

Research Assessment Exercise 2020

Impact Overview Statement

University: The Chinese University of Hong Kong

Unit of Assessment (UoA): 7

Total number of eligible staff of the university in the UoA: 24

(1) Context

Research in the UoA are broadly grouped into four clusters: Biophysics/Soft Matter/Complex Systems, Fundamental Physics (Astrophysics and Particle Physics), Materials Science, and Quantum Coherence and Quantum Matter. Impacts are delivered to industry, the public and schools, the media, and to the government. Impacts on the economy are delivered through technology transfer to industry and establishing spin-out companies that develop and commercialize products based on our research on applied physics and materials science, as exemplified by the UoA's impact cases by Wang and by Xiao in this RAE. Impacts on society and culture are generated by the UoA's long tradition of promoting public understanding and appreciation of science and new research discoveries through public science lectures and TV and radio programmes, and engaging in the betterment of science education in secondary schools. Impacts on public policy and services are delivered through members of the UoA serving as advisors and members to various government bodies including the Curriculum Development Council, Hong Kong Science and Space Museums, and Radiation Board of Department of Health, as well as through students in the UoA working as interns in secondary schools, Hong Kong Observatory, and Hong Kong Space Museum.

(2) Approach to impact

The UoA has strength and a long tradition in applied physics, fundamental physics, and materials science research. It offers the PhD & MPhil programmes in Physics and in Materials Science & Engineering. Various approaches to its interaction with non-academic users are described below.

Technology Transfer and Industrial Collaboration: The environment for encouraging impact at this UoA is characterized by a strong support for technology transfer through establishing start-up companies to demonstrate commercialization of research under the support of internal and external grants as well as support from the UoA's policies. The University, being the formal recipient of all grants, provides policy and administrative support, and supervision on protecting intellectual property (IP). The UoA's engagement with industry has grown significantly throughout the RAE assessment period. The UoA considers connections with industrial partners strategically important. Such partnerships are central to the grants (HK\$7.7M in total from 2013 to 2019) awarded by the government's Innovation and Technology Fund (ITF). These connections and grants, and resulting IPs such as patents are valued and rated positively in staff appraisal. From 2013/4 to 2018/9, staff of the UoA obtained 58 patents, with 40 and 7 of these forming the bases of Xiao's and Wang's impact cases respectively. Four spin-off companies were formed.

Structures and Initiatives: The UoA supports the underlying research, including PIs' salary, and recognizes efforts and achievements in and beyond academia in staff appraisal (annual appraisals, pay-review and promotion exercises). The UoA provides free research lab space, free computing facilities, and free postgraduate students. In addition, development of the technological know-hows is supported free-of-charge by a host of materials characterization facilities in the UoA's HK\$50M+ Central Laboratory. The UoA strategically channels University funds to projects with potentially major impact. The University's Project Impact Enhancement Fund was allocated to Xiao and Wang for developing their cases, as well as to build up a new front on the UoA's impact focusing on promoting a cultural change towards science in society. The UoA also directed funds from the University's Impact Postdoctoral Fellowship Scheme (for 5 postdocs in 2019) for impact building.

Besides commercialization, the UoA sees it as an important duty to engage the public for better understanding and appreciation of science and technology, with research in the UoA as the lively examples. These outreach activities include numerous public talks (over 20 per year and reaching over 1,000 in audience), production of short videos to introduce our research, and exhibitions held in the Hong Kong Science Museum (on the Large Hadron Collider experiments and nano medicine) and Hong Kong Space Museum (on black holes and event horizons). Ng and Tong in the UoA are famous locally for their regular appearances in a popular TV show (Sidewalk Scientist) to explain science,

reaching millions in audience. Several members of the UoA have been actively involved in some of the most important recent ground-breaking discoveries in fundamental physics: the Higgs boson (Large Hadron Collider, Flores Castillo); neutrino oscillations (Daya Bay Experiment, Chu); and gravitational waves (LIGO, Li). Their works have attracted wide media coverage and public interest. Chu and Hui have served as advisors for Hong Kong Science Museum for many years.

Several members of the UoA have been active in promoting and enhancing science education, particularly at the school level. Hui chaired the committee that wrote the secondary school physics curriculum now serving over 30,000 students in Hong Kong annually. The UoA organizes talks, courses, workshops for physics teachers and students regularly. The UoA's Summer Teacher AppRenticeship internship programme has sent 5–10 undergraduate physics majors to high schools each year to work as teacher apprentices since 2002. The UoA has fostered strong partnership with Hong Kong Science and Space Museums, Hong Kong Academy of Gifted Education, selected high schools, and the CERN and LIGO Outreach teams to offer courses, study tours, workshops, and educational materials for high school teachers and students. From 2013 to 2019, 28 and 17 students in the UoA worked as interns in secondary schools and Hong Kong Observatory respectively, contributing to education and public services through their science training. Examples of impact include the improvement in weather forecast through machine learning and organization of STEM education activities for secondary school students.

(3) Strategy and plans

The UoA's multi-pronged impact development strategy starts with identifying research projects for impact building, enables them by providing free-of-charge in-house facilities for research and development, and develops and monitors their impacts by strategically deploying University's Impact Development resources from the University's Office of Research and Knowledge Transfer Services (ORKTS). An environment has been built up, in part using staff appraisals metrics as a vehicle, that cherishes impact development alongside research output addressed to academic peers.

The UoA Outreach Team was formed in 2018 to coordinate centrally our outreach activities. Our strategy is to foster stronger ties to high school physics teachers, many being our alumni, through special events and workshops. A plan is to leverage the knowledge, experience and contact network of research groups in the UoA to design, develop and produce science exploration modules to better communicate the possibilities and opportunities open to young students in Hong Kong, in collaboration with Hong Kong Science Museum. This will include the design of educational activities, models and experiments related directly to the research of PIs in the UoA, in close collaboration with, and for the benefit of, education professionals, science enthusiasts, students and the general public.

During the review period, the UoA has succeeded in bringing large-scale experimental studies in fundamental physics to Hong Kong, namely the Daya Bay Reactor Neutrino Experiment, ATLAS Experiment at CERN, and LIGO gravitational-wave observatory – works that have led to two Nobel Prizes and two Breakthrough Prizes (that our PIs shared). The UoA has communicated actively these major discoveries to the public. The UoA's paradigm shifting efforts have made it a reality that students in Hong Kong can be a part of these endeavors, and has established Hong Kong firmly as a center of fundamental research in addition to her traditional role of being a finance centre.

The UoA, with strategy in place, plans to build future impacts for our efforts in quantum optics and sensing, and in fundamental physics with an emphasis on shifting the paradigm in Hong Kong.

(4) Relationship to case studies

The two impact case studies: “Colloidal Plasmonic Metal Nanocrystals: A new page in food safety and various photonic applications”, and “Production and commercialization of flexible CIGS thin film solar cells”, are excellent examples of the impact developed by the UoA's materials science research supported for free by its Central Lab facilities, leading to patents and spin-off companies in both cases. Wang was nominated by the UoA and was awarded a CUHK Research Excellence Award 2017–18 for his research on plasmonics, which is the basis of his impact case. As part of science dissemination, the UoA has brought the work on plasmonics to public attention through the media. The UoA's Outreach Team will produce on-line videos based on these two impact cases to both broaden the impact to the public and explain the science involved as educational examples.