Exact ground states and deconfined gapless excitation for the three-leg spin-1/2 tube

M. Lajko[1,2], P. Sindzingre[3] and K. Penc[1]
[1]*Institute for Solid State Physics and Optics, Wigner Research Centre for Physics, Hungarian Academy of Sciences , Budapest, Hungary*
[2]*Department of Physic, Budapest University of Technology and Economics, Budapest, Hungary*
[3] *Laboratoire de Physique Théorique de la Matière Condensée, Université P. et M. Curie, Paris, France*
E-mail: lajko.miklos@wigner.mta.hu

We consider a spin-1/2 tube (a three-leg ladder with periodic boundary conditions) with a Hamiltonian given by two projection operators - one acting on the triangles, and the other on the square plaquettes on the side of the tube – the latter can be written in terms of nearest and next-nearest Heisenberg and four-spin ring exchange interactions. We can identify 3 phases by changing the intra-triangle interaction: (i) for strongly antiferromagnetic exchange on the triangles, an exact ground state with a gapped spectrum can be given as an alternation of spin and chirality singlet bonds between nearest triangles; (ii) for ferromagnetic exchange on the triangles, we recover the phase of the spin-3/2 Heisenberg chain; (iii) between these two phases, a gapless phase exists. We can construct an exact ground state with two deconfined domain walls and a gapless excitation spectrum at the quantum phase transition point between the intermediate and dimerized phases. We further examine the low energy excitations around the aforementioned critical point with a variational approach.

[1] M. Lajko, P.Sindzingre and K. Penc, Phys. Rev. Lett. **108**, 017205 (2012)