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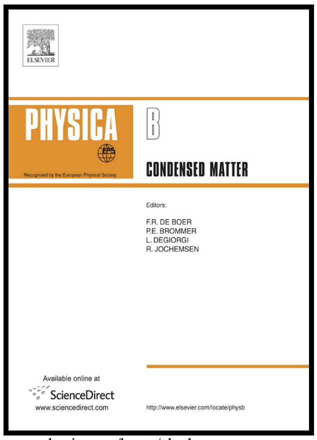

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Role of Entropy in the ground state formation of Frustrated systems

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Abstract

The absence of magnetic order in Rare Earth-based frustrated compounds allows to recognize the action of the third law of thermodynamics in the low temperature behavior of those systems. One of the most relevant findings is the appearance of a coincident specific heat $C_m/T|_{T\to0} \approx 7\,\mathrm{J/molK^2}$ 'plateau' in six Yb systems. This characteristic feature occurs after a systematic modification of the thermal trajectory of their entropies $S_m(T)$ in the range of a few hundred milikelvin degrees. Such behavior is explained by the formation of an *entropy-bottleneck* imposed by the third law constraint ($S_m|_{T\to0} \geq 0$), that drives the system into alternative ground states. Based in these finding, three possible approaches to the $S_m|_{T\to0}$ limit observed in real systems are analyzed in terms of the $\partial^2 S_m/\partial T^2$ dependencies.

Keywords: Entropy, Frustrated systems, Nernst postulate

1. Introduction

In the study of the physical properties of new compounds at very low temperature, a number of cases are found not showing magnetic order down to the milikelvin range due to their magnetically frustrated character. All of them exhibit very large density of magnetic excitations ($\propto C_m(T)/T$), which increase at low temperature due to the enhanced spin-correlations in their paramagnetic (Par) state. The observed values of $C_m/T|_{T\to0}$ exceed those of the classical heavy fermions (HF) because they range between ≈ 5 [1] and $\approx 12\,\mathrm{J/molK^2}$ [2], allowing to be identified as Very heavy fermions (VHF). These values can be compared with the $3\,\mathrm{J/molK^2}$ of the well known non-Fermi-liquid (NFL) $CeCu_{5.9}Au_{0.1}$ [3], at $\approx 100\,\mathrm{mK}$, which is tuned to a quantum critical point (QCP). Such increase in the density of magnetic