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ShanghaiTech *Highlights*



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Nobel Laureate **Richard Henderson** Gives ShanghaiTech Lecture



On November 22nd, Chemistry Nobel Laureate Richard Henderson delivered the ShanghaiTech Lecture on “The CryoEM Revolution in Structural Biology” in the ShanghaiTech auditorium.

Vice President and Provost Yin Jie introduced the host of this lecture, Professor Rao Zihe, a fellow of the Chinese Academy of Sciences and a distinguished professor at Shanghai Institute of Advanced Immunochemical Studies (SIAIS) since 2013.

Professor Rao in turn introduced Richard Henderson to the audience as one of the leaders of the Cryo-EM revolution and highlighted his contributions to the field of structural biology. Under Henderson’s direction, the MRC Laboratory of Molecular Biology has produced outstanding achievements and cultivated numerous Nobel laureates.

In his one-hour lecture, Henderson detailed the advances of the Cryogenic Electron Microscopy technique for protein structure determination. He began by describing advances in resolving the three-dimensional structures of proteins through Cryo-EM. He described his collaboration with Nigel Urwin in 1975, where they determined the structure of bacterial rhodopsin to a resolution of 7 Å through electron microscopy 3D reconstruction. Constant improvements

were made in this field in terms of sample preparation from room temperature to cryogenic conditions, which eventually gave rise to the Cryo-EM techniques we have today.

With the advent of better electron detectors, data processing software and cryo-sample preparation techniques, there has been an exponential increase in the number of protein structures solved by Cryo-EM. In addition, protein structures of increasingly smaller proteins can also be determined, and the resolution of protein structures solved is constantly increasing, even reaching atomic resolution. These factors have made cryo-EM a popular choice for protein structure determination.

At the close of his lecture, Henderson listed some challenges in the field of Cryo-EM, and encouraged all staff members and students of ShanghaiTech University to overcome these problems together and develop cutting edge Cryo-EM techniques. Following his lecture, faculty and students held a fruitful discussion on overall use of Cryo-EM, technical details as well as future directions of this technique.

Henderson toured the campus and met with President Jiang Mianheng, discussing Sino-UK higher education and technological development. He also joined a Thanksgiving dinner organized by members of Professor Rao’s laboratory in the Y building.

Richard Henderson was born in 1945 in Edinburgh, Scotland. He completed his bachelor’s degree at University of Edinburgh and received his PhD degree from the University of Cambridge. He is currently the group leader of the MRC Laboratory of Molecular Biology. He collaborated with Nigel Unwin in 1975 to determine the 3D structure of the bacterial rhodopsin at Å through electron microscopy, the first time the secondary structure of the biological molecule was discerned using electron microscopy. In recent years, Henderson has been focusing on single particle cryo-electron microscopy. He is a fellow of the Royal Society and a foreign associate of the US National Academy of Sciences. He was awarded the Copley Medal of the Royal Society in 2016.

Vice President and Provost Yin Jie thanked Richard Henderson on behalf of the ShanghaiTech community and handed him a plaque as a token of appreciation.





Royal Dutch Shell CTO Visits ShanghaiTech

On November 7th, Royal Dutch Shell Chief Technology Officer Yuri Sebregts led a delegation to visit ShanghaiTech University.

President Jiang extended a warm welcome to the visitors and expressed his wishes that the two sides would cooperate in energy efficiency and environmental protection on the basis of their existing solid partnership. Yuri Sebregts also expressed his strong willingness to boost collaboration between Shell and ShanghaiTech.

Shell Principal Scientist Alexander Van Der Mate, Long Range Research Program Manager Sander Van Bavel, Senior Scientist Joost Smits and Shell China Manager for Innovation & New Energy Technologies Deng Qun attended the meeting, along with Chairman of the University Council Li Ruxin, School of Physical Science and Technology Vice Dean Liu Zhi, Office of Research Administration Vice Director Wang Jiang and Shanghai Advanced Research Institute (SARI), CAS Research Fellow Sun Yuhan.

ShanghaiTech and SARI, CAS have cooperated with Royal Dutch Shell for many years, exploring leading technologies in energy and environment.



Professor Chapman is one of the pioneers in applying the X-ray free electron laser (XFEL) to the analysis of crystal structures.

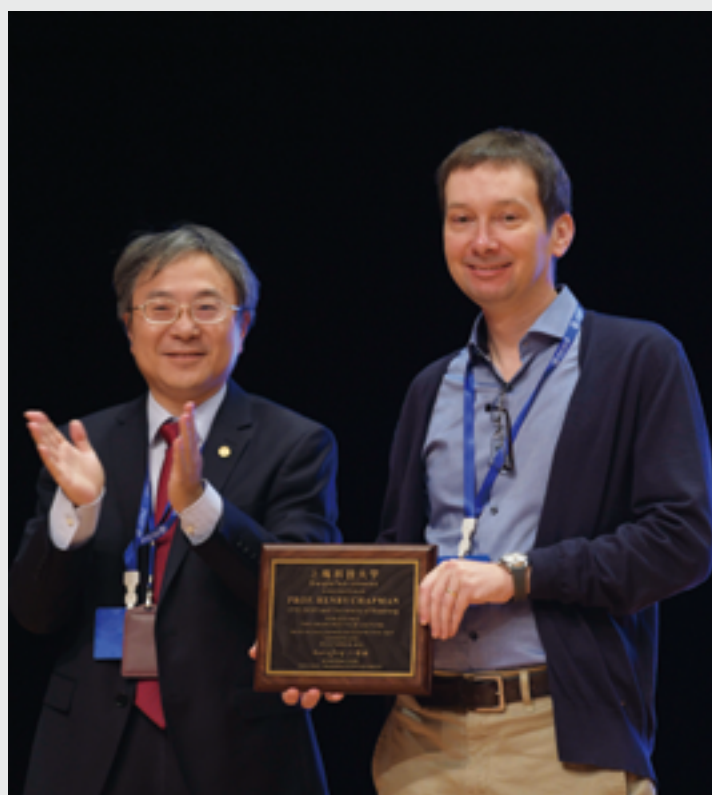
Henry Chapman Gives ShanghaiTech Lecture

ShanghaiTech invited Henry Chapman, director of the Center for Free-Electron Laser Science at the Deutsches Elektronen-Synchrotron (DESY) and professor at University of Hamburg (Germany), to attend the 17th International Conference on Crystallization of Biological Macromolecules (ICCBM17 2018) and the 6th iHuman Forum. Professor Chapman gave a speech entitled “Imaging Macromolecules with X-ray Laser Pulses” to ShanghaiTech faculty, students and attendees in the conference center.

iHuman Institute Executive Director Liu Zhijie, chairman of the conference, introduced Professor Chapman's research background and academic achievements. In his speech, Professor Chapman happily shared new techniques and methods of X-ray research in structural biology. He explained that X-rays can help scientists shoot clear 3D photos of biomacromolecule crystals, “like taking a biomacromolecule group photo.” However,

during the imaging process, X-rays cause radiation damage to the biological sample and can affect photo resolution. Before the advent of X-ray free electron lasers, the radiation damage problem was not solved, but now imaging can be performed quickly by using ultra-strong X-ray free electron laser pulses to complete imaging before the sample is

damaged. Professor Chapman also mentioned that research in this area has achieved initial success but the latest development direction of X-ray free electron lasers is to directly shoot single shots of biological macromolecules without prior crystallization, which requires stronger X-ray free electron lasers and more advanced imaging equip-



Vice President and Provost Yin Jie thanked Professor Chapman for sharing his insights with the ShanghaiTech community

ment. "If we can achieve this goal," he said, "it will be a huge leap in human biology in the field of structural biology."

Students said the speech gave them a deeper understanding of the scientific facilities that ShanghaiTech is leading or participating in the development of, including the Hard

X-ray Free Electron Laser Device, Soft X-ray Free Electron Laser User Device and Living Cell Imaging Platform, and Super Ultra-Short Laser Experimental Device. They said they felt more confident devoting themselves to scientific research using these hi-tech scientific facilities.

Professor Chapman is one of the pioneers in applying the X-ray free electron laser (XFEL) to the analysis of crystal structures. The research team

he leads analyzed an important protein structure using XFEL Serial Crystallography and published their research in December 2012. Since then, Professor Chapman and the team have continued to promote the development of XFEL data collection and data processing methods.



SIST Hosts AI Forum at Global VR Conference

The 2018 World VR Industry Conference was held in Jiangxi from October 19th to 21st. Jointly sponsored by the Ministry of Industry and Information Technology and Jiangxi Provincial Government, the conference featured 14 sub-forums, including one hosted by SIST on Artificial Intelligence. Ma Yun, chairman of the board of directors of Alibaba Group and George Smoot, Nobel Laureate in Physics and academician of the American Academy of Sciences, attended the conference and delivered keynote speeches. President Xi Jinping sent a congratulatory letter to the meeting.

SIST Vice Dean Yu Jingyi moderated a panel featuring Ziguang Group Senior Vice President Wang Hongtao, Keda Xunfei CEO Hu Yu and Unity Global Vice President Zhang Junbo. They discussed the status quo, prospects and respective planning and technological development of the three companies.

Professor Nadia M. Thalmann (Geneva University), who is also a life member of the Swiss Academy of Engineering Sciences,

Professor Kavita Bala, chair of Cornell's Computer Science Department, Microsoft Research Chief Scientist Dr. Sing Bing Kang, and another ten experts from academia and industry attended the conference as invited speakers.

In recent years, AI technologies such as robotics, machine learning, and natural language processing have enabled VR/AR technology to allow participants to become part of a computer-generated virtual reality system or an augmented reality system in which virtual information is superimposed on the real world. The final goal is to perform real-time data analysis and object manipulation through natural interactions such as gestures and language. The efficient combination of AI and VR and AR technology will be widely used in such fields as medical surgery, education and training, military security, design and maintenance, film and television production, and entertainment and digital culture, providing new modes, methods and solutions for people's production and life.



SLST Holds the 6th Frontier of Genome Engineering Forum

From October 19th to 20th, SLST held its sixth annual Frontier of Genome Engineering (FoGE2018). Vice President and Provost Yin Jie delivered opening remarks, highlighting the remarkable progress that ShanghaiTech University has achieved. The conference was officially opened by SLST Vice Dean Professor Liu Jilong, who focused on SLST's achievements in the last few years. Nearly 400 researchers from ShanghaiTech University and other research institutes, universities and pharmaceutical R&D companies attended the two-day conference to present and discuss their cutting-edge research. A total of 25 speakers from China and overseas, affiliated with such institutions as ShanghaiTech University, Chinese Academy of Sciences, Tsinghua University, Peking University, Zhejiang University, Shanghai Jiao Tong University, Tongji University, East China Normal University, Harvard University, UC Berkeley, UCSF, and Yonsei University, shared their latest research progress in a variety of subjects, including DNA repair and genome stability, genome engineering tools, therapeutic genome engineering, bioinformatics of genome engineering, genetic screening, genome engineering applied to plant and animal models, and applications of genome engineering. Nearly 45 organizers and volunteers participated in the preparation of the conference.

ShanghaiTech University invests heavily in the training and development of its students. ShanghaiTech's iGEM 2018 team, consisting of SLST undergraduate students who traveled to MIT to participate in an international competition in November 2018, were also invited to FoGE2018. A total of 26 poster presenters introduced their exciting research to the audience during the evening poster session. ShanghaiTech's student orchestra performed and the best four Poster Award winners were selected to give flash talks at the conference.

ShanghaiTech BioFrontier is an annual event hosted by SLST, featuring different talks each year. During the past six years, topics have included metabolism, neuroscience, cancer biology, cell biology, genetics and genomics, and genome engineering. It is designed to build a platform for academic interaction and research cooperation for young scientists. The 6th ShanghaiTech BioFrontier was sponsored by Banco Santander of Spain.



On November 2nd, the 17th International Conference on the Crystallization of Biological Macromolecules (ICCBM17) and the 6th iHuman Forum successfully concluded.

Co-hosted by iHuman Institute and Northwestern Polytechnical University as well as Shanghai Biophysical Society, ICCBM is a well-recognized international academic conference affiliated with the International Organization for Biological Crystallization (IOBCr). Held every two years, it has a strong reputation in the scientific and technological community. The ICCBM17 is the first international event in the field of biological macromolecules crystallization held by ShanghaiTech University. iHuman Institute Executive Director Professor Liu Zhijie and Professor Yin Dachuan (Northwestern Polytechnical University) co-chaired the conference.

The six-day conference attracted over 530 delegates from universities, research institutions and corporations from more than 20 countries and regions. In addition to the invited world-renowned senior scientists, there were also a number of young scientists and students. From the submitted abstracts, it is clear that the young scholars and graduate students have done great science in their own research fields.

Vice President and Provost Professor Yin Jie gave opening remarks, expressing his sincere welcome to the attendees. Eight undergraduate students of the Folk Music Society performed "Flowery Moonlit River in Spring," featuring eight classical Chinese instruments, reflecting the integration of science and art. ICCBM16 Chair Professor Ivana Kuta Smananova from Prague, Czech Republic handed over the crystal trophy of the ICCBM to Professor Liu Zhijie to kick off the conference. Professor Henry Chapman – the internationally renowned crystallographer and director of the Deutsches Elektronen Synchrotron (DESY), gave an inspiring speech on "Imaging Macromolecules with X-ray Laser Pulses" as part of the ShanghaiTech Lecture series and was presented with a certificate by Professor Yin Jie as a small token of appreciation.

The conference was divided into three workshops and eight seminar sessions, with the aim of discussing the latest developments and theoretical practices in the field of bio-macromolecule crystallization. 37 internationally well-

known crystallographers, structural biologists and biophysicists were invited as speakers or session chairs. The topics covered include: 1. Theory and practice of crystallization; 2. Crystallization of membrane proteins; 3. Crystallization and sample delivery for serial crystallography; 4. Electron diffraction or Micro ED; 5. Crystallization for neutron diffraction; 6. Crystallization under special physical or chemical environments; 7. Instrumentation, automation and crystal to beam; 8. Crystallization in industry and biomedicine.

The conference provided an excellent opportunity for young scientists and students to deliver oral and poster presentations. Seven young scientists from China and abroad presented their latest research results while forty-nine participants presented their research achievements and progress in the poster session. Representatives of the con-



ference organizing committee presented awards for nine best poster presenters.

On the last day of the conference, the internationally renowned crystallographer Professor Wayne Hendrickson from Columbia University delivered a closing speech entitled "The Importance of Being Crystallized." iHuman Founding Director Professor Ray Stevens and Professor Liu Zhijie presented the first "iHuman Structure of Life Award" to Professor Hendrickson. This award is presented to the worldwide scientists who have

made outstanding contributions to the structural biology community. Professor Yin Dachuan wrapped up the conference, acknowledging those whose contributions led to the success of the conference and Professor Yin announced the location of ICCBM18 in Arizona, USA.

The ICCBM17 was strongly supported by organizations including Shanghai Municipal Government, International Society for Biological Crystallization, the International Union of Crystallography (IUCr), Chinese Crystallographic Society (CCrS), Biophysical Society of China (BSC), and industry partners. It is strongly believed that the success of ICCBM17 will play a significant role in promoting the great progress and development of the field of bio-macromolecule crystallization.



The Symposium on Probing Protein Structures with Bio-MS and Complementary Technologies was held at ShanghaiTech University on November 18th, organized by Shui Wenjing Group of iHuman Institute and supported by Shanghai Institute for Advanced Studies, CAS.

iHuman Holds Bio-MS Symposium

Li Huilin from Sun Yat-sen University lectured on the unique advantages of native MS and top-down MS in analyzing structural features of protein complexes from different angles. Research Associate Professor Yang Bei from SIAIS at ShanghaiTech and Dr. Zheng Jie from the Scripps Research Institute shared their experiences in

This symposium aims to explore multiple Bio-MS techniques and complementary approaches to the structural composition, interaction interface and conformation dynamics of protein complexes. Technical breakthroughs, major applications and future directions of versatile Bio-MS techniques were introduced and discussed to help researchers outside the field better understand the unique contribution of Bio-MS to structural biology. A total of 11 speakers were invited to lecture and about 100 people attended the symposium.

Professor Huang Lan from UC Irvine and Professor Dong Mengqiu from NIBS introduced the latest developments of chemical cross-linking mass spectrometry (CXMS) for mapping interaction interfaces and dynamics of large protein assemblies. Professor Shi Yi from the University of Pittsburgh, Professor Wang Guanbo from Nanjing Normal University and Professor

studying protein structural dynamics using HDX-MS. The organizer of the symposium, iHuman Institute Research Associate Professor Shui Wenjing, reported on her group's progress in the CXMS analysis of challenging GPCR proteins. Professor Zhao Qiang and Professor Tang Chun from CAS shared their experiences and thoughts in applying MS techniques and complementary approaches to protein structural studies. Finally, a team member of Professor He Simin at Institute of Computing Technology, CAS, introduced new characteristics of the CXMS data processing software pLink developed by his group.

The speakers held fruitful discussions between each other and with the attendees. The speakers all praised the success of the symposium in promoting the exchange of ideas and future development of interdisciplinary research on bio-mass spectrometry and structural biology.





SIAIS Hosts 5th ShanghaiTech-SIAIS Bioforum

The 5th ShanghaiTech-SIAIS Bioforum was successfully held from November 13th to 16th at ShanghaiTech University, with the theme of “Advances in Integrative Biology of Cellular Processes.” The main topic discussed was breakthrough Technological Advances in Protein Research (Cryo-EM, Optogenetics, DNA-encoded Chemical Libraries).

