Achieving fast, high fidelity gates of novel quantum dot qubits

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This talk will present theoretical work at the University of Wisconsin-Madison on optimizing the gate fidelity of novel quantum dot qubits. First, we will discuss our recent work on optimizing gates of the quantum dot hybrid qubit, which consists of three electrons in a double quantum dot and which can be viewed as a hybrid of a spin and charge qubit. This qubit has been implemented experimentally [1,2,3], and coherence times and gate speeds consistent with fidelities ∼99% have been demonstrated. Our recent work shows that fidelities of 99.9% with gate times of ∼1 ns are achievable by appropriate tuning and simultaneous driving of the detuning and the tunnel couplings [4].

Second, we will discuss the charge quadrupole qubit, a highly symmetric charge qubit formed in a triple quantum dot [5]. The unique design of the quadrupole qubit enables a particularly simple pulse sequence for suppressing the effects of noise during gate operations. Simulations yield gate fidelities 10-1,000 times better than traditional charge qubits, depending on the magnitude of the environmental noise [5,6]. Our results suggest that any qubit scheme employing Coulomb interactions (for example, encoded spin qubits or two-qubit gates) could benefit from such a quadrupolar design.

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