現，獲聘為「澳大濠江學者」，並受邀前往海外頂尖大學深造。學成歸來後，他們將所學奉獻給澳門社會和母校，回饋培育之恩。目前，李家明和于維翰擔任澳大模擬與混合信號超大規模集成電路國家重點實驗室及微電子研究院助理教授，而郭善知則在澳大智慧城市物聯網國家重點實驗室及科技學院土木工程系擔任助理教授。

李家明教授2016年在澳大完成電機及電腦工程博士學位後，獲邀前往哈佛大學擔任訪問學者。他專注於核磁共振平台的研究，致力於通過醫療科技的微型化技術，將大型醫療設備縮小至便攜尺寸，大幅降低成本，使尖端且昂貴的醫療設備更加普及化。這項研究能夠優化醫療流程，縮短患者等候時間。值得一提的是，李家明教授在哈佛大學的出色表現不僅獲得了哈佛教授的高度認可，還為他後來帶領的學生前往哈佛深造創造了更多機會，形成了良性循環，助力澳門培養更多高端科研人才。



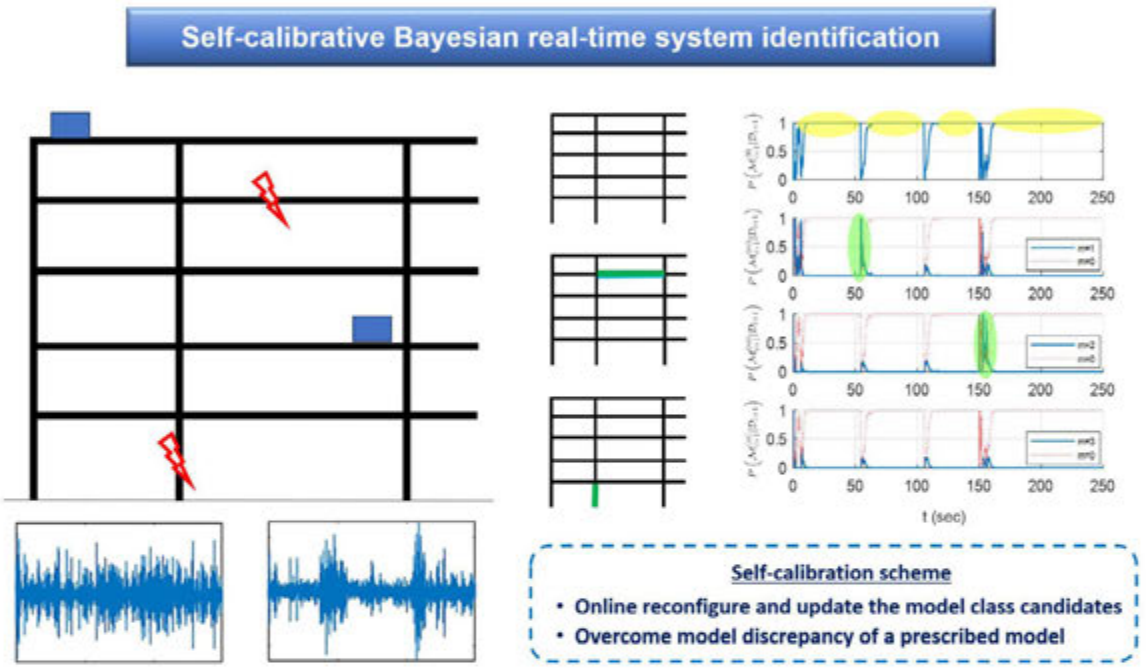
可攜式核磁共振檢測平台
Portable Nuclear Magnetic Resonance System

于維翰教授2018年在澳大完成電機及電腦工程博士學位後，以訪問學者身份前往史丹福大學深造。于教授專注於人工智能與微電子技術結合的研究，尤其在語音人工智能技術上取得突破，將語音控制與自然語言處理應用於設備操作。他希望實現設備的進一步微型化，例如將手機功能逐步轉移到智能手錶、耳機等設備，甚至完全免除設備依賴，通過語音和生物震蕩識別完成任務。這將大幅提升人機交互的自然性和便捷性。



用於語音控制邊緣裝置的關鍵字偵測（KWS）芯片
Keyword-spotting (KWS) Chip for Voice-control Edge Devices

郭善知教授2015年在澳大完成土木工程博士學位後，受邀前往美國康奈爾大學的研究團隊從事概率模型分析以及結構健康監測研究，並於2018年通過「澳大濠江學者」計劃前往英國牛津大學和劍橋大學擔任訪問學者。她專注於概率機器學習在結構健康監測的研究，致力於結合物理機理和數據信息來評估建築物的健康狀況，特別是為大灣區地標基礎建設和本澳世界文化遺產建築提供運營維護和保養修復的決策支持。



阮家榮教授和郭善知教授提出的自我修復模型的貝葉斯系統識別，能自動變更及修正模型，解決結構健康監測中預設模型缺陷和失真的問題，為建築物的結構評估和維護修復提供支持

The Bayesian real-time system identification based on self-calibratable model classes proposed by Professor Ka-Veng Yuen and Professor Sin Chi Kuok can reconfigure and update the model class candidates, addressing the issues of prescribed model defects and distortions in structural health monitoring, and provides support for the structural assessment, maintenance and restoration of buildings

「薪火相傳」的理念不僅體現在澳大培養的本地科研人才身上，更在研究的延續和精進中得到充分展現。阮教授與其導師——「地震工程之父」George W. Housner的徒孫、加州理工學院教授James Beck合作，開啟了土木工程第一代貝葉斯模型選擇研究的曙光。2004年，師徒合著的論文《使用結構響應測量的模型選擇：貝氏機率方法》奠定了他們在學術界的地位，至今已被引用近800次，成為土木工程領域的重要學術參考。隨著研究的深入，阮教授與他的學生慕何青合作，在2015年發展出貝葉斯模型選擇實時算法。這一進展標誌著貝葉斯研究在土木工程領域達到了新的里程碑，阮教授欣慰地將這種師生代代相傳的力量稱為「傳承」。

從興趣到實踐：科研創新的不懈追求

培養科研人才的根本在於從興趣出發，並通過實踐來深化興趣和鞏固基礎。麥教授回憶起當年在實驗中因電線短路而產生的火花，正是這一刻燃起了他對微電子芯片的興趣和熱情。麥教授說：「讓學生感受到科研的挑戰性，提供豐富的實踐學習機會，並鼓勵他們提出自己的創意，對提升興趣至關重要。」從事科研工作超過二十載，麥教授始終堅持追求卓越和極致。他認為，科研成功與否的差距在於從99分到99.9分之間那微小的零點幾分，而這取決於科研人員願意付出多少努力去超越大多數人。

從事科研不僅需要興趣的支撐，更需要堅定不移的決心。阮教授在研究的道路上始終堅定方向，摸著石頭過河，從最初坐冷板凳一步一腳印走到今天。他引用了自己非常喜歡的一句歌詞：「偶爾遇上急風，步伐未凌亂。」這恰好表達了他在科研路上專心致志的成功寫照。阮教授說：「當你堅持到有一天你的研究被大眾接受時，你收獲的回報很多，因為你就是奠定研究基石的開拓者。」

科研人員的核心競爭力在於面對艱難挑戰的堅定決心。麥教授認為，當前年輕人在職業選擇上往往偏向取易不取難，這導致越來越少人願意投身於艱難的科研道路，從而加大了培養科研人才的難度。他強調，大學應將科研融入生活，激發年輕一代對科研的興趣，讓他們意識到從事科研不僅是理論學習，更是實際應用，能夠為世界帶來價值。當年輕人了解到成功的科研成果能夠獲得世界關注並對國家發展具有重大意義時，將激勵他們投身於未來科技的發展。麥教授說：「大學應培養學生成為發明者，而不是僅僅是消費者。」

麥教授和阮教授目前分別教授大一和大二的學生，旨在更早地啟發新生對科研的興趣，兩位教授的理念剛好不謀而合。阮教授表示，只要學生有興趣，他經常會在抽出課餘時間與他們進行交流。麥教授則強調，澳門的學生應該把握機遇，善用特區政府和大學提供的優質科研資源。他建議特區政府可對優秀的理工科學生提供免學費的獎勵措施，進一步激勵年輕人選擇修讀理工科。

澳門研發＋橫琴轉化：打造科研成果轉化新引擎

在粵港澳大灣區的戰略推進下，澳門這座「微型城市」正以科技創新為支點，撬動發展新格局。從阮家榮教授在土木工程貝葉斯領域的開拓性突破，到麥沛然教授在微電子芯片設計的國際性顛覆；從澳大構建「五位一體」產學研創新體系，到橫琴合作區為科研成果轉化與青年創業鋪就的廣闊舞台，澳門用實踐證明了微型經濟體亦能成為國家科技戰略中的閃耀節點。

這一發展態勢與澳門特區政府「1+4」適度多元發展策略深度契合。《橫琴粵澳深度合作區建設總體方案》將科技研發與高端製造列為重點發展產業，為區域轉型注入強勁動能。目前，橫琴已形成顯著的產業集群效應。以集成電路產業為例，區內集聚超過50家芯片設計企業，創造了大量高質量就業崗位。而麥教授團隊孵化的迪奇孚瑞生物科技有限公司等成功案例，充分驗證了「澳門研發+橫琴轉化」模式的可行性。作為「人才留澳」戰略的堅定踐行者，麥教授指出，橫琴合作區的設立，通過其便捷的跨境交通、稅收優惠及產業集聚優勢，吸引澳門高校應屆畢業生跨境就業，使高等教育投入實現本地價值回饋，有效解決了澳門因經濟結構單一導致的人才流失問題。

展望未來，澳門大學將持續以科研創新為驅動，秉持「薪火相傳」的育人理念，「點亮」工程與微電子研究。通過「毫米級的突破」丈量科技疆界，深度融入大灣區創新生態，為國家科技強國建設貢獻澳門智慧。

The Glory of Science and Technology Engineering: Establishing the Foundation for Bayesian Research in Civil Engineering

Ka-Veng Yuen, who was born and raised in Macao, currently serves as a Distinguished Professor in the Department of Civil and Environmental Engineering of the Faculty of Science and Technology at UM. He started his career at UM after completing his Ph.D. and has been deeply involved in the field of civil engineering for more than 20 years. Professor Yuen has achieved remarkable success in research areas such as Bayesian inference, uncertainty quantification, system identification, structural health monitoring, reliability analysis, and analysis of dynamic systems. According to Web of Science, he is ranked 2nd in the world for the number of publications on Bayesian inference in engineering. According to a citation ranking published in PLOS Biology in 2020, he ranked 36th among civil engineering scholars worldwide. In 2024, Professor Yuen was awarded the 15th Guanghua Engineering Science and Technology Prize, becoming the only Macao scholar to receive the award, which is considered as the most prestigious award in the field of engineering in China. His outstanding achievements play an important role in inspiring young scientific researchers.

Professor Yuen has received the prestigious Guanghua Engineering Science and Technology Prize due to his outstanding research achievements in Bayesian inference in the field of civil engineering, further establishing his leading position in this academic domain. He has successfully developed a series of Bayesian identification methods without measurements of the external forces; and significantly advanced the progress of model class selection research. Furthermore, the research has expanded beyond the two levels of system identification, which include parametric identification and model class selection, to a third level: system identification using self-calibratable model classes; and has also proposed a new paradigm of online dual-rate distributed identification.

Professor Yuen has made ground-breaking progress in system identification, particularly in structural health monitoring, where he has developed a series of real-time algorithms for structural damage identification. He highlighted the incident in 2015 when a ship struck the Kap Shui Mun Bridge in Hong Kong, resulting in the bridge being closed for nearly two hours and causing huge economic losses. Professor Yuen stated that regardless of whether a bridge experiences an impact, implementing long-term real-time structural health monitoring can enable early assessment of the structural safety and identification of the damaged locations and the extent of the damage. This proactive approach can avoid unnecessary traffic closures, effectively reducing social costs and improving the safety and operational efficiency of engineering projects.

In addition, the system identification based on self-calibratable model classes proposed by Professor Yuen has further improved the practicality of system identification for complex model structures. He explained, 'In the past, when faced with several problematic models, we could only select the one with relatively fewer problems. Now, our algorithm allows the structure of the models to be automatically adjusted and optimised based on the data, rather than merely adjusting the parameters in the models. This approach could ultimately transform waste into value by evolving into a more comprehensive and usable model.'

Professor Yuen and his student Ke Huang proposed a new paradigm of online dual-rate distributed identification that has fundamentally changed the traditional way of data collection and processing. He pointed out, 'In contrast to traditional centralised data processing, this new method allows each sensor node to process its own data first. By reducing the data transmission frequency, for example from 200 times per second to once per second, it significantly reduces the transmission burden and decreases the reliance on the central node. In addition, this method addresses the issue of data inconsistency caused by time differences between different sensors, thereby greatly improving the efficiency and accuracy of data processing.' These achievements have not only been published in top academic journals, but Professor Yuen and his student Ke Huang have also co-authored the monograph *Bayesian Real-time System Identification: From Centralized to Distributed Approach* in 2023.

Professor Yuen's Bayesian research has not only achieved substantial applications in the field of structural engineering, but has also extended to air pollution modelling and geotechnical engineering, demonstrating the broad value and innovative potential of Bayesian methods across multiple domains. Since 2005, Professor Yuen has collaborated with Professor Kai Meng Mok, the current Vice Rector of UM, to apply Bayesian models to air quality modelling and prediction, successfully achieving dynamic prediction of pollutant source dispersion. This research won the second prize of the Technological Invention Award for the Macao Science and Technology Awards in 2012. In 2023, together with Professor Yongjie Li and Dr. Ka-In Hoi from the Department of Civil and Environmental Engineering at UM, they published the monograph *Air Quality Monitoring and Advanced Bayesian Modeling*. In 2021, Professor Yuen and Professor Wanhuan Zhou, Head of the Department of Civil and Environmental Engineering at UM, together with Professor Zhenyu Yin from the Hong Kong Polytechnic University, jointly published the monograph *Practice of Bayesian Probability Theory in Geotechnical Engineering*.

阮家榮教授的專著
Professor Ka-Veng Yuen's Monographs

Core Breakthrough in Chip Technology: Unlocking the Future of Analog and Radio Frequency

Professor Pui In Mak, Director of the State Key Laboratory of Analog and Mixed-Signal VLSI at UM, is an outstanding local scientist nurtured by UM. He focuses on analog and radio frequency integrated circuit design, interdisciplinary science, and engineering innovation. Professor Mak has received numerous honours as a 'first for Macao'. In 2018, he was appointed as an associate editor of the *IEEE Journal of Solid-State Circuits* (JSSC), becoming the only academic from China to be appointed to this position at that time; he was elected as a fellow of the Institution of Engineering and Technology (IET) at the same year. In 2019, he became a fellow of the Institute of Electrical and Electronics Engineers (IEEE), the first local from Macao to receive this honour. In 2022, he became the first scholar from Macao to receive the Xplorer Prize for his research on 'Battery-less Intelligent Electronic Chips'. In 2024, he was elected as the first foreign corresponding member of the Academy of Sciences of Lisbon, Portugal, who was born and educated in Macao; he was awarded the Medal of Merit—Education from the Macao SAR Government. He received the second prize of the State Scientific and Technological Progress Award, and has won the Technological Invention Award eight times and the Special Award once for the Macao Science and Technology Awards. He is currently the editor-in-chief of the *IEEE Solid-State Circuits Letters*, a prestigious journal in the field of electronics. Professor Mak and his research team have published more than 150 papers in the *IEEE Journal of Solid-State Circuits* (JSSC) and the *IEEE Transactions* series of journals, and have been granted more than 30 patents in the U.S. and China. These achievements highlight his outstanding contributions to the field of microelectronics and integrated circuits.

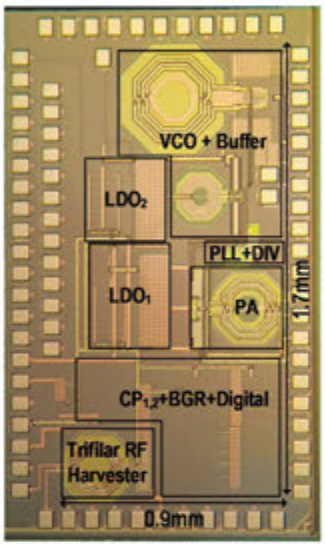
Professor Mak and his team have long focused on analog and radio frequency integrated circuit design, dedicated to addressing the pain points in this area. They have made significant advances in high-performance multi-band wireless transceiver circuits. Such circuits can support the transmission and reception of wireless signals across multiple frequency bands, making them a key technology in 5G communications. This is essential because 5G requires the simultaneous processing of signals from multiple bands to achieve stable and efficient communications.

The team has developed a series of innovative N-path switched-capacitor front-end circuit design. This design integrates the filter functions into the transceiver, achieving signal sampling and filtering through the N-path switched-capacitor network. It has the characteristics of high gain, low noise, and good linearity. It can effectively replace traditional SAW filters, overcoming the limitations of inflexible frequency coverage, large size, high cost, and difficulty of dynamic adjustment. This has significantly reduced the cost and improved the efficiency of 5G communication systems.

In addition, the team has also proposed a fully dynamic power signal chain chip processing technology. This technology enables efficient power management under dynamic signal conditions while optimising the quality of signal processing. It addresses the cost-performance trade-off issues in the collaborative integration of analog signal acquisition interfaces and analog computing, and is widely applied in areas such as noise detection, keyword recognition, and magnetic resonance systems.

In the area of ultra-low power wireless transceivers, the team has developed transceivers with outstanding energy efficiency through ultra-low voltage and passive component technology. This technology uses low operating voltages and passive components (such as capacitors and inductors) to achieve a highly efficient circuit design that is particularly suitable for low-power devices and can maximise signal transmission quality and device life under limited power conditions.

The research team has also developed 'Battery-less Smart Intelligent Electronic Chips', which addresses the issues of battery replacement and environmental pollution in IoT devices. This chip can replace traditional batteries by harvesting micro-energy from the environment, which holds great significance to the sustainable development of the IoT industry. Professor Mak was awarded the Xplorer Prize 2022 for this achievement, becoming the first recipient from Macao.



麥沛然教授以「無電池智能電子芯片」項目榮獲 2022 年度「科學探索獎」
Professor Pui In Mak was awarded the Xplorer Prize 2022 for his project on 'Battery-less Smart Intelligent Electronic Chips'

Passing on the Torch: Local Talent Cultivation and Scientific Research Inspiration

Professor Mak and Professor Yuen are not only dedicated to advancing research innovation but have always adhered to the spirit of passing on the torch, training many outstanding local research talents. The students of Professor Mak, Ka Meng Lei and Weihan Yu, and the student of Professor Yuen, Sin Chi Kuok, are all outstanding examples of UM's cultivation of young local research talents. They were appointed as 'UM Macao Fellow' for their excellent performance and were invited to pursue further studies at top universities overseas. Upon returning, they dedicate their knowledge to Macao society and their alma mater, in gratitude for the cultivation they received. Currently, both Ka Meng Lei and Weihan Yu serve as assistant professors at the State Key Laboratory of Analog and Mixed-Signal VLSI and the Institute of Microelectronics at UM, while Sin Chi Kuok serves as an assistant professor at the State Key Laboratory of Internet of Things for Smart City and the Department of Civil and Environmental Engineering of the Faculty of Science and Technology at UM.

After completing his Ph.D. degree in Electrical and Computer Engineering at UM in 2016, Professor Ka Meng Lei was invited by Harvard University to be a visiting scholar. His research focuses on the nuclear magnetic resonance (NMR) platform, which aims to miniaturise large medical equipment to a portable size through medical technology, significantly reducing costs and making advanced and expensive medical devices more accessible. This research can help optimise medical procedures and reduce waiting times for patients. It is worth noting that Professor Lei' s exceptional performance at Harvard not only earned him high recognition from Harvard professors, but also opened up more opportunities for his students to further pursue studies at Harvard, creating a positive cycle that supports Macao in cultivating more high-end research talent.

After completing his Ph.D. degree in Electrical and Computer Engineering at UM in 2018, Professor Weihan Yu engaged in advanced research at Stanford University as a visiting scholar. Professor Yu focuses on the integration of artificial intelligence and microelectronics, particularly making breakthroughs in speech artificial intelligence technology. He has applied voice control and natural language processing to device operation. He aims to further miniaturise devices, such as gradually transferring the functions of smartphones to smartwatches, earphones, and other devices, and even eliminating device dependency altogether by using voice and biometric recognition to perform tasks. This will greatly enhance the naturalness and convenience of human-machine interaction.

After completing her Ph.D. degree in Civil Engineering at UM in 2015, Professor Sin Chi Kuok was invited to join a research team at Cornell University in the United States to conduct research on probability model analysis and structural health monitoring. In 2018, she participated in the UM Macao Fellow programme and served as a visiting scholar at the University of Oxford and the University of Cambridge in the United Kingdom. Her research focuses on the application of probabilistic machine learning in structural health monitoring, aiming to integrate physical mechanisms and data information to assess the health status of buildings, especially providing decision-making support for the operation, maintenance, and restoration of landmark buildings in the Greater Bay Area and World Cultural Heritage buildings in Macao.

李家明教授（左）、于蔚翰教授（中）、麥沛然教授（右）
Professor Ka Meng Lei (left), Professor Weihan Yu (middle), Professor Pui In Mak (right)

郭善知教授（左）和阮家榮教授（右）
Professor Sin Chi Kuok (left) and Professor Ka-Veng Yuen (right)

The concept of 'passing on the torch' is not only evident in the local research talent nurtured by UM but also fully demonstrated by the continuity and advancement of research. Professor Yuen, in collaboration with his supervisor—Professor James Beck of the California Institute of Technology, who learned at the feet of a student of George W. Housner, the father of earthquake engineering—pioneered the first generation of Bayesian model selection research in civil engineering. In 2004, their co-authored paper, 'Model Selection Using Response Measurements: Bayesian Probabilistic Approach', established their status in academia and has been cited nearly 800 times to date, becoming a significant academic reference in the field of civil engineering. As research progressed, Professor Yuen worked with his student, Heqing Mu, to develop a real-time Bayesian model class selection algorithm in 2015. This advancement marked a new milestone for Bayesian research in civil engineering. Professor Yuen fondly referred to this generational transfer of knowledge and expertise as 'inheritance'.

From Interest to Practice: The Tireless Pursuit of Research Innovation

The key to nurturing research talents is to start with interest and deepen it through practice to solidify the fundamentals. Professor Mak recalled the moment when a spark was generated from a short circuit during an experiment, which ignited his interest and passion for microelectronic chips. 'It is crucial for students to experience the challenges of conducting research, to have rich hands-on learning opportunities, and to be encouraged to come up with their own ideas to enhance their interest,' said Professor Mak. Having engaged in research for over two decades, Professor Mak has always adhered to the pursuit of excellence and perfection. He believes that the difference between success and failure in research lies in that tiny fraction of points between 99 and 99.9, which depends on how much effort researchers are willing to put into outperforming the majority.

Engaging in scientific research requires not only a genuine interest, but also unwavering determination. Professor Yuen has always been steadfast in his research direction, overcoming challenges step by step from the early stages to where he is today. He quoted a lyric from a song that he particularly likes: 'Occasionally facing strong winds, yet not losing my stride.' This perfectly reflects his success in staying focused and determined on the research journey. Professor Yuen said, 'When you persevere until the day your research is accepted by the public, the rewards you reap are substantial, because you are the pioneer who lays the foundation for the research.'

The core competitiveness of researchers lies in their strong determination to face difficult challenges. Professor Mak believes that young people today often prefer easier career choices to challenging ones, resulting in fewer people willing to take the demanding path of research, thereby increasing the difficulty of cultivating research talent. He emphasises that universities should integrate scientific research into everyday life to spark the interest of the younger generation, and help them realise that engaging in research involves not only theoretical learning but also practical applications that can create value to the world. When young people understand that successful research achievements can

gain global attention and have significant implications for national development, they will be motivated to devote themselves to the development of future technologies. Professor Mak said, 'Universities should train students to be inventors, not just consumers.'

Professors Mak and Professor Yuen are currently teaching first-year and second-year students, respectively, aiming to inspire freshmen's interest in scientific research at an earlier stage. Their philosophies align perfectly. Professor Yuen stated that as long as students are interested, he often takes time outside of class to engage with them. Professor Mak emphasised that students in Macao should seize the opportunities and make good use of the high-quality research resources provided by both the Macao SAR Government and the university. He suggested that the Macao SAR Government could offer tuition-free incentives to outstanding science and engineering students to further encourage young people to pursue studies in these fields.

R&D in Macao + Transformation in Hengqin: Establishing New Driving Force for Research Results Transfer

Under the strategic advancement of the Greater Bay Area, Macao, with its unique 'micro-city' model, is leveraging technological innovation to unleash new momentum for development. From Professor Ka-Veng Yuen's pioneering breakthroughs in Bayesian research in civil engineering, to Professor Pui In Mak's international innovations in microelectronic chip design; from the establishment of UM's industry-academia collaboration platform in the '5-in-1' system to the research results transfer and youth entrepreneurship established by the Cooperation Zone in Hengqin; Macao demonstrates that a micro-economy can also play a key node in the national scientific and technological strategy.

This development trend closely aligns with the Macao SAR Government's '1+4' strategy for appropriate economic diversification. The Master Plan of the Development of the Guangdong-Macao In-Depth Cooperation Zone in Hengqin identifies R&D and high-end manufacturing as key industries, driving significant progress in regional transformation. Currently, Hengqin has attracted a cluster of industries; for instance, over 50 chip design companies have been established in the integrated circuit sector, creating numerous high-quality job opportunities. One notable success is Digifluidic Biotechnology Co., Ltd. incubated by Professor Mak's team, which fully demonstrates the feasibility of 'R&D in Macao + transformation in Hengqin'. As a supporter of talent retention in Macao, Professor Mak highlighted that the establishment of the Cooperation Zone in Hengqin, with its convenient cross-border transportation, tax incentives, and industrial clustering advantages, is attracting fresh graduates from Macao universities to pursue cross-border employment. This approach not only maximises the local value of higher education investments but also effectively addresses the talent loss issue resulting from Macao's reliance on a single industry.

Looking ahead, UM will continue to drive innovation through research while embracing the educational philosophy of 'passing on the torch' to advance engineering and microelectronics research. With its pioneer breakthroughs, UM aims for deep integration into the Greater Bay Area's innovation ecosystem, contributing Macao's wisdom to the country's goal of becoming a technological powerhouse.

特稿

Feature Article

濠鏡觀天下：澳大人文社科學者對澳門與世界的不懈探索

Macao's Global Insight: UM Scholars' Unwavering Research of Macao and the World on Humanities and Social Sciences

文：原維維、鄧林
Chinese & English Text: Wayne Yuan, Chloe Deng

圖：部分由受訪者提供
Photo: Partially provided by the interviewee

1991 年，在東亞大學的基礎上，澳門大學正式成立，並肩負起新的歷史使命。近年來，澳大人文社科不斷發展，成立了人文社科高等研究院、澳門研究中心、中國歷史文化中心、孔子學院、中葡雙語教學暨培訓中心、藝術設計中心及澳門中小學生人文社科教育基地等多個教研單位。同時，精神病學 / 心理學、社會科學總論及經濟與商學躋身美國頂尖學術指標基本科學指標（ESI）全球前 1% 學科，為澳門本地的經濟、文化和法治建設提供了堅實的學術支持。這些成就的取得，離不開澳大人文社科學者對澳門與世界的不懈探索，以朱壽桐教授、趙心樹教授和劉建宏教授為代表的澳大學者，長期深耕於各自研究領域，緊密結合澳門社會發展的脈搏，成為推動本地創新與發展的重要力量。

In 1991, based on the University of East Asia, the University of Macau (UM) was officially established, shouldering a new historical mission. In recent years, UM's humanities and social sciences have continued to develop, establishing several teaching and research units such as the Institute of Advanced Studies in Humanities and Social Sciences, the Centre for Macau Studies, the Centre for Chinese History and Culture, the Confucius Institute, the Chinese-Portuguese Bilingual Teaching and Training Centre, the Centre for Arts and Design, and Macao Base for Primary & Secondary Education in Humanities & Social Science. And also, the Psychiatry/Psychology, Social Sciences (General), and Economics & Business have entered the top 1% in the Essential Science Indicators (ESI), a top U.S. database for ranking in terms of citation frequency of published papers, providing solid academic support for Macao's local economy, culture, and rule of law construction. These accomplishments would not have been possible without the unwavering research of Macao and the world by scholars in humanities and social sciences at UM. Represented by professors such as Shoutong Zhu, Xinshu Zhao, and Jianhong Liu, UM scholars have long dedicated themselves to advancing their respective research fields, closely aligning with the evolving dynamics of Macao' s societal development. Their work has solidified their role as vital forces driving local innovation and progress.

朱壽桐教授：發揮澳門獨特優勢，珍視傳統，面向未來

曾任澳大南國人文研究中心主任、中國歷史文化中心主任、澳大人文學院特聘教授的朱壽桐教授，致力於中國現代文學、比較文學等領域的研究。他學術成果豐碩，至今已出版《酒神的靈光》《情緒：創造社的詩學宇宙》《中國新文學的現代化》《寬容的廣床－十九世紀文學主流》等個人專著30部，主持《澳門文學編年史》《人文社會科學十萬個為什麼》《中國文學現代社團流派》等11部書籍的編著，並發表學術論文300餘篇。

朱壽桐教授
Professor Shoutong Zhu

澳門人文社科研究獨特的優勢

《澳門文學編年史》是由朱壽桐教授主編、多位學者共同編撰的大型文學史料叢書。該書系統梳理了澳門自新文學運動以來至20世紀80年代上半期的文學發展脈絡；通過搜集散佚文獻、甄別史料，為澳門文學研究提供了系統化的歷史線索，填補該領域文獻整理的空白，被譽為「澳門文學歷史的存照」。本書是澳門基金會2010年立項的重要研究項目，是國家重點出版基金項目，榮獲廣東省人民政府首屆政府出版獎，旨在推動澳門文學文獻的系統化整理與研究。

朱教授指出，澳門這座歷史悠久且充滿現代氣息的城市，其人文社科研究得天獨厚。國家賦予澳門「以中華文化為主，多元文化共存」的文化定位，為相關研究提供了豐富的素材和廣闊的視野；在這種文化定位的引領下，澳大等學術機構的人文社科研究得以順利開展，並取得了一系列顯著成果，《澳門文學編年史》的出版便是其中的代表。

澳門作為中西文化交流的視窗，見證了不同文明的碰撞與融合，這種多元文化的交融不僅為學術研究提供了豐富的資源和靈感，也使澳門在文史研究方面具有獨特優勢，能夠深入挖掘和傳承中華文化的精髓。

重新審視中國傳統文化

90年代初期，隨著改革開放的推進，現代化文明思潮、社會思潮和政治思潮相互交織，朱教授的著作《中國新文學的現代化》應運而生。他指出，中國現代文學的誕生是在對舊文學的反叛與西方文學資源吸收的基礎上孕育而成的。他強調：「現代化是一種思想意識、思想觀念的現代化，不是說用現代人的語言、文字寫作就是現代化。」通過這些研究，他希望為中國現代文學的學術研究和文化傳承做出更大貢獻，同時也為澳門乃至全球的文學研究和文化發展提供寶貴的見解和支持。

在當下對中國新文學現代化進程的探索中，朱教授深刻認識到中國傳統文化的重要性。儘管中國的現代意識與現代化理念已基本確立，但對傳統文化的回顧與審視依然不可或缺。他強調必須將中國文化的精髓與馬克思主義的普遍真理相融合。朱教授表示：「我們不應再盲目追求現代化，現代化的方向必須堅持，同時也要深刻認識到中國文化的根本所在。」他還提到，孔子學院作為國家戰略的重要組成部分，在中國文化國際化進程中發揮了深遠影響。

新時代人文社科的跨學科研究

隨着全球化的深入發展和科技的飛速進步，跨學科研究已成為人文社科領域的重要趨勢。朱教授積極響應這一趨勢，致力於打破傳統學科的界限，整合不同領域的知識和方法，以適應當代社會和科技發展的需求。

朱教授指出：「跨學科研究不僅是學術發展的趨勢，更是時代的需求和技術的挑戰。」他說道，跨學科研究能夠突破傳統學科的界限，整合不同領域的知識和方法，適應當代社會和科技發展的需求。他提到，上世紀80年代的文化熱實際上是跨學科研究的熱潮。當時，學者們開始從社會學、政治學、文化學和心理學等多學科角度解讀文學作品，為人文社科研究帶來了新的視角和方向。朱教授認為，現代文學研究也應超越傳統學科界限，採用跨學科方法，融合社會學、政治學、文化學等多領域的理論和方法，從而全面理解文學作品的社會文化意義。

趙心樹教授：量化社會科學的實踐與反思

趙心樹教授
Professor Xingshu Zhao

趙心樹教授，現任澳大傳播係講座教授，美國北卡羅萊納大學終身教授，著有《媒體的力量》《選舉困境－世界選舉制度與憲政改革批判》《民主與選舉－香港政制改革的回顧與展望》，發表相關學術論文多篇，2009年被提名為中國「長江學者」。

量化社會科學視野下的政治傳播與廣告研究

在對美國政治傳播的研究中，趙心樹教授結合政治學、傳播學和社會學等多學科知識，通過精確的數據分析，揭示了媒體信息如何塑造公眾的政治認知，以及這些認知如何轉化為具體的政治行動。通過量化分析深入探討了媒體如何塑造選民態度和投票行為，揭示了媒體在政治過程中的作用。這不僅為理解政治傳播提供了新的視角，也為國內的政治傳播研究奠定了量化分析的基礎。

趙教授表示：「我特別關注量化研究如何幫助我們更好地理解社會現象，減少社會中的戾氣，並促進人們之間的共贏。」他的著作《媒體的力量》《選舉的困境－民選制度及憲政改革批判》《民主與選舉－香港政制改革的回顧與展望》等，深入分析了媒體如何影響選民的態度和投票行為，為理解民主過程中的公共意見形成提供了新的視角。他強調，未來將繼續深化對量化研

究方法的探索，並將其應用於更廣泛的社會科學領域。趙教授認為，澳大寬鬆的學術氛圍為創新研究提供了肥沃的土壤。

趙教授計劃進一步深化政治傳播和廣告研究，並探索兩者的交叉點。他希望通過跨學科研究，更好地理解媒體在不同的社會和政治背景下的作用。他指出，未來的研究將更加注重量化方法與實際社會問題的結合，尤其是在大數據和人工智能技術快速發展的背景下，他希望開發新的研究工具，以更精確地分析和預測媒體對公眾行為的影響。這不僅為學術界提供新的理論貢獻，也將為政策制定者提供實際的指導建議。

運用量化社會科學方法對中國問題的開創性研究

趙教授在美國完成博士學業後，原計劃博士畢業後立即回國，將所學的量化研究方法應用於中國的社會科學研究。然而，由於當時的政治環境和中美關係的影響，他暫時留在了美國。儘管如此，他從未放棄回國的念頭。

在美國求學和工作期間，趙教授不僅在量化研究方法上取得了顯著的成就，還逐漸萌生了將這些方法應用於中國研究的想法。他意識到，儘管當時中國在該領域的基礎還很薄弱，但隨著改革開放的深入和國家的快速發展，這樣的研究必將大有可為。因此，他始終關注著中國社會科學的發展動態，尋找將所學應用於中國研究的機會。

1994年，趙教授在國內重要期刊上發表了一篇題為《Media Effect Under a Monopoly：The Case of Beijing Economic Reform》的文章。他運用量化方法對資料進行了深入分析，並得出了有價值的結論。這篇文章在國內傳播學界產生了深遠的影響，不僅標誌著量化研究方法在國內社會科學領域的首次成功應用，還為後續的研究提供了重要的參考和借鑒。這也成為趙教授回國計劃中的一個重要里程碑，進一步堅定了他回國的決心，期待將自己的知識和經驗貢獻給中國的社會科學研究事業。

對量化社會科學方法的批判性思考

趙教授回憶，他在70年代末入學時，由於文革的影響，國內的社會科學研究，尤其是量化研究，幾乎是一片空白。直到出國深造，他才接觸到完整的量化研究方法。在美國學習期間，他深刻體會到量化方法的優勢，如提供統一的標準和規範化研究過程。然而，他也敏銳地察覺到了量化方法的潛在缺陷，尤其是對統計顯著性的過度重視，可能導致研究過於簡化，強化了兩分法的思維傾向。這種傾向可能誤導社會科學家、政策制定者甚至整個社會，將世界簡化為黑白兩分的對立面，而忽視了其中的多樣性和複雜性。

趙教授指出，量化方法雖然有其優點，但隨著時間的推移，其缺點可能逐漸凸顯，甚至成為主導。他強調，必須警惕量化方法可能帶來的思維僵化，避免將複雜的社會現象簡單化為二分法。他認為，真正的科學進步應該建立在多元、開放和包容的思維基礎上，而不是盲目追求統計顯著性或形式上的精確。

2024年5月，趙教授在題為《Percentage Coefficient (bp) -- Effect Size Analysis (Theory Paper 1)》的文章開篇指出：世界並非非黑即白，而是連續、多彩、複雜的灰色光譜；人類受限於認知能力，通過創造概念、符號、數學模型等工具將現實簡化為二元對立；這種「非黑即白」的認知框架在工具濫用與互動強化中，形成自我迴圈的選擇性簡化螺旋。

劉建宏教授：跨學科研究與犯罪學的前沿探索

劉建宏教授是澳大實證法學研究中心主任、法學院特聘教授。他的學術轉型之路經歷了從物理學到哲學，再到社會學，最終專注於犯罪學與刑事司法領域。至今，他已公開發表超過100篇SSCI或Scopus文章、220餘篇學術論著（含部分合作作品），出版了31本書籍。他的研究成果在國際上獲得了廣泛認可，包括2016年美國犯罪學學會授予的「弗裡達・艾德勒傑出學者獎」、2018年美國刑事司法學會頒予的「吉哈德. O. W. 米勒傑出學術貢獻獎」，以及亞洲犯罪學學會頒發的「傑出圖書獎」和美國華人社會科學教授協會頒發的「最佳學術出版物獎」等。

劉建宏教授
Professor Jianhong Liu

實證法學，跨學科研究的交響

劉建宏教授的求學之路頗具傳奇色彩。他從物理學起步，歷經哲學、社會學，最終在美國紐約州立大學奧爾巴尼分校獲得犯罪學博士學位。這一系列的學科跨越不僅塑造了他寬廣的學術視野，更為他在國際和比較犯罪學、比較刑事司法等領域的深入研究奠定了堅實基礎。

在採訪中，劉教授分享了他的學術轉變和研究心得。他強調，犯罪學作為一個跨學科領域，需要融合社會學、心理學、法學等多個學科知識。他選擇實證法學作為研究方向，是因為它可以通過數據和分析，更深入地理解犯罪現象和刑事司法制度。在澳大的研究團隊中，劉教授積極推動博士生運用數學公式和最新研究方法，探索法學領域的未知問題。這種跨學科的研究方式不僅提升了團隊的研究水準，也為澳大在國際學術界贏得了聲譽。

「作為77級大學生，跨學科研究是響應社會和國家需求的結果，希望能夠盡自己所能為國家做一點事。」劉教授表示，傳統法學研究需要與時俱進，結合現代科技，特別是大數據和人工智能技術，開拓新的研究視野。他認為，計算法學的興起為傳統法學研究提供了新的機遇，可以通過數據分析揭示法律現象背後的規律，並對法律實踐產生積極影響。「計算法學不僅僅是將AI技術簡單地嫁接到法學研究中，而是要深入挖掘法學數據，提出關於法學領域的一般規律性認識。」劉教授說。

亞洲犯罪學的新範式：關係主義理論

在刑事司法領域，劉教授基於亞洲社會獨特的文化背景，創新性地提出了「關係主義理論」。這一理論深刻挖掘了亞洲社會的核心價值觀，並將其融入刑事司法體系的構建之中，為跨文化刑事司法結果的解釋提供了獨特的視角；它強調依戀家庭和社區、看重榮譽、追求和諧、偏重整體思維等四個基本要素，這些要素不僅反映了亞洲社會的文化特徵，也為刑事司法實踐提供了新的方向。

劉教授提出的「關係主義理論」不僅在學術上取得重大突破，還為亞洲國家的法治建設提供了新視角和方法，強調通過合作而非對抗實現司法公正，契合亞洲社會的文化特點。例如，恢復性司法通過修復犯罪人與家庭、社區的關係，有效降低了再犯率，提升了司法公信力。同時，這一理論注重本土文化適應性，如中國法律中的「天理人情」和印度的社區調解機制，都體現了文化與司法的有機結合。亞洲範式理論揭示了亞洲社會中這些獨特且有效的司法實踐，強調在制定改革方案時應充分考慮各國在經濟、社會和文化上的差異。

2024年3月，劉教授受邀在劍橋大學法學院犯罪學研究所就「關係主義刑事司法理論——範式轉變」進行講座，吸引了來自不同學科的學者、研究人員、政策制定者和從業者等多元化的觀眾。同時，「關係主義刑事司法理論」近期取得重要國際突破——該理論被美國權威學術出版社Routledge編入犯罪學經典教材《The Development of Criminological Thought》（第二版）。這部由查得·波斯克（Chad Posick）編著的教材自2018年首版以來，已成為美國和西方國家犯罪學與刑事司法領域核心教學用書，其修訂版特別增設章節系統闡釋該理論體系。犯罪學學科主流教材中歷史上從未有過包含源於非西方作者的理論內容的先例。這是首例由中國澳門地區學者原創、經西方主流學界認可並納入通用教材的刑事司法理論，標誌著我國在構建自主法學理論體系、推動學術成果國際化傳播、提升全球學術話語權方面取得里程碑式進展，生動踐行了「講好中國故事」的學科建設戰略。

立足澳大 ，放眼世界，打造人文社科研究的新高地

澳門獨特的地理位置和多元文化背景，不僅為學術研究提供了豐富的素材和多樣的視角，也為學術探索開闢了新的視野。在這片獨具特色的土地上，澳大人文社科領域的傑出學者們各展所長：朱壽桐教授深入探討中國文學在現代化進程中的轉型與挑戰，揭示文學如何在時代變遷中保持生命力的路徑；趙心樹教授聚焦於政治傳播與廣告領域，分析媒體在全球化背景下對公眾政治認知和消費行為的影響；劉建宏教授則致力於「計算法學」，將現代化技術應用於法學領域，為澳門的法治建設提供了新的視角和方法。他們的研究不僅促進跨文化交流，也彰顯了澳大在全球化背景下對現代化進程中人文社科問題的深刻洞察和積極應對。

人文社科研究承載著一個地區的歷史與文化，是一個地區未來發展的堅實基石。展望未來，澳大將充分利用這一獨特優勢，持續推動人文社科的發展，深入研究中華現代文明在澳門的發展軌跡，為澳門的多元化發展注入不竭動力和創新活力，推動澳門在全球化時代中綻放更加璀璨的光芒，同時為全球文化交流貢獻澳門智慧。

Professor Shoutong Zhu: Leverage Macao's Unique Strengths, Cherish Heritage, and Embrace the Future

Professor Shoutong Zhu, previously the Director of Research Centre for Humanities in South China, the Director of the Centre for Chinese History and Culture, and a Distinguished Professor at the Faculty of Arts and Humanities at UM, is dedicated to the research of modern Chinese literature and comparative literature. He has a rich academic output, having published 30 personal monographs to date, including *The Divine Light of Dionysus, Emotion: The Poetic Universe of the Creation Society, The Modernisation of Modern Chinese Literature, and The Magic Bed of Tolerance - The Mainstream of 19th Century Literature*. He has also presided over the compilation of 11 books such as *The Chronological History of Macao Literature, One Hundred Thousand Whys of Humanities and Social Sciences, and Modern Chinese Literary Societies and Schools* and has published over 300 academic papers.

