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## Relation between increased transmission in XAS and increase in Abrikosov Vortices as $T \rightarrow T_c$

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# J.V. Acrivos Group Poster 2

## K1.186: Relation between increased transmission in XAS and increase in Abrikosov Vortices as $T \rightarrow T_c$

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### ABSTRACT

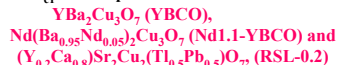
The **increased** transmission, observed in the EXAFS region of their X-ray absorption spectra, as **cuprate** materials go through the superconducting transition temperature  $T_c$  is correlated with a **critical** increase in **Abrikosov Vortex** expulsion in zero magnetic field as the temperature  $T \rightarrow T_c$ .

### 1. The Phenomenon

The formation of **quantized vortices** in rotating **superfluid  $^4\text{He}$**  induces transparency in its [1969]. In this work we report **absorption spectrum** that the same effect can be observed in cuprate superconductors due to the formation of superconducting **Abrikosov vortices** [1957]. Magnetic flux expulsion from a bulk superconductor is related to the magnitude of the external magnetic field: when it goes through zero the disintegration of Abrikosov vortex lattice is a cooperative dynamic phenomenon leading to B-K-T critical phenomena as  $T \rightarrow T_c$  [Berezinskii 1970- Kosterlitz-Thouless1973].

### 2. The Measurements

The **flux lattice is oriented** by ac fields and its **expulsion in zero field** is detected by the induced emf in an rf coil versus temperature  $T (\pm 1\text{K})$ , using a Varian Wide Line nmr spectrometer and a copper constantan thermocouple. The induced emf  $A_Y$  and the thermocouple output (mV) were recorded versus time  $t$  as the static field,  $B_z$  was cycled through zero in a given period. The ac field amplitudes (Fig. 1a) are  $B_1, B_{2m} \sim 0.05 \alpha \sim H_{c1}$ . The cuprates:



were ground, selected to a homogeneous particle size between 4 and 5  $\mu\text{m}$  by sieves, and dispersed into an equal volume ratio of mixed 5 minute epoxy and filled into 2 inch long, 1mm id Pyrex tubes open on both sides, within a minute. They were then placed to cure in an external orienting field  $H_0 = 9 \text{ T}$  in different geometries (Fig. 1b) with respect to the sample tube axis  $y'$  for an h [1994].

### 3. RESULTS AND DISCUSSION

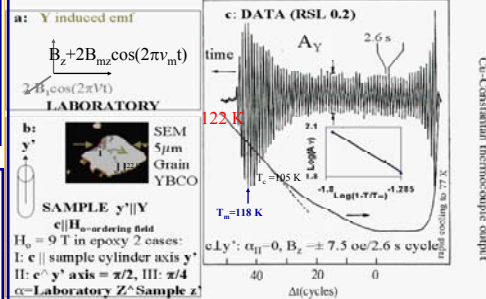


Fig. 1: Samples/Detectors

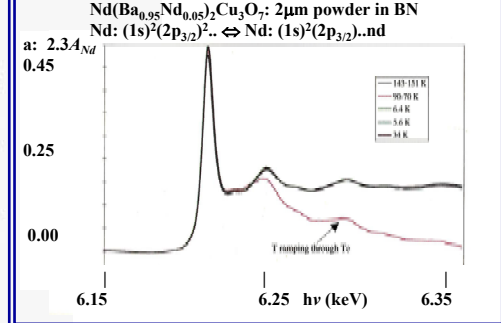


Figure 3: XAS as  $T \rightarrow T_c$ . Increased transmission is observed only as  $T$  goes through  $T_c$ . a: 100 % transparency in the EXAFS region is induced in  $2\mu\text{m}$  particles [1995] b: 20% transparency is induced in a bulk single [2002].

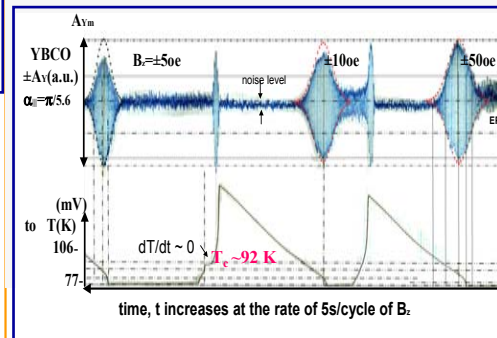
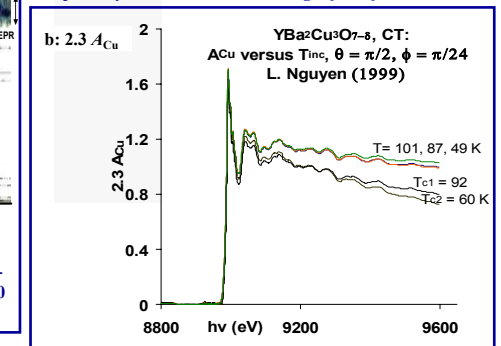


Fig.2: Field scans through zero, as  $T \rightarrow T_c$ . Observations: a: B-K-T critical flux expulsion is observed at  $T > T_c$ . b: For  $|B_z| > 10 \text{ oe}$  the observed signal below  $T_c$  suggests EPR,  $g \leq 1$



**4. CONCLUSIONS** The disintegration of the **Abrikosov vortex lattice**, a cooperative dynamic phenomenon influences the EXAFS spectrum when the vortex concentration diverges beyond a critical value near  $T_c$ , inducing a transparency in the absorbance just as **critical superfluidity** induces transparency in  $^4\text{He}$ .

[1957] A.A. Abrikosov, *Zh.Eksp.Teor.Fiz.* 32, 1442-1452 (1957); [1969] R. E. Packard and T. M. Sanders, Jr., *Phys.Rev.Lett.* 43, 823(1969); [1970] a) V.L. Berezinskii. *Soviet Phys. JETP* 59 907 (1970); [1973] J.M. Kosterlitz and D.J. Thouless. *J. Phys. C: Solid State Phys.* 6 (1973); [1994] J.V. Acrivos, Lei Chen, C.M. Burch, P. Metcalf, J.M. Honig, R.S.Liu and K.K. Singh, *Phys. Rev. B* 50, 13710 (1994); [1995] J.V. Acrivos, Lei Chen and C.M. Burch, *Superlattices and Microstructures*, 18, 197 (1995); [2000] J.V. Acrivos, *Solid State Sciences*, 2, 807-820 (2000)