Crystal Field Excitation of TmAg2In

Takeshi Matsumura
Department of Physics, Graduate School of Science, Tohoku University

A ternary compound RAg2In (R=rare earth) crystallizes into cubic Heusler-type structure. This system has a characteristic that the magnetic ordering temperatures are very low. Here, in TmAg2In, the specific heat and magnetic susceptibility measurements have suggested that the ground state is gamma5 and it has been clarified that the magnetic order does not occur down to 0.5 K. However, the specific heat exhibits an anomalous peak around 1 K, which is much lower than the 1st excited state at about 15 K. Then, the possibility of Kondo effect has been suggested for TmAg2In.

The purpose of the present neutron scattering study is to investigate the possibility of Kondo effect in TmAg2In. Determining the crystalline electric field (CEF) level scheme also is another important purpose.

We have performed inelastic neutron scattering experiments on powder sample using TOPAN(6G) and HER(C11) 3-axis spectrometers. First, using TOPAN, we measured the inelastic spectrum up to an energy transfer of 20 meV, and found the CEF excitation peaks around 1.5 and 2.7 meV. The spectrum and its temperature dependence was successfully explained by the CEF model. However, because of the limited energy resolution, it was not possible to discuss the possibility of Kondo effect. Next, using HER spectrometer, we measured the spectrum with much higher resolution.

The figure shows the energy spectrum at T=0.75 K, below the anomaly of the specific heat. We can clearly see two CEF excitation peaks at 1.68 meV and at 2.87 meV. By investigating the temperature dependence, the CEF level scheme has been determined as G_5,1(0)-G_3(19.5)-G_4(33.4)-G_1(35.3)-G_5,2(52.8)-G_2(72.5 K), which is experessed by the parameters of x=-0.013 and W=0.239 K.

Solid line is a fit to the data assuming three Lorentzians at E=0 (quasi-elastic) and at two CEF levels. At temperatures higher than 3 K, the data can be well fitted by this model. However, below 1.5 K, the data gradually deviate from the Lorentzian shape, and at 0.75 K, the spectrum cannot be simply expressed by three Lorentzians. It also seems that the CEF excitation peaks are slightly splitted.

A simple scenario is that the CEF level is slightly modified (~ 1 K) by the possible local distortion that reduces the cubic symmetry. Such a disorder can happen in Heusler structure where the Tm and In sites can exchange relatively easily. At temperatures higher than this splitting, the peak can be expressed by a single Lorentzian. But at low temperatures, it is not the case. The width of the peaks about 0.1 meV is comparable to the Kondo temperature estimated by the specific heat. It is also a typical value for localized f-electron systems. It can also be caused by extrinsic effect of disorder.

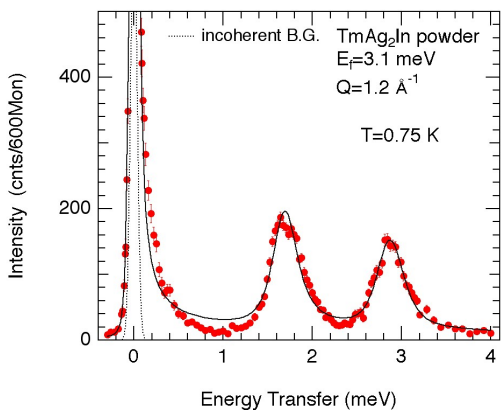

Fig. 1.