Suppression of inhomogeneous broadening effects of qubit ensemble under optimized driving

Sergey V. Remizov[1,2], Dmitriy S. Shapiro[1,2], Alexey N. Rubtsov[1,3,4]

[1] *Dukhov Research Institute of Automatics (VNIIA), 127055 Moscow, Russia*
[2] *Kotel'nikov Institute of Radio-engineering and Electronics of Russian Academy of Sciences, 125009 Moscow, Russia*
[3] *Russian Quantum Center, Skolkovo, 143025 Moscow Region, Russia*
[4] *Department of Physics, Moscow State University, 119991 Moscow, Russia*

One of the crucial distinctions of artificial qubits from natural atoms is that their excitation energies are in many cases tunable *in situ* by external magnetic fields. The flip side of this tunability is unavoidable disorder in excitation frequencies and, as a consequence, inhomogeneous broadening of the density of states in qubit ensembles. This effect is related to fundamental mechanisms such as an exponential dependence of excitation energy on Josephson and charging energies in superconducting qubits or spatial fluctuations of background magnetic moments in systems based on NV-centers in diamonds.

It is known a number of methods to suppress the effect of disorder, such as an atomic frequency comb (AFC) which is based on a frequency-selective optical pumping and subsequent transitions to metastable auxiliary hyperfine states or cavity protection' effect related to a decreasing of relaxation rate of collective qubit modes proportional to the spectral broadening.

We propose another universal technique of effective suppression of inhomogeneous broadening in spectral density of realistic qubit ensemble coupled to transmission line[1]. Our technique is based on applying of optimally chosen electromagnetic pulse with smooth envelope. We study excitation dynamics of an off-resonant qubit subjected to a strong classical electromagnetic driving field with a large reference frequency and slow envelope. Within this solution we optimize the envelope to achieve a preassigned accuracy in qubit synchronization.

This technique can be applied to excite qubits as well as to prepare entangled states of the inhomogeneously broadened qubits.

[1] S. V. Remizov, D. S. Shapiro, A. N. Rubtsov, "Synchronization of qubit ensemble under optimized π-pulse driving", Phys. Rev. A **92**, 053814 (2015).