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Effect of fixed charge gate oxide defects on the exchange energy of a multi-valley silicon double quantum dot[1]
RAJIB RAHMAN, ERIK NIELSEN, RICK MULLER, MALCOLM CARROLL, Sandia National Laboratories — Exchange interaction at the MOS interface has been proposed as a qubit coupling approach for both MOS quantum dots and donor qubits. An intrinsic source of disorder in the MOS system is the charge defects in silicon dioxide, nanometers away from the interface and qubit electrons. The presence of a charge defect so near the qubit can significantly perturb the confinement potential and alter the intended coupling. Using a large-scale atomistic tight-binding method coupled to a full configuration interaction technique, we investigate the role of these defects on the two-electron coupling of a double quantum dot (DQD) as a function of detuning bias. We show how the multi-valley character of silicon is manifested in the two-electron spectrum, and hence in the exchange energies of excited triplet states corresponding to different valley configurations. Our results show that defects near the tunnel barrier can adversely affect the tunability of the DQD, while defects distributed asymmetrically relative to the two dots can act as an additional detuning source.

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