Spin dependant recombination study of bismuth in silicon


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Bismuth in silicon is one of the main candidates as a possible qubit for a scalable quantum computer. It has a long coherence time, similar to phosphorus, making it ideal as a quantum memory, and its typical EPR frequency range at low magnetic field allows for a coupling to superconducting circuits for fast computation [1].

In this regard, we present a study of the spin properties of bismuth in silicon by making use of the spin dependant recombination mechanism [2]. Of particular interest are the low magnetic field properties of the system, as superconducting qubits need to be operated below their critical field, and the properties of ionized bismuth, as it is the ideal state for information storage [3].

Therefore, we first show that it is possible to successfully induce both electron spin and nuclear spin transitions at low magnetic field, so that bismuth in silicon can be used jointly with superconducting qubits [4].

Then, we studied the nuclear transition of ionized bismuth individually, through a modified ENDOR technique, which makes use of the spin dependant recombination process [5]. Their position reveals a chemical shift of ionized bismuth in silicon. A spread in g factor is also observed, probably due to the interaction with $^{29}$Si spins, as it is a natural silicon sample.

A further study in $^{28}$Si could yield some information about the electric quadrupole of the bismuth nucleus; as a realistic quantum computer model using ionized bismuth spin states for information storage would most likely include electrical gates for electron manipulation, the phase shift induced on ionized bismuth spin states by such gates could then be estimated [6].

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