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Spin Relaxation due to Charge Noise in Si Quantum Dot with Valley Splitting[1] PEIHAO HUANG, XUEDONG HU, State Univ of NY - Buffalo
— We study the relaxation of an electron spin qubit in a Si quantum dot due to charge noise. In particular, we clarify how the presence of the conduction band valleys influences the spin relaxation. In single-valley semiconductor quantum dots, spin relaxation is through the mixing of spin and envelope orbital states via spin-orbit interaction. In Si, the relaxation could also be through the mixing of spin and valley states. We find that this additional spin relaxation channel, via spin-valley mixing and charge noise, is indeed important for an electron spin in a Si quantum dot. By considering both spin-valley and intra-valley spin-orbit mixings and the charge noise in a Si device, we find that spin relaxation rate peaks at the hot spot, where the Zeeman splitting matches the valley splitting. Furthermore, because of a weaker field-dependence, the spin relaxation rate due to charge noise could dominate over phonon noise at low magnetic fields, which fits well with recent experiments.

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