Over 500 attendees from universities, research institutions and corporations from around the world took part in the BioForum. University Council Chairman Professor Li Ruxin gave opening remarks, welcoming the speakers and participants and then Professor Ernesto Carafoli, chairman of this year’s BioForum and professor at ETH Zurich and Padova University, expressed sincere gratitude to the university for its strong support and assistance. Professor Yan Nieng (Princeton) gave the keynote speech, discussing “How is electrical signal generated? Structural and mechanistic investigations of NaV channels,” while in the plenary speech sessions, Professor Sriram Subramaniam (Center for Cancer Research, National Cancer Institute), Professor Ernst Bamberg (Max Planck Institute of Biophysics, Germany) and Professor Yu Jin-Qian (The Scripps Research Institute) introduced recent breakthroughs and directions in the fields of Cryo-EM, Optogenetics, DNA-encoded Chemical Libraries. There were 25 presentations during the four-day Bioforum.

Attendees exchanged opinions on the more than 50 posters displayed at the poster session and the organization secretary gave a souvenir to each participant who submitted a poster.

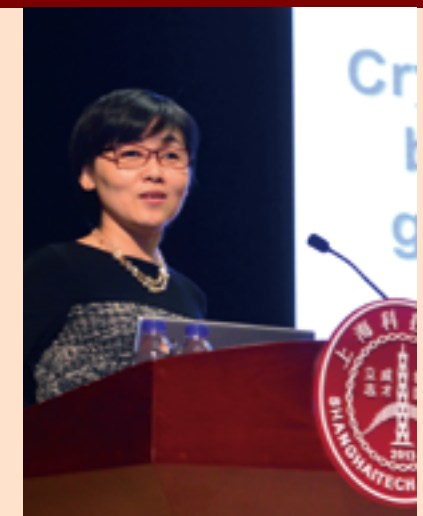
As an annual first-class symposium, ShanghaiTech-SIAIS BioForum has successfully provided a high-level exchange platform for delegates to strengthen innovation and cooperation between academia and industry. The School of Life Science and Technology (SLST), SIAIS, and iHuman Institute will join efforts to organize a joint Bioforum on November 10-14, 2019, to discuss the exciting fields of Cellular Mechanism in Health and Disease.



Opening remarks by
Professor Li Ruxin



Opening welcome by
Prof. Ernesto Carafoli



Keynote Lecture by Prof.
Yan Nieng (Princeton University)



Plenary lecture by
Prof. Sriram Subramaniam



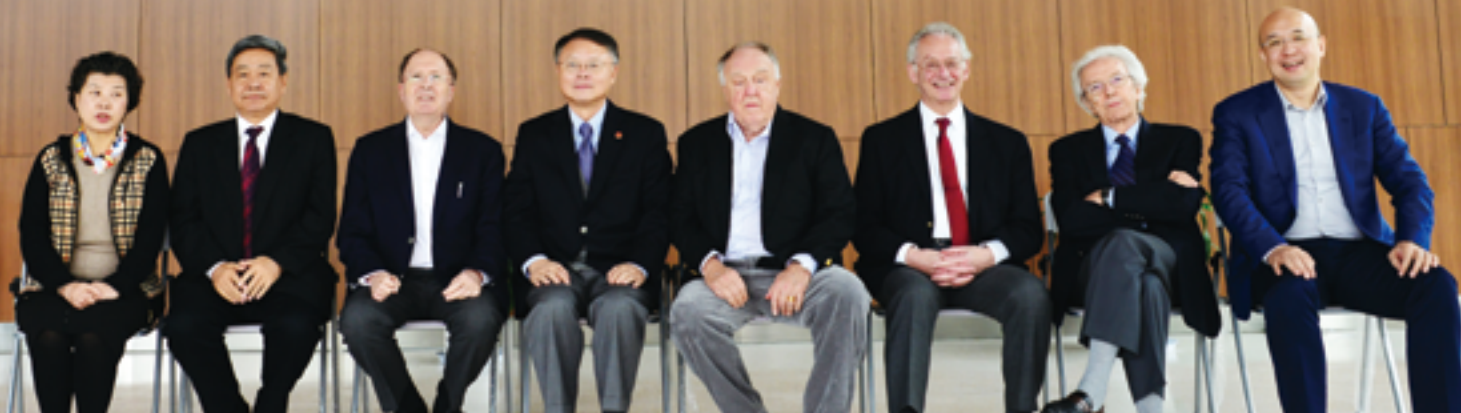
Plenary lecture by
Prof. Ernst Bamberg



Plenary lecture by
Prof. Yu Jin-Qian

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Gregory Winter (third from left) with other SIAIS Scientific Governing Board members

SIAIS Scientific Governing Board Member Shares Nobel Prize

The 2018 Nobel Prize in Chemistry was announced on October 3rd. The winners were Frances H. Arnold (USA), George P. Smith (USA) and Sir Gregory P. Winter (UK). Frances Arnold shares half of the prize for her research “for the directed evolution of enzymes.” George Smith and Gregory Winter share the other half of the prize for their research on the phage display of peptides and antibodies.

World-renowned biochemist Sir Gregory Winter is currently the Master of Trinity College of Cambridge University (UK). He has served on the Scientific Governing Board of Shanghai Institute for Advanced Immunochemical Studies (SIAIS) since its establishment in October 2012, and has provided enormous help and guidance for the development of SIAIS and ShanghaiTech University.

Professor Richard Lerner, the founding director of SIAIS, is a long-term collaborator with Sir Gregory Winter in antibody phage display technology which SIAIS has been setting up since its establishment. Currently, SIAIS researchers have successfully acquired several important antibody precursors by screening phage display libraries, and are establishing an excellent foundation for further development of therapeutic antibodies.

Econometric Society Elects SEM Dean as Fellow



Fang Hanming, School of Entrepreneurship and Management Dean and Class of 1965 Term Professor of Economics at University of Pennsylvania, was among 22 academics newly elected as fellows of the Econometric Society. He is the 14th Chinese economist to be elected to this top economics professional society.

Founded in 1930, The Econometric Society is the most renowned society in economics and publishes one of the world’s leading academic journals in economics, *Econometrica*. The society aims to promote the development of economic theories and address the relationship between mathematics, statistics and economics. The Econometric Society also helps promote the unity of quantitative empirical research and theoretical analysis.

To qualify as an Econometric Society fellow, successful candidates must make original, impactful contributions to economic theory using quantitative methods. The recognition of a new fellow to The Econometric Society requires anonymous votes by all current fellows and represents the highest honor by the economics academic community.

Professor Fang Hanming has long been committed to the application of micro-economic theory, micro-empirical analysis, public economics and China’s economic research. He has made original contributions in labor economics, social insurance and public economics and in 2008 was awarded the Kenneth J. Arrow Award by International Health Economics Association. Professor Fang has served as co-editor of well-known international economics journals including *International Economic Review* and *Journal of Public Economics*, and as associate editor of the *American Economic Review* - flagship journal of the American Economic Association, among others.

Professor Fang Hanming has served as dean and distinguished adjunct professor of the School of Entrepreneurship and Management (SEM) since January, 2018.

IMS Founding Director Wins 2019 Oswald Veblen Prize in Geometry



On November 20th, the American Mathematical Society announced that the 2019 Oswald Veblen Prize in Geometry had been awarded to Chen Xiuxiong, along with Simon Donaldson and Sun Song, for their three-part series entitled “Kähler-Einstein metrics on Fano manifolds, I, II and III,” published in 2015 in the *Journal of the American Mathematical Society*. Chen Xiuxiong is a Distinguished Adjunct Professor and the Founding Director of the Institute of

Mathematical Sciences at ShanghaiTech University.

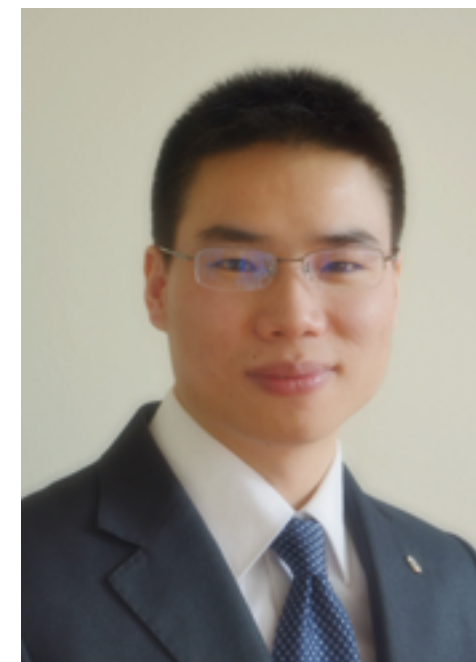
The award recognizes the trio’s breathtaking proof of a long-standing conjecture in differential geometry. One of the nominators wrote on the importance of the work: “This is perhaps the biggest breakthrough in differential geometry since Perelman’s work on the Poincaré conjecture. It is certainly the biggest result in Kähler geometry since Yau’s solution of the Calabi conjecture 35 years earlier. It is already having a huge impact that will only grow with time.”

Awarded every three years, the Veblen Prize is the highest honor given for a work in geometry or topology. Previous recipients include Fields Medalist Stephen Smale, William Thurston, Shing-Tung Yau, Michael Freedman; and Able Prize Laureate Mikhael Gromov. Famed mathematician, hedge fund manager, and philanthropist James Simons was also a winner.



SPST Professor Listed in “Highly Cited Researchers”

On November 27th, Clarivate Analytics released its annual list of “Highly Cited Researchers,” which selected 6,078 researchers from 21 fields for their outstanding research performance, as demonstrated by publication of multiple highly cited papers ranking in the top 1% by citations for field and year.



China were selected to the list in 2018.

Ning Zhijun joined the School of Physical Science and Technology at ShanghaiTech University in December, 2014. His research interests focus on solution-processed photoelectric functional materials and devices, including new materials synthesis, material surface modification and

For the first time, this year the Highly-Cited Researchers list introduced a new cross-field category to identify researchers with substantial influence across several fields during 2006-2016. 2,020 researchers with cross-field impact were selected along with the other 4,058 who made the highly cited researchers list. SPST Assistant Professor Ning Zhijun was selected for the “Highly Cited Researchers 2018” list, demonstrating ShanghaiTech University’s remarkable progress in cultivating young talents and constructing interdisciplinary research platforms. Altogether 160 researchers from universities in mainland

interface engineering, and device design and fabrication. Multiple disciplines such as materials, chemistry, physics and electric engineering are integrated in his research.

In recent years, Ning’s research group has made important progress in interdisciplinary research with works published in well-known journals such as *Joule*, *Advanced Materials*, *Journal of American Chemical Society*, *Advances in Functional Materials*, *Energy Environmental Science*, and others. For photovoltaics, his team explored low-dimensional tin perovskite structures solar cells, which

Clarivate Analytics

Highly Cited Researchers

Executive Summary

Cross-Field

Methodology

Resources

FAQ

Highly Cited Researchers 2018

This list recognizes world-class researchers selected for their exceptional research performance, demonstrated by production of multiple highly cited papers that rank in the top 2% by citations for field and year in Web of Science.

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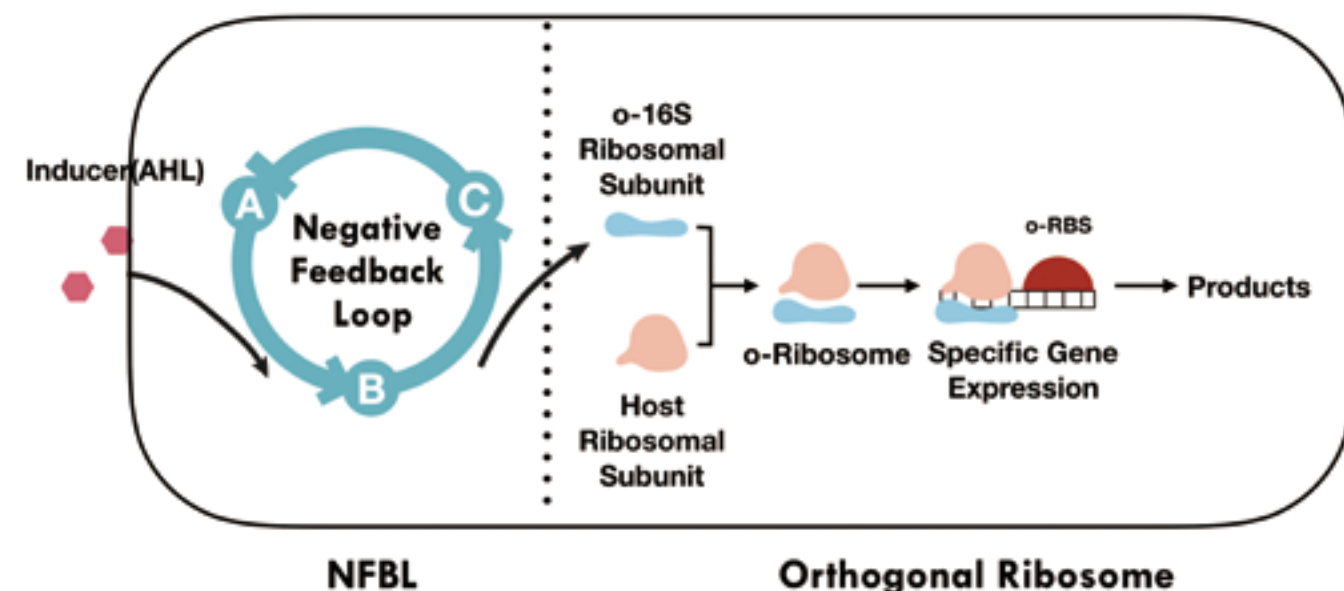
Last Name	First Name	Category	Primary Institution	Primary Region	Secondary Affiliation	Profile
Reijnders	Albert A.	Environment/Ecology	Wageningen Univ Res	Netherlands		
Lau	Chun Ning	Physics	Univ Calif Riverside	United States		
Li	Yongming	Engineering	Liaoning Univ Technol	China Mainland		
Li	Yan-Jun	Computer Science	Liaoning Univ Technol	China Mainland		
Li	Yan-Jun	Engineering	Liaoning Univ Technol	China Mainland		
Marrink	Siward J.	Cross-Field	Univ Groningen	Netherlands		
Ning	ZhiJun	Cross-Field	ShanghaiTech Univ	China Mainland		
Reijnders	Albert A.	Cross-Field	Univ Groningen	Netherlands		

greatly improved the material stability and reduced the defect concentration. Due to the well-matched bandgaps and surface passivation, the reduced carrier recombination led to a fast extraction rate of electron at the interface. Based on the combination of the optimization of materials and device structure, the lead-free perovskite solar cell achieved a record power convention efficiency of 9.4%. For electroluminescent devices, his group designed and fabricated low-dimensional perovskite structures with high luminescence quantum yield. High carrier injection efficiency

was realized by optimization of carrier transport layers. Finally, a record efficiency of red-light perovskite quantum-dot light-emitting diodes was achieved. For photocatalysis, his group reduced the defects of nanocrystals and carrier recombination through the rational design of organic surface ligands and element doping, giving rise to much improved hydrogen generation efficiency. Subsequently, the team developed a zero-dimensional quantum dot/two-dimensional MoS2 nanocomposite photocatalytic system for high performance hydrogen. This work improved the photocatalytic

hydrogen production efficiency of narrow band gap and environmentally friendly nanomaterials.

Overall, Ning's ranking in the highly-cited researchers list can be ascribed to the great work of Ning and his team, as well as the interdisciplinary research platform supported by ShanghaiTech University. Ning's team is carrying out multidisciplinary in-depth cooperation with other groups of SPST in chemistry, physics and materials, aiming at accelerating groundbreaking research.



ShanghaiTech Grabs iGEM Gold Again

◊◊◊◊ The ShanghaiTech team won gold medal for the third consecutive year ◊◊◊◊

On October 28th, the ShanghaiTech team once again took gold as the International Genetically Engineered Machine (iGEM) Competition World Finals finally drew to a close at the Hynes Convention Center in Boston, Massachusetts.

This year's iGEM competition attracted over 340 teams from top universities from around the world, including Harvard University, Massachusetts Institute of Technology, Stanford University, Oxford University, University of Zurich, William and Mary College, and others, all of which have a long history of competing at iGEM. A total of 103 undergraduate teams from Chinese universities, including Tsinghua University, Peking University, Fudan University and Shanghai Jiao Tong University, entered the competition as well. This year, ShanghaiTech's iGEM Team was led by Assistant Professor Fan Gaofeng (SLST) as a PI, and Assistant Professor Li Jian (SPST) as a joint PI. Team members included SLST undergraduate students

Tang Weiyi (Team Leader), Shi Haoer, Chen Tiancheng, Zhang Kaida, Li Jiaxin, Fu Wenhan, Li Zonghao, Gong Difei, Liu Yang, Du Jiaying, Wang Yanzhi and Qin Yuqi; SPST undergraduate students Sang Mankun, Chen Liuhao and Chen Lihan; as well as SIST undergraduate students Jin Yuzhuo and Luo Jianwen.

