de Haas-van Alphen Measurements of Iron-pnictide Superconductors $(Ba_{1-x}K_x)Fe_2As_2$

Taichi Terashima, Naoki Kikugawa, Shinya Uji (Natl. Inst. Mat. Sci., Japan); Eun-Sang Choi, James S. Brooks (NHMFL); Nobuyuki Kurita (Tokyo Inst. Tech.)

Introduction

A high-T_c binary alloy $(Ba_{1-x}K_x)Fe_2As_2$ is a unique system. The optimally doped compound x ~ 0.4 is a full-gap superconductor, while the x = 1 end member is a nodal superconductor. How do the Fermi surface and related properties change with x ? Answering this question will help deepen our understanding of the high-T_c mechanism of the iron pnictides. We have therefore planned dHvA oscillation measurements as a function of x and have observed oscillations in samples with x = 1, 0.93, 0.76, and 0.88 so far.

Experimental

High-quality single crystals necessary for dHvA measurements were prepared by research groups led by H. Eisaki (AIST, Japan), H. Fukazawa (Chiba Univ.), and S. Uchida (Univ. Tokyo). dHvA oscillation measurements on samples with x = 1 and 0.93 were performed with the field modulation technique in a dilution refrigerator and 20 T superconducting magnet at the NIMS, while those on samples with x = 0.88 and 0.76 were performed with a torque method in the PDF and 35 T resistive magnet at the NHMFL (Summer 2012).

Results, Discussion, and Conclusions

Figure 1 shows Fourier transforms of dHvA oscillations in KFe_2As_2 and $Ba_{0.07}K_{0.93}Fe_2As_2$ measured at the NIMS with the field-modulation technique. Two major frequencies α and β are clearly observed not only in the pure compound (x = 1) but also in the x = 0.93 mixed crystal. These frequencies arise from quasi-two-dimensional hole Fermi surfaces [1]. The x = 0.93 compound is less hole-doped, and accordingly the frequencies are smaller.

Figure 2 shows dHvA torque oscillations and the corresponding Fourier transform in the x = 0.76 compound. To improve the signal-to-noise ratio, data from four field sweeps were averaged. The α frequency is clearly resolved. The associated effective mass was determined to be 4 m_e, which is not very much different from 6 m_e and 4 m_e determined for x = 1 and 0.93, respectively, in spite of the fact that T_c ~ 16 K for x = 0.76 is four times larger than T_c ~ 4 K for x = 1.

We will continue measurements on smaller x compounds to see whether effective masses are really enhanced when we approach the putative quantum critical point at x ~ 0.4.

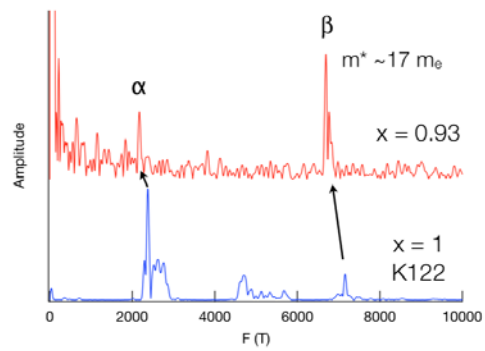

Figure 1. Fourier transforms of dHvA oscillations in KFe_2As_2 (lower) and $Ba_{0.07}K_{0.93}Fe_2As_2$ (upper).

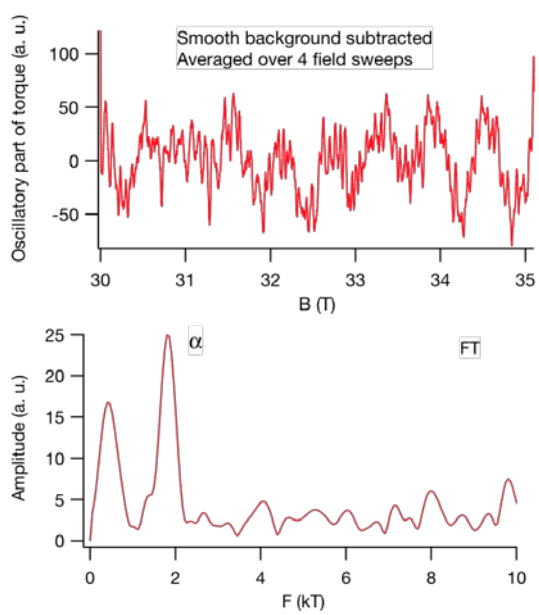

Figure 2. dHvA torque oscillations (upper) and the corresponding Fourier transform (lower) in $Ba_{0.24}K_{0.76}Fe_2As_2$.

Acknowledgements

The work was supported by JST, Transformative Research-Project on Iron Pnictides (TRIP) and MEXT KAKENHI, Japan.

References

[1] T. Terashima *et al.*, J. Phys. Soc. Jpn. **79**, 053702 (2010).