Measurement and simulation of exchange interaction in CMOS spin qubits

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Exchange interaction is at the core of 2 qubit operations in the Loss-DiVincenzo encoding of spin qubits. In this context, it is important to understand and eventually predict its behaviour with simulations tools.

In this poster, we present measurement of exchange energy in CMOS quantum dot array fabricated in 300mm foundry. More precisely, we have isolated a double quantum dot read by gate-based reflectometry [1][2]. We measure the evolution of the exchange energy between two or four electrons as a function of the detuning and the confinement using spin manipulation protocols.

In parallel, numerical device simulations are made to estimate exchange interactions in these devices. We make use of a combination of the Full Configuration interaction (FCI) method and analytical models to reproduce and understand better experimental results.

The combination of experiment and simulation have improved our ability to predict and control the exchange interaction in CMOS spin qubits. A better understanding of the physical properties specific to exchange interaction is key for the integration of two qubits quantum logic gates on FDSOI spin qubit devices.

References

[1] Yang, C.H., et al. Nature 580, 350–354 (2020)

[2] F. Vigneau et al, Applied Physics Review 10, 021305 (2023)

Figures

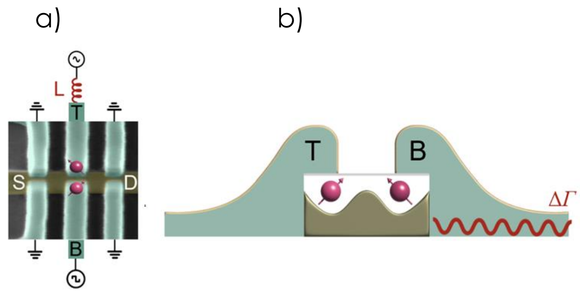

Figure 1: a) SEM micrograph of the device comprising 6 split gates. The rightmost and leftmost gates are closed to isolate the DQD from reservoirs. The device is fabricated in the CEA-LETI industrial foundry using FDSOI (fully depleted silicon on insulator) technology. (b) Artistic cross section of the device with the double dot formed between the two split-gates.

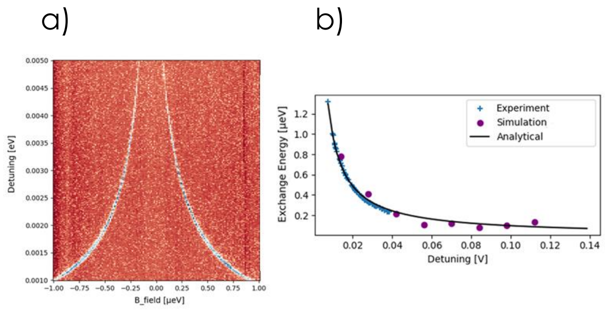

Figure 2: a) Measurement of exchange interaction as function of detuning with a tunnel coupling *tc* equal to 31 µeV. (b) Comparison of experimental exchange with FCI simulations and analytical model.