ESRF

Experiment title: Study of the electron coherent motion between Cu-O layers in $YBa_2Cu_3O_7$ with Compton Scattering	Experiment number: HE 278
Beamline: ID15B	**Date of Experiment:** from: 26.11.97 to: 8.12.97
Shifts: 30	**Local contact(s):** A. Shukla, T.Buslaps
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Report:

The aim of this experiment was to study the role of interlayer coupling between the copper-oxide layers of the high temperature superconductor $YBa_2Cu_3O_7$. The standard local density approximation (LDA) predicts an energy splitting for 2-layer high Tc compounds, due to electron coherent motion between the layers, hence two Fermi surfaces in the x-y plane of the Brillouin zone. Several publications have suggested there is no coherent electronic transport in the c-direction as a result of a possible Fermi liquid break-down (see [l] for a review). These works suggest that quasiparticles injected into the non-Fermi liquid would decay into collective or soliton excitations, so that electrons, not being elementary excitations cannot move between layers coherently, except as a pair with opposite spin. F'urthermore, the resulting effective pairing interaction could explain high temperature superconductivity [2].

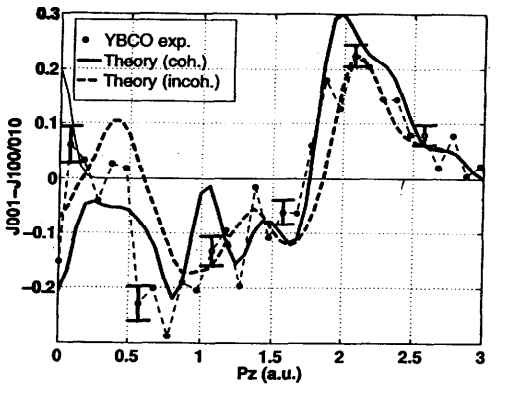
The first objective was to investigate indirectly if this splitting exists, by measuring the c-axis projection of the momentum density and then computing the directional difference with the in-plane momentum density. A splitting of the kind predicted would then be reflected in the momentum density projected perpendicular to the planes as a feature at $p = 2\pi/d$ = 1 a.u., where $d = 6.43$ a.u. In figure 1 this can be seen as a peak at p = 1 a-u. in the solid line which represents the theoretical anisotropy based on LDA band-structure calculations.

The thick dashed curve is a calculation where the splitting has been artificially reduced by shifting the Fermi surface by 1.3 eV and it can be seen that this suppresses the peak.Within statistical accuracy, the experiment (thin dashed line) does not show this feature either. This implies a degenerate FS of the Cu-0 planes, consistent with Luttinger liquid theory. However it has also been argued that many body effects can strongly reduce the splitting without destroying the Fermi liquid behavior. The second objective was to investigate the temperature dependance of the c-axis Compton profile with very good statistical accuracy (0.1 percent). In figure 2 we show differences of profiles measured at 20K, 60K and 100K with respect to the one measured at 300K. There is no significant structure in these differences. This could be an indication that even in the superconducting state the single particle tunneling remains blocked.

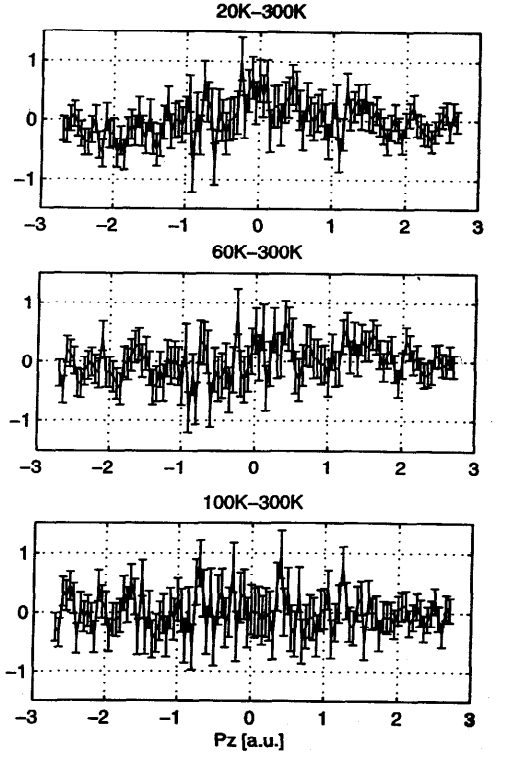
References

[1] P.W. Anderson, The *Theory of Superconductivity in the High* T_c *Cuprates*, Princeton U-P., Prince ton, N.J. (1997)

[2] S. Chakravarty, A. Subdø, P.W. Anderson and S. Strong, Science 261 (1993) p. 33.



figure(1)



figure(2)