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Anisotropic exchange interactions between electron spins in coupled semiconductor quantum dots Ş.C. BĂDESCU, T.L. REINECKE, NRL Washington, DC, Y. LYANDA-GELLER, Purdue University, IN — Electron spins in semiconductor quantum dots (QDs) are of considerable interest for qu-bits in quantum computing. Quantum gates (QGs) can be obtained by pulsing the exchange interaction between two spins by external fields. The anisotropic parts of the exchange determine the pulse shapes and also provide a dephasing mechanism affecting the gate fidelity. We have derived an anisotropic term caused by the electron-electron interaction, by treating the Coulomb interaction and the $\mathbf{k}\cdot\mathbf{p}$ band mixing on an equal footing. This term arises from the coupling of spins in addition to single spin effects such as spin-orbit coupling, asymmetry of the confining potential, and inversion asymmetry of the bulk material. The anisotropic contribution obtained here can represent $\sim 10^{-2}$ of the isotropic exchange, which has a significant effect on gate shapes and fidelity. We use a general model of elliptically shaped dots in arbitrarily oriented magnetic fields. We give results for vertically coupled InAs/GaAs quantum dots and laterally coupled GaAs electrostatic dots, and we describe the operation of the XOR gates.

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