

Competing order in the 1144-type iron-based superconductors

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In Iron-based high- transition temperature (high- T_c) superconductors, various ordered phases exist in the vicinity of the superconducting phase. In typical materials, such as BaFe₂As₂ – based (122) and LaFeAsO -based (1111) systems, competing order shows up when their structures changes from tetragonal to orthorhombic, which stabilize stripe spin-density wave (SSDW) magnetic order. However, in CaKFe₄As₄, so-called 1144 type system, substitution of Fe for other transition metals TM (= Co, Ni) stabilizes the hedgehog-type antiferromagnetism (H-AFM) while maintaining the tetragonal crystal structure [1]. Since different ordered phases appear in this 1144 system, despite having similar crystal structures and constituent elements, a comparative study is important for elucidating the relationship between the superconductivity and the competing ordered phase.

In this study, we synthesized Ca_{1-x}La_xKFe₄As₄, in which out-of-plane Ca is substituted with La, and studied their physical properties. Here La substitution is expected to dope electrons as TM substitution without introducing disorder into Fe planes.

We have found that T_c decreases monotonically with La substitution. This behavior is quite different from that of 122-type Ba_{1-x}K_xFe₂As₂. Neutron diffraction results indicate that the magnetic order is also H-AFM type. The magnetic transition temperature T_N was found to be higher with La substitution compared with TM substitution. The possible origin for stabilizing H-AFM will be discussed.

[1] W. R. Meier, et al. npj Quantum Mater. 3, 5 (2018).

[2] A. Kreyssig et al., Phys. Rev. B 97, 224521 (2018) .