Experimental demonstration of motional averaging in a transmon

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When the transition frequency of a two-level quantum system is randomly jumping between two values $\pm\delta$, the shape of this system's spectrum is dependent on the average jumping frequency Ω. For $\Omega^2 \ll \delta^2$, there are two spectrum lines with the same linewidth 4Ω and a separation 2δ; for $\Omega^2 \gg \delta^2$, there is only one spectrum line with a linewidth δ^2/Ω. This phenomenon is known as motional averaging in NMR.[1] We observe this phenomenon (see also [2]) experimentally in a circuit QED[3] system which consists of a transmon qubit[4] and a superconducting coplanar waveguide (CPW) resonator. With nonrandom (square and sinusoidal) modulations of transmon's transition frequency, we also observe Landau-Zener-like interference pattens. The experimental data is in good agreement with numerical simulations.

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[3]A. Wallraff *et al.*, Nature (London) **431**, 162 (2004).
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