

Research Assessment Exercise 2020
Impact Overview Statement

University: The Hong Kong University of Science and Technology

Unit of Assessment (UoA): 7-Physics and Astronomy

Total number of eligible staff of the university in the UoA: 30

(1) Context

An important goal of our research is to transfer research knowledge from academia to industrial and societal beneficiaries, and we have a long track record of demonstrating this commitment. The UoA has a wide range of distinguished research groups in condensed matter physics (including advanced materials, wave functional materials and soft matter) and cold atom and quantum optics (including biomedical imaging), which have produced a variety of practical applications, ranging from technology transfer to the materials industry through startup companies and patent licensing to commercialization of the state-of-the-art sensors and devices. The main types of impact arising from our research are: (i) Economic impact and job creation evidenced by the creation of startup companies based on the technology breakthroughs achieved through our research; (ii) Public policy and societal impact through the Department-led efforts in science and gifted education; and (iii) Public interest and engagement in science through the outreach activities led by the physics faculty. The main non-academic beneficiaries of our research, therefore, include (i) industrial partners and startup companies, who use our technologies to manufacture products and sell to their customers and business partners, and (ii) public and in particular secondary school teachers and students, who benefitted from the science policy changes and promoting engagement in science.

(2) Approach to impact

Making use of university platforms for technology transfer and entrepreneurship. HKUST is actively engaged in stimulating and assisting a campus-wide culture of innovation and entrepreneurship and organizes a variety of entrepreneurship activities (such as seminars, workshops, competitions, and networking events), acceleration programs and startup supports. The University's Technology Transfer Center serves as a bridge between the HKUST research community and the business sector, identifying collaboration opportunities in the local, regional and international markets. Our approach to creating research impact includes use of the existing University platforms, resources, and emerging opportunities driven by the University. Over the RAE period, we have 34 patents filed, 21 patents granted and 10 patent licenses or service agreements signed, totaling HK\$3.8M. Ten faculty members participated in the patent applications. Five faculty members (Du, Sheng, Sou, Wen and Yang) played a central role in the creation and development of eight startup companies since 2013, which used the novel technologies obtained through our research, ranging from acoustic metamaterial noise remediation and application of advanced materials to optoelectronic sensors and biomedical imaging instruments. These startup companies employed approximately 620 staff members in Hong Kong and Mainland China.

Enhancing science education and public engagement: The UoA has a long track record of developing strong science education and public engagement programs with a range of outreach activities, which lasts for the past two decades. Many faculty members and teaching associates were involved and the Department has provided continuing support including teaching staff, lab facilities and directed funds for these activities. Our efforts in this area lead to significant societal impact on STEM (science, technology engineering and math) education, gifted education and science pedagogy in Hong Kong and the wider region. Examples include organizing and training the Hong Kong Physics Olympiad Team for the international, Asian and other national and regional physics Olympiad competitions, involving around 9,400 gifted secondary school students, and build-up of the Center for the Development of Gifted and Talented, which offers enriched credit-bearing physics courses with participation by over 100 secondary schools in Hong Kong. The latter efforts led to the establishment of the government-sponsored Hong Kong Academy for Gifted Education (HKAGE), with Chair Professor TK Ng, the Center's founder, served as the founding director (since 2014), who masterminded the expansion of HKAGE through the HK\$800 million Gifted Education Fund,

approved by the Hong Kong Legislative Council.

Fostering innovation culture, training and opportunities. A key mechanism for achieving impact from physics research is to create a culture in the UoA where generating impact is actively encouraged and supported with specialist training and services, and with directed funding, not only to the faculty but also to the undergraduate (UG) and postgraduate (PG) students and post-doctoral researchers. A modular UG course was introduced so that the 4th-year UG students are exposed to the most recent research/technology breakthroughs (such as quantum information, machine learning and atmospheric physics) related to their job search. A credit-bearing internship course was introduced to encourage the 3rd-year UG students to take summer internships in industry, startup companies, and secondary schools. A required PG course was developed, which is composed of a series of workshops and modules on research conduct, intellectual properties, entrepreneurship and career development. Indeed, some of our PhD graduates become CEOs and CTOs of new startup companies. Close collaborative relationships with industry were promoted through industrially sponsored research and fellowships, such as the Huawei PhD Fellowship Scheme, which supports PhD students for two years at HKUST and two years at Huawei, a well-known information and telecommunications company in China. Faculty's achievements in knowledge transfer and public engagement are recognized and rewarded via our annual merit salary review.

(3) Strategy and plans

The UoA will continue to strengthen its effective and successful measures in supporting impact, as outlined above, and our aim is to create a culture in which fundamental research and impact generation go hand-in-hand. First, our science education and public engagement programs have long established and involved a substantial proportion of the physics faculty. Our plan for improvement includes (i) providing directed supports, including teaching staff, laboratory facilities and available outside funding, to continue our successful training programs for the Hong Kong Physics Olympiad team, science education and outreach; (ii) refining our education and outreach activities based on the feedback that we collected during this RAE period; (iii) developing a more effective communication network with the outside world including our alumni through our webpage and social media; and (iv) working in partnership with more secondary schools and other organizations in Hong Kong to extend our reach in science education and public engagement. Second, while our initial efforts in creating innovation and entrepreneurship culture, training and opportunities have already produced promising results, as outlined above, the UoA has a bold vision for achieving even bigger goals in the next RAE period. In particular, we plan to enlarge our internship program, which is in high demand among our UG students, by continuing to develop and strengthen our collaborations with our partners in industry, startup companies, and secondary schools. More recently, the UoA launched a new one-year Master of Science (MSc) program in Data-Driven Modeling, in which we offer a new entrepreneurship course, Innovation in Practice. Based on this course, we plan to build up a departmental program open to both UG and PG students, which will offer entrepreneurship training and provide career opportunities by inviting leading individuals from outside academia to present industrial challenges and opportunities. Finally, the UoA will undergo a retirement peak in the next RAE period, and we will take this opportunity to recruit outstanding new faculty in the targeted research areas of our core strength with high potential impact. In particular, HKUST will build a new branch campus in the nearby Guangzhou city, China, which will offer interdisciplinary PG programs to serve the "Greater Bay Area," a project to turn Hong Kong, Macau and nine nearby cities in Guangdong province, China, into an innovation and technology hub. We will leverage this opportunity by proactively recruiting new faculty for the HKUST Guangzhou campus in potentially high impact areas, such as quantum science and engineering, metamaterials and advanced materials.

(4) Relationship to case studies

Our approaches in knowledge transfer to industrial and societal beneficiaries have resulted in a wide range of impacts. Herein we choose two distinct examples to highlight our achievements. The biomedical imaging case demonstrates our efforts in innovation and entrepreneurship with our PhD graduates serving as the CEO and CTO of the startup companies. The public outreach case illustrates our long-time commitment to science education, public policy and public engagement.