Macao's Unique Strengths on Humanities and Social Science Research

朱壽桐教授主編的《澳門文學編年史》
The Chronological History of Macao Literature, edited by Professor Shoutong Zhu

The Chronological History of Macao Literature edited by Professor Shoutong Zhu and co-authored by multiple scholars, is a large-scale literary historical material collection. The book systematically combs through the literary development of Macao from the New Literature Movement to the first half of the 1980s. By collecting scattered documents and identifying historical materials, it provides a systematic historical clue for Macao's literary research, filling the gap in the field of literature sorting, and is hailed as the 'record of Macao's literary

history'. This book is a major research project initiated by the Macao Foundation in 2010 and a component of the National Key Publication Fund. Awarded the First Government Publishing Award by the People's Government of Guangdong Province, it is dedicated to advancing the systematic organisation and research of Macao's literary heritage.

Professor Zhu pointed out that Macao, a historic city full of modern atmosphere, has unique advantages in humanities and social science research. The country's cultural positioning of Macao as 'predominance of Chinese culture with multicultural coexistence' provides rich materials and broad vision for relevant research.

Under the guidance of this cultural positioning, the humanities and social science research of academic institutions such as UM has been successfully carried out and has achieved a series of significant results, with the publication *of The Chronological History of Macao Literature being* a representative example.

Macao, as a window for Sino-Western cultural exchange, has witnessed the collision and integration of different civilisations. This multicultural integration not only provides rich resources and inspiration for academic research but also gives Macao a unique advantage in historical and cultural research, enabling it to deeply explore and inherit the essence of Chinese culture.

Re-examining Chinese Traditional Culture

In the early 1990s, with the advancement of China's reform and opening up policy, modern civilisation, social, and political trends intertwined, and Professor Zhu's work *The Modernisation of Modern Chinese Literature* came into being. He pointed out that the birth of modern Chinese literature was nurtured on the basis of rebellion against old literature and the absorption of Western literary resources. He emphasised that 'modernisation, that is a modernisation of ideological consciousness and concepts, is not just writing in modern language and text.' Through these studies, he hopes to make greater contributions to the academic research and cultural heritage of modern Chinese literature, as well as to provide valuable insights and support for literary research and cultural development in Macao and even globally.

In the current exploration of the modernisation process of modern Chinese literature, Professor Zhu profoundly recognises the importance of Chinese traditional culture. Although China's modern consciousness and modernisation concepts have been basically established, the review and examination of traditional culture are still indispensable. He emphasised the need to integrate the essence of Chinese culture with the universal truths of Marxism. Professor Zhu stated, 'We should no longer blindly pursue modernisation, the direction of modernisation must be adhered to. While we should also profoundly recognise the essence of Chinese culture.' He also mentioned that the Confucius Institute, as an important part of the national strategy, has had a far-reaching impact on the internationalisation of Chinese culture.

Interdisciplinary Research in Humanities and Social Sciences in the New Era

With the in-depth development of globalisation and the rapid progress of technology, interdisciplinary research has become an important trend in the field of humanities and social sciences. Professor Zhu actively responds to this trend, dedicated to breaking down the boundaries of traditional disciplines and integrating knowledge and methods from different fields to meet the needs of contemporary society and technological development.

Professor Zhu pointed out that 'interdisciplinary research is not only a trend in academic development but also a demand of the times and a challenge of technology.' He said that interdisciplinary research can break through the boundaries of traditional disciplines, integrate knowledge and methods from different fields, and meet the needs of contemporary society and technological development. He mentioned that the cultural craze in the 1980s was actually a wave of interdisciplinary research. At that time, scholars began to interpret literary works from the perspectives of sociology, political science, cultural studies, and psychology, bringing new perspectives and directions to humanities and social science research. Professor Zhu believes that modern literary research should also transcend traditional disciplinary boundaries, adopt interdisciplinary methods, and integrate theories and methods from multiple fields such as sociology, political science, and cultural studies to fully understand the social and cultural significance of literary works.

Professor Xingshu Zhao: The Practice and Reflection of Quantitative Social Science

Professor Xingshu Zhao, currently a Chair Professor in the Department of Communication at UM and a tenured professor at the University of North Carolina, has authored several books including *The Power of Media, Plight of Elections – A Critique of the World's Election Systems and the Constitutional Reforms,* and *Democracy and Election — Retrospect and Prospect of Hong Kong's Political Reform.* He has also published numerous academic papers and was nominated as China's Changjiang (Yangtze River) Scholar in 2009.

Political Communication and Advertising Research from the Perspective of Quantitative Social Science

In his research on American political communication, Professor Xingshu Zhao combines knowledge from political science, communication studies, and sociology. Through precise data analysis, he reveals how media messages shape the public's political cognition and how these cognitions are transformed into specific political actions. His quantitative analysis deeply explores how media shapes voter's attitudes and voting behaviour, revealing the role of media in the political process. This not only provides a new perspective for understanding political communication but also lays the foundation for quantitative analysis in domestic political communication research.

Professor Zhao stated, 'I particularly focus on how quantitative research can help us better understand social phenomena, reduce hostility in society, and promote win-win situations among people.' His works such as *The Power of Media, Plight of Elections – A Critique of the World's Election Systems and the Constitutional Reforms,* and *Democracy and Election — Retrospect and Prospect of Hong Kong's Political* Reform provide in-depth analyses of how media influences voter's attitudes and voting behaviour, offering new perspectives for understanding the formation of public opinion in the democratic process. He emphasised that he will continue to deepen his research of quantitative research methods and apply them to a wider range of social science fields in the future. Professor Zhao believes that the open academic environment at UM provides fertile ground for innovative research.

Professor Zhao plans to further deepen his research on political communication, advertising and explore their intersections. He hopes to better understand the role of media in different social and political contexts through interdisciplinary research. He pointed out that future research will place greater emphasis on combining quantitative methods with real social issues, especially in the context of the rapid development of big data and artificial intelligence technologies. He hopes to develop new research tools to analyse and predict the impact of media on public behaviour more accurately. This will not only provide new theoretical contributions to the academic community but also offer practical guidance for policymakers.

Pioneering Research on Chinese Issues Using Quantitative Social Science Methods//

After completing his doctoral studies in the United States, Professor Zhao originally planned to return to China immediately after graduation to apply the quantitative research methods he had learned to Chinese social science research. However, due to the political environment and the state of Sino-U.S. relations at the time, he temporarily stayed in the United States. Despite this, he never gave up the idea of returning to China.

During his studies and work in the United States, Professor Zhao not only achieved significant success in quantitative research methods but also gradually conceived the idea of applying these methods to Chinese research. He realised that although China's foundation in this field was still weak at that time, with the deepening of reform and opening up and the rapid development of the country, such research would surely be very promising. Therefore, he always kept an eye on the development trends of Chinese social sciences, looking for opportunities to apply what he had learned to Chinese research.

In 1994, Professor Zhao published an article titled *Media Effect Under a Monopoly: The Case of Beijing Economic Reform* in a domestic important journal. He used quantitative methods to conduct an in-depth analysis of the data and drew valuable conclusions. This article had a profound impact on the domestic communication studies community, not only marking the first successful application of quantitative research methods in the domestic social science field but also providing important references for subsequent research. This also became an important milestone in Professor Zhao' s plan to return to China, further strengthening his determination to return and contribute his knowledge and experience to China' s social science research.

MEDIA EFFECTS UNDER A MONOPOLY: THE CASE OF BEIJING IN ECONOMIC REFORM*

Xinshu Zhao, Jian-Hua Zhu, Hairong Li, and Glen L. Bleske

ABSTRACT

趙心樹教授關於中國問題研究的文章
Professor Xingshu Zhao' s article on Chinese issues

Critical Thinking on Quantitative Social Science Methods

Professor Zhao recalled that when he entered university in the late 1970s, due to the impact of the Cultural Revolution, social science research in China, especially quantitative research, was almost a blank slate. It was not until he went abroad for further studies that he was exposed to a complete set of quantitative research methods. During his studies in the United States, he deeply appreciated the advantages of quantitative methods, such as providing unified standards and a standardised research process. However, he also keenly perceived the potential shortcomings of quantitative methods, especially the overemphasis on statistical significance, which may lead to oversimplified research and reinforce dichotomous thinking. This tendency may mislead social scientists, policymakers, and even the entire society into simplifying the world into black-and-white opposites, while ignoring the diversity and complexity within.

Professor Zhao pointed out that although quantitative methods have their advantages, over time, their disadvantages may gradually become more prominent and even dominant. He emphasised the need to be vigilant against the potential for quantitative methods to lead to rigid thinking and avoid oversimplifying complex social phenomena into dichotomies. He believes that true scientific progress should be based on a foundation of diverse, open, and inclusive thinking, rather than blindly pursuing statistical significance or formal precision.

In May 2024, at the beginning of his article titled *Percentage Coefficient (bp) -- Effect Size Analysis (Theory Paper 1),* Professor Zhao stated that the world is not black and white but a continuous, colourful, and complex spectrum of grey; humans, limited by their cognitive abilities, simplify reality into binary opposites through the creation of concepts, symbols, mathematical models, and other tools. This 'black-and-white' cognitive framework, when misused and interactively reinforced, forms a self-perpetuating selective simplification spiral.

澳大出版的學術期刊
Academic Journals Published by UM

Professor Jianhong Liu: Interdisciplinary Research and Frontier Exploration in Criminology

Professor Jianhong Liu is the Director of Centre for Empirical Legal Studies and a Distinguished Professor of the Faculty of Law at UM. His academic journey has spanned from physics to philosophy, then to sociology, and finally focusing on criminology and criminal justice. To date, he has published over 100 SSCI or Scopus articles, more than 220 academic works (including some co-authored pieces), and authored 31 books. His research achievements have gained widespread international recognition, including the *Frieda Adler Distinguished Scholar Award* granted by the American Society of Criminology in 2016, the *Gerhard O.W. Mueller Award for Distinguished Scholar* bestowed by the American Society of Criminal Justice in 2018, the *Distinguished Book Award* from the Asian Criminological Society, and the *Best Scholarly Publication Award* presented by the Chinese Sociological Association of America.

Empirical Legal Studies, the Symphony of Interdisciplinary Research

Professor Jianhong Liu' s academic path is quite legendary. Starting from physics, he went through philosophy and sociology before obtaining his Ph.D. in Criminology from the State University of New York at Albany. These disciplinary transitions not only shaped his broad academic vision but also laid a solid foundation for his in-depth research in international and comparative criminology and comparative criminal justice.

In the interview, Professor Liu shared his academic transformation and research insights. He emphasised that criminology, as an interdisciplinary field, requires the integration of knowledge from multiple disciplines such as sociology, psychology, and law. His choice of empirical legal studies as his research direction is because it can provide a deeper understanding of crime phenomena and criminal justice systems through data and analysis. In UM' s research team, Professor Liu actively promotes the use of mathematical formulas and the latest research methods by Ph.D. students to explore unknown issues in the field of law. This interdisciplinary research approach not only enhances the research level of the team but also wins UM a reputation in the international academic community.

'As a student of the year of 1977, interdisciplinary research is a response to the needs of society and the country, hoping to contribute to the nation in my own way,' Professor Liu said. He indicated that traditional legal studies need to keep pace with the times and integrate modern technology, especially big data and artificial intelligence technologies, to open up new research horizons. He believes that the rise of computational law provides new opportunities for traditional legal research, revealing the patterns behind legal phenomena through data analysis and positively impacting legal practice. 'Computational law is not just a simple grafting of AI technology onto legal research but a deep exploration of legal data to propose general regularities in the field of law,' Professor Liu said.

劉建宏教授在馬尼拉舉行的亞洲犯罪學協會第 15 屆年會上發表演講
Professor Jianhong Liu giving a keynote speech at the 15th Annual Conference of the Asian Criminological Society in Manila

The New Paradigm of Asian Criminology: Relationalism Theory

In the field of criminal justice, Professor Liu innovatively proposed the *Relationalism Theory* based on the unique cultural background of Asian societies. This theory deeply explores the core values of Asian societies and integrates them into the construction of the criminal justice system, providing a unique perspective for explaining cross-cultural criminal justice outcomes. It emphasises four basic elements: attachment to family and community, valuing honour, pursuing harmony, and holistic thinking. These elements not only reflect the cultural characteristics of Asian societies but also provide a new direction for criminal justice practice.

Professor Liu's *Relationalism Theory* has not only achieved significant academic breakthroughs but also provided new perspectives and methods for the rule of law in Asian countries. It emphasises achieving judicial justice through cooperation rather than confrontation, which fits the cultural characteristics of Asian societies. For example, restorative justice effectively reduces recidivism and enhances judicial credibility by repairing the relationships between offenders and their families and communities. At the same time, this theory focuses on the adaptability of local culture, such as the 'nature's justice and human feelings' in Chinese law and the community mediation mechanisms in India, which demonstrate the organic integration of culture and justice. The Asian paradigm theory reveals these unique and effective judicial practices in Asian societies and emphasises that reform plans should fully consider the differences in economy, society, and culture among countries.

In March 2024, Professor Liu was invited to give a lecture on *Relationalism Criminal Justice Theory - Paradigm Shift* at the Institute of Criminology at the University of Cambridge. The lecture attracted a diverse audience of scholars, researchers, policymakers, and practitioners from different disciplines. Meanwhile, the *Relationalism Criminal Justice Theory* has recently achieved significant international breakthroughs - the theory has been included in the classic criminology textbook *The Development of Criminological Thought (2nd Edition)* published by the authoritative U.S. academic publisher Routledge. This textbook, edited by Chad Posick and first published in 2018, has become a core teaching book in the field of criminology and criminal justice in the United States and other Western countries. The revised edition specifically added a chapter to systematically explain this theoretical system. Historically, mainstream criminology textbooks have never included theories from non-Western authors. This is the first case of a theory originally created by a scholar from Macao, China, being recognised by the Western mainstream academic community, and included in a general textbook. This marks a milestone in China's efforts to build an independent legal theory system, promote the international dissemination of academic achievements, and enhance global academic discourse power. It vividly implements the disciplinary construction strategy of 'telling China's stories well'.

Rooted at UM, Global Vision: Building a New Hub of Excellence in Humanities and Social Sciences Research

Macao's unique geographical location and multicultural background not only provide rich materials and diverse perspectives for academic research but also open up new horizons for academic exploration. On this distinctive land, the outstanding scholars in the field of humanities and social sciences at UM have harnessed their expertise to advance ground breaking research. Professor Shoutong Zhu deeply explores the transformation and challenges of Chinese literature in the modernisation process, revealing the path for literature to maintain its vitality in the changing times; Professor Xingshu Zhao focuses on the field of political communication and advertising, analysing the impact of media on the public's political cognition and consumer behaviour in the context of globalisation; Professor Jianhong Liu is committed to 'computational law', applying modern technology to the field of law and providing new perspectives and methods for Macao's rule-of-law construction. Their research not only promotes cross-cultural communication but also highlights UM's profound insights and active responses to the issues of humanities and social sciences in the modernisation process under the context of globalisation.

Humanities and social science research embody the history and culture of a region and serves as the solid foundation for its future development. Looking ahead, UM will fully leverage this unique advantage, continue to promote the development of humanities and social sciences, and conduct in-depth studies on the trajectory of modern Chinese civilisation in Macao. This will inject endless momentum and innovative vitality into Macao's development on diversification, enhance Macao's brilliance in the era of globalisation, and contribute Macao's wisdom to global cultural exchanges.

前沿科學・湧新潮

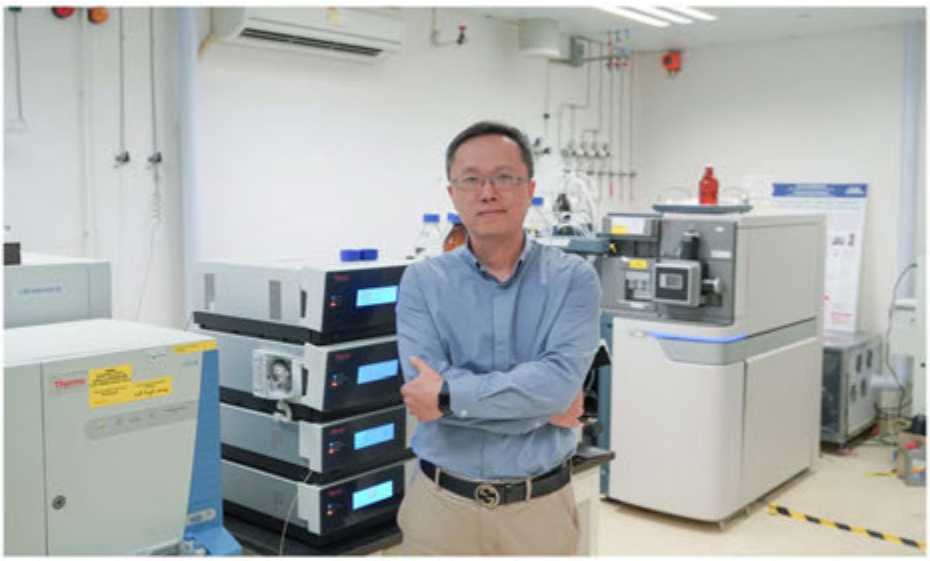
Frontier Science・Embracing the New Wave

李鵬教授：破解中藥質量密碼的探索者

Professor Peng Li: An Explorer Decoding the Quality of Traditional Chinese Medicine

文：原維維、鄧林
Chinese & English Text: Wayne Yuan, Chloe Deng

圖：部分由受訪者提供
Photo: Partially provided by the interviewee



李鵬教授
Professor Peng Li

李鵬教授，澳門中藥研發中心主任、澳門大學中華醫藥研究院副院長、國家藥監局中藥材質量監測評價重點實驗室學術委員會委員、澳門產品優質認證委員會委員、中華中醫藥學會青年委員會常務委員。他致力於中藥質量的系統評價和安全性關鍵技術研究，重點聚焦中藥外源性有害殘留快速檢測創新方法的開發。

Professor Peng Li serves as the Director of the Macao Centre for Research and Development in Chinese Medicine, Deputy Director of the Institute of Chinese Medical Sciences at the University of Macau (UM), Academic Committee Member of the NMPA Key Laboratory for Quality Monitoring and Evaluation of Chinese Medicine (Chinese Materia Medica), Member of the Macao Product Quality Certification Committee, and Youth Committee Member of the China Association of Chinese Medicine. He is dedicated to the development of key techniques for quality control and safety evaluation of traditional Chinese medicine, focusing particularly on the development of innovative methods for rapid determination of exogenous harmful residues in Chinese medicines.

在澳門大學的中華醫藥研究院裡，有一位潛心中藥質量研究二十餘載的學者，他就是李鵬教授。作為澳大中華醫藥研究院首批生物醫藥博士，李鵬教授的科研軌跡不僅折射出澳門中醫藥發展的獨特路徑，更為中醫藥現代化進程貢獻了寶貴的智慧與力量。

At the Institute of Chinese Medical Sciences (ICMS) at UM, Professor Peng Li stands out as a scholar who has dedicated over two decades to researching the quality of Traditional Chinese Medicine (TCM). As one of the first Ph.D. graduates in biomedical sciences from the ICMS, Professor Li' s research trajectory not only mirrors the distinctive development path of TCM in Macao, but has also contributed invaluable expertise and momentum to the modernisation of TCM.

聚焦中藥安全性，探索中藥質量評價的創新策略

李鵬教授（左）與研究團隊進行討論
Professor Peng Li (left) is discussing with his research team

過去十幾年，李教授及其團隊一直致力於中藥質量的系統評價和安全性關鍵技術研究，重點聚焦中藥外源性有害殘留快速檢測創新方法研發。談及為何選擇這一領域，李教授說，在中藥質量研究中，主要包括有效性、安全性、穩定性和可控性幾個環節。其中，安全性是一個重要但相對較少被關注的領域。「上工治未病，安全性乃中醫藥之根基，不可不察。」2014年，他們決定將研究重心轉向這一領域，專注於中藥國際貿易中的安全性關鍵問題研究，主要包括內源性毒性成分的作用評價、外源性有害殘留的快速檢測，以及毒性智能追溯體系的構建。李教授舉例，1992年，比利時婦女服用含有馬兜鈴酸的中藥材減肥，造成腎衰竭事件，引起醫學界注意。防微杜漸，通過科學的檢測方法識別中藥中的有毒成分並監測其發展過程顯得尤為重要。

如何檢測中藥的安全性？尋找毒性「標誌物」成為關鍵。李教授說，毒性標誌物研究不僅有助於精準識別風險成分，為制定限量標準提供依據，而且有利於闡明毒性作用機制，增強臨床監測與預警能力。中藥尤其是中藥複方成分複雜，目前常用的毒性評價方法無法全面分析具體分

子機制，欠缺準確性和客觀性。組學技術的出現可以為中藥毒性及解毒作用提供更有效的研究模式。觀察毒物或解毒相關蛋白的基因類型（基因組）、基因表達（轉錄組學）、蛋白質水準（蛋白質組學）或代謝物含量（代謝組學）等，並基於上述結果提出合理假設，利用分子生物學手段驗證假設，尋找毒性或解毒生物標誌物，可以揭示多組分協同毒性或減毒機制。

李教授舉例，安宮牛黃丸在組方中雖然採用了雄黃，硃砂兩味毒性藥材，但經過中藥理論配伍形成複方，毒性大大降低甚至消失。但對安宮牛黃丸配伍減毒的作用機制還缺乏有效認識。團隊首次利用代謝組學技術深入闡述了安宮牛黃丸配伍解毒的作用機制。通過UPLC/Q-TOFMS技術，鑒定出與硃砂、雄黃肝腎毒性相關的41個內源性代謝產物。通路分析證明這些代謝產物分別歸類於肝、腎靶組織炎症反應相關的甘油磷脂、花生四烯酸、亞油酸、鞘脂、醚酯類代謝途徑。通過分析代謝產物濃度變化情況，發現安宮牛黃丸經過組方配伍，可使其中36個代謝成分恢復至正常小鼠水準。

展望未來，李教授指出，毒性標誌物研究是破解中藥「安全密碼」的核心，通過科學識別與監控風險因子，可在繼承傳統經驗的同時，構建符合現代醫學標準的安全保障體系，對中藥可持續發展至關重要。團隊將整合多組學、AI模型和高通量篩選等技術，加速標誌物發現，同時，開發快速檢測試劑盒或可攜式裝置，以實現毒性標誌物的床旁監測。

「針對行業痛點開發新技術」，助推成果產業化

李教授說，中藥中除了內源性毒性成分，還包括外源性有害殘留，如農藥、重金屬及真菌毒素等。這些物質並非中藥本身所含，而是在種植、加工、儲存等環節中引入。若未能有效控制這些殘留物，將嚴重影響中藥的安全性，長期服用可能損害人體健康。

目前，傳統的檢測方法依賴大型儀器設備，需專業人員在實驗室進行，通常是在產品流通後進行終端檢測。但這種方式難以追溯污染源，造成了過程控制的問題及原材料浪費。因此，開發快速檢測方法顯得尤為重要。「我們的目標是開發一種能夠快速定性和定量檢測外源性有害殘留的方法。初步的定性檢測將識別是否存在污染物，隨後進行定量分析，以確認其含量是否超出相關安全標準。類似於疫情期間的核酸抗原檢測試紙。」李教授說道。

在過去十幾年中，李教授在此領域進行了大量探索，包括參與廣西和四川的相關課題研究，並獲得了國家教育部的二等獎。李教授表示：「我們針對行業痛點開發新技術，目標不僅限於發表學術論文，更希望將研究成果轉化為實際產品，便於廣泛應用於日常生活中。」

自2021年起，澳門中藥研發中心與一家深圳生物公司及深圳市藥檢所建立了合作關係，共同申報廣東省與澳門聯合資助項目。儘管疫情期間遭遇挑戰，影響了產品市場化進程，但他們仍在積極尋求成果轉化機遇。展望未來，李教授說，他們將持續關注行業痛點，通過引入多學科交叉新技術，開發靈敏度更高、操作更便捷、成本更低的快速檢測技術，兼顧產品的應用價值與成本效益，推動中醫藥快速檢測領域的發展。

快速檢測產品研製及成果展覽
Rapid Screening Product Development and Results Exhibition

機遇與挑戰，見證澳門中醫藥的發展

回顧澳門中醫藥的發展歷程，李教授感慨萬千。「從2002年到2010年，我們只用了8年就成功申請獲批了中醫藥領域的第一個國家重點實驗室。」李教授說道。

2002年澳大中華醫藥研究院建院之初，李教授便來此學習。從澳大學生再到澳大老師，回望過去的20多年，李教授不禁感慨良多：「那時的條件比較艱苦，實驗室設在改建的學生宿舍內，設備和設施都比較簡陋。」然而，正是這樣的艱苦環境，激發了李教授和他的同事們迎難而上的決心和毅力。他們不僅在教學上尋求突破，還積極申請科研項目，逐步建立起科研平台。

「除了我們自身的努力，國家對澳門的支持也至關重要。」李教授坦言，中醫藥研究在內地已有深厚的基礎和眾多的研究團隊，但國家仍選擇支持澳門，為澳大提供了建設國家重點實驗室的機會，這一支持成為研究院發展的強大助力。2010年，國家重點實驗室的獲批為研究院的發展注入了新的活力。中藥質量研究國家重點實驗室致力於中藥質量評價的關鍵科學和技術問題，建設完善的中藥質量研發平台，凝聚建設多學科交叉的學術團隊，開展系統的轉化型研究，為中藥創新研發建立科學質量標準，發揮國際輻射交流作用。

在獲批建立國家重點實驗室後，研究院的發展進入快車道。研究項目數量和質量顯著提升，發表的學術論文數量逐年增加，影響力不斷擴大。李教授說：「我們的研究成果逐年增加，年均高水平學術論文發表數量超過三百篇，這在中醫藥領域中實屬不易。」李教授認為，澳門在中醫藥領域具有獨特的優勢。「澳門是一個多元文化交融的城市，擁有國際化的視野和開放的心態。同時，澳門與內地在中醫藥領域有著深厚的合作基礎。」他表示，將充分利用這些優勢，推動澳門中醫藥事業的蓬勃發展。

在傳承的土壤播撒中醫藥創新的種子

在推動澳門中醫藥走向國際化方面，李教授及其團隊也在積極探索。李教授說：「中醫藥的國際化需要考慮市場的實際需求和產品的認可度。東南亞地區因其深厚的華人文化基礎，對中醫藥的接受度相對較高，這為澳門中藥產業的拓展提供了良機。」他認為，馬來西亞、越南和泰國可以成為澳門中醫藥進入東南亞市場的切入點。在與馬來西亞代表的溝通中，他了解到中藥在當地的影響力已拓展至華人以外的族群。他期望，政府部門能與東南亞國家的相關方面洽談合作，未來中藥在澳門註冊後，能夠更便利地進入東南亞市場。

最後，談及對澳大學子的寄語，李教授說，希望大家真正熱愛這個學科，只有真正有興趣，才有動力去做得更好。同時希望大家充分運用澳大的資源，利用在校的有限時間，積極參與各類活動和項目，為未來的發展奠定堅實的基礎。目前許多大型科研設備向學生開放，只需通過培訓和預約即可使用，大家一定要抓住這些寶貴的資源和機會。「苟日新，日日新，又日新。」不懼挑戰，在學術上取得更大成就；勇於創新，為未來的職業發展鋪路。

Focusing on TCM Safety and Innovative Strategies for Quality Evaluation

Over the past decade, Professor Li and his team have been dedicated to developing key techniques for quality control and safety evaluation of TCM, with a particular focus on developing innovative methods for rapid determination of exogenous harmful residues in TCM. Explaining why he chose this field, Professor Li said that the study of TCM quality research mainly involves several aspects: efficacy, safety, stability, and controllability. Among these, safety is an important yet relatively overlooked area. 'Disease prevention is better than cure, and safety is the foundation of traditional Chinese medicine and must not be neglected,' he said. In 2014, they decided to shift their research focus to this area, concentrating on the key safety issues in the international trade of TCM, which mainly includes the evaluation of the effects of endogenous toxic components, the rapid detection of exogenous harmful residues, and the construction of a toxic intelligent traceability system. Professor Li gave an example that in 1992, Belgian women took TCM containing aristolochic acid for weight loss, which caused kidney failure and drew the attention of the medical community. It is particularly important to identify toxic components in TCM and monitor their development process through scientific detection methods to prevent minor issues from becoming major problems.

How can the safety of TCM be assessed? Finding toxic 'biomarkers' has become key. Professor Li said that the research of toxic biomarkers not only helps in accurately identifying risk substances and providing a basis for setting limit standards, but also helps clarify the mechanisms of toxicity and enhance clinical monitoring and early warning capabilities. TCM, especially TCM compound prescriptions, has complex components, and the currently commonly used toxicity evaluation methods cannot comprehensively analyse specific molecular mechanisms, lacking accuracy and objectivity. The emergence of omics technologies can provide a more effective research model for the toxicity and detoxification effects of TCM. Observing the gene types (genomics), gene expression (transcriptomics), protein levels (proteomics), or metabolite content (metabolomics) related to toxins or detoxification-related proteins, and proposing reasonable hypotheses based on the above results, verifying the hypotheses using molecular biology methods, and searching for toxic or detoxification biomarkers can reveal the mechanisms of multi-component synergistic toxicity or detoxification.

Professor Li gave an example that, although Xionghuang (Realgar) and Zhusha (Cinnabaris), two toxic medicinal materials, are used in the formula of Angong Niuhuang pill, their toxicity is greatly reduced or even disappears after being combined according to the theory of TCM to form a compound prescription. However, the mechanism of detoxification by the combination in Angong Niuhuang pill is still not effectively understood. The research team first used metabolomics technology to deeply elucidate the mechanism of detoxification by the combination in Angong Niuhuang pill. By using UPLC/Q-TOFMS technology, 41 endogenous metabolites related to the liver and kidney toxicity of Zhusha (Cinnabaris) and Xionghuang (Realgar) were identified. Pathway analysis showed that these metabolites were respectively classified into the metabolic pathways of glycerophospholipids, arachidonic acid, linoleic acid, sphingolipids, and ether esters related to the inflammatory response of liver and kidney target tissues. By analysing the changes in the concentration of metabolites, it was found that after the combination, Angong Niuhuang pillcould restore 36 of the metabolites to the level of normal mice.

Looking to the future, Professor Li pointed out that the study of toxic biomarkers is the key to cracking the 'safety code' of traditional Chinese medicine. By scientifically identifying and monitoring risk factors, it is possible to build a safety assurance system that meets the standards of modern medicine while inheriting traditional experience, which is crucial for the sustainable development of TCM. The research team will integrate multi-omics, AI models, and high-throughput screening technologies to accelerate the discovery of biomarkers. At the same time, they will develop rapid detection kits or portable devices to achieve point-of-care monitoring of toxic biomarkers.

Developing New Technologies to Address Industry Pain Points and Promote Industrialisation of Results

Professor Li stated that, in addition to endogenous toxic components, TCM also includes exogenous harmful residues, such as pesticides, heavy metals, and mycotoxins. These substances are not inherent to the TCM itself but are introduced during the stages of cultivation, processing, and storage. If these residues are not effectively controlled, they will severely affect the safety of TCM, and long-term consumption may harm human health.

Currently, traditional detection methods rely on large-scale instruments and equipment, which require professional personnel to conduct tests in laboratories, typically performing end-product testing after the products have entered circulation. However, this approach makes it difficult to trace the source of contamination, leading to issues in process control and the waste of raw materials. Therefore, the development of rapid detection methods is particularly important. 'Our goal is to develop a method that can rapidly perform qualitative and quantitative detection of exogenous harmful residues. The initial qualitative detection will identify whether pollutants are present, followed by quantitative analysis to confirm whether their content exceeds relevant safety standards. It is similar to the Rapid Antigen Test package used during the pandemic,' Professor Li said.

Over the past decade or so, Professor Li has conducted extensive exploration in this field, including participating in related research projects in Guangxi and Sichuan Province, and has been awarded the second-prize award by the Ministry of Education of the People' s Republic of China. Professor Li said: 'We develop new technologies targeting the pain points of the industry. Our goals are not limited to publishing academic papers, but also hope to transform research findings into practical products for widespread application in daily life.'

Since 2021, the Macao Centre for Research and Development in Chinese Medicine has established a cooperative relationship with a Shenzhen-based biotech company and the Shenzhen Institute for Drug Control, jointly applying for projects jointly funded by Guangdong Province and Macao. Despite facing challenges during the pandemic that affected the marketisation process of products, they have still been actively seeking opportunities for the transformation of results. Looking to the future, Professor Li said that they will continue to focus on industry pain points, develop more sensitive, convenient, and cost-effective rapid detection technologies by introducing new technologies from interdisciplinary fields. This approach aims to promote the development of the rapid detection field in TCM while taking into account the application value and cost-effectiveness of products.

快速檢測試劑盒
Rapid Screening Kit

Opportunities and Challenges: Witnessing the Development of TCM in Macao

Looking back on the development of TCM in Macao, Professor Li is filled with emotion. 'From 2002 to 2010, it only took us eight years to successfully apply for and obtain approval for the first State key laboratory in the field of traditional Chinese medicine,' said Professor Li.

Since the establishment of ICMS at UM in 2002, Professor Li came here to study. From being a student at UM to becoming a faculty member, looking back on the past 20 years, Professor Li can' t help but feel a great deal of emotion: 'The conditions back then were relatively harsh, with the laboratory located in a converted student dormitory and the equipment and facilities being quite basic.' However, it was this harsh environment that inspired Professor Li and his colleagues to face difficulties with determination and perseverance. They not only sought breakthroughs in teaching but also actively applied for research projects, gradually establishing a research platform.

'In addition to our own efforts, the support from the country for Macao is also crucial.' Professor Li acknowledged that while the research of TCM already has a solid foundation and numerous research teams in mainland China, the country still chose to support Macao, providing UM with the opportunity to build a state key laboratory. This support has become a strong driving force for the development of the institute. In 2010, the approval of the state key laboratory injected new vitality into the institute' s development. The State Key Laboratory of Quality Research in Chinese Medicine is committed to the key scientific and technological issues of quality evaluation of traditional Chinese medicine, building a comprehensive research and development platform for quality of Chinese medicine, gathering a multidisciplinary academic team, conducting systematic transformational research, establishing scientific quality standards for the innovative research and development of traditional Chinese medicine, and playing a role in international exchange.

After the approval to establish the state key laboratory, the development of the institute entered the fast lane. The quantity and quality of research projects have significantly improved, the number of academic papers published has increased year by year, with an expanding impact. Professor Li said: 'The number of our research results has been increasing annually, with an average of over 300 high-level academic paper published each year, which is quite remarkable in the field of traditional Chinese medicine.' Professor Li believes that Macao has unique advantages in the field of TCM. 'Macao is a city where diverse cultures converge, possessing an international vision and an open mindset. At the same time, Macao and mainland China have a solid foundation for cooperation in the field of traditional Chinese medicine.' He stated that he will make full use of these advantages to promote the flourishing development of TCM in Macao.

Sowing the Seeds of Innovation in TCM on the It's Heritage

In promoting the internationalisation of TCM in Macao, Professor Li and his team are actively exploring opportunities. Professor Li said, 'The internationalisation of traditional Chinese medicine needs to consider the actual market demand and the recognition of products. The Southeast Asian region, with its deep cultural foundation of the Chinese community, has a relatively high acceptance of TCM, which provides a good opportunity for the expansion of Macao' s TCM industry.' He believes that Malaysia, Vietnam, and Thailand can serve as the entry points for Macao' s TCM to enter the Southeast Asian market. In communication with Malaysian representatives, he learned that the influence of TCM in the local area has expanded beyond the Chinese community. He hopes that government departments can negotiate cooperation with relevant parties in Southeast Asian countries, so that in the future, TCM can more easily enter the Southeast Asian market after being registered in Macao.

Finally, when talking about his message to the students of UM, Professor Li said that he hopes everyone will truly love this discipline. Only with genuine interest can there be the motivation to do better. He also encourages everyone to fully utilise the resources at the university, make the most of their limited time on campus, actively participate in various activities and projects, and lay a solid foundation for future development. Currently, many large-scale research facilities are open to students, and they can be accessedthrough training and reservation. Everyone must seize these valuable resources and opportunities. 'Strive for innovation and renewal.' He emphasised not to fear challenges and to achieve greater academic accomplishments; be brave in innovation to pave the way for future career development.

引領微電子前沿：高效數據轉換器與集成電路設計的新突破

Leading the Frontier of Microelectronics: New Breakthroughs in High-Performance Data Converters and Integrated Circuit Design

文：關詠瑜、趙怡璋
Chinese & English Text: Christy Kuan, Eva Zhao

圖：部分由受訪者提供
Photo: Partially provided by the interviewee

冼世榮教授
Professor Sai Weng Sin

冼世榮，於2008 年獲得澳門大學電機及電子工程博士學位。他現為澳大微電子研究院副院長（學術），模擬與混合信號超大規模集成電路國家重點實驗室副主任，以及電機及電子工程系副教授，IEEE 高級會員。冼教授專注於高效數據轉換器和電源管理集成電路技術的前沿研究，特別是在無線通信、信號處理、無線傳感器網絡和物聯網等領域取得了卓越的研究成果。他獲得澳門科學技術獎勵「技術發明獎」四次和「特別獎勵」一次，並在施普林格出版了一本專著、擁有12 項發明專利及超過 180 篇高性能數據轉換器和模擬混合信號集成電路領域的學術期刊和會議論文。此外，他還擔任*IEEE Transactions on Circuits and Systems II – Express Briefs*的副主編。

Sai Weng Sin obtained his Ph.D. in Electrical and Electronics Engineering from University of Macau (UM) in 2008. He is currently the Deputy Director (Academic) of the Institute of Microelectronics, Deputy Director of the State Key Laboratory of Analog and Mixed-Signal VLSI, and an Associate Professor in the Department of Electrical and Electronic Engineering at UM. He is also a Senior Member of the IEEE. Professor Sin focuses on cutting-edge research in high-performance data converters and power management integrated circuits, achieving remarkable results especially in wireless communication, signal processing, wireless sensor networks, and the Internet of Things (IoTs). He has received the Technological Invention Award four times and the Special Award once for the Macao Science and Technology Awards. He has published a monograph with Springer, holds 12 invention patents, and has authored over 180 academic journals and conference papers in the field of high-performance data converters and analog and mixed-signal integrated circuits. Additionally, he serves as an associate editor for *IEEE Transactions on Circuits and Systems II – Express Briefs*.

隨著高度數字化時代的到來，人工智能、大數據和物聯網等技術急速發展，市場對通信和物聯網傳感器的需求日益增加，這需要高性能、低功耗的模數轉換器芯片來實現高效的數據處理和傳輸。因此，提升信號轉換的模擬信號處理能力，使其更強、更快、更精準，同時降低芯片功耗並延長電池壽命，是冼世榮教授一直專注的研究目標。

With the arrival of a highly digitalised era, the rapid development of technologies such as artificial intelligence, big data, and the Internet of Things has led to an increasing demand for communication and IoT sensors. This requires high-performance, low-power analog-to-digital converter (ADC) chips to achieve efficient data processing and transmission. Therefore, enhancing the analog signal processing capabilities of signal conversion to make it stronger, faster, and more precise, while reducing chip power consumption and extending battery life, has always been the research focus of Professor Sai Weng Sin.

