北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Weekly Seminar

Multi-fermion-clustering Physics

Congjun Wu

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Time: 3:00 pm, Oct. 23, 2024 (Wednesday)

时间：2024年10月23日 （周三）下午3:00

Venue: Room w563, Physics building, Peking University

地点：北京大学物理楼，西563会议室

Abstract

Typical mean-field theories for many-body states rely on two-fermion orderings. Order parameters lie in either the particle-particle channel such as pairing orders for superconductivity, or, in the particle-hole channel such as spin-density-wave orders for antiferromagnetism. Nevertheless, in high energy quantum chromodynamics, three quarks form a colorless baryon, and in nuclear physics, two protons and two neutrons form a spin and isospin singlet α-particle. We examine this class of multi-particle fermion multi-particle clustering instabilities in one-dimensional spin-3/2 fermion systems via the renormalization group and bosonization method, which exhibit the quartetting superfluidity (charge 4e) and quartet density wave orderings. For a two-band superconductivity, we identify a normal state with a two-particle-two-hole type ordering exhibiting time-reversal symmetry breaking because of strong phase fluctuations. We also introduce a mechanism of the charge-6e state via frustration of pair-density-wave state, which may be relevant to the recent hc/6e oscillations observed in the Little-parks type experiments in Kagome superconductors.

Ref..

1.Zhiming Pan, Chen Lu, Fan Yang, Congjun Wu, Frustrated superconductivity and sextetting order, Sci. China Phys. Mech. Astron. 67, 287412 (2024) (arXiv:2209.13745)

2.Yu-Bo Liu, Jing Zhou, Congjun Wu, Fan Yang，Charge-4e superconductivity and chiral metal in 45° -twisted bilayer cuprates and related bilayers， Nat Commun 14, 7926 (2023).

3.Meng Zeng, Lun-hui Hu, Hong-Ye Hu, Yi-Zhuang You Congjun Wu, High-order time-reversal symmetry breaking normal state, Sci. China Phys. Mech. Astron. 67, 237411 (2024).

4.Congjun Wu, "Competing orders in one dimensional spin 3/2 fermionic systems", Phys. Rev. Lett. 95, 266404 (2005)

About the speaker

Congjun Wu received his Ph.D. in physics from Stanford University in 2005 and did his postdoctoral research at the Kavli Institute for Theoretical Physics, University of California, Santa Barbara, from 2005 to 2007. He became an Assistant Professor in the Department of Physics at the University of California, San Diego in 2007, an Associate Professor in 2011, and a professor in 2017. In 2021, he became a Chair Professor at Department of Physics, Westlake University and the founding chair of this department. He was selected as a New Cornerstone Investigator (the inaugural award) in 2023, elected to a Fellow of American Physical Society in 2018, and awarded the Sloan Research fellowship in 2008. His research interests are exploring new states of matter and reveling their organizing principles, including quantum magnetism, superconductivity, topological states, mathematical physics, and the numerical method of quantum Monte Carlo simulations.