This year's theme was 'Fast & Fidelity,' and the project endeavored to establish a high-fidelity biological control system whose output would maintain the highest equivalence to its input signal, thus ensuring fine control of any designed biological circuit. To achieve this, the 2018 ShanghaiTech iGEM team compared circuits of various control systems, from which a three-node control loop was chosen as the basis of the whole high-fidelity system. To complement the circuit, specific parts contributing to control accuracy were also carefully chosen. Meanwhile, based on comments from field experts, the team introduced an orthogonal ribosome to further



Project Presentation by ShanghaiTech's 2018 iGEM Team

ensure signal fidelity by isolating the whole system from host disturbance even at the translational level. To optimize circuit design, the team also designed software for conducting large-scale simulations and calculations. The results demonstrated the clear advantages of the three-node loop, which were in line with the team's expectations. Additionally, the results of the above-mentioned system perfectly corresponded to the modeling, highlighting the success of the project as a whole.

Given its brief history so far, ShanghaiTech has an impressive track record at iGEM. In 2016, ShanghaiTech sent two teams to compete for the first time and won the gold and silver medals. Last year, the team won the gold medal, the Best Hardware Award and several Best Award nominations; and in 2018, the ShanghaiTech team won gold medal for the third consecutive year.

iGEM is an international academic competition in the field of synthetic biology, initiated by the Massachusetts Institute of Technology in the United States in 2003. The competition encourages creative innovation, interdisciplinary collaboration, scientific progress, as well as using biology to tackle social issues. The teams participating in the competition propose their own projects, and design models and verifi-

cation methods in a variety of topics relating to energy, medical and environmental applications, to name a few. Preliminary research on all projects is conducted at participating institutions, while the final stage of competition is held in the United States. Gold, silver and bronze medals, as well as individual prizes, are awarded through many rounds of competition, some of which are based on poster and project presenta-

tions. Over the years, research results of many participating teams have been published by top international academic journals, such as *Science* and *Nature*, highlighting the level and value of this contest.

Apart from lab work, team members also engage in various social activities, including the popularization of synthetic biology and the spreading of biosafety knowledge. For example, the 5th CCIc (Conference of the China iGEM Community) was successfully held at ShanghaiTech University in August, led by team member Li Jiaxin, with strong support from SLST. During the conference, the iGEM community engaged the public, thus advancing iGEM's outreach in China.

<http://2018.igem.org/Team:ShanghaiTech>



Members of ShanghaiTech's 2018 iGEM Team



Li Jing
presenting at
the venue

ShanghaiTech Team Takes Second at AI Competition

In October, the Baidu Star Developer Competition, a deep learning algorithm competition for global AI technology enthusiasts, was held in Beijing, and a team from ShanghaiTech took second place. The team from South China University of Technology won the first prize; and teams from Shanghai Jiao Tong University, Universitat Autònoma de Barcelona, Northwestern Polytechnical University, Dalian University of Technology, Nanjing University, Beihang University, University of California, Riverside, Harbin Institute of Technology, and South China University of Technology were among the 1,000 teams from around China and the world (including teams from Spain, US and England) that participated.

This was the 15th Baidu Star Programming Competition held since Baidu transformed into an artificial intelligence technology

company. This competition presents awards for first place, second place (2), and third place (3).

The ShanghaiTech team was made up of five students from the School of Information Science and Technology: Li Jing (graduate student), Lian Dongze (PhD student), Luo Weixin (PhD student), Jin Lei (undergraduate), and Hu Junhao (graduate student), under the guidance of Assistant Professor Gao Shenghua. This year's competition, with the theme of crowd counting, began on July 4 and was divided into a preliminary, semi-final and final competition. The ShanghaiTech team focused on pedestrian analysis visual technology applied to surveillance scenes, which has received increasing attention in the last few years. A variety of visual technologies, including human detection, human body

attribute recognition, and population density estimation, have been widely used in many fields such as home security, public security and retail. Because of its accuracy and speed (faster than using the naked eye), the crowd density estimation method, applied to crowded scenes, has been widely used in airports, mass transit stations, public transport vehicles, art galleries, etc. It can effectively prevent hidden dangers such as stampedes and overcapacity, while helping retailers and monitoring traffic. Competition participants used the PaddlePaddle framework to develop a common human flow density estimation algorithm that could be used for dense, sparse, high-altitude, on-board and other complex scenarios to accurately estimate the total number of people in the input image.

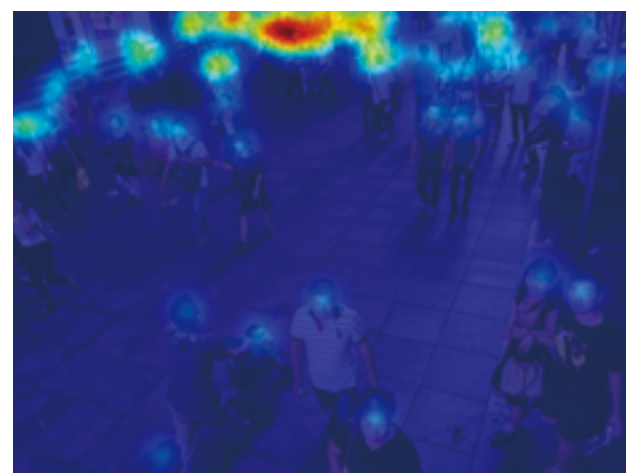
The ShanghaiTech team fully analyzed the data distribution in the competition, and proposed a data augmentation method for generating crowd density maps online. They proposed a balanced crowd density error loss function for the extremely uneven distribution of the number of people in the image and the students considered the final deployment of the model, reducing the model capacity and calculation time as much as possible. More importantly, they used the crowd counting algorithm based on density map regression even if the pedestrian boundary box labeling information was discarded, and still achieved good performance in the competition. The algorithm achieved third-place in terms of performance using only a single model, and achieved the fastest speed, eventually leading to an overall second-place finish in the final.



ShanghaiTech team from left to right:
Luo Weixin,
Li Jing,
Jin Lei

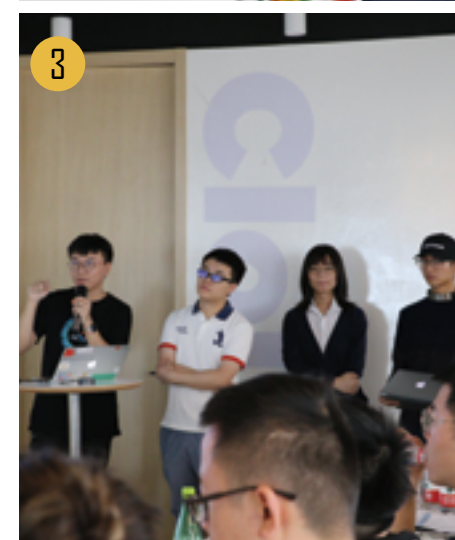


The original image



Density map results

ShanghaiTech Students Win at Hackathon



- 1 Pyxis team wins Second Place
- 2 Pyxis team's BidChain Demo
- 3 Demo of "Team Name I Forgot"
- 4 "Team Name I Forgot" wins Team Outstanding Works Award and MakerDAO Sponsor Special Award

Recently Shanghai hosted BitRun Hackathon 48H, a national contest for blockchain technology developers and enthusiasts. Undergraduate and graduate students competed on the blockchain hackathon, and nearly one hundred technology enthusiasts from Zhejiang University, Fudan University, Tongji University and Central University of Finance and Economics, and others took part. After several days of competition, Pyxis, part of ShanghaiTech's GeekPie community, won second place. The Team Name I Forgot team received the Outstanding Work Award and the MakerDAO Sponsor Special Award; a team consisting of a

mix of Zhejiang University graduate students and game industry practitioners won the first place, while third place was taken by Zhejiang University Blockchain Club members.

The Pyxis team consisted of three freshmen from School of Information Science and Technology (Zhang Qixuan, Jing Haotian, Zheng Zeyu) and a freshman from Zhejiang Gongshang University. This was unusual as 70% of the players in the competition were juniors or above; and many PhD and master's degree students and IT practitioners participated as well. Among this stiff competition, Pyxis was the only team solely composed of freshmen students. The Pyxis team members had less than a month to learn about blockchain technology for this competition.

Their strategy was to use the Nervos AppChain development tool, and they designed and developed a multi-mode bidding system based on blockchain within 48 hours - no competition Bid-Chain and a full-featured Demo show in the final. The system uses blockchain technology and cryptography to achieve blockchaining of bidding. Under the premise of ensuring complete logic, the operation process from the perspective of both bidders in a streamlined bidding process; drawing on the concept of "Zero-Knowledge Proof," the bidders' complete "double-blindness" was guaranteed, and the risks for both parties reduced. The method of freezing tokens by the Ethereum Smart contract ensures

that the bidder has limited control over the maximum deposit.

"Team Name I Forgot" team was composed of two ShanghaiTech students (Li Zhao, Wang Yi) and two other undergraduate students from University of Shanghai for Science and Technology and Fudan University. The team developed a next-generation business based on a stable currency. The ad delivery model, which uses smart contracts, ensures the interests of the sitter are not lost, and uses the Dharma Protocol to motivate users to advertise and the DAI Stablecoin to avoid the potential risk brought by digital currency price fluctuation, thus enabling the economic model of the team design arrived at a win-win situation.

After the competition, Pyxis team-members said, "Before participating, it was not clear to us what the composition of the other participating members would be, but at the end of the competition it was rewarding to compete with big players on the same stage. We would like to thank the Nervos Appchain team, as their technicians helped us fix some bugs in the Nervos AppChain suite found during the competition. Our main advantage was in the design of our product and the complete demo, showcasing the final product. Our underlying technical understanding of blockchain might be less than the other school's seniors, and there are still many things to learn."



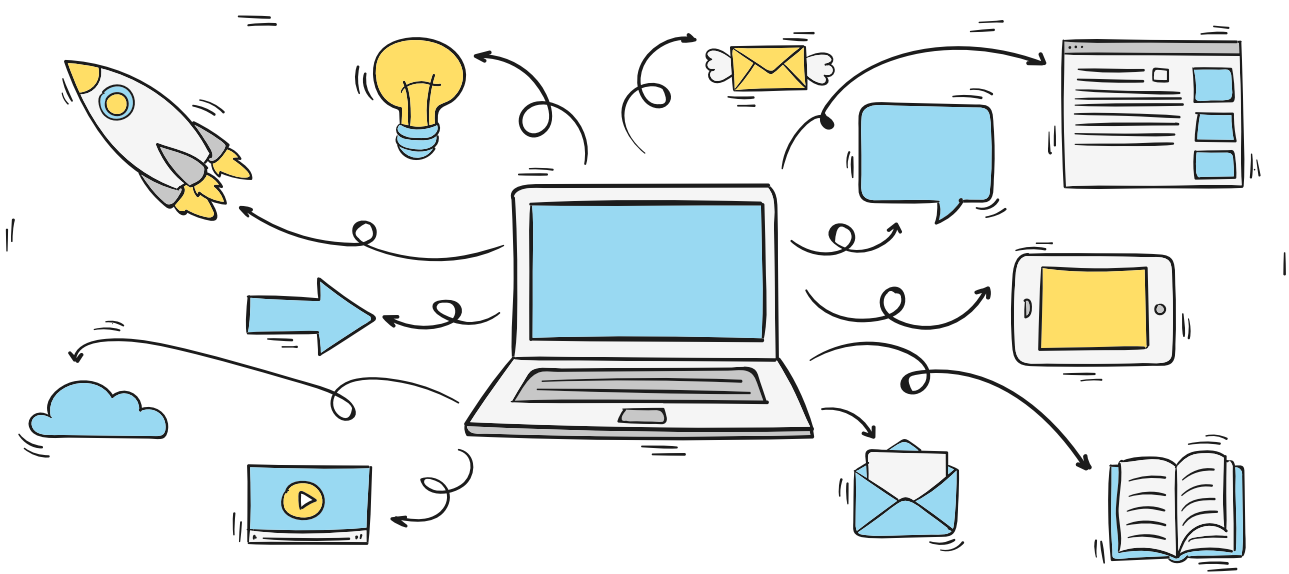
first prize

Student Hackers Win Swiss Trip



An award-winning team of hackers from ShanghaiTech won an all-expenses paid trip to Switzerland after crushing the competition in "The New Transport Experience Hackathon" at Suzhou Xi'an Jiaotong-Liverpool University last November. After 24 hours of high-intensity mental and physical challenges, the Everything Crashes team of four undergraduates (Zhang Jiajian, Zou Muyang and Wang Weitian, and captain Luo Shengcheng) won the first prize.

The competition was co-sponsored by the large-scale multinational company Schindler Group Schindler Elevator Asia-Pacific R&D Center and InnoSpace, a famous startup incubator platform and 150 students and hackers from Shanghai Jiaotong University, Xi'an Jiaotong-Liverpool University, New York University, Paris 11th University, and Mushroom Cloud Maker Space, Schindler Group and other universities joined the competition. Participants were challenged to develop innovative and effective solutions in the field of smart travel, sustainability, and



elevator experience upgrades around the elevator application scenario, with the aim of promoting new business model development, optimization strategies and application technologies...all within a 24-hour period.

Following eight hours of brainstorming, the Everything Crashes team targeted claustrophobia sufferers, and tackled problems they might experience during elevator travel. After poring through psychology and engineering papers, the team spent 12 hours without sleep working on project development. By the end of the 24 hours, they had successfully combined a barrage system with a touch screen and elevator system- calling the project "Elepainter."

During the project road show, Everything Crashes won the judges' unanimous approval with their logical and clear creative ideas,

excellent product design and confident style. The first prize award was a trip to visit Schindler headquarters in Switzerland and the Swiss Federal Institute of Technology.

The trip to Switzerland took place in February. The four students traveled to Schindler's headquarters for a tour and also showed their project to Schindler's core technician team. Later, they participated in Schindler's annual conference, and had a face-to-face meeting with Schindler's CEO and CFO to learn about how technology companies are innovating in today's competitive environment.

The students toured the Schindler Lab at EPFL University, a world-renowned institution. The students and postgraduates discussed the development direction of Schindler's future research, EPFL's educational philosophy and teaching methods.

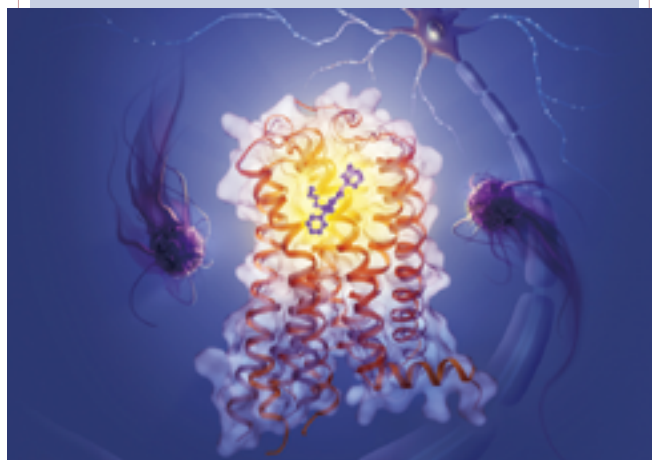


iHuman & SIAIS Publish Important Research Findings

On January 25th, 2019, iHuman Institute and Shanghai Institute for Advances in Immo-chemical Science (SIAIS) held a joint press conference to announce the simultaneous publishing of two important research studies in the same issue of the prestigious *Cell* journal. Founding iHuman Director Ray Stevens emphasised that teamwork and collaboration is an important value for both iHuman and SIAIS research. The two institutes are located in the same building and frequently carry out cross-disciplinary collaboration. The first authors of the two studies both are PhD students in the first class jointly cultivated by ShanghaiTech and Chinese Academy of Sciences. The two research studies share an interesting commonality, explained iHuman Institute Executive Director Liu Zhijie. Rimonabant, an antagonist for human cannabinoid receptor CB1, which an iHuman Institute team had published the structure of in *Cell* before, was also found to be an inhibitor of MmpL3, a mycobacterial protein that was the subject of the SIAIS study.

A team of scientists led by ShanghaiTech's iHuman Institute has deciphered the crystal structure of human cannabinoid receptor CB2, another "marijuana receptor." Their work reveals the structural features of antagonist-bound CB2 and the unique ligand binding mode, which facilitates rational drug design toward precise modulation of the endocannabinoid system. These new findings were published in the January issue of *Cell*, titled "Crystal structure of the Human Cannabinoid Receptor CB2."

Cannabis sativa L. has had medicinal, religious and recreational uses for centuries, and there were a large number of records on the medicinal uses of cannabis in the traditional Chinese



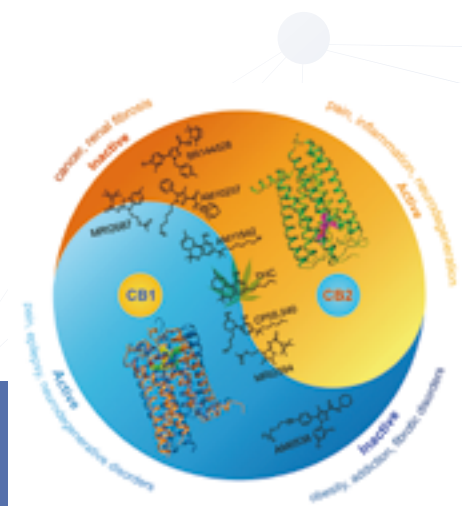
Artistic illustration of AM10257-bound cannabinoid receptors expressed in neuron and immune cells depicts the precise modulation of CB1 and CB2 to central nervous system and immune system (Image designed by Julie Liu)

medical books such as "Shennong Herbal Classics" and "Compendium of Materia Medica." In recent years, the medicinal properties of cannabis have been more and more widely recognized and clinically applied; for example, in 2018 the European Union EMA and the United States FDA approved the new drug "Epidiolex," with Cannabidiol (CBD) extracted from cannabis as the major active ingredient, to treat children's epilepsy.

