Hole spin manipulation by hopping in the presence of disorder

Ana Sempere-Sanchis[1]
Biel Martínez[2], José C. Abadillo-Uriel[3] and Yann-Michel Niquet[1]

[1] *Univ. Grenoble Alpes, CEA, IRIG-MEM-L_Sim, F-38000, Grenoble, France.*
[2] *Univ. Grenoble Alpes, CEA, Leti, F-38000, Grenoble, France.*
[3] *ICMM, CSIC, San Juana Inés de la Cruz 3, 28049, Madrid, Spain.*

ana.semperesanchis@cea.fr

In the quest of a spin qubit quantum computer, variability and power consumption are two main bottlenecks for scalability. In this context, spin manipulation by hopping has recently been proposed as a promising strategy for hole spin qubits [1]. This mechanism indeed uses variability as an asset and enables efficient spin manipulation with baseband control by taking advantage of the scattering of the spin precession axes caused by disorder for pairs of nominally circular QDs (Fig. 1a). However, the requirement of disorder for spin manipulation raises concerns regarding its compatibility with the long-term evolution of spin qubits devices, which look for higher quality materials and cleaner interfaces. In this work [2], we show with numerical simulations how the implementation of this technique can indeed become challenging when the level of disorder is reduced. Instead, we propose an alternative, disorder-independent manipulation strategy that consists on hopping between intentionally squeezed QDs (Fig. 1b), which improves robustness and scalability prospects (Fig. 2).

References

[1] Chien-An Wang et al., Science 385, Operating semiconductor quantum processors with hopping spins (2024) 447- 452.
[2] B. Martinez, A. Sempere-Sanchis et al., In preparation (2026)

Figures

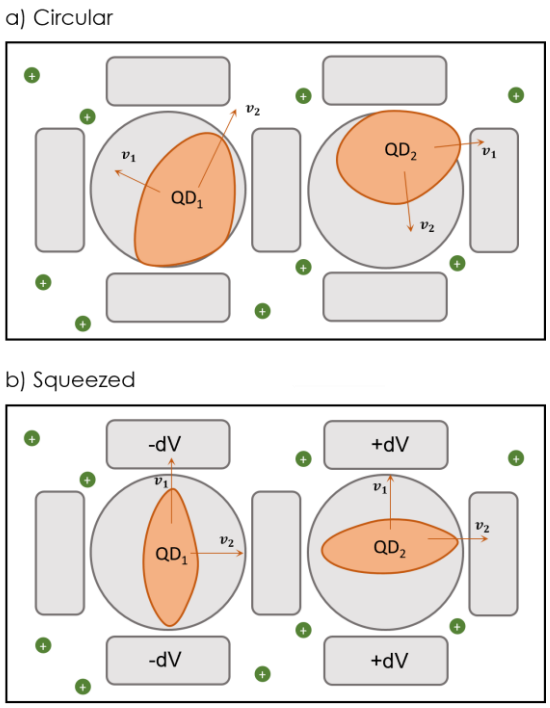

Figure 1: Schematic representation of a pair of (a) nominally circular and (b) electrostatically squeezed QDs (in orange) in the presence of charge traps (in green). The grey shapes highlight the gate layout and the orange arrows indicate the magnetic axis v_1, v_2.

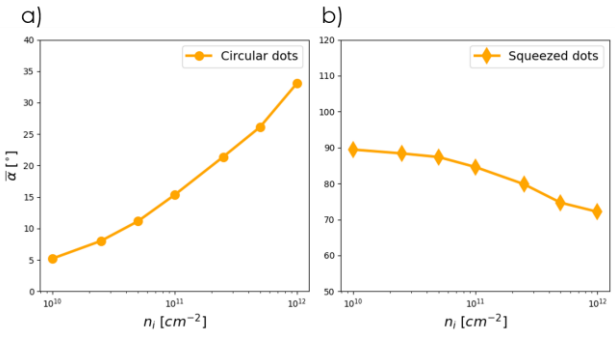

Figure 2: Median of the angle between quantization axes (α) of (a) circular and (b) squeezed QDs as a function of the charge trap density n_i.