**Appendix: Project details**

**Senior Research Fellow Scheme**

**Prof. CHEN Jing Kevin
Project Title:** Unlocking the Full Potential of Wide-bandgap Semiconductors through Heterogeneous Integration and Junction Engineering for Highly Efficient Power Conversion Systems

**Abstract**

Wide-bandgap (WBG) semiconductors such as gallium nitride (GaN) and silicon carbide (SiC) possess superior material properties and have entered commercialization for next-generation electric power supply systems. Meanwhile, there remains to be untapped potential waiting to be unlocked by exploiting GaN- and SiC-based power devices from new angels.

The project first aims to develop heterogeneous WBG power devices to harness the complementary merits of GaN and SiC for realizing unprecedented power conversion efficiency and power density. Studies will be carried out along two directions, namely, three-dimensional co-packaging and monolithic integration. The second aim of the project is to develop a new GaN power device technology to enhance performance and reliability for high-performance computing, industrial and automotive applications. By incorporating quantum effects in critical junctions, the new device aims to overcome challenges faced by current GaN devices.

**Prof. ZHANG Qian**

**Project Title:** A Framework for Human-Centric Contactless Sensing Using mmWave Signals

**Abstract**

Hong Kong's aging population challenges elderly care services. Government prioritizes home care over institutional care, prompting the need for smart solutions like AI and IoT. However, existing wearable and surveillance cameras have limitations.

Millimeter wave (mmWave) radar technology offers accurate, non-contact monitoring with better privacy protection. By developing a human-centric sensing framework using mmWave, this project aims to overcome current radar system challenges and provide personalized healthcare. The innovative approach includes developing advanced radar systems with a cascade design that embeds computation, communication, and storage resources; quality with reconfigurable intelligent surface and virtual antenna array techniques; utilizing networked mmWave sensors for broader coverage and context-aware sensing; and designing AI algorithms tailored for mmWave sensing that consider the physical characteristics of mmWave signals and information enrichment from other modalities. The success of this project will enhance long-term care services, promote smart home applications, and drive growth in the smart home industry.

**Research Fellow Scheme**

**Prof. Tom CHEUNG**

**Project Title:** Post-transcriptional regulation of muscle stem cell quiescence during physiological conditions and aging

**Abstract**

With better healthcare and living conditions, humans are living longer, but aging is accompanied by poorer health span partly due to the aging-related deterioration in tissue functions. Muscle stem cells (MuSCs) are the adult stem cells of skeletal muscle, playing critical roles in maintaining tissue homeostasis and repair. MuSCs remain in a dormant state until they receive signals from external stimuli (e.g. muscle injury) to rapidly activate, proliferate, and differentiate to regenerate the injured muscle. However, this regenerative capacity is lost during aging, leading to loss of muscle mass, function, and capacity for repair. MuSC functions are under tight regulatory control through numerous pathways, which become dysregulated during aging. The Cheung laboratory is dedicated to understanding why MuSC functions are lost and developing interventions to restore their stem cell functions. This project will investigate how these mechanisms regulate MuSC functions and how aging may impact these pathways.

**Prof. LIU Kai**

**Project Title:** Enhance locomotor recovery by transforming a complete spinal cord injury into an incomplete injury

**Abstract**

Severe and long-lasting neurological deficits result from neurological injuries such as brain or spinal cord injury. Successful regeneration and reconnection of nerves has the potential to restore lost function. The team’s previous work on optic nerve injury and regeneration has led to a new approach to promote axonal regeneration and neurological recovery. They will apply this knowledge and methods to spinal cord injury. Recent research on spinal cord injury has shown that multiple descending tracts can regenerate across the lesion site, offering exciting opportunities to study the function of axonal pathways in the regeneration and repair of damaged neural circuits. The team aims to enhance functional recovery by combining various strategies and gain a deeper understanding of the cellular and molecular mechanisms involved in nerve fiber regeneration and functional connectivity. Successful completion of this project will improve our understanding of the fundamental processes that promote functional connectivity after central nervous system injury.

**Prof. WANG Yi**

**Project Title:** Cosmological Collider Physics in Light of Bootstraps

**Abstract**The high energy of the primordial universe provides a unique opportunity to study high-energy particle physics through cosmological observations. However, the existence of numerous primordial universe models poses a challenge in extracting model-independent information. The cosmological collider approach pioneered by Prof. Wang Yi and his collaborator aims to solve this problem by making predictions independent of the details of these models, such as the mass, spin, parity and lifetime of the primordial heavy particles.

The precise calculation of cosmological collider physics is very difficult. Recently, the emergence of the cosmological bootstrap method has made precise computations possible. This proposal seeks to leverage the bootstrap method to calculate the predictions of cosmological collider phenomenology accurately, enabling comparisons with next-generation cosmological experiments. Additionally, it aims to generalize current bootstrap results to more general cosmological backgrounds, testing the expansion history of the primordial universe and addressing the fundamental question "where do we come from?"

**Prof. ZHU Pengyu**

**Project Title:** Regional Science and Complex Systems: A Five-year Research Plan on Transportation, Land Use, Labor, and Innovation Systems

**Abstract**

The places people inhabit today are comprised of many complex systems. This research project explores the complex interactions of four critical systems for urban and regional development: transportation, land use, labor, and innovation. The first research stream examines the non-linear spatial and temporal impacts of high-speed rail (HSR) on land use and values, and the heterogeneity and spillover of these impacts, using historical data and recent transaction records along with machine learning to estimate the relationship between the transportation system and land use system. The second stream investigates how connections to HSR and air transport networks impact patent dropout rates, offering insights into how transportation facilitates innovation through increased competition. The third stream analyzes the effects of recent Land Management Right Mortgage Reform in rural China on labor misallocation and farmers’ welfare. The research findings will inform policies and interventions that promote efficient, sustainable, and inclusive urban and regional development.