Crucial influence of magnetic domain structure on low-temperature magnetic phase transition in $DyAl_3(BO_3)_4$

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Low-temperature specific heat studies of the $DyAl_3(BO_3)_4$ single crystal, performed down to 50 mK, revealed the presence of a second order phase transition at $T \approx 0.52$ K, accompanied by a sharp λ-shaped specific heat maximum. Based on the magnetization and specific heat studies performed, it was shown that the transition has a magnetic character and is related to the appearance of a long-range ordering of Dy^{3+} magnetic moments. It was found that magnetic field, B_c, applied along the 3-fold, *c*, crystallographic axis at first, shifts the specific heat maximum to lower temperatures, conserving its sharp character (like in the case of antiferromagnetic materials), and then, for $B_c > 0.35$ T, it smears the transition and shifts the specific heat maximum towards higher temperatures (like in the case of ferromagnets). The performed studies showed that the low temperature magnetic order has a ferromagnetic character and that the system saturates quickly in the field parallel to the *c* axis (for $B_c \sim 0.2$ T), whereas it saturates much slower in the field perpendicular to ***c*** axis (it does not reach saturation even for $B_c \sim 8$ T).

This atypical behavior was shown to result from the fact that in the studied material, the molecular field, related to the strength of exchange interactions, the demagnetizing field and the field of saturation of the domain structure are of the same order. Calculations performed within the molecular field and the crystalline electric field, CEF, approximations confirmed this interpretation and revealed a crucial role of the magnetic domain structure in the initial lowering of the temperature of appearance of the specific heat maximum. The results of calculations remain in a qualitative agreement with all the experimental data and describe correctly all the measured dependences.

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