DEPARTMENT OF PHYSICS
THE UNIVERSITY OF HONG KONG
香港大學物理系

SHKU Science

Physics

Newsletter

April | 2021

Editorial notes:

In this newsletter, we would like to introduce our new faculty member, Prof. Shuang Zhang. We also have some very exciting news concerning major new research funding. Remarkably, our Department has won not one, but two large grants in the most recent round of Area of Excellence (AoE) awards by the University Grants Committee (UGC)! First, Prof. Wang Yao is principal investigator in winning a HKU-led "Area of Excellence Award" for 2D Materials Research with over $80 million HKD. The research involves multiple universities in Hong Kong. Second, Prof. Shuang Zhang is participating in a Poly. U – led AoE on Meta-optics, Meta-acoustics and Meta-devices. To add to these major achievements, several Department members have won or participate in 5 CRFs (collaborative research fund) awards in the current round. Finally, Prof. Zidan Wang won a Guangdong-Hong Kong science award to establish a Joint Laboratory of Quantum Matter.

Departmental members are also very much in the news. For instance, Prof. Wang Yao has recently been awarded Fellow of the American Physical Society (APS Fellow). This is quite an honour. Congratulations!

We have decided to add an alumnus profile in this issue. We thank Mr. Brian Chan (BSc, 2015 and M. Phil. 2017 both at HKU) who kindly tells us his exciting career path after graduation from our Department. We would love to hear from other alumni and, if possible, report them in future newsletters. If you or other alumni have any news to report, please don't hesitate to write to Dr. Kai-Ming Lee, kmlee@lily.physics.hku.hk We look forward to hearing from you soon!

Chief Editor,

Dr. Kai-Ming Lee

New Member of the Department

Prof. Shuang Zhang

Chair Professor, Fellow of Optical Society of America
(Joint appointment with Department of Electrical and Electronic Engineering)
M.S. Northeastern; Ph.D. UNM

Professor Shuang Zhang received BS and MS in Physics from Jilin University in 1996 and Ph.D in Electrical Engineering from the University of New Mexico in 2005. He worked as a postdoc at the University of California Berkeley before joining the University of Birmingham in 2010. In October 2020, he joined the University of Hong Kong as a Chair Professor in Physics. Prof. Zhang's research focuses on metamaterials, nanophotonics and topological photonics. Professor Zhang is the recipient of IUPAP (International Union of Pure and Applied Physics) Young Scientist Prize in Optics, the Royal Society Wolfson Research Merit Award in 2016. He was elected a Fellow of the Optical Society of America (OSA) in 2016.

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https://www.physics.hku.hk/

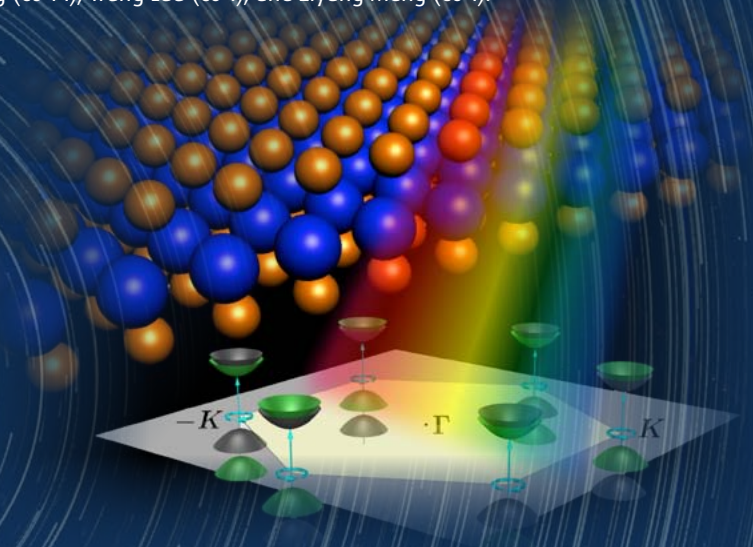
Area of Excellence on

2D Materials Research: Fundamentals Towards Emerging Technologies

For decades, the advance of information technology has followed the empirical Moore's Law, which states that the number of transistors that can be placed on an integrated circuit doubles roughly every two years, allowing consumers to get their hands on tablets and smartphones that are much more powerful in computation capacity than a room-sized computer in the old days. This dream run based on silicon technology is unfortunately coming to an end because of the fundamental difficulties in further shrinking done the size of silicon microelectronics. The crisis, on other hand, has become an opportunity. We are now entering a new era of innovation, calling for: new quantum materials platform to host even smaller electronics devices; new ways of encoding information, e.g. by quantum degrees of freedom other than the charge of electron, and new ways of processing information at the nanoscopic scale.

