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BIPARTITE ENTANGLEMENT IN THE SPIN-1/2 ISING-HEISENBERG PLANAR LATTICE CONSISTING OF INTER-CONNECTED TRIGONAL BIPYRAMIDS

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The present work deals with the exactly solvable spin-1/2 Ising-Heisenberg model on an infinite but regular two-dimensional lattice composed of identical inter-connected bipyramidal plaquettes with the aim to clarify a bipartite entanglement between the Heisenberg spins at zero as well as finite temperatures. The quantity called concurrence is used as an indicator for determining a strength of this quantum-mechanical correlation.
It is demonstrated that the Heisenberg spins of each bipyramidal plaquette can be mutually entangled at zero temperature only if the two-fold degenerate spontaneously ordered quantum phase characterized by a symmetric quantum superposition of three possible up-up-down (or down-down-up) states of these spins is stable. Otherwise, the bipartite quantum entanglement of the Heisenberg spins is totally absent. Interestingly, the entanglement between the Heisenberg spin pairs persists also at finite temperatures, even far above the critical temperature of the model if the exchange anisotropy between these spins is sufficiently strong. The entangled Heisenberg spin states can also be thermally activated above non-entangled ground state if the values of the exchange anisotropy parameter are taken sufficiently close to the boundary with the quantum ground-state phase.

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