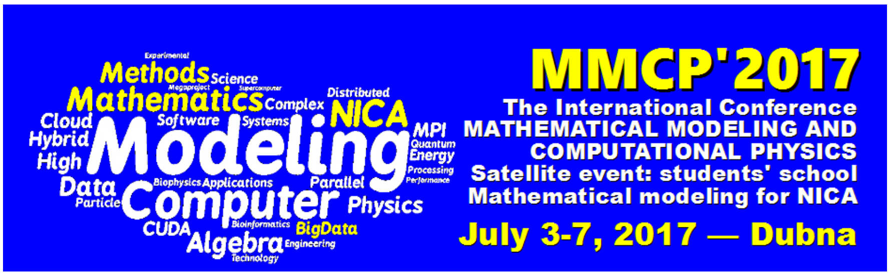

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Quantum correlations in bipartite systems

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Quantum correlations are different from all other correlations in many-particle systems. They depend on measurements. Quantum correlations are responsible for the advantages of quantum devices over their classical counterparts and ensure efficient work of all quantum devices, including quantum computers. Entanglement is a measure of quantum correlations for pure states. According to the current understanding, total correlations, classical and quantum, can be described by the mutual quantum information [1, 2]. In order to separate quantum and classical correlations, one should perform a total system of projective measurements over one of the subsystems of a bipartite system [1, 2]. As a result of those measurements, at least a part of quantum correlations disappears. Performing minimization of the quantum conditional entropy over all possible total sets of projective measurements, one can annihilate all quantum correlations and separate the contributions of classical and quantum correlations to the mutual quantum information. The contribution of quantum correlations to the mutual quantum information is called quantum discord [1].
The calculation of quantum discord is a very difficult problem because it requires complex optimization. The problem can be solved in general bipartite systems only with numerical methods. We consider here some cases where quantum discord can be found analytically [3,4].
First we consider quantum correlations in a bipartite heteronuclear (N-1)x1 system in an external magnetic field. The system consists of a spin ring with an arbitrary number N-1 of spins on the ring and one spin in its center [3]. The spins on the ring are connected by the secular dipole-dipole interaction (DDI) and interact with the central spin through the Heisenberg zz-interaction. We show that quantum discord can be obtained analytically in the high-temperature approximation. The model allows us to find contributions of different parts of the spin-spin interactions to quantum correlations [3].
We investigate also [4] quantum correlations in a two-spin system with the DDI in NMR multiple-pulse spin locking experiments [5]. We demonstrate that quantum correlations are absent in the multiple-pulse spin-locking with $\pi/2$-radio-frequency pulses even at long times. At the same time, entanglement emerges after several periods of the pulse sequence with $\pi/4$-radio-frequency pulses. We demonstrate the dependence of entanglement on the number of periods of the multiple-pulse sequence. Quantum discord is obtained for the multiple-spin-locking experiment at different temperatures [6].
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Short biography note

I am working as the Head of the Theoretical Department of the Institute of Problems of Chemical Physics of RAS. My scientific interests are theory of magnetic resonance and quantum information theory. I am a Professor and Doctor of Science (Physics).

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