

Pauli-Limited Behaviour in an iron-based Superconductor ?

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We proposed a small angle neutron scattering experiment to measure the magnetic vortex lattice (VL) in clean KFe_2As_2 crystals with the field-direction close to the basal a-b plane. In this configuration, B_{c2} in Tesla is more than double T_c in Kelvin, which is a simple version of the condition for Pauli-limiting of superconductivity. We had expected to observe unusual behaviour, like “field-contrast” magnetic form factor of the VL, a possible FFLO state or magnetic ordering, similar to that observed in d -wave CeCoIn_5 superconductor. However the pairing in KFe_2As_2 is probably s^+ , rather than d -wave, giving a new perspective on the physics. For this purpose, during the end of May 2014, I visited PSI and performed VL measurements on new KFe_2As_2 crystals.

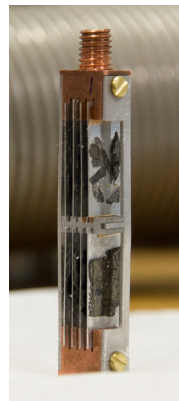


Fig. 1
Sample holder made
for this experiment.

Fig.1 shows the sample holder that we prepared for the experiment. It allows us to stack 8 Al plates parallel and to change two sets of mosaic crystals by changing the dilution stick position.

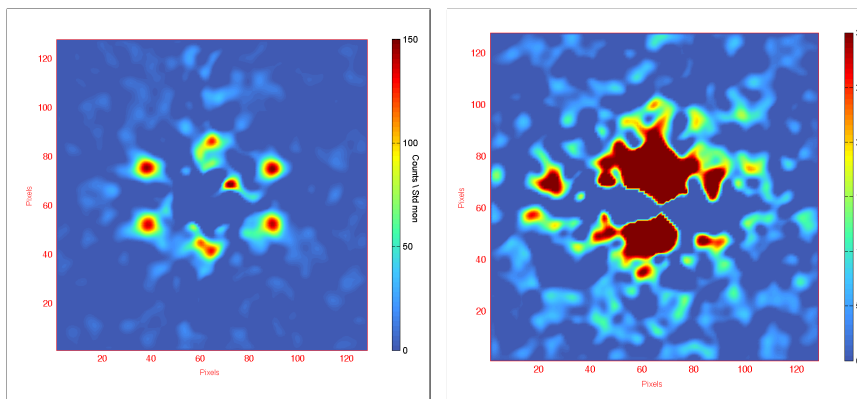


Fig. 2
VL scattering patterns.
Conditions were
described in the text.

Figs.2 show the sum of omega scans at sample angles to the crystal c-axis of 30deg. (left) and 80deg. (right), at $T=0.04\text{K}$ and $H=0.4\text{T}$. In the latter case, only left side of Bragg peaks were rocked through. The results revealed that we could observe VL signal even at high angle condition. Then we tried to proceed this experiment further but the dilution refrigerator failed to control temperature and we could not finish the measurements. PSI promised to cover this loss in coming cycle. We would like to extend this experiment further to test the Pauli-Limited behaviors in an iron-based Superconductor. This travel was done with a financial support of by ISSP. We appreciate it pretty much since it could not be done without it.