New Anomaly at Superconducting Instability inside a Magnetically Ordered Phase.

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Superconductivity is a quantum phase where a material shows zero resistance and was discovered in 1911 by H. K. Onnes for Mercury[1]. The first successful microscopic theory of superconductivity was proposed by three prominent physicists Bardeen, Cooper, and Schrieffer in 1957[2]. The theory, later called BCS theory, successfully explained various features observed in superconductors. In the BCS theory, the superconducting instability is assumed to occur in a non-magnetic metallic phase. However, the superconducting instability can occur also inside a magnetically ordered phase, leading to the coexistence of the two ordered phases. This possibility is discussed in cuprate superconductors[3], heavy electron systems[4], and iron-based superconductors[5]. Since superconductivity generally competes with magnetism, it is still under debate: do the two ordered phases arise from the same electrons? or are they just phase-separated?. Aiming to get some insights on the above issue, we investigate the longitudinal spin susceptibility inside a magnetic phase where superconducting instability occurs via a continues phase transition and the coexistence of superconductivity and magnetism is stabilized at low temperature. What we newly find is that the spin susceptibility exhibits a jump at the superconducting transition temperature. The origin of the jump traces back to the breaking of spin rotational symmetry in the magnetically ordered phase and thus the obtained jump can be a general feature. Our finding can be utilized as a thermodynamic probe that the two ordered phases arise from the same electrons.

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