A Critical Point at Which Magnetocaloric Effect Can Be Manifested

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Since in the isostructural compounds of Gd_4Bi_3 and Gd_4Sb_3 the only parameters which determine the magnetic behaviour as the sign and strength of the exchange parameter, J_{ij} depend on the following parameters (related to the chemical pressure due to the size effect of $R_{Bi} > R_{Sb}$); (1) the topological positions of the magnetic ions, and (2) the nature and the density of the conduction electrons, both of which are strongly depend not only on the nearest neighbor but also on the correlation length defined by the $R_c = 2k_f R_{ij}$. The Gd_4Bi_3 should be the critical composite for which R_c is not its extremum value. At this compound, the dominance of dispersion of exchange or even the competition of magnetic ions (intracluster exchange) overcomes the thermal fluctuations $\mu_0 H_{in} \geq K_B T$ where $H_{in} = \ll S_i \cdot S_j \gg$. This behavior can be the cause of $T_c = 347$ K and its drop to 266 K for Gd_4Sb_3 and even to 110 K with the change of crystal structure for Gd_5Bi_3, which means that the internal magnetic energy can change to thermal ($\Delta T_c = 347 - 110\ K$ for the second one).