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Renormalization group method for weakly-coupled quantum chains: application to the spin one-half Heisenberg model SAMUEL MOUKOURI, JOSE ALVAREZ, PORSCHA MCROBBIE, University of Michigan — The Kato-Bloch perturbation formalism is used to present a density-matrix renormalization-group (DMRG) method for strongly anisotropic two-dimensional systems. This method is used to study Heisenberg chains weakly coupled by the transverse couplings J_{\perp} and J_d (along the diagonals). An extensive comparison of the renormalization group and quantum Monte Carlo results for parameters where the simulations by the latter method are possible shows a very good agreement between the two methods. It is found, by analyzing ground state energies and spin-spin correlation functions, that there is a transition between two ordered magnetic states. When $J_d/J_{\perp} \lesssim 0.5$, the ground state displays a Néel order. When $J_d/J_{\perp} \gtrsim 0.5$, a collinear magnetic ground state in which interchain spin correlations are ferromagnetic becomes stable. In the vicinity of the transition point, $J_d/J_{\perp} \approx 0.5$, the ground state is disordered. But, the nature of this disordered ground state is unclear. While the numerical data seem to show that the chains are disconnected, the possibility of a genuine disordered two-dimensional state, hidden by finite size effects, cannot be excluded.

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