HKBU/PHYS Impact Overview Statement 2019
University: HKBU
Unit of Assessment (UoA): 7 physics & astronomy

(1) Context

HKBU's Department of Physics delivers impact through various means, including, since 1 October 2013: 6 start-up companies (more than half of HKBU's start-ups); 10 granted patents (48 others filed); advanced materials for industry; health monitoring devices in hospitals; authentication for forensics and artwork certification; media stories and TV appearances on our impacts; exhibits and lectures in museums; Physics Olympiad training of secondary school students; and school outreach.

The 6 start-up companies founded by members of our Department are by far the largest number of start-ups among departments in our University: 4 are still active. The most advanced, Cathay Photonics Limited (founded by KW Cheah in 2014) is now valued at over US$100 million and doing trial production runs: it is the subject of our Impact Case Study. Booguu Technology Limited (TK Cheung 2016) and develops health care and medical devices (Balance Scale and Portable Gait Analyzer); it received ~HK1.2 million from private investors and has 2 employees: it has trials in Taiwan, planning others in Hong Kong; it engaged Pedorthic Technology Limited as a research partner. Mat-A-Cell (ZF Huang 2018) develops extracellular nanomatrices for cell differentiation and cell therapies. Crimson Vision Technology Limited (FR Zhu 2019) develops near-infrared visualizing technologies to detect materials (e.g., microplastics in marine life) and monitor wellness. These companies earned one Grand Prix and 4 Gold Medals at the International Exhibition of Inventions in Geneva in 2015-2018. They have altogether exhibited their technology in 23 technology exhibitions.

The principal beneficiaries and forms of our impacts include:

Industry: Our inventors remain closely linked with the start-up companies which inherited the technologies and indirectly with their contacts (e.g., The Merck Group). The green-energy focus of some of our research and teaching gives rise to various interactions with industry, including through the worldwide Association of Energy Engineers, which connects us with their many member companies and also assists us in delivering quality training and certification (Certificate of Energy Management) for future employees graduating from our specialized undergraduate programme in Green Energy and our master's programme in Green Technology (Energy). Since 2015, 27 undergraduates and 115 master's students had taken this training.

Public Engagement: Through Hong Kong's public Science Museum, we have contributed a major exhibit based on our research: "Portable Energy Harvesting Devices" was displayed at the Science Museum for 7.5 months in 2017 and was part of the annual Hong Kong SciFest 2017 series of public events, to which we have also contributed research-based public lectures. We delivered 33 television appearances in Hong Kong (each with 1-1.5 million audience). Based on our green-energy expertise, we have also trained the Hong Kong teams for the Asian and International Physics Olympiad competitions in 2014/15 and 2015/16. The 2014/15 team became sixth among the 84 participating countries or regions in the 2015 International Physics Olympiad, beating Japan, India, Indonesia, Germany, France, UK, etc.

Health Care: Two of our start-up companies (Booguu and Mat-A-Cell) contribute directly to health care and medicine. Booguu's products are in use by major hospitals in Hong Kong and Taiwan, while Mat-A-Cell develops a new-generation medical device to differentiate functional cells without fatal adverse effects, urgently demanded by the development of cell therapies to treat incurable diseases.

Schools: We have delivered over 50 school lectures in Hong Kong, with a total audience around 2,000.

(2) Approach to impact

As mentioned above, much of our Department's research interfaces readily with industry and society, especially in advanced materials and biophysical methodologies with optoelectronic, analytical and medical applications. We actively encourage such interactions to our existing staff and favour the hiring of candidates with a strong interest in knowledge transfer, as evidenced by our start-up companies. We also collaborated with interested members of the HKBU Faculty of Science Advisory Committee,

especially to enhance our relevance and our students' job prospects. All this is clearly evidenced by a record 6 companies started up by a department with only a dozen academics. In fact, the patents have already generated HK$1,860,000 of income for the university in IP Rights.

Our impact is greatly facilitated by HKBU's Knowledge Transfer Office (KTO), which operates the Technology Start-up Support Scheme for Universities (TSSSU) grants from Hong Kong's Innovation and Technology Commission (ITC); KTO also assists in patent application and commercialization. Through KTO the department received support of HK$900,000 for applied research projects (MCPF).

Our staff are encouraged through annual performance reviews that influence salary and cash bonuses, University-level President's Awards for Outstanding Performance, and other University reward schemes. For example, the founder of one of our start-up companies, KW Cheah, was awarded a series of internal (and external) prizes and was also honoured with an Endowed Chair of Advanced Materials and an 8-year extension of appointment beyond normal retirement.

Our students, especially our Research and Taught Postgraduates but also our Undergraduates, benefit directly from our Department's various initiatives. For instance, through our start-ups, our 50 RPgs and 383 TPgs (since 1 Oct. 2013) had the training in the physical concepts and methodologies in authentic applications. Our Undergraduates also participate in research through final-year projects and a separate guided research program that is tailored to their specific abilities.

(3) Strategy and plans

Our Department encourages research directions with prospective impact. Fully supported by a thorough 2016 review of our Department by a President-appointed panel of three external experts, we concentrate on two research areas with strong impact potential: advanced materials, and biophysics & complex systems. We also participate in collaborative HKBU research focus areas that promote impact.

For our impact on human health, the Department will continue to consolidate existing expertise in nano- and micrometer scale data collection and physical modelling to develop novel diagnostic, predictive and therapeutic methodologies. Ongoing projects include: i) discovery of new combinatorial targets led by J Shi to sensitize drug response of distinct cancer types; ii) identification of sensitive biomarkers for early diagnosis of Alzheimer's Disease led by CS Zhou based on neuroimaging and cognitive behaviour data across individuals; iii) stimulation of miniature brain organoid self-assembly with nanomatrices by ZF Huang for treatment of Parkinson's disease; iv) development of microbiome-based diagnostics and therapeutics by L Tian using novel network-based methodologies to identify the universal assembly pattern and the associated resilience/stability of the gut microbial communities. We will capitalise on existing research infrastructure within the Science Faculty (e.g. Institute of Computational and Theoretical Studies and the State Key Laboratory for Environmental and Biological Analysis) to boost efforts in product development in the coming years. We have also appointed, jointly with other departments, a Visiting Professor from UC-Berkeley with extensive practical and educational experience to strengthen our staff's and students' performance in both Entrepreneurship and Artificial Intelligence.

(4) Relationship to case studies

We present herewith one Impact Case Study that describes the start-up company Cathay Photonics Limited, founded in 2014 by KW Cheah of our Department. Among the advanced materials studied within the Department, aluminium oxide nano-structures and films have been investigated for their surface structure modifications and optical properties, in an ITC (Innovation and Technology Commission) project sponsored by a company. The research group of KW Cheah thereby acquired in-depth understanding of aluminium oxide properties. Upon project completion, the research group turned its attention to the possibility of using hard nanoscale-thick aluminium oxide films for anti-scratching applications. The project was supported by the annual research/teaching budget of the Department. When the optimum hardness was achieved, the process was patented. With the support of TSSSU funding through the University's Knowledge Transfer Office, the technology was then commercialised.