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Coherence and control of single electron spins in quantum dots¹

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Following our earlier work on single-shot read-out and relaxation of a single spin in a quantum dot, we now demonstrate coherent control of a single spin (detection is done using a second spin in a neighbouring dot). First, we manipulate the spin using conventional magnetic resonance. Next, we show that we can also rotate the spin using electric fields instead of magnetic fields. In both cases, 90 rotations can be realized in about 50 ns or less. We use these control techniques to probe decoherence of an isolated electron spin. The spin dephases in about 30 ns, due to the hyperfine interaction with the uncontrolled nuclear spin bath in the host material of the dot. However, since the nuclear spin dynamics is very slow, this dephasing can be largely reversed using a spin-echo pulse. Echo decay times of about 0.5 μ s are obtained at 70 mT. In parallel, we have started work on quantum dots in graphene, which is expected to offer superior coherence times. As a first step, we have succeeded in opening a bandgap in bilayer graphene, necessary for electrostatic confinement of carriers.

F.H.L. Koppens et al., Nature 446, 56 (2006).

K.C. Nowack et al., Science Express, 1 Nov 2007.

F.H.L. Koppens et al., arXiv:0711.0479.

J.B. Oostinga, Nature Mat., in press.

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