高效模數轉換器與電源管理：智慧城市的核心驅動力

在現今信號處理和無線通訊系統中，模數轉換器（ADC）和電源管理技術對提升設備性能至關重要。這兩者如同孿生兄弟，相互依賴、協同工作，以實現高性能的模數轉換器，並在高採樣速度和低功耗之間達成理想平衡。模數轉換器能將現實世界的圖像、聲音和無線通訊等模擬信號轉換為數字信號，便於電子設備進行處理和分析。隨著設備功能增多和功耗上升，如何有效管理電源成為一大挑戰。電源管理技術能提高設備的效率和性能，延長電池壽命，減少能耗，滿足現代智慧城市的應用需求。

冼世榮教授便是專注於高性能模數轉換器和電源管理集成電路的核心技術。他和研究團隊致力於研發各種不同架構的模擬數字轉換器，通過算法處理增加有效帶寬，從而提升在移動通訊和物聯網應用中的分辨率。目標是開發高精度、高速度的模數轉換器，以及低功耗自供能的電源管理系統芯片技術。

在模數轉換器方面，高精度和高速度的重要性體現在物聯網和無線通信應用中。冼教授舉例說，家用清潔機器人依賴傳感器採集環境數據，並通過雷達精確偵測障礙物；而無線通信芯片則需要高帶寬來支持數據的高速傳輸。

在電源管理技術方面，電源管理穩壓器可與模數轉換器結合使用，以優化供電性能，提升系統效率和穩定性，並解決因電流驅動產生的紋波問題，實現系統之間的協同優化。此外，電源管理芯片需具備低功耗設計，並支持自供能以採集環境能量，例如來自太陽能或無線電波的能量，從而減少人工更換電池的需求。這些關鍵技術對推動智慧城市的大規模部署發揮了重要作用。

高效模擬芯片技術的產學研合作與應用

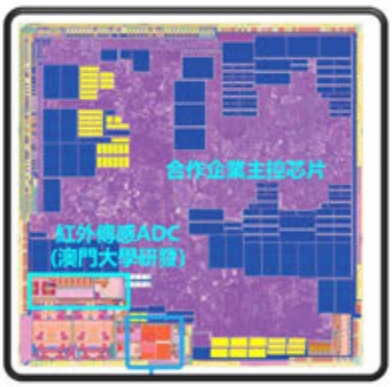
澳門特區政府一直積極推動高新技術的新產業發展。在《澳門特別行政區經濟和社會發展第二個五年規劃（2021-2025 年）》中，提出了「加快構建特色芯片設計、測試和檢測的微電子產業鏈」的目標。

為配合澳門特區政府在芯片領域的發展策略，並加速橫琴粵澳深度合作區（下稱「橫琴合作區」）的產業轉化，冼教授憑藉在高效模數轉換器芯片研發方面的豐富經驗，積極參與產學研結合的項目。他表示，目前相關研發成果已在無線通訊接收芯片、物聯網傳感器以及家用和商用移動機器人的傳感器等多種應用場景中測試及應用，並已達到較高的技術成熟度。

作為相關研究的項目負責人，冼教授代表澳大與橫琴芯片企業合作，聯合珠海澳大科技研究院（下稱「珠研院」）共同申請多項重大研究項目，包括國家重點研發計劃「智能機器人」重點專項，該項目是「十三五」「智能機器人」專項中唯一的芯片項目，對國家人工智能領域的發展具有重要意義。此外，他們的研究項目還獲得了澳門科學技術發展基金與廣東省科技廳聯合科研資助計劃（FDCT-GDST項目）的支持，並實現了省粵港澳科技合作專題及市產業核心和關鍵技術攻關方向的科研項目合作，進一步加強琴澳科技創新聯動，推動科研成果產業化。

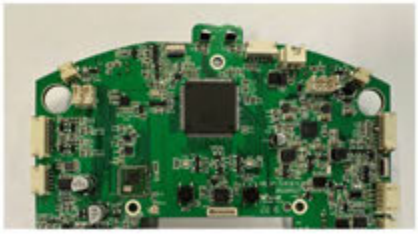
冼教授研發的模數轉換器芯片技術主要應用於家用清潔機器人的傳感器，目前已在機器人主控板中實際使用，獲得業界的認可和產業化應用。其中一個合作項目旨在結合多種傳感器和深度學習技術，利用視覺和激光技術進行定位和導航，開發一種低功耗、低延遲且支持語音交互的模數轉換器芯片，應用於移動機器人的核心模組。此項目將建立一套機器人定位建圖及導航技術芯片化的流程，以有效解決目前機器人芯片在環境建模和定位導航方面性能不佳的問題。

合作企業的主控晶片
(整合澳大的ADC)

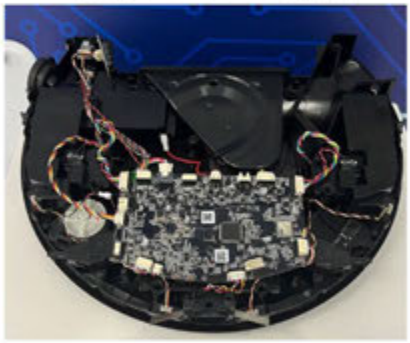


合作企業的機器人導航方案

AM790 光達導航方案



機器人主控電路板



冼世榮教授與橫琴芯片企業研發的家用清潔機器人芯片核心模組
The core integrated circuits of home cleaning robots developed by Professor Sai Weng Sin and the Henqin chip company

隨著研究的深入推進，冼教授在拓展產學研合作的道路上沒有停下腳步。澳大與橫琴芯片合作企業通過珠研院於2023年共建聯合實驗室，並共同完成了國家、省、市的科研項目合作，參與了澳門科學技術發展基金支持的澳門重點研發資助計劃項目。這些努力進一步推動了集成電路與機器人關鍵技術的研究與應用，助力澳大實現科研成果轉化。未來，他們將在傳感器及低功耗模擬電路神經網絡芯片等領域展開更多科研合作。

冼教授在模數轉換器芯片研究上精益求精，不僅參與多項產學研轉化項目，還積極進行跨領域的合作研究。他認為，芯片研發需要融合人工智能技術的機器學習和算法處理，以進一步提升性能並突破研究的關鍵瓶頸。例如，在模擬電路的卷積神經網絡算法中應用模擬技術來進行乘加運算，可以顯著提升芯片的運算性能，超越傳統數字技術的表現。此外，將模擬技術應用於清潔機器人的數據採集，更能顯著增強機器人對物體的識別能力。這些例子體現了跨領域合作對芯片研發的重要性。

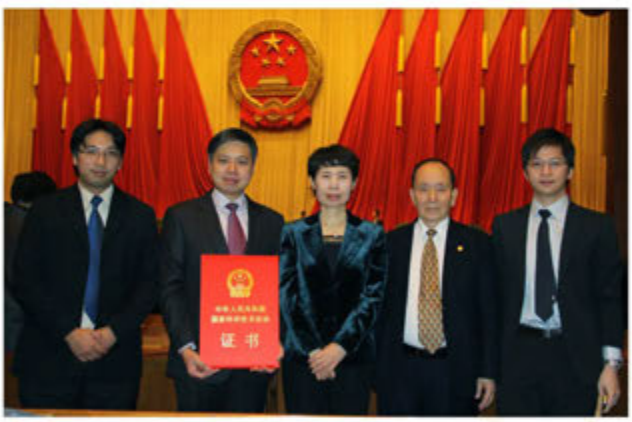
自主創新：澳門模數轉換器芯片的先驅

澳大的微電子芯片發展已有超過二十年的歷史，積累了豐富的模擬芯片設計技術。在模數轉換器芯片尚未被開發的初期，冼教授不畏艱難，持續深入研究這一領域，成為澳門首位開創模數轉換器技術的先驅，這對於在澳門土生土長的冼教授來說更具意義。

回顧冼教授在微電子領域的科研生涯，有幾個關鍵時刻對他展開模數轉換器芯片的研究具有重大影響。2008年，冼教授以博士論文「應用於高速並行管道式模數轉換器芯片之廣義低壓電路設計技術」開展了模擬芯片技術的科研探索。2010 年，澳大被國家科技部授予「模擬與混合信號超大規模集成電路國家重點實驗室」，在國家和澳門特區政府的大力支持下，澳大的模擬芯片設計水平顯著提升並屢獲佳績。同年，由冼教授、余成斌博士和馬許願教授合編的專著《應用於超高速時域交錯模數轉換器的廣義低壓電路設計技術》正式面世，這也是冼教授的第一本專著。

對冼教授而言，2011年是個「雙喜臨門」的重要年份。憑藉出色的研究成果，他與余成斌博士和麥沛然教授合作研發的芯片設計技術，首次為澳門獲得國家科技進步獎二等獎。同年，他的一名博士生研發出高性能低功耗的逐次逼近型ADC，並在IEEE國際固態電路會議（ISSCC）上發表了相關論文，成為該年唯一獲得ISSCC絲綢之路獎的得獎者，該研究成果也在《IEEE固態電路雜誌》(JSSC)上發表。

這些年來，冼教授見證了澳大模數轉換器芯片領域的飛速發展。他在澳大建立了成熟的模數轉換器研究平台，成功實現了自主模數轉換器芯片的研發，擺脫了對進口芯片的依賴，為澳門在該領域的技術突破作出了重大貢獻。



冼世榮教授（左一）、余成斌博士（左二）和麥沛然教授（右一）合作的芯片研發專案獲得國家科技進步獎二等獎
Professor Sai Weng Sin (first from left), Dr. Seng Pan U (second from left), and Professor Pui In Mak (first from right) receiving the second prize of the State Scientific and Technological Progress Award for their collaborative chip R&D project

以科研熱情助力澳門模擬芯片技術發展

冼教授從事科研多年，依然充滿熱情。他常說：「有壓力便是原動力」，這激勵他和團隊在科研中不斷追求卓越。目前，他的研究團隊已擴展至約20名碩士和博士生。他們努力不懈，有時甚至通宵達旦，全因對科研的熱情和使命感，如今已取得豐碩研究成果。

冼教授回憶起一次他的博士生發表芯片設計論文時，評審指出了未曾發現的盲點和瓶頸。團隊在壓力下與時間競賽，不屈不撓地尋求解決方案，重演測試環境，僅用五天便成功解決所有問題。冼教授對團隊的堅毅精神和默契合作深感自豪。

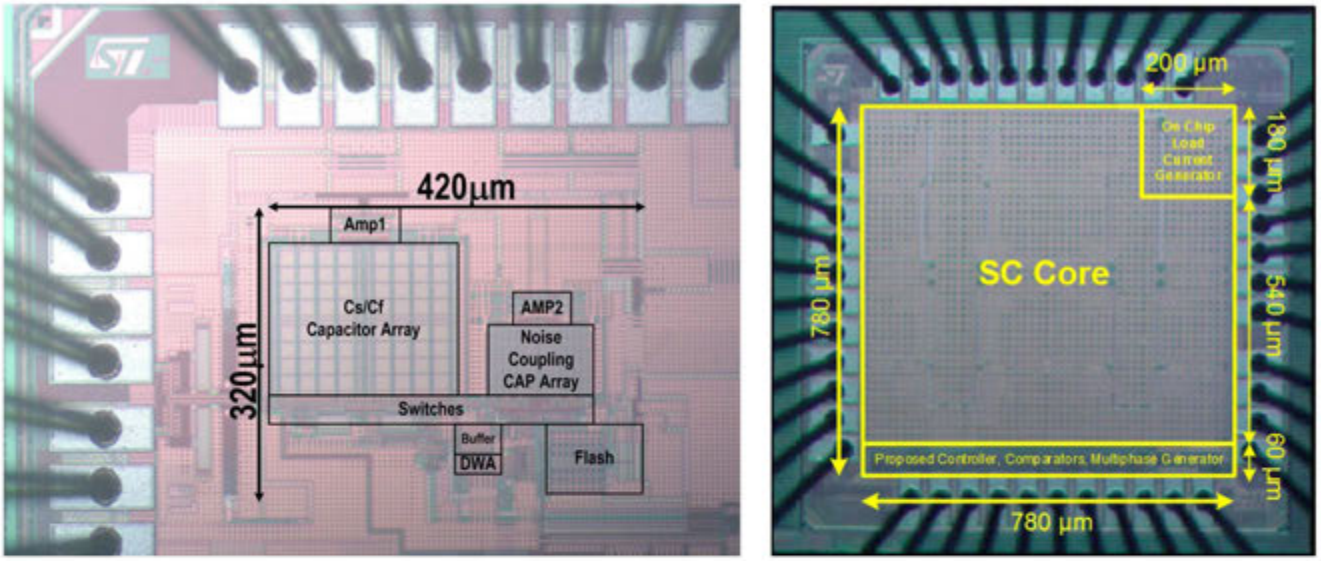
冼教授展望未來，認為在電子化和數字化的時代，模擬芯片技術的重要性不可替代。他指出：「模擬信號是人類感知世界的基礎，而模擬芯片更是所有電子產品的核心技術，因此，芯片研發的最終目標是『為人類服務』。」

冼教授感到十分慶幸，澳門作為國際交流和科技合作的匯聚點，獲得了國家及澳門特區政府在科研資助上的支持，營造了一個自由探索的科研環境，使他和團隊能夠充分運用資源進行研究工作。未來，冼教授將繼續深耕模擬芯片技術領域，為澳門模擬芯片研發和智慧城市物聯網的未來發展貢獻力量。

冼世榮教授與研究團隊參加 IEEE 亞洲固態電路研討會
Professor Sai Weng Sin and his research team attended the IEEE Asian Solid-State Circuits Conference

High-Performance Analog-to-Digital Converters and Power Management: The Core Driving Force of Smart Cities

In today' s signal processing and wireless communication systems, analog-to-digital converters (ADCs) and power management technologies are crucial for enhancing device performance. These two are like twin brothers, interdependent and working in synergy to achieve high-performance ADCs and strike an ideal balance between high sampling speed and low power consumption. ADCs can convert real-world analog signals such as images, sounds, and wireless communications into digital signals for easy processing and analysis by electronic devices. As device functionalities increase and power consumption rises, effective power management has become a significant challenge. Power management technology can improve device efficiency and performance, extend battery life, reduce energy consumption, and meet the application needs of modern smart cities.



高效模數轉換器芯片設計
Design of High-performance Analog-to-Digital Converter Chip

Professor Sin focuses on the key technologies of high-performance ADCs and power management integrated circuits. He and his research team are committed to developing various ADC architectures, leveraging algorithm processing to increase effective bandwidth and enhance chip resolution in mobile communications and IoT applications. The goal is to develop high-precision, high-speed ADCs and low-power, self-sustaining power management system chip technologies.

In terms of ADCs, the importance of high precision and high speed is evident in IoT and wireless communication applications. Professor Sin cited the example of home cleaning robots that rely on sensors to collect environmental data and use radar to precisely detect obstacles. Meanwhile, wireless communication chips require high bandwidth to support high-speed data transmission.

Regarding power management technology, power management voltage regulators can be used in conjunction with ADCs to optimise power supply performance, enhance system efficiency and stability, and address ripple issues caused by the current drive, achieving system-wide collaborative optimisation. Moreover, power management chips need to be designed for low power consumption and support self-sustaining energy harvesting from environmental sources, such as solar energy or radio wave energy, thereby reducing the need for manual battery replacements. These key technologies play an important role in promoting the large-scale deployment of smart cities.

Industry-Academia Collaboration and Application of High-Performance Analog Chip Technology

The Macao SAR Government has been actively promoting the development of new industries in high technology. In Macao's second Five-Year Plan for Economic and Social Development (2021-2025), the goal of accelerating the construction of microelectronics industry chain with distinctive chip design, testing, and inspection was proposed.

To align with the Macao SAR Government's development strategy in the chip sector and accelerate the industrial transformation in the Guangdong-Macao In-depth Cooperation Zone in Hengqin (Cooperation Zone in Hengqin), Professor Sin is actively participating in industry-academia collaboration projects, leveraging his extensive experience in the development of high-performance ADC chips. He stated that the relevant research and development results have been tested and applied in various application scenarios such as wireless communication receiver chips, IoT sensors, and sensors for home and commercial mobile robots, and have achieved a high level of technological maturity.

As the project leader of the relevant research, Professor Sin, on behalf of UM, collaborates with a Hengqin chip company and they have jointly applied for several major research projects with the Zhuhai UM Science and Technology Research Institute (ZUMRI). These include China's National Key R&D Programme focused on key technologies for intelligent robots, which is the only chip project in the 13th Five-Year Plan for intelligent robots and holds significant importance for the development of the national artificial intelligence sector. Additionally, their research projects have been supported by the Joint Research Funding Programme between the Macau Science and Technology Development Fund and the Department of Science and Technology of Guangdong Province (FDCT-GDST project). They have also established collaborations on scientific research projects related to Guangdong-Hong Kong-Macao at the provincial level, as well as key technological breakthroughs at the municipal level. This further strengthens the technological innovation linkage between Hengqin and Macao, and promotes the industrialisation of research results.

The ADC chip technology developed by Professor Sin is mainly applied to sensors for home cleaning robots and has been practically used in robot main control boards, recognised and applied by the indiustry. One of the collaborative projects aims to integrate multiple sensors and deep learning techniques and utilise simultaneous localisation and mapping with visual-LiDAR technology for positioning and navigation. The aim is to develop a low-power, low-latency ADC chip that supports voice interaction for the core integrated circuits of mobile robots. This project will establish a process for chip-based robot localisation, mapping, and navigation technology to effectively address the current performance issues in robot chips related to environmental modelling and localisation navigation.

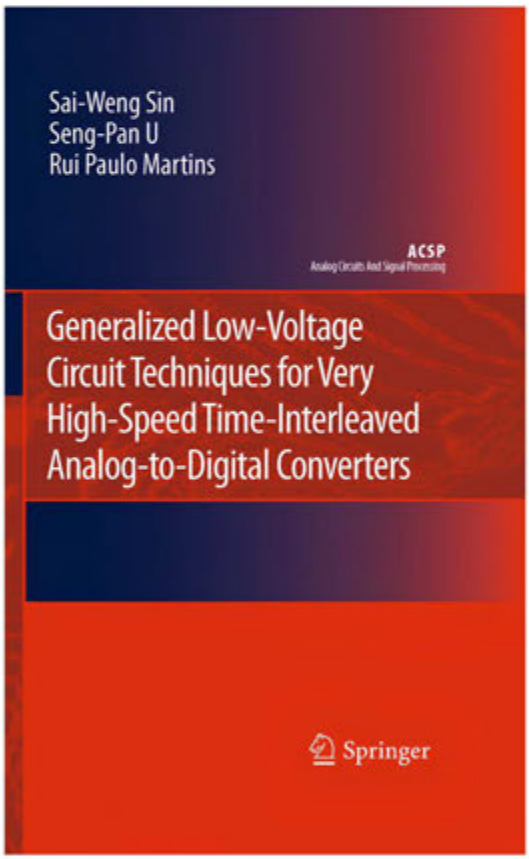
As research progresses, Professor Sin has not stopped expanding industry-academia collaboration. In 2023, UM and a Hengqin chip company jointly established a laboratory through ZUMRI and completed collaborative research projects at the national, provincial, and municipal levels. They also participated in the Funding Scheme for Key R&D Projects supported by the Macao Science and Technology Development Fund (FDCT). These efforts have further promoted the research and application of integrated circuits and robotics, helping UM to achieve the transformation of research outcomes. In the future, they will pursue more scientific research collaborations in areas such as sensors and low-power analog neural network chips.

Professor Sin is dedicated to the advancement of ADC chip research. He is involved in several industry-academia collaborative projects and actively engages in interdisciplinary collaboration. He believes that chip development should integrate machine learning and algorithm processing from artificial intelligence technologies to further enhance performance and overcome key research bottlenecks. For example, applying analog techniques to perform multiply-accumulate operations in the convolutional neural network algorithms for analog circuits can significantly improve the computational performance of chips, surpassing traditional digital techniques. In addition, the use of analog techniques for data collection in cleaning robots can significantly enhance the robots' object recognition capabilities. These examples demonstrate the importance of interdisciplinary collaboration in chip design.

Autonomous Innovation: Macao's Pioneer in ADC Chips

The development of microelectronic chips at UM has a history of over twenty years and has accumulated rich experience in analog chip design. In the early days when ADC chips were not yet developed, Professor Sin, undaunted by the difficulties, continued to work in this field and became the pioneer of ADC technology in Macao, which is particularly meaningful to him as he was born and raised in Macao.

Looking back at Professor Sin's research career in microelectronics, several key moments have significantly influenced his exploration of ADC chips. In 2008, Professor Sin began his research on analog chip technology with his Ph.D. thesis titled 'Generalized Low-Voltage Circuit Design Techniques for Very High-Speed Time-Interleaved Pipelined ADCs'. In 2010, UM was granted the State Key Laboratory of Analog and Mixed-Signal VLSI by the Ministry of Science and Technology of the People's Republic of China. With strong support from the country and the Macao SAR Government, the university's analog chip design capabilities have significantly improved and achieved remarkable results. In the same year, the monograph *Generalized Low-Voltage Circuit Design Techniques for Very-High-Speed Time-Interleaved Analog-to-Digital Converters*, co-authored by Professor Sin, Dr. Seng Pan U, and Professor Rui Martins, was officially published, marking Professor Sin's first monograph.



冼世榮教授與佘成斌博士及馬許顏教授的合作專著
Monograph co-authored by Professor Sai Weng Sin, Dr. Seng Pan U and Professor Rui Martins

For Professor Sin, 2011 stands as the year marked by two significant achievements. Leveraging his outstanding research achievements, he collaborated with Dr. Seng Pan U and Professor Pui In Mak to develop a chip design technology that earned Macao its first-ever second prize of the State Scientific and Technological Progress Award. In the same year, one of his Ph.D. students developed a high-performance, low-power successive approximation ADC that was presented at the IEEE International Solid-State Circuits Conference (ISSCC), making him the only recipient of the ISSCC Silk Road Award that year. This research was also published in the *IEEE Journal of Solid-State Circuits* (JSSC).

Over the years, Professor Sin has witnessed the rapid development of ADC chips at UM. He has established a mature ADC research platform at the university, successfully achieving independent ADC chip development and breaking free from reliance on imported chips. His efforts have made a significant contribution to Macao's technological breakthroughs in this field.

Supporting Macao's Analog Chip Development with a Passion for Research

Despite years of research, Professor Sin remains as passionate as ever. He often says, 'Pressure is the driving force,' which motivates him and his team to continually strive for excellence in their research. Currently, his research group has grown to about 20 masters and Ph.D. students. Their tireless efforts, sometimes working through the night, stem from their passion for research and a strong sense of mission, and have yielded fruitful results.

Recalling an instance when one of his Ph.D. students presented the research on chip design, Professor Sin mentioned that the reviewers pointed out previously unnoticed blind spots and bottlenecks. Under pressure and racing against time, the team persevered, recreated the test environment, and successfully resolved all issues in just five days. Professor Sin takes great pride in his team's resilience and collaborative spirit.

Looking to the future, Professor Sin believes that the importance of analog chip technology is irreplaceable in the electronic and digital age. He points out, 'Analog signals are the foundation of human perception of the world, and analog chips are the core technology of all electronic products. Therefore, the ultimate goal of chip development is to serve mankind.'

Professor Sin feels fortunate that Macao, as a hub for international exchange and scientific cooperation, has received strong support from the country and the Macao SAR Government in terms of research funding. This has created a free and exploratory research environment, allowing him and his team to fully utilise resources for their research work. In the future, Professor Sin will continue to delve into the field of analog chip technology and contribute to the future development of analog chip research and IoT for smart cities in Macao.

冼世榮教授與研究團隊討論
Professor Sai Weng Sin is discussing with his research team

AI+通信：新時代下移動通信的創新研究

AI+Communication: Innovative Research in Mobile Communication in the New Era

文：原維維、鄧林
Chinese & English Text: Wayne Yuan, Chloe Deng

圖：部分由受訪者提供
Photo: Partially provided by the interviewee

馬少丹教授
Professor Shaodan Ma

馬少丹，澳門大學智慧城市物聯網國家重點實驗室副主任，IEEE（國際通信學會）傑出講師。馬少丹教授長期致力於陣列信號處理、多天線無線通信系統收發機優化設計、性能分析、資源配置等方向理論研究及實踐工作，在國際權威期刊及會議上發表學術論文230餘篇。

Professor Shaodan Ma is the Associate Director of the State Key Laboratory of Internet of Things for Smart City (SKL-IOTSC) at the university of Macau (UM) and an Institute of Electrical and Electronics Engineers (IEEE) Distinguished Lecturer. She has long been dedicated to theoretical and practical research in array signal processing, signal processing for multiple-antenna wireless communication systems, transceiver optimisation design, performance analysis, and resource allocation. She has published over 230 academic papers in international authoritative journals and conferences.

在信息時代，移動通信如同一條無形的紐帶，將全球各地的人們緊密相連，讓信息的傳遞變得瞬息可達。在這條紐帶的背後，有一群默默耕耘的科研工作者，他們用智慧和汗水不斷推動著移動通信技術的革新與發展。來自澳大智慧城市物聯網國家重點實驗室的馬少丹教授，便是其中的佼佼者，她致力於研究移動通信領域，探索更高效、更智能的通信方式，為數字世界的順暢運行貢獻著自己的力量。

In the information age, mobile communication acts as an invisible bond, connecting people around the globe and enabling instant information transfer. Behind this bond, there is a group of dedicated researchers who continuously push the boundaries of mobile communication technology. Professor Ma from the SKL-IOTSC at UM is one of the leading figures in this field. She is committed to exploring more efficient and intelligent communication methods to ensure the smooth operation of the digital world.

深耕MIMO技術，做數字世界的「搬運工」

通信從服務人類起步，如今正向萬物互聯拓展。作為數字世界的搬運工，怎樣可以實現萬物互聯並更好地為人們提供服務？這始終是馬教授科研探索的核心動力。20多年來，馬教授始終致力於移動通信領域的研究，核心方向為MIMO（Multiple-Input Multiple-Output）技術，這是一種多入多出的移動通信系統，通過在收發兩端布置多根天線，充分利用空間資源，實現信號的高效傳輸。在移動通信領域，馬教授及其團隊一直在探索如何更高效地利用有限的頻譜資源，MIMO技術的出現，讓他們看到了希望。馬教授說：「通過優化天線佈局與陣列信號處理技術，可在同一時頻資源下實現多用戶並行數據傳輸，大幅提升移動通信系統容量。這一突破性技術已廣泛應用於現代通信系統中。」

然而，隨著MIMO技術規模的不斷擴大，信號處理的複雜度也在急劇上升。在5G、6G時代，MIMO技術的應用場景更加廣泛，天線數量和通信帶寬的維度都在不斷增長，這給信道估計、干擾消除、信號檢測、功率分配等處理環節帶來了前所未有的挑戰。在對MIMO技術的深入研究過程中，馬教授敏銳地察覺到，傳統的信號處理方法在面對如此高維度的數據時，已經顯得力不從心。如何降低通信系統的計算負擔與導頻開銷，實現低複雜度、低開銷的通信，成為他們新的研究課題。

跨學科融合，突破傳統瓶頸

人工智能技術的迅猛發展為馬教授提供了新的思路。她秉持著「當單一學科遇到瓶頸的時候，就嘗試跨學科的方法」的理念，開始嘗試將AI技術引入通信領域，利用AI強大的數據處理能力和模式識別能力，來解決MIMO技術中的一些難題。「AI技術就像是一把神奇的鑰匙，它能夠幫助我們打開傳統方法難以觸及的大門。」馬教授表示，在處理高維信道信息時，可以通過AI技術提取出信號的時空相關性特徵，然後對這些特徵進行壓縮，從而大幅減少信道信息的傳輸開銷。

馬教授深知，現代科學研究已經進入了跨學科融合的時代。她的研究工作涉及通信、人工智能、大數據、物聯網等多個領域，與電子、計算機、土木、海洋、數學、機械機電等多個學科的專家學者開展緊密合作。跨學科研究

像是一場精彩的交響樂，每個學科都是其中的一個音符，只有將它們完美地融合在一起，才能奏出美妙的樂章。馬教授說：「在智慧城市物聯網國家重點實驗室，不同學科的專家學者攜手合作，共同攻克了一個又一個科研難題。」通過跨學科融合，實驗室的研究團隊在多個領域取得了突破性進展。例如，在智慧能源領域，相關的研究團隊結合通信技術、人工智能和大數據分析，開發了一套綜合能源管理平台，實現了對能源的智能調度和優化配置，為實現雙碳目標提供了有力支撐。

大規模天線通信系統
Large-scale Antenna Communication Systems

創新架構設計，拓展通信邊界

除了在陣列信號處理和AI應用方面的突破，馬教授還致力於通信架構的創新設計。針對大規模物聯網海量通信需求及現網功耗和覆蓋等缺陷，以克服傳統智能超表面部署挑戰和乘性衰落為目標，結合分布式天線技術，馬教授帶領團隊提出全新的可重構分布式天線與反射表面架構。

在傳統的通信系統中，天線通常都是固定配置的，而馬教授的這一架構設計，使得天線的布局和功能可以根據實際需求進行靈活調整，能有效解決信道乘性衰落、高維信道估計與控制信令高開銷等難題。她將天線設計成可重構的模塊，既可以作為主動的發射天線，也可以作為反射面來改變信號的傳播方向。這種設計不僅提高了系統的靈活性和適應性，還為實現更複雜的通信與感知功能提供了可能。此外，她還建立了基於可重構分布式天線與反射表面的無線通信系統性能分析理論，構建了無線通信原型驗證平台，並首次應用該架構於通信感知一體化場景，實現高速率通信與室內精準定位，從理論和應用層面揭示了該架構的有效性與發展潛力。

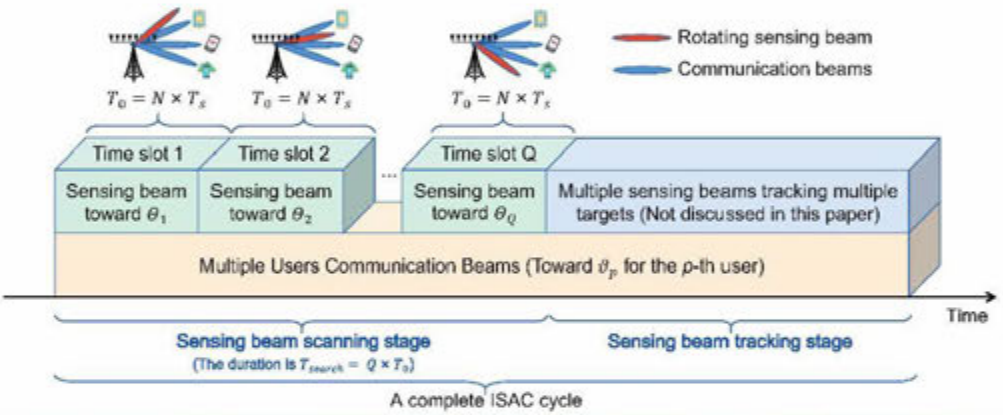
「我們的目標是打造一個更加智能、更加靈活的通信系統，通過這種可重構的架構，我們可以根據不同的應用場景和環境條件，動態調整天線的布局和功能，從而實現最佳的通信與感知效果。」馬教授說。

通感一體化，開啟通信新紀元

在 6G 移動通信系統中，更高的頻段（毫米波乃至太赫茲）、更寬的帶寬、更大規模天線陣列使高精度、高分辨感知成為可能，從而可以在一個系統中實現通信感知一體化（Integrated Sensing and Communication，ISAC），使通信與感知功能相輔相成，開啟了通信研究新紀元。

這也是馬教授研究的一部分，主要利用無線信號來實現通信和感知兩個功能。馬教授表示，以前通信是通信，雷達是雷達，通感一體化技術可以將二者有效的合併，不僅降低硬體成本，而且是支撐當前諸多物聯網業務的一項重要技術。具體而言，為了提升通信效率，馬教授團隊積極引入AI技術，旨在降低通信的計算複雜度和開銷；同時，充分利用多模態信息，特別是通過攝像頭等感測器獲取的視頻感知信息，不僅進行環境感知，還輔助通信過程，極大地支撐了物聯網的多樣化業務需求。

然而，馬教授在通感一體化的研究絕非一日之功。從2022年開始，「通感一體化」方面的文章數量顯著增加，且研究主題逐漸深入廣泛，從最初的IRS輔助通信到複雜的ISAC系統設計、動態環境下的波束管理等；同時，研究逐漸關注於實際應用場景，如車輛間通信、無人機輔助的資料收集等，更加彰顯了通感一體化技術的實用價值。馬教授說：「我們正深入探索通信與感知的一體化，力求在這一領域取得突破性進展。」



ISAC 框架圖來源於 *Dynamic Target Sensing for ISAC Systems in Clutter Environment* 一文
The ISAC framework diagram is adapted from the paper *Dynamic Target Sensing for ISAC Systems in Clutter Environment*

借助國家級科研平台，技術賦能城市創新發展

澳門大學智慧城市物聯網國家重點實驗室自2018年成立以來，以跨學科科研突破與場景化技術落地為核心，成為粵港澳大灣區智慧城市建設的重要引擎。作為全國首個聚焦該領域的國家級平台，實驗室在智慧感知、能源管理、城市安全等領域取得顯著成果，並獲多項殊榮，展現了「產學研」深度融合的創新實力。作為實驗室副主任，馬教授表示，展望未來，實驗室將繼續秉持跨學科、國際化的科研理念，致力於打破學科壁壘，挖掘跨學科潛力，為能源、交通、智慧城市建設等關鍵領域提供創新技術。

面向未來，不斷增強基礎研究與原始創新能力，實現物聯網與人工智能技術突破，並有序推進科研成果轉化與落地應用。隨著6G、人工智能、數字孿生等技術與智慧城市深度融合，澳門正以「小而精」模式，為全球高密度城市提供從「單點智慧」到「系統共生」的中國方案，彰顯科研賦能城市可持續發展的深層價值。在粵港澳大灣區蓬勃發展的浪潮中，澳門憑借其獨特的地理位置和政策優勢，正逐漸成為科研創新的熱土。馬教授說：「澳大是一塊科研淨土，澳門特區政府和學校對科研人員的大力支持，創造了國際化的科研環境和一流的硬件設施，為科研工作提供了肥沃的土壤。」

Delving into MIMO Technology: The‘ Mover’ of the Digital World

Communication originated from serving humanity and is now expanding into the Internet of Everything. As a ‘mover’ in the digital world, Professor Ma has always been motivated by how to better serve people through her research. For over 20 years, Professor Ma has focused on mobile communication research, with a core emphasis on Multiple-Input Multiple-Output (MIMO) technology. This is a mobile communication system with multiple inputs and outputs that utilises multiple antennas at both the transmitter and receiver ends to fully exploit spatial resources and achieve efficient signal transmission. In the field of mobile communication, Professor Ma and her team have been exploring how to more efficiently utilise limited spectrum resources. The emergence of MIMO technology has brought hope. Professor Ma said, ‘By optimising antenna layout and array signal processing techniques, parallel data transmission for multiple users can be achieved within the same time-frequency resources, significantly enhancing mobile communication system capacity. This groundbreaking technology has been widely implemented in modern communication systems.’

However, as the scale of MIMO technology continues to expand, the complexity of signal processing is also increasing rapidly. In the 5G/6G era, as MIMO technology finds increasingly extensive application scenarios with growing antenna arrays and communication bandwidths, unprecedented challenges emerge in channel estimation, interference cancellation, signal detection, and power allocation. During her in-depth exploration of MIMO technology, Professor Ma astutely recognised that conventional signal processing approaches have proven inadequate when confronted with such high-dimensional data. Reducing computational burdens and pilot overhead while achieving low-complexity, cost-efficient communication systems has become their new research frontier.

Interdisciplinary Integration: Breaking Traditional Bottlenecks

The rapid development of artificial intelligence (AI) technology has provided Professor Ma with new ideas. Adhering to the concept that ‘when a single discipline encounters a bottleneck, try interdisciplinary methods’ , she began to introduce AI technology into the field of communication. By leveraging AI’ s powerful data processing and pattern recognition capabilities, she aimed to solve some of the challenges in MIMO technology. ‘AI technology is like a magical key that can help us open doors that traditional methods cannot reach,’ Professor Ma said. When dealing with high-dimensional channel information, AI technology can extract the spatiotemporal correlation features of signals and compress these features to significantly reduce the transmission overhead of channel information.

Professor Ma is well aware that modern scientific research has entered an era of interdisciplinary integration. Her research involves multiple fields such as communication, AI, big data, and the Internet of Things, and she collaborates closely with experts from departments such as electronics, computer science, civil engineering, marine science, mathematics, and mechanical and electrical engineering. Interdisciplinary research is like a magnificent symphony, with each discipline being a note. Only by integrating them perfectly can a beautiful melody be played. Professor Ma said, ‘In the SKL-IOTSC, experts from different disciplines work together to solve one scientific problem after another.’ Through interdisciplinary integration, the research team at the SKL-IOTSC has achieved breakthrough progress in multiple fields. For example, in the field of smart energy, the dedicated research group have developed an integrated energy management platform by combining communication technology, artificial intelligence, and big data analysis, achieving intelligent scheduling and optimisation of energy and providing strong support for achieving carbon goals.

Innovative Architecture Design to Expand Communication Boundaries

In addition to breakthroughs in array signal processing and AI applications, Professor Ma is also committed to innovative communication architecture design. To address the massive communication needs of the Internet of Things and the defects in network power consumption and coverage, and to overcome the challenges of traditional intelligent super-surface deployment and multiplicative fading, Professor Ma and her team have proposed a new reconfigurable distributed antenna and reflective surface architecture, combining distributed antenna technology.

In conventional communication systems where antennas typically maintain fixed configurations, Professor Ma's architecture enables dynamic reconfiguration of antenna layouts and functionalities based on operational requirements. This effectively addresses persistent challenges including multiplicative fading channels, high-dimensional channel estimation, and excessive control signalling overhead. Her design transforms antennas into reconfigurable modules capable of operating as active transmitting/receiving elements or signal-reflecting units that redirect propagation paths. This dual functionality not only enhances system flexibility and adaptability but also unlocks advanced communication-sensing integration capabilities. Additionally, she established a theoretical framework for performance analysis of wireless communication systems based on reconfigurable distributed antennas and reflecting surfaces, developed a wireless communication prototype verification platform, and for the first time, applied this architecture to integrated communication and sensing scenarios, achieving high-speed communication and precise indoor positioning. This demonstrates the effectiveness and potential of the architecture from both theoretical and application perspectives.

'Our goal is to create a smarter and more flexible communication system. Through this reconfigurable architecture, we can dynamically adjust the layout and functionality of antennas according to different application scenarios and environmental conditions to achieve optimal communication and sensing performance,' Professor Ma said.

Integrated Sensing and Communication: A New Era of Communication

In 6G mobile communication systems, the adoption of higher frequency bands (millimetre-wave to terahertz), broader bandwidths, and massive antenna arrays enables high-precision, high-resolution sensing capabilities. This technological evolution facilitates Integrated Sensing and Communication (ISAC) within unified systems, where communication and sensing functions mutually reinforce each other, heralding a new era in telecommunications research.

This paradigm forms a core component of Professor Ma's research, which strategically leverages wireless signals to simultaneously fulfill dual functionalities. 'Historically, communication and radar systems operated independently,' Professor Ma noted. 'ISAC technology effectively converges these domains, not only reducing hardware costs but also serving as a critical enabler for diverse IoT applications.' To enhance

communication efficiency, her team actively integrates AI-driven solutions aimed at minimising computational complexity and operational overhead. Concurrently, they exploit multi-modal data fusion—particularly video-aided environmental perception through camera-equipped sensors—to both augment situational awareness and optimise communication processes. This dual approach significantly bolsters support for heterogeneous IoT service demands.

Professor Ma's ISAC research represents years of systematic exploration. Since 2022, scholarly publications in this field have exhibited exponential growth, with research trajectories evolving from initial Intelligent Reflecting Surface (IRS)-assisted communication prototypes to sophisticated ISAC system designs and dynamic beam management in fluctuating environments. The research scope now increasingly prioritises practical implementations, including vehicle-to-vehicle coordination and drone-assisted data harvesting, thereby demonstrating ISAC's tangible operational value. 'We are delving deeper into the convergence of communication and sensing. Our mission is to achieve transformative breakthroughs that will redefine next-generation network capabilities,' Professor Ma emphasised.

Empowering Urban Innovation through National Research Platforms

Since its establishment in 2018, the SKL-IOTSC at UM has focused on interdisciplinary research breakthroughs and the implementation of scene-based technologies, becoming an important engine for smart city construction in the Guangdong-Hong Kong-Macao Greater Bay Area. As the first national-level platform in this field in China, the laboratory has achieved significant results in smart perception, energy management, urban safety, and other areas, winning multiple honours. These achievements demonstrate the SKL-IOTSC's innovative strength in the deep integration of 'industry-academia'. Looking ahead, the laboratory will continue to adhere to interdisciplinary and international research concepts, breaking down disciplinary barriers and exploring interdisciplinary potential to provide innovative technologies for key fields such as energy, transportation, and smart city construction.

Looking to the future, the SKL-IOTSC will strengthen fundamental research and original innovation, drive breakthroughs in Internet of Things-AI convergence, and systematically advance technology transfer. With the deep integration of technologies like 6G, AI and digital twins into smart cities, Macao is adopting a 'small but refined' model, offering a Chinese solution for global high-density cities that transitions from 'single-point intelligence' to 'systemic symbiosis' and highlights the deep value of scientific research in empowering sustainable urban development. Leveraging its unique geographic and policy advantages within the thriving Guangdong-Hong Kong-Macao Greater Bay Area, Macao is emerging as a hub for scientific innovation. Professor Ma said, 'The University of Macau is a pristine land for scientific research. The strong support from the Macao SAR Government and the university has created an international research environment and first-class hardware facilities, providing fertile ground for scientific research.'

