Strong coupling of a superconducting flux qubit to single bismuth donors

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The realization of a quantum computer represents a tremendous scientific and technological challenge due to the extreme fragility of quantum information. The physical support of information, namely the quantum bit or qubit, must at the same time be strongly coupled to other qubits by gates to compute information, and well decoupled from its environment to keep its quantum behavior.

An interesting physical system for realizing such qubits are magnetic impurities in semiconductors, such as bismuth donors in silicon. Indeed, spins associated to bismuth donors can reach extremely long coherence times - of the order of seconds. Yet it is extremely difficult to establish and control efficient gates between distant spins.

Here we experimentally demonstrate a protocol where single bismuth donors can coherently transfer their quantum information to a superconducting flux qubit, which acts as a mediator or quantum bus. This superconducting device allows to connect distant spins on-demand with little impact on their coherent behavior.

References

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Figures

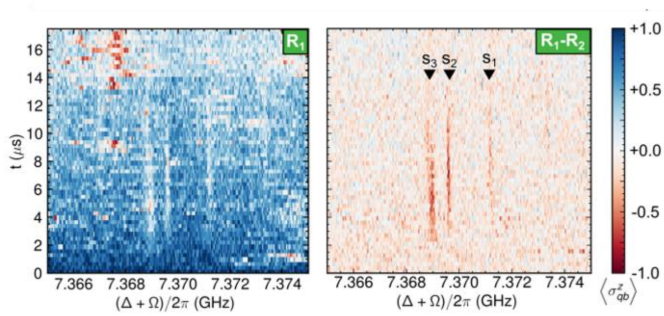

Figure 1: Detection of single bismuth donors (s1, s2, s3) by using a superconducting flux qubit. The coupling between the two systems is controlled by driving the flux qubit at its resonance frequency Δ/2π with an amplitude Ω and during an interaction time t. The signal from bismuth donors is filtered from the background by using their long relaxation properties.