Phase transition induced by magnetic field in a two-leg spin-ladder system

T. Sugimoto,[1,2] M. Mori, [1,2] T. Tohyama,[3] and S. Maekawa[1,2]
[1] *ASRC, JAEA, Tokai, Ibaraki 319-1195, Japan*
[2] *CREST, JST, Chiyoda-ku, Tokyo 102-0075, Japan*
[3] *YITP, Kyoto University, Sakyo-ku, Kyoto 606-8502, Japan*
sugimoto.takanori@jaea.go.jp

Recently, a successive phase transitions induced by magnetic field has been observed in $BiCu_2PO_6$ [1]. The experimental study claims that a magnetic anisotropy is an origin of this interesting phenomenon. The existence of the magnetic anisotropy can be confirmed by a splitting of the triplet excitation observed in inelastic neutron scattering experiment without magnetic field [2]. Thus, we numerically study magnetic excitations in a frustrated two-leg spin-ladder system, in which all magnetic exchange interactions, i.e., the nearest-, next-nearest-neighbor sites in the leg direction, and the nearest-neighbor sites in the rung direction, are antiferromagnetic [3]. This is a minimal model describing a low-dimensional quantum spin compound, $BiCu_2PO_6$ [4,5]. The dynamical density-matrix renormalization-group method is used to calculate the excitation spectrum in the incommensurate rung-singlet phase without magnetic field [1]. We show a splitting of the triplet excitation, which is experimentally observed, with respect to magnetic anisotropy of the exchange interaction in the rung.

In addition, we study the successive phase transitions induced by magnetic field. Two ground-state phases emerge with magnetic field both longitudinal and perpendicular to the leg directions. Therefore, the two phases may occur without magnetic anisotropy. First, we discuss the phase transitions by using density-matrix renormalization-group method without magnetic anisotropy. In addition, we mention effects of anisotropy on phase transitions induced by magnetic field.

References

[1] Y. Kohama, S. Wang, A. Uchida, K. Prsa, S. Zvyagin, Y. Skourski, R. D. McDonald, L. Balicas, H. M. Ronnow, C. Rüegg, and M. Jaime, Phys. Rev. Lett. 109, 167204 (2012).
[2] K. W. Plumb, Z. Yamani, M. Matsuda, G. J. Shu, B. Koteswararao, F. C. Chou, Y.-J. Kim, arViv:1301.5324.
[3] T. Sugimoto, M. Mori, T. Tohyama, and S. Maekawa, Phys. Rev. B **87**, 155143 (2013).
[4] B. Koteswararao, S. Salunke, A. V. Mahajan, I. Dasgupta, and J. Bobroff, Phys. Rev. B **76**, 052402 (2007).
[5] O. Mentré, E. Janod, M. Hennion, F. Leclercq-Hugeux, J. Kang, C. Lee, M.-H. Whangbo, and S. Petit, Phys. Rev. B **80**, 180413(R) (2009).