學科融合・開新篇

Interdisciplinary Integration・Pioneering New Chapters

Carlos Silvestre 教授：開拓空中與海洋機器人載具研究

Professor Carlos Silvestre Pioneers Robotics Research for Aerial and Ocean Vehicles

文：原維維
Chinese & English Text: Wayne Yuan

圖：部分由受訪者提供
Photo: Partially provided by the interviewee

Carlos Silvestre 教授
Professor Carlos Silvestre

Carlos Silvestre教授是澳門大學科技學院電機及電腦工程系主任，發表超過190篇期刊論文，並擔任多家知名期刊編委。其研究領域涵蓋線性與非線性控制、估計理論、混合系統、多智能體控制、網路控制系統、慣性導航，以及基於機器學習的自主系統控制與估計方法，尤其聚焦無人海洋與空中載具。

Professor Carlos Silvestre is the Head of the Department of Electrical and Computer Engineering at the Faculty of Science and Technology, University of Macau (UM). He has authored over 190 journal publications and serves on the editorial boards of several top-tier journals. His research interests include linear and nonlinear control, estimation theory, hybrid systems, multi-agent control, networked control systems, inertial navigation, and machine learning-based control and estimation methods for autonomous systems, with a particular focus on unmanned ocean and aerial vehicles.

基礎理論研究應用於空中與海洋機器人載具

Carlos Silvestre教授的研究將先進控制理論與機器人實際應用相結合，重點關注自主空中與海洋載具。2000年於里斯本高等理工學院（IST）取得電機工程與電腦科學博士學位後，他深耕該領域二十餘年，成為公認的權威專家，並成功將卓越的學術研究與創新實用的解決方案相融合。

Silvestre教授表示：「我們開發了最先進的空中載具運輸算法，使無人平台能執行複雜任務，例如通過多旋翼飛行器協作完成重型負載運輸。這些創新可應用於港口起重機自動化等領域。」其團隊核心成果包括非線性濾波技術、機器學習驅動的控制系統，以及確保動態環境中操作魯棒性的感測器融合架構。

基於六至七年發表於頂級期刊的開創性研究成果，團隊計劃通過戰略合作將理論成果轉化為工業應用。其中一項關鍵應用是使用配備超聲波感測器的自主旋翼飛行機器人檢查大型水庫。Silvestre教授解釋道：「載具需精確地沿著預定軌跡飛行，同時與水庫表面保持不間斷地接觸以採集資料——這是一項極具挑戰的任務。」該項目不僅驗證機器人系統的實際能力，並將推動該領域的進一步創新。

澳大的支持與全球合作促進研究突破

Silvestre教授將其深厚的控制理論背景與自主系統工程新挑戰結合，這一戰略舉措使研究團隊躋身開發先進控制與估計技術的前沿，尤其在海洋與空中應用領域。但Silvestre教授坦言，所有成就離不開澳大的支持，以及澳門科學技術發展基金（FDCT）與國家自然科學基金（NSFC）的項目資助。他表示：「澳大擁有卓越設施與研究環境，為我的研究提供了極大便利。」

水下機器人研究的重要推動力之一是澳大即將建設的水下載具測試池（預計2026年完工），該設施將大幅提升自主水下載具的原型設計、算法開發與嚴格驗證流程。團隊現有成果包括淺水檢測自主水面艇——由澳大全自主研發，用於精確海岸測深與污染監測；以及全驅動式遠端操控水下航行器ORVIS，該設備配備多波束聲吶、多普勒速度計程儀（DVL）、高清攝像頭及高精度慣性測量單元（IMU），其搭載的高性能嵌入式計算機與專用AI處理器使其能勝任複雜水下計算任務。此外，團隊正開發兩款專用水下機器人：一款專為海底側掃成像優化，另一款配備機械臂，可在200米深度執行干預任務。

目前正在開發的「水下干預機器人」是FDCT 2024年度獲批項目「探索與海底干預的機器人自主車輛」（RAVESI-0193/2023/RIA3）的一部分，與葡萄牙里斯本大學密切合作，聚焦自主操控算法，彰顯了澳大對推動前沿

ORVIS 自主水下載具
The ORVIS Autonomous Underwater Vehicle

科技研發的責任與擔當。該項目所有系統均為團隊自主設計及建造，即時感測器融合與多智慧體協調等嘗試體現了團隊的嚴謹工程理念；未來項目計劃通過機器學習控制與估計技術，應對嚴苛海底環境的不確定性，推動自主海洋作業的前沿發展。

國際合作層面，Silvestre教授團隊積極與葡萄牙、法國、巴西、美國等頂尖機構合作。他表示：「與全球頂尖大學的協作至關重要。儘管我們重視葡語國家的聯繫，但卓越無國界。」此類國際合作促進了思想、知識與資源的交流，顯著增強了團隊的研究能力。

探索學術「藍海」開展卓越研究

Silvestre教授對海洋機器人的探索始於30多年前在里斯本高等理工學院的碩士階段。職業生涯早期，他便意識到自主海洋機器人在巡航、貨物運輸、海洋研究、搜救任務、油氣勘探與海底電纜鋪設等領域的巨大潛力與多樣性，其在非線性控制與導航系統（2002-2005）的開創性研究使其在該新興領域脫穎而出，為未來的學術與科研貢獻奠定基礎。

談及學術成功， Silvestre教授強調原創性與堅持，「找到研究團隊可脫穎而出的領域，開發獨特方法論，嚴謹發表成果，逐步建立聲譽。」他建議年輕學者培養好奇心，視挑戰為成長機遇，並持續尋求複雜問題的創新解決方案。

他還強調團隊合作、跨學科與國際協作的重要性，「科學研究極少是單打獨鬥，而需跨學科支持。」他表示，傾聽與溝通能力是此過程中的關鍵。最終，他希望年輕學者將工作與社會需求結合，推動技術進步並為人類未來貢獻力量。

助力澳門發展，融入科創浪潮

Silvestre教授強調澳大在培養人才與提升澳門全球科研地位中的關鍵作用。他表示：「我們的博士生持續在全球頂尖機構任職，印證了澳門在尖端研究領域的實力。」

Silvestre團隊致力於將理論與工程實踐結合，其未來項目（如開發用於環境監測與深海干預的先進水下機器人）有望在自主機器人領域產生重大全球影響。通過擴展自主系統在嚴苛環境中的能力，團隊旨在實質性推動科學知識與技術創新。

總括而言，Silvestre教授在自主空中與海洋機器人領域的開創性研究，體現了學術卓越與實踐創新的融合；其致力於應對複雜工業與環境挑戰、推動國際合作、培養青年人才的努力，必將持續提升澳門的科研實力，並引領機器人學領域的進步。

Carlos Silvestre 教授研究團隊
Professor Carlos Silvestre's Research Team

Applying Fundamental Theoretical Research to Aerial and Ocean Robotic Vehicles

無人水面載具
The Autonomous Surface Craft

多架空中載具重型負載運輸
Load transportation by multiple aerial vehicles

Professor Carlos Silvestre' s research bridges advanced control theory and practical robotics applications, with a particular focus on autonomous marine and aerial vehicles. Since earning his Ph.D. degree in Electrical Engineering and Computer Science from Instituto Superior Técnico (IST), Lisbon, in 2000, he has built a distinguished career spanning over two decades. Recognised as a leading expert in his field, Professor Silvestre combines academic excellence with the development of innovative practical solutions.

Professor Silvestre stated, 'We have developed state-of-the-art algorithms for load transportation using aerial vehicles, enabling unmanned platforms to perform complex tasks such as coordinated heavy-load transport through multi-rotorcraft collaboration. These innovations have applications across various domains, including port crane automation.' His team core innovations include nonlinear filtering techniques, machine learning-driven control systems, and sensor fusion architectures for control and estimation that ensure operational robustness in dynamic environments.

After six to seven years of pioneering research published in top-tier journals, the group now aims to translate its theoretical advancements into practical industrial applications through strategic partnerships. One key application involves the inspection of large reservoirs using autonomous rotorcraft aerial robots equipped with ultrasonic sensors. 'The vehicle must precisely follow predefined trajectories while maintaining consistent contact with the reservoir surface to gather accurate data—an exceptionally challenging task,' explained Professor Silvestre. This ambitious project seeks to showcase the practical capabilities of robotic systems and to drive continued innovation in the field.

UM's Institutional Support and Global Collaborations: Catalysing Research Breakthroughs

Professor Silvestre combines his strong background in control theory with the new challenges of autonomous systems engineering, this strategic move establishing his research group at the forefront of developing advanced control and estimation techniques for autonomous robotic platforms, particularly in marine and aerial applications. However, he admitted that all these achievements were inseparable from the support of the UM, as well as the project funding from the Science and Technology Development Fund (FDCT) and the National Natural Science Foundation of China (NSFC). He said that the UM has excellent facilities and a research environment that facilitate his research.

A key factor driving advancements in underwater robotics research is the planned construction of a dedicated underwater vehicle testing tank at UM, scheduled for completion in 2026. This facility will greatly enhance the prototyping, algorithm development, and rigorous validation of autonomous underwater vehicles. It builds on the team's existing achievements, including the shallow-water inspection autonomous surface craft—an in-house development at UM for precise coastal bathymetry and pollution monitoring, and the ORVIS vehicle, a fully actuated autonomous underwater vehicle with remote operation capabilities—ORVIS is equipped with a multibeam sonar, Doppler velocity log (DVL), high-definition camera, and high-grade inertial measurement unit (IMU). It is powered by a high-performance onboard embedded computer and a dedicated AI processor, making it suitable for computationally demanding underwater missions. The research group is also developing two specialised underwater robots: one optimised for high-resolution side-scan imaging of the seabed, and another featuring a robotic arm capable of performing intervention tasks at depths of up to 200 metres.

The underwater intervention robot, currently under development under the FDCT-funded RAVESI project (0193/2023/RIA3) in collaboration with the University of Lisbon, Portugal, focuses on autonomous manipulation algorithms, and highlights UM's strong commitment to research and innovation. All systems are conceived, designed, and built in-house. The project addresses complex challenges such as real-time sensor fusion and multi-agent coordination, demonstrating the team's rigorous engineering approach. Future initiatives will push the boundaries of autonomous marine operations through machine learning-based control and estimation, enabling robust performance in the uncertain and demanding conditions of the underwater environment.

Internationally, Professor Silvestre's team actively collaborates with prestigious institutions across Portugal, France, Brazil, the USA, and beyond. 'Collaboration with leading global universities is vital. Although we greatly value our connections with Portuguese-speaking countries, excellence transcends borders,' stated Professor Silvestre. Such international partnerships encourage the exchange of ideas, knowledge, and resources, significantly enriching the team's research capabilities.

Navigating Academic 'Blue Oceans' and Research Excellence

Professor Silvestre's work on marine robotics began over 30 years ago during his master's studies at IST in Lisbon. Early in his career, he identified the significant potential and versatility of autonomous ocean robotics in diverse fields such as patrol operations, cargo transport, marine research, search and rescue missions, oil and gas exploration, and submarine cable installation. His pioneering research on nonlinear control and navigation systems (2002-2005) distinguished him in a developing area, laying a robust foundation for his future academic and research contributions.

2006 年於葡萄牙塞辛布拉參與歐洲項目 GREX 測試的國際團隊
Tests in Sesimbra, Portugal in 2006, as part of the European Project GREX with an international team.

When asked about achieving academic success, Professor Silvestre emphasised originality and persistence. 'Identify a niche where your research group can excel, develop distinctive methodologies, publish rigorously, and steadily build recognition,' he advised. He encouraged young researchers to nurture their curiosity, embrace challenges as opportunities for growth, and consistently pursue innovative solutions to complex problems.

Professor Silvestre also emphasised the importance of teamwork and interdisciplinary, and international collaboration. 'Scientific research is rarely a solo endeavour but requires cross-disciplinary support,' he said. Listening and communication skills are crucial for success in this process. Ultimately, he hopes that young researchers will align their work with societal needs, driving technological progress and contributing to humanity's future.

Driving Macao's Progress through Science and Technology Innovation

Professor Silvestre emphasised UM's crucial role in nurturing talent and enhancing Macao's global research profile. 'Our Ph.D. graduates consistently secure positions at top institutions worldwide, underscoring Macao's strength in advanced research,' he remarked.

He and his team are dedicated to combining theoretical rigor with practical engineering impact. Their upcoming projects, such as developing advanced underwater robots designed for environmental monitoring and deep-sea interventions, are expected to have significant global influence in autonomous robotics. By extending the capabilities of autonomous systems in challenging environments, the team aims to substantially advance scientific knowledge and technological innovation.

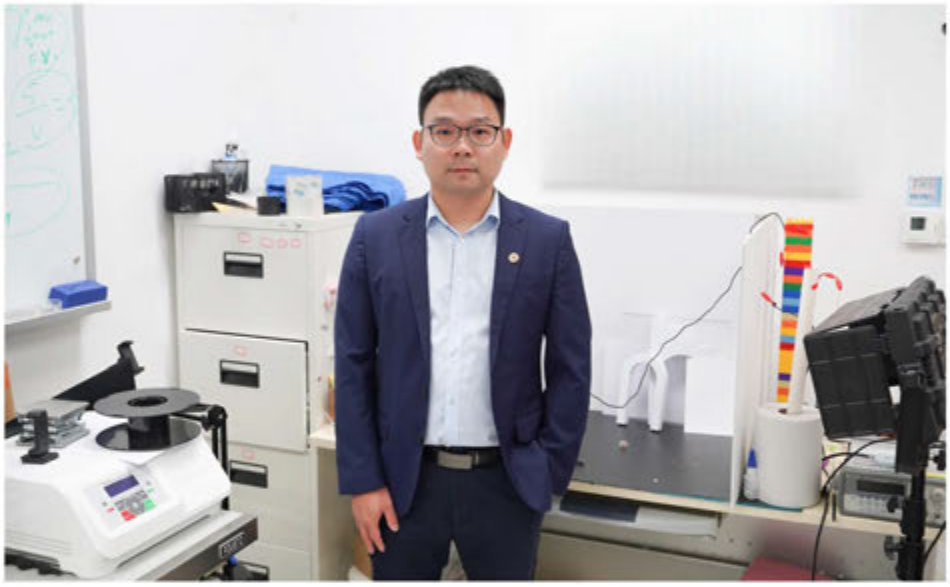
In conclusion, Professor Silvestre's pioneering research in autonomous robotics with application to underwater and aerial vehicles exemplifies the integration of academic excellence with practical innovation. His commitment to tackling complex industrial and environmental challenges, promoting international collaboration, and mentoring young talent continues to enhance Macao's research standing and drive advancements in the field of robotics.

鍾俊文教授：探索柔性機電的無限可能

Professor Junwen Zhong: Exploring the Infinite Possibilities of Flexible Electromechanical System

文：原維維、鄧林
Chinese & English Text: Wayne Yuan, Chloe Deng

圖：部分由受訪者提供
Photo: Partially provided by the interviewee



鍾俊文教授
Professor Junwen Zhong

鍾俊文教授現為澳門大學科技學院機電工程系助理教授、人工智能與機器人研究中心成員。主要研究方向為柔性機電系統，涵蓋柔性機器人、傳感器與執行器的開發。其研究屢獲國際認可：2022年當選國際先進材料協會會士，2023年榮獲該協會科學家獎章，突顯其在柔性機電領域的學術影響力。

Professor Junwen Zhong is currently an Assistant Professor in the Department of Electromechanical Engineering of the Faculty of Science and Technology, University of Macau (UM), and a member of the Centre for Artificial Intelligence and Robotics. His primary research focus is on flexible electromechanical system, including the research and development of soft robotics, sensors, and actuators. His research has repeatedly received international recognition: he was elected as a Fellow of the International Association of Advanced Materials (IAAM) in 2022, and he was honoured with the IAAM Scientist Medal in 2023, highlighting his academic influence in the field of flexible electromechanical system.

當智能手套的振動器傳來遠方友人的溫度，當電子昆蟲在坍塌廢墟中探測生命跡象，澳大科技學院鍾俊文教授的實驗室裡，柔性機電系統正悄然打破虛實邊界。這位機電工程系助理教授，以「讓虛擬交互擁有真實觸感」為使命，帶領團隊在可穿戴技術與微型機器人領域開疆拓土。

When the vibrator of a smart glove conveys the warmth of a friend far away, and when electronic insects detect signs of life in a collapsed ruin, flexible electromechanical systems are quietly breaking the boundaries between the virtual and the real in Professor Junwen Zhong's laboratory at UM. As an Assistant Professor in the Department of Electromechanical Engineering, he is committed to the mission of 'bringing real tactile sensations to virtual interactions', leading his team to explore new frontiers in wearable technology and microrobots.

從視頻會議到觸覺革命

「2016年視頻會議時，我突然意識到，屏幕那端的人明明近在咫尺，卻連一次真實的握手都無法傳遞。」鍾教授回憶起研究初衷。正是這份對「觸覺缺失」的洞察，催生了智能手套的雛形——通過分佈式傳感器與振動驅動器的協同，將動作數據轉化為觸覺信號。

鍾教授的研究重點在於開發基於高性能駐極體和壓電駐極體聚合物的柔性電機傳感器，這些自供電的傳感器在低驅動電壓下實現了高分辨率的低壓檢測極限，並在惡劣環境中展現出優異的穩定性，特別適用於監測人類生理信號。透過可穿戴的觸覺傳感器，使用者在虛擬環境中能夠獲得更真實的觸感體驗，從而提高沉浸感。目前，鍾教授研製的機械振動驅動器，能夠在低驅動電壓下提供大輸出力，向人類皮膚傳遞多模態觸覺回饋，他研發的智能手套和智能衣服，讓身處不同地方乃至千里之外的兩個人能夠體驗到握手、觸摸甚至擁抱的感覺。

鍾教授及其團隊正全力以赴，繼續探索柔性機器人和可穿戴技術的無限潛力。但研究面臨著兩個主要挑戰：一方面是基礎研究的深度，另一方面是應用研究的實用性。在基礎研究方面，他們需要在器件構造的底層機理上進行創新。例如，在可穿戴技術中，傳感信號與驅動信號之間的協同度不足，如何高效地減少信息損失並確保信號的保真度，這需要在軟硬件的底層進行構建。此外，微型機器人也面臨著挑戰，如何提供更強大的驅動方式以及節省能源的通信和驅動方案，因為這些機器人本身體積小、搭載的器件有限，必須在高效協同工作方面尋求創新。

鍾教授表示，在應用研究方面，必須重視實用性和可靠性。目前的研發成果要實現市場化，仍需探索大規模的低成本製造方法，尤其是在可穿戴設備和微型機器人的可靠性提升方面。「這一過程中，與國際合作和同行交流至關重要。最近我參加學術交流，發現同行們大多選擇了一條清晰的研究路徑，這給我們的研究也提供了一點方向。」鍾教授說道。

柔性機電的極限挑戰

此外，鍾教授的研究還延伸至柔性微型機器人的開發，這些機器人模仿自然界中的生物，能在複雜環境中進行探測。例如，在地震後的災後救援中，這些電子昆蟲能夠進入傳統儀器無法到達的區域，尋找生命跡象，為救援行動提供重要信息。同樣，在城市的管道系統中，這些微型機器人可以及時發現潛在的危險，如洩漏等問題，保障城市的安全。

鍾教授補充道，「我們最近做了一個很有意思的水面機器人，我們把它做成樹葉一樣，然後它就可以分佈在水面上；作為一個新環境信號的偵測，必要的時候它還可以進行運動，機動到某個特定的位置去進行待命。」

水面機器人
Aquatic Robot

跨學科研究服務澳門多元發展

在倡導多元融合發展的今天，跨學科研究已成為推動科技創新和社會進步的重要力量。鍾教授深知這一點，他的研究涵蓋物理、化學、材料科學和電子機械等多個領域。他認為，個人知識的有限性使得團隊合作變得尤為重要。他不僅尋求與自己專業領域不同的合作夥伴，還希望能與那些在其專業內具有豐富經驗的同行合作，以實現知識的互補和突破性創新。這種跨學科的合作不僅能加速成果的產出，還能為不同領域的研究者帶來新視角和靈感。

他表示，澳門因其獨特的地理和文化優勢，為研究者提供了良好的合作氛圍。這也讓澳大在國際合作方面有著良好的窗口，吸引了眾多外部機構的合作意願。他與多所國際知名大學保持著密切的合作關係，進一步加強了學校在國際合作方面的優勢。他提到，澳門特區政府正在推動「1+4」適度多元發展策略，這為新材料和大健康等領域的研究提供了支持和資源。鍾教授相信，透過跨學科的合作，他們能夠在這片特別的土地上，培養出創意和應用的新事物，為澳門的發展注入新的活力。

在狂飆時代守護人性的溫度

面對AI技術的倫理困境，鍾教授展現出罕見的人文關懷。他認為，人工智能對隱私權的侵犯卻是一個不容忽視的問題，隨著信息收集的日益普遍，如何確保個體的自主性和隱私不被少數人所控制，成為亟待解決的關鍵。當前，人工智能仍處於一個「野蠻生長」的階段，迫切需要建立合理的規範體系，以平衡數據利用與個人隱私之間的關係。

他更將中國哲學融入技術架構，指出正如中國的中庸之道所強調的，找到這一平衡點是更高層面需要深思的問題。未來5至10年，隨著技術的成熟和倫理限制的逐漸嚴格，科研界必須在推動技術進步的同時，承擔起相應的社會責任，確保人工智能的發展符合人類的長遠利益。

在科研淨土培育未來

提及未來的研究方向，鍾教授說，他的研究將著重於微型機器人的多功能性和可穿戴技術的工業應用。在微型機器人方面，他希望機器人能實現全地形的覆蓋能力，包括水面和空中，甚至在太空探索中發揮作用。這些柔性的小型機器人將能夠在各種環境中執行任務，例如進行太空站的維修等，這不僅是技術上的挑戰，更是對他們創新能力的考驗。在可穿戴技術方面，他更傾向於將其應用於工業場景，例如數字孿生技術。鍾教授說，最近，他們與核電行業的專家進行了接觸，他們面臨著高昂的核事故模擬訓練成本，因為模擬訓練不可能真的製造核事故出來。「我們的目標是協助建立一套集成聲學、光學和觸覺的系統，讓培訓過程更加真實。」

「路漫漫其修遠兮，吾將上下而求索。」鍾教授說，總之，面對這些挑戰，他和團隊始終選擇往高處走，衝破束縛。他們堅信，對柔性機器人的研究不僅是科學技術上的探索，更是對未來智能社會的一份積極貢獻。

最後，鍾教授鼓勵澳大學子珍惜這樣一個充滿機遇的學術環境。他說，人生中能有幾年的時間靜心從事科研的機會實屬難得。希望大家珍惜這片學術的「世外桃源」， 充分利用學校的資源，在這個特殊的環境中，深入探索自己的興趣與潛力，努力實現突破。每一份微小的努力終將匯聚成改變的力量，推動個人與社會的共同進步。

From Video Conferencing to a Tactile Revolution

'In 2016, during a video conference, I suddenly realised that although the person on the other side of the screen was seemingly close, we couldn't even share a real handshake,' Professor Zhong recalled the origin of his research. It was this insight into the 'absence of touch' that gave birth to the prototype of the smart glove—through the collaboration of distributed sensors and vibration actuators, the motion data is converted into tactile signals.

Professor Zhong's research focuses on developing flexible electromechanical transducers based on high-

機械振動驅動器
Mechanical Vibration Actuators

performance electret and piezoelectric electret polymers. These self-powered sensors achieve high-resolution low-voltage detection limits with low driving voltage and demonstrate excellent stability in harsh environments, making them particularly suitable for monitoring human physiological signals. Through wearable tactile sensors, users can experience a more realistic tactile sensation in virtual environments, thereby enhancing immersion. Currently, the mechanical vibration actuators developed by Professor Zhong can provide large output forces with low driving voltage, delivering multimodal tactile feedback to human skin. The smart gloves and smart clothing he has developed allow two people in different places or even thousands of miles away to experience the sensations of shaking hands, touching, and even hugging.

Professor Zhong and his team are fully committed to continuing to explore the infinite potential of flexible robots and wearable technology. However, the research faces two main challenges: the depth of basic research and the practicality of applied research. In terms of basic research, they need to innovate at the underlying mechanism of device construction. For example, in wearable technology, the lack of coordination between sensing signals and driving signals leads to inefficient information loss and the need to ensure signal fidelity. This requires construction at the hardware and software levels. In addition, micro-robots also face challenges, such as how to provide more powerful driving methods and energy-saving communication and driving solutions. These robots, being small in size and limited in the devices they can carry, must seek innovation in efficient collaborative work.

Professor Zhong noted that in applied research, practicality and reliability must be emphasised. To achieve marketisation, current research results still need to explore large-scale, low-cost manufacturing methods, especially in improving the reliability of wearable devices and micro-robots. 'In this process, international cooperation and peer exchanges are crucial. Recently, I attended an academic exchange and found that most peers have chosen a clear research path, which also provides some direction for our research,' Professor Zhong said.

The Ultimate Challenges of Flexible Electromechanical System

In addition, Professor Zhong' s research extends to the development of soft micro-robots that mimic natural organisms and can conduct exploration in complex environments. For example, in post-earthquake disaster relief, these electronic insects can enter areas inaccessible to traditional instruments to search for signs of life and provide vital information for rescue operations. Similarly, in urban pipeline systems, these micro-robots can detect potential dangers such as leaks and ensure the safety of the city.

Professor Zhong added, 'We recently developed an interesting aquatic robot. We designed it to look like a leaf so that it can be distributed on the water surface. As a new environmental signal detector, it can also move to a specific location when necessary to remain on standby.'

Interdisciplinary Research for Macao's Development on Diversification

In today's context of advocating development on diversification and integration, interdisciplinary research has become an important force in driving technological innovation and social progress. Professor Zhong is well aware of this, and his research covers multiple fields, including physics, chemistry, materials science, and electromechanics. He believes that the limitations of individual knowledge make teamwork particularly important. He not only seeks partners from different professional backgrounds but also hopes to collaborate with peers who have rich experience in their fields to achieve complementary knowledge and breakthrough innovations. This interdisciplinary cooperation can not only accelerate the output of results but also bring new perspectives and inspiration to researchers in different fields.

He noted that Macao's unique geographical and cultural advantages provide a good collaborative atmosphere for researchers. This also allows UM to have a good window for international cooperation, attracting many external institutions to collaborate. He maintains close collaborative relationships with many internationally renowned universities, further strengthening the university's advantages in international cooperation. He mentioned that the Macao SAR Government is promoting the '1+4' strategy for appropriate economic diversification, which provides support and resources for research in new materials and the great healthcare sector. Professor Zhong believes that through interdisciplinary cooperation, they can cultivate creativity and new applications on this unique land and inject new vitality into Macao's development.

Guarding the Warmth of Humanity in an Era of Rapid Development

Facing the ethical dilemmas of AI technology, Professor Zhong shows rare humanistic concern. He believes that the infringement of privacy by artificial intelligence is a problem that cannot be ignored. With the increasing prevalence of information collection, how to ensure the autonomy and privacy of individuals from being controlled by a few people has become a key issue that needs to be solved urgently. Currently, artificial intelligence is still in a stage of 'wild growth', and there is an urgent need to establish a reasonable regulatory system to balance the use of data with personal privacy.

He further integrates Chinese philosophy into the technological framework, pointing out that, as emphasised by the Doctrine of the State of Equilibrium and Harmony in Chinese philosophy, finding this balance is a higher-level issue that requires deep contemplation. In the next 5 to 10 years, as technology matures and ethical restrictions become stricter, the scientific community must take social responsibility while promoting technological progress to ensure that the development of artificial intelligence is in line with the long-term interests of humanity.

Cultivating the Future in the Pure Land of Research

Mentioning future research directions, Professor Zhong said that his research will focus on the multifunctionality of micro-robots and the industrial application of wearable technology. In terms of micro-robots, he hopes that robots can achieve full-terrain coverage, including water surfaces and airspace, and even play a role in space exploration. These flexible micro-robots will be able to perform tasks in various environments, such as repairing space stations, which is not only a technological challenge but also a test of their innovation capabilities. In terms of wearable technology, he is more inclined to apply it to industrial scenarios, such as digital twin technology. Professor Zhong said that recently, they have been in contact with experts in the nuclear power industry, who face high costs for nuclear accident simulation training, as it is impossible to actually create nuclear accidents for simulation purposes. 'Our goal is to help establish an integrated system of acoustics, optics, and touch to make the training process more realistic.'

'Although the journey is endless and faraway, I still want to pursue the truth in the world,' Professor Zhong said. In summary, facing these challenges, he and his team always choose to aim higher and break through constraints. They firmly believe that research on soft robots is not only a scientific and technological exploration but also a positive contribution to the future intelligent society.

Finally, Professor Zhong encouraged students at UM to cherish this academic environment, which is brimming with opportunities. He remarked that the chance to devote a few years to research with a tranquil mindset is truly rare in one's life. He urged everyone to treasure this academic 'paradise', fully utilise the university's resources, and in this unique setting, delve deeply into their interests and potential, striving to achieve breakthroughs. Every small effort will eventually converge into a powerful force for change, propelling both individual and societal progress.

鍾俊文教授和研究團隊
Professor Junwen Zhong and His Research Team

Joseph Dexter 教授：數據科學的多語境探索之路

Professor Joseph Dexter: The Multi-Contextual Research of Data Science

文：原維維、鄧林
Chinese & English Text: Wayne Yuan, Chloe Deng

圖：部分由受訪者提供
Photo: Partially provided by the interviewee

Joseph Dexter 教授
Professor Joseph Dexter

Joseph Dexter教授是澳門大學協同創新研究院的助理教授，曾任哈佛大學數據科學研究員。憑借其獨特的研究視角和創新方法，Dexter教授正在為多個領域的研究帶來新的突破，從古典文學的深度挖掘到公共衛生的前沿應用。

Professor Joseph Dexter is an Assistant Professor at the Institute of Collaborative Innovation (ICI) of the University of Macau (UM). Previously he was a Data Science Fellow at Harvard University. With his unique research perspective and innovative methods, Professor Dexter is bringing new breakthroughs to research across multiple fields, ranging from in-depth exploration of classical literature to cutting-edge applications in public health.

用「計算方法」解讀文學特徵

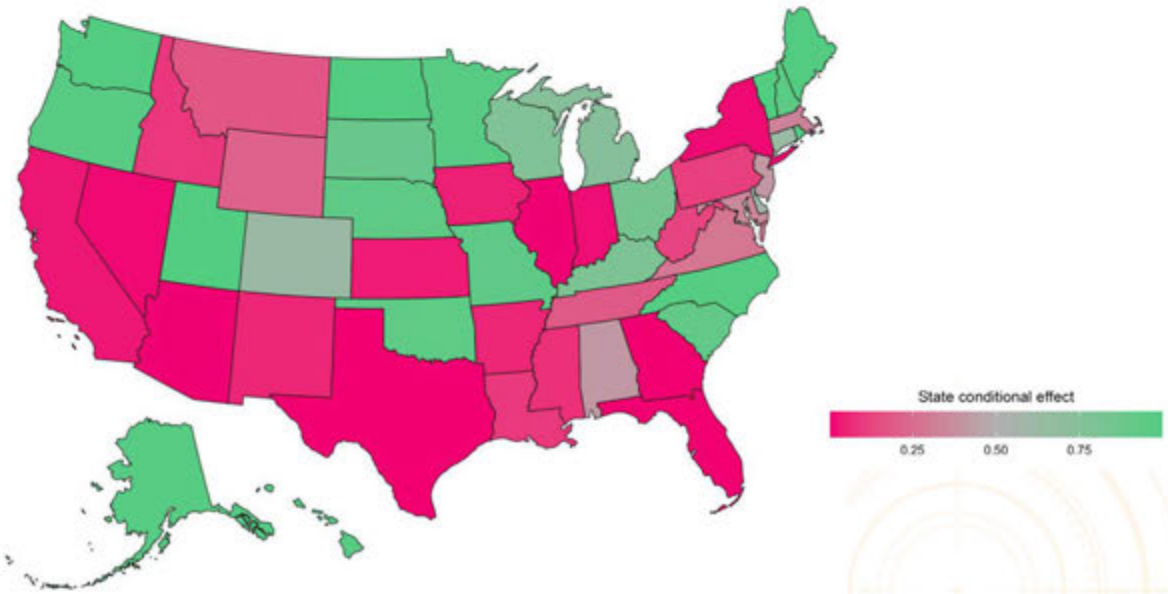
2021年，Joseph Dexter教授及其研究團隊在北美計算語言學協會上發表《拉丁文學中互文性的特徵分析：基於詞嵌入的方法》。基於拉丁史詩詩歌的傳統學術研究，他和團隊構建一個包含945個已知平行文本的新數據集，為互文性檢索方法提供了定量評估的基礎。

此外，Dexter教授在大型詞形化拉丁語語料庫上訓練了優化的 word2vec 模型，該模型在同義詞檢測方面實現了最先進的性能，並優於廣泛使用的互文搜尋詞彙方法。然後，他們證明，在非常小的語料庫上訓練詞嵌入可以捕捉文學風格的顯著性，並應用這種方法來複製羅馬歷史學家Livy之前的互文研究，該研究依賴於手工製作的文體特徵。這項工作有助於驗證計算方法在古典文學研究中的有效性，該研究不僅推進了古典文學的核心計算資源，還為文學研究和自然語言處理（NLP）之間的跨學科合作開闢了新的途徑。

促進語言公平，數據科學裡的人文關懷

Dexter 教授在其研究中高度關注數據科學中的語言公平性問題，並致力於通過跨學科方法解決這一挑戰。他指出，儘管自然語言處理和大語言模型在過去十年中取得了顯著進展，但語言技術的發展在資源豐富和資源匱乏的語言之間存在巨大不平等。世界上約有7,000種語言，其中大多數語言的處理基礎設施非常有限。這種不平等不僅影響自然語言處理領域，還對醫學、心理學和教育學等領域，產生深遠影響。

Dexter教授舉例，如果醫生試圖確定患者是否患有失語症，通常會進行語言或語音測試，這是語言評估的一個典型案例。然而，許多廣泛使用的語言評估工具最初是在英語使用者群體中開發和驗證的。在實際應用中，人們常常將這些評估工具從英語翻譯成其他語言，卻往往沒有進行大量新的驗證就直接投入使用。英語在許多方面是一種非常特殊的語言，那些使診斷在英語使用者中有效的假設，可能並不適用於其他語言的使用者，即使翻譯得非常完美。這可能會帶來嚴重問題，因為不同語言之間存在細微的結構差異。為解決這一問題，Dexter教授開展多項研究，系統記錄語言評估中的偏見，通過利用自然語言處理和跨語言研究的專業知識，開發更具跨語言通用性的評估工具。



優化信息溝通，疫情期間的數據科學洞察

新冠疫情期間，Dexter 教授及其研究團隊開展了評估公共衛生溝通有效性的研究，特別是針對美國疾病控制與預防中心（CDC）發布的隔離和檢疫指南。Dexter教授指出，2021年1月，奧密克戎變種的出現導致美國病例數和傳播率急劇上升，CDC不得不迅速調整其防疫指南。Dexter教授通過在線調查的方式，招募了具有代表性的美國居民樣本，以評估公眾對CDC信息的理解程度。研究發現，許多人在理解CDC的初步信息時存在困難，尤其是在如何應用規則變化方面。

此外，研究還關注了公共衛生溝通中的一個關鍵問題——如何準確傳達風險信息。CDC在指南中提到了之前變種的感染率和住院率，但對於奧密克戎，僅強調了其感染率的大幅增長，而未提及住院率和死亡率的變化。這導致公眾對奧密克戎的嚴重性產生了誤解，許多人高估了因奧密克戎住院或死亡的風險。Dexter教授指出，這種誤解可能源於缺乏足夠的信息，公眾往往會根據已知數據進行外推，從而得出錯誤的結論。

在談到該研究的驅動力時，Dexter教授強調了應用和社會影響的重要性，「我傾向於關注如何將現有方法應用於真正有趣且重要的問題，比如對健康和醫學有重要意義的溝通問題。」

助力健康溝通，大語言模型在醫療領域的創新應用

在2024年發表的眾多論文中，最令Dexter教授驕傲的研究成果之一發表於《美國醫學互聯網研究雜誌》。這項研究聚焦於大語言模型（LLM）聊天框在健康溝通中的應用，尤其是如何通過這些工具為患者提供準確且易於理解的健康信息。

Dexter教授與多位醫生合作，共同探討了如何利用人工智能技術改善信息傳遞。研究團隊選取了一系列患者在就醫過程中可能提出的與心臟病和心血管疾病相關的問題，通過評估大語言模型對問題的回答質量，分析其提供的信息是否準確、是否存在錯誤或遺漏關鍵事實。此外，研究還關注了如何根據不同的閱讀水平和語言複雜性調整信息的呈現方式，以確保信息能夠被更廣泛的患者群體理解。

為了實現這一目標，Dexter教授和團隊開發了一種提示策略，能夠生成既完整又醫學上準確的信息，同時以易於理解的方式呈現給患者。Dexter教授指出，這項研究的創新之處在於將人工智能技術與醫學專業知識相結合，為患者提供定製化的健康信息。他認為，這種跨學科的合作不僅推動了健康溝通的進步，也為人工智能在醫療領域的應用提供了新的方向。

跨學科新紀元，澳門的多語言優勢與未來研究展望

Dexter教授深刻指出，跨學科研究的最大挑戰在於找到合適的合作者。理想的合作者不僅需要具備深厚的專業知識，還需具備開放的心態，勇於嘗試新事物，並能夠克服跨學科合作中常見的溝通障礙。即便是與Dexter教授合作多年的伙伴，由於學科背景的差異，也需不斷探索更有效的溝通方式和任務分配策略。

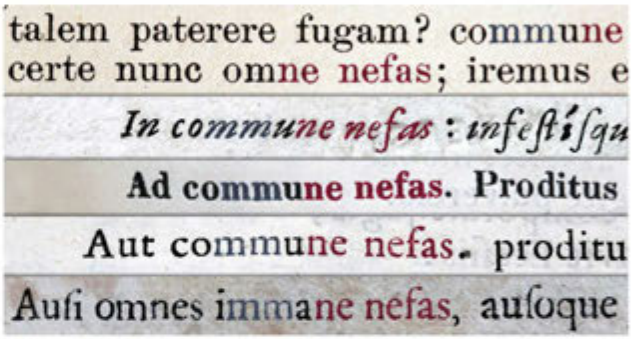
然而，在澳門開展跨學科研究，Dexter教授發現了獨特的優勢。澳大設有專門的跨學科研究機構——協同創新研究院（ICI），這在全球範圍內實屬罕見。ICI不僅擁有充足的資金支持，還具備直接招聘教師的權力，為跨學科研究提供了堅實的結構基礎。這樣的環境無疑吸引了眾多像Dexter教授這樣致力於跨學科研究的學者。

展望未來，Dexter教授對其研究領域的發展充滿期待。他指出，澳門作為一個多語言城市，為研究語言公平性提供了得天獨厚的環境。他計劃利用澳門多語言環境的優勢，開展語言公平性在公共衛生溝通中的應用研究，旨在為不同語言背景的人群提供更公平、更有效的健康信息和診斷工具。這一研究不僅將深化對語言公平性的理解，還將為公共衛生領域帶來創新性的解決方案。

Applying 'Computational Methods' to Interpret Literary Features

In 2021, Professor Joseph Dexter and his research team published *Profiling of Intertextuality in Latin Literature Using Word Embeddings in the Proceedings of the 2021 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies*. Based on traditional scholarship on Latin epic poetry, he and his team curated a new dataset of 945 known parallels, providing a basis for quantitative assessment of intertextuality retrieval methods.

Furthermore, Professor Dexter trained an optimised word2vec model on a large corpus of lemmatized Latin, which achieved state-of-the-art performance for synonym detection and outperformed a widely used lexical method for intertextual search. Then, they demonstrated that training word embeddings on very small corpora can capture salient aspects of literary style and applied this approach to replicate a previous intertextual study of the Roman historian Livy, which relied on hand-crafted stylometric features. This work helped to validate the effectiveness of computational methods in classical literary research, both by advancing core computational resources for classical literature and by suggesting new pathways for interdisciplinary collaboration between literary studies and natural language processing (NLP).



拉丁文學互文研究
Intertextuality in Latin Literature

Promoting Linguistic Equity: Humanitarian Concerns in Data Science

Professor Dexter's research is highly concerned with linguistic equity in data science and is dedicated to addressing this challenge through interdisciplinary approaches. He highlights that despite significant progress in NLP and large language models (LLM) over the past decade, there remains a substantial inequality in language technology development between resource-rich and resource-poor languages. With approximately 7,000 languages worldwide, the majority lack adequate processing infrastructure. This inequality affects not only the field of NLP but also has far-reaching impacts on medicine, psychology, and education.

Professor Dexter cited an example that, if a doctor tries to assess whether a patient has aphasia, they typically conduct language or speech tests, a common case of language evaluation. However, many widely used language assessment tools were initially developed and validated within English-speaking populations. In practice, these tools are often translated into other languages without extensive revalidation before being used. English is a unique language in many respects, and assumptions that make a diagnosis effective for English speakers may not apply to speakers of other languages, even with perfect translation. This can lead to serious issues due to subtle structural differences between languages. To address this, Professor Dexter has conducted several studies to systematically document biases in language assessment and develop more cross-linguistically universal assessment tools by leveraging expertise in NLP and comparative linguistics.

Optimising Information Communication: Data Science Insights on the Pandemic

During the COVID-19 pandemic, Professor Dexter and colleagues conducted research to evaluate the effectiveness of public health communication, particularly the isolation and quarantine guidelines issued by the Centers for Disease Control and Prevention (CDC) in the U.S. He noted that in January 2021, the emergence of the Omicron variant led to a sharp increase in cases and transmission rates in the U.S., prompting the CDC to quickly adjust its guidelines.

This research focused on a key issue in public health communication—how to accurately convey risk information. The CDC's guidelines mentioned the infection and hospitalisation rates of previous variants, but for Omicron, they only emphasised the significant increase in infection rates, without addressing changes in hospitalisation and mortality rates. This omission may have led to public misunderstanding of the severity of Omicron, with many people overestimating the risk of hospitalisation or death due to the new variant. Professor Dexter pointed out that this misunderstanding likely stemmed from not communicating important contextual information about risk, as the public would often extrapolate from known data and thus draw incorrect conclusions.

