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ELECTRO-MAGNETIC-optical properties of YBa2Cu3O7 Crystal and 50 nm films on STO-BC 24 DEG GB

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ELECTRO-MAGNETIC-optical properties of $YBa_2Cu_3O_7$ Crystal and 50 nm films on STO-BC 24 DEG GB.

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ABSTRACT

Comparison of I_s/I_0 with TEY/I_0, F/I_0 and A, at the Cu $L_{2,3}$ and Ba $M_{4,5}$ edges indicates that $YBa_2Cu_3O_7$ (YBCO) 50 nm films scatters the circular components of linearly polarized light in a different way. The YBCO, Ba $L_{2,3}$ XAS shows indication of Faraday rotation near T_c. Hilbert analysis of data was done.

1. Introduction: Phenomenon

The presence of spin polarized states in metals populates the spin-orbit split conduction band states differently, and produce electro magneto optical rotation of ± circular components.

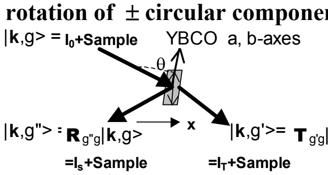


FIG. 1: Sample Geometry

Contributions to the amplitude I_s, I_T from atom a and incident beam I_0 are :

$$f_a = f_a^0 + f_a' + i f_a'' . \quad (1)$$

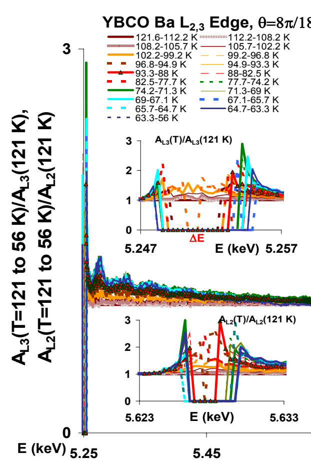
But when only one component determines I_s, I_T or F the real and imaginary components are mixed:

$$\begin{pmatrix} I_s/I_0 \\ KK\{I_s/I_0\} \end{pmatrix} = \begin{pmatrix} \cos(\varphi_{K/F}) & -\sin(\varphi_{K/F}) \\ \sin(\varphi_{K/F}) & \cos(\varphi_{K/F}) \end{pmatrix} \begin{pmatrix} f'' \\ f' \end{pmatrix} \quad (2)$$

The degree of mixture is determined by the angle of rotation $\varphi_{Faraday}$ and φ_{Kerr} determined by the changes in the complex index of refraction n_+, n_- of the two components. Hilbert transform: $KK\{I_s/I_0\}=1/\pi\int_{-\infty}^{\infty} dE'/(E'-E)\{I_s/I_0(E')\}$. (3)

2. Experiment/Results/Discussion

The XAS of a 22 μm thick single crystal YBCO grown at the Cavendish Laboratory were determined in transmission (T) geometry (FIG. 1,2) at SSRL. Measurements with plane polarized light, 10 μm wide aperture incident on a 50 nm YBCO film on STO were done at station of LBNL-ALS 6.3.1 Kortright chamber in scattering geometry (S) (FIG. 1,3) and fluorescence (F) and total electron yield (TEY). CuO and $BaBr_2$ powder were used as standards. The YBCO film was prepared at the Complutense University with ab grain boundary, of 24 DEG characterized by XRD at SSRL.



I_T vanishes @ Ba $L_{2,3}$ WL interval ΔE depends on T (inserts) critical angle $(2\delta)^{1/2}$ produces total internal reflection, δ<0 in ΔE due to index of refraction changes:

$$n=1-i\beta-\delta$$

Enhanced A vs T<Tc in XAFS may be due to δ. $\Delta E(L_3)/\Delta E(L_2) \propto$ vac states

T(K)	$\Delta E(L_3)/\Delta E(L_2)$
92	3.8
74	1.7
69	1.8

$Re(n_+ - n_-) = (\Delta\varphi/\pi)hc/(z\Delta E)$,

$\Delta E_{92, 74, 63\ K}(@L_2)$ ~ 1.4, 3.5, 3.9 eV

$\Delta E_{92, 74, 63\ K}(@L_3)$ ~ 5.3, 6, 7 eV

FIG.3: Ba $L_{2,3}$ white line near T_c for single crystal

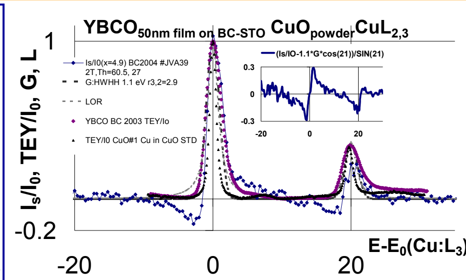


FIG.2: Fit of TEY/I_0 to Gaussian (G) & φ_{Kerr} in (2) determines symmetric $(I_s/I_0 - G^*\cos(\varphi_{Kerr}))/\sin(\varphi_{Kerr})$.

FIG. 2,3 predict unbalance in final states in FIG. 4.

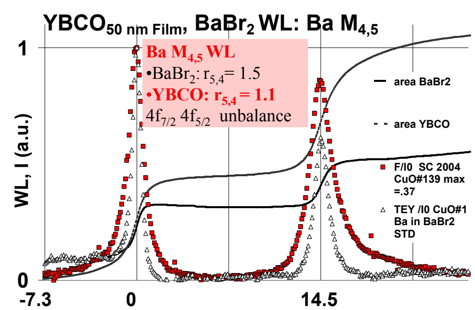


FIG. 4: Final states population unbalance @ Ba $M_{4,5}$.

3. CONCLUSIONS

The cause of detected electro-magneto-rotation is for the individual bands but since the material is non magnetic, e_1e_2= pairing must occur to: $J = J_1 + J_2 = 0 = J_z$.

$|Cu:3d_{3/2}>_1|O:2p_{3/2}>_2$ or $|O:2p_{3/2}>_2|Ba:5d_{3/2}>_1$ etc.

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