Two-dimensional materials have offered great potential to revolutionise microelectronics and information technology, for their atomic-level thickness enabling ultimate miniaturisation of devices, unparalleled electrostatic controllability, unprecedented flexibility in their combinations to create new structures and properties, and rich quantum degrees of freedom as potential information carriers. Since the discovery the first 2D material - graphene - in 2004, 2D materials research has grown into a vast and most active interdisciplinary frontier across condensed matter physics, material science, chemistry, and electrical engineering. 2D materials have also attracted great interest from leading industrial companies.

A research team led by HKU Physics has received funding of over HKD 80 millions from Areas of Excellence Scheme, set to explore the fundamentals of 2D materials targeted at emerging technologies. The team members from our unit include Wang Yao (PC), Maohai Xie (deputy PC and Co-PI), Xiaodong Cui (Co-PI), Dongkeun Ki (Co-PI), Shuang Zhang (Co-PI), Trung Luu (Co-I), and Ziyang Meng (Co-I).



CRF (Collaborative Research Fund) Awards

- As co-PI in a CRF led by Prof. Tao Liu at HKUST, Dr. Jeremy Lim is leading the effort to confront theoretical predictions for different forms of Dark Matter with astrophysical observations utilizing gravitational lensing by galaxies. The observational part of the project, titled "Dark Matter in the Universe", builds upon research work conducted by Dr. Lim's group at HKU over the past 6 years based on RGC/GRF grants. At HKU, we anticipate hiring 2 graduate students and a postdoctoral fellow to work on this project.
- Dr Stephen Ng is a Co-Principal Investigator of a CRF project "Hong Kong's Window on the Universe: Building a Pioneering Submillimetre Astronomical Camera". This aims to build a terahertz camera to put on the Greenland Telescope for astronomy research.
- Prof. Djurisic is Co-Principal Investigator of "Low-dimensional perovskite materials for efficient and stable light emitting diodes: Materials, devices and fundamental understanding"
- Prof. Djurisic is Principal Investigator of "Controlling the moisture - towards stable and efficient flexible perovskite solar cells"
- Prof. Z.D. Wang and Dr. S.Z. Zhang are Co-Principal Investigators of "New phases of quantum matter in engineered atomic systems"

Greenland telescope

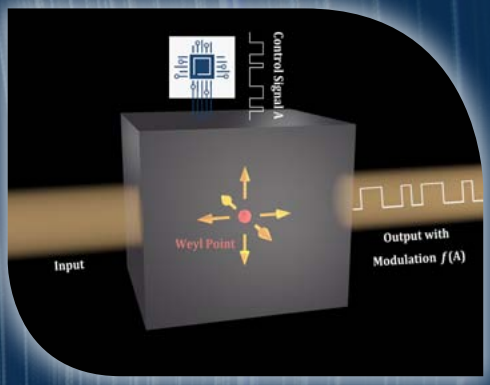
New Joint Laboratory

Recently, together with Prof Enke Wang at South China Normal University (SCNU), Prof Zidan Wang, as one of two leaders/co-PCs, received a prestigious innovation platform fund, which is established by Department of Science and Technology of Guangdong Province. It is entitled the "Guangdong-Hong Kong Joint Laboratory of Quantum Matter", with 5,000,000 RMB as start-up.

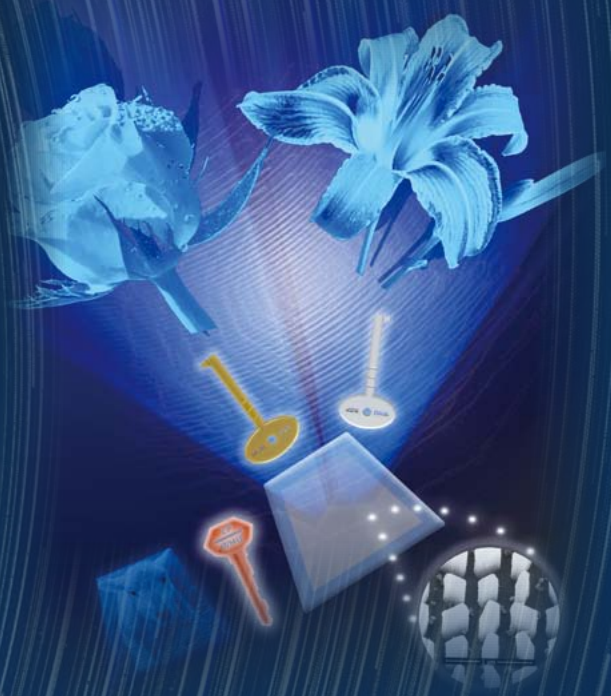
This lab will consolidate research strengths in quantum matter on Guangdong and Hong Kong and conduct cutting edge research on quantum technology with an anticipated high impact globally. This new lab is expected to meet the demand of initiatives and emerging opportunities in this area for the Greater Bay Area and China as a whole.

