Inelastic Magnetic Scattering of Fe oxypnictide superconductors

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To identify the origin of the superconductivity of Fe based systems, whose highest transition temperature Tc is ~56 K, the determination of the symmetry of the superconducting order parameter is essentially important. On this issue, we have been experimentally studying the rate of the Tc suppression by nonmagnetic impurities [1] and T dependence of the NMR longitudinal relaxation rate [2], using so-called Ln1111 system LnFe1-yMyAsO1-xFx (Ln=La, Nd; M=Co, Mn, Ru).
Theoretically, it has been predicted on the basis of spin-fluctuation mechanism of the pair formation that the symmetry is S-like, but unconventional in the sense that even though it does not have nodes of the order parameter, the two kinds of order parameter on the disconnected Fermi surfaces have opposite signs. We call it S? symmetry. Although many experimental data supporting this prediction were published, almost all of them cannot distinguish whether the sign change really exists between the disconnected Fermi surfaces. Actually, to experimentally prove this prediction, it is important to directly approach this phase difference between the order parameters. One of the ways to do this is to study the coherence factors, which usually reflects in various physical quantities the relative phases of the order parameters. The coherence peak, which can be observed in the T dependence of the NMR 1/T1 of the ordinary S-symmetry superconductor is such an example. However, we have to be careful, because if the damping of the quasi particles is large, the coherence peak cannot be seen, and because this kind of large damping can be easily expected for the present Fe based systems with strong magnetic fluctuations. Therefore, it is rather important to study the magnetic excitation spectra of the systems in detail, as another quantity which reflects the coherence factor directly.
Truly speaking, our results on the rate of the Tc suppression by nonmagnetic impurities indicate rather rigidly that the sign difference between the order parameters on the two disconnected Fermi surface is quite unlikely, and it seems at this moment the most reliable experimental evidence on the symmetry problem. Therefore, it seems to be very urgent to see the magnetic excitation spectra in detail to establish the symmetry of the order parameter without any uncertainty.
We have carried out neutron inelastic scattering measurements to see the magnetic excitation spectra for polycrystalline samples of LaFeAsO0.89F0.11 [3] and Ba(Fe,Co)2As2 (Tc~22 K), at the scattering vector corresponding to the so-called (?,?) point in the reciprocal space, and the data are shown in Figs. 1(a) and 1 (b) at two temperatures below and above Tc. We have also been trying to prepare single crystals large enough for the measurements. However, the Bragg reflection intensity shown in Fig 2 is not strong enough for the measurements, and now, we are making much effort to prepare large crystals and/or to align crystals obtained up to now. Our crystals were also used in the study of various measurements. Figs. 3 and 4 show that the magnetic field dependence of the specific heat C(T) can be described in a unified way, showing that the system has no nodes.

references

[1] M. Sato et al. J. Phys. Soc. Jpn. 79 (2010) No. 1 014710-(1-10).
[2] Y. Kobayashi et al. J. Phys. Soc. Jpn. 78 (2009) No. 7 073704 (1-4).
[3] T. Moyoshi et al. Physica C to be published. doi:10.1016/j.physc.2009.11.085.

Fig. 1(a)

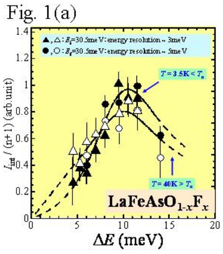

Fig. 1(b)

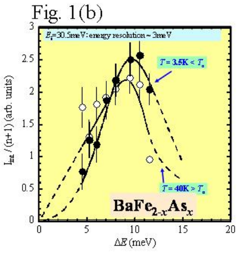

Fig. 2

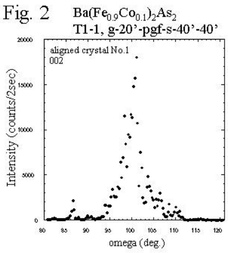

Fig. 3

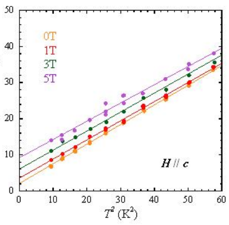

Fig. 4

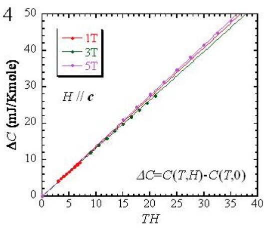

Fig. 1. Fig. 1. I/(n+1) ?E curves at Q˜1.1 ; (a) LaFeAsO0.89F0.11 and (b) Ba(Fe0.9Co0.1)2As2 (Tc˜22 K). Fig. 2. ω-scan profile of 002 nuclear reflection of a Ba(Fe0.9Co0.1)2As2 crystal. Fig. 3. C/T ?T2 curves. Fig. 4. Δ C(≡ C(T,H)-C(T,0)) ? TH curves.