Effects of magnetic field in two-leg spin ladder with ring exchanges

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The ground-state properties of the two-leg spin-1/2 ladder with four-spin ring exchange under a magnetic field are studied. We are particularly interested in novel quantum states and exotic orders induced by the ring exchange and the field. In the absence of the field, it has been shown that when the ring exchange J_4 is strong enough the system exhibits exotic phases, such as the scalar-chirality phase and the rung-singlet phase with a dominant vector-chirality correlation [1,2]. It is also known that for J_4=0 and a sufficiently strong field, the system exhibits a gapless phase described as the Tomonaga-Luttinger (TL) liquid [3,4]. In this work, we apply the spin-chirality duality [1], which is an exact transformation interchanging the Neel-spin and vector-chirality operators, to the results obtained so far. We thereby show that under a magnetic field the system with large J_4 exhibits a gapless phase described as a TL liquid with a dominant vector-chirality correlation. We also discuss how the dominant correlation function changes as the strength of J_4 and the field vary.

[1] T. Hikihara, T. Momoi, and X. Hu, Phys. Rev. Lett. 90, 087204 (2003).
[2] A. Laeuchli, G. Schmid, and M. Troyer, Phys. Rev. B 67, 100409(R) (2003).
[3] R. Chitra and T. Giamarchi, Phys. Rev. B 55, 5816 (1997).
[4] T. Hikihara and A. Furusaki, Phys. Rev. B 63, 134438 (2001).