清华大学高等研究院

Institute for Advanced Study, Tsinghua University

物理学术报告

Physics Seminars (biweekly)

Title: **Directional-dependent Berezinskii-Kosterlitz-Thouless transition at superconducting KTaO3-based interfaces**

Speaker: **Ziji Xiang (University of Science and Technology of China)**

Time: **4:00 pm, Tuesday, September 2, 2025**

Venue: **Conference Hall 322, Science Building, Tsinghua University**

Abstract

In two dimensions, a phase-coherent superconducting state is established via a Berezinskii-Kosterlitz-Thouless (BKT) transition, whose critical temperature TBKT is determined by the global superfluid stiffness in uniform superconducting systems. In an earlier work, we have reported on the intrinsic directional signatures of the resistive superconducting transition --- which appears to be dependent on the direction of in-plane bias current --- at the EuO/KTaO3(110) interfaces [1]. Novel theoretical proposals [2,3] have since been inspired; these models, however, raise a serious question that whether disparity of the apparent superconducting transition temperature Tc translates to a directional-dependent TBKT. Recently, we have revealed that at the interface between (111)-oriented KTaO3 and ferromagnetic EuO, the two-dimensional superconducting state exhibits a BKT transition explicitly relying on the current direction. Exploiting deliberate device fabrication, we show that the highest TBKT occurs when current is applied along one of the [11-2] axes of KTaO3, underscoring a spontaneous breaking of the threefold lattice rotational symmetry. Such directional dependence of TBKT is consistently reflected in the nonreciprocal signals stemming from superconducting fluctuations above the transition. We attribute this phenomenon to an interfacial phase segregation; the phase with higher TBKT self-organizes into quasi-one-dimensional textures that stretch along one of the [11-2] directions.

[1] Xiangyu Hua, Zimeng Zeng, Fanbao Meng, Hongxu Yao, Zongyao Huang, Xuanyu Long, Zhaohang Li, Youfang Wang, Zhenyu Wang, Tao Wu, Zhengyu Weng , Yihua Wang, Zheng Liu, Ziji Xiang* and Xianhui Chen*, Nat. Phys. 20, 957-963 (2024).
[2] Zi-Xiang Li, Steven A. Kivelson, Dung-Hai Lee, arXiv 2407.10269
[3] Zhipeng Xu, Kun Jiang, Jiangping Hu, arXiv 2506.05830