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External field control of donor electrons at the Si-SiO_2 interface[1]

MARIA J. CALDERON, Condensed Matter Theory Center, Department of Physics, University of Maryland, BELITA KOILLER, Instituto de Fisica, Universidade Federal do Rio de Janeiro, Brazil, and Condensed Matter Theory Center, Department of Physics, University of Maryland, XUEDONG HU, Department of Physics, University at Buffalo, SUNY, SANKAR DAS SARMA, Condensed Matter Theory Center, Department of Physics, University of Maryland — Prospects for the quantum control of electrons in the silicon quantum computer architecture are considered theoretically. In particular, we investigate the feasibility of shuttling donor-bound electrons forth and back between the impurity in the bulk and the Si-SiO_2 interface by tuning an external electric field. We calculate the shuttling time to range from sub-picoseconds to nanoseconds depending on the distance ($\sim$ 10-50 nm) of the donor from the interface. For a certain range of parameters, the state at the interface is localized in all three dimensions, which allows to take the electron back to the donor. The size of the wave-function at the interface can be manipulated by applying a perpendicular magnetic field. Our results establish that quantum control in such nanostructure architectures should be achievable.

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