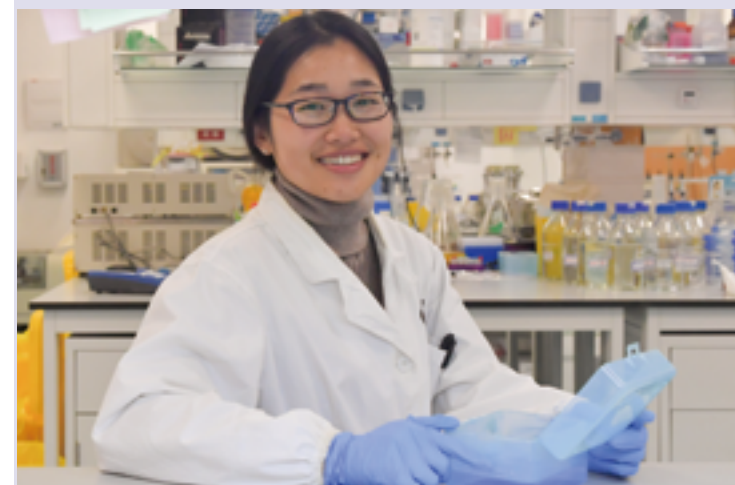
The cannabinoid receptors CB1 and CB2 serve as key components of the human endocannabinoid system and are the principal targets of phytocannabinoid Δ9-THC. CB1 is expressed throughout the body and is widely distributed in the central nervous system (CNS), while CB2 is mainly expressed in the immune system and, to a lesser extent, in the CNS. CB2 is emerging as an attractive therapeutic target for immunomodulation, the treatment of inflammatory and neuropathic pain, neuroinflammation, and neurodegenerative disorders. Recent studies indicate that CB2 antagonists can ameliorate renal fibrosis and also delay tumor progression, indicating their potential for treating fibrotic conditions

and cancer. Although, CB2 has a high degree of homology and shares 44% sequence identity with CB1, there are many differences between them in receptor distribution and physiological function. "Determination of the structure of CB2, along with our previously solved CB1 structures (*Cell*, 2016; *Nature*, 2017), will provide new insights into precise modulation of the endocannabinoid system for therapeutic applications," said corresponding author Liu Zhijie, Executive Director of iHuman Institute and School of Life Science and Technology professor at ShanghaiTech University.

"To generate the stable CB2 protein for structural determination, we designed and screened hundreds of constructs and optimized purification procedures," said Li Xiaoting, first author of the paper, and the first batch PhD students at ShanghaiTech University. With a great deal of effort and in collaboration with Alexandros Makriyannis' lab at Northeastern University in the United States, the team finally solved the crystal structure of human CB2 in complex with a rationally designed antagonist, AM10257, at 2.8Å resolution.



The effect of different ligands on CB1 and CB2 "yin-yang" functional relationship as well as respective related diseases



First author of paper, Li Xiaoting, one of the first batch of PhD students of ShanghaiTech University



Photo of the research team members from iHuman Institute (from left to right: Raymond Stevens, Wu Lijie, Wang Jingjing, Hua Tian, Li Xiaoting, Liu Zhijie, Zhao Suwen, Wu Meng)

"The CB2-AM10257 structure reveals a distinctly different binding pose compared with antagonist bound CB1," said Hua Tian, the co-first author of the paper and Research Associate Professor at iHuman Institute. The extracellular portion of the antagonist-bound CB2 shares a high degree of conformational similarity with the agonist-bound CB1, which led to the discovery of AM10257's unexpected opposing functional profile of CB2 antagonism

versus CB1 agonism. "CB2 antagonist and CB1 agonist profiles probably occur in certain compounds, representing a CB2 and CB1 yin-yang functional relationship. The physiological implications of such opposing activation profiles between CB1 and CB2 are worth exploring further," said Liu Zhijie.

"It's my great honor to grow up with ShanghaiTech University together as one of the first batch of graduate students. My six-year study life at ShanghaiTech University has been both long and fast. Failures, dilemma and persistence made me stronger. I hope the structures of cannabinoid receptors will facilitate drugs discovery that targeting to cannabinoid system," said Li Xiaoting.

"The endocannabinoids system is very important for the human body. It relates to many physiological and pathological processes. Such remarkable findings should aid in the rational design of CB1/CB2 ligands with improved functional selectivity," said iHuman Institute Director Raymond Stevens.

Other co-authors of this paper are Wu Yiran, Wu Lijie, Qu Lu, Wang Jingjing, Wu Meng and Zhao Suwen from ShanghaiTech University; Kiran Vemuri, Othman Benchama, Nikolai Zvonok and Alexandros Makriyannis from Northeastern University; Jo-Hao Ho, K'ara Locke, Laura M. Bohn from Scripps Research, Florida; Malliga R. Iyer, Resat Cinar, Nathan J. Coffey and George Kunos from National Institute on Alcohol Abuse and Alcoholism, NIH; Gye Won Han and Vsevolod Katritch from University of Southern California; and Petr Popov from Moscow Institute of Physics and Technology. Financial support for this work came from National Natural Science Foundation of China, Ministry of Science and Technology of China, Shanghai Municipal Government, and ShanghaiTech University.



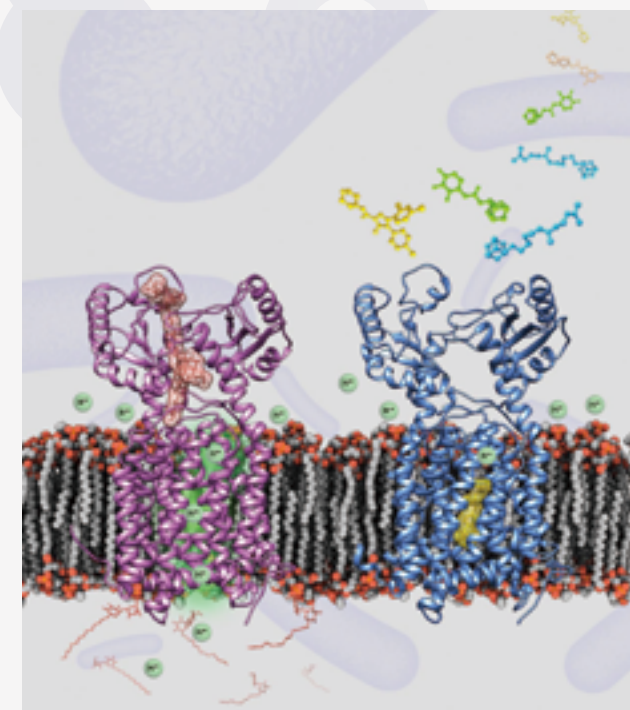
Group photo of Rao Zihe's Research Team in SIAIS, ShanghaiTech

Meanwhile ShanghaiTech SIAIS Distinguished Adjunct Professor Rao Zihe's team published research in *Cell* with the title "The crystal structures of membrane transporter MmpL3, an anti-TB drug target." MmpL3 has emerged as an important new target for anti-tuberculosis drug discovery with inhibitors of this protein currently in clinical trials. Their research determined the crystal structures of mycobacterial MmpL3 alone and in complex with four TB drug candidates. This data paves the way for the rational development of MmpL3 inhibitors as potent TB drugs.

Despite intensive efforts to discover highly effective treatments to eradicate tuberculosis (TB), the disease remains a major threat to global human health. In 2017 alone, there were an estimated 10 million new cases of TB leading to 1.3 million deaths, making it the leading cause of human fatality due to infectious disease (World Health Organization, 2018). Furthermore, the emergence of multi-drug-resistant, extensively drug-resistant and totally drug-resistant TB makes the disease exceptionally difficult to treat. Thus, there is an urgent need to develop new therapeutic drugs to target TB.

Mycobacterial genomes encode a membrane protein named MmpL3, which is deemed essential for the replication and viability of bacterial cells. MmpL3 belongs to the Resistance, Nodulation and Division (RND) protein superfamily, which are driven by the proton motive force (PMF). Particularly for Mycobacterium tuberculosis, MmpL3 is responsible for the translocation of the precursor of mycolic acids (a special chemical compound) from their production site in the cytoplasm to periplasmic space, where they can be further processed. Mycolic acids are key components of mycobacterial cell wall and essential for mycobacterial growth, rendering the bilayer impermeable to many antibiotics. Hence inactivation of the MmpL3 transporter inhibits the pivotal step of the synthetic pathway of the mycolic acids. Thus, it is an ideal target for developing novel anti-tubercular drugs. Although several compounds have been developed as MmpL3 inhibitors, its structural data for MmpL3 has remained elusive, preventing the development of more potent anti-tuberculosis drugs.

The research team solved the crystal structures of Mycobacterial MmpL3 alone and in



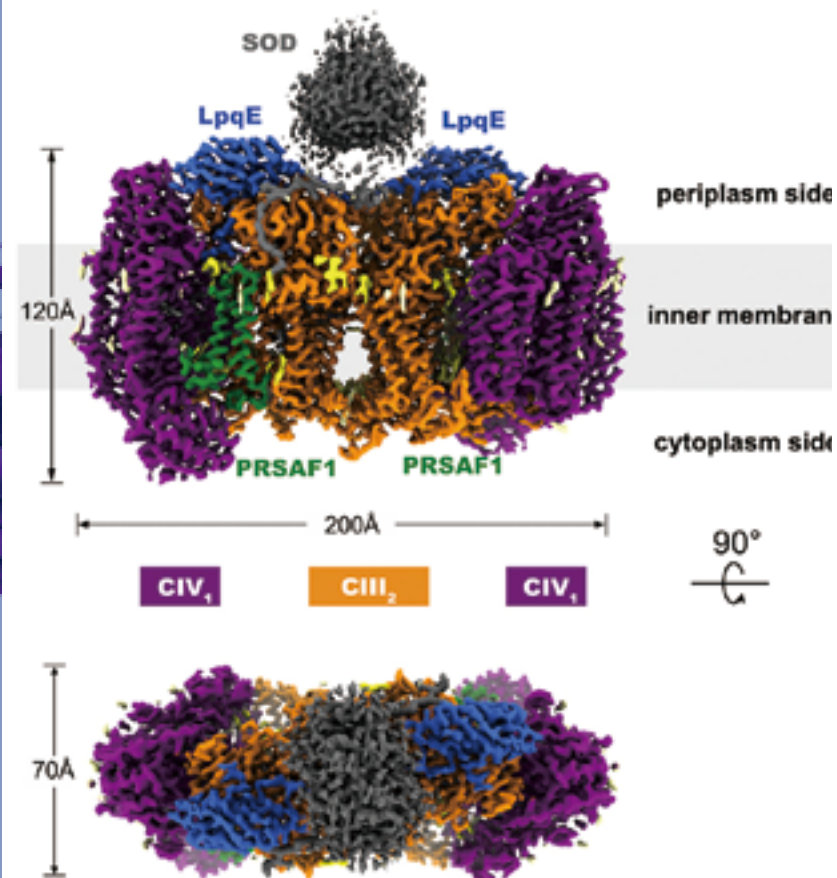
Structure of mycobacteria MmpL3 protein binding substrate analogues (left) and structure of complex with anti-tuberculosis clinical drug SQ109 (right)

complex with four TB drug candidates by X-ray diffraction method, achieving a major conceptual breakthrough in understanding how four important anti-TB drug candidates inhibit their target. Their initial breakthrough came when we were able to design a construct for MmpL3 which allowed, for the first time, the crystal structure of MmpL3 to be determined. More importantly, the crystal structures of the complex with SQ109, AU1235, ICA38 and rimonabant show precisely their modes of binding to proton-translocating channel in MmpL3, blocking the proton motive force for substrate translocation. SQ109 is a compound with much promise as an anti-TB drug, as it has recently been the subject of a Phase 2b-3 clinical study. Rimonabant is an inverse agonist for the cannabinoid receptor CB1 and was the first drug approved in that class. They identified it as a potential inhibitor based on virtual screening analysis of

the solved structures. Importantly, these new structures will reshape the current thinking as to how to proceed to fully optimize these and other lead compounds as inhibitors of MmpL3. Then it is now possible to rationally design, using structure-based methods, more potent and selective anti-TB drug drugs by targeting MmpL3.

In addition, this is the first time to describe structures of drug candidates which can block the proton motive force to inhibit an RND family member, many of which are important targets for anti-bacterial drug discovery. This data will therefore provide inspiration for the design of new classes of antibiotics.

Professor Rao Zihe's research team has long been committed to researching the structural biology of anti-TB drug target and drug development. Three months ago, they published a research article on the same topic in *Science*, titled "An electron transfer path connects subunits of a mycobacterial respiratory super-complex." Multiple institutions contributed to this research. SIAIS doctoral student Zhang Bing is the first author of this article. SIAIS Research Associate Professor Li Jun is the co-first author and co-corresponding author. SIAIS PI and SLST Associate Professor Yang Haitao and SIAIS Adjunct Professor Rao Zihe are the co-corresponding authors. SIAIS Professor Jiang Biao, iHuman Institute Professor Liu Zhijie and Shanghai Institute of Materia Medica of Chinese Academy of Sciences Professor Jiang Hualiang also contributed to this work. In addition, School of Life Science and Technology, the National Center for Protein Science (Shanghai), and Institute of Biochemistry and Cell Biology of Chinese Academy of Sciences provided technical support for this work.



The 3.5-Å resolution cryo-EM structure of mycobacterial respiratory supercomplex CIII₂CIV₂SOD₂

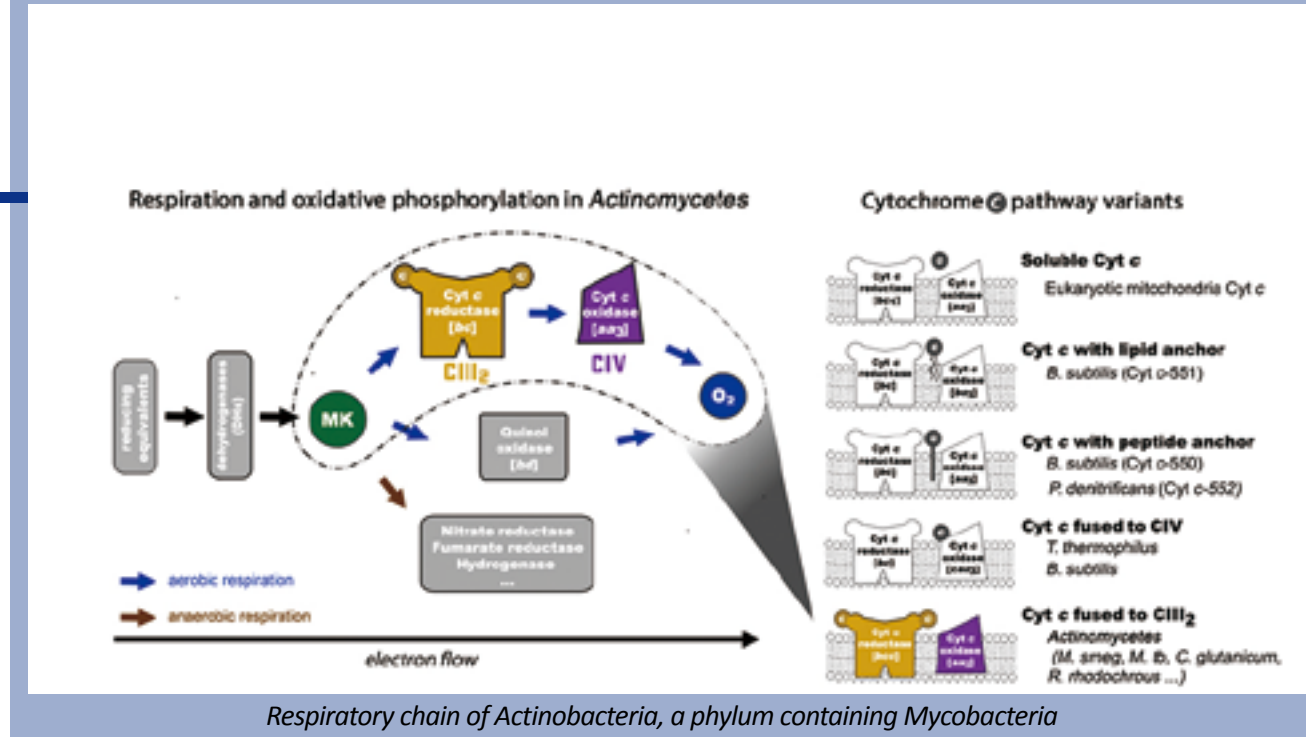
ShanghaiTech

Scientists Published in *Science*

On October 25th, 2018, ShanghaiTech Distinguished Adjunct Professor Rao Zihe and his team's research on "An electron transfer path connects subunits of a mycobacterial respiratory supercomplex" was published online in *Science* journal.

On the strength of cryo-electron microscopy (cryo-EM) with high resolution (3.5 Å) structure of mycobacterial respiratory supercomplex, the team revealed a new electron transfer mechanism coupling quinone oxidation with oxygen reduction. Furthermore, they discovered that superoxide dismutase (SOD) are directly involved in the assembly of the supercomplex and work in concert. These new findings have laid a solid groundwork for new drug R&D targeting tuberculosis, which poses a grave human health threat.

