The momentum and energy lost by the neutron are absorbed by the electron system and can be described, as transitions from the lower to the upper curve. Singular points in the scattering probability as function of energy can appear, if both, the initial and the final point correspond to the maxima of the density of states, i.e. to the extrema of the curves. The lowest energy corresponds to the transition between the maximum of the lower curve (1) to the minimum of the upper (1'), and at T=0 this is the threshold, located at 2Δ. Then comes the transition from the maximum of the lower curve (1) to the maximum of the upper (2'). Ths must be a maximum but it is not a threshold, since processes with smaller and larger energies are possible. Finally comes the transition from the minimum of the lower curve (2) to the maximum of the upper (A'). This corresponds to the end of a certain absorption path, and hence the scattering probability must have a drop at this point. Rigorous calculations confirm this picture. The result is presented at Fig.8. This has to be compared with the experimental curve at Fig.9 [19].

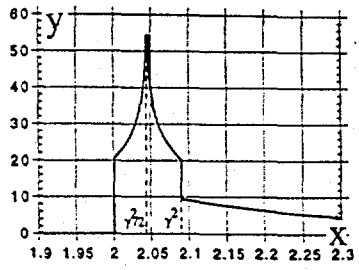

Fig. 8. Plot of the $y = \chi''_m \times \frac{2\pi d}{m}$ (χ''_m - imaginary part of the electronic spin susceptibility, m - effective mass, d - period along c), which is proporti0nal to the energy-dependent factor in the neutron inelastic scattering cross section, as function of $x = \Omega/\Delta$, where Ω is the energy loss, in the case $\gamma = \mu_1/\Delta = 0.3$.

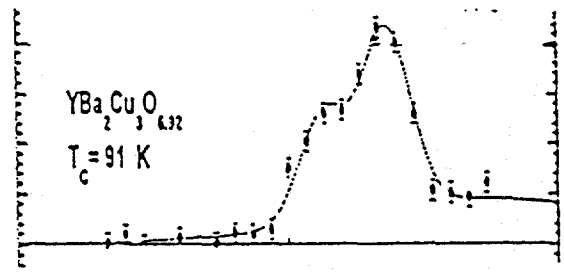

Fig. 9. Experimental data from [20] for the same quantity in arbitrary units as function of energy loss for optimally doped YBCO.

It should be added that due to the so called "coherence factor" the maximum appears only, if the order parameter has different signs for the initial and final states (d-wave symmetry). This makes the inelastic neutron scattering, as well as the negative isotope effect described above, rather unique bulk measurements confirming the d-wave order parameter. The measurements associated with surfaces and interfaces can reveal properties different from the bulk, as, e.g., the suppression of the d-wave order parameter and appearance of a subdominant s-wave.

Another important feature is that in a two-layered substance, which is YBCO, the maximum appears only in the channel which corresponds to the interaction of neutrons with the electron spin fluctuations antisymmetric with respect to the layers. Such fluctuations correspond to "acoustical" gapless spin-wave branch in the antiferromagnetic insulating phase. This is natural, since other fluctuations immediately decay into quasiparticles. On the other hand, such fluctuations are rather long ranged, and therefore they define, actually, the true "coherent" gap. It is no surprise, therefore, that with underdoping the energy of the neutron maximum decreases proportional to T_c and not to the gap in the quasiparticle spectrum measured in tunneling experiments.

8. Upper critical field

The last interesting consequence of the model, which I have described, is the positive curvature of the upper critical magnetic field, as function of temperature [22] which was observed in many experiments, (e.g. [23], see Fig.10). The usual calculation gives a negative curvature. The reason for such a change is contained in the form of the spectrum. As it was mentioned before, the most important are the vicinities of the singular regions, where the motion of electrons becomes one-dimensional. There is, however, a hopping between the "a" and "b" vicinities, and hence a two-dimensional motion. Therefore, close to T_c the field H_{c2} is defined by the usual orbital motion. With departing from T_c the situation changes. This can be seen from the Ginsburg-Landau type equations derived in the vicinity of T_c. They correspond to the minimum of the free energy