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Report:

We have measured the directional Compton profiles of single crystal MgB_2 in two principal directions, parallel and perpendicular to the c axis. The size of the single-crystal sample was approximately $400\times400\times50$ μm^3, hence the high-resolution spectrometer could not be used due to low count rates. The energy of the incident photons was 56 keV and the scattered photons were measured using a multi-element solid-state detector in a scattering angle of 148°. Hence the moderate momentum resolution was about 0.55 atomic units. The experimental anisotropy J_{001}-J_{100}, shown in figure 1, is in good agreement with a theoretical prediction, based on a KKR-LDA computation [1]. However, due to the moderate momentum resolution the interesting fine structure related to the Fermi surface is smeared out. Clearly, with large enough single crystals and/or proper focusing optics, the anisotropy should be measured again using the high-resolution spectrometer.

The aim of the experiment was to measure directional Compton profiles of novel superconductor MgB_2 both above and below the critical temperature of 39 K. The motivation for this was to validiate earlier experiments on polycrystalline MgB_2 using Compton scattering [2] and positron annihilation [3]. In these works, a narrowing of the momentum distribution is observed in the transition from normal to superconducting state. This is, however, in contradiction to the theory of positron annihilation in Cooper-pair superconductors, according to which a broadening of the momentum ditribution should be observed [4].

The profiles were measured at temperatures of 25, 55 and 293 K. Since the expected effect is extremely small, it is essential to change the temperature back and forth several times, in order to check the consistency of the data. In fact for such small effects the uncertainty is not limited by statistical accuracy but by the systematic errors. Despite of great efforts we were unsuccessful in acquiring consistent data sets. The inconsistency of the data made the temperature-dependent experiment impossible. It is still uncertain if the data inconsistency is due to instability of beam position, measurement electronics or if the sample suffered from deterioration.

[1] A. Bansil, unpublished.
[2] K. Nygård et al., Phys. Rev. B **469**, 020501 (2004).
[3] P. K. Pujari et al., Phys. Rev. B **66**, 012518 (2002).
[4] S. E. Barnes and M. Peter, Phys. Rev. B **40**, 10958 (1989).

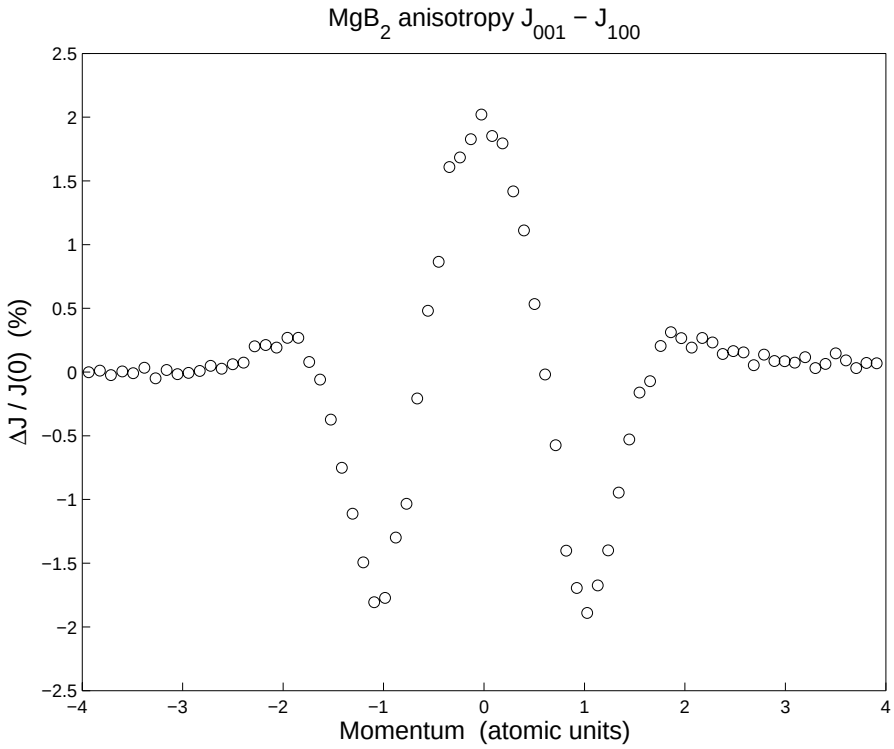

Figure 1. Compton profile anisotropy J_{001}-J_{100} of novel superconductor MgB_2, measured using a moderate-resolution solid-state detector ($\Delta p_z = 0.55$ atomic units).