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Valley-orbit hybrid states in Si quantum dots[1] JOHN KING GAMBLE, MARK FRIESEN, S.N. COPPERSMITH, Department of Physics, University of Wisconsin-Madison, Madison, WI 53706 — The conduction band for electrons in layered Si nanostructures oriented along (001) has two low-lying valleys. Most theoretical treatments assume that these valleys are decoupled from the long-wavelength physics of electron confinement. In this work, we show that even a minimal amount of disorder (a single atomic step at the quantum well interface) is sufficient to mix valley states and electron orbitals, causing a significant distortion of the long-wavelength electron envelope. For physically realistic electric fields and dot sizes, this valley-orbit coupling impacts all electronic states in Si quantum dots, implying that one must always consider valley-orbit hybrid states, rather than distinct valley and orbital degrees of freedom. We discuss the ramifications of our results on silicon quantum dot qubits.

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John Gamble
Dept of Physics, University of Wisconsin-Madison, Madison, WI 53706

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