Searching for moiré-induced quantum spin liquid - the DMRG and ED study of twisted TMD hetero-bilayers

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Quantum spin liquid (QSL) is an exotic, highly correlated phase of matter characterized by the absence of long-range order and extremely large entanglement. The most intriguing property of QSL is its ability to support non-local excitations [1]. Such a phase occurs in frustrated triangular lattices and can be described by the Hamiltonian with four-spin terms [2].

Twisted hetero-bilayers of transition metal dichalcogenides are advantageous platforms for the study of correlated phases. Due to the mismatch between the lattice constants and a nonzero twist, a new periodicity called the moiré pattern arises in such materials, which can be effectively described by the Hubbard model on the triangular lattice [3,4]. For a range of twist angles, analyzed by us in previous work [5], moiré TMD materials at the half-filling can also be adequately described by the spin Hamiltonian.

In our work, we study finite structures craved from twisted TMD hetero-bilayers described by a spin Hamiltonian with four-spin terms. Using the DMRG method, we search for the range of parameters for which the QSL phase occurs and compare it with the results from the exact diagonalization analysis. In addition, we investigate the entanglement entropy of ground states.

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