Experimental report

11/03/2019

Proposal: 5-41-943 **Council:** 4/2017

Title: Doping dependence of the q=0 magnetic order in the high-Tc superconductor HgBa2CuO4+d

Research area: Physics

This proposal is a continuation of 5-53-256

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Samples: Hg-Ba-Cu-O

Instrument	Requested days	Allocated days	From	To
D7	10	7	19/06/2018	26/06/2018

Abstract:

One of the most interesting feature in high-temperature cuprates is the pseudogap phenomenon: in the normal state, a partial gap opens on the Fermi surface below a temperature T*, leading to peculiar changes in the electronic and magnetic degrees of freedom. Polarized neutron diffraction has revealed universal q = 0 magnetic order (which preserves the lattice translational symmetry) below T*, yet there remain important open questions concerning the nature of this magnetism. For example, the spatial geometry of the magnetically-ordered state has not been fully determined, i.e., whether the magnetic moment lies in the copper-oxygen plane or has a c-axis component as well. Due to its structural simplicity and high transition temperature, HgBa2CuO4+d (Hg1201) is a model system. We have successfully demonstrated the feasibility of measuring the q = 0 order in Hg1201 on D7 (Exp. No. 5-53-256, see ILL report) and observed evidence of c-axis component of the q = 0 order at one doping level. Here we propose to extend this work as a function of hole doping. Due to the simple structure of Hg1201, this will allow us to put constraints on theoretical models for the pseudogap phenomenon.

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Title: **Doping dependence of the q=0 magnetic order in the high-Tc superconductor HgBa2CuO4+d**
Instrument: D7
Experimental team: Zachary Anderson Dalila Bounoua, Yvan Sidis, Philippe Bourges, Martin Greven
Local Contact: Lucile Mangin-Thro

High-temperature cuprate superconductors exhibit unusual charge and magnetic properties as a result of their strong electronic correlations. One of their most interesting features is the pseudogap phenomenon: in the normal state, a partial gap opens on the Fermi surface below a temperature T* (T* > Tc), leading to peculiar changes in the electronic and magnetic degrees of freedom. The physics of the pseudogap has been under intense debate [1]. Polarized neutron diffraction has revealed an unusual **q** = 0 magnetic order (which preserves the lattice translational symmetry) below T* in both double-layer YBa2CuO6+δ [2] and single-layer Hg1201 (Figure 1) [3]. This magnetism has now also been detected in Bi2212 [4] and LSCO [5], and is therefore universally observed in the cuprates. We subsequently discovered novel pseudogap excitations that appear to be associated with the **q** = 0 magnetic order: neutron scattering measurements of both under-doped (Tc ≈ 65 K; UD65) and nearly-optimally-doped (Tc ≈ 95 K, OP95) Hg1201 revealed two weakly dispersive magnetic excitation branches below T* throughout the entire Brillouin zone [6]. Furthermore, these excitations appear only below the pseudogap temperature.

Compared to our previous study on UD71 recently published in PRB [7], the magnetic signal associated to the intra unit cell order (loop current) is very much reduced for UD55 (see the figure). This result will be published soon.

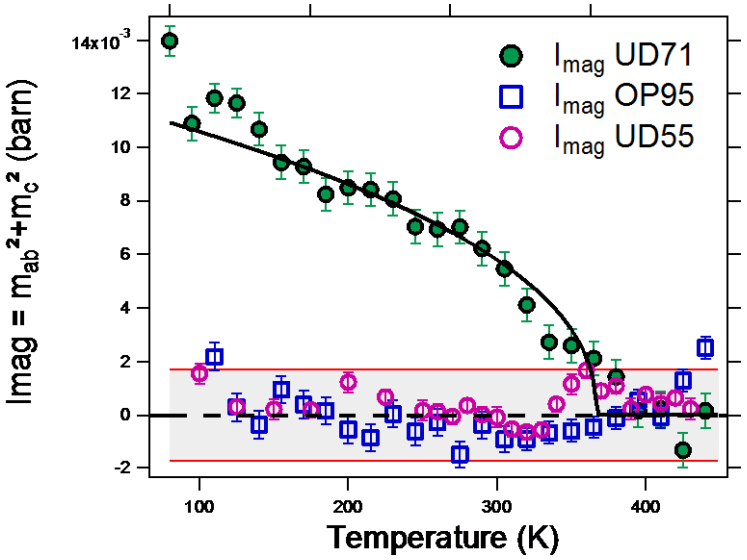

Fig.1. Pure magnetic intensities extracted from D7 data analysis on UD71, OP95 and UD55 samples, using the blind test (Method 1) given in the supplemental information In ***Y. Tang et al, Phys. Rev B. 98 214418 (2018)***
The shaded area corresponds to the 1.7 mbarn upper bound for OP95 magnetic intensity.

[1] B. Keimer *et al.*, Nature **518**, 179 (2015)
[2] B. Fauqué *et al.*, Phys. Rev. Lett. **96**, 197001 (2006).
[3] Y. Li *et al.*, Nature **455**, 372 (2008); Y. Li *et al.* Phys. Rev. B **84**, 224508 (2011).
[4] S. De Almeida-Didry *et al.* Phys. Rev. B **86**, 020504(R) (2012).
[5] V. Balédent *et al.*, Phys. Rev. Lett. **105**, 027004 (2010).
[6] Y. Li *et al.*, Nature **468**, 283 (2010); Y. Li *et al.*, Nature Phys. **8**, 404 (2012).
[7] Yang Tang *et al.*, Phys. Rev. B **98**, 214218 (2018).