Respiration is one of the most basic energy metabolisms in life, and helps energy transform substances (e.g., sugar, amino acid and fatty acid) into adenosine triphosphate (ATP) that could be immediately consumed by the living body. It is run mainly by five large transmembrane complexes on the microbial cytoplasmic membrane or the inner mitochondrial membrane: complex I (NADH dehydrogenase), complex II (succinate dehydrogenase), complex III (quinone: cytochrome *c* oxidoreductase), complex IV (cytochrome *c* oxidase) and



complex V (ATP synthase), together with two carriers for electron transfer, quinone and cytochrome *c*, therefore called the respiratory chain. Electron transfer inside and between the complexes I-IV forms an electron transport chain, coupling the transmembrane proton gradient used to drive the ATP synthesis by complex V. Previous studies have shown that respiratory chain components could be further assembled into supercomplexes to promote tandem reaction among them. This is of great significance in the regulation of energy metabolic efficiency and various physiological processes. The disorder in supercomplex assembly would be closely related to the occurrence of diseases in higher animals; when interrupted in microorganisms, it would be an important strategy for developing new drugs to inhibit their growth and infection.

"It is common for the assembly of complex III and complex IV to form a supercomplex, which is particularly important in energy production for *Actinobacteria*, a phylum containing *Mycobacterium tuberculosis* and multiple pathogenic bacteria," said Professor Rao. "There were no extensive and direct in-

teractions between complex III and complex IV in the previous reported structures including mammalian respiratory supercomplex I₁III₂IV₁. Meanwhile, the cytochrome *c* protein in mitochondria exists in free soluble form to mediate electron transfer between complex III and complex IV. So, it is still questionable whether it shuttles inside the supercomplex or across multiple supercomplexes. In this research, we revealed the whole electron transfer path from complex III to complex IV and the tandem reaction mechanism for the two complexes. Such a revelation answers one of the scientific questions of wide concern that has long been unresolved in the respiratory field, following our first report of the crystal structure of the eukaryotic mitochondrial complex II in *Cell* in 2005."

As explained by Gong Hongri and Xu Ao, doctoral students of Nankai University and co-first authors of this article, this research finding came from years of preparation and technical accumulation in the study of *Mycobacterium tuberculosis* by the team. Their close cooperation runs from the purification and optimization of samples to activity validation, from preparation of cryo-EM samples

to improvement of data processing methods and eventually to the resolution of near-atomic resolution structural model. Such cooperation, coupled with harmonized efforts in multiple biochemical and biophysical methods, such as lipidomics analysis, atomic absorption spectrometry and electron paramagnetic resonance test, empowered the researchers to gain comprehensive intimate knowledge of the whole electron transfer path inside this particular supercomplex.

“Another unexpected discovery is superoxide dismutase (SOD). While in zymologic function it has long been regarded as correlated with redox reaction of the respiratory chain by radicals scavenging and also with the host’s immunoreactions during microbial infection, direct evidence is still absent,” said Dr. Wang Quan and Research Associate Professor Li Jun, key members of the team. “Additionally, the molecular mechanism of SOD involved in such connection is rather controversial. From the viewpoint of the structural biology for the first time, we confirmed the direct interaction in the mycobacterial periplasm between SOD and the respiratory chain complex as well as SOD’s capability of scavenging the potential free radicals to drive redox reaction. Moreover, this finding implies an important mechanism of *Actinomycetes* represented by *Mycobacterium tuberculosis* to resist immunoreactions in the host’s macrophage, thus bringing new revelations to the further understanding of in-

teractions between *Mycobacterium tuberculosis* and its host,” they said.

Their research bears great significance in the R&D of new drugs, especially targeting tuberculosis. The World Health Organization (WHO) reports that tuberculosis has become

a leading infectious disease in the world. For decades, the long-term use of isoniazid, rifampicin and other drugs has resulted in increasingly acute drug resistance. Drug resistance has become one of the grave challenges in treating tuberculosis. Studies in recent years which indicate that targeting energy metabolic system can address drug resistance have been attracting attention. In 2012, the US FDA expedited approval of Bedaquiline, the first drug treating the multiple-drug resistant tuberculosis and it gained access to China in March 2018. The working principle of this drug is to inhibit the

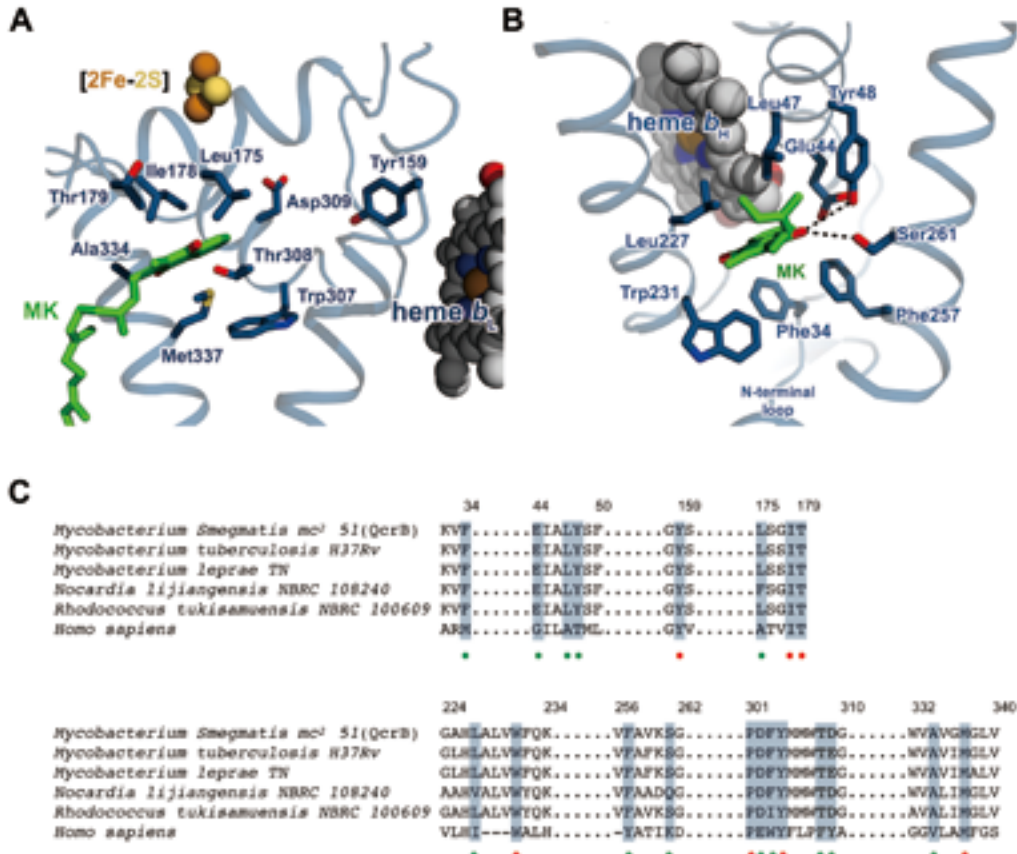
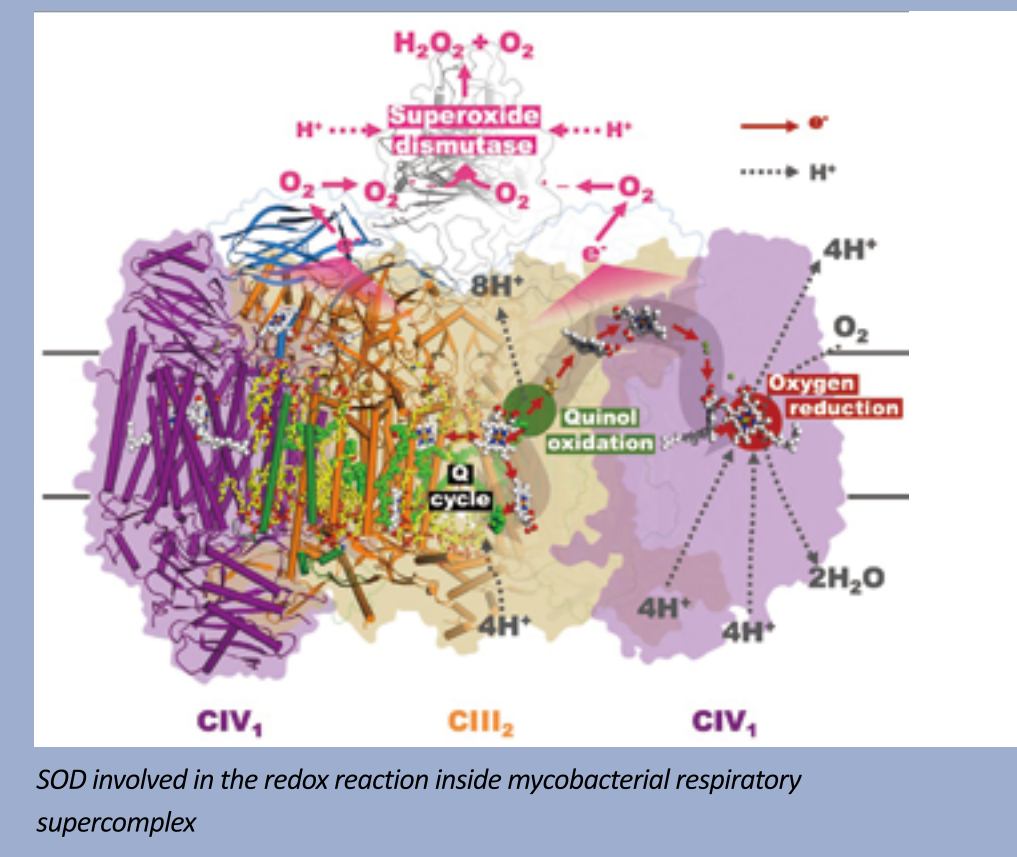
respiratory chain system from synthesizing ATP to wipe out *Mycobacterium tuberculosis*.

“The complex III under our research is a highly popular drug target. The pharmaceutical molecule Telacebec (Q203) in the phase II clinical trials is just suppressing the binding of natural substrate of the complex to block the aerobic respiration pathway of *Mycobacterium tuberculosis*, thus to play its pharmacological role. Our research will serve as a great powerhouse for further improvement of this drug and development of even newer drugs with better efficacy,” Professor Rao said.

Professor Rao Zihe and his research team have long been committed to researching the structural biology of emerging and reemerging infectious disease pathogens in China. This article is their second one

published in *Science* this year, following publication of the assembly mechanism of herpes virus earlier this year. Multiple institutions contributed to this research with ShanghaiTech University being one of the three key initiators. Research Associate Professor Li Jun of the Shanghai Institute for Advanced Immunochemical Studies is the co-first author of this article and Adjunct Professor Rao Zihe is the co-corresponding author. Professor Jiang Biao, doctoral student Wang Shuhui and Research Associate Professor Yang Xiuna have also contributed to this work. In addition, the National Center for Protein Science (Shanghai) provided some technical support for this work.

Read more at: <http://science.sciencemag.org/content/early/2018/10/24/science.aat8923>



Binding site of substrate (MK) and the potential drug in mycobacterial complex III

Scientists Make Learning and Memory Breakthrough

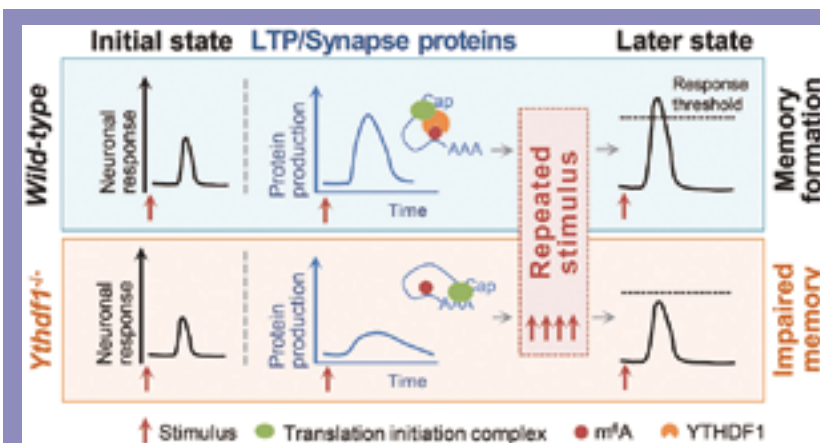


A team of scientists led by Dr. Zhou Tao from ShanghaiTech's School of Life Science and Technology, Dr. He Chuan from University of Chicago and Dr. Song Hongjun from University of Pennsylvania, have made a breakthrough in the field of RNA methylation (m^6A) in regulating brain functions. Their work, entitled " m^6A Facilitates Hippocampus-Dependent Learning and Memory through YTHDF1" was published online in *Nature* on November 1st.

First discovered in 1975, m^6A is the most prevalent internal RNA modification in mammalian mRNA. The discovery of first m^6A demethylase in 2011 and the development of transcriptome-wide mapping method of m^6A have sparked extensive research on the biological functions of m^6A . After binding by its reader proteins, m^6A affects nearly every step of RNA lifecycle and many biological processes. Among all the tissues, the brain has the most abundant distribution of m^6A and its reader proteins. Whether and how m^6A and its reader proteins affect specific brain functions, such as learning and memory, remains unknown.

In order to explore the functional roles of m^6A and its readers in learning and memory process, the researchers generated reader protein knock-out mice by using CRISPR/Cas9, combined with behavior analysis, electrophysiological recording, brain region-specific over-expression or knock-down, m^6A -seq, RNA-seq and CLIP-seq technologies. They found that m^6A facilitates hippocampus-dependent learning and memory through its reader protein YTHDF1, and that this process is dependent on neuronal activity. This is the first research to show the molecular mechanism of learning and memory at an epitranscriptome level, and has improved our knowledge of the in-vivo functions of m^6A .

Dr. Zhang Xuliang is co-first author and Dr. Zhou Tao is the last and co-corresponding author. This work was supported by grants from National Natural Science Foundation of China, National Key R&D Program of China, Shanghai Rising-Star Program and Startup Foundation of ShanghaiTech University.



A proposed mechanism for how Ythdf1 contributes to memory formation: Ythdf1 promotes translation of m^6A -modified target transcripts, including synaptic transmission and LTP-related ones, in response to learning stimulus, thus facilitating synapse strength adequately for a memory to occur.

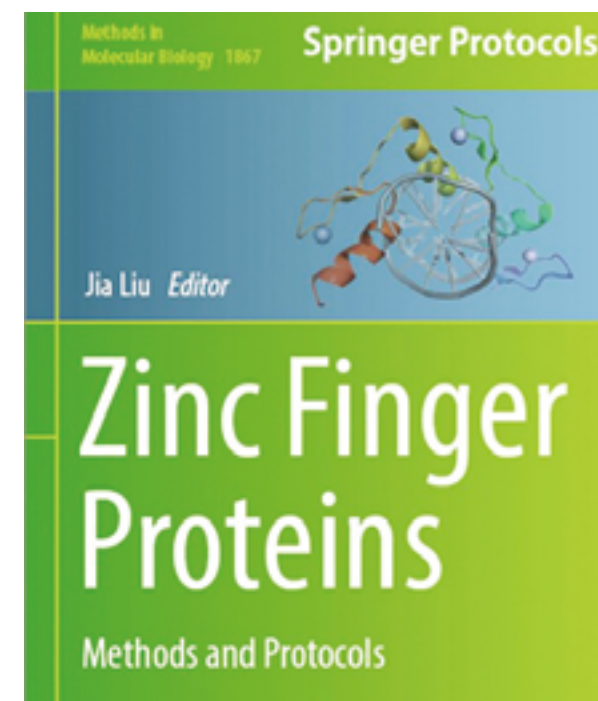


SIAIS ADC Chem Lab Publishes a Volume on Zinc Finger Proteins

Dr. Liu Jia from SIAIS Professor Jiang Biao's ADC Chemistry Lab has completed editing Volume 1867 of *Methods in Molecular Biology (MiMB)*, entitled "Zinc Finger Proteins: Methods and Protocols," now available from Springer, Amazon and other booksellers.

The *MiMB* series, providing methods and protocols in molecular biology, was founded by editor John Walker in 1983 and is well known for providing step-by-step experimental procedures. The first *MiMB* volume specializing in zinc finger proteins (ZFPs) was edited by Professor Joel Mackay and Professor David Segal in 2010. In response to notable progress in recent years on both the basic research and therapeutic applications of ZFPs, the new *MiMB* volume on ZFPs covers the methods and protocols of cutting-edge ZFPs technologies, providing thorough guidance for researchers in the ZFPs field.