Area of Excellence on

Meta-optics, Meta-acoustics and Meta-devices



Professor Shuang ZHANG was one of the Co-Principal Investigators of a successful grant application entitled "Meta-optics, Meta-acoustics and Meta-devices" in the Areas of Excellence (AoE) Scheme 2020/21 (Ninth Round). The application, led by Professor Din-Ping TSAI of The Polytechnic University of Hong Kong (PolyU), focuses on development of metamaterials and metasurfaces for bridging the gap between fundamental research and industrial applications of metamaterials. Specifically, the project aims at developing novel meta-materials and meta-devices that can control and manipulate electromagnetic and acoustic waves for improving the quality of human daily life. The project has been awarded funding of HK$65 million from the AoE Scheme (Ninth Round) under the University Grants Committee (UGC). In this project, Professor Zhang will be responsible for the development of topological photonics based on metamaterials, and tunable metasurfaces for dynamically shaping the wave-front of light.



Metamaterials and meta-devices take advantages of the localized and non-localized resonances of artificial structures in which the response of the electrons, phonons, plasmons, and excitons are strongly modified to give novel properties and functionalities which are not found in nature. This AoE project will cover the design, numerical simulation, advanced manufacturing, characterizations and measurements of these materials for various applications including environment, biomedical, imaging and sensing, and information security. It is expected that this AoE project will generate a new platform for knowledge-based intelligent artificial materials and devices which are low energy consumption ("green") and compatible with advanced manufacture in micro- and nano-electronics industrial techniques for wearable or portable innovation. The team consists of seven research groups across three institutions: Prof. Din-Ping Tsai, Dr. Jie Zhu and Dr. Kin Hung Fung from PolyU, Prof. Che Ting Chan, Prof. Ping Sheng and Prof. Jensen Li from The Hong Kong University of Science and Technology and Prof. Shuang Zhang from The University of Hong Kong.

In the News

- Prof. Wang YAO elected as a Fellow of the American Physical Society 2020 https://www.hku.hk/press/press-releases/detail/21681.html
- Prof. Jian WANG's research selected as one of the 50 Milestone papers in Physical Review B https://www.scifac.hku.hk/news/news-physical-review-b-Prof-Jian-Wang
- Dr. Zi Yang MENG was awarded the "2020 Tianhe Star Award" https://www.scifac.hku.hk/news/news-2020-Tianhe-Star-Award
- Prof. Hoi-Kwong Lo was interviewed by Apple Daily on quantum technology in China and the world (in chinese). https://hk.appledaily.com/china/20210108/PTO3X7574ZHNBINQITRNYBEWXQ/
- Dr. Z.Y. Meng is pursuing a new paradigm of quantum material research reveals topological KT phase of TMGO for the first time. https://www.scifac.hku.hk/news/news-KT-Phase-TMGO
- Dr. Z.Y. Meng joins international effort to unveil the behaviour of "strange metals". https://www.scifac.hku.hk/press/release/press-release-non-Fermi-liquid

Tidbits

New UG Course

PHYS4656 Advanced Astrophysics

New RPG Courses

PHYS8751 Device Physics
PHYS8852 Photonics and Metamaterials
PHYS8352 Quantum Information

Physics Colloquium

We have resumed the Physics Colloquium, after a long break.
https://www.physics.hku.hk/event/coming/col-2021

FoS Distinguished Lecture series

https://www.scifac.hku.hk/events/quest-for-new-quantum-materials

Alumni Profile – Brian Chan

Brian Chan got his BSc in 2015 and Mphil in 2017, both from the department. He was working on astronomy/astrophysics. Now, his job is something completely different. Thank Mr. Chan a lot to share his story and advice.

1. Why did you choose to study Physics at HKU?

I was already deeply fascinated by physics in secondary school. I was most interested in astrophysics and theories like general relativity and quantum physics. I still remember in the summer of F.5, I spent quite a lot of time researching on the internet to understand the spin of a particle! Before I have decided on my choices in JUPAS, I did research on all university Physics departments in Hong Kong, and found out HKU is the only university offering an extensive astrophysics curriculum. This attracts me to choose HKU. I also joined physics courses offered by the Junior Science Institute (JSI), from the Department of Science. In the courses, I like the teaching style and campus experience I received.

