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Molecular realizations of 3D Heisenberg magnet: critical scaling

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Abstract

The critical properties of two related bimetallic compounds $\{[M^{II}(H_2O)_2]_2[Nb^{IV}(CN)_8]\cdot 4H_2O\}_n$ (M= Mn, Fe) are reported. The compounds exhibit the transition to a magnetically ordered phase at T_c=43 K in the case of the Fe-based sample (**FeNb**), and at T_c = 50 K for the Mn-based sample (**MnNb**). They differ in relative orientation of the M and Nb sublattices, which is parallel, i.e. ferromagnetic, in **FeNb** and antiparallel, i.e. ferrimagnetic, in **MnNb**. Critical exponents β and γ, governing the temperature dependence of the spontaneous magnetization below T_c and the temperature dependence of the initial susceptibility above T_c, respectively, have been determined using the Kouvel-Fisher method. Critical exponent δ has been obtained through the analysis of the critical magnetization isotherm. Thus determined values of the critical exponents were verified by employing two independent forms of the scaling equation of state. All the magnetization data are demonstrated to collapse either onto two universal branches corresponding to $T<T_c$ and $T>T_c$, respectively, or onto a single universal curve. The critical exponents allow to ascribe **FeNb** as well as **MnNb** to the universality class of the three-dimensional (3D) Heisenberg model.

Keywords

molecular magnets, critical behavior, phase transition

Highlights

- Critical behavior in $\{[M^{II}(H_2O)_2]_2[Nb^{IV}(CN)_8]\cdot 4H_2O\}_n$ (M= Mn, Fe) is studied
- The critical exponents β and γ have been determined using the Kouvel-Fisher method
- The critical exponent δ has been obtained based on critical magnetization isotherm
- The values of β and γ were verified by two forms of the scaling equation of state
- Both compounds can be assigned to the universality class of the 3D Heisenberg model