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Numerical contractor renormalization method for quantum spin models SYLVAIN CAPPONI, Laboratoire de Physique Theorique, Toulouse, ANDREAS LAEUCHLI, IRRMA - EPFL, Lausanne, MATTHIEU MAMBRINI, Laboratoire de Physique Theorique, Toulouse — We demonstrate the utility of the numerical contractor renormalization (CORE) method for quantum spin systems by studying one- and two-dimensional model cases. Our approach consists of two steps: (i) building an effective Hamiltonian with longer ranged interactions up to a certain cutoff using the CORE algorithm and (ii) solving this new model numerically on finite clusters by exact diagonalization and performing finite-size extrapolations to obtain results in the thermodynamic limit. This approach, giving complementary information to analytical treatments of the CORE Hamiltonian, can be used as a semiquantitative numerical method. In two dimensions we consider the plaquette lattice and the kagom lattice as nontrivial test cases for the method. As it becomes more difficult to extend the range of the effective interactions, we propose diagnostic tools (such as the density matrix of the local building block) to ascertain the validity of the basis truncation. On the plaquette lattice we have an excellent description of the system in both the disordered and the ordered phases, thereby showing that the CORE method is able to resolve quantum phase transitions. On the kagom lattice we find that the previously proposed twofold degenerate S=1/2 basis can account for a large number of phenomena of the spin 1/2 kagom system.

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