Synthesis and neutron diffraction of iron-based high-T_c superconductor $^{154}SmFeAsO_{1-x}D_x$

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Electron-doped SmFeAsO shows the highest critical temperature (T_c) among all iron-based superconductors. Antiferromagnetic (AFM) fluctuations have been proposed to be one of important pairing glue of the high T_c superconductivity. Thus, it is crucial to determine the magnetic structure of adjacent AFM phase to the superconducting phase to understand the origin of the high T_c superconductivity.

Neutron diffraction is the most widely used technique to determine the magnetic structure. However, due to the prohibitively large neutron absorption cross-section of natural Sm, the magnetic ground state of non-doped as well as electron-doped SmFeAsO have not been determined yet. Therefore, we synthesized Sm-isotope-substituted samples ($^{154}SmFeAsO_{1-x}D_x$), and constructed the electronic phase diagram by neutron diffraction and heat capacity measurements.

Figures 1a-c show the phase diagram of $^{154}SmFeAsO_{1-x}D_x$, the AFM structure at x = 0 (AFM1) and 0.73 (AFM2), respectively. The AFM1 structure was a conventional stripe-type order observed in AFM phases of other iron-based superconductors, while the AFM2 showed an incommensurate-type magnetic structure. The magnetic moment on Fe site reached to be 2.73μ_B/Fe, which is the largest value among all iron-based superconductors except a Mott-insulating $K_2Fe_4Se_5$. The unique phase diagram, *i.e.*, highest-*T*c superconducting phase adjacent to the strongly correlated phase in electron-overdoped regime, yields important clues to the unconventional origins of superconductivity.

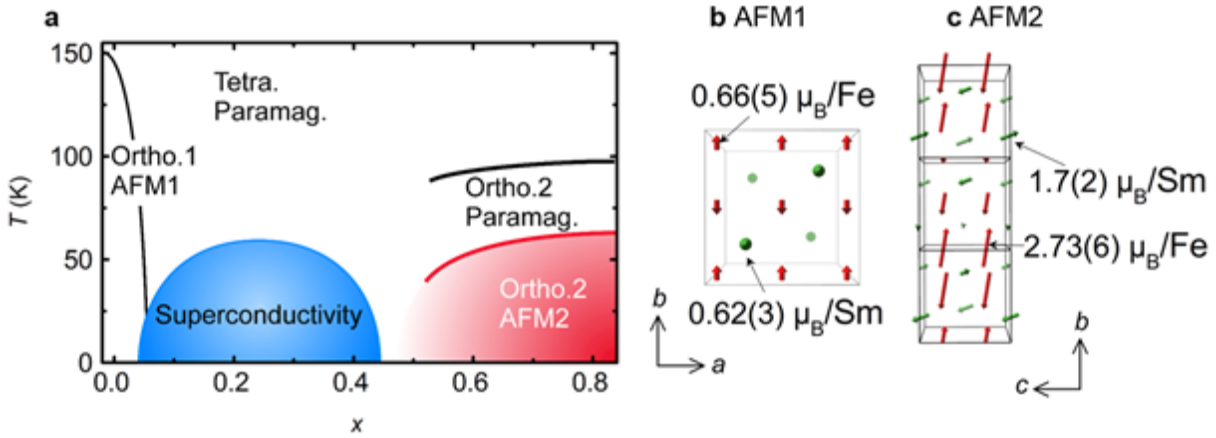

Figure 1: Phase diagram of $^{154}SmFeAsO_{1-x}D_x$ (a) and magnetic structures at x = 0 and 0.73 (b and c).

Bibliography

[1] S. Iimura *et al.*,; Proc. Natl. Acad. Sci. USA, **A114(22)**, E4354 (2017).

External links

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https://www.ill.eu/press-and-news/press-room/press-releases/ill-d20s-neutron-beam-yields-important-clues-to-the-unconventional-origins-of-superconductivity-april-2017/