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Tunnel coupling of charge qubits in semiconductor quantum computer architectures¹ BELITA KOILLER, Instituto de Fisica, Universidade Federal do Rio de Janeiro, RJ, Brazil, XUEDONG HU, Department of Physics, University at Buffalo, the State University of New York, Buffalo, NY, S. DAS SARMA, Condensed Matter Theory Center, Department of Physics, University of Maryland, College Park — Charge-based qubits in solid state quantum computer proposals have the attractive advantage of being relatively easy to manipulate and measure. We study the feasibility of P_2^+ charge qubits in Si, focusing on single qubit properties in terms of tunnel coupling between the two phosphorus donors. We take into consideration the multi-valley structure of the Si conduction band and show that valley interference could have important effects on the operations of P_2^+ charge qubits by producing a tunnel-coupling distribution centered at zero value. We conclude that the Si bandstructure significantly (and adversely) influences the tunnel coupling between the two phosphorous donors in terms of defining elementary charge qubits in the P_2^+ system in Si, since the energy splitting in these effective two-level systems is essential for quantum computation. We also critically compare charge qubits properties for Si: P_2^+ and GaAs double quantum dots and discuss effects of dot size variations.

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