Magnetic-phase transitions in a frustrated two-leg spin ladder

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Recently, successive phase transitions induced by magnetic field have been observed in a frustrated two-leg spin ladder $BiCu_2PO_6$ [1], in which the frustration is introduced by the next-nearest-neighbor antiferromagnetic exchange interaction in the leg direction. The ground-state phase of the compound has been determined by an inelastic-neutron-scattering experiment [2] and numerical calculations [3,4]. The preceding works claims that there is a strong frustration. Therefore, the frustration will play a key role to generate the successive phase transitions.

First, we calculate the magnetic-field dependence of magnetization by using density-matrix renormalization-group method with and without the frustration. In this calculation, we find a phase transition induced by strong frustration, which does not appear in a non-frustrated two-leg spin ladder. The phase transition emerges as a jump of susceptibility with unsaturated finite magnetization. We also investigate the origin of the phase transition by using the bond-operator mean-field approximation. We conclude that the phase transition is the same type as the Lifshitz transition. Our study is useful to analyze experimental data of inelastic neutron scattering for $BiCu_2PO_6$.

References

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