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# ABSTRACTS

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# On the decoherence in large NMR quantum registers

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At present, great progress has been made in the construction of so-called NISQ-era devices [1, 2] (Noisy Intermediate-Scale Quantum). Unlike full-scale quantum computers, NISQ-computers will not be protected by quantum error correction, and noise severely limits the scale of computations (quantum register size) that can be executed accurately using NISQ technology. The rate of decoherence under the action of dipole-dipole interaction (DDI) over the evolution period of large quantum registers was studied experimentally in adamantane by the method of multiple quantum (MQ) NMR spectroscopy of solids [3]. The dependence of the decoherence rate on the order of coherence $M$ and on the size $\bar{K}$ of the average cluster of dynamically correlated spins, which is formed as a result of two-quantum-two-spin interaction in the preparatory period, has been revealed. The first phenomenological explanation of the measured dependences was given in Ref. [4]. The authors proposed to divide the field from the DDI with the spins of the cluster into correlated and uncorrelated parts. Using the decomposition, a the signal from the MQ spectrum component is presented as the sum of two terms from spins, the dynamics of which is determined by either the correlated field or the uncorrelated field, respectively. The first term is a function of the order of coherence $M$, and the second term is a function of the average number of spins in the cluster $\bar{K}$. The degree of correlation is set by the ratio of the amplitudes of two terms. Despite the similarity of the theoretical dependences and experimental results, the assumption about heterophase nature of the complex desired time correlation function needs to be substantiated in the homogeneous spin system of adamantane under consideration at high temperatures. The conjecture that the local field consists of two parts on each spin, but not at different spins is more natural and long used for explanation the dynamics of the nuclear spin system in solids [5, 6]. In the present work, we perform a theoretical analysis results obtained in Ref. [3, 4]. The proposed theory takes into account the distributions of clusters of dynamically correlated spins that form during the preparatory period, according to the number of spins in the cluster $K$ [6] and according to their structure (perimeter [7] and density). The observed MQ spectrum is the sum of the MQ spectra from different clusters. The contribution to the sum from a cluster of $K$ spins will be represented by a Gaussian MQ spectrum with a dispersion of $K/2$, multiplied by the weight function and by the function [6], which describes the degradation of the cluster under the action of DDI over the evolution period [3]. The latter is represented by the product of two factors from two contributions to the local dipole field. The rate of degradation from the uncorrelated contribution depends on the cluster size $K$. The rate of the correlated contribution depends on $M$ and on the structure of the cluster. Good agreement is obtained between the theoretical and experimental dependences of the decoherence rates in adamantane. The parameters of the above functions are found from the comparison of these dependences.

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