Critical Behavior Study of the Magnetic Transitions in $R_3Co$ ($R$=rare earth) by Means of ac Photopyroelectric Calorimetry

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The intermetallic family $R_3T$ ($R$=Gd, Tb, Dy, Ho, Er; $T$=Co, Ni) is especially interesting because of its promising technological applications as potential cryocoolers due to the presence of an important magnetocaloric effect; moreover, they present giant magnetoresistance as well as relatively high spin-ordering temperatures for the rare earths. A study of the critical behaviour of the magnetic transitions in single crystals of the intermetallic Dy$_3$Co has been undertaken (as a first step in a comprehensive study of the critical behaviour in the whole family) through the study of thermal diffusivity, specific heat and thermal conductivity using an ac photopyroelectric calorimeter in the standard back configuration. There are two phase transitions, both of which present singularities in the three variables. The first one is an antiferromagnetic to paramagnetic phase transition at about 42 K for which the critical exponents and coefficients retrieved comply with the short range, isotropic universality class, 3D-Heisenberg ($\alpha_{\exp} = -0.133, A'/A_{\exp} = 1.64$ for specific heat, $b_{\exp} = -0.145, U'/U_{\exp} = 1.41$ for thermal diffusivity while $\alpha_{\text{theor}} = b_{\text{theor}} = -0.13, A'/A_{\text{theor}} = 1.52 = U'/U_{\text{theor}}$). The second transition takes place at a lower temperature and is due to a rearrangement of the antiferromagnetic spin ordering at about 32 K. The critical behavior of this transition shows a deviation from an isotropic universality class, both in specific heat and thermal diffusivity ($\alpha_{\exp} = -0.168, A'/A_{\exp} = 1.18$ for specific heat, $b_{\exp} = -0.138, U'/U_{\exp} = 0.85$ for thermal diffusivity). These results are linked to magnetic measurements already found in literature. Further studies on Tb$_3$Co and $(Gd_{1-x}Y_x)_3Co$ are currently been carried out in order to present a broader view of the magnetism in this family.

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