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Geometrical Effects in Noise Spectra of Superconducting Flux Qubits[1] ANDRE PETUKHOV, NASA Ames Research Center, Moffett Field, California, VADIM SMELYANSKIY, Google Inc, Venice, California, JOHN MARTINIS, University of California, Santa Barbara and Google Inc, Santa Barbara, California — We present theoretical study of geometrical effects related to spin diffusion in superconducting flux qubits. We adopt a model of a long superconducting wire surrounded by a thin oxide layer with spins distributed uniformly over cross-sectional area of the oxide layer. Using a continuous transformation from a round cylinder to a flat wire strip, we demonstrate that the noise spectral density tends to a power law $S(\omega) \propto (\omega/\Gamma)^{-s}$ with $s \gtrsim 3/4$, approaching $s = 3/4$ for very thin wires. The ω^{-s} dependence is valid in a broad frequency range above $\omega \gtrsim \Gamma$ stretching up to four orders of magnitude in units of characteristic diffusion decay rate $\Gamma \sim 1 - 10^2$ Hz. The effect is highly sensitive to a cross-sectional aspect ratio of a thin wire thus revealing its geometrical origin. We substantiate our findings by detailed comparison with available experimental data and conclude that 3/4 power law distinguishes spin diffusion flux noise from generic "$1/f$" family.

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