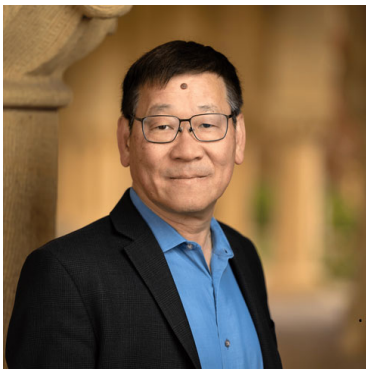
Fundamental Quantum Science Program
Seminar series No.9

RIKEN TRIP

● Date & Time : **Tuesday 22nd April 2025 10:00-11:30**
● Venue : # Room309, Frontier Research Laboratory



Prof. Zhi-Xun Shen

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" High-Temperature Superconductivity in Cuprates – Strides Made and Challenges Remain "

The enduring mystery of high-temperature superconductivity in copper-based materials, with critical temperatures surpassing earlier expectations set by the BCS theory, remains one of the most intriguing puzzles in physics, even three decades after its initial discovery. What makes this enigma so captivating is its simultaneous simplicity - characterized by a single-band and half-spin system - and its extraordinary complexity, featuring rich phenomena such as d-wave superconductivity, the pseudogap, spin and charge orders, and the peculiar behavior of strange metals. Consequently, cuprates have become a paramount model system for exploring correlated electrons, igniting discussions on topics ranging from the physics of the Hubbard model to quantum critical points and Planckian metals.

Angle-resolved photoemission spectroscopy (ARPES) has emerged as the premier experimental technique for unraveling the intricacies of electronic structure and many-body interactions. In this presentation, I aim to deliver a comprehensive overview of the cuprate conundrum, highlighting both the strides made and the hurdles that persist, with focus on recent advancements [1-7]. I will delve into five key themes: i) the unconventional characteristics of the superconducting state, exploring non-s wave pairing and the remarkably robust phase fluctuations; ii) the enduring enigma of the pseudogap, examining its manifestations within the complex electronic phase diagram and the anomalous normal state; iii) the indispensable role played by Mott-Hubbard physics and antiferromagnetic interactions; iv) the inadequacies of the Hubbard model in capturing the pronounced attractive interactions among doped carriers in cuprates; v) and the plausibility of elucidating the entire spectra of phenomena, including the enhanced superconductivity of unconventional nature, through the interplays of anisotropic electron-electron and electron-phonon interactions.

[1] Yu He et al., Science, 362, 62 (Oct. 2018)
[2] S.D. Chen et al. Science 366, 6469 (2019)
[3] Yu He et al., Phys. Rev. X 11, 031068 (2021)
[4] Z.Y. Chen, Science 373, 6560 (2021)
[5] S.D. Chen et al., Nature 601 (7894), 562-567 (2022)
[6] Ke-Jun Xu, et al. Nature Physics 19 (12), 1834-1840 (2023).
[7] Ke-Jun Xu, et al., Science 385 (6710), 796-800

・Hosted by : Dr. Naoto Nagaosa
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