When discussing the motivation behind this research, Professor Dexter emphasised the importance of application and social impact, 'I prefer to focus on how to apply existing methods to truly interesting and important problems, such as communication issues that are significant to health and medicine.'

Facilitating Health Communication: Innovative Applications of LLM in the Healthcare

Among his many papers in 2024, one of Professor Dexter's proudest achievements was published on the *Journal of Medical Internet Research*. This research focused on the application of LLM chatbots in health communication, particularly how these tools could provide accurate and easily understandable health information to patients.

Professor Dexter collaborated with several doctors to explore how artificial intelligence could improve information delivery. The research team selected a series of questions patients might ask during medical consultations related to heart disease and other cardiovascular issues. In addition to evaluating the quality of responses from LLMs and analysing whether the provided information was accurate and free from omissions, the study also examined how to tailor the presentation of information according to different reading levels and language complexities to ensure it could be understood by a broader patient population.

To achieve this goal, Professor Dexter and his team developed a prompting strategy that could generate complete and medically accurate information presented in an easily understandable manner. He noted that the innovation of this research lies in combining artificial intelligence with medical expertise to provide customised health information for patients. He believes that this interdisciplinary collaboration not only advances health communication but also offers new directions for the application of artificial intelligence in healthcare.

A New Era of Interdisciplinary Research: Macao's Multilingual Advantages and Future Research Prospects

Professor Dexter pointed out that the greatest challenge in interdisciplinary research is finding the right collaborators. Ideal collaborators should not only possess deep professional knowledge but also have an open mindset, be willing to try new things, and work to overcome the communication barriers that often arise during interdisciplinary research. Even with partners who have worked with Professor Dexter for many years, continuous exploration of more effective communication methods and task allocation strategies is necessary due to differences in disciplinary backgrounds.

However, conducting interdisciplinary research in Macao offers unique advantages. UM has established a dedicated interdisciplinary research institution, ICI, which is rare globally. ICI not only has ample funding support but also has the authority to directly recruit faculty members, providing a solid structural foundation for interdisciplinary research. This environment undoubtedly attracts many scholars like Professor Dexter, who are committed to interdisciplinary research.

Looking ahead, Professor Dexter is full of anticipation for the development of his research field. He pointed out that, Macao as a multilingual city, offers a unique environment for studying language justice. He plans to leverage Macao's multilingual environment to conduct research on linguistic equity in public health communication, aiming to provide fairer and more effective health information and diagnostic tools for people from diverse linguistic backgrounds. This research has the potential not only to deepen our understanding of linguistic diversity but also bring innovative solutions to the field of public health.

Joseph Dexter 教授研究團隊
Professor Joseph Dexter's Research Team

法律與科技：從矛盾修辭時代到被AI控制的潛意識

Law and Technology: From the Time of Oxymora to Subliminal AI Systems

文：原維維、趙怡瑋
Chinese & English Text: Wayne Yuan, Eva Zhao

圖：部分由受訪者提供
Photo: Partially provided by the interviewee

Rostam J. Neuwirth 教授
Professor Rostam J. Neuwirth

Rostam J. Neuwirth 是澳門大學法學院環球法律學系主任及特聘教授，其研究重點聚焦於跨學科領域。他是《矛盾修辭時代的法律：語言、邏輯和法律之間的通感》（Routledge 2018）和《歐盟人工智能法案：被AI監管的潛意識》（Routledge 2023）等著作的作者，並通過探索法律與語言、認知、藝術、文化、社會及技術之間的內在聯繫，發表了大量針對當代全球法律問題的研究成果。

Rostam J. Neuwirth is Professor of Law and Head of the Department of Global Legal Studies at the Faculty of Law of the University of Macau (UM), whose research interests focus strongly on interdisciplinarity. He is the author of *Law in Time of Oxymora: A Synaesthesia of Language, Logic and Law* (Routledge 2018), *The EU Artificial Intelligence Act: Regulating Subliminal AI Systems* (Routledge 2023) and numerous other publications that focusing on contemporary global legal problems by exploring the intrinsic linkage between law, on the one hand, and language, cognition, art, culture, society, and technology, on the other.

隨著技術的迅猛發展，法律體系正面臨前所未有的挑戰。以人工智能（AI）為代表的新興技術不僅改變了社會運作方式，還模糊了傳統法學領域的邊界。正如Neuwirth教授所指出的，「在這個世界中，複雜性與加速的變革並駕齊驅地威脅著法律——如同一場『新型全球流行病』——可能削弱法律，尤其是法治作為提供法律確定性和可預測性工具的作用。」在此背景下，法律體系必須迎接跨學科挑戰，主要包括AI技術如何重塑人類認知、AI引發的倫理困境，以及數位化無國界特性導致的司法管轄權衝突。

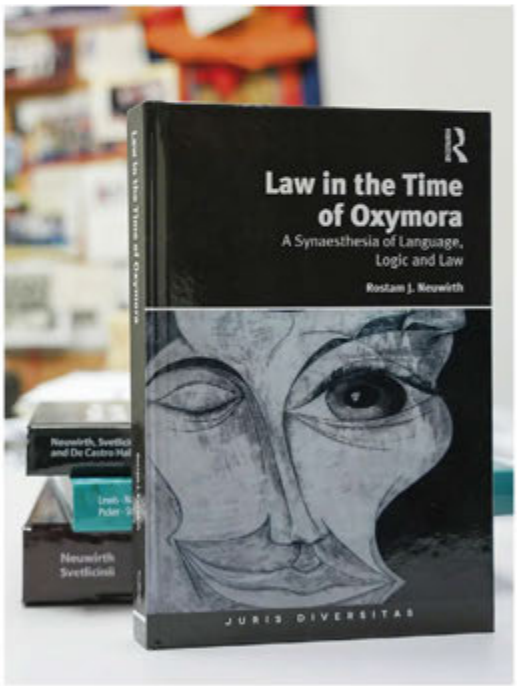
With the breakneck advancement of technology, legal systems are confronting unprecedented challenges. Emerging technologies, exemplified by artificial intelligence (AI), have not only transformed the way societies operate but also blurred the boundaries of traditional legal domains. As Professor Neuwirth points out, 'In this world, the complexity and the accelerated pace of change equality threaten—like a *new pandemic global disease*—to undermine law, especially the rule of law as an instrument providing legal certainty and predictability.' In this context, interdisciplinary challenges that legal frameworks must address—such as how AI technologies reshape human cognition, the ethical dilemmas posed by AI, and jurisdictional conflicts stemming from the borderless nature of digitalisation.

跨學科視角下的法律與科技融合

數字化與網路空間的「無國界性」進一步加劇了法律體系的複雜性。Neuwirth教授指出，法律研究者不僅需要理解技術，還需應對重疊的司法管轄權。這種複雜性被形象地稱為「布魯塞爾效應」「北京效應」或「華盛頓效應」，即某些主要國家或地區的立法對全球產生影響，並引發其他司法管轄區的連鎖反應。因此，面對技術進步，法律體系必須超越傳統邊界，採用更開放、動態的模式以應對全球化與技術創新的雙重挑戰。

為了應對科技發展帶來的多維度問題，跨學科研究顯得尤為重要。Neuwirth教授回憶起自己在學生時代，法律被嚴格劃分為不同類別，例如國家法、國際法、公法及私法，而這些類別之間的關係鮮少被探討。然而，隨着科技的複雜性增加，領域之間的界限逐漸模糊，尤其是人工智能等技術的多用途性，使得法律與心理學、工程學、計算機科學等學科的結合成為必要。

這種跨學科融合需要引入新方法論。Neuwirth教授將法律與科技的協作比作「團隊運動」，強調法律研究者不再是孤立的個體，而需與其他學科專家緊密合作。此外，他指出跨領域整合的關鍵在於建立有效溝通管道。由於不同學科的術語與概念差異，跨學科合作常面臨「術語壁壘」。例如，「全球連通性」在通信領域指技術互通性，而在神經科學中則指大腦連接結構。為突破此類壁壘，Neuwirth教授借鑒其法律與語言研究，利用語言學工具（如悖論與矛盾）化解術語分歧，從而促進更順暢的跨學科對話。



《矛盾修辭時代的法律：語言、邏輯和法律之間的通感》
Law in Time of Oxymora: A Synaesthesia of Language, Logic and Law

人工智能的社會與倫理影響

AI技術的快速發展為社會帶來了深遠影響，其雙重性不容忽視。一方面，AI顯著提升了社會效率，推動醫療診斷、自動化生產、司法輔助等領域的創新，為人類社會創造了前所未有的便利與價值；另一方面，該技術也潛藏諸多風險與挑戰，尤其在倫理與社會層面。

Neuwirth教授指出，歐盟將部分AI技術列為「不可接受的風險」。例如，神經技術可能干擾思想自由等基本人權，甚至「讀取」或「操縱」人類思維。儘管這些技術進步令人驚歎，但也引發了深刻的倫理擔憂。Neuwirth教授強調，AI不能簡單被貼上「好」或「壞」的標籤，而應在法律與技術間尋求平衡，通過綜合框架全面理解並規範其應用。

AI技術的廣泛應用對個人、社會乃至基本人權構成嚴峻挑戰。例如， Neuwirth教授特別提到，社交媒體算法與個性化廣告可能對兒童產生負面影響——這些技術可能導致兒童網路成癮，或因「信息繭房」效應（即信息來源同質化）阻礙其認知發展。此外，AI可能加劇社會不平等。例如，招聘與貸款審批中的演算法偏見可能隱性強化社會偏見，進一步邊緣化弱勢群體。這些現象表明，AI的發展並非全然有益——在享受技術紅利的同時，我們必須警惕其對社結構與基本人權的負面衝擊。

儘管技術進步必然伴隨新問題，但這些挑戰並非不可逾越。Neuwirth教授認為，關鍵在於通過多學科協作尋找最優解。他還提到，全球範圍內關於AI的討論日益增多，為探索與創新提供了機遇。例如，歐盟《人工智能法案》不僅是嘗試，更為全球AI立法提供了重要參考。中美等國可在此基礎上，結合國情探索適宜的監管模式，並通過國際合作應對AI的跨境問題。

法學教育與法律體系的未來展望

舊法束縛雙手，新法控制心智。

——湯瑪斯・阿奎那

隨著技術飛速發展，傳統法學教育已難以滿足現代社會對法律人才的需求。Neuwirth教授指出，法學教育需應對AI、數字化與網路技術帶來的深刻變革——法律人才不僅要掌握傳統法學知識，還需理解技術基本原理及其對社會與人權的影響。

澳大法學院在此領域提供了寶貴經驗。作為一所三語法學院（中文、葡語、英語），其課程設置既融合本地法律傳統，又關注全球法律趨勢。Neuwirth教授提到，學院已開設「中國法與環球法學」學士課程，旨在培養既精通中國法、又能在全球化背景下理解跨國法律問題的學生。這種創新教育模式說明學生適應快速變化的技術環境，並在全球法律體系中發揮作用。

面對AI等顛覆性技術，法律體系正處於關鍵轉型期。Neuwirth教授認為，現行法律框架具有一定靈活性，可通過重新解釋適應技術發展。然而，當技術變革過於顛覆時，現有框架可能失效，甚至需要從零構建新體系。他將此過程比作修繕房屋：若結構仍可支撐，可修補調整；但若結構過時或無法滿足需求，則需推倒重建。AI的廣泛應用與快速迭代正推動我們走向「重建房屋」的階段。例如，現行法律體系難以應對演算法偏見、隱私保護及自動化決策責任歸屬等問題。

最後，他指出法律體系的調整需融入人類認知與社會行為的最新科學研究。AI技術已開始改變人類行為模式，這可能需要法律重新界定權利與責任的邊界——這不僅是對法律體系的改革，更是對社會認知的革新。

Interdisciplinary Perspectives on the Convergence of Law and Technology

The borderless nature of digitalisation and cyberspace has further exacerbated the complexity of legal systems. Professor Neuwirth points out that legal researchers need not only to understand technology but also to navigate overlapping jurisdictions. This complexity is aptly termed the 'Brussels Effect', 'Beijing Effect', or 'Washington Effect', where legislation from certain major countries or regions influences the globe and triggers chain reactions in other jurisdictions. Therefore, in the face of technological advancements, legal systems must transcend traditional boundaries and adopt more open and dynamic models to address the dual challenges of globalisation and technological innovation.

Addressing the multidimensional issues posed by technological development necessitates interdisciplinary research. Professor Neuwirth recalls his student days when law was strictly categorised into different fields such as national law, international law, public law, and private law, with little exploration of the relationships between them. However, as technology has grown more complex, boundaries between fields have blurred, especially with the versatility of technologies like AI, making integration with disciplines such as psychology, engineering, and computer science essential for law.

This interdisciplinary integration requires the introduction of new methodologies. Professor Neuwirth likens the collaboration between law and science to a 'team sport', emphasising that legal researchers are no longer lone players but need to closely cooperate with experts from other disciplines. Additionally, he notes that a key to integrating fields is establishing effective communication channels. Due to terminological and conceptual differences across disciplines, interdisciplinary collaboration often faces 'terminological barriers'. For instance, 'global connectivity' refers to technical interoperability in the field of communications and to brain connectivity structures in neuroscience. To overcome these barriers, Professor Neuwirth draws on his research on law and language, using linguistic tools (such as paradoxes and contradictions) to resolve terminological disagreements, thereby fostering smoother interdisciplinary dialogue.

Social and Ethical Implications of Artificial Intelligence

The rapid development of AI technology has brought profound impacts on society, with its dual nature is ignorable. On one hand, AI has significantly enhanced social efficiency, driving innovations in medical diagnosis, automated production, judicial assistance, and other fields, creating unprecedented convenience and value for human society. However, on the other hand, this technology also poses numerous potential risks and challenges, particularly at the ethical and social levels.

Professor Neuwirth stated that some AI technologies are considered 'unacceptable risks' by the European Union (EU). For example, neurotechnologies may interfere with fundamental human rights such as freedom of thought, potentially even 'reading' or 'manipulating' human minds. While these technological advancements are astonishing, they also raise profound ethical concerns. Professor Neuwirth emphasised that AI cannot be simply labelled as 'good' or 'bad' but should instead seek a balance between law and technology, comprehensively understanding and regulating its applications through an integrated framework.

《歐盟人工智能法案：被 AI 控制的潛意識》（本書中文版於 2024 年 10 月出版）
The EU Artificial Intelligence Act: Regulating Subliminal AI Systems (The Chinese version of this book was published in October 2024)

The widespread application of AI technology poses severe challenges to individuals, society, and even fundamental human rights. For instance, Professor Neuwirth specifically mentioned that social media algorithms and personalised advertising may negatively affect children. These technologies can lead to internet addiction among children or hinder their cognitive development due to the echo chamber effect (i.e., a homogenisation of information sources). Furthermore, AI may exacerbate social inequalities. For example, algorithmic bias in areas such as hiring and loan approvals may implicitly reinforce social prejudices, further marginalising vulnerable groups. These phenomena indicate that the development of AI is not entirely beneficial. While enjoying the dividends of technology, we must be vigilant about its negative impacts on social structures and fundamental human rights.

Although technological advancements inevitably bring new problems, these issues are not insurmountable. Professor Neuwirth believes the key lies in finding optimal solutions through multidisciplinary collaboration. He also mentions that discussions on AI are increasingly occurring globally, providing opportunities for exploration and innovation. For example, the EU' s Artificial Intelligence Act is not only an attempt but also an important reference for global AI legislation. Countries like China and the United States can build upon this foundation, explore suitable regulatory models considering their national conditions, and address cross-border issues related to AI through international cooperation.

Future Prospects for Legal Education and Legal Systems

The Old Law restrains the hand, but the New Law controls the mind.

-- Thomas St. Aquinas

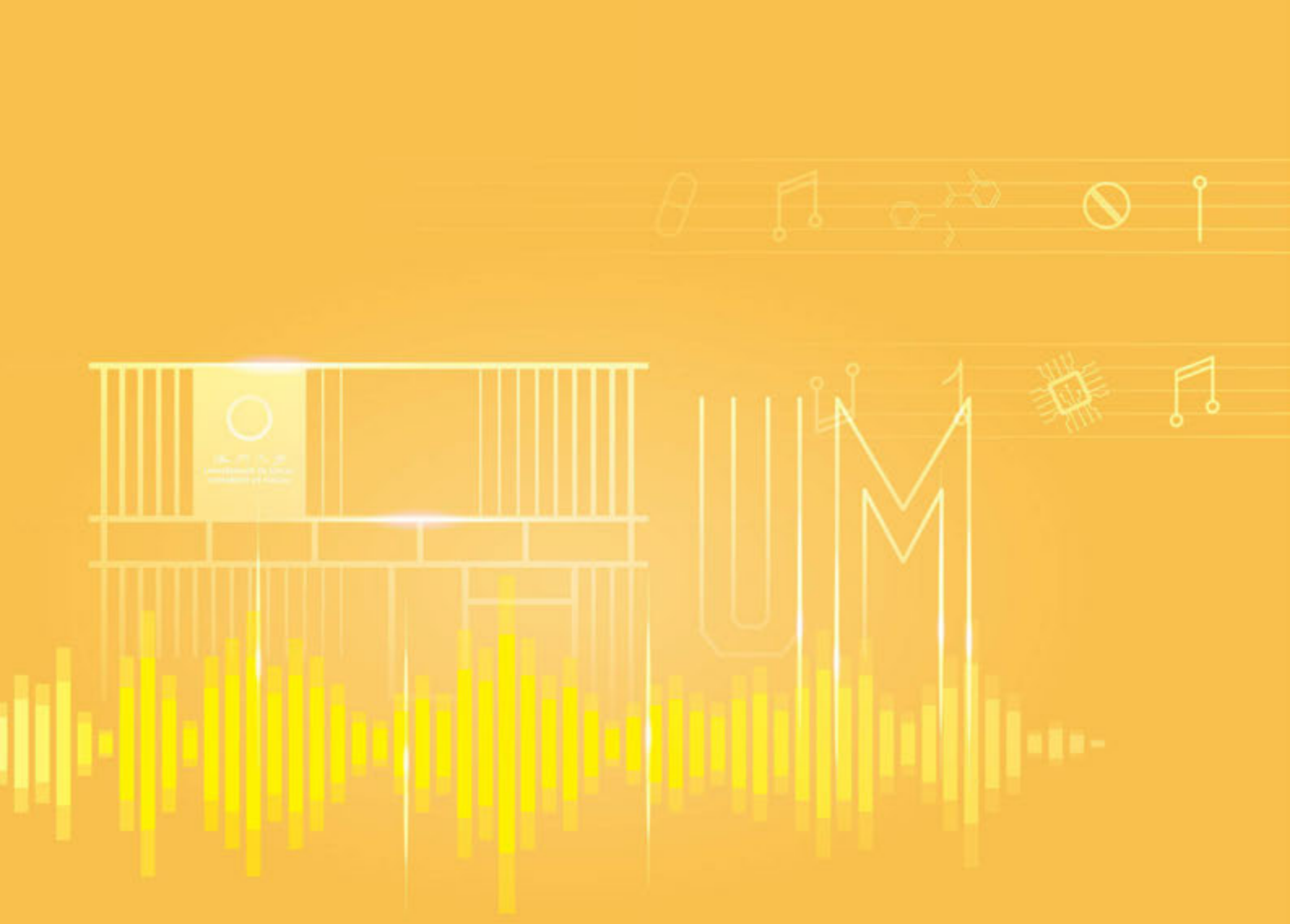
With the rapid development of technology, traditional legal education has struggled to meet the demands of modern society for legal talent. Professor Neuwirth notes that legal education needs to address the profound changes brought about by AI, digitalisation, and network technologies. Legal talent must not only master traditional legal knowledge but also understand the basic principles of technology and its impact on society and human rights.

The Faculty of Law at UM offers valuable experience in this field. As a trilingual law school (Chinese, Portuguese, English), its curriculum combines local legal traditions with a focus on global legal trends. Professor. Neuwirth mentions that the faculty has introduced a Bachelor' s program in 'Chinese Law and Global Legal Studies,' aimed at cultivating students who can grasp Chinese law while understanding cross-national legal issues in a globalisation context. This innovative educational model prepares students to adapt to rapidly changing technological environments and work within global legal systems.

In the face of disruptive technologies such as AI, legal systems are undergoing a critical transformation. Professor Neuwirth believes that the current legal framework has some flexibility and can adapt to technological developments through reinterpretation. However, when technological changes are too disruptive, the existing framework may prove inadequate, and even the need to construct a new legal system from scratch arises. He compares this process to repairing a house: when the structure is still viable, repairs and adjustments can be made; but if the structure is outdated or unable to meet demands, it must be demolished and rebuilt. The widespread application and rapid iteration of AI are pushing us toward the stage of 'rebuilding the house'. For example, the current legal system struggles to address issues such as algorithmic bias, privacy protection, and the attribution of responsibility for automated decisions.

In conclusion, he notes that adjustments to the legal framework need to incorporate the latest scientific research on human cognition and social behaviour. AI technologies have started to change human behaviour patterns, which may require law to redefine the boundaries of rights and responsibilities. This is not only a reform of the legal system but also a transformation of social perceptions.

Rostam J. Neuwirth 教授在澳門大學授課
Professor Rostam J. Neuwirth teaches at UM



澳琴和鳴・譜新曲

Harmony of Macao and Hengqin・Composing a New Movement

珠海澳大科技研究院：協同創新驅動琴澳產學研深度融合

ZUMRI: Collaborative Innovation Drives Deep Integration of Industry-Academia in Hengqin and Macao

文：原維維
Chinese & English Text: Wayne Yuan

圖：部分由受訪者提供
Photo: Partially provided by the interviewee

在粵港澳大灣區創新發展的浪潮中，珠海澳大科技研究院（下稱「珠研院」）猶如一艘破浪前行的科創旗艦，承載著澳門大學與橫琴粵澳深度合作區的戰略使命。作為澳門高校首個跨境產學研示範基地，珠研院自2019年落地橫琴以來，已發展成為鏈接琴澳創新要素的「超級樞紐」。

In the tide of innovation and development in the Guangdong-Hong Kong-Macao Greater Bay Area (Greater Bay Area), Zhuhai UM Science and Technology Research Institute (ZUMRI) is like a flagship of scientific and technological innovation, forging ahead through the waves. It carries the strategic mission of the University of Macau (UM) and the Guangdong-Macao In-Depth Cooperation Zone in Hengqin (Cooperation Zone in Hengqin). As the first cross-border industry-academia collaboration base established by a Macao higher education institution, ZUMRI has developed into a 'super hub' bridging the innovation resources between Hengqin and Macao since its inauguration in 2019.

珠海澳大科技研究院
Zhuhai UM Science and Technology Research Institute

砥礪前行，勇立灣區產學研創新潮頭

陳國凱教授
Professor Guokai Chen

「珠研院的誕生，是澳大服務國家戰略的關鍵落子。」現任珠海澳大科技研究院院長的陳國凱教授開宗明義。作為《橫琴粵澳深度合作區建設總體方案》的重要實踐載體，珠研院依託澳門大學三個國家重點實驗室的科研勢能，已建有微電子、中華醫藥、轉化醫學、智慧城市、先進材料五大研發中心，累計承擔政府科研項目172項，企業委託研發項目158項，合同金額合計超過3億元人民幣；基於澳大科研成果已孵化科技公司10家。

陳教授認為，「珠研院的成立使得澳大在產業轉化上有了自己真正的實體，這一平台拓寬了澳大研究成果的轉化空間及應用場景。」在智慧城市領域，珠研院取得了多項突破性研究成果，為智慧城市的可持續發展和安全保障注入了新的活力：由澳大校長宋永華教授領導的團隊，攜手多家領軍企業和知名大學，系統性地研究了智慧城市綜合能源系統的關鍵問題，並在澳門及內地實施了示範應用，旨在提高城市綜合能源利用效率，保障能源供應安全；澳大科技學院周萬歡教授的研究團隊研發了一系列高性能傳感器和智慧監測設備，能夠實時掌握重大基礎設施的運行狀態，為智慧城市的公共安全提供了重要保障。

在微電子領域，珠研院微電子研發中心依託澳大模擬與混合信號超大規模集成電路國家重點實驗室。與此同時，微電子研發中心積極探索創新合作模式，搭建「工業盟友」平台，以科研、人才和產業化聯結大灣區科技合作，通過資訊共用、人才培養和論壇活動等方式，加強與業界晶片企業緊密互動，是院企間瞭解所需、交流成果、輸送人才的重要管道。

移動機器人專用晶片
Chip for Mobile Robot

突出澳門元素，打造院企合作新範式

自成立以來，珠研院與大灣區的創新企業及政府部門積極開展合作，逐步構造了一個從原創科技、關鍵技術突破到融入大灣區產業鏈的一整套生態鏈；截至目前，珠研院已與16家企業建立聯合實驗室，包括中國南方電網、華潤醫藥集團、國藥集團、一微半導體、凌煙閣晶片科技等多家企業。

聯合實驗室的成立是推進粵港澳大灣區協同創新發展的重要舉措。陳教授表示，聯合實驗室不簡單的以一個橫向項目作為核心，它確立的是雙方長期合作的關係；院企合作模式最大的優勢是為企業和高校老師提供了便利，因為相對高校而言，這種合作模式為高校帶來了企業轉化的團隊，大大縮短了高校老師尋求專利市場化的時間。

在項目選擇上，陳教授強調要遴選一些好的項目，且一定要有澳門元素。2024年7月，橫琴粵澳深度合作區舉辦的澳琴科創產學研資對接會暨簽約儀式上，澳大與8家企業成功簽約，其中珠研院分別與中國中藥控股一方製藥共建中成藥及健康產品聯合實驗室、與國藥集團中國生物共建醫學美容生物製品聯合實驗室、與國藥現代聯合共建藥物遞送研究實驗室。陳教授指出，澳大推出的項目就具有天然的澳門元素，要藉助澳大平台，尋求與企業更廣闊的合作。

橫琴粵澳深度合作區舉辦澳琴科創產學研資對接會暨簽約儀式
Macao-Hengqin Industry-Academia-Research-Investment Networking in Tech Innovation and Signing Ceremony

協同創新，驅動琴澳深度融合

自2019年成立以來，珠研院始終肩負著促進澳門與珠海科技創新協同發展的戰略使命。作為跨境科研合作的先行者，該院依託五大核心研發中心，通過高端人才引育與技術資源整合，持續為琴澳產業升級注入創新動能，構建起產學研深度融合的創新生態系統。

在科技創新領域，珠研院通過首創性構建工業盟友協作體系，開創了校地協同創新的典範模式；人才培養體系呈現顯著的產教融合特徵，為粵港澳大灣區輸送了大批具有國際視野的複合型科技人才；在推動澳門經濟適度多元發展方面，珠研院探索出獨具特色的跨境協同路徑，既有效盤活澳門高校的智力資源，又為橫琴導入先進技術成果。

隨著橫琴粵澳深度合作區澳門大學高等研究院（下稱「琴研院」）於2023年12月正式獲批，琴澳協同創新進入2.0發展階段。作為澳大在橫琴合作區佈局的產學研示範基地，琴研院既延續協同創新經驗，更在制度層面實現突破，構建起更具活力的創新生態系統。珠研院與琴研院基於功能互補形成戰略聯動，前者作為境內執行機構協助完成籌建工作，後者依託「一國兩制」制度優勢推動「基礎研究—應用開發—產業轉化」創新閉環，共同為粵港澳大灣區建設提供實踐範例。兩院形成有機協作，通過跨境要素流動和制度銜接，彰顯區域協同創新的獨特潛力，助力橫琴合作區加速向國際科技創新樞紐演進。

Striving Ahead and Leading the Trend of Industry-Academia Collaboration Innovation in the Greater Bay Area

'The establishment of ZUMRI stands as a strategic cornerstone in UM's implementation of national development initiatives,' said Professor Guokai Chen, the current Director of ZUMRI. As an important implementation carrier for the Master Plan of the Development of the Guangdong-Macao In-Depth Cooperation Zone in Hengqin, ZUMRI relies on the scientific research momentum of UM's three State Key Laboratories and has established five major research and development centres in microelectronics, traditional Chinese medicine, translational medicine, smart cities, and advanced materials. It has undertaken a total of 172 government-funded research projects and 158 enterprise-commissioned R&D projects, with a combined contract value exceeding RMB 300 million. Additionally, based on the research achievements of UM, it has incubated 10 technology companies.

Professor Chen believes that 'the establishment of ZUMRI has given UM a real entity for industrial transformation. This platform has expanded the space for the transformation and application scenarios of UM's research achievements.' In the field of smart cities, ZUMRI has achieved several breakthrough research results, injecting new vitality into the sustainable development and security of smart cities. The team led by Professor Yonghua Song, the Rector of UM, in collaboration with several leading enterprises and renowned universities, has systematically studied the key issues of integrated energy systems in smart cities, which has been implemented in pilot applications in Macao and mainland China, aiming to improve the overall energy efficiency of cities and ensure energy supply security. The research team led by Professor Wanhuan Zhou from the Faculty of Science and Technology at UM, has developed a series of high-performance sensors and intelligent monitoring devices that can monitor the operating status of major infrastructure in real time, providing important security for the public safety of smart cities.

In the field of microelectronics, the Microelectronics R&D Center of ZUMRI is anchored by the State Key Laboratory of Analog and Mixed-Signal VLSI (UM). At the same time, the Center has actively explored innovative cooperation models by establishing the 'Industry Allies' platform. This platform connects scientific research, talent development, and industrialisation across the Greater Bay Area through information sharing, talent cultivation, and forum activities. It strengthens close interactions with chip companies in the industry, serving as an important channel for understanding needs, exchanging research outcomes, and delivering talent between the institute and enterprises.

綜合能源系統智慧管理平台
Smart Integrated Energy Management Platform

Highlight Macao's Unique Strengths and Forge a New Paradigm for Institute-Enterprise Collaboration

2024 年 12 月，珠研院—康美華大聯合實驗室揭牌儀式在橫琴深合區舉行
In December 2024, the plaque unveiling ceremony of the ZUMRI-KMHD Joint Laboratory was held in Cooperation Zone in Hengqin

Since its establishment, ZUMRI has actively engaged in cooperation with innovative enterprises and government departments in the Greater Bay Area, gradually constructing an integrated ecosystem that spans from original technology, breakthroughs in key technologies, to integration into the Greater Bay Area's industrial chain. To date, ZUMRI has established joint laboratories with 16 companies, including China Southern Power Grid, China Resources Pharmaceutical Group Limited, China National Pharmaceutical Group Co Ltd (Sinopharm), Amicro Semiconductor Co., Ltd., and Lingyange Semiconductor Inc. among others.

The establishment of the joint laboratory is an important measure to promote collaborative innovation and development in the Greater Bay Area. Professor Chen stated that the joint laboratory is not simply centred around a single horizontal project; instead, it establishes a long-term collaborative relationship between the two parties. The biggest advantage of the institute-enterprise collaboration model is that it provides convenience for both enterprises and university faculty. Compared to traditional university settings, this collaboration model brings corporate transformation teams to the university, significantly reducing the time it takes for university professors to seek patent commercialisation.

In terms of project selection, Professor Chen emphasised the importance of selecting good projects that must highlight Macao's unique strengths. In July 2024, during the Macao-Hengqin Industry-Academia-Research-Investment Networking in Tech Innovation and Signing Ceremony held in the Cooperation Zone in Hengqin, UM successfully signed agreements with eight companies. Among them, ZUMRI established joint laboratories with several enterprises: a traditional Chinese medicine and health products Joint Laboratory with Efong Pharmaceutical under China Traditional Chinese Medicine Holdings, a medical aesthetics bioproducts Joint Laboratory with China National Biotec Group Company Limited under Sinopharm, and a drug delivery research Laboratory with Shanghai Shyndec Pharmaceutical Co. Ltd. Professor Chen pointed out that the projects launched by UM naturally possess Macao's unique strengths, and it is essential to leverage the platform of UM to seek broader cooperation with enterprises.

Collaborative Innovation: Driving Deep Integration between Hengqin and Macao

Since its establishment in 2019, ZUMRI has steadfastly carried out its strategic mission to advance collaborative technological innovation between Macao and Zhuhai. As a pioneer in cross-border scientific research cooperation, ZUMRI relies on its five major R&D centres to drive industrial upgrading in Hengqin and Macao and establish a holistic innovation ecosystem that bridges cutting-edge research with real-world industrial applications, through the cultivation and integration of high-end talents and technological resources.

In the field of technological innovation, ZUMRI has pioneered the establishment of 'Industry Allies' cooperation system, creating a model of collaborative innovation between universities and localities. Its talent cultivation system is characterised by significant integration of industry and education, delivering a large number of composite scientific and technological talents with an international perspective to the Greater Bay Area. In promoting the Macao SAR's development on appropriate economic diversification, ZUMRI has explored a unique cross-border collaborative path that not only effectively mobilises the intellectual resources of Macao's universities but also introduces advanced technological achievements to Hengqin.

With the official approval of the establishment of University of Macau Advanced Research Institute in Hengqin in December 2023, the collaborative innovation between Hengqin and Macao has entered a 2.0 development phase. As a demonstration base of industry-academia collaboration established by UM in the Cooperation Zone in Hengqin, the UM Advanced Research Institute in Hengqin not only builds on existing cross-border innovation expertise but also achieves institutional breakthroughs, fostering a more dynamic innovation ecosystem. ZUMRI and the UM Advanced Research Institute in Hengqin have forged strategic synergy through functional complementarity. The former serves as an onshore implementation body, driving preparatory operations and infrastructure development. The latter leverages the 'One Country, Two Systems' policy advantages to propel an end-to-end innovation cycle—from basic research to applied development and industrial commercialisation—jointly establishing a practical paradigm for the integrated advancement of the Greater Bay Area. Through organic collaboration, the two institutes exemplify the unique potential of regional synergy by enabling cross-border flows of talent, capital, and knowledge resources, coupled with institutional alignment. This dynamic partnership accelerates the transformation of the Cooperation Zone in Hengqin into a global hub for scientific and technological innovation, showcasing how policy-enabled frameworks and cross-functional integration can redefine collaborative innovation on an international scale.

琴研院未來概念圖
Conceptual Diagram of the UM Advanced Research Institute in Hengqin

唐遠炎教授：人工智能領域的領航者與校企合作典範

Professor Yuanyan Tang: A Pioneer in the Field of Artificial Intelligence and a Model of University-Enterprise Collaboration

文：原維維
Chinese & English Text: Wayne Yuan

圖：部分由受訪者提供
Photo: Partially provided by the interviewee

唐遠炎教授
Professor Yuanyan Tang

在人工智能這一充滿挑戰與機遇的領域，唐遠炎教授以其卓越的學術成就和深遠的行業影響力，成為了備受矚目的領航者。作為澳門大學的榮譽講座教授，他不僅在該領域取得了豐碩的研究成果，還積極推動校企合作，為澳門及大灣區的科技發展和產業升級注入了強勁動力。

In the field of artificial intelligence (AI), which is full of challenges and opportunities, Professor Yuanyan Tang has become a highly respected pioneer with his outstanding academic achievements and profound industry influence. As a Chair Professor Emeritus at University of Macau (UM), he has not only achieved fruitful research results in this field but also actively promoted university-enterprise collaboration, injecting strong momentum into the technological development and industrial upgrading of Macao and the Guangdong-Hong Kong-Macao Greater Bay Area (Greater Bay Area).

理論疆域的拓荒者：《小波理論在模式識別中的應用》

唐遠炎教授的學術生涯始於20世紀80年代，當時他在加拿大康科迪亞大學攻讀博士學位，師從加拿大皇家科學院院士孫靖夷教授，致力於人工智能的重要分支——文本分析和識別的研究。這一開創性工作不僅為他贏得了學術界的廣泛關注，更為他後續在人工智能領域的深入探索奠定了堅實基礎。

唐遠炎教授與導師孫靖夷教授（從左至右：唐遠炎，宋永華校長，孫靖夷院士及夫人）
Professor Yuanyan Tang and his mentor Professor Ching Yee Suen (From left to right: Yuanyan Tang, Rector Yonghua Song, Professor Ching Yee Suen and his wife)

這位深耕模式識別領域半個世紀的學者，用一本再版三次的《小波理論在模式識別中的應用》(1999, 2009, 2025)，悄然改寫了人工智能的理論版圖。唐教授在終章展望「小波智慧」的進化路徑，從固定小波基的淺層特徵提取，到參數化小波核的深度網路架構，再到物理啟發式小波生成模型，正重塑人工智能的理論基礎。這部著作不僅標誌著特徵工程從經驗技藝向精密科學的轉型，更為後深度學習時代指明了方向。其學術價值和影響力，無疑使其成為人工智能領域的一部奠基之作。

翻開唐教授的學術履歷，一組數字勾勒出清晰的學術脈絡：自到珠海澳大科技研究院（下稱「珠研院」）工作至2024年，5年間共發表SCI論文106篇，39篇發表於*IEEE Transactions*系列頂刊，18篇入選ESI高被引論文。這些成果並非簡單的數量堆砌，而是嚴格遵循「基礎理論—演算法創新—應用驗證」的科研範式，不僅彰顯了他的學術實力，也體現了他對人工智能領域的持續關注和深入研究。

校企合作的典範：推動科研成果轉化與創新

除了卓越的學術成就外，唐教授在推動校企合作方面也取得了顯著成果。他深知科研成果只有轉化為實際應用，才能發揮最大價值。因此，他積極推動與知名企業的合作，共同建立聯合實驗室，推動技術創新和應用。珠研院是唐教授推動校企合作的重要平台。目前，珠研院與華為、南方電網、阿里巴巴、國藥集團、華潤醫藥和九州製藥等多家知名企業建立了緊密的合作關係。這些合作不僅涵蓋了智慧城市、智慧交通、智慧能源等多個領域，還推動了商業專案的立項和實施。截至目前，珠研院的商業專案立項已超過150項，其中不乏具有重大影響力的創新專案。

唐遠炎教授負責研發的「基於數字孿生和人工智能的城市運營平台」
Urban Operation Platform Based on Digital Twin and Artificial Intelligence Developed by Professor Yuanyan Tang

在與企業的合作中，唐教授非常注重技術創新和實際應用的結合。他帶領團隊深入企業一線，瞭解實際需求，共同攻克技術難題。例如，他的團隊及澳大微電子研究院的同事在與珠海一微半導體股份有限公司的合作中，他們共同建立了聯合實驗室，專注於機器人技術及高集成度數模混合晶片設計。這一專案突破了多項晶片關鍵技術，實現了機器人產品自動識別環境並主動躲避障礙物、自主定位和導航等功能。目前，該專案已進入試產階段，有望為機器人產業的發展注入新動力。

2024年，唐教授與南方航空公司旗下珠海翔翼航空技術有限公司的合作更是取得了豐碩成果。他們共同獲得了《橫琴國際科技創新創業大賽獎》第三名，獎金高達1,000萬元人民幣。目前，雙方正在籌劃建立聯合實驗室，以進一步推動技術創新和應用。這一合作不僅彰顯了唐教授在人工智能領域的領先地位，也為澳門與大灣區企業的合作樹立了典範。

珠海一微半導體股份有限公司相關項目
Collaborated Projects with Amicro Semiconductor Co., Ltd.

展望未來：深度融合與跨學科創新

在科技創新與產業升級的浪潮中，校企合作以其獨特的優勢，成為了推動社會進步和經濟發展的重要引擎。珠研院在這一領域取得了顯著成就，其中，唐教授作為珠研院的重要引領者，以其深厚的學術背景和前瞻性的戰略眼光，為校企合作的發展注入了新的活力。

唐教授深知，校企合作的深度融合是推動科技創新的關鍵。他強調，高校、企業和政府應形成緊密的產學研一體化創新體系，共同推動科技成果的轉化和應用。在這一體系中，珠研院不僅促進了科技成果的快速轉化，還推動了區域產業的快速發展和升級。這種深度融合的合作模式，正是教授所宣導的「協同創新」理念的具體體現。同時，唐教授也深刻認識到跨學科創新對於校企合作的重要性。他指出，智慧城市作為一個綜合性較強的研究方向，其研究成果應用於多個領域，需要跨學科的合作來整合各領域的優勢，解決複雜的問題。因此，通過在珠研院設立國家重點實驗室橫琴分部，開展跨學科交叉合作研究，已經在自動駕駛關鍵技術平台、感測器技術、智慧城市混合現實模擬與智慧決策平臺等方面取得了重要進展。這些成果不僅提升了技術的適用性和可持續性，還為智慧城市的建設提供了有力的技術支撐。

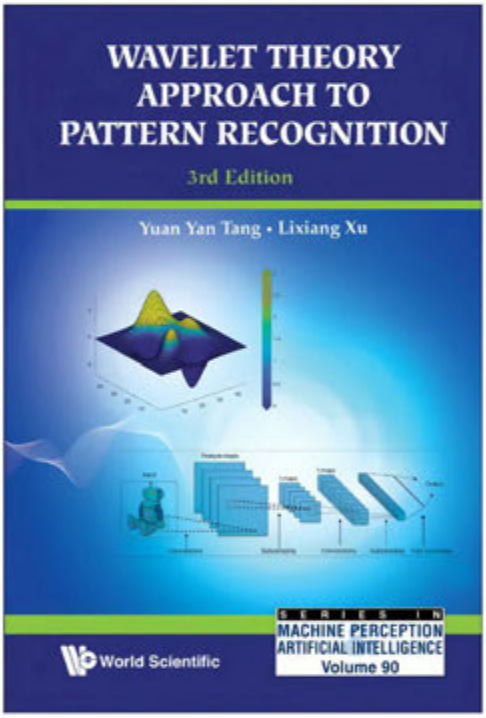
展望未來，唐教授對未來的校企合作充滿期待。他希望澳門大學與各行業企業之間的合作能夠更深入地參與到國家新興產業的建設中，特別是在具身智能、低空經濟等新興領域取得更多突破。他認為，跨學科合作和深度融合將是未來校企合作的主要趨勢，智慧化技術的廣泛應用將推動智慧城市的發展。唐教授的研究和合作不僅推動了人工智能領域的進步，也為澳門及大灣區的科技發展和產業升級做出了重要貢獻。他的成就和願景為未來的研究者和企業家提供了寶貴的經驗和啟示。作為人工智能領域的領航者與校企合作典範，唐教授的故事將繼續激勵著更多人勇往直前，探索未知，為科技的進步和社會的繁榮貢獻自己的力量。

The Pioneer of Theoretical Frontiers: *Wavelet Theory Approach to Pattern Recognition*

Professor Yuanyan Tang' s academic career began in the 1980s when he was pursuing his Ph.D. degree at Concordia University in Canada under the supervision of Professor Ching Yee Suen, fellow of the Academy of Sciences of the Royal Society of Canada, focusing on the research of document recognition and analysis, an important branch of AI. This pioneering work not only won him widespread attention in the academic community but also laid a solid foundation for his subsequent in-depth exploration in the field of artificial intelligence.

