北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Weekly Seminar

Tunneling into the Pesudogap Phase of Cuprate Superconductor

Zengyi Du

Hefei National Laboratory

Time: 3:00 pm, Nov. 22, 2023 (Wednesday)

时间：2023年11月22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

In the first part of my talk, I will list evidences supporting the existence of a Pair Density Wave (PDW) state in the pesudogap phase of cuprate. We observed a modulating gap in $Bi_2Sr_2CaCu_2O_{8+\delta}$ by using the Spectroscopic Imaging-Scanning Tunneling Microscopy (SI-STM) technique, proving the presence of a PDW order in this system. The gap modulation shows 8-unit-cell spatial periodicity along the Cu-O-Cu bond directions. We also observed local density of states modulating at 4-unit-cell and 8-unit-cell periodicities along the Cu-O-Cu bond directions. These density of states modulations can be understood as a coupling of the PDW order with itself and d-wave superconductivity respectively.

Then, I will present how the lattice in $Bi_2Sr_2CaCu_2O_{8+\delta}$ is coupled to the CDW order in the pseudogap phase. We directly visualize a spatial modulation of the lattice distortion that has the same periodicities with the unidirectional CDW orders, and furthermore we find that the lattice distortion always has a π out of phase locked-in with CDW order. Overall, our visualization of the PDW states and strong electron-lattice interactions here will help uncover the mysterious pesudogap phase of the cuprate.

Zengyi Du, et al., Nature 580, 6570 (2020) ;
Zengyi Du, et al., J. Phys. Soc. Jpn. 90, 111003 (2021);
Zengyi Du, et al., Physical Review X, 13, 021025(2023).

About the speaker

杜增义，合肥国家实验室研究员。2012年本科毕业于内蒙古大学，2017年博士毕业于南京大学物理学院，导师为闻海虎教授，2018-2023年先后在美国布鲁克海文国家实验室、石溪大学从事博士后研究。课题方向为高温超导体的扫描隧道显微镜研究，主要工作包括证明了极度电子掺杂的铁基超导体的超导能隙中仍然存在符号反转的现象以及在铜氧化物赝能隙中直接观测到配对密度波现象。以第一作者身份发表文章在Nature、Nature Physics、Nature Communications、Physical Review X等杂志上。2023获得国家海外高层次人才引进计划支持，加入合肥国家实验室和中国科学技术大学封东来院士团队，计划发展扫描近场光学显微镜技术，并利用其探究量子材料中光与物质在纳米尺度下的相互作用。