# Dynamics of entanglement of two singlet-tripet qubits in GaAs-AlGaAs heterostructure

**Igor Bragar and Łukasz Cywiński**

*Laboratory for Cryogenic and Spintronic Research, Institute of Physics, Polish Academy of Sciences, al. Lotników 32/46, Warszawa, Poland*

A singlet-triplet (S-T) qubits is a promising realization of a spin qubit [1], in which a quantum state of the qubit is stored in the joint spin state of two electrons located in two quantum dots. Specifically, the two states of the logical qubit are the singlet $|S\rangle$ and spin-unpolarized triplet $|T_0\rangle$ two-electron states. Recently it has been shown that it is possible in the experiment to perform a procedure of entangling of two S-T qubits [2]. However, the states obtained in that experiment were not maximally entangled – due to interaction with environmental noise these states were partially mixed.

We present a theoretical analysis of factors that do not allow for obtaining a maximally entangled state of two S-T qubits. In particular, we consider the influence of fluctuations of gradient of effective magnetic field (the Overhauser field due to the nuclei) between the two dots electrons in a qubit, $\Delta B_z$, as well as fluctuations of the exchange splitting between $|S\rangle$ and $|T_0\rangle$ states, $J$, on the efficiency of entangling procedure.

First we consider the influence of these two factors on free evolution decay (FID) signal as well as on echo signal of a single S-T qubit. It turns out that even quasistatic fluctuations of either $\Delta B_z$ or $J$ lead to complete decay of the signal in the case of FID, while in the case of spin echo experiment the signal is only lowered proportionally to the level of quasistatic fluctuations.

The analysis of an entangling procedure of two qubits [2], in which a Hahn echo-like sequence of single-qubit rotations is employed in order to suppress the influence of environmental noise, shows that main obstacle to obtaining highly entangled states are fluctuations of two-qubit coupling, $J_{12} \propto J_1 J_2$, which cannot be removed by echo. We will present analytical and numerical calculations of decoherence and entanglement decay caused by fluctuations of $J_1$ and $J_2$ induced by random telegraph and $1/f$-like charge noise.

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[1] J. R. Petta et al., Science **309**, 2180 (2005).
[2] M. D. Shulman et al., Science **336**, 202 (2012).