This scholar, who has been deeply involved in the field of pattern recognition for half a century, has quietly rewritten the theoretical map of AI with a book titled *Wavelet Theory Approach to Pattern Recognition* that has been reprinted three times (1999, 2009, 2025). Professor Tang' s vision for the evolution of 'wavelet intelligence' in the final chapter, from fixed wavelet basis for shallow feature extraction to parametric wavelet kernel for deep network architecture, and then to physically inspired wavelet generation models, is reshaping the theoretical foundation of artificial intelligence. This work not only signifies the transition of feature engineering from an empirical craft to a precise science but also points the way for the post-deep learning era. Its academic value and influence undoubtedly make it a foundational work in the field of artificial intelligence.

Looking through Professor Tang' s academic resume, a set of numbers outlines a clear academic trajectory: from working at Zhuhai UM Science and Technology Research Institute (ZUMRI) till 2024, during those 5 years, he has published 106 SCI papers, 39 of which were published in the top *IEEE Transactions* series, and 18 were selected as ESI highly cited papers. These achievements are not simply a matter of quantity but strictly follow the scientific research paradigm of 'basic theory - algorithm innovation - application verification', not only demonstrating his academic strength but also reflecting his continuous attention to and in-depth research in the field of AI.



《小波理論在模式識別中的應用》第三版
Wavelet Theory Approach to Pattern Recognition, Third Edition

A Model of University-Enterprise Collaboration: Promoting the Transformation and Innovation of Scientific Research Achievements

In addition to his outstanding academic achievements, Professor Tang has also achieved remarkable results in promoting university-enterprise collaboration. He is well aware that scientific research achievements can only realise their maximum value when transformed into practical applications. Therefore, he actively

promotes cooperation with well-known enterprises to jointly establish joint laboratories to promote technological innovation and application. ZUMRI is an important platform for Professor Tang to promote university-enterprise collaboration. At present, ZUMRI has established close cooperative relationships with many well-known enterprises, including Huawei, China Southern Power Grid, Alibaba, China National Pharmaceutical Group Co Ltd., China Resources Pharmaceutical Group Limited, and Jiuzhou Pharmaceutical. These cooperations cover multiple fields such as smart cities, smart transportation, and smart energy and have promoted the initiation and implementation of commercial projects. So far, more than 150 commercial projects have been initiated at ZUMRI, including many innovative projects with significant influence.

In cooperation with enterprises, Professor Tang places great emphasis on the combination of technological innovation and practical application. He leads his team to go deep into the front line of enterprises to understand actual needs and jointly tackle technological challenges. For example, his team and colleagues from the Institute of Microelectronics of UM, in cooperation with Amicro Semiconductor Co., Ltd., jointly established a joint laboratory focusing on robot technology and high-integration analog-digital mixed chip design. This project has broken through several key chip technologies, realising functions such as robot products' automatic recognition of the environment, active obstacle avoidance, autonomous positioning, and navigation. Currently, the project has entered the trial production stage and is expected to inject new momentum into the development of the robot industry.

In 2024, Professor Tang cooperated with Zhuhai Xiangyi Aviation Technology Co., Ltd., a subsidiary of China Southern Airlines, has achieved fruitful results. They jointly won the third place in the Hengqin International Scientific and Technological Innovation and Entrepreneurship Competition, with a prize of up to RMB 10 million. At present, both parties are planning to establish a joint laboratory to further promote technological innovation and application. This cooperation not only highlights Professor Tang's leading position in the field of AI but also sets an example for the cooperation between Macao and the Greater Bay Area's enterprises.

橫琴國際科技創新創業大賽獲獎照片
Award-winning Photo of Hengqin International Scientific and Technological Innovation and Entrepreneurship Competition

Looking to the Future: Deep Integration and Interdisciplinary Innovation

In the wave of technological innovation and industrial upgrading, university-enterprise collaboration, with its unique advantages, has become an important engine for promoting social progress and economic development. ZUMRI has achieved remarkable results in this field, and Professor Tang, as an important leader of ZUMRI, has injected new vitality into the development of university-enterprise collaboration with his profound academic background and forward-looking strategic vision.

Professor Tang is well aware that the deep integration of university-enterprise collaboration is the key to promoting technological innovation. He emphasises that universities, enterprises, and the government should form a close integration of industry-academia innovation system to jointly promote the transformation and application of scientific and technological achievements. In this system, ZUMRI not only promotes the rapid transformation of scientific and technological achievements but also promotes the rapid development and upgrading of regional industries. This deeply integrated cooperation model is a concrete manifestation of the 'collaborative innovation' concept advocated by Professor Tang. At the same time, Professor Tang also profoundly recognises the importance of interdisciplinary innovation for university-enterprise collaboration. He points out that smart cities, as a comprehensive research direction, whose research results are applied in multiple fields, require interdisciplinary cooperation to integrate the advantages of various fields and solve complex problems. Therefore, the Hengqin base of the State Key laboratories has been set up by ZUMRI to carry out interdisciplinary cross-cooperation research and has made important progress in key technology platforms for autonomous driving, sensor technology, smart city mixed reality simulation, and intelligent decision-making platforms. These achievements not only enhance the applicability and sustainability of technology but also provide strong technical support for the construction of smart cities.

Looking to the future, Professor Tang is full of expectations for university-enterprise collaboration. He hopes that the cooperation between UM and enterprises in various industries can be more deeply involved in the construction of national emerging industries, especially to achieve more breakthroughs in emerging fields such as embodied intelligence, low-altitude economy. He believes that interdisciplinary cooperation and deep integration will be the main trends of university-enterprise cooperation in the future, and the wide application of intelligent technology will promote the development of smart cities. Professor Tang's research and cooperation not only promote the progress of the field of AI, but also make important contributions to the technological development and industrial upgrading of Macao and the Greater Bay Area. His achievements and vision provide valuable experience and inspiration for future researchers and entrepreneurs. As a pioneer in the field of artificial intelligence and a model of university-enterprise collaboration, Professor Tang's story will continue to inspire more people to move forward bravely, explore the unknown, and contribute their strength to the progress of science and technology and the prosperity of society.

校企合作助推產業轉化：珠海澳大科技研究院——中國生物技術股份有限公司聯合實驗室

University-Enterprise Collaboration Boosts Industrial Transformation: Joint Laboratory of ZUMRI and China National Biotec Group Company Limited

文：由王春明教授研究團隊供稿
Chinese & English Text: Provided by Professor Chunming Wang's Research Team

圖：部分由受訪者提供
Photo: Provided by the interviewee

王春明教授
Professor Chunming Wang

2024年7月，在橫琴粵澳深度合作區（下稱「橫琴合作區」）舉辦的澳琴科創產學研資對接會暨簽約儀式上，珠海澳大科技研究院（下稱「珠研院」）與國藥集團中國生物共建醫學美容生物製品聯合實驗室項目簽約，研究以中藥多糖為原料的祛疤和毛囊生長技術，並聯合推動研發產品產業化。該項目由澳門大學中華醫藥研究院、健康科學學院藥物科學系王春明教授擔任項目負責人。

In July 2024, at the Macao-Hengqin Industry-Academia-Research-Investment Networking in Tech Innovation and Signing Ceremony held in the Guangdong-Macao In-depth Cooperation Zone in Hengqin (Cooperation Zone in Hengqin), the Joint Laboratory of Zhuhai UM Science and Technology Institute (ZUMRI) and China National Biotec Group Company Limited under China National Pharmaceutical Group Co Limited (Sinopharm) signed a project agreement to establish a Joint Laboratory of medical aesthetic bioproducts. The project, led by Professor Chunming Wang from the Institute of Chinese Medical Sciences and the Department of Pharmaceutical Sciences of the Faculty of Health Sciences at UM, focuses on the research of scar removal and hair follicle growth technologies using polysaccharide of Traditional Chinese Medicine as raw materials in order to jointly promote the industrialisation of the research and development products.

在粵港澳大灣區的創新浪潮中，珠海澳大科技研究院——中國生物技術股份有限公司聯合實驗室的建立，開啟了一場校企合作、產業轉化的新征程。這不僅是科研與產業深度融合的生動實踐，更是琴澳融合背景下，生物醫藥產業崛起的強勁信號。

In the wave of innovation across the Guangdong-Hong Kong-Macao Greater Bay Area (Greater Bay Area), the establishment of the Joint Laboratory of ZUMRI and China National Biotec Group has launched a new journey of university-enterprise collaboration and industrial transformation. This is not only a vivid practice of the deep integration of scientific research and industry, but also a strong signal of the rise of the biopharmaceutical industry under the background of the integration of Hengqin and Macao.

糖鏈構築生命土壤，多糖密碼的再生醫學革命

糖類分子廣泛存在與自然界中，既是人體組織支撐細胞生長的重要成分，也是許多中藥、海藻、植物富含的活性物質。王教授多年來對這一類分子的生物學效應情有獨鍾，期望用化學和材料學的技術手段，發掘出糖類分子豐富和更加可控的功能活性，促進創傷癒合與組織修復，應用於臨床實踐。

自2012年在澳大建立課題組以來，王教授團隊就聚焦來源於藥材（如白及、杜仲）、植物（如蒟蒻）、動物（如透明質酸）中的多糖分子，研究它們的生物學活性。然而，天然來源的糖類最大的挑戰，是其組分結構的異質性；因此，多年以來，團隊一直嘗試結合生物化學方法與材料工程技術，讓這些靈巧的分子，更好地成為再生醫學的工具，期望從實驗室一步步走向臨床應用。

從南京接受生物化學本科和碩士訓練，到新加坡專攻組織工程獲得博士學位後，再到劍橋化學系和幹細胞研究所兩位不同領域大師聯合指導下鑽研皮膚幹細胞分化，王教授始終堅信自己大膽的猜想——「如果說細胞是種子，微環境就是土壤，那糖鏈就是土壤裡的養分輸送管道。」這份洞見催生了獨特的研究路徑：用糖分子重構細胞外基質。王教授說，「就像修復貧瘠土地不能只撒種子。創傷不癒、疤痕增生、毛囊萎縮，其實本質都是土壤需要改良。」

基於這一理念，研究團隊不斷開發出獨特的定向修飾技術與精準酶解技術，對不同的多糖進行活性控制，並將看不見的糖分子變化成各種尺度的納米顆粒、微米線條、多孔海綿、生物蛛網和乳劑，應用在免疫調節、皮膚癒合、成骨修復、血管再造、疤痕修復等不同領域，申請二十餘項中國和美國發明專利，在國際一流學術期刊發表數十篇論文，獲得專家學者與臨床醫師的高度關注。

研究團隊正在進行實驗
Research Team is conducting experiment in laboratory

校企攜手，共築產業轉化新高地

廣東省某三甲醫院開啟杜仲多糖創傷敷料臨床合作啟動會
The Launch of the Clinical Collaboration of EU-based Wound Dressings at a Tertiary Hospital in Guangdong Province

王教授深知基礎研究與轉化應用之間的鴻溝，在大學的支持下，於2019年開始探索臨床轉化，儘管這是一條更加艱辛和未知的路途。團隊先後獲得「互聯網+」金獎、創客中國國際賽澳門站冠軍、粵港澳大灣區創新創業大賽亞軍等十餘項殊榮，更在內地與澳門產學研對接會上簽訂逾20份合作意向書，團隊從澳大創新中心孵化而出的「金創克有限公司」累計融資數百萬澳門元，技術授權已為下游企業創造超數千萬營收增長，並作為澳大孵化科技企業榮獲澳門科學技術獎勵之「技術發明二等獎」，加速構建「澳門研發+橫琴轉化」的創新體系。

2024年，團隊與國藥集團中國生物有限公司在橫琴合作區共建聯合實驗室，與該公司下屬的全國醫美領域領軍企業蘭州生物技術開發公司共同開發促進瘢痕修復與毛髮再生的兩類糖類產品。聯合實驗室坐落於澳大在內地的首個產學研基地——珠研院。

國藥集團中國生物副總裁、首席科學家率領從事生物大分子開發的核心技術團隊多次造訪或深入探討分析項目背景後，對澳大團隊鮮明的技術特色和顯著的轉化前景讚不絕口，雙方決定充分結合澳大的技術優勢與國藥中生在產品開發方面的豐富經驗，聚焦兩個核心項目：硫酸化多糖乳液和葡甘寡糖OG6生髮藥物。其中第一個項目創新性地開發出非常柔軟的多糖液滴，可以在創傷原位抑制上游信號分子的活化，阻止疤痕形成；第二個項目則製備出一系列的「分子剪刀」，使用定向酶解的方式從葡甘聚糖長長的分子鏈剪出六節「糖鑰匙」，加速毛囊再生。目前已進入轉化研究快車道。

「聯合實驗室讓我們的科研『種子』在橫琴開花結果。」團隊合作負責人指著臨床試驗進度表說：「兩家三甲醫院的初期數據顯示，患者的疤痕有著明顯改善，這將加速產品上市進程。」聯合實驗室參與方保持密切合作，在近期王教授團隊赴合作方研討時雙方一致認為，現有的工作不僅從理論上突破了傳統治療的局限性，更通過系統性的毒理、藥理和藥效學研究，充分驗證了其有效性和安全性，為後續的臨床應用奠定了堅實的科學基礎。

國藥集團中國生物副總裁、首席科學家張雲濤（左）與王春明（右）團隊聯合研討項目進展
Vice-president and chief scientist of China National Biotec Group Yuntao Zhang (left) and Professor Chunming Wang's Team Discuss Project Progress

從琴澳出發，邁向生物醫藥產業的星辰大海

依託珠研院「中華醫藥及轉化醫學研發中心」以及橫琴的跨境科研政策優勢，王教授團隊的每一步探索都折射出琴澳融合的戰略智慧。珠研院不僅是技術轉化的加速器，更是粵澳規則銜接的試驗田——跨境科研資金流動、港澳科研物資通關便利化、內地與澳門知識產權互認等創新機制，為糖類分子研究的產業化掃除壁壘。正如王教授所言：「橫琴的獨特定位，讓我們的科研既能紮根澳門特色，又能擁抱大灣區產業鏈，真正實現『一顆種子，兩地開花』。」

從澳大實驗室裡的糖分子探索，到橫琴聯合實驗室的產業攻關，王教授的科研之路印證了粵港澳大灣區創新協同的強大張力，這場跨越制度邊界的科研接力，不僅催生了生物醫藥領域的創新突破，更為澳門經濟適度多元發展提供了生動範本。在這裡，王教授團隊的糖類分子研究，正從實驗室的微觀世界躍入產業化的星辰大海。

Polysaccharides Construct the Soil of Life: The Regenerative Medicine Revolution of the Polysaccharide Code

Polysaccharide molecules are widely present in nature, serving as both an important component supporting cell growth in human tissues and an active substance rich in many traditional Chinese medicine, seaweeds, and plants. Professor Wang has long been fascinated by the biological effects of these molecules and hopes to use chemical and material science techniques to explore the richness and more controllable functional activities of polysaccharide molecules to promote wound healing and tissue repair for clinical application.

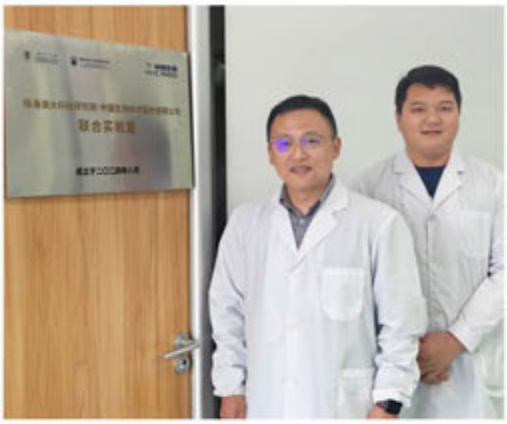
Since establishing his research group at UM in 2012, Professor Wang's team has focused on polysaccharide molecules derived from medicinal materials (such as Bletilla striata and Eucommia ulmoides), plants (such as konjac), and animals (such as hyaluronic acid), studying their biological activities. However, the biggest challenge of naturally sourced polysaccharides is their heterogeneous composition. Therefore, over the years, the team has been trying to combine biochemical methods with material engineering techniques to make these versatile molecules better tools for regenerative medicine, with the expectation of moving from the laboratory to clinical application step by step.

After receiving his undergraduate and master's training in biochemistry in Nanjing, obtaining his Ph.D. in Tissue Engineering in Singapore, and conducting research on skin stem cell differentiation under the joint guidance of two masters in different fields at the University of Cambridge's Department of Chemistry and Stem Cell Institute, Professor Wang has always firmly believed in his bold hypothesis, that is, 'If cells are seeds and the microenvironment is the soil, then sugar chain are the nutrient delivery pipelines in the soil.' This insight has given birth to a unique research path: using sugar molecules to reconstruct the extracellular matrix. Professor Wang said, 'Just as repairing barren land cannot be done by simply sowing seeds, the essence of non-healing wounds, scar hyperplasia, and hair follicle atrophy is that the soil needs to be improved.'

Based on this concept, the research team has continuously developed unique directional modification techniques and precise enzymatic hydrolysis techniques to control the activity of different polysaccharides. They have transformed the invisible sugar molecules into various forms such as nanoscale particles, micrometre-sized lines, porous sponges, biomimetic spider webs, and emulsions. These innovations have been applied in diverse fields, including immune regulation, skin healing, bone repair, blood vessel regeneration, and scar repair. The team has applied for more than twenty invention patents in China and U.S., and published dozens of papers in top international academic journals, attracting significant attention from experts, scholars, and clinicians.

University-Enterprise Collaboration to Build a New High Ground for Industrial Transformation

Professor Wang is well aware of the gap between basic research and translational application. With the support of UM, he began to explore clinical transformation in 2019, despite the more arduous and unknown journey ahead. The team has successively won more than ten honours, including the Gold Award at China College Students' 'Internet+' Innovation and Entrepreneurship Competition, the Champion of the Macao Station of the International Maker's Competition, and the Runner-up of the Greater Bay Area Innovation and Entrepreneurship Competition. They have also entered into more than 20 cooperation intention agreements at Industry-University-Research Collaboration Roadshow and Matchmaking Meeting Between Mainland China and Macao. The team's 'Genetrump Co., Ltd.' hatched from UM Centre for Innovation and Entrepreneurship has raised millions of Macao Patacas in financing. The technology licensing has created tens of millions of revenue growth for downstream enterprises and has been awarded the second prize for Technological Invention Award of Macao Science and Technology Awards as a technology enterprise hatched from UM, accelerating the construction of the 'R&D in Macao, transformation in Hengqin' innovation system.



位於橫琴粵澳深度合作區的澳大珠研院 - 國藥中生聯合實驗室
The Joint Laboratory of ZUMRI and Sinopharm, located in Cooperation Zone in Hengqin

In 2024, the team jointly built a Joint Laboratory with China National Biotec Group Company Limited (Sinopharm) in the Cooperation Zone in Hengqin and developed two types of polysaccharide products for scar repair and hair regeneration in collaboration with the Sinopharm's leading enterprise in the national medical aesthetics field, Lanzhou Biotechnology Development Co., Ltd. The Joint Laboratory is located at ZUMRI, the UM's first industry-academia base in mainland China.

團隊抗疤痕多醣項目榮獲「創客中國」亞軍殊榮
The team's glycans for wound healing Project Wins the Runner-up of the 'Maker in China' Competition

After the vice-president of China National Biotech Group and its chief scientist, with the core technical team engaged in the development of biological macromolecules to visit and conduct in-depth discussions on the project background several times, they highly praised the distinct technical characteristics and significant transformation prospects of UM's team. The two parties decided to fully combine UM's technical advantages with China National Biotec Group's rich experience in product development, focusing on two core projects: sulfated polysaccharide emulsion and oligoglucosamine OG6 hair growth drug. The first project innovatively developed very soft polysaccharide droplets that can inhibit the activation of upstream signalling molecules at the wound site to prevent scar formation. The second project prepared a series of 'molecular scissors' to cut out six 'sugar keys' from the long molecular chain of oligoglucosamine using directional enzymatic hydrolysis to accelerate hair follicle regeneration. Both projects have now entered the fast track of translational research.

'The Joint Laboratory allows our scientific research seeds to blossom and bear fruit in Hengqin,' said the team's collaboration leader, pointing to the clinical trial schedule. 'Initial data from two tertiary hospitals show significant improvement in patients' scars, which will accelerate the product's market launch.' The participants of the Joint Laboratory maintain close cooperation. During a recent visit by Professor Wang's team to the partner, both parties unanimously agreed that the current work has not only theoretically broken through the limitations of traditional treatments but also, through systematic toxicology, pharmacology and pharmacodynamics research, fully verified its effectiveness and safety, laying a solid scientific foundation for subsequent clinical application.

From Hengqin and Macao to the Boundless Future of the Biopharmaceutical Industry

Relying on the Research and Development Centre For Chinese Medicine and Translational Medicine under ZUMRI and the unique cross-border research and development policy advantages of Hengqin, every step of Professor Wang's team reflects the strategic vision of Hengqin-Macao integration. ZUMRI not only serves as an accelerator for technology commercialisation but also acts as a testing ground for aligning Guangdong-Macao regulations - innovative mechanisms such as cross-border research and development capital flow, facilitation of cross-border research and development material passage, and mutual recognition of intellectual property rights between mainland China and Macao have removed barriers to the industrialisation of polysaccharide molecule research. As Professor Wang said, 'The unique positioning of Hengqin allows our scientific research to take root in Macao's characteristics while embracing the Greater Bay Area's industrial chain, truly achieving *one seed, two flowers in different places.*'

From the exploration of polysaccharide molecules in UM's laboratory to tackling industrial challenges of the Joint Laboratory in Hengqin, Professor Wang's scientific research path has verified the strong synergy of innovation and collaboration in the Greater Bay Area. This cross-border research relay, transcending institutional boundaries, has not only catalysed breakthroughs in biopharmaceuticals but also provided a compelling blueprint for Macao's development on appropriate economic diversification. Here, Professor Wang's team is propelling polysaccharide molecules research from the microscopic realm of the laboratory into the boundless horizon of industrialisation.

2024 年澳大科研總體情況

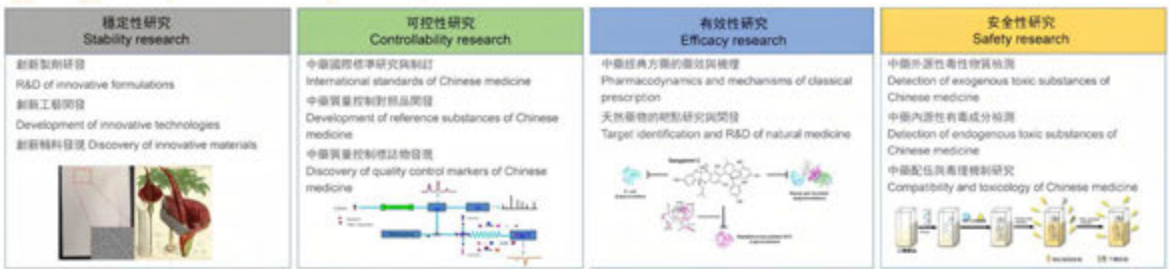
2024 Overview of UM Scientific Research

國家重點實驗室年度總體情況
Overview of State Key Laboratories

中藥質量研究國家重點實驗室（澳門大學）
State Key Laboratory of Quality Research in Chinese Medicine (University of Macau)

● 主要研究

實驗室聚焦中藥臨床療效的生物學機制及其物質基礎，致力基於藥效機制的中藥質量研究、基於毒理機制的中藥安全性評價、新技術新方法的中藥質量評價，以及科學成果轉化與監管科學研究。同時，實驗室積極推動先進材料、合成生物學及人工智能等前沿技術與中藥研究的融合，並加強成果轉化，推動中藥現代化、產業化及國際化，服務國家及澳門中藥產業發展。



人才建設與培養

實驗室於2024年8月引進了專注於流行病學、公共衛生和藥物流行病學研究的優秀學者李馳華博士，其在哥倫比亞大學獲得碩士和博士學位，並先後在密歇根大學、約翰·霍普金斯大學和哥倫比亞大學進行博士後研究。自加入實驗室以來，李博士在高影響力研究方面做出了顯著貢獻。他作為主研人員，關於生命早期逆境與慢性病風險的研究成果發表於國際頂尖期刊《Science》，並引起了學術界廣泛關注。此外，他的系列研究成果發表於《BMJ Global Health》《BMC Medicine》《Pain》等多家知名醫學期刊上。實驗室建立了完善的人才培養體系，2024年招收生物醫藥博士研究生78人、中藥學和醫藥管理碩士研究生117人、藥物科學本科學生25名。

實驗平台

實驗室圍繞中藥藥效與機制、安全性評價、創新製劑、質量控制等方向建立了先進的研究平台。2024年，實驗室的SPF級動物中心投入使用，進一步完善了實驗室的科研平台。

主要成就

研究獎項

2024年度，實驗室多項研究成果獲得科學技術獎勵，尤其是囊括了6項2024澳門科學技術獎，包括自然科學獎二等獎1項、三等獎2項，技術發明獎二等獎2項、三等獎1項。

學術交流與合作

實驗室於2024年舉辦「第二屆中藥與天然藥物國際研討會」、「首屆計算藥劑學研討會—製藥4.0中的人工智能和建模」、「監管科學創新與醫藥國際化研討會」等推動國際學術交流與合作。

第二屆中藥與天然藥物國際研討會
2nd International Symposium on Chinese Medicine and Natural Products (Macao)

首屆計算藥劑學研討會
1st Symposium on Computational Pharmaceutics

監管科學創新與醫藥國際化研討會
Regulatory Science for Pharmaceutical Innovation and Internationalization Conference

重大項目

實驗室萬建波教授首次揭示了中藥三七葉中存在位於葉綠體的新型β-葡萄糖苷水解酶和原人參二醇型皂苷組成的雙元素化學防禦系統，並在人參屬其他重要的藥用植物人參和西洋參中，也發現了類似的雙元素防禦反應。這些發現為開發植物源性農藥提供了重要的啟示和研究思路，為中藥研究和中藥材的可持續發展做出積極的貢獻。

研究成果

項目	成果
2024年論文發表期刊	347
高被引論文數量	6+
累積發表 SCI 論文數	4,200+
總被引次數	140,000+

Main Research Areas

The State Key Laboratory of Quality Research in Chinese Medicine (SKL-QRCM) focuses on the biological mechanisms and material basis of the clinical efficacy of Chinese medicine. SKL-QRCM is dedicated to carrying out quality research of Chinese medicine based on efficacy mechanisms, safety evaluations of Chinese medicine based on toxicological mechanisms, quality assessment of Chinese medicine using new technologies and methods, as well as transformation of research achievements and research on regulatory science. At the same time, SKL-QRCM actively promotes the integration of advanced materials, synthetic biology, and artificial intelligence with Chinese medicine research, and strengthens the transformation of results to drive the modernisation, industrialisation, and internationalisation of Chinese medicine, serving the development of the Chinese medicine industry in China and Macao.

Talent Development and Cultivation

In August 2024, SKL-QRCM welcomed a new academic staff, Dr. Chihua Li, who is an outstanding scholar focused on epidemiology, public health, and pharmacological epidemiology research. He obtained his DrPH and master' s degrees from Columbia University and conducted postdoctoral research at the University of Michigan, Johns Hopkins University, and Columbia University. Since joining SKL-QRCM, Dr. Li has made significant contributions to high-impact research. As a principal investigator, his findings on early life adversity and chronic disease risk were published in the internationally renowned journal *Science*, attracting widespread attention in the academic community. Additionally, his series of research results have been published in several prestigious medical journals, including *BMJ Global Health, BMC Medicine, and Pain.* SKL-QRCM has established a comprehensive talent training system. It admitted 78 doctoral students in Biomedical Sciences, 117 master' s students in Chinese Medicinal Science and Medicinal Administration, and 25 undergraduate students in Pharmaceutical Sciences.

Research Platforms

SKL-QRCM has established advanced research platforms focusing on areas such as the efficacy and mechanisms of Chinese medicine, safety evaluation, innovative formulations, and quality control. The SPF animal center under SKL-QRCM started its operation in 2024, further enhancing the research capabilities of SKL-QRCM.

Major Achievements

Research Awards

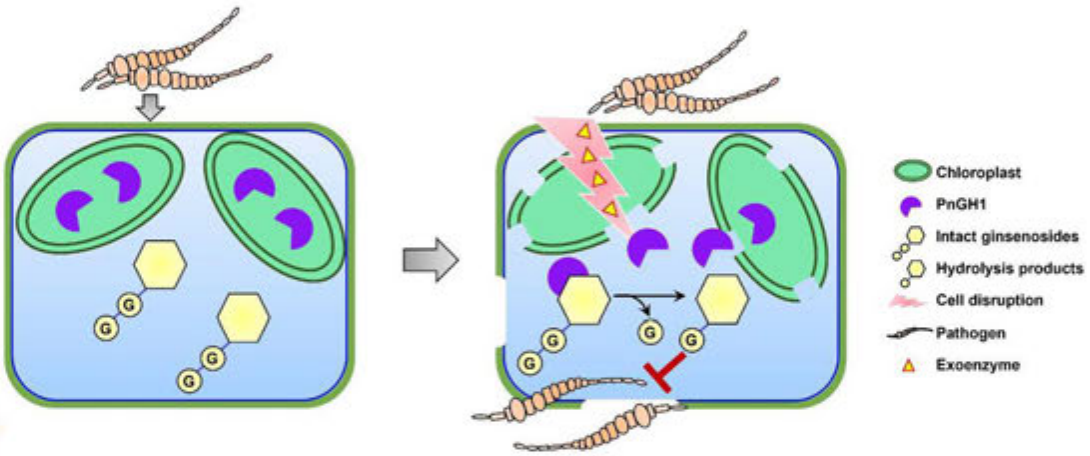
In 2024, SKL-QRCM received multiple scientific and technological awards, notably winning six awards at the 2024 Macao Science and Technology Awards. These include one second prize and two third prizes in the Natural Sciences category, as well as two second prizes and one third prize in the Technological Invention category.

Academic Exchanges and Collaborations

In 2024, SKL-QRCM hosted several international academic conferences to promote scholarly exchange and collaboration, including the '2nd International Symposium on Chinese Medicine and Natural Products (Macao)', the '1st Symposium on Computational Pharmaceutics—AI and Modeling in Pharma 4.0' and the 'Regulatory Science for Pharmaceutical Innovation and Internationalization Conference'.

Major Projects

Prof. Jianbo WAN of SKL-QRCM has unveiled a novel dual-element chemical defense system located in the chloroplasts of the Chinese medicine *Panax notoginseng*, which consists of a new β-glucosidase and ginsenoside of the protopanaxadiol type. Similar dual-element defense responses have also been identified in other important medicinal plants, including ginseng and American ginseng. These findings provide significant insights and research directions for the development of plant-based pesticides, contributing positively to the study of Chinese medicine and the sustainable development of Chinese medicinal herbs.



人參屬植物中雙元素防禦反應示意圖
A schematic diagram of the two-component chemical defence system in Panax species

Research Output

Items	Outcomes
Papers Published in SCI-indexed journals	347
Highly Cited Papers	6+
Total Number of Papers Published in SCI-indexed Journals	4,200+
Total Number of Citations	140,000+

模擬與混合信號超大規模集成電路國家重點實驗室（澳門大學）
State Key Laboratory of Analog and Mixed-Signal VLSI (University of Macau)

● 主要研究

實驗室的主要研究領域集中於前沿電子學及相關新興領域，重點是模擬和混合信號電路。實驗室重點推進模擬與混合信號集成電路科研進行前沿研究，包括數據轉換器，模擬電路和信號處理，無線通信，生物醫學工程，電源管理以及人工智能等方面，同時研發應用於大規模印刷電子的高能效與高性能微電子芯片，探索存內計算與低溫電子學等新領域。這些芯片是5G+無線通信，人工智能物聯網（AI-IoT）和量子計算等新興應用不可或缺的基石。實驗室連續多年在全球頂尖微電子會議——國際固態電路會議（ISSCC）上取得突破性成果，累計發表88篇論文，其中2024年發表14篇芯片研究成果及相關論文。

● 人才建設與培養

實驗室核心研究團隊包括1位講座教授、2位正教授、7位副教授、13位助理教授、2位澳大濠江學者和3位研究助理教授。團隊成員中包括2位葡萄牙里斯本科學院院士、2位美國IEEE會士和1位英國皇家化學學會（RSC）及國際工程技術學會（IET）會士。為了支持實驗室的快速發展，持續大力度招聘正教授、副教授、助理教授等各職級教研人員，面向全球吸引高質量、具有國際競爭力的優秀人才加入，提升整體科研水平和人才培養能力。2024年完成4名助理教授及2名研究助理教授的招聘工作，分別專精於射頻集成電路、奈米光學與超材料、神經元計算架構、生物醫學/環境應用的微型芯片、可再生能源電力電子、集成感測器等前沿電子學領域。另外，亦招聘了17名博士後研究員、17名研究助理，加強各個集成電路科研團隊的人才建設。

實驗室正在培養超過350名博士和碩士研究生，學生直接參與尖端研究項目，獲得前沿微電子學的研發及實踐經驗，支持並鼓勵學生於ISSCC和JSSC頂級會議及期刊發表論文。2024年3月19日至22日，與復旦大學、電子科技大學、清華大學和東南大學等國內頂尖高校合作，於上海舉辦第六屆「華人芯片設計技術研討會」，為中國集成電路設計的學術界和產業界同仁建立一個頂尖的技術交流平台，營造開放的技術討論氛圍，促進可能的合作。實驗室除了參與為組織本地中學生夏令營，推廣STEM教育，並激發下一代微電子學研究人員的興趣外，亦於橫琴組織學生就業對接活動，積極邀請大灣區及周邊地區的知名企業參與，為學生搭建與產業界面對面交流的平台，助力實驗室的畢業生更順利地融入大灣區集成電路產業發展，實現個人職業發展與區域產業發展的良性互動。

華人芯片設計技術研討會
Workshop on IC Advances in China

為中學生舉辦的芯片設計夏令營
IC Design Summer Camp for Secondary School Students

● 實驗平台

實驗室的實驗平台達6,000平方米，配備了超過550台微電子及跨學科領域的專業儀器。這些儀器包括高端微電子測量儀器、高性能網絡和電子設計自動化（EDA）仿真伺服器、先進測量及特殊處理潔淨實驗室、生物電子學實驗室和微電子測量實驗室等設施。實驗室還建立了一套獨立且高度安全的訪問控制系統，並與EDA相關的設計流程相結合。

主要成就

研究獎項

實驗室成員於2024年持續獲得多個科研及功績獎項，包括麥沛然教授獲頒澳門特區政府教育功績勳章，表揚他對澳門的科研教育事業作出了積極貢獻。馬許願教授獲葡萄牙工程師學會頒發電機工程國家獎，以表彰他在電機工程領域的貢獻，以及推動澳大電機工程教研發展和促進產學技術轉移的努力。另外，一名博士生亦於2024國際固態電路會議（ISSCC）獲得博士生成就獎，以及實驗室的產學研團隊獲2024澳門大學中銀杯極創客創業大賽一等獎及最佳展示獎。實驗室於2024年度科學技術獎獲獎者中獲兩項技術發明獎三等獎，以及三名博士生獲研究生科技研發獎。

學術交流與合作

實驗室鼓勵學科交叉和高水準學術研究，並積極促進與國內外科研機構的合作交流。實驗室與美國哈佛大學、美國北卡羅萊納州立大學、比利時荷語天主教魯汶大學、南方科技大學、西安電子科技大學、西安交通大學、電子科技大學、中國科學院大學等進行科研合作，於IEEE固態電路期刊（JSSC）、分析化學等電子及跨學科領域期刊共同發表論文。實驗室在重點研究領域設立開放課題，鼓勵待與優秀研究團隊攜手合作，共同推動科研發展。2024年促成了與馬來亞大學的「為超低功耗（ULP）物聯網（IoT）感測器節點設計完全整合的喚醒計時器」開放課題項目。

重大項目

實驗室於2024年進行兩項科學技術發展基金（FDCT）重點研發專項資助項目，當中「於先進納米級工藝下開發高能效高分辨率吉赫茲採樣率的模數轉換器」於2024年結題，項目中針對在先進納米CMOS及finFET工藝下，建立高速高精及高能效的ADC系統架構、放大器、參考緩衝及校準等關鍵技術，完成高集成度ADC芯片應用測試、理論驗證及關鍵技術突破。透過設在橫琴的珠海澳大科技研究院與相關領域企業進行合作研究，帶動企業於項目中投入六百多萬人民幣，並圍繞項目中多項產業化相關參數進行深入討論和研發。

另外，「面向未來智能移動機器人的關鍵芯片電路技術研究」的重點研發專項資助項目於2024年獲批。本研究將面向未來高能效、智能化的智能機器人系統對核心芯片在功能及性能上的需求，對關鍵傳感器、電能轉換、數據轉換與處理芯片等領域開展前沿性技術創新與研發。

實驗室於2024年正在進行12項FDCT與廣東省、科技部、國家自然科學基金（NSFC）等聯合項目，7項FDCT項目，參與3項NSFC項目、10項由省部級項目，以及19項產學研合作項目。當中NSFC項目及6個產學研合作項目於2024年結題。

研究成就

實驗室團隊一直專注於研發先進的低功耗模數轉換器（ADC）。這種ADC已被整合到機器人控制器的系統級芯片中。為了進一步將研究成果產業化，基於國家重點研發計劃「智能機器人」重點專項「機器人環境建模與導航定位專用芯片及軟硬件模組」與一微半導體（Amicro）的合作，實現了智能機器人可以進行自助定位和導航，並成功向市場推出商用產品。項目共發表4篇IEEE期刊（包括國際頂刊JSSC）、1篇IEEE國際會議論文。2023年完成2項澳門大學、一微半導體、珠海澳大科技研究院專利授權簽約，共建聯合實驗室揭牌，廣東省移動機器人專用芯片工程技術研究中心揭牌。於 2024 年 12 月與一微半導體簽署了諒解備忘錄（MoU），進一步推進關鍵機器人技術的研究和應用，從而實現「澳門研發，橫琴產業化」的模式，助力於澳門產業的多元化發展，並將更多智能機器人產品帶向海外。

研究成果

項目	成果
2024年發表國際期刊論文	108
2024年發表國際會議論文	72
總被引次數	16,264*

*注：1. 當中 JSSC 論文「A 10-bit 100-MS/s Reference-Free SAR ADC in 90 nm CMOS」獲 626 次引用，入選 ESI 高被引論文榜。

2. 在 IEEE Xplore 數據庫中，在前 250 篇被引用的 SAR ADC 論文中被引用次數排第二。

Main Research Areas

The Laboratory' s principal research fields are concentrated upon the state-of-the-art electronics and emerging domains, with research emphasis in analog and mixed-signal circuits, particularly focusing on analog and mixed-signal integrated circuit research at the forefront. The Laboratory conducts advance research in diverse areas, including data converters, analog circuits and signal processing, wireless communication, biomedical engineering, power management, and artificial intelligence. In addition, the Laboratory is engaged in the development of high-efficiency and high-performance microelectronic chips purposed for large-scale printed electronics, and the exploration of novel fields such as in-memory computation and cryo-electronics. These chips are indispensable cornerstones for emergent applications, encompassing 5G+ wireless communication, Artificial Intelligence of Things (AI-IoT), and quantum computation.

The Laboratory has consistently achieved ground-breaking results at the International Solid-State Circuits Conference (ISSCC), the world' s premier microelectronics conference, with a cumulative total of 88 papers published. In 2024, 14 papers on chip research and related advancements were presented.

Talent Development and Cultivation

The core research team of the Laboratory encompasses a Chair Professor, 2 Full Professors, 7 Associate Professors, 13 Assistant Professors, 2 UM Macao Fellows, and 3 Research Assistant Professors. Amongst the distinguished members of the team are two Academicians of the Academy of Sciences of Lisbon, Portugal, two Fellows of the Institute of Electrical and Electronics Engineers (IEEE) of the United States, and one Fellow of both the Royal Society of Chemistry (RSC) & the Institution of Engineering and Technology (IET).

To sustain the Laboratory' s rapid advancement, a vigorous and continuous effort is dedicated to the recruitment of faculty and research personnel across all ranks, including Full Professors, Associate Professors, and Assistant Professors. This endeavor is directed towards attracting high-caliber, internationally competitive talents to join the Laboratory, thereby elevating the overall research standard and talent cultivation capabilities. In the year 2024, the recruitment of 4 Assistant Professors and 2 Research Assistant Professors was successfully concluded, each specializing in the state-of-the-art researches of radio-frequency integrated circuits, Nano-optics and metamaterials, Neuromorphic computing architecture, miniaturized chips for biomedical/environmental applications, power electronics for renewable energy, and integrated sensors. Furthermore, 17 Post-doctoral Fellows and 17 Research Assistants were also recruited, thus strengthening the human resources of each integrated circuit research team.

