MAGNETIC EFFECTS OF IMPURITIES IN K_2MnF_4

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The temperature dependence of the local magnetization near dilute substitutional impurities (Zn, Mg, Ni) in the quadratic-layer antiferromagnet K_2MnF_4 is studied both experimentally and theoretically.

The effects of an impurity on the local magnetization in the ordered two-dimensional antiferromagnet K_2MnF_4 have been measured and analyzed. The experimental method used is a fixed-frequency NMR technique with a variable external field applied parallel to the c axis. The systems studied are $K_2Mn_{1-x}X_xF_4$, with X = Zn, Mg, or Ni, and concentrations $x \sim 1\%$. The Green-function theory with a decoupling procedure accounting for correlation between nearest-neighbor spins is developed, and compared with the existing literature. Up to order $1/S$ the theory is equivalent to the Oguchi-type energy renormalization. Using the spectral distribution of the spin excitations, including local mode contributions, our Green-function calculations of the temperature dependence of the magnetization at the impurity site, as well as the first *three* shells of Mn sites around the impurity, are in excellent agreement with experimental data (fig. 1). For nonmagnetic impurities, the nearest-neighbor magnetization drops more strongly with temperature than the magnetization in pure K_2MnF_4; in the temperature range 16–22 K the thermal spin deviation is 33% larger. In contrast, in the Ni-doped system the thermal spin deviation is within 1% equal to that in the pure system. The zero-point deviation of the Ni spin amounts to only 62% of that in pure K_2MnF_4, which is experimentally confirmed by the high out-of-layer ^{19}F resonance frequency. A full report will appear in Phys. Rev. B.

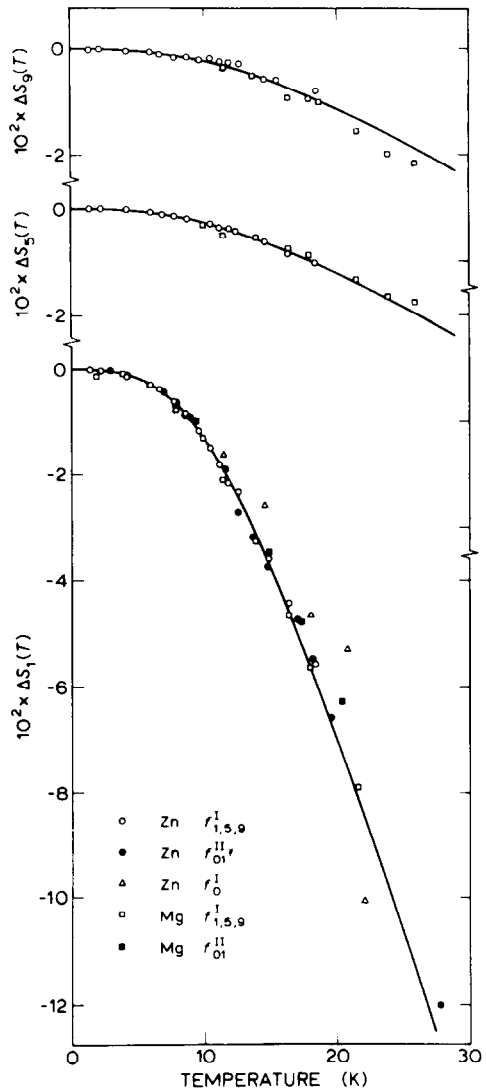

Fig. 1. Temperature-dependent part of the local spin shifts ΔS_1, ΔS_5, and ΔS_9 in the first three shells, respectively, about nonmagnetic impurities. Curves are Green-function results based on a 13-site cluster including nearest-neighbor correlations.