2. What did you do after graduation?

My first job after graduation is as a consultant in the management consulting industry, which helps organizations to improve their performances. I specialized in Artificial Intelligence and Robotics Process Automation. In my day to day work, I went into different companies, learnt about the 'best practice' in the industry, and provided advice to companies to improve their efficiencies by automating previously manual jobs using AI technologies.

After about 1.5 years in my first job, I moved to my current company (FTI Consulting).

3. Can you tell us about your current job and how your physics training is relevant there?

I am now working as an AI consultant in forensic investigations. In the current corporate world, companies are so huge and deeply integrated into software systems. Therefore, when there is any criminal activities in a company, it is inevitably going to leave traces in the digital records. Our role is like a detective - to find out these signals among all noises in the data. I am working on advanced technologies like AI to detect these signals. My analysis have been used as legal settlement evidences in international financial crimes, like tracing the fund source of money laundering, and detecting suspicious shipments to sanction countries. I work with different colleagues depending on projects, and from different locations also (US, UK, Canada, India, Singapore...). My colleagues are from a huge diversity of backgrounds, including ex-FBI officials, accountants, bankers, software developers etc.

International travel was essential for my job, because I analyze a lot of sensitive data. These data are the company's commercial secrets, or even 'state's secrets'. These data cannot be transmitted freely on the internet and I have to be onsite to do the analysis. At the same time, it is nice to travel around the globe with expenses covered by the clients/companies. In the year 2019, I spent more nights in five stars hotels around the globe than in my own bed. Thanks to a project, I had the experience of taking a shower 30,000 feet in the air at the first-class cabin on the flight back to Hong Kong. These are nice benefits to ensure you at the best condition to provide state-of-the-art consultation service anytime, and anywhere around the world. You are expected to work in normal working hours, and sometimes in the evening.

I found a lot of transferable skills from a physics degree to my current job, especially in these few aspects:

i. Outstanding mathematics/arithmetic skills when cracking through the physics theories: You will be able to perform numerical analysis faster than others. I was able to pick up theories in AI very easily. For example, concepts like entropy are used widely in both fields (although they differ in the details).

ii. Being self-responsible and having self-learning ability from doing research: In my current job, I need to adapt to the business of a new project very quickly. One week I might be trying to understand how to assemble a phone from thousands of parts, the other week I might need to figure out the cause of environmental pollutions in a third world country. You are responsible for acquiring such new knowledge quickly. It is like doing a research project, there is not a textbook to following. You need to know how to learn efficiently.

iii. An experimental mindset: Physics graduates are well equipped with skills for doing experiments. The scientific method is a core part of the curriculum. In fraud investigations, we also approach problems in a scientific way, by testing hypothesis, varying independent variables etc. It is extremely important to have a robust experimental framework to form a persuasive case when it is used as lawsuit evidence.

iv. Presentation skills: This is not a standard curriculum in physics, but fortunately I have received well guidance from my research supervisor. He inspired me that it is critical to be able to present research findings both to the experts and to the public. It is difficult to present AI concepts to a group of CEOs/lawyers, as it is difficult to explain quantum physics to other people not studying physics. However, the approach to reduce complex concepts to laymen terms share the same skill set in both scenarios.

4. Any thoughts on the application of physics knowledge besides academia and research?

I know physics graduates became teacher, data analyst in financial institutions, data scientist. Fields in artificial intelligence/machine learning and data science are quite popular in recent years. When I just graduated, the market was in a shortage of expertise in such fields. Now the market is more competitive as more students from formal data science degrees are graduated. One way to stand out is to build your own portfolio of small data science projects while learning it. Proficiency in computer coding (especially in Python or R) is essential.

5. What is your advice to secondary schools students who are considering physics as their major?

- Take a chance to chat with current undergraduates to find out more about university physics. University physics is very different from DSE physics.
- Do not limit your learning to textbooks. Go extra miles to understand the theories when you find a physics topic truly interesting.
- Be serious about learning secondary school physics and mathematics. You will need to have these as 'common sense' to be proficient in university physics.
- Develop your soft skills (communication, interpersonal skills) in parallel with your academics. It will become a valuable asset no matter whether you are going to choose physics as your career.
- Consider learning computer coding, it can be useful in doing projects/research in university physics.