Specific heat measurement of the Cu-1234 superconductor with two T_c's

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We examined a thermodynamical property of two superconducting transitions in Cu-1234. To extract anomaly of the electronic specific heat we measured the difference between the specific heat under the magnetic field ($C_{H\neq 0T}$) and that without field ($C_{H=0T}$). As shown in Fig. 1 $(C_{H=0}-C_{H=14T})/T$ has sharp anomaly due to the first superconducting transition temperature (T_c) just below 118 K. It corresponds to the T_c determined by the Meissner signal and zero resistivity. The broad feature below 80 K can be also recognizable. We consider that this anomaly is due to T_{c2} proposed by the NMR study.

We calculated the specific heat on a simple model where there are two Fermi surfaces (FSs) as shown in Fig.2. The specific heat of the single gap system (thin line) is modified by the interaction between two FSs (dotted line). For smaller λc we found the second anomaly below 0.6 T/Tc (thick line and broken line). It corresponds to anomaly below 80K. When there are two kinds of gaps of which symmetries are different from each other, we can also expect the second anomaly due to the weak pair scattering between these two. Cu-1234 may be the first example having two anomalies due to this mechanism.

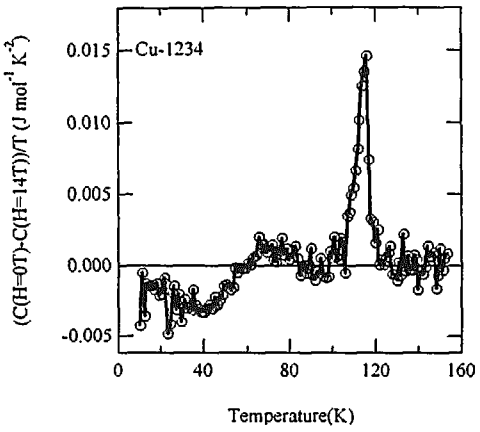

Figure 1. $(C_{H=0T}-C_{H=14T})/T$ where $C_{H=0T}(C_{H=14T})$ is the specific heat under 0T (14T). Two anomalies can be seen. The entropy balance is also satisfied.

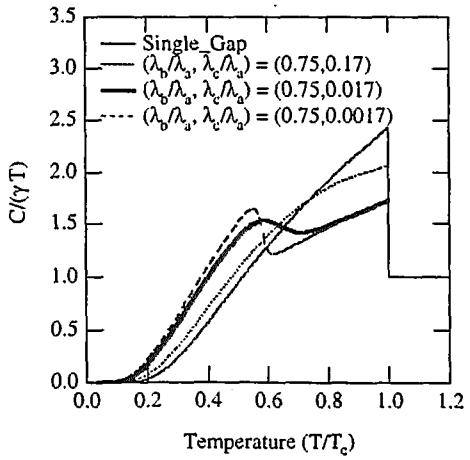

Figure 2. The calculated electronic specific heat divided by γ T (the electronic specific heat of the normal state). Two Fermi surface (FS) denoted by "a" and "b" is taken into account. λa and λb are coupling constant in each FS. λc is the pair scattering between two FSs.