Diagrammatics for SU(2) invariant matrix product states

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We report on a systematic implementation of su(2) invariance for matrix product states (MPS) with concrete computations cast in a diagrammatic language. As an application we present a variational MPS study of $su(2)$ invariant quantum spin systems. For efficient computations we make systematic use of the su(2) symmetry at all steps of the calculations: (i) the matrix space is set up as a direct sum of irreducible representations, (ii) the local matrices with state-valued entries are set up as superposition of su(2) singlet operators, (iii) products of operators are evaluated algebraically by making use of identities for $3j$ and $6j$ symbols. The remaining numerical computations like the diagonalization of the associated transfer matrix and the minimization of the energy expectation value are done in spaces free of symmetry degeneracies. The energy expectation value is a strict upper bound of the true ground-state energy and yields definite conclusions about the accuracy of DMRG results reported in the literature. Furthermore, we present explicit results with accuracy better than 10^{-4} for nearest- and next-nearest neighbour spin correlators and for general dimer-dimer correlators in the thermodynamical limit of the spin-1/2 Heisenberg chain with frustration.

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