Exotic Quantum Phase Transitions in the Spin Nanotubes

T. Sakai[a], M. Sato[b], K. Okunishi[c], K. Okamoto[d], and C. Itoi[e]

[a]JAEA, SPring-8 and University of Hyogo, Hyogo, Japan
[b]Aoyama Gakuin University, Kanagawa, Japan
[c]Niigata University, Niigata, Japan
[d]Tokyo Institute of Technology, Tokyo, Japan
[e]Nihon University, Kanagawa, Japan

Recently some quantum spin systems on tube lattices, so called "spin nanotubes"[1], have been synthesized. As the first step of theoretical study on the spin nanotube, we investigate the S=1/2 three-leg spin tube, which is the simplest one, using the DMRG and the numerical diagonalization, conbined with a precise finite-size scaling analysis named level spectroscopy[2]. The spin gap, which is one of the most interesting macroscopic quantum effects, was revealed to be open for any finite rung exchange couplings, in contrast to the three-leg spin ladder system which is gapless. It is consistent with the previous effective Hamiltonian approach. We also found a new quantum phase transition caused by an asymmetric rung interaction. When one of the three rung coupling constants is changed, the spin gap would vanish. In addition we theoretically predict some new field-induced quantum phase transitions. A chiraliy-mediated novel superconductivity mechanism will be also proposed.

[1]See, for example, T. Sakai et al., J. Phys.: Condens. Matter **22**, 403201 (2010)
[2]T. Sakai et al., Phys. Rev. B **78**, 184415 (2008)