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Report:

Compton profiles (CPs) of a single crystal of $YBa_2C_3O_7$ have been measured in [100] direction at temperatures above, below and close to its superconducting transition temperature of $T_c = 90.5$ K at a scattering angle of 172° and for an incident energy of 56.98 keV utilizing the Compton spectrometer of ID15 B at ESRF. Several single spectra have been taken at each temperature. In addition a Ge solid-state detector at a scattering angle of 158° has been used to take an MCA spectrum during each spectrometer scan. The sum spectra of the spectrometer scans were corrected for electronic noise, background, analyzer reflectivity, vertical acceptance of the spectrometer, sample absorption, air absorption, scale and relativistic correction. In the case of the MCA sum spectra corrections for air and tin foil absorption, sample absorption and relativistic cross section have been applied. A tin foil was used for suppressing the yttrium fluorescence signals which appeared at lower energies in the spectrum recorded by the solid-state detector. Finally, the corrected spectra have been converted to p_z-scale and normalized to the number of electrons. Before the machine day break CPs have been obtained at 8 different temperatures starting from 108.6 K (well above T_c) and going via 90.8 K, 90.2 K and 89.2 K to a temperature of 73.1 K (1^{st} run). After the machine day break CPs have been measured starting from 85.8 K over 89.8 K to a temperature of 129.6 K high above T_c (2^{nd} run) . A total of 3×10^5 counts and 1.7×10^6 counts were collected in the top of the Compton peak for the spectrometer and the MCA spectra, respectively, corresponding to a statistical accuracy of 0.18 % and 0.08 %. The sample, approximately 5 x 5 x 0.2 mm^3 in size was cooled utilizing a closed cycle cryostat and the temperature was monitored using two thermocouples, one directly above and the other below the sample position. The readings of these two thermocouples differed by about 0.7 K. The sample temperature was assumed to be the average of both readings. The maximum of the amplitude of the temperature oscillation during the measurement of a single spectrum was at maximum 0.2 K.

The CP results should be discussed as follows in the light of recent results of Doppler Broadened Positron Annihilation Lineshape (DBPARL) experiment on $YBa_2C_3O_7$ [1] . This positron measurement shows a strong change of the S-parameter across the superconducting transition temperature. Therefore, a similar parameter,

referred to as Compton S-parameter, has been calculated as the ratio of the area (integral) between $p_z = \pm 0.5$ a.u. of the CP (characterizing the low momentum electrons, approximately the valence electrons) and its area (integral) between $p_z = \pm 7$ a.u. The Compton S-parameters data points are presented in figure 1 as a function of temperature. As guide to the eye the shape of the temperature dependence of the positron S-parameter of Ref. [1] is scaled by a factor of 0.3, shifted by 1.5 K and plotted as thick line together with the values obtained by the Compton experiment. The shift corrects for the effective difference in transition temperature of the $YBa_2C_3O_7$ sample used in these two experiments. The changes observed in the Compton S-parameter are in the order of 0.2% close to T_c. The results from the solid-state detector spectra (triangles) are in line with the results of the DBPARL experiment. The data points of the spectrometer scans (circles) show partly strong deviations from the DBPARL result which could be due to the 1 order of magnitude smaller counting rate in these spectra so that it is difficult to say, whether there is a decrease in the Compton S-parameter across T_c or not. However, except for the values at T = 108.6 K and 73.1 K a similar tendency compared to the solid-state detector data is obvious. The observation of the change in the S-parameter in both DBPRAL and Compton scattering experiments indicates that there is a momentum redistribution of the valence electrons across the superconducting transition temperature and positron localization effects can be excluded as a reason for the DBPRAL S-parameter change across T_c .Theoretical work to explain this redistribution is planned which may give strong impact in the understanding of the high T_c superconductors.

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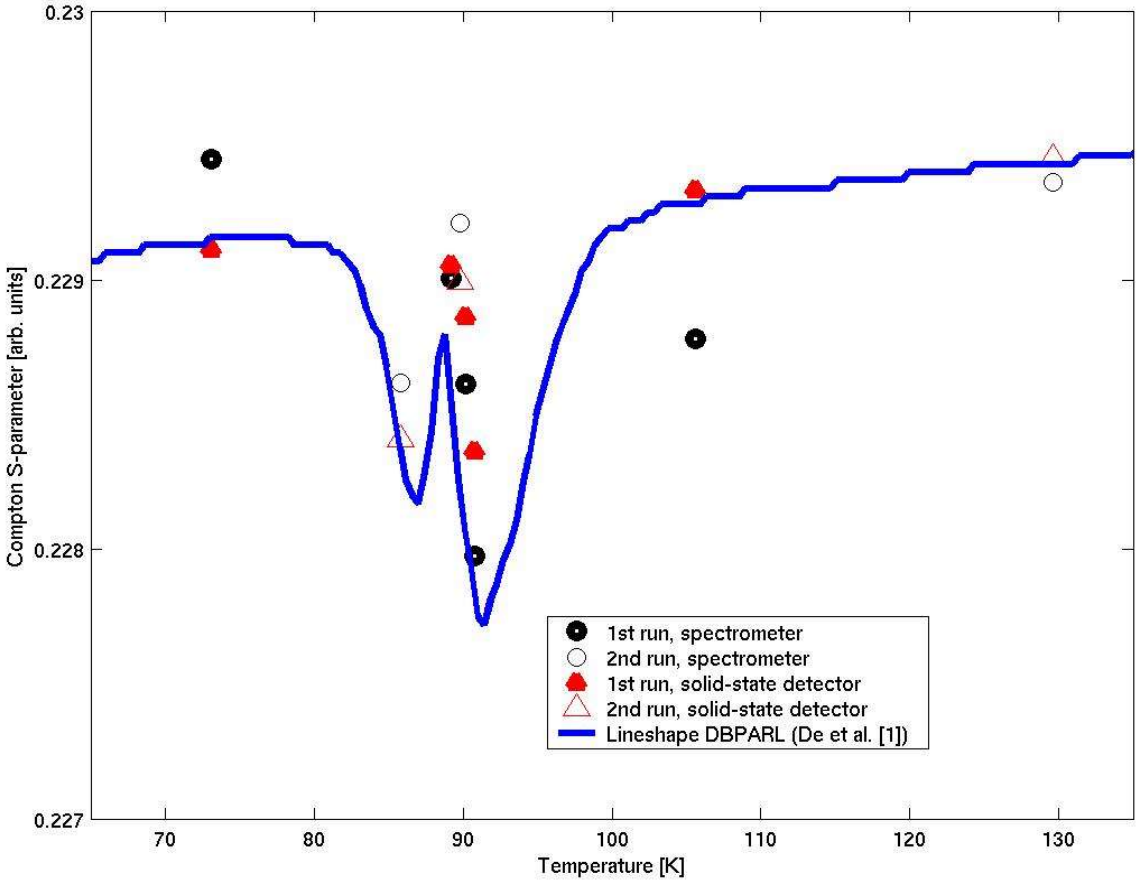

Figure 1: The values of the Compton S-parameter calculated using the experimental $YBa_2C_3O_7$ Compton profiles are shown as a function of temperature and compared with the line shape of the DBPARL S-parameter temperature dependence measured by De et al.

[1] U. De et al., PRB **62**, 14519 (2000)