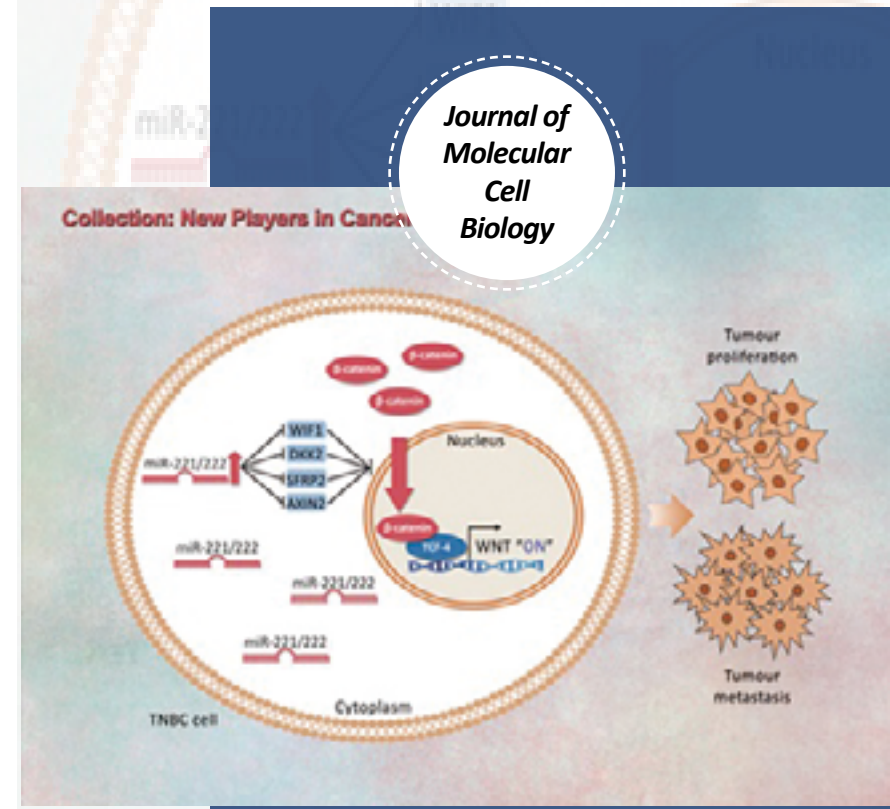
ZFPs are the most abundant transcription factors in eukaryotes, playing important



roles in a variety of biological functions such as DNA methylation, DNA transcription, cell cycle, cell division, tumorigenesis and others. ZFPs bind zinc ions via cysteine and histidine residues and can be categorized into C_2H_2 , C_4 , and CCHC type ZFPs, according to different means of chelating zinc ions. Decades of studies have deciphered the DNA recognition of ZFPs. Artificial ZFPs along with the newly emerged TALE and CRISPR systems have been widely used in gene regulation and genome engineering fields. Recent studies also have proven that zinc finger nucleases, which contain ZFPs as the DNA binding domain, are safe in human trials, which sheds some light on the potential of ZFPs for biomedical applications.

This *MiMB* volume of ZFPs contains three parts, divided into 19 chapters covering topics such as the basic biological functions, design of artificial ZFPs, evaluation of the cytotoxicity, and delivery methods. It will facilitate both basic ZFPs research and development of next-generation ZFP therapeutics.

Collection: New Players in Cancer



TNBC

SIAIS

Breast Cancer Research

Makes Journal Cover

SIAIS's Stem Cell Biology Lab has revealed a new mechanism of Wnt/ β -catenin signaling pathway activation in triple-negative breast cancer, and was published as a cover story in *Journal of Molecular Cell Biology* with the title "MiR-221/222 activate the Wnt/ β -catenin signaling to promote triple negative breast cancer."

Breast cancer is the most invasive type of cancer in women. Triple negative breast cancer (TNBC), characterized by the lack of expression of the estrogen receptor (ER), the progesterone receptor (PR), and the human epidermal growth factor receptor 2 (HER-2), is an aggressive form of cancer that conveys unpredictable and poor prognosis due to limited treatment options and a lack of effectively targeted therapies accounting for approximately 15–20% of breast cancer patients. Although considerable progress

has been made in breast cancer research, the mortality rate of TNBC has remained unchanged in the last decade primarily due to the lack of a specific target.

Wnt/ β -catenin signaling is hyperactivated in TNBC, which promotes the progression of TNBC. However, the molecular mechanism of Wnt/ β -catenin activation in TNBC remains unknown. In this study, ShanghaiTech SIAIS scientists report that TNBC cells over-express miR-221/222. Moreover, they demonstrate that miR-221/222 overexpression promotes the proliferation, viability, epithelial-to-mesenchymal transition, and migration of breast cancer cells by both ex vivo and xenograft experiments. MiR-221/222 achieves this by directly repressing multiple negative regulators of the Wnt/ β -catenin signaling pathway, including WIF1, SFRP2, DKK2, and AXIN2, to activate the pathway. Furthermore,

scientists show that the level of miR-221/222 expression is inversely correlated with patient survival; whereas that of their target genes in the Wnt/ β -catenin pathway is positively correlated with patient survival. Remarkably, anti-miR-221/222 significantly increases apoptosis with tamoxifen/Wnt3a treatment but not with cyclophosphamide/Wnt3a treatment. These results reveal the causal regulatory relationship between miR-221/222 and the Wnt signaling pathway as well as their critical roles in TNBC. In addition, our study

offers a new entry point for TNBC treatment.

The main authors are Research Associate Professor Liu Sanhong and technician Wang Zifeng, along with SIAIS graduate student Liu Zukai. The corresponding authors are Liu Sanhong and Lin Haifan. Their work has been supported by NSFC and ShanghaiTech University.

Read more at: <https://academic.oup.com/jmcb/article/10/4/302/5059631>

MiR-221/222 activates Wnt/ β -catenin signaling pathway by directly repressing multiple negative regulators of the Wnt/ β -catenin signaling pathway, including WIF1, SFRP2, DKK2, and AXIN2 in TNBC cells, thereby promoting the proliferation and metastasis of TNBC cells.



Scientists Develop Novel 4D Genome Imaging Technique

CRISPR-Sirius, a sensitive and bright imaging system, has been developed by research groups led by Dr. Ma Hanhui at ShanghaiTech University and Dr. Thoru Pederson at the University of Massachusetts Medical School. Their study was recently published in *Nature Methods*, a prestigious scientific journal.

CRISPR-Sirius makes it possible to detect low-copy repeats distributed in the intergenic and genic regions and to track the dynamics of multiple genomic elements from kilobases to megabases apart. Dr. Ma has engineered CRISPR guide RNA scaffolds for signal amplification in genome imaging, collaborating with Dr. Zhang Shaojie's group at the University of Central Florida.

The human genome contains 3 billion base pairs with an approximately 2-meter length in the majority of cells in a human body. It is still unclear how the chromatin DNAs are packed into a nucleus with a diameter of 10 to 20 micrometers and orchestrated by dynamic interactions in living cells. CRISPR has been repurposed for imaging chromatin dynamics in live cells. However, the previously-developed methods rely heavily on rare high-copy repeats with limited biological applications in the human genome.

Previously, Dr. Ma has developed CRISPR-Broccoli to monitor guide RNA stability in living cells. Here the CRISPR-Broccoli technology reveals that guide RNAs produced by inserting RNA aptamers into their tetraloop are much more stable than those produced by tagging RNA aptamers to their 3'-terminus (Figure 1a, 1b).

Dr. Ma and collaborators have developed the

CRISPR-Sirius technology by designing stable octet of RNA aptamers rationally and then inserting them into the tetraloop of the guide RNA scaffold (Figure 1c, 1d). This modification increases brightness and sensitivity significantly for the DNA imaging without disrupting guide RNAs stability. Therefore, the enhanced CRISPR-Sirius imaging system provides a platform for a variety of biological applications, including genomic interactions from kilobases to megabases, chromatin organization and dynamics of sister chromatid separation.

Key co-authors of this paper include Tu Li-Chun and David Grunwald from University of Massachusetts Medical School, Ardan Naseri from University of Central Florida and Chung Yu-Chieh from University of Tokyo. Their work was supported in part by ShanghaiTech University and NIH 4D Nucleome Program.

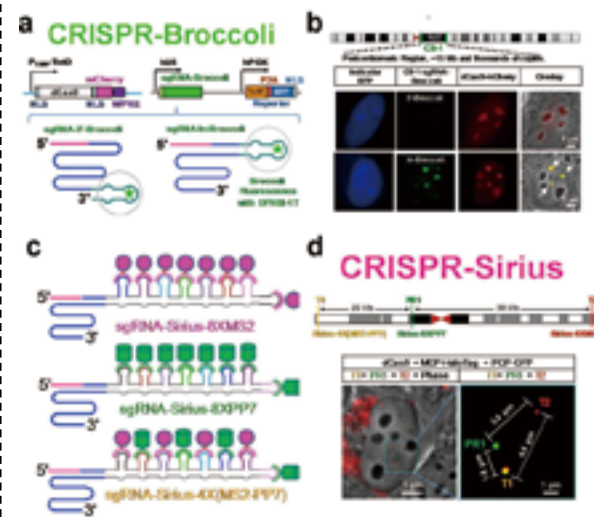


Figure 1. Development and applications of CRISPR-Sirius. a. Diagram of the CRISPR-Broccoli system; b. Monitoring the stability of CRISPR guide RNA in living cells by CRISPR-Broccoli; c. Diagram of the CRISPR-Sirius system; d. Tracking chromatin dynamics in live cells by CRISPR-Sirius.



SPST Group Publishes Review Article

School of Physical Science and Technology (SPST) Adjunct Professor Chen Yulin's group recently published a review article on the photoemission study of quantum materials in *Nature Reviews Materials* titled "Visualizing electronic structures of quantum materials by angle-resolved photoemission spectroscopy."

Electronic structures are the genes of materials that determine their electronic, magnetic, and optical properties and their relevant applications. Capable of directly visualizing the band dispersions and Fermi surface topography, angle-resolved photoemission spectroscopy (ARPES) has emerged as a powerful experimental tool to investigate electronic structures and their coupling to different degrees of freedom in materials.

Among the vast number of new materials, topological quantum materials (TQMs) represent a brand-new class of quantum matter that can be characterized by topological invariant, and have recently attracted significant research attention. Since the discovery of the quantum Hall effect in 1980 and the recent prediction and realization of quantum Spin Hall effect in 2005, great efforts

have been devoted to the investigation of different exotic topological phases in solids, such as topological insulators, topological Dirac and Weyl semimetals, and topological superconductors. Among these efforts, ARPES has provided the most straightforward experimental proof revealing the existence of these new topological phases.

Meanwhile, the study on 2D transitional metal chalcogenides (TMDs) is another timely topic for condensed matter physics and material science due to their rich and tunable properties (e.g. thickness-dependent indirect-direct crossover of bandgap, superconductivity, charge density wave, and the quantum Spin Hall effect, etc.) with great application potential in electronic and spintronic devices. In the study of these functional materials in the past decade, ARPES has also played a key role, especially with the development of spatially-resolved ARPES technique (i.e. micro- and nano-ARPES), allowing us to directly study the low dimensional TMDs with mesoscopic size or in devices.

The review article first introduced the principle of the ARPES (see Figure 1), then gave a demonstration in the studies on TQMs

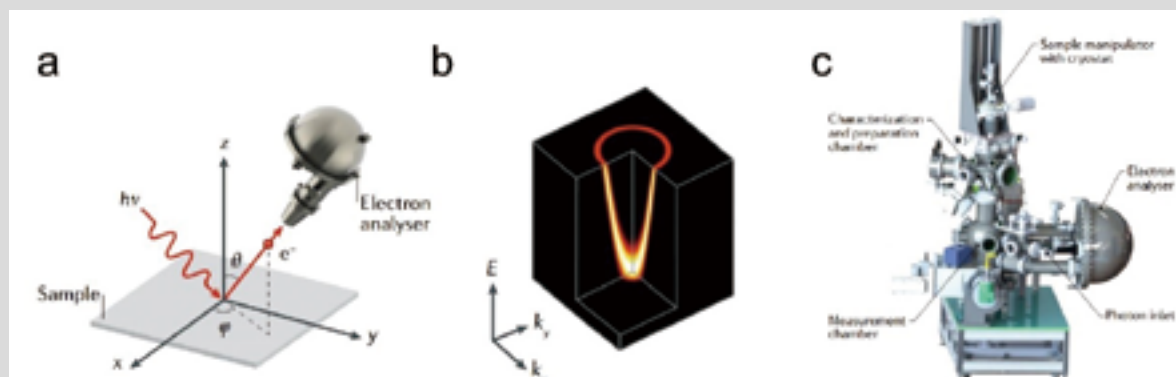


Figure 1: a. The principle of angle-resolved photoemission spectroscopy (ARPES) measurement b. Simulated ARPES data showing the band structure of a 2D free-electron system c. An illustration of an ARPES spectrometer.

and TMDs with a focus on the direct relation between their novel physical properties and the electronic structure. Finally, the review outlined future development of ARPES and its great potential in condensed matter physics and materials sciences.

Professor Chen Yulin's group is a leading ARPES group focusing their research on discovering and investigating novel states of quantum matter. Their endeavor has led to fruitful results and publications in renowned scientific journals (see Figure 2), including the discoveries/investigations of massless/massive 2D Dirac fermions in 3D topological insulators; 3D Dirac fermions (in 3D Dirac semimetals) and Weyl fermions (in Weyl semimetals with Fermi arcs); as well as other exotic topological phases such as nodal-line semimetals and hourglass fermions. Furthermore, with the support of SPST, Chen's group has also been devoted to the

development of advanced scientific facilities, based on the infrastructure of advanced light sources in Shanghai, including the Shanghai Synchrotron Radiation Facility and the high frequency X-ray free electron laser that are currently under construction.

The review paper mainly focuses on a series of important works in the field of TQMs and TMDs from Professor Chen's group and many other groups. The article also credits Dr. Yang Haifeng as first author and recognizes the contribution of other ShanghaiTech academics. The research was jointly supported by the National Science Foundation of China, the Shanghai Municipal Science and Technology Commission, ShanghaiTech University and China Postdoctoral Science Foundation.

Read more at: <https://doi.org/10.1038/s41578-018-0047-2>

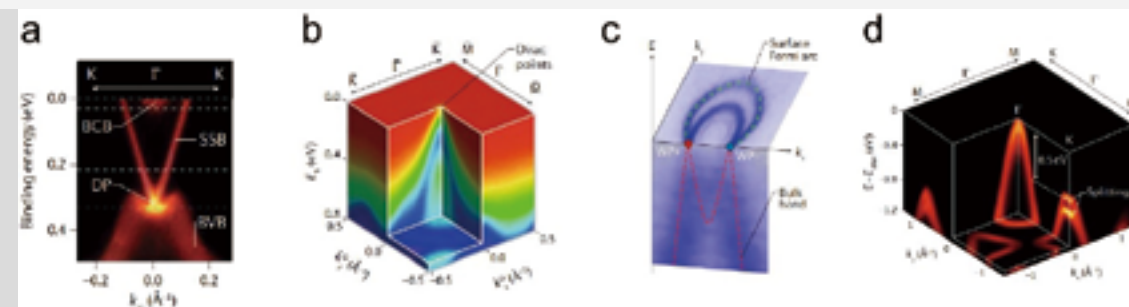
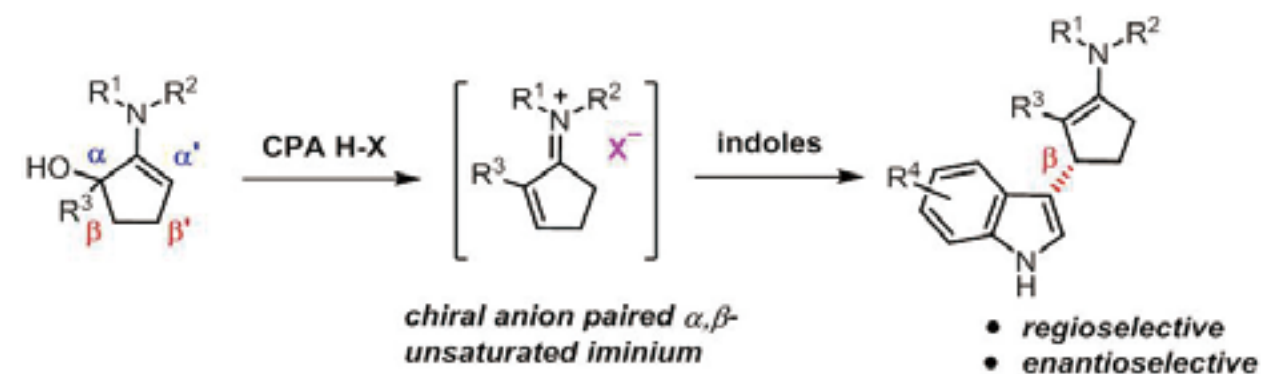
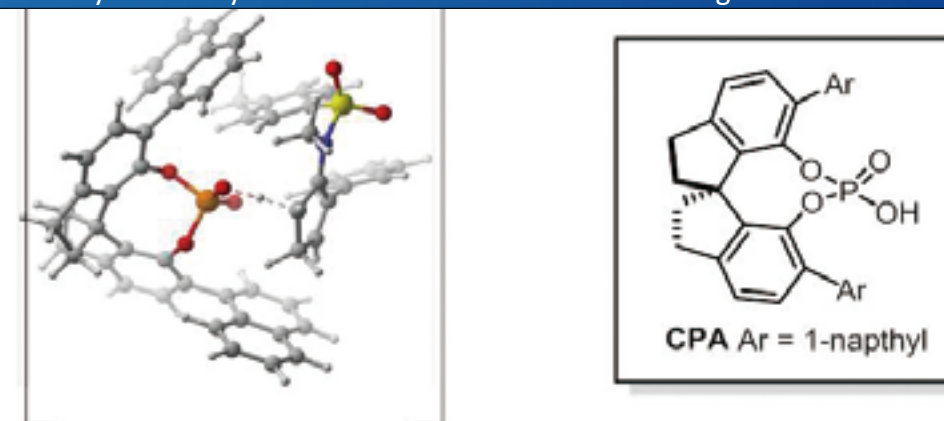


Figure 2: Electronic structure of quantum materials probed by ARPES

a. Topological insulator (Bi_2Te_3) b. Massless Dirac fermion (Na_3Bi) c. Weyl fermions with surface Fermi arcs (TaAs) d. Transitional metal chalcogenide (MoS_2).



