MAGNETIC FIELD EFFECTS IN FRUSTRATED LOW-DIMENSIONAL MAGNETS

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9.7 cm

We investigate the frustrated two-dimensional $S = 1/2$ next nearest neighbor anisotropic Heisenberg antiferromagnet on a square lattice as described by the $J_{1a,b}$-J_2 model. We use spin-wave theory and exact diagonalization for finite tiles including a new method for the finite size scaling procedure. We present results obtained from the extension of our numerical method to finite magnetic fields as well as from spin-wave theory. The induced uniform and the staggered moment in the antiferromagnetically ordered phases in the presence of a magnetic field are calculated. They deviate strongly from classical behaviour depending on frustration ratio $J_2/J_{1a,b}$ and the $J_{1a,b}$ exchange anisotropy. The magnetization becomes strongly nonlinear and is suppressed from the classical value. This is due to enhanced quantum fluctuations already at moderate frustration. In contrast, applying a magnetic field H up to $H \approx (1/2)H_{\text{sat}}$ stabilizes the staggered moment in the columnar (CAF) and Néel (NAF) ordered antiferromagnetic phases. This field-induced stabilization is most pronounced for frustration ratios $J_2/J_{1a,b}$ near the edges of the phase diagram where quantum fluctuations tend to destroy NAF and CAF order. For small spatial exchange anisotropy, the field dependence of the staggered moment uniquely determines the exchange parameters. This allows to derive the frustration ratio J_2/J_1 from the field dependence of magnetic neutron diffraction data. As an example we analyze recent experiments by Tsyrulin et al. on $Cu(pz)_2(ClO_4)_2$.

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