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Identifying and Controlling Sources of Decoherence In Superconducting Quantum Devices.

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Despite the promises of superconducting qubits, their performance is presently limited by short coherence times due to defects intrinsic to materials. As a result, future quantum computers would require massive error correction circuits, which seem to be very challenging to build. Another more promising path would be to improve this coherence time, which would relax the constraints on the quantum error correction circuits and would thus make a quantum computer more feasible. This task is considered one of the main challenges in the field. Our recent results [1] gave vital clues to the long-standing problem of noise and decoherence in superconducting devices: a technique for on-chip Electron Spin Resonance (ESR) [2], allowed to identify, for the first time, the chemical species responsible for the flux noise in superconducting circuits [3]. Furthermore, the most recent noise measurements in superconducting resonators point to the link between charge and flux noise in superconducting circuits [3]: a mild sample treatment has lead to tenfold reduction of the surface spins, responsible for the flux noise, as evidenced by ESR, and this treatment has also lead to tenfold reduction of the low frequency noise in superconducting resonator, usually associated with the charge noise. The chemical identification of the possible remaining sources of noise in superconducting devices allows for an active chemical intervention, aiming at silencing the defects and, therefore, improving the coherence in superconducting quantum devices.

[1] Phys. Rev. Lett. 118, 057703, (2017) [2] Journ. of Appl. Phys. 112, 123905, (2012) [3] Phys. Rev. Lett. 118, 057702, (2017) [4] Nature Comms. 9, 1143, (2018)

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