Ground State Properties of the S=3/2 Three-Leg Heisenberg Tube

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The ground state properties of the S=3/2 three-leg Heisenberg tube are studied using the density-matrix renormalization group method [1]. We find that the spin excitation gap associated with a spontaneous dimerization opens in the entire region of the coupling strength, as seen in the S=1/2 three-leg Heisenberg tube. However, in contrast to the case of the S=1/2 tube, the gap increases very slowly with increasing the coupling strength of the rungs and its size is only a few % or less of the exchange interaction of the legs, in particular in the weak- and intermediate-coupling regions. We thus argue that, unless the coupling of the rungs is significantly stronger than that of the legs, the gap may be quite hard to be observed experimentally. We also calculate the quantized Berry phase to show that there exist three types of the valence-bond-solid states depending on the ratio of the coupling strengths between the legs and rungs.

Reference:

[1] S. Nishimoto, Y. Fuji, and Y. Ohta, preprint cond-mat/1102.4559.