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Quantum control of donor electron charge and spin in Si close to a Si-SiO_2 interface

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Doped Si is a promising candidate for quantum information processing due to its potential for scalability, long spin coherence times, and the continuing progress on Si material processing, technology and miniaturization over several decades. I will discuss important issues for single- and two- qubit operations in Si-based quantum computer proposals involving P donors close to a SiO_2 interface. For a single donor, donor-bound electron manipulation between the donor and the interface by electric and magnetic fields is investigated [1,2]. Valley interference and how it affects a donor electron close to an interface under an applied electric field is also considered, taking the valley-orbit coupling at the interface as a parameter. It will be shown that, for nonzero interface valley-orbit coupling, this configuration leads to oscillatory behavior of the donor ionization time as a function of the donor-interface distance while the characteristic ionization field does not oscillate with distance [3]. The physical origin of these effects, and their impact in proposed operations of donor-based qubits, will be discussed. For a donor pair, the exchange coupling of interface electrons bound to the donors double well potential is calculated within the Heitler London approach [2,4]. The feasibility and convenience of performing exchange operations for electron pairs at the interface as opposed to around the donors will be assessed. Work done in collaboration with M.J.Calderon and S. Das Sarma and partially supported by LPS-NSA and MICINN-Spain.

[1] M.J. Calderon, B. Koiller, X. Hu, and S. Das Sarma, Phys. Rev. Lett. 96, 096802 (2006).
[2] M.J. Calderon, B. Koiller and S. Das Sarma, Phys. Rev. B 75, 125311 (2007).
[3] M.J. Calderon, B. Koiller and S. Das Sarma, Phys. Rev. B 77, 155302 (2008).
[4] A. L. Saraiva, M. J. Calderon, and B. Koiller Phys. Rev. B 76, 233302 (2007).

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