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Control and Measurement of an Exchange-Only Spin Qubit

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Gate-defined semiconductor quantum dots have proven to be a versatile testbed for exploring quantum systems and quantum information. We demonstrate the fast all-electrical control of a spin qubit using the two coherent exchange interactions in a triple quantum dot. Our measurements identify the role of nuclear spins from the host GaAs in this system as a mechanism for both dephasing and leakage out of the qubit subspace. We also show that by increasing both exchange interactions in a balanced fashion, we enter a second regime of operation. In this regime, leakage from the subspace has been suppressed, resulting in a spin qubit with a tunable electric dipole moment, which we refer to as the resonant exchange qubit.