北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Weekly Seminar

Experimental Exploration of Deconfined Quantum Criticality

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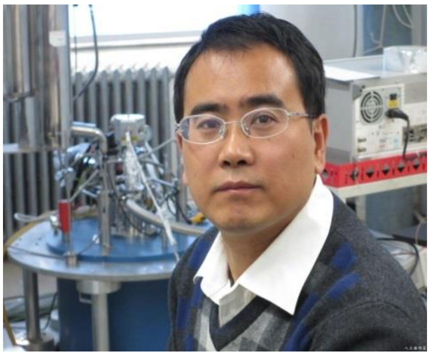

Time: 3:00pm, April. 19, 2023 (Wednesday)

时间：2023年4月19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

摘要

Landau theory predicts that there is no continuous quantum phase transition between two symmetry breaking states. However, in recent years, many-body computation based on some specifically designed models seems to support the existence of second-order phase transitions through deconfined quantum critical points (DQCP). The DQCP, if exists, should also be accompanied with enhanced symmetries and fractional excitations [1]. Experimentally, however, such DQCP has not been found yet.

Here I report our experimental investigation of DQCP on a spin-frustrated Shastry-Sutherland material $SrCu_2(BO_3)_2$ [2], through high-pressure, high-field, and ultra-low temperature NMR studies. In support of a phase transition from a dimerized state (DS) to a plaquette singlet (PS) state [3,4,5], we established spectroscopic evidence of a full-plaquette (FP) singlet state under pressure. At pressures of 2.1 GPa and 2.4 GPa, a field-induced, weak first-order quantum phase transition emerges from the PS to the antiferromagnetic (AFM) state, with the coexistence temperature of two phases as low as 0.07 K and decreasing with pressure. A duality in transition temperature of both phases by the same power-law scaling with field, and a quantum critical scaling behavior in low-energy spin dynamics are also established. Further numerical simulations also support an enhanced O(3) symmetry at the quantum phase transition. These results [6] reveal the first experimental existence of a proximate DQCP, which provides a concrete platform for further investigation on DQCP in the material under pressure.

References:

[1] R. R. P. Singh, Physics, 3, 35 (2010).

[2] H. Kageyama, et al., Phys. Rev. Lett. 82, 3168 (1999).

[3] M. E. Zayed, et al., Nat. Phys. 13, 962 (2017).

[4] J. Guo, et al., Phys. Rev. Lett. 124, 206602 (2020).

[5] J. Larrea Jimenez, et al., Nature 592, 370 (2021).

[6] Y. Cui et al., arXiv: 2204.08133 (2022).

报告人简介

于伟强，中国人民大学物理系教授。2004年在UCLA获得博士学位，先后在马里兰大学、麦克马斯特大学做博士后，2008年起任现职，开展强关联体系的凝聚态核磁共振研究。搭建的核磁共振谱仪系统具有稀释制冷极低温、高压和强磁场等先进的联合样品调控条件。近十多年来专注于铁基高温超导材料和量子磁性材料的调控和物性研究，在铁基高温超导材料的配对对称性、向列序、自旋涨落和超导的关联，以及量子磁性材料的量子自旋液体态、量子相变等方面做出多项前沿研究成果。已发表ESI论文70余篇，引用3000余次，获基金委优青支持。

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