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Theory of non-Fermi liquid behavior in dilute Pr systems

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The low temperature properties of $Pr_xLa_{1-x}Pb_3$ with very dilute Pr ions show the non-Fermi liquid (NFL) behavior.[1] The specific heat of the properties, C/T, increases as $-\ln T$ in the low temperatures. The Pr^{3+} ion in the properties has a non-Kramers Γ_3 doublet lowest state subject to the cubic crystalline electric field (CEF). The Γ_3 doublet state has no magnetic moments but it has the electric quadrupolar moments. The first and the second excited states are expected to be a Γ_4 triplet with energy splitting of 14 K, and a Γ_5 triplet with 21 K, respectively. It may be expected that the NFL behavior of the properties can be explained by the two-channel Kondo model (TCKM) type. In the previous papers we showed that the low energy properties of the impurity Anderson model, which has a non-Kramers doublet lowest state of f^2 configuration subject to the tetragonal CEF, depend on the parameters of the model.[2, 3] We require the analyses of experimental results by using the realistic parameters.

In this study we investigate the low energy properties of the impurity Anderson model, which lowest state of f^2 configuration is Γ_3 doublet subject to the cubic CEF, by using the numerical renormalizaton group method. When the hybridization between the f-electron and the conduction electron is increased with fixed the CEF energy levels, there is a critical hybridization that the low energy spectrum changes from the NFL state to the local Fermi liquid one. We calculate the magnetic susceptibility as shown in the Figure.

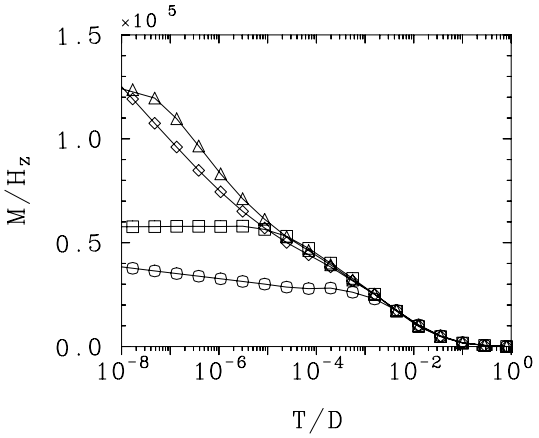

Figure 1: The magnetic susceptibilities of the model for various parameters. The magnetic susceptibility shows $-\ln T$ behavior for weak hybridization case ($\bigcirc, \diamond$). The magnetic susceptibility has the sizable coefficient for the cases that the hybridization is close to the critical value ($\diamond, \triangle$).

References

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