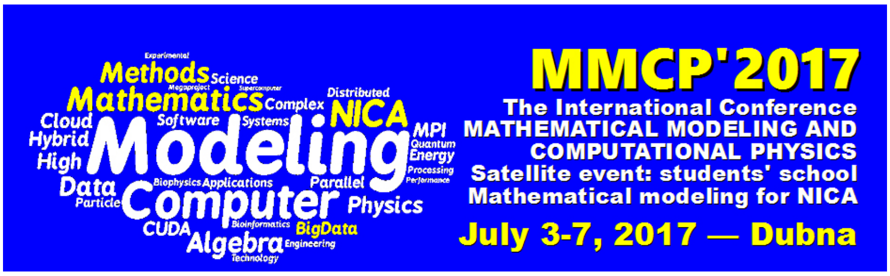

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Entanglement and quantum state transfer in spin chains with XY-Hamiltonian

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We investigate quantum state transfer [1] and quantum entanglement [2], emerging in this process, in spin chains. We consider a quantum system, consisting of N spins, connected by the XY-Hamiltonian in the approximation of the nearest neighbor interactions [3]. Initially the spin chain is in the thermodynamic equilibrium state. Magnetic resonance methods allow us to create a pure state of the first chain spin, which is called the sender. As a result of the evolution under the action of the XY-Hamiltonian, the pure quantum state transmits along the chain to its end. The last chain spin is called the receiver. A quality of the quantum state transfer is estimated by fidelity [4]

$F=\langle\psi|\chi|\psi\rangle$ (1)

where $|\psi\rangle=a|0\rangle+b|1\rangle$ is the transmitted quantum state (a, b are complex numbers, $|a|^2+|b|^2=1$), χ is the reduced density matrix over all spins besides the receiver. We evaluate analytically a quality of the transferred state with fidelity between the sender state and the receiver one.

We found also that the quantum entanglement between the sender and the receiver emerges in the transmission process. We investigate numerically the dependencies of entanglement on parameter |b| and the temperature by simulations with the computational program “Mathematica”. We use concurrence [5] for the estimation of quantum entanglement in the system. We found the critical temperature of emerging entanglement. We established that the critical temperature depends on the polarization of the initial pure state. It is shown that the critical temperature decreases with increasing parameter |b| at small |b|. However, the critical temperature increases with increasing |b| at large values of |b|. A break point between regions of increasing and decreasing the critical temperature does not depend on the number N of spins in the chain.

Time of emerging entanglement grows with increasing N in the considered quantum system.

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Short biography note

I am graduated from Faculty of Physics of Moscow State University in 2004. Then I started to work at IPCP RAS in the laboratory of spin dynamics and spin computing. In this laboratory I defended my PhD in 2010. Now I am senior researcher in this laboratory. My scientific interests are connected with the quantum information theory.

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