Novel asymmetric synthesis of chiral indole derivative through chiral anion catalysis.



SPST

Researchers Published in Top Chemistry Journal

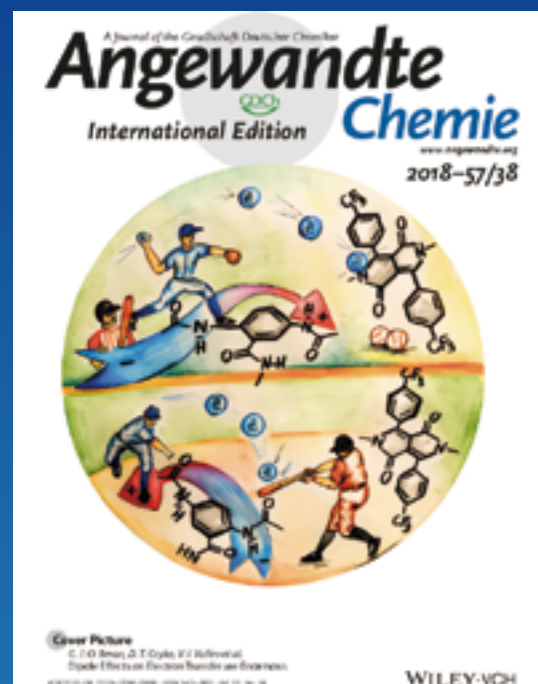
School of Physical Science and Technology (SPST) Assistant Professor Yang Xiaoyu's research group has developed a novel method for chiral indole derivatives synthesis through chiral anion catalysis. Their work, "Regioselective and Enantioselective Synthesis of β -Indolyl Cyclopentenamides by Chiral Anion Catalysis" was recently published in *Angewandte Chemie International Edition*, a top chemistry journal.

Indole derivatives are one of the most privileged heterocyclic compounds in pharmaceutical chemistry, and over ten thousand biological active indole derivatives have been identified to date. Meanwhile, they also represent a common moiety in various bioactive alkaloids natural products, as well as in material science. Enamides are likewise a valuable class of compound

because of their wide application in the construction of heterocycles and chiral amines as well as their presence in some natural products. Therefore, the asymmetric functionalization of indoles to provide products which incorporate an enamide functional handle would pro-

vide valuable chiral building blocks for the synthetic community, and would have wide applications in both medicinal chemistry and total synthesis of natural products. Among various indole substituted enamides, Yang's research group is particularly interested in β -indolyl cyclopentenamides because of their potent pharmacologically activities and the lack of a versatile method for their highly efficient asymmetric synthesis.

In this study, the researchers developed regioselective and enantioselective synthesis of β -indolyl cyclopentenamides, a versatile chiral building block, by asymmetric addition of indoles to α,β -unsaturated iminium intermediates through chiral anion catalysis. Key to the success of this methodology is the generation of a chiral anion-paired ketone-type α,β -unsaturated iminium intermediate from α -hydroxyl enamides. Preliminary mecha-



nistic studies and DFT calculations (in collaboration with Professor Peng Qian at Nankai University) are consistent with a mechanism involving multiple, concurrent pathways for isomerization of the initially formed azaallylcat to the key α,β -unsatu-

rated iminium intermediate, all mediated by the phosphoric acid catalyst.

Dr. Subramani Rajkumar (post-doc) and Wang Jiawen (third-year PhD student) are co-first authors of this paper. Wang Donglei, Ye Xueqian (second-year MSc student) and Li Xuejiao (a senior undergraduate student) are co-authors of this paper. ShanghaiTech University is the first responsible institution. This work was supported by start-up funding from ShanghaiTech University, the Youth Talents Program, Shanghai Pujiang Program and National Natural Science Foundation of China. The DFT calculation work was finished by Professor Peng Qian and colleagues at Nankai University.

Read more at: <https://onlinelibrary.wiley.com/doi/abs/10.1002/anie.201807010>

Teamwork Leads to SPST Semiconductor Discovery

Successful teamwork by several SPST research groups (including those of Professors Chen Yulin, Liu Zhongkai, Xue Jiaming and Li Gang) and Peking University Professor Peng Hailin's group has made remarkable progress in the understanding of the electronic structures of a new layered oxide semiconductor $\text{Bi}_2\text{O}_2\text{Se}$. Their work was published in the September issue of *Science Advances*, with the title of "Electronic Structures and Unusually Robust Bandgap in an Ultrahigh Mobility Layered Oxide Semiconductor, $\text{Bi}_2\text{O}_2\text{Se}$."

Semiconductors are essential materials in the modern world affecting our everyday life, and the search for new materials with superior electronic properties is critical to the development and prosperity of the semiconductor industry. In the past decade, 2D materials (e.g. graphene, TMDs, black phosphorus) have grown as promising candidates with great potential for future electronic applications. However, the drawbacks of these new materials (e.g. the zero or very small gap in graphene, the relatively low carrier mobility in TMDs, and the instability of black phosphorus in ambient environments have created a major challenge for the search for semiconductor materials with high carrier mobility, moderate bandgap, and stability in ambient environment.

Recently, $\text{Bi}_2\text{O}_2\text{Se}$, an air-stable layered oxide, has emerged as a promising new semiconductor with excellent electronic properties. Its layered nature (Figure 1a) makes it ideal for fabricating electronic devices down to few atomic layers (even monolayer) with high carrier mobility ($\sim 28900 \text{ cm}^2/\text{V}\cdot\text{s}$ at 1.9 K), superior current on/off ratio (>106) and moderate band gap ($\sim 0.8 \text{ eV}$). These attractive properties, together with its stability in ambient environment and easy accessibility (bulk crystal, thin film, and nano-structures are all readily accessible), make $\text{Bi}_2\text{O}_2\text{Se}$ a promising semiconductor candidate for future ultra-small high-performance and low-power electronic devices. Furthermore, the structural compatibility between $\text{Bi}_2\text{O}_2\text{Se}$ and interesting perovskite oxides (e.g. cuprate high transition temperature superconductors and commonly used substrate material SrTiO_3) makes it possible for hetero-structures between $\text{Bi}_2\text{O}_2\text{Se}$ and these oxides to be platforms for realizing novel physical phenomena.

In their work, the teams of SPST combined different experimental techniques, including angle-resolved photoemission

spectroscopy (ARPES) and scanning tunneling microscopy (STM) to fully visualize the electronic structures of this promising new semiconductor with key parameters crucial for the device applications (Figure 1b); and understand its unusually robust band gap (even with up to 50% of the surface impurities, see Figure 1c) with the help of ab initio calculations (Figure 1d).

The study credited Dr. Chen Cheng and Dr. Wang Meixiao as co-first authors; Adjunct Professor Chen Yulin and Assistant Professor Liu Zhongkai's groups carried out the ARPES measurements; Assistant Professor Xue Jiaming's group carried out the STM study; and Assistant Professor Li Gang's group carried out the ab initio calculations. Their teamwork was jointly supported by the national key R&D program of China, National Natural Science Foundation of China and Bureau of Frontier Sciences and Education, Chinese Academy of Sciences.

Read more at: <http://advances.sciencemag.org/content/4/9/eaat8355>

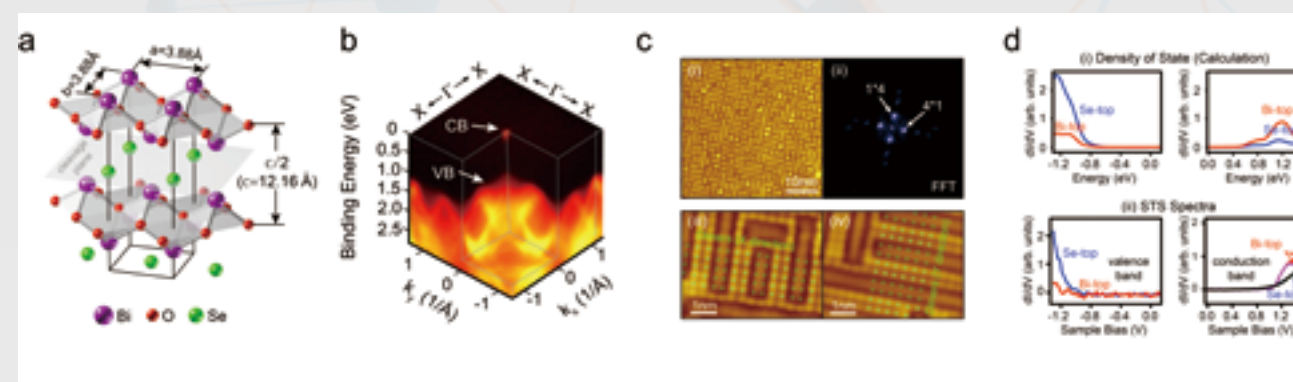


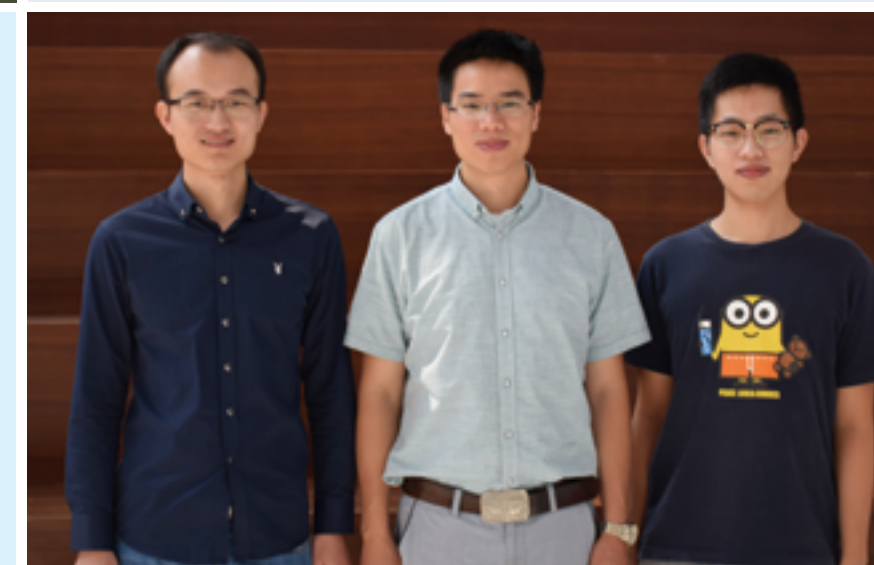
Figure 1. a. Layered crystal structure of $\text{Bi}_2\text{O}_2\text{Se}$. b. 3D band structures showing the conduction band (CB, valence band) and the band gap. c. Surface topography of $\text{Bi}_2\text{O}_2\text{Se}$ with atomic resolution and the distribution of Se-defects. d. Comparison of the density of states (DOS) between experiments and calculations.



SPST Scientists Develop High-Efficiency Tin Perovskite Photovoltaic Materials

School of Physical Science and Technology Assistant Professor Ning Zhijun's research group developed 2D-quasi-2D-3D hierarchy structural tin perovskite photovoltaic materials. Tin perovskite solar cells (PSCs) based on this structure achieved a power conversion efficiency (PCE) of 9.41%, the highest steady-state PCE of lead-free PSCs reported up to now. Their work was published in *Joule*, titled "2D-Quasi-2D-3D Hierarchy Structure for Tin Perovskite Solar Cells with Enhanced Efficiency and Stability."

The global energy crisis is one of the biggest challenges in the 21st century. Solar cells are one effective strategy to meet human's energy demand. Perovskite is an ideal photovoltaic material due to its merits such as high carrier mobility, intense light absorption and low defect density.

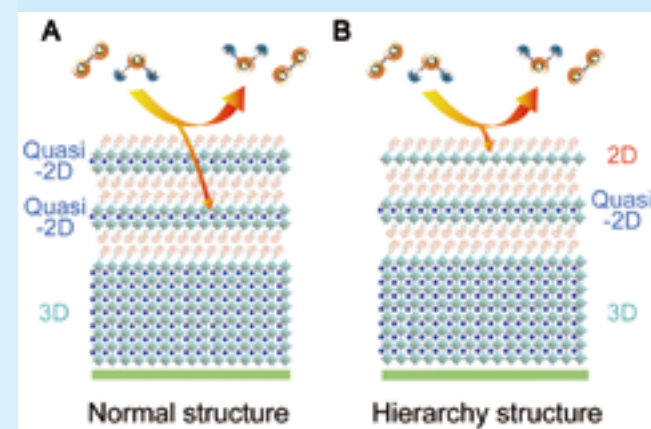


After years of development, the PSCs achieved a certified PCE of 23.3% over polysilicon solar cells. However, the toxicity of lead perovskite brings certain uncertainty to its application; the exploration of lead-free perovskite materials is therefore vital to PSCs. Among the lead element substitutes, tin (from the same group as lead in periodic table of the elements) is an ideal candidate owing to a similar shell electron structure and ideal bandgap (1.3 eV) for solar cells. Tin perovskite, however, suffers from high tin vacancy concentration and extremely poor resistance to oxidation. In their previous work, Ning's group explored a low-dimensional tin perovskite by introducing long-chain organic molecule (phenethylamine, PEA) and achieved a PCE of 6% (*J. Am. Chem. Soc.* 2017, 139, 6693-6699). However, it is still a challenge to further improve the efficiency of tin PSCs due to the difficulty of controlling oxidation.

In this work, Ning's group developed a way to manipulate the crystallization process during tin perovskite film fabrication utilizing pseudohalogen regulator ammonium thiocyanate

(NH_4SCN). Pseudohalogen regulator NH_4SCN can separate perovskite nucleation and crystal growth processes, and NH_4SCN can be removed during annealing process. In this way, they are able to build a 2D-quasi-2D-3D hierarchy structural tin perovskite film. The hierarchy structure perovskite (HSP) can enhance resistance to oxidation, decrease defect concentration and increase carrier mobility. A PCE of 9.41% of tin PSCs was achieved based on the HSP. The device retains 90% of its initial performance for almost 600h without encapsulation during a stability tracking test.

This work demonstrates that hierarchy structure can effectively reduce tin perovskite oxidation and improve PCE of solar cell. It also sheds some light on the structural manipulation of perovskite film by removable regulator in film fabrication.



All the work on this research was done by ShanghaiTech faculty and students at ShanghaiTech University. This first author is Wang Fei and the co-first author is Jiang Xianyuan, doctoral students from Assistant Professor Ning Zhijun's research group. Transient absorption spectra were carried out by Assistant Professor Liu Weimin's research group and master's degree student Wei Jingle from Liu's group is one of the authors. Assistant Professor Ning Zhijun is the corresponding author. ShanghaiTech University is the first responsible institution. This work was supported by National Key Research and Development Program of China, ShanghaiTech start-up funding and National Natural Science Foundation of China.

Read more at: [https://www.cell.com/joule/fulltext/S2542-4351\(18\)30450-1](https://www.cell.com/joule/fulltext/S2542-4351(18)30450-1)

Figure 1. (A) Structure of the control film and stability schematic (B) Structure of 2D-quasi-2D-3D hierarchy structure perovskite film and stability schematic.

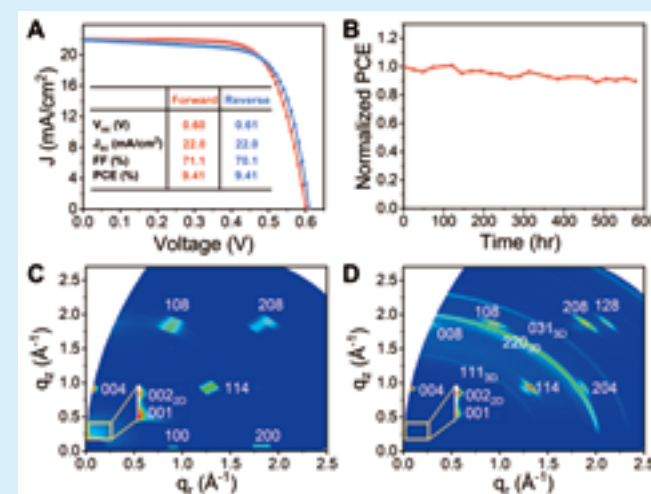
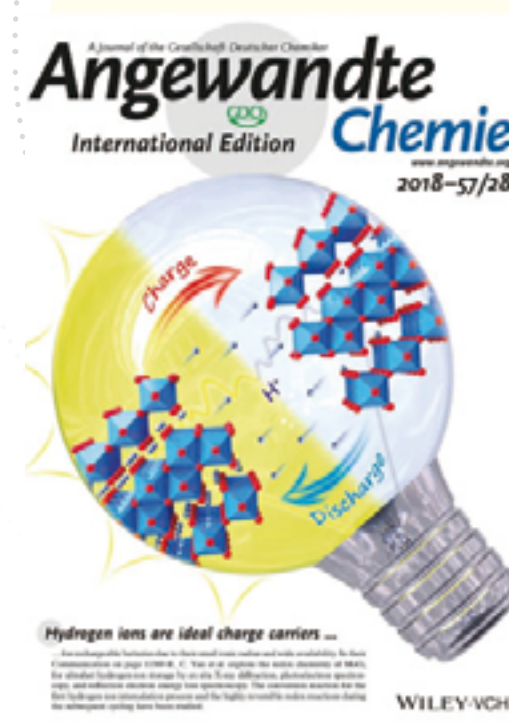


Figure 2. (A) J-V curves of a HSP champion device under one sun illumination (AM1.5G, 100mW/cm²) (B) Stability tracking test of HSP device stored in N_2 atmosphere glovebox (C) GIWAXS image of surface structure of HSP (the incident angle of 0.2°) (D) GIWAXS image of deep part structure of HSP (the incident angle of 2°).

