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Theory of anisotropic exchange in laterally coupled quantum dots FABIO BARUFFA, Institute for Theoretical Physics, University of Regensburg, 93040 Regensburg, Germany, PETER STANO, Institute of Physics, Slovak Academy of Sciences, 84511 Bratislava, Slovak Republic, JAROSLAV FABIAN, Institute for Theoretical Physics, University of Regensburg, 93040 Regensburg, Germany — We consider an interacting pair of quantum dot electron spin qubits (a two electron double quantum dot). In this setup, two-qubit operations are generated by the (isotropic) exchange interaction, which results from the tunable inter-dot coupling. In the presence of spin-orbit interactions, additional effective inter-qubit coupling arises, termed anisotropic exchange. We show that in GaAs, where spin-orbit interactions are weak, the magnitude of the anisotropic exchange is proportional to the external magnetic field and therefore directly controllable, boosting prospects for spin-based quantum computing. We show how the form of anisotropic exchange follows from its spin-orbit origin and that its magnitude can be traced down to dipole moment matrix elements. Based on this findings, we propose an effective spin Hamiltonian suitable for practical modeling of two-electron spin dynamics. We prove the effective Hamiltonian quantitative accuracy confronting it with a microscopic numerical model.

[1] F. Baruffa, P. Stano, J. Fabian, Phys. Rev. Lett. 104, 126401 (2010)
[2] F. Baruffa, P. Stano, J. Fabian, Phys. Rev. B 82, 045311 (2010)

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