The Laboratory is presently nurturing over 350 doctoral and master' s degree candidates. Students directly participate in cutting-edge research projects, gaining research and development and practical experience in the vanguard of microelectronics. The Laboratory actively supports and encourages students to publish papers in top-tier conferences and journals such as ISSCC and JSSC.

From 19 - 22 March 2024, in collaboration with top domestic universities such as Fudan University, the University of Electronic Science and Technology of China, Tsinghua University, and Southeast University, the 6th 'Workshop on IC Advances in China' was organised in Shanghai. This served as a foremost platform for technical exchange for colleagues in the academic and industrial spheres of integrated circuit design in China, fostering an open atmosphere for technical discourse and facilitating potential collaborations.

In addition to participating in the organisation of summer camps for local secondary school students to promote STEM education and inspire the interest of the next generation of microelectronics researchers, the Laboratory also organised student job-matching activities in Hengqin. Renowned enterprises from the Greater Bay Area and surrounding regions were actively invited to participate, providing a platform for students to engage directly with industry representatives, thereby assisting graduates of the Laboratory to more readily integrate into the development of the integrated circuit industries in the Greater Bay Area, and to realize a virtuous cycle between personal career advancement and regional industrial development.

Research Platforms

The Laboratory' s experimental platforms extend across 6,000 square metres, equipped with over 550 specialised instruments pertinent to microelectronics and interdisciplinary domains. These instruments include high-end microelectronic measurement apparatus, high-performance networks and servers for Electronic Design Automation (EDA) simulation, advanced measurement and specialised processing cleanroom laboratories, bioelectronics laboratories, and microelectronics measurement laboratories, amongst other facilities. The Laboratory has also established a discrete and highly secure access control system, integrated with design flows related to EDA system.

模數轉換器測量設備
Analog-to-Digital Converter (ADC) Measurement Equipment

Major Achievements

Research Awards

In 2024, members of the Laboratory continued to achieve numerous research and merit awards. Notably, Prof. Pui In Mak was awarded the Medal of Merit – Education by the Macao Special Administrative Region Government, in recognition of his significant contributions to scientific research and education in Macao. Prof. Rui Martins received the national award in electrical engineering from Ordem dos Engenheiros of Portugal, in recognition of his significant contributions to the field of electrical engineering, as well as his

efforts to promote the development of teaching and research in electrical engineering at UM and to facilitate industry-academia technology transfer. Moreover, a PhD student was honoured with the SSCS Pre-doctoral Achievement Award at the 2024 International Solid-State Circuits Conference (ISSCC). Also, a Laboratory's industry-academia-research team was awarded the Championship and Best Display Award at the 2024 University of Macau Bank of China Cup Extreme Innovators Entrepreneurship Competition. The Laboratory was listed amongst the proposed recipients of the 2024 Macao Science and Technology Awards, securing two 3rd Prizes for Technological Invention and 3 Doctoral Research and Development Student Awards.

Academic Exchanges and Collaborations

The Laboratory actively encourages interdisciplinary studies and high-standard scholarly research, and proactively fosters collaborative exchanges with research institutions both domestically and internationally. The Laboratory engages in research collaborations with top institutions such as Harvard University, North Carolina State University, KU Leuven, the Southern University of Science and Technology, Xidian University, Xi'an Jiaotong University, the University of Electronic Science and Technology of China, the University of Chinese Academy of Sciences, etc. Joint publications have been achieved in journals of electronics and interdisciplinary fields, such as the IEEE Journal of Solid-State Circuits (JSSC) and Analytical Chemistry.

The Laboratory has established open research topics within key research areas, encouraging collaboration with distinguished research teams to jointly advance scientific progress. In the year 2024, an open research project was initiated with University Malaya, entitled 'Design of Fully Integrated Wakeup Timer for Ultra-Low-Power (ULP) Internet-of-Things (IoT) Sensor Nodes'.

Major Projects

In 2024, the Laboratory was conducting two Science and Technology Development Fund (FDCT) Key Research and Development Projects. Amongst these, the project 'Develop Power-Efficient High-Resolution GHz-Range Analog-to-Digital Converters in Advanced Nanometer-Scale Technology' was concluded in 2024. This project aimed to establish key technologies such as high-speed, high-precision, and high-efficiency ADC system architectures, amplifiers, reference buffers, and calibration techniques under advanced nanometre CMOS and FinFET processes. It concentrated on the application testing of highly integrated ADC chips, theoretical validation, and significant technological breakthroughs. Through collaborative research with enterprises in related fields via the Zhuhai UM Science and Technology Research Institute (ZUMRI) located in Hengqin, the project attracted corporate investment exceeding RMB 6 million, and facilitated in-depth discussions and research and development focused on numerous parameters pertinent to industrialisation.

Furthermore, the Key Research and Development Special Funding Project 'Research and Development on Key Integrated Circuit Technologies for Future Intelligent Robots' was approved in 2024. This research will address the functional and performance demands of core chips in future high-efficiency, intelligent robot systems, and will conduct pioneering technological innovation and research and development in key areas such as sensors, power conversion, data conversion and signal processing chips.

In the year 2024, the Laboratory had 12 ongoing projects jointly funded by the FDCT and Guangdong Province, the Ministry of Science and Technology, and the National Natural Science Foundation of China (NSFC), 7 FDCT projects, participation in 3 NSFC projects, 10 provincial and ministerial-level projects, and 19 industry-academia research collaboration projects. Amongst these, NSFC projects and 6 industry-academia research collaboration projects were concluded in 2024.

Research Achievement

The Laboratory team has consistently focused on the research and development of advanced low-power Analog-to-Digital Converters (ADCs). This type of ADC has been integrated into the system-on-chip of robot controllers. To further industrialize research outcomes, and under the auspices of the National Key R&D Program's 'Intelligent Robot' Key Special Project, 'Special Chips and Software and Hardware Modules for Robot Environment Modeling and Navigation Positioning', collaboration with Amicro Semiconductor (Amicro) has enabled intelligent robots to perform self-localization and navigation, and has successfully launched commercial products into the market. The project has resulted in the publication of 4 IEEE journal papers (including the preeminent international journal JSSC) and 1 IEEE international conference paper. In 2023, two patent licensing agreements were signed between UM, Amicro, and ZUMRI, and two joint laboratories are established with Amicro in 2023. Additionally, ZUMRI and Amicro Technology (Macau) have signed a memorandum of understanding (MOU) in December 2024 to further advance the research and application of key robotics technologies, thereby realising the model of 'Research in Macao, Commercialise in Hengqin'. This partnership will also fully leverage Macao's market resources and platform advantages, enabling more smart robot products to establish a foothold in Hengqin and expand into Portuguese-speaking countries. This initiative will contribute to the diversified development of Macao's industries and bring more smart robot products overseas.

Research Output

Items	Outcomes
IInternational Journal Papers Published in 2024	108
IInternational Conference Papers Published in 2024	72
Total Number of Citations	16,264 *

* 1. Amongst these, the JSSC paper 'A 10-bit 100-MS/s Reference-Free SAR ADC in 90 nm CMOS' has obtained 626 citations, and has been selected for the ESI Highly Cited Papers list.

2. In the IEEE Xplore database, it is ranked 2nd in citation count amongst the top 250 cited SAR ADC papers.

智慧城市物聯網國家重點實驗室（澳門大學）
State Key Laboratory of Internet of Things for Smart City (University of Macau)

● 主要研究

實驗室的研究聚焦智能傳感與網路通信、城市大數據與智能技術、智慧能源、智能交通、城市安全與災害防治五個關鍵領域。各團隊積極探索，共同豐富智慧城市建設的技術理論體系：提出「新型可重構分佈式天線與反射面輔助通信感知一體化架構」，具備成為未來6G無線通信關鍵技術的巨大潛力；與國家電投合作開發了區域供冷系統供冷需求預測算法包、蓄冰量優化算法包，並在橫琴區域的供冷系統中應用，達成顯著的節能降耗效果；通過AI與大數據優化城市交通流量，推動自動駕駛與車聯網技術的研發；基礎設施安全智能預警技術應用於港珠澳大橋與橫琴二橋等重大工程，提升了對城市大型基建的實時健康監測和維護管理。未來，實驗室將在通感一體化、城市大數據與智能決策、複雜能源建模分析、自動駕駛，以及濱海城市海洋災害評估與基礎設施智慧監測與運維等研究方向持續創新，為智慧城市的建設提供有力的技術支撐。

● 人才建設與培養

實驗室秉持開放多元的理念，面向全球招募優秀人才，每年持續引入多位教職員和研究人員，涵蓋通信、物聯網、大數據等研究方向，以及文物保護技術等跨學科創新領域。新成員的加入為實驗室的學術氛圍注入了新活力，進一步夯實了實驗室的研究能力及推動創新成果的轉化。實驗室致力於支持早期職業研究人員和學生的成長，過去六年，實驗室已成功培養了89名博士研究生和201名碩士研究生。目前，在讀學生人數達到267名博士研究生和245名碩士研究生。為了促進學術交流和科研能力的提升，我們舉辦了「優秀大學生暑期研習營」，為優秀大學生提供了一個學術交流的平台，促進了他們與研究人員之間的互動和學習。此外，實驗室還通過開展面向小學生的科普活動，向他們普及城市災害與風險管理知識，幫助培養未來的科學人才和提升公眾對城市安全問題的意識。通過這些多元化的培養模式，實驗室不僅為學生提供了紮實的學術訓練，還積極為他們創造了更多的實踐機會，幫助各年齡段的人才在研究、創新和社會服務等領域取得全面發展。

實驗平台

實驗室配備了多項先進的實驗平台，包括智能超算中心，通過對硬軟件環境升級，大幅提升大規模數據分析與模型訓練能力，達到領先水平；設立遙感衛星地面站，確保高效的遙感數據採集與處理；智慧綜合能源管理平台，通過電力系統分析程序和實時仿真裝置，實現了能源調度與優化控制的再升級。此外，我們還擁有虛實結合的交通平台，包括自動駕駛巴士、智能車路協同系統和用於城市環境建模的前沿機器人，為智能交通系統的研究提供了豐富的測試環境。自主研發的高精度傳感器技術，不斷提升了物聯設備的通感能力，為智慧城市創新應用奠定了基礎，推動了跨學科、跨領域的研究合作。

主要成就

研究獎項

過去一年，實驗室團隊在多個國際賽事中屢獲殊榮。學術帶頭人阮家榮教授榮獲中國工程界最高獎項之一「第十五屆光華工程科技獎」，發展出一系列沒有外力數據的貝葉斯參數識別法，引領模型選擇研究。吳遠教授的算網融合協同優化理論，獲得了廣東省電子信息科學技術一等獎和浙江省科學技術獎自然科學二等獎，表彰了其在智能計算與網絡優化領域的突出貢獻。此外，實驗室的30餘名教授、博士後研究人員以及優秀碩博學生分別斬獲國際會議最佳論文獎、全球技術挑戰賽特等獎，大學生論文競賽一、二等獎。這些獎項不僅體現了實驗室的科研實力，也展示了團隊在全球技術創新和學術交流中的影響力。

學術交流與合作

實驗室自2021年起設立開放課題，截至2024年，共計38項課題，提供支持經費超過175萬。2024年，獲批6個項目，合作單位涵蓋國內外多個知名學府，包括漢諾瓦萊布尼茲大學、北京大學、浙江大學、武漢大學等。研究方向涉及智慧城市前沿與熱點課題，如數字孿生、網絡安全、視頻分析等。這些合作不僅增強了實驗室在全球科研領域的影響力，還為推動跨學科創新和解決全球城市化挑戰提供了有力支持。同時，實驗室積極組織學術交流項目，成功舉辦了第四屆澳門國際智慧城市技術研討會、智慧城市可持續發展研討會，與全球頂尖學者展開深入討論，促進了科技成果的共享和技術的互通。

第四屆澳門國際智慧城市技術研討會
4th Macao International Conference on Smart City Technologies

智慧城市可持續發展研討會
Smart City Sustainable Development Seminar

重大項目

實驗室領導和參與了多個來自政府、學界、業界的科研攻堅課題，資金來源涵蓋國家自然科學基金、澳門基金會以及校企合作等。這些項目聚焦於集成能源系統、智能監控技術在交通和基礎設施中的應用等前沿領域，具有重要的科研價值和實際意義。其中，海底滑坡流體動力學及其力學過程和岩土災害防治項目，旨在深入剖析岩土災害的機制，並探索高效的防災減災技術，期望為實際應用提供理論支持和技術保障。自動駕駛電動汽車車隊優化項目，採用先進的機器學習和邊緣計算技術，致力於提升交通效率、降低能源消耗，為智能交通系統的未來發展提供技術突破。我們還專注於環境管理，通過風暴潮預警與災害預測技術項目，研究氣候變化對沿海社區的影響，期望為災害預警和防治提供科學依據和技術解決方案。這些重大項目的實施將推動環境與城市管理領域的創新，推動更加韌性強、能源高效且可持續的城市發展。我們通過這一系列的科研工作，不僅助力科學進步，更致力於解決實際問題，服務社會，推動可持續發展。

研究成就

實驗室在多個領域取得了突破性進展。首先，新型可重構天線和反射面架構有效解決了物聯網設備的通信問題，提升了系統覆蓋範圍和通信質量；在車載通信中應用的可重構天線技術，顯著增強了智能交通系統的可靠性和效率。實驗室開發了高效計算的微虛擬機啟動技術、基於機器學習的時空軌跡預測方法和多媒體數據去噪技術，並創新性地提出了基於圖神經網絡的新型應用，這些研究顯著提升了城市數據分析的智能化與自動化水平。在智慧能源方面，實驗室研發了集成城市微氣候與建築能源系統的全新模型，緩解了城市熱浪與建築能源消耗之間的負面效應。同時，實驗室通過因果推理方法優化了負荷預測，顯著提升了預測準確性，並且通過新型溫控負載頻率響應技術，增強了電力系統的穩定性和可靠性。在智能駕駛與自動駕駛領域，實驗室致力於提升交通系統的安全性和效率。利用虛實融合技術，實驗室開發了精確的仿真平台，用於交通系統優化與新技術測試。此外，實驗室還在城市災害安全領域做出了重要貢獻，深入研究了颱風、暴雨引發的水災及山體滑坡，並提出了針對性的應對策略。通過優化電力電子控制系統，實驗室為基礎設施安全和城市韌性提供了有力支持。

研究成果

項目	成果
2024年發表國際期刊論文	485
2024年發表國際會議論文	94
2024年累積發表SCI論文數	485
總被引次數	74,000+
2024年出版書籍	1

Main Research Areas

IOTSC focuses on five key areas: intelligent sensing and network communication, urban big data and smart technologies, smart energy, intelligent transportation, and urban safety and disaster prevention. Teams are actively exploring and enhancing the technological framework for smart city development. Notable achievements include the development of a 'reconfigurable distributed antenna and reflective surface-assisted communication and sensing integrated architecture,' which has significant potential for future 6G wireless communication; In collaboration with the State Power Investment Corporation, a cooling demand forecasting algorithm package and an ice storage optimization algorithm package, which has been applied to the cooling system in the Hengqin area, achieving substantial energy savings; AI and big data-driven optimization of urban traffic flow, promoting the development of autonomous driving and V2X technologies; and the application of infrastructure safety intelligent early warning technologies in major projects such as the Hong Kong-Zhuhai-Macao Bridge and Hengqin Second Bridge, enhancing real-time health monitoring and maintenance of large-scale urban infrastructure. Looking ahead, IOTSC will continue innovating in integrated sensing, urban big data and intelligent decision-making, complex energy modelling, autonomous driving, and coastal city disaster assessment and facility monitoring, providing strong technical support for smart city construction.

Talent Development and Cultivation

IOTSC adheres to an open and diverse philosophy, recruiting outstanding talents globally. Each year, we continuously introduce new faculty and researchers in fields such as communications, the Internet of Things, big data, as well as interdisciplinary innovation areas like cultural heritage protection technologies. The addition of new members injects fresh energy into the academic atmosphere, further strengthening its research capabilities and promoting the transformation of innovative results.

優秀大學生暑期研習營
Summer Camp for Outstanding University Students

IOTSC is committed to supporting the growth of early-career researchers and students. Over the past six years, IOTSC has successfully trained 89 Ph.D. students and 201 Master's students. Currently, there are 267 Ph.D. students and 245 Master's students enrolled. To promote academic exchange and enhance research capabilities, we have organized the 'Summer Camp for Outstanding University Students', providing an academic exchange platform for outstanding university students, facilitating interaction and learning between them and researchers. Additionally, IOTSC has conducted science popularization activities for elementary school students, educating them on urban disaster and risk management, helping to cultivate future scientific talent and raise public awareness of urban safety issues. Through these diverse training models, IOTSC not only provides students with solid academic training but also actively creates more practical opportunities, helping talents of all ages achieve comprehensive development in research, innovation, and social service.

Research Platforms

IOTSC is equipped with several advanced experimental platforms, including the Intelligent Supercomputing Center, which significantly enhances large-scale data analysis and model training capabilities through hardware and software upgrades, achieving a leading level of performance. A remote sensing satellite ground station has been established to ensure efficient collection and processing of remote sensing data. The Smart Integrated Energy Management Platform, through power system analysis programs and real-time simulation devices, has enabled further upgrades in energy dispatch and optimization control. In addition, we have a hybrid physical-virtual transportation platform, including autonomous driving buses, intelligent vehicle-road collaboration systems, and cutting-edge robots for urban environmental modeling, providing a rich testing environment for intelligent transportation systems research. The self-developed high-precision sensor technology continuously improves the sensing capabilities of IoT devices, laying the foundation for innovative smart city applications and driving interdisciplinary and cross-domain research collaborations.

Major Achievements

Research Awards

In the past year, IOTSC has earned multiple prestigious awards in various international competitions. Academic leader Professor Ka Veng Yuen was awarded one of China' s highest engineering honors, the ' 15th Guanghua Engineering Science and Technology Prize', which developed a series of Bayesian identification methods without measurements of the external forces, which becomes a leading example in model class selection research. Professor Yuan Wu's theory of integrated computing and network optimisation won the first prize in the Guangdong Province Electronic Information Science and Technology Awards and the second prize in the Zhejiang Province Science and Technology Awards for Natural Sciences, recognizing his outstanding contributions to intelligent computing and network optimization. In addition, over 30 professors, postdoctoral researchers, and outstanding master's and doctoral students have won awards such as Best Paper at international conferences, Grand Prize at global technology challenges, and first and second prizes in the University Student Paper Competition. These awards not only reflect the IOTSC research strength but also demonstrate the team's influence in global technological innovation and academic exchange.

Academic Exchange and Collaboration

IOTSC has established open research projects since 2021. By 2024, a total of 39 projects have been launched, with funding support exceeding 1.75 million. In 2024, 7 new projects were approved, and collaborative partners include several prestigious universities both domestically and internationally, such as Leibniz University of Hannover, Peking University, Zhejiang University, and Wuhan University. The research focuses on cutting-edge topics in smart cities, such as digital twins, cybersecurity, and video analysis. These collaborations not only enhance the IOTSC influence in global scientific research but also provide strong support for advancing interdisciplinary innovation and addressing global urbanisation challenges. At the same time, IOTSC actively organises academic exchange programs and successfully hosted the 4th Macao International Conference on Smart City Technologies and the Smart City Sustainable Development Seminar, facilitating in-depth discussions with leading scholars worldwide and promoting the sharing of scientific achievements and technology exchange.

Major Projects

IOTSC leads and participates in several important research projects funded by the government, academia, and industry. These include funding from the National Natural Science Foundation, the Macau Government Foundation, and university-industry partnerships. The projects focus on advanced fields such as integrated energy systems and the use of smart monitoring technologies in transportation and infrastructure. These projects are highly valuable for both research and practical applications.

One key project, on submarine landslides and geotechnical disaster prevention, aims to better understand the causes of these disasters and develop better methods for prevention and mitigation. Another project focuses on optimising autonomous electric vehicle fleets using machine learning and edge computing to improve traffic flow and reduce energy use, paving the way for the future of smart transportation. We also work on climate change impacts, with a project focused on storm surge early warnings and disaster prediction to help protect coastal communities.

These projects will drive innovation in environmental and urban management, helping create cities that are more resilient, energy-efficient, and sustainable. Through these efforts, we aim to solve real-world problems and contribute to scientific progress, benefiting society and supporting sustainable development.

Research Achievements

IOTSC has made breakthrough progress in several fields. Firstly, the new reconfigurable antenna and reflector architecture effectively solved the communication problems of IoT devices, improving system coverage and communication quality. The reconfigurable antenna technology applied in vehicle communication significantly enhanced the reliability and efficiency of intelligent transportation systems. We developed high-efficiency micro-virtual machine startup technology, machine learning-based spatiotemporal trajectory prediction methods, and multimedia data denoising techniques, and innovatively proposed new applications based on graph neural networks, all of which significantly enhanced the intelligence and automation level of urban data analysis.

In the field of smart energy, we developed a novel model integrating urban microclimates and building energy systems, alleviating the negative effects of urban heat waves and building energy consumption. At the same time, IOTSC optimised load forecasting using causal inference methods, significantly improving forecast accuracy, and enhanced the stability and reliability of the power system through new temperature-controlled load frequency response technology.

In the field of intelligent and autonomous driving, IOTSC is committed to improving the safety and efficiency of transportation systems. Using virtual-real integration technology, IOTSC developed an accurate simulation platform for transportation system optimisation and testing of new technologies.

Furthermore, IOTSC has made significant contributions in the field of urban disaster safety, conducting in-depth research on floods and landslides caused by typhoons and heavy rainfall, and proposing targeted response strategies. By optimizing power electronics control systems, IOTSC provided strong support for infrastructure safety and urban resilience.

Research Output

Items	Outcomes
International Journal Papers Published in 2024	485
International Conference Papers Published in 2024	94
The Total Number of Papers Published in SCI-indexed Journals in 2024	485
Total Number of Citations	74,000+
Books Published in 2024	1

2024 年新成立的合作聯盟
Newly Established Cooperation Alliances in 2024

中興通訊產學研合作論壇
ZTE Industry-Academy-Research Cooperation Forum

中興通訊產學研合作論壇是由中興通訊發起，由高校、科研院所和企業共同參與的論壇組織，旨在資訊通信前沿領域加強成員單位之間的技術交流和項目合作。

The ZTE Industry-University-Research Cooperation Forum is an initiative by ZTE, involving participation from universities, research institutions, and enterprises. It aims to strengthen technical exchanges and project cooperation among member units in the forefront of information and communication technology.

國際海洋科技聯盟
International Marine Science and Technology Alliance

國際海洋科技聯盟旨在彙聚世界各地的海洋研究機構、涉海高等院校、涉海組織、海洋科技工作者等海洋科研優勢資源，建立全球海洋科技協同創新網路，通過國際交流與合作，促進科技資源分享，推動海洋科技創新，為構建海洋命運共同體提供科學支撐。

The International Marine Science and Technology Alliance aims to gather marine research institutions, marine-related universities, marine organisations, and marine science and technology workers from the world, to establish a global marine science and technology collaborative innovation network. Through international exchanges and cooperation, it promotes the sharing of scientific and technological resources, drives marine technological innovation, and provides scientific support for building a community with a shared future for the oceans.

2024 年新建聯合實驗室

Newly Established Joint Laboratories in 2024

澳門大學 - 數字動力智慧交互聯合實驗室

University of Macau - Digit Force Joint Laboratory of Intelligent Interaction

澳門大學與澳門數字動力科技有限公司協同建設「澳門大學 - 數字動力智慧交互聯合實驗室」，孵化優質產業項目，創新高端科研人才培養，建立長期、緊密、穩定的校企戰略合作關係。雙方資源互通，優勢互補，開展人機交互、物聯網、電子設計自動化等多領域的全面合作，助力澳門產業適度多元，助力智慧酒店產業轉型升級。

UM collaborates with Macau Digital Power Technology Co., Ltd. to jointly build the 'University of Macau - Digit Force Joint Laboratory of Intelligent Interaction', incubate high-quality industrial projects, innovate the cultivation of high-end scientific research talents, and establish a long-term, close, and stable strategic cooperative relationship between the university and the enterprise. Both parties share resources and complement each other's strengths, conducting comprehensive cooperation in multiple fields such as human-computer interaction, Internet of Things, and electronic design automation, to promote the appropriate diversification of Macao's industries and assist in the transformation and upgrading of the smart hotel industry.

澳門大學 - 阿里巴巴大模型雲計算聯合研究創新中心

University of Macau - Alibaba Joint Innovation Centre for Cloud Infrastructure for Large AI Models

阿里巴巴（中國）有限公司在系統、資源、集群、訓練推理、人工智能等領域有領先的技能、知識和資源、相關專案經驗及背景。澳門大學在雲計算資源調度、混部優化、人工智能等領域有領先的技能、專門知識和資源，以及其他相關項目經驗及背景。雙方共同合作建設「澳門大學 - 阿里巴巴大模型雲計算聯合研究創新中心」，為期三年，並計劃在合作期內開展每年 1 至 2 項主題項目研究。

Alibaba Group Holding Limited has leading skills, knowledge, and resources in the fields of systems, resources, clusters, training and inference, artificial intelligence, as well as relevant project experience and background. UM has leading skills, expertise, and resources in the fields of cloud computing resource scheduling, mixed deployment optimisation, artificial intelligence, and other relevant project experience and background. Both parties jointly cooperate to build the 'University of Macau - Alibaba Joint Centre for Cloud Infrastructure for Large AI Models' for a period of three years, and plan to conduct 1 to 2 thematic project studies each year during the cooperation period.

數智賦能新型配用電技術聯合實驗室

Digital Intelligence Empowered New Power Distribution Technology Joint Laboratory

澳門大學、澳門電力股份有限公司及東方電子股份有限公司透過共建聯合實驗室，建設高度電氣化的澳門數字電網，研究通過資料推動方法實現澳門雙碳目標的最優策略路徑，提高用電安全和服務品質，實現電網可視化。

UM, Companhia de Electricidade de Macau S.A., and Dongfang Electronics Corporation, jointly build a laboratory to construct a highly electrified Macau digital power grid. They research the optimal strategy path to achieve Macao' s dual carbon goals through data-driven methods, enhance electrical safety and service quality, and realise the visualisation of the power grid.

廣西中醫藥大學 - 澳門大學中藥研發聯合實驗室

Guangxi University of Chinese Medicine—University of Macau Joint Laboratory for Research and Development of Chinese Medicine

透過廣西中醫藥大學及澳門大學的人才和技術優勢，共建「廣西中醫藥大學 - 澳門大學中藥研發聯合實驗室」，促進澳門大學相關科技成果產業轉化，提高廣西中醫藥大學的研發能力、自主創新能力、中藥大品種培育和產業化能力，從而推動桂澳中醫藥產學研深度合作。

Leveraging the talent and technological strengths of Guangxi University of Chinese Medicine and UM, the'Guangxi University of Chinese Medicine - University of Macau Joint Laboratory for Research and Development of Chinese Medicine' has been jointly established. This initiative aims to facilitate the industrial transformation of relevant scientific and technological achievements from UM, enhance the research and development capabilities, independent innovation capabilities, cultivation of major Chinese medicine varieties, and industrialisation capabilities of Guangxi University of Chinese Medicine, thereby promoting in-depth cooperation in industry-academia collaboration between Guangxi and Macao in the field of traditional Chinese medicine.

澳門大學 - 廣東省智能科學與技術研究院認知與類腦智慧聯合實驗室（研究中心）

Joint Laboratory (Research Center) of Cognition and Brain-Inspired Intelligence of University of Macau and Guangdong Institute of Intelligence Science and Technology

澳門大學與廣東省智慧科學與技術研究院基於雙方的研究方向和發展目標，以聯合研究中心為載體，作為雙方科研交流、人才培養基地，將共同探索以重大任務和目標為導向的合作新機制，進一步實現科教融合新模式，進行友好合作、實現互惠互利、優勢互補和共同發展。

UM and the Guangdong Institute of Intelligent Science and Technology, based on their respective research directions and development goals, will use the joint research center as a carrier to serve as a base for scientific research exchanges and talent cultivation. They will jointly explore a new cooperation mechanism oriented by major tasks and goals, further realise a new model of integration of science and education, and engage in friendly cooperation to achieve mutual benefit, complementary advantages, and common development.

澳門大學 - 澳門協和醫院聯合臨床醫學研究中心

University of Macau-Macao Union Hospital Joint Research Centre for Clinical Medicine

離島醫療綜合體北京協和醫院澳門醫學中心及澳門大學通過建立協同創新的高水平研究合作平台「澳門大學 - 澳門協和醫院聯合臨床醫學研究中心」，強化醫學領域人才的交流合作與培養。善用雙方學術、科研及臨床資源，實現優勢互補，促進雙方在臨床醫學及疑難重症等領域科學研究的協同發展、合作與實踐。

The Islands Healthcare Complex-Macao Medical Center of Peking Union Medical College Hospital, and UM have established a high-level research cooperation platform for collaborative innovation, the 'University of Macao - Macao Union Hospital Joint Research Centre for Clinical Medicine' to strengthen the exchange, cooperation, and training of talents in the medical field. By effectively utilising the academic, research, and clinical resources of both parties, they achieve complementary advantages and promote the collaborative development, cooperation, and practice of scientific research in the fields of clinical medicine and difficult and critical illnesses.

粵澳模塊化芯片設計和測試聯合實驗室

Guangdong-Macao Joint Laboratory for Modular Chip Design and Testing

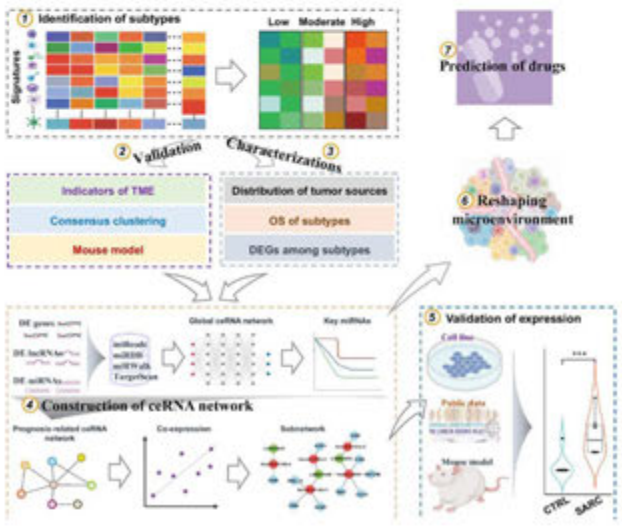
澳門大學、橫琴粵澳深度合作區澳門大學高等研究院、芯耀輝半導體科技（珠海）有限公司、深圳楠欣半導體科技有限公司、珠海極海半導體有限公司、廣東矽力微電子技術有限公司、中山大學及香港科技大學（廣州）共同開展粵澳模塊化芯片設計和測試聯合實驗室的建設和合作研究工作；共同研究電源管理芯片、混合信號芯片設計等前沿技術及商業應用，研發具有全球影響力的高性能模塊化芯片設計，服務粵澳芯片產業升級發展，促進粵澳芯片協同發展，打造產業芯片高地。

UM, the University of Macau Advanced Research Institute in the Hengqin, AkroStar Technology (Zhuhai) Co., Ltd., Shenzhen Nanxin Semiconductor Technology Co., Ltd., Geehy Semiconductor Co., Ltd., Sili Microelectronics Technology Co., Ltd., Sun Yat-sen University, and the Hong Kong University of Science and Technology (Guangzhou) jointly carry out the construction and cooperative research work of the Guangdong-Macao Joint Laboratory for Modular Chip Design and Testing; jointly study cutting-edge technologies and commercial applications such as power management chips and mixed-signal chip design, develop high-performance modular chip designs with global influence, serve the upgrading and development of the Guangdong-Macao chip industry, promote the coordinated development of Guangdong-Macao chips, and create a highland for industrial chips.

研究亮點 Research Highlights

澳大研究團隊在肉瘤臨床治療有新發現

UM research team makes new discoveries in clinical treatment of sarcoma

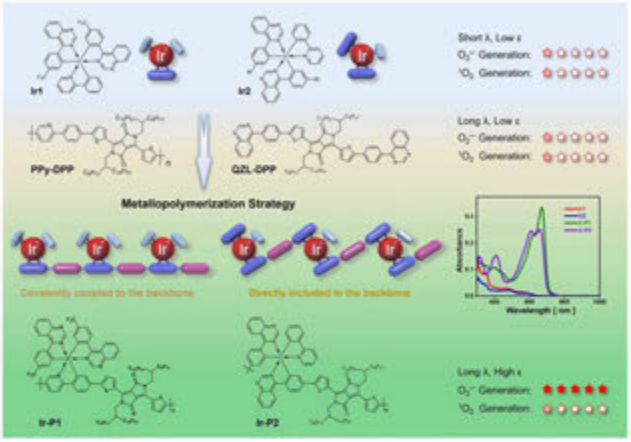


研究從腫瘤免疫微環境的角度定義了肉瘤的亞型，並識別出腫瘤免疫微環境的調控 ceRNA 網絡，通過分析疾病的分子機理及關鍵因子的數據，最終提出了潛在的治療藥物，為肉瘤的臨床治療提供了新的思路。

The research has defined sarcoma subtypes from the perspective of the tumour immune microenvironment (TIME) and identified a competing endogenous RNA (ceRNA) network that regulates TIME. By analysing the molecular mechanisms of the disease and data on the key factors, the research proposed a potential therapeutic drug, offering a new approach to the clinical treatment of sarcoma.

澳大成功開發提高療效的光敏感抗癌藥

UM achieves breakthrough in developing light-sensitive anti-cancer drugs

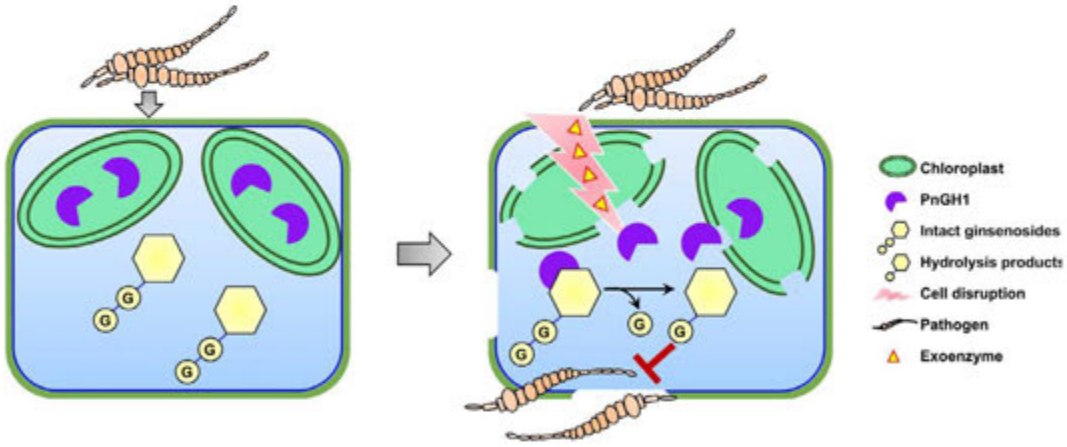


研究開發了高效光敏型抗癌藥物，不受氧氣濃度限制，有效解決光動力學治療過程中腫瘤微環境乏氧造成療效不佳的難題，在實用型光敏藥物開發方面獲得重大突破。

The research has developed a highly effective photosensitive anticancer drug, representing a major breakthrough in the development of practical photosensitive drugs. The drug is not constrained by oxygen concentration and can effectively address the problem of low efficacy caused by hypoxia in the tumour microenvironment during photodynamic therapy.

澳大研究團隊發現中藥三七防禦系統

UM research team discovers chemical defence system in traditional Chinese medicine Panax notoginseng

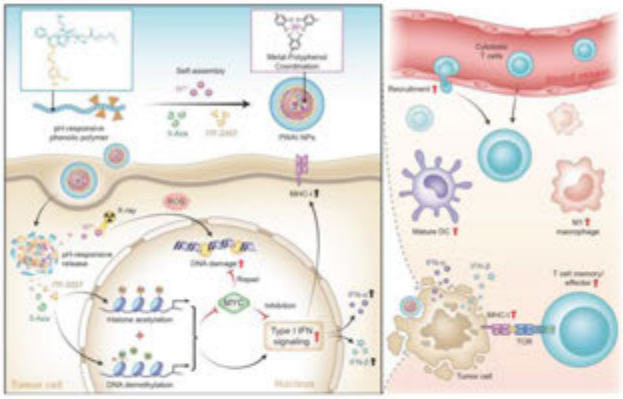


研究首次發現中藥三七植物中存在由葡萄糖苷水解酶介導的雙元素植物防禦反應，將有助於理解人參屬植物如何抵抗病原菌入侵，並為綠色植物源農藥的開發提供思路。

The study unveiled a two-component chemical defence system in *Panax notoginseng* mediated by chloroplast-localised β-glucosidase and 20(S)-protopanaxadiol ginsenosides, which will contribute to a deeper understanding of how Panax species defend against pathogens and provide valuable insights for the development of sustainable botanical pesticides.

澳大成功研發提升乳癌療效藥物

UM develops advanced nano-radiosensitizer to improve radiotherapeutic outcome of breast cancer



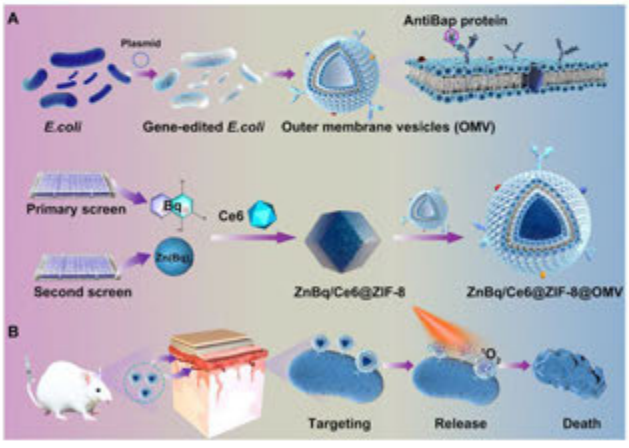
研究成功研發出一種新型放療增敏納米藥物，能夠顯著提升放療對乳腺癌的治療效果。這種納米藥物不僅增強了放療的功效，還能逆轉放療所引發的 MYC 上調和免疫抑制，從而激發出強力的抗腫瘤免疫反應，有效抑制乳腺癌生長、復發及轉移。

The research has developed a novel nano-radiosensitizer capable of significantly improving the radiotherapeutic outcome of breast cancer. This nanomedicine not only improves the efficacy of radiotherapy but also relieves the MYC-correlated immunosuppression induced by radiation, thereby triggering a systemic anti-tumour immune response and effectively inhibiting the growth, recurrence, and metastasis of breast cancer.

澳大新藥能有效治療腦膜炎

UM develops promising new drug for meningitis treatment

這項研究不僅解決了傳統抗生素對鮑曼不動桿菌的限制，還提供了一種靶向策略，由基因工程 OMV 提供，代表了靶向滅菌領域的重大進步。該抗生素能夠有效消除多重耐藥細菌而不會引起耐藥性，並有助於應對日益嚴重的抗生素耐藥性的全球威脅，代表了非傳統抗生素開發的重大進展。



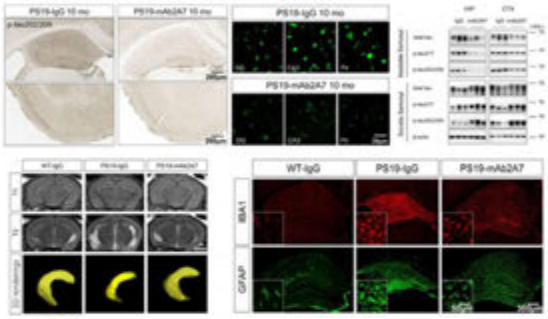
This study not only addresses the limitations of traditional antibiotics against *A. baumannii,* but also provides a targeting strategy using genetically engineered OMVs, representing a significant advance in the field of targeted bacterial eradication. This antibiotic, which can effectively eradicate multidrug-resistant bacteria without causing resistance, also represents a significant advance in the development of non-traditional antibiotics and will help combat the growing global threat of antibiotic resistance.

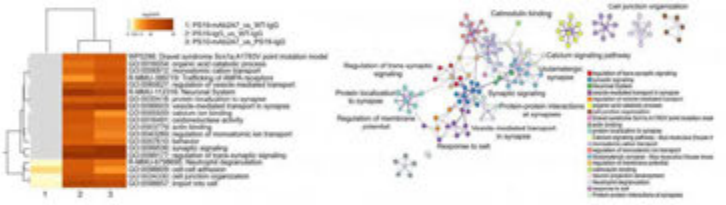
澳大聯合開發阿爾茲海默病新療法

UM join forces to develop new treatment for Alzheimer's disease

該成果在阿爾茲海默病研究取得突破性進展，開發出一種有效且副作用較小的阿爾茲海默病潛在療法。

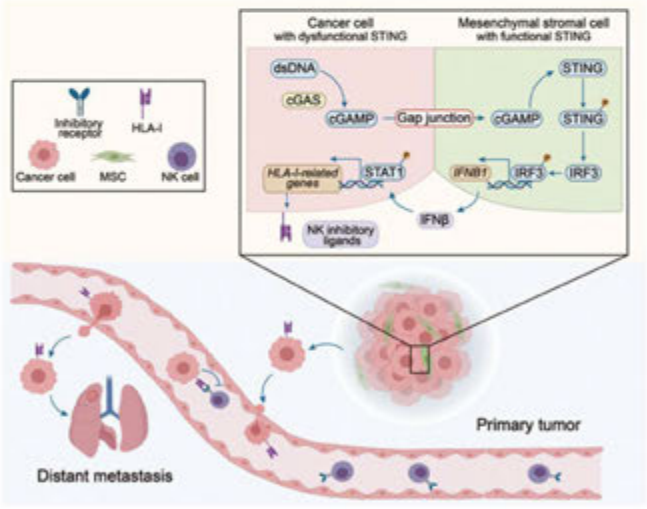
The findings have made a breakthrough in Alzheimer's disease (AD) research, which have developed a potentially effective treatment for AD with fewer side effects.





澳大幹細胞研究揭示抗腫瘤免疫新機制

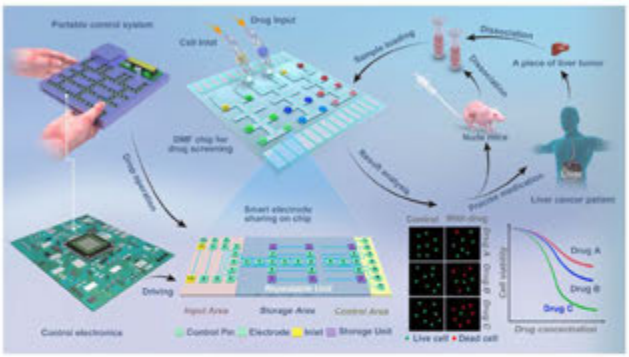
UM's stem cell research discovers new mechanism for anti-tumour immunity



研究利用幹細胞模擬腫瘤微環境（TME）中的間充質基質細胞（MSC），發現 MSC 能通過與腫瘤細胞相互作用，產生一系列細胞間信號，從而提高腫瘤細胞對自然殺傷（NK）細胞的抵抗力，促進腫瘤轉移。該發現已在臨床樣本中取得驗證，揭示了一種新的腫瘤免疫逃逸機制，為抗腫瘤免疫治療提供了新的靶點。

The research used stem cells to simulate mesenchymal stromal cells (MSCs) in the tumour microenvironment (TME), and found that MSCs can produce a cascade of intercellular signals by interacting with tumour cells, thereby enhancing the resistance of tumour cells against natural killer (NK) cells and promoting tumour metastasis. These findings, validated in clinical samples, reveal a novel mechanism of tumour immune evasion and provide a new therapeutic target for anti-tumour immunotherapy.

澳大成功研發新型精準醫療藥篩技術
UM develops new drug screening technology for precision medicine

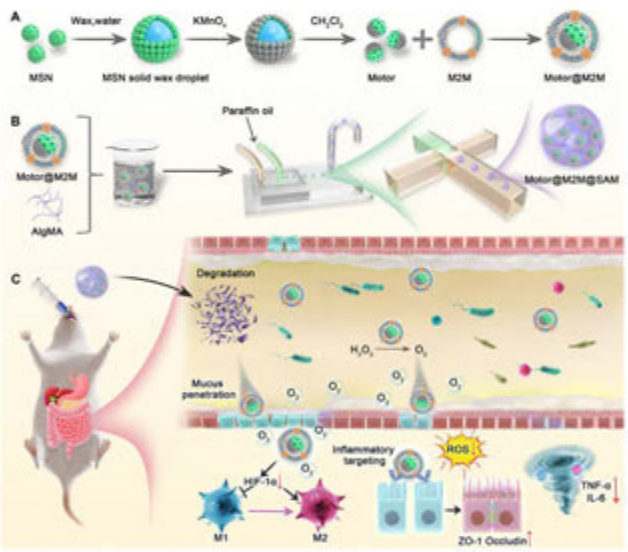


研究研發出一種利用原代癌症細胞進行藥物篩選的微流控系統，該系統可針對個體癌症患者進行藥物篩選並給出治療方案，確保最佳治療效果。

The research has developed a microfluidic system for drug screening using primary tumour cells, which can offer individual cancer patients a tailored treatment plan that exhibits the best therapeutic results.

澳大研發創新結腸炎口服藥
UM develops novel oral formulation for ulcerative colitis

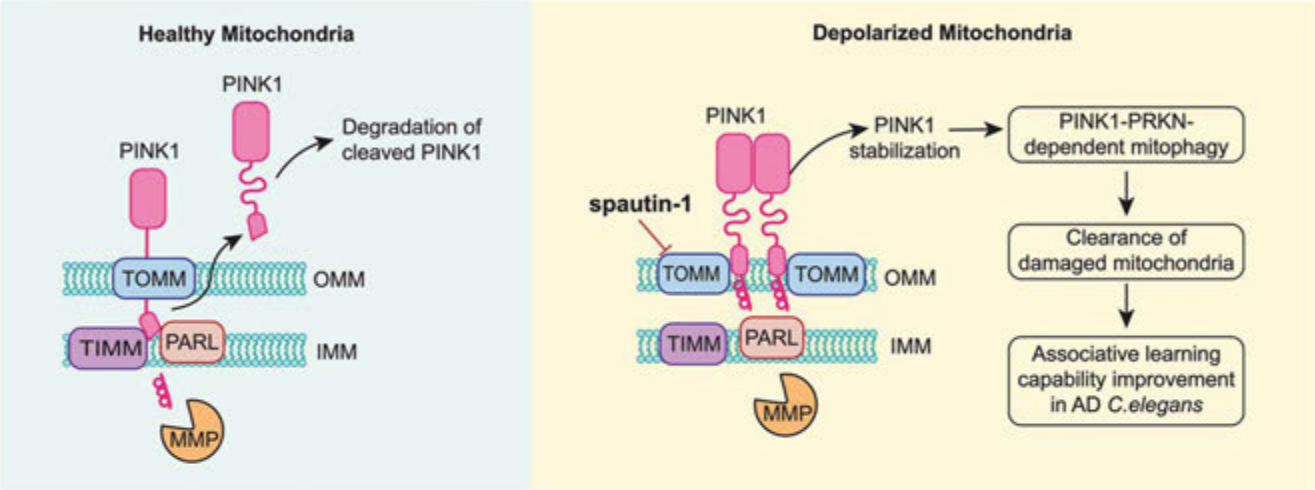
澳大研究團隊最近開發了一種不含小分子藥物的口服製劑。該製劑使用 M2 巨噬細胞膜塗層的非對稱納米馬達（M2 巨噬細胞仿生納米機器人），並將其嵌入海藻酸鈉水凝膠微球中。海藻酸鈉微球確保了納米馬達在惡劣的胃液環境中的穩定性，並將其釋放到腸道中。M2 巨噬細胞膜提高了納米馬達進入炎性結腸的遞送效率，同時作為納米海綿高效中和炎性因子。此外，納米馬達通過催化過氧化氫產生的氧氣的推進力，穿過結腸黏膜屏障進入炎性組織。這一過程清除活性氧，緩解組織乏氧，極化巨噬細胞，並減輕結腸上皮細胞的凋亡。



The UM research team then developed an oral medication that does not contain small-molecule drugs. This formulation uses asymmetric M2 macrophage membrane-coated Janus nanomotors (M2 macrophage-biomimetic nanorobots) embedded in sodium alginate hydrogel microspheres. The sodium alginate microspheres ensure the stability of the nanomotors in the harsh gastric environment and release them into the intestinal tract. The M2 macrophage membrane enhances the delivery efficiency of the nanomotors to the inflammatory colon and acts as a nanosponge to effectively neutralise inflammatory factors. Additionally, the propelling force of oxygen generated by the catalytic consumption of hydrogen peroxide facilitates the penetration of nanomotors through the colonic mucus barrier into inflammatory tissues. This process eliminates ROS, alleviates tissue hypoxia, polarises macrophages, and reduces colonic epithelial cell apoptosis.

澳大研究發現小分子藥物能改善阿茲海默症

UM research discovers small molecule drug that improves Alzheimer's disease symptoms

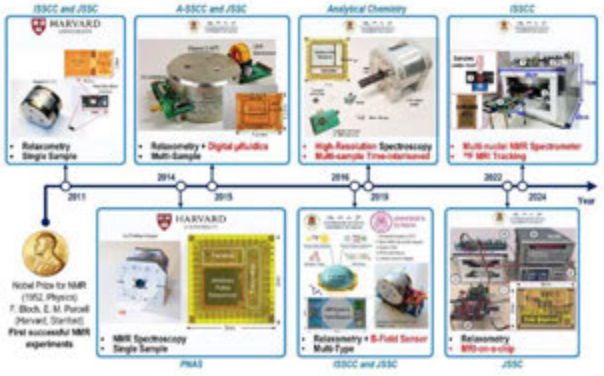


研究發現，在線粒體受損傷的情況下，自噬抑制劑（spautin-1）靶向線粒體外膜轉運體（TOMM）複合物中的 TOMM70，能夠促進線粒體自噬並有效清除受損的線粒體。同時在線蟲模型研究中發現，spautin-1 通過促進線粒體自噬明顯改善了阿茲海默症線蟲模型的聯想學習能力。

The study has discovered that spautin-1, an autophagy inhibitor, can target TOMM70, a component of the translocase of the outer mitochondrial membrane (TOMM) complex upon mitochondrial damage, effectively clearing the damaged mitochondria by promoting mitophagy. The study also shows that spautin-1 can significantly improve associative learning ability in an Alzheimer's disease (AD) Caenorhabditis elegans (C. elegans) model by promoting mitophagy.

CMOS 技術革新小型化核磁共振掃描儀

Transformative impact of CMOS technology on miniaturised MRI scanners



澳門大學微電子研究院的研究團隊近期開發出一款基於互補式金屬氧化物半導體（英文簡稱 CMOS）技術的小型化核磁共振成像掃描器，期望改進個性化醫療技術。

The research team in the Institute of Microelectronics (IME) at the University of Macau (UM) has recently developed a compact MRI scanner based on complementary metal-oxide-semiconductor (CMOS) technology, aiming to advance personalised medicine.

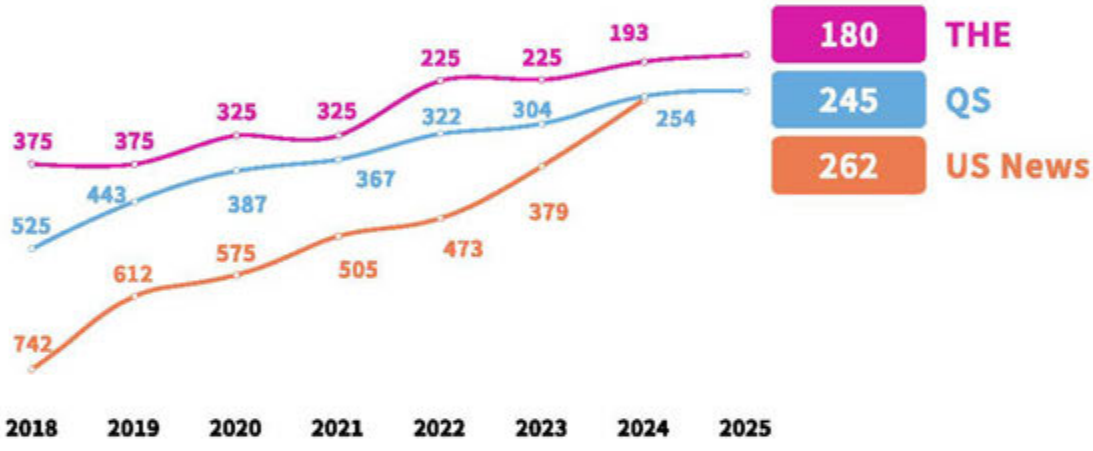
數據資料 Facts and Figures

概況
General Information

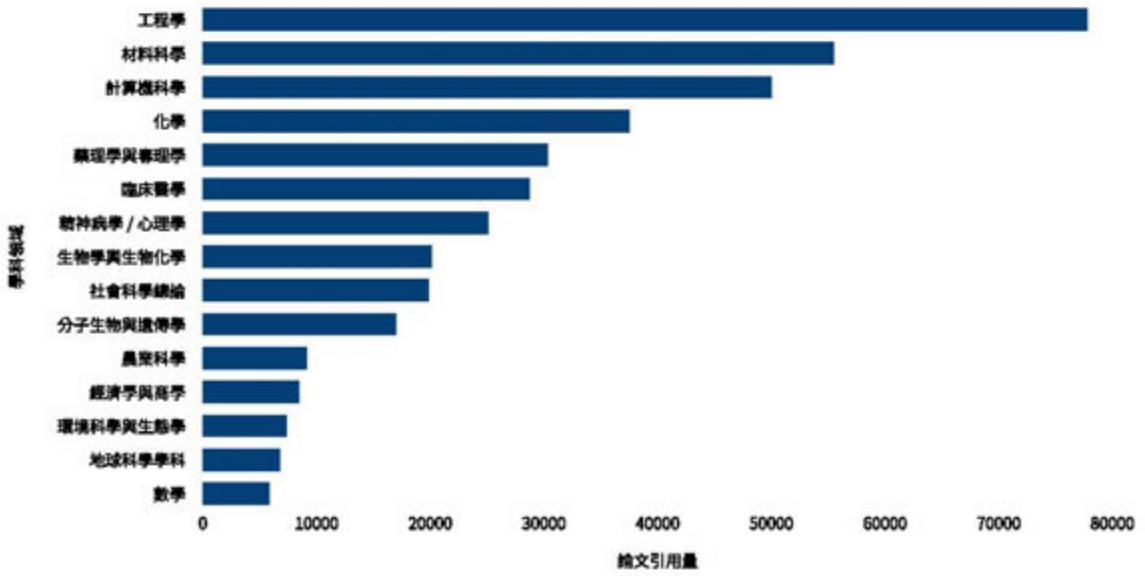
創校時間： 1991 年（前身東亞大學於 1981 年成立）
Year of Establishment: 1991 (The predecessor, the University of East Asia, was founded in 1981)

國際聲譽：
International Reputation:

澳大在泰晤士高等教育 (THE),QS 和 US News 世界大學排名
Times Higher Education (THE), QS, US News World University Rankings (WUR) Trend

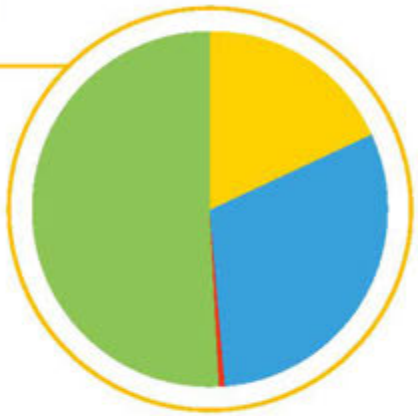


澳大進入基本科學指標資料庫（ESI）的 15 學科領域
UM is among top 1% in 15 fields in Essential Science Indicators (ESI)



註冊學生數量（2024/2025 學年第一學期）：
Number of registered students (1st Semester of Academic Year 2024/2025):

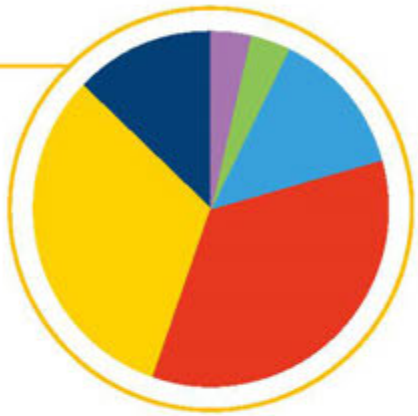
總人數 Total：
15,147



- 博士：Ph.D.programmes 2,769
- 碩士：Master programmes 4,612
- 學士後：Post-Baccalaureate programmes 78
- 學士：Bachelor programmes 7,688

教學人員數量（截至 2024 年 12 月 31 日）：
Number of faculty members (as of 31 December 2024):

總人數 Total：
690



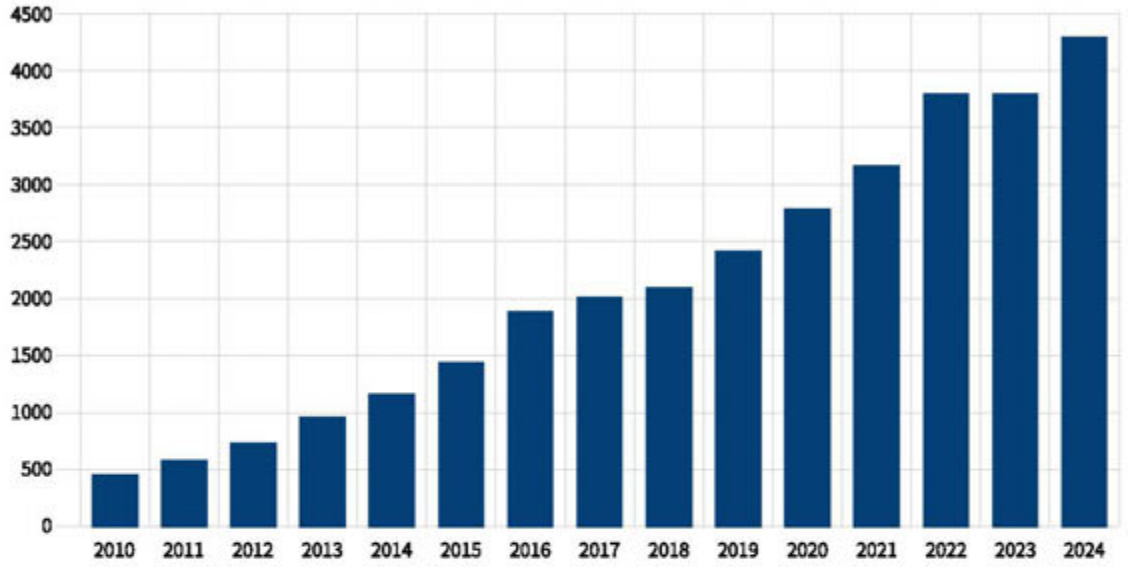
- 講座教授：Chair Professor 26
- 特聘教授：Distinguished Professor 24
- 教授：Full Professor 93
- 副教授：Associate Professor 240
- 助理教授：Assistant Professor 219
- 其他：others 88

學院及研究院數量： 14 個
Number of faculties & institutes: 14

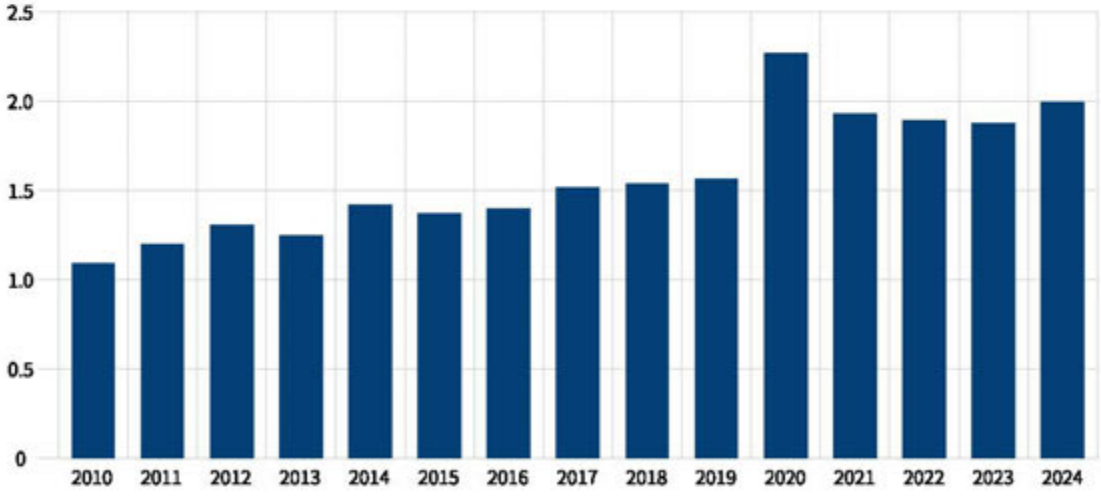
住宿式書院數量： 10 個
Number of residential colleges: 10

學術論文產出：
Research Outcomes:

論文發表數量（截至 2024 年 12 月 31 日）
Yearly Number of Publications (as at 31 December 2024)

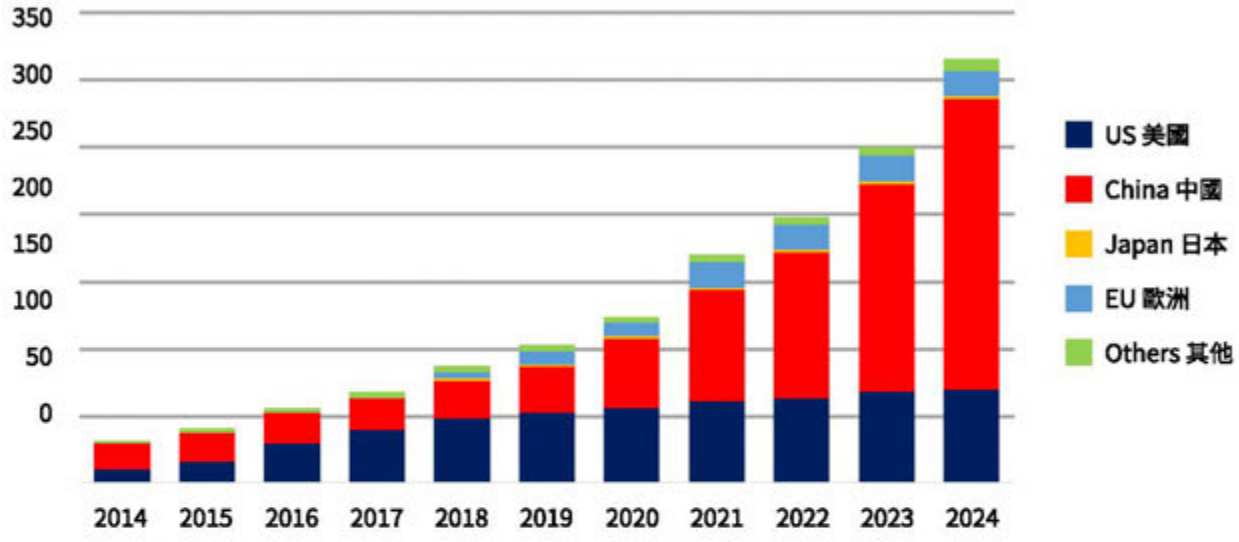


領域權重引用影響力指數（截至 2024 年 12 月 31 日）
Field Weighted Citation Impact (as at 31 December 2024)



專利
Patents:

專利數目（截至 2024 年 12 月 31 日）
Number of Patents (as at 31 December 2024)



注:包括已期滿之專利 Notes: Includes inactive patents

2023/2024 學年獲批科研項目
2023/2024 Approved Research Projects

澳門大學研究委員會資助的研究項目總數：305 總金額：澳門元92,212,000
Total number of research projects approved by the UM Research Committee: 305, funding amount: MOP 92,212,000

澳門特別行政區科學技術發展基金資助的研究項目總數：85 總金額：澳門元130,878,000
Total number of research projects approved by Macao SAR FDCT: 85, funding amount: MOP 130,878,000

其他（包括內地、香港資助）項目總數：49 總金額：澳門元18,045,000
Total number of research projects approved by other funding organizations (including Mainland China and Hong Kong): 49, funding amount: MOP 18,045,000

活動與訪問

Events and Visits

澳大學人研究論壇
UM Scholar Research Forum

周明明分享如何科學培養堅毅力
Mingming Zhou gives talk on how to cultivate grit

周明明教授 Professor Mingming Zhou

「澳大學人研究講壇」之第十六講於2024年1月18日舉行，由澳大教育學院教授周明明以「堅毅力：堅持的力量和成功的策略」為題發表演說。講座上，周明明從東西方文化的視角探討中國學生堅毅力品格的形成及堅毅力的重要作用。她還分享了堅毅力的特質與其科學培養方法，指導與會者如何在學校和家庭中培養堅毅力，幫助其保持生活熱情，發揮潛力，創造快樂成功的人生。

The 16th lecture of the UM Scholar Research Forum was held on 18 January. Mingming Zhou, professor in the Faculty of Education, held a talk titled 'Grit: The Power of Persisting and Strategies for Success'. During the talk, Prof Zhou discussed how Chinese students' grit comes into being and the importance of grit from the perspective of Eastern and Western cultures. She also shared the characteristics of grit and ways of cultivating grit, and guided the audience on how to cultivate grit in schools and at home, so as to maintain passion and unlock their potential for a happy and successful life.

傅曉青分享博彩產業負責任投資

Xiaoqing Fu gives talk on responsible investing in gaming industry

傅曉青教授 Professor Xiaoqing Fu

「澳大學人研究講壇」之第十七講於2024年2月26日舉行，由澳大工商管理學院教授傅曉青以「博彩產業的負責任投資」為題發表演說。傅曉青談到當前負責任投資從一種避免投資於特定產業（如煙草、酒精和博彩行業）的投資組合策略，轉變為將環境、社會和企業管治（ESG）議題整合到投資決策中的投資過程，以更好地管理風險並產生可持續及長期的投資回報。該演變引發關注，企業社會責任是否會影響機構投資者對博彩產業的投資決策。她亦探討澳門政府在ESG問題上採取的各種舉措對博彩公司機構投資人持股的影響。

The 17th lecture of the UM Scholar Research Forum was held on 26 February. Xiaoqing Fu, professor in the Faculty of Business and Administration held a talk titled 'Responsible Investing in the Gaming Industry'. Prof Fu discussed the transformation of responsible investment from a portfolio strategy that typically excludes investments in specific industries (such as tobacco, alcohol, and gaming) to an investment process that integrates environmental, social, and corporate governance (ESG) issues into investment decision-making in order to manage risk better and generate sustainable, long-term returns. She mentioned that this transformation raised the question of whether social responsibility would affect the investment decisions of institutional investors in the gaming industry. She also investigated the impact of Macao SAR Government's ESG initiatives on the institutional ownership of casino firms in Macao.

周建濤分享如何在生成式 AI 時代辨別真假

Jiantao Zhou gives talk on how to distinguish truth from falsehood in era of generative AI

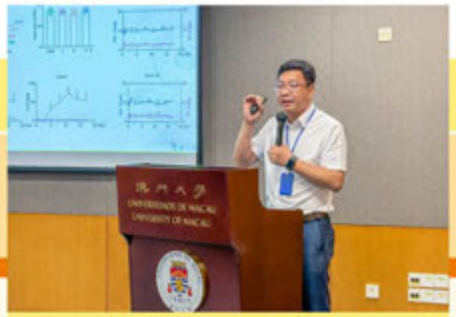
周建濤教授 Professor Jiantao Zhou

「澳大學人研究講壇」之第十八講於2024年3月22日舉行，由澳大科技學院電腦及資訊科學系和智慧城市物聯網國家重點實驗室教授周建濤以「生成式AI時代的去偽存真」為題發表演說。講座上，周建濤結合其在AI安全和取證領域累積的豐富經驗，詳細闡述了生成式AI的基本概念及其在多種場景中的實際應用。他強調這種技術可能帶來的倫理風險，並深入剖析了當中的隱患。此外，周建濤還重點介紹了三種主要的偽造內容檢測技術，包括圖像偽造檢測、Deepfake視頻檢測及AIGC檢測技術。他進一步指出，在當前生成式AI技術普及的趨勢下，辨別真偽不僅是技術問題，更上升為一項需要各方面共同努力的數字倫理議題。他認為，為應對這一挑戰，不僅需要提升個人對偽造內容的辨識能力，國家層面也應推出相關策略，以確保其合理、安全和透明的使用。

The 18th lecture of the UM Scholar Research Forum was held on 22 March. Jiantao Zhou, professor in the Department of Computer and Information Science of the Faculty of Science and Technology and the State Key Laboratory of Internet of Things for Smart City held a talk titled 'Eliminate Fake and Retain Real in the Era of Generative AI'. During the talk, Prof Zhou, who has many years of research experience in the field of AI security and forensics, explained the basic concepts of generative AI and its practical applications in various scenarios, and analysed the potential risks. He also introduced the three main techniques for forgery detection, namely image forgery detection, deepfake video detection, AI-generated content (AIGC) detection.

萬建波分享人參如何抵抗病原菌

Jianbo Wan gives talk on how Panax plants resist pathogen invasion


萬建波教授 Professor Jianbo Wan

「澳大學人研究講壇」之第十九講於2024年4月23日舉行，由澳大中華醫藥研究院、中藥質量研究國家重點實驗室教授兼課程主任萬建波以「解密人參屬藥用植物的雙元素化學防禦系統」為題發表演說。講座上，萬建波首先介紹了中藥三七的藥效、地理分佈及化學成分，並講述了他對中藥三七葉進行成分分析時得到的意外發現。他表示，植物為應對環境中的各種威脅，通過產生次生代謝產物來適應環境，其中化學防禦在植物生存中發揮著重要作用。萬建波詳細闡述了他如何通過科學方法發現三七葉中存在位於葉綠體的新型β-葡萄糖苷水解酶和原人參二醇型皂苷組成的雙元素化學防禦系統。該發現將有助理解人參屬植物如何抵抗病原菌入侵，並為綠色植物源農藥的開發提供思路。

The 19th lecture of the UM Scholar Research Forum was held on 24 April. Jianbo Wan, professor and programme coordinator at the Institute of Chinese Medical Sciences and the State Key Laboratory of Quality Research in Chinese Medicine held a talk titled 'Natural Defense Shield: Deciphering the Two-component Chemical Defense System of Panax Plants'. During the talk, Prof Zhou first presented the efficacy, geographical distribution and chemical composition of Chinese medicine *Panax notoginseng*. He also explained how he discovered the two-component chemical defence system in the leaves of *Panax notoginseng*, which contributes to our understanding of how Panax plants resist pathogen invasion and provides insights into the development of green pesticides.

孫鵬展分享石墨烯研究

Pengzhan Sun gives talk on graphene research


孫鵬展教授 Professor Pengzhan Sun

「澳大學人研究講壇」之第二十講於2024年9月24日舉行，由澳大應用物理及材料工程研究院助理教授孫鵬展以「不『透』的石墨烯究竟有多『通透』？」為題發表演說。孫鵬展指出石墨烯是由單層碳原子組成，並具有優異電學、光學、機械等性能的傑出二維材料。人們普遍認為，儘管石墨烯及其他二維晶體只有單原子層厚度，其晶格仍能完全阻斷所有氣體和液體的跨膜傳輸。然而，孫鵬展分享他怎樣利用石墨烯密封石墨單晶微腔的全新器件結構，將氣體跨膜傳輸的測量精度相較此前領域內的最高水準提高了8至9個數量級。他又以該測量精度為基礎，發現氫分子反常穿透石墨烯晶格（比氫分子尺寸還要小的氦原子無法穿透）的現象。相關研究為科研界帶來了新的視角，有助於推動納米技術和新材料的應用發展。

The 20th lecture of the UM Scholar Research Forum was held on 24 September. Pengzhan Sun, assistant professor in the Institute of Applied Physics and Materials Engineering held a talk titled 'How Permeable is the Impermeable Graphene?'. During the talk, Prof Sun mentioned that graphene, which consists of only one atomic layer of carbon atoms, is a two-dimensional material with excellent electronic, optical, and mechanical properties. He also explained how his innovative device, which consists of small monocrystalline containers tightly sealed with graphene, can significantly improve the accuracy of detecting gas permeation through membranes by eight to nine orders of magnitude compared to the previous highest standards in the field. The relevant research provides new perspectives to the research community and helps promote the applications of nanotechnology and new materials.

郭珩輝分享從動物毒液中尋找抗癌新療法

Henry Kwok Hang Fai gives talk on research into new cancer treatments using animal venoms

郭珩輝教授 Professor Henry Hang Fai Kwok

「澳大學人研究講壇」之第二十一講於2024年10月22日举行，由澳大健康科學學院生物醫學系系主任郭珩輝以「從動物毒液中尋找抵抗癌症的新療法」為題分享其研究成果。郭珩輝介紹過去30年間，毒液作為包含100多種不同化合物的來源，已被廣泛應用於藥物開發領域。然而，從毒液研究庫中被評估出約1至5千萬種化合物中，只有不到千分之一被鑒定及特徵化。因此，郭珩輝深入淺出地向與會者剖析如何鑒定和表徵具有抗癌特性的新型毒液多肽，以及這些基於毒液的抗癌多肽輸送到癌細胞的最新研究進展。在問答環節，與會者積極提問，交流氣氛熱烈。

The 21st lecture of the UM Scholar Research Forum was held on 22 October. Henry Hang Fai Kwok, head of the Department of Biomedical Sciences of the Faculty of Health Sciences held a talk titled 'Looking into New Cures from Animal Venoms to Fight against Cancer'. During the talk, Prof Kwok mentioned that venoms, which contain more than 100 different compounds, have been extensively utilised for drug development over the past three decades. However, less than one-thousandth of the estimated 10 to 50 million compounds in venom libraries have been identified and characterised. Prof Kwok then explained how to identify and characterise novel venom-based peptides with anti-cancer properties, and discussed the latest research advancements in delivering these peptides to cancer cells.

劉志分享數據時代統計學

Zhi Liu gives talk on statistics in data science age

劉志教授 Professor Zhi Liu

「澳大學人研究講壇」之第二十二講於2024年11月27日举行，由澳大科技學院數學系教授劉志以「數據時代的統計學」為題分享其研究成果。劉志介紹在大數據時代，各行各業時刻都在產生海量的數據。為此，怎樣有效處理這些數據，從而助力社會發展已成一種需求。他認為統計學作為以數據為出發點的學科，為這種需求提供了強而有力的理論和技術支撐。劉志亦回顧統計學的起源和發展歷程，以及通過一些簡單的例子來詮釋統計學的重要作用。在問答環節，與會者積極提問，交流氣氛熱烈。

The 22nd lecture of the UM Scholar Research Forum was held on 27 November. Zhi Liu, professor in the Department of Mathematics of the UM Faculty of Science and Technology held a talk titled 'Statistics in Data Science Age'. During the talk, Prof Liu highlighted the growing need to effectively process the constant stream of data generated in various industries in the era of big data to support social development, and that statistics provide robust theoretical and technical support for this need. He also gave an overview of the origins and development of statistics, and illustrated the important role of statistics through several simple examples.

展會活動 Exhibitions

澳大發佈博鰲研究項目成果
UM presents findings of Boao research project

「以博鰲亞洲論壇『構建全球科技治理新框架』倡議為指導建設澳門國際化科創平台的研究」成果發佈會於2024年2月27日在澳大舉行。該研究項目受博鰲亞洲論壇粵港澳大灣區建設澳門委員會委託，在澳門基金會的資助下，由澳大研究團隊完成，並獲博鰲亞洲論壇研究院高度評價。

The Report Presentation on 'Research on Building an International Science and Technology Innovation Platform in Macao, Guided by Boao Forum for Asia's Initiative on "Constructing a New Framework for Global Science and Technology Governance"' was held at UM on 27 February 2024. Commissioned by the Boao Forum for Asia (BFA) Macao Committee for Guangdong-Hong Kong-Macao Greater Bay Area Development, the UM research team conducted the research with funding from the Macao Foundation. The report is highly regarded by the Boao Forum for Asia Research Institute.

澳大科研成果於 MIECF 展出
UM research projects showcased at MIECF

澳門大學三項科研成果於2024年3月28日在「2024年澳門國際環保合作發展論壇及展覽」（2024 MIECF）展出，獲一眾嘉賓和與會者的高度關注，並與多家企業進行有效對接。是次活動有效提高澳大科研成果的影響力，促進澳大與企業在環保領域的交流合作。是次展出的澳大科研成果包括：一、澳大模擬與混合信號超大規模集成電路國家重點實驗室路延副教授研發的「電子設備間雙向充電的芯片設計」；二、科技學院黎永杰副教授研發的「多旋翼無人機在大氣垂直測量中的應用」；三、澳大書院創業團隊研發的「澳門BioPeTech環保麥芽貓砂」。

Three research projects of UM are being showcased at the 2024 Macao International Environmental Co-operation Forum & Exhibition (2024 MIECF) on 28 March 2024, attracting great attention from guests and attendees. The UM research teams have also established business connections with several enterprises. The event has effectively enhanced the impact of UM's research results and promoted the exchange and cooperation between the university and enterprises in the field of environmental protection. The research projects showcased at the exhibition include (1) 'Chip Design for Device-to-Device Bi-Directional Charging' developed by Yan Lu, professor at the State Key Laboratory of Analog and Mixed-Signal VLSI; (2) 'Applications of Multi-copter Unmanned Aerial Vehicle (UAV) for Atmospheric Measurements in South China' developed by Yongjie Li, associate professor in the Faculty of Science and Technology; and (3) 'Macau BioPeTech Eco-friendly BSG Cat Litter' developed by an entrepreneurial team of a UM residential college.

澳大參加「產學研對接會」促研究成果轉化
UM Participates in 'Industry-University-Research Collaboration Meeting' to Promote Research Achievements

「澳琴珠產學研合作對接會暨澳琴珠科技人才供需見面會」（對接會）於2024年6月13日在橫琴粵澳深度合作區成功舉行。本次活動採取「以需求/成果徵集－前期對接－活動現場洽談－後期跟蹤」的方式推動澳琴珠產學研合作。澳門大學在精準醫療、中醫藥及新材料等領域的四個科研團隊攜其具創新及應用前景的研究成果赴琴參會，其中健康科學學院袁振教授團隊的項目成功達成合作意向。

The 'Macao, Hengqin and Zhuhai Industry-University-Research Collaboration Meeting', organised by the Science and Technology Development Fund (FDCT) and the Zhuhai Municipal Science and Technology Innovation Bureau, was successfully held in Hengqin on 13 June 2024. UM sent four research teams from the fields of precision medicine, traditional Chinese medicine, and new materials to participate in this event, demonstrating their innovative and promising research achievements. One of the teams successfully signed a Letter of Intent for Cooperation with a mainland enterprise.

澳大多項科研成果於澳門工展會展出
UM showcases research achievements at Macau Industrial Products Show

澳門大學有9項科研及孵化成果於2024年10月4日在第十屆澳門工展會亮相，讓大眾了解澳大在工業方面的科研和轉化成果。澳大展出成果涵蓋創新科技、大健康等領域，包括5項科研成果及4項孵化企業的產品，吸引一眾嘉賓的濃厚興趣。

The University of Macau (UM) is showcasing nine research projects and products at the 10th Macau Industrial Products Show on 4 October 2024, providing the public with an opportunity to learn about the university's achievements in industrial research and technology transfer. Five research projects developed at UM and four products launched by companies incubated at UM, covering innovative technology and 'big health', are showcased at the fair.

89 項澳大科研成果於科技周展出
UM showcases 89 research achievements at Science and Technology Week

澳門大學89項科研成果於2024年10月18日在「2024科技周暨創科成果展」展出，涵蓋信息與通信技術、自然科學、工程與材料科技、生命科學與醫學、中醫藥、環境與能源科技等領域，獲一眾嘉賓和與會者的高度關注及肯定，並與多家企業進行了有效對接。澳大校長宋永華亦在活動期間作學術報告。

The University of Macau (UM) is showcasing 89 research achievements at the 'Science and Technology Week 2024 and Exhibition of Achievements in Science and Technology Innovation' on 18 October 2024. The achievements cover various fields, including information and communication technology, natural sciences, engineering and materials science, life sciences and medicine, Chinese medicine, and

environmental and energy technology. The exhibits have attracted great attention from guests and participants, and the university has established connections with a number of enterprises. Yonghua Song, rector of UM, also gave a presentation during the event.

2024 大灣區科學論壇廣州召開 - 澳大舉辦澳門分論壇
Greater Bay Area Science Forum 2024 held in Guangzhou, UM holds Macao Forum

「2024大灣區科學論壇」於廣州南沙舉行，大會今年還首次設立澳門論壇並於澳門大學進行，以進一步加強科技交流合作與協同創新，共同推動粵港澳大灣區高品質發展。「2024大灣區科學論壇」的澳門論壇由澳大於2024年11月18日舉行，以「科創澳門　多元發展」為主題，近400名海內外知名科學家、科研學者、科技企業專家及青年學子聚首澳大交流探討。今年大會首次設立澳門論壇，設有主旨報告、圓桌科學對話環節，深度結合集成電路、人工智能、月球與行星科學等領域，與嘉賓暢談澳門科技事業的發展、科技人才的培養，以及澳門經濟適度多元發展。

The 'Greater Bay Area Science Forum 2024' was held in Nansha, Guangzhou. This year, the forum introduced the 'Macao Forum', which was held at the University of Macau (UM) to enhance exchanges and cooperation in science and technology and collaborative innovation, and promote high-quality development in the Guangdong-Hong Kong-Macao Greater Bay Area. The 'Greater Bay Area Science Forum 2024 Macao Forum', themed 'Technology and Innovation – Diversified Development of Macao', brought together 400 renowned scientists, scholars, researchers, technology experts, and students from around the world. It featured keynote speeches and the Roundtable Scientific Dialogue. The 'Sub-Forum of Brain Science and Brain-Inspired Intelligence Technology & Sub-Forum of Macau Cognitive and Brain Science' and the 'Parallel Session on Artificial Intelligence and Robotics' were also held concurrently, bringing together nearly 100 experts and scholars from home and abroad.

參訪交流 Visits and Exchange

2024 年 1 月 30 日，中國國際人才交流中心夏兵副主任率團參訪澳門大學。

A delegation led by Xia Bing, deputy director of the China Association for International Exchange of Personnel, visited the University of Macau (UM) on 30 January 2024.

2024 年 2 月 26 日，國藥集團代表團訪問中華醫藥研究院開展生物醫藥合作。

A delegation from Sinopharm visited ICMS on 26 February 2024.

2024 年 2 月 29 日，廣東省科學技術廳廳長王月琴率團參訪澳門大學。
A delegation led by Wang Yueqin, director-general of the Department of Science and Technology of Guangdong Province, visited the University of Macau (UM) on 29 February 2024.

2024 年 3 月 20 日，無錫錫山區委書記方力率團訪問澳門大學。
A delegation led by Fang Li, secretary of Wuxi Municipal Xishan District Party Committee, visited the University of Macau (UM) on 20 March 2024.

2024 年 9 月 16 日，離島醫療綜合體北京協和醫院澳門醫學中心副院長李偉成率團參訪澳門大學。
A delegation led by Lei Wai Seng, deputy director of the Islands Healthcare Complex – Macao Medical Center of Peking Union Medical College Hospital (Macao Union Hospital), visited the University of Macau (UM) on 16 September 2024.

澳大研究委員會

UM Research Committee

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