SPST

Professor Reports Novel Semiconductor Material



and moisture. These advantages of CsSnBr_3 suggest potential applications in solar cells and photodetectors. Their research has recently been published online in the academic journal *Angewandte Chemie International Edition*.

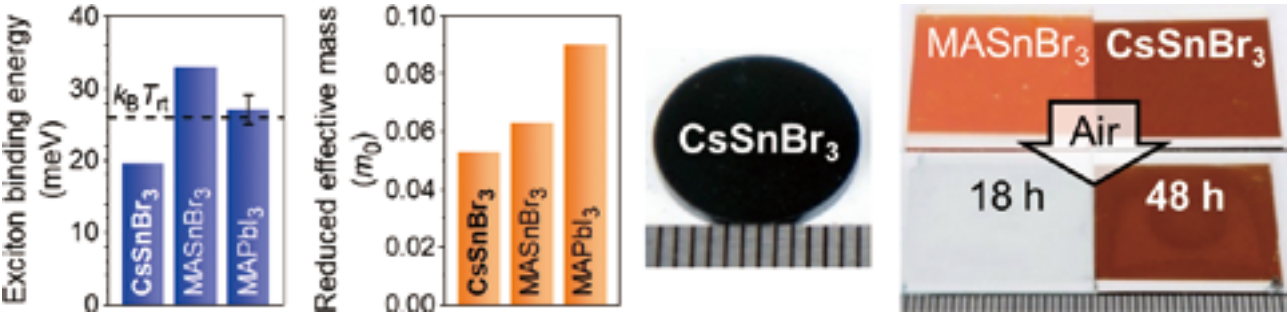
A large family of semiconductor materials with a general formula ABX_3 and the perovskite-type structure ('perovskite materials' in short) have been intensely investigated for their excellent optoelectronic properties. As a particular example, MAPbI_3 (methylammonium lead iodide) containing lead and an organic ion has been fabricated into novel solar cells and photodetectors with high efficiency and low cost. However, applications of MAPbI_3 are limited by the instability of methylammonium toward temperature and moisture and the toxicity of lead. A promising solution is to substitute lead for tin.

In a paper titled "All-Inorganic Perovskite CsSnBr_3 as a Thermally Stable, Free-Carrier Semiconductor," School of Physical Science and Technology (SPST) Assistant Professor Mi Qixi's group studied a new semiconductor material CsSnBr_3 (cesium tin bromide). Compared with similar materials, a more favorable crystal structure and electronic band structure enable CsSnBr_3 to generate free charge carriers under illumination, and render significantly higher stability toward temperature

Accordingly, the research group aimed at inorganic, tin-containing perovskite materials, and prepared high-quality samples of thin films and crystals of CsSnBr_3 . Using various techniques, the authors measured and calculated key properties of CsSnBr_3 , such as bandgap energy, exciton binding energy, dielectric constant, and effective charge-carrier mass. Notably, experimental and calculated results of bandgap energy and exciton binding energy agree with

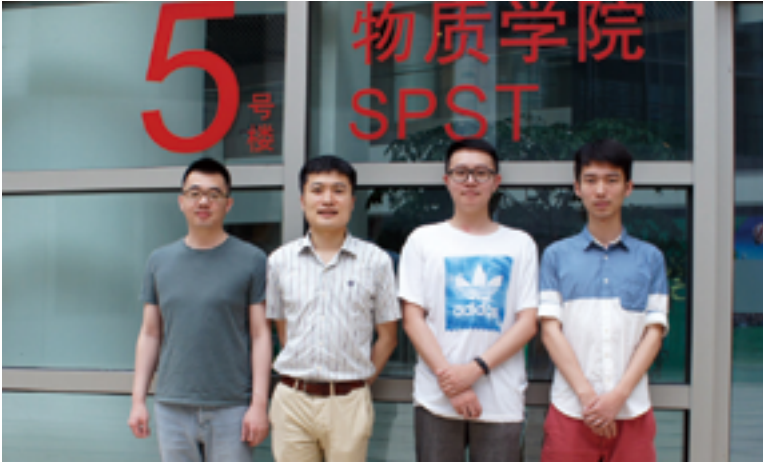
each other, showing that CsSnBr₃ features an exciton binding energy lower than the thermal energy at room temperature. This conclusion suggests that the light-induced electron and hole move freely inside CsSnBr₃, ready to be collected and converted to electricity. On the other hand, taking an organic perovskite material as reference, the authors demonstrate that the semiconductivity of CsSnBr₃ originates from the tin bromide framework, and the inorganic cesium ion significantly enhanced the material's stability.

Their research achievement reveals a quantitative relationship between the key semiconductor properties of CsSnBr₃ and its framework structure, finding that CsSnBr₃ thin films do not decompose easily in air and are more stable than organic perovskite materials. The research indicates that the semiconductor characteristics of CsSnBr₃ makes this material suitable for tandem solar cells and direct X-ray detectors.



The semiconductor properties (left) and stability (right) of CsSnBr₃ (center) are significantly advantageous over other similar materials.

Research group (from left to right): Li Binghan, Mi Qixi, Long Ruiying, Xia Yu



The authors of this paper are Li Binghan (fifth year PhD student, first author), Long Ruiying (second year MSc student), Xia Yu (Class of 2018 undergraduate), and Mi Qixi (assistant professor, corresponding author). ShanghaiTech University is the first responsible institution. This research has been assisted by the research groups of Xue Jiamin, Li Gang, and Ning Zhijun, as well as by Dr. Yu Na of SPST's Center for Characterization and Analysis. Financial support comes from State Key Research Project, Ministry of Science and Technology, as well as the Shell-CAS Frontier Sciences Program. A patent (CN107059122A) is pending for techniques related to the new material under study.

Read more at: <https://onlinelibrary.wiley.com/doi/abs/10.1002/anie.201807674>

SIST Researchers Propose E-Vehicle Advanced Power Electronic Converter

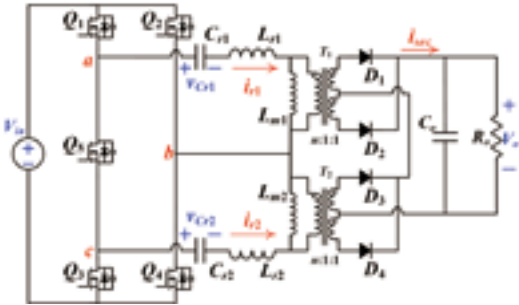
School of Information Science and Technology Assistant Professor Wang Haoyu's research group proposed a highly efficient LLC resonant topology for plug-in electric vehicle charging applications. Their work, "A Five-Switch Bridge Based Reconfigurable LLC Converter for Deeply-Depleted PEV Charging Applications," was published in *IEEE Transactions on Power Electronics*.

The work presents a reconfigurable dual LLC converter based on a five-switch bridge to charge the deeply depleted PEV onboard battery packs. Due to the reconfiguration of the primary-side switch network, two resonant tanks could operate in integrated half-bridge, half-bridge, hybrid bridge, and full-bridge modes. Thus, four operation modes are derived, with their normalized voltage gains scaled to 1:2:3:4, respectively. Those four modes enable a squeezed switching frequency span, which is close to the resonant frequency. Therefore, the efficiency performance over an ultra-wide output voltage range can be optimized. Zero-voltage-switching can be realized in all power MOSFETs over the entire load range. The operating principles and voltage gains analysis are briefed.

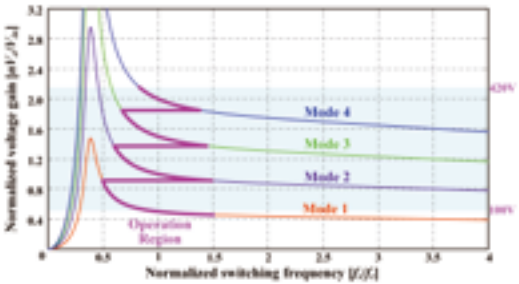
A 1.1 kW-rated prototype converting the 390V input to 100V-420V output is designed and tested to validate the proof of concept. The prototype demonstrates 97.64% peak efficiency and good efficiency over the full charging range.

All the work was done at ShanghaiTech University. The first author is Li Cheng, a third-year master's student and the co-author is Shang Ming who earned his master's degree last year from ShanghaiTech. Wang Haoyu is the corresponding author. The work was supported by Shanghai Sailing Program, ShanghaiTech start-up funding, and the National Natural Science Foundation of China.

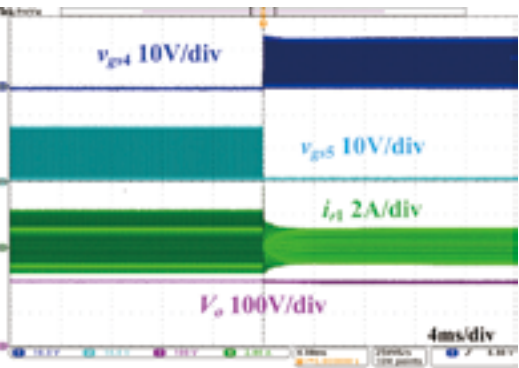
Read more at: <https://ieeexplore.ieee.org/document/8486680/>



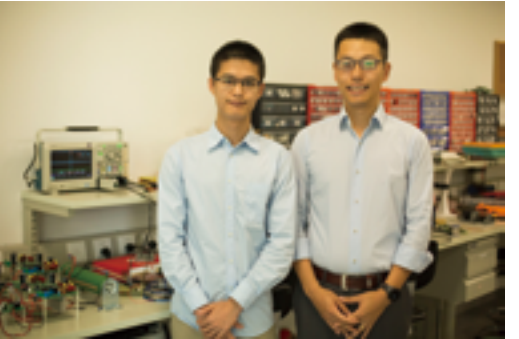
Schematic of the proposed reconfigurable LLC topology



Curves of normalized voltage gain versus normalized f_s



Waveforms of mode transition



Li Cheng and Assistant Professor Wang Haoyu in PEARL lab



Team Researches Personalized Saliency

School of Information Science and Technology Professor Yu Jingyi and Assistant Professor Gao Shenghua's research group's work on personalized saliency detection problem was published online in *IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI)* in an article titled, "Personalized Saliency and Its Prediction."

Nearly all existing visual saliency models so far have focused on predicting a universal saliency map across all observers. Yet psychology studies suggest that visual attention of different observers can vary significantly under specific circumstances, especially when a scene is composed of multiple salient objects. To study such visual attention patterns across observers, the researchers first constructed a personalized saliency dataset and explored correlations between visual attention, personal preferences, and image contents. Specifically, they proposed to decompose a personalized saliency map (referred to as PSM) into a universal saliency map (referred to as USM) predictable by existing saliency detection models and a new discrepancy map across users that characterizes personalized saliency. They then presented two solutions towards predicting such discrepancy maps, i.e., a multi-task convolutional neural network (CNN) framework and an extended

CNN with Person-specific Information Encoded Filters (CNN-PIEF).

Almost all previous approaches focused on exploring a universal saliency model, i.e., to predict potential salient regions common to observers while ignoring their differences in gender, age, personal preferences, etc. Such universal solutions are beneficial in the sense that they are able to capture all "potential" saliency regions. Yet they are insufficient in recognizing heterogeneity across individuals. Examples in the figure illustrate that while multiple objects are deemed highly salient within the same image, e.g., human face (first row), text (last two rows, 'DROP COFFEE' in the last row) and objects of high color contrast (zip-top cans in the third row), different observers have very different fixation preferences when viewing the image. The researchers use the term universal saliency to describe salient regions that incur high fixations across all observers via a universal saliency map (referred to as USM); in contrast, they use the term personalized saliency to describe the heterogeneous ones via a personalized saliency map (referred to as PSM).

Personalized saliency detection hence can potentially benefit various applications. For example, in image retargeting, texts on the

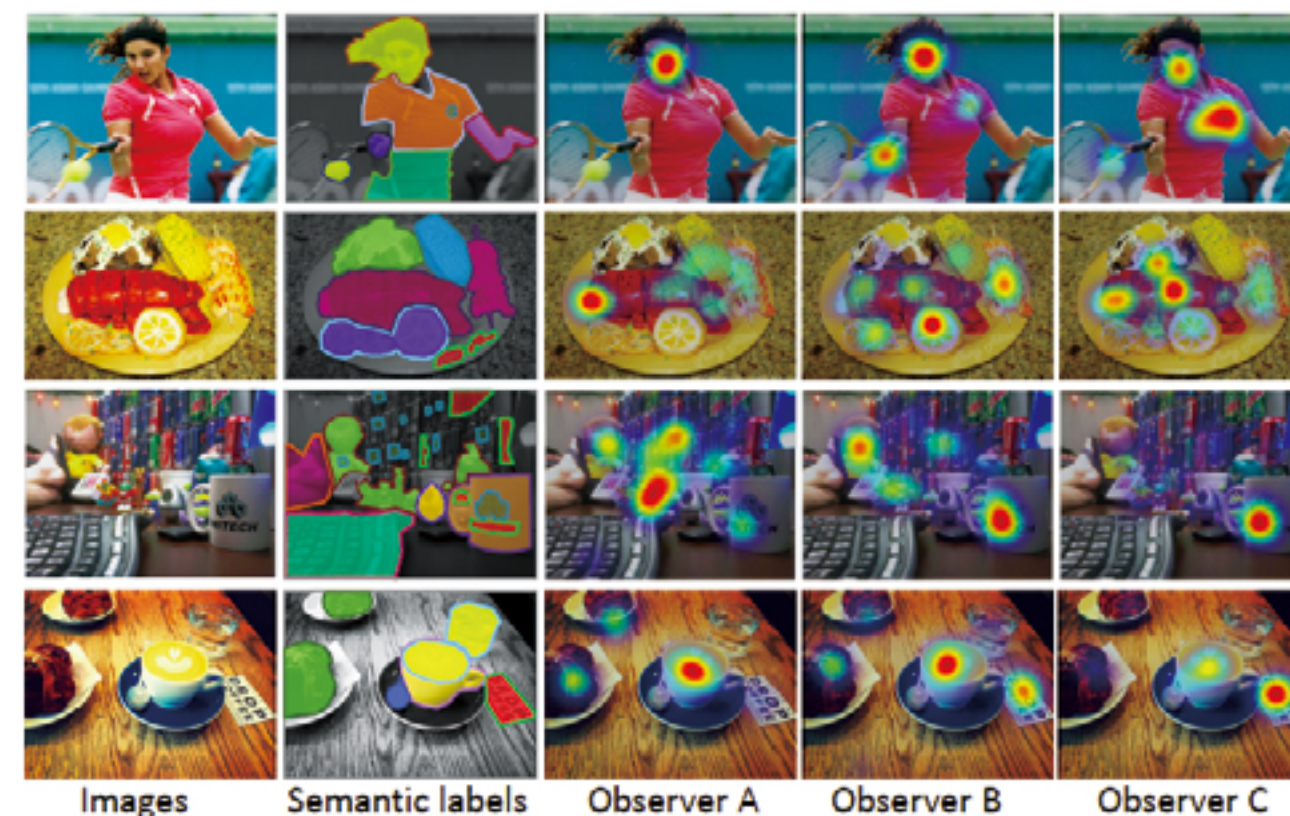
table in the fourth row in the figure should be preserved for observer B and C when resizing the image but can be eliminated for observer A. In VR content streaming, a user-correlative compression algorithm can be realized: data compression algorithms can be designed that preserve personalized salient regions but further reduce the rest to minimize transmission overhead. Finally, in advertisement deployment, the location of the advertising window can be adapted according to the predicted personal preferences.

To predict PSM, the wisdom of USM motivated the researchers to decompose PSM as the summation of USM and a discrepancy between PSM and USM. They proposed two solutions to predict such discrepancy: i) a Multi-task CNN framework for the prediction of this discrepancy; ii) since personalized saliency is closely related

to each observer's personal information (gender, race, major, etc.); and as such discrepancy is related to image content and identity, the researchers proposed to concatenate the USM and RGB image and feed them to a CNN-PIEF to predict this discrepancy. Extensive experiments validated the effectiveness of their methods for personalized saliency prediction.

The first author is PhD candidate Xu Yanyu and Gao Shenghua is the corresponding author. Wu Junru, Li Nianyi and Yu Jingyi are co-authors. The work was supported by the National Natural Science Foundation of China, ShanghaiTech start-up funding, and Li Nianyi is also supported by grants from US National Science Foundation.

Read more at: <https://ieeexplore.ieee.org/document/8444709/>



If an observer's personalized interestingness (personalized saliency) for a scene is known, tailored algorithms can be potentially designed to cater to his/her needs. For example, in image retargeting, texts on the table in the fourth row in Fig. 1 should be preserved for observer B and C when resizing the image, but can be eliminated for observer A.

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