New Insights in Low-Frequency Excess Flux Noise of Superconducting Quantum Devices

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***Abstract*– Low-Frequency noise impairs the performance of a variety of devices that are based on superconducting quantum circuits. This includes not only superconducting quantum interference devices (SQUIDs) but also flux or phase qubits, low-temperature particle detectors such as metallic magnetic calorimeters or superconducting microwave resonators. However, in contrast to the frequency appearance, the underlying physical processes creating low-frequency noise are often not well understood. This applies in particular to low-frequency excess flux noise which currently limits the coherence time of flux or phase qubits or makes SQUID-based high-precision measurements of low-frequency signals challenging.**

Recent experiments suggest that low-frequency excess flux noise in Josephson junction based superconducting quantum devices (SQDs) originates from the random reversal of interacting spins located in surface layer oxides or in the interface between the substrate and the SQD wiring. Though this explanation proves to be generally correct, the physical nature of these spins, i.e., their origin as well as their interaction mechanisms, has not been revealed so far and many open questions remain.

In this presentation, we discuss our most recent measurements which we performed to shine light on the origin of low-frequency excess flux noise. More precisely, we discuss a comprehensive analysis of the low-frequency energy sensitivity of more than 80 superconducting quantum devices. This analysis revealed a hint for the existence of a material and device type dependence of low-frequency excess flux noise. In addition, we find that SQUID arrays mostly feature higher noise exponents than single SQUIDs. This result facilitates to engineer the shape of magnetic flux noise spectra and thus to modify key SQD properties such as coherence of measurement times.

***Keywords (Index Terms)*– superconducting quantum interferences devices, flux qubits, phase qubits, low-frequency excess flux noise, superconducting quantum devices, noise analysis.**

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