Experimental Report

Proposal: **4-01-1185** **Council:** 4/2012

Title: Investigation of the effect of an external magnetic field on the low-energy spin response of ortho-II ordered YBa2Cu3O6.5

This proposal is a new proposal

Researh Area: Physics

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Samples: YBa2Cu3O6.5

Instrument	Req. Days	All. Days	From	To
IN14	10	8	03/04/2013	09/04/2013

Abstract:

The recent discovery of quantum oscillations in highly ordered ortho-II phase YBa2Cu3O6.5 crystals indicates the existence of a small pocket-like Fermi surface in the ground state of underdoped cuprates which is reached in high magnetic fields. An important task in cuprate research is to clarify the origin of these Fermi surface pockets. Here we propose to investigate the effect of an external magnetic field on the low-energy spin response of fully detwinned and highly ordered ortho-II phase YBa2Cu3O6.5 crystals which are comparable to those samples where quantum oscillations have been found. This will test possible explanations of the origin of the small Fermi pockets.

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The goal of the experiment was to study the effect of an external magnetic field, applied mostly along the crystallographic *c*-direction, on the low energy spin response for a fully detwinned and highly ordered ortho-II phase $YBa_2Cu_3O_{6.55}$ (T_c=61K, p=0.11) sample, which was previously studied on PUMA at FRM-II [1]. We were following earlier work on the magnetic field effect in $YBa_2Cu_3O_{6.45}$ (T_c=35K, p=0.08), which revealed a field-enhanced incommensurate spin density wave [2]. Our $YBa_2Cu_3O_{6.55}$ sample is a mosaic of about 100 individually prepared crystals with a total mass of 2.5 grams. The crystals were coaligned to a silicon plate with a diameter of 17 mm, such that it would fit into the ILL 15T magnet. The measurements on IN14 had been delayed due to an accident with the original sample, which made a new sample preparation necessary.

We were using IN14 equipped with the vertical field 15T magnet in the focusing configuration with PG(002) monochromator and analyzer with fixed final wave vectors k_f=1.5A^{-1}. No collimation was used to maximize the neutron flux and a beryllium filter extinguished higher-order contaminations of the neutron beam. The sample was mounted in the (H, K, 2K) scattering plane and momentum scans along the *a**-direction were performed through the antiferromagnetic wave vector Q_{AF} = (0.5, 0.5, 1) for energy transfers between E=0meV and E=4meV, both above and below T_c, with and without applied magnetic field.

Unfortunately, we could not reliably reproduce the low energy spin excitation data collected at PUMA in zero magnetic field [1], and we could therefore not study their dependence on applied magnetic field. One likely reason why we couldn't reproduce the data obtained on the thermal spectrometer PUMA might have been a reduced intensity resulting from a significantly smaller volume of the resolution ellipsoid at IN14. Therefore, to achieve the goal of the experiment a thermal spectrometer seems better suited. In addition, the IN14 team notified us about a problem with irregularly high counts. We tried to discard these high counts employing a rather strict cutoff procedure, which could indicate a possible field effect at 4meV. However, since the result strongly depends on the cutoff procedure, we believe that the high field experiment should be repeated on a thermal spectrometer, which allows to explore a wider energy range.

References

[1] T. Loew *et al.*, unpublished data at FRM-II.
[2] D. Haug *et al., PRL* **103**, 017001 (2009).