Electric-field driven donor-based charge qubits in semiconductors

BELITA KOILLER, Instituto de Fisica, UFRJ, Rio de Janeiro, Brazil, XUEDONG HU, University at Buffalo, SUNY, Buffalo, NY, SANKAR DAS SARMA, CMTC, Department of Physics, UMD, Maryland — We theoretically investigate donor-based charge qubit operation driven by external electric fields [1]. We consider initially a single electron bound to a shallow-donor pair in GaAs: This system allows the basic physics of the problem to be presented. In the case of Si, heteropolar configurations such as P-Sb\(^+\) pairs are also considered. For both homopolar and heteropolar pairs, the multivalley conduction band structure of Si leads to short-period oscillations of the tunnel-coupling strength as a function of the relative position of the donors. However, for any fixed donor configuration, the response of the bound electron to a uniform electric field in Si is qualitatively very similar to the GaAs case, with no valley quantum interference-related effects, leading to the conclusion that valley interference does not prevent the coherent manipulation of donor-based charge qubits by external electric fields. We also discuss the effect of perturbations due to additional distant donors. [1] B. Koiller, X. Hu, and S. Das Sarma, Phys. Rev. B 73, 045319 (2006)

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