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Relation between increased transmision in XAS and increase in Abrikosov Vortices as T→Tc

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K1.186: Relation between increased transmision in XAS and increase in Abrikosov Vortices as T→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 →T_c.**

1. The Phenomenon

The formation of quantized vortices in rotating superfluid ^{4}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->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 (±1K), 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_{zm} ~ 0.05 oe ~ H_{c1}. The cuprates:

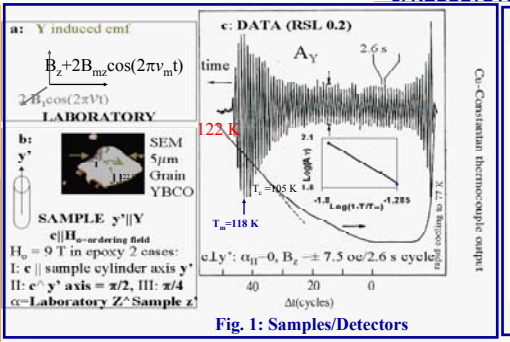
$YBa_2Cu_3O_7$ (YBCO),

$Nd(Ba_{0.95}Nd_{0.05})_2Cu_3O_7$ (Nd1.1-YBCO) and

$(Y_{0.2}Ca_{0.8})Sr_2Cu_2(Tl_{0.5}Pb_{0.5})O_7$, (RSL-0.2)

were ground, selected to a homogeneous particle size between 4 and 5 μm 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_o = 9 T in different geometries (Fig. 1b) with respect to the sample tube axis y' for an h [1994].

3. RESULTS AND DISCUSSION



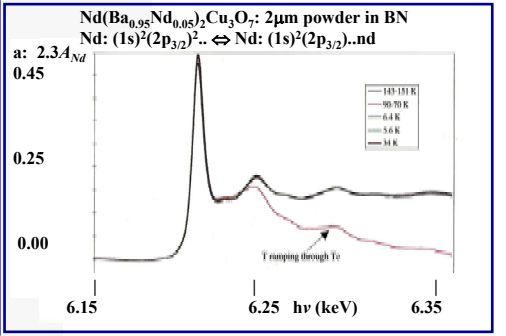


Figure 3: XAS as T→T_c Increased Transmission is observed only as T goes through T_c. a: 100 % transparency in the EXAFS region is induced in 2μm particles [1995] b: 20% transparency is induced in a bulk single [2002].

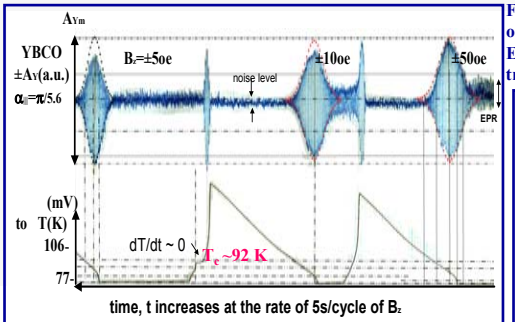
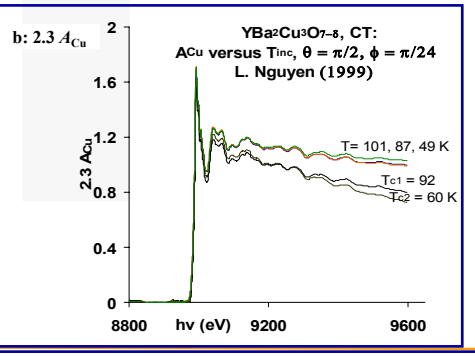


Fig.2: Field scans through zero, as T → T_c. Observations: a: B-K-T critical flux expulsion is observed at T> T_c. b: For $|B_z|$ > 10 oe the observed signal below T_c suggests EPR , g≤1



4. CONCLUSSIONS 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}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 Microsturcturres*, **18**, 197 (1995); [2000] J.V. Acrivos, *Solid State Sciences*, **2**, 807-820 (2000)