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Effective description of the frustrated Heisenberg three-leg and four-leg tubes in a strong magnetic field

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We investigate the low-temperature properties of the spin-1/2 antiferromagnetic Heisenberg model on the frustrated three-leg [1-2] and four-leg [3-5] tubes with almost dispersionless (almost flat) lowest magnon band placed in an external magnetic field. The aim of our study is to develop a systematic theory of low-temperature high-field properties of the models by hand. Using standard operator perturbation theory and strong coupling approach, we construct low-energy effective Hamiltonians for three-leg and four-leg tubes, which are much simpler than the initial ones. Based on the effective-model description we examine the low-temperature properties of the considered frustrated quantum Heisenberg antiferromagnets in the high-field regime. To verify the region of the applicability of the obtained effective Hamiltonians we perform extensive exact diagonalization and density matrix renormalization group calculations